



Best Practice Guidance for Avoidance & Mitigation of Water Damage in Buildings Under Construction

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Author Mark Redding
 Account Manager Risk Engineering
 Mitsui Sumitomo
 mredding@msilm.com

1.0 Introduction

Over recent years the incidence (and magnitude) of water damage claims in the construction industry has been on the increase. The reasons for this increase are many and varied and the causes not always simple to tackle. Unfortunately, to date, the industry has failed to attempt any co-ordinated response to address the problem. The purpose of this document is to outline some of the ways in which the industry can attempt to tackle the root causes of the problem and also to suggest ways in which individuals can mitigate the effects of an incident should a loss occur.

Water damage losses can be divided into two main groups: weather related incidents and man made incidents (failure of heating/cooling and domestic water systems).

Listed below are some of the causes of recent losses and also factors that have contributed to the scale and magnitude of them:

- Increase in high rise, multi-tenant residential developments
- Failure of jointing systems allied to a preponderance of new plumbing materials and techniques
- Low standards of workmanship and a skills shortage within the industry, partly attributable to a lack of qualified workers and fewer apprenticeships. Also, and probably most importantly, there are no statutory or legal bars to working as a plumber in the United Kingdom
- Use of plastic plumbing (including plastic/copper interfaces)
- Absence of consistent installation and commissioning standards within the industry
- Losses occurring at night time in unattended or unmonitored buildings
- Inappropriate design features (in particular routing of pipe work and location of storage tanks) which have greatly exacerbated the problem
- Expensive and vulnerable fixtures and fittings (e.g. hardwood flooring) and the increased use of (water absorbent) plasterboard partitions
- Programme pressure leading to substantial internal works being carried out prior to the completion of the building envelope and commissioning of mechanical systems
- Lack of independent, on-site supervision
- The non-compatibility of components used within a system e.g. the mixing of UK and continental size fittings

There is no one solution to the problems currently being experienced but improvements in the three areas of design (designing out faults in systems and building layout), manufacture (removing the potential for fault to arise) and workmanship (improving standards of installation and site management) should all assist in reducing the number of water damage claims. Failing this, there are mitigation measures that can be instigated to reduce the effects of water damage should a failure still occur.

This document does not address the problems associated with river / coastal flooding or rising sea levels.

2.0 Design Considerations

2.1 The Problem

Certain design features, if not the initial cause of damage in themselves, can greatly exacerbate the nature and extent of damage. Through early involvement in a construction project i.e. at the design stage, it may be possible to identify and design-out certain unfavourable features. These features may include, for example: design and location of water tanks; jointing and location of water pipes; location of isolation valves; the use of porous cabling and open risers from the top (plant rooms) to the bottom of a building.

2.2 Solutions

2.2.1 Combined Service Risers. Combining water and electrical services in undivided risers is one of the most significant factors in increasing the extent and quantum of water damage losses. The solution is simple: they should be avoided. Once exposed to water, the majority of electrical and data cabling has to be replaced. Notwithstanding the direct financial burden of replacement, this often delays the completion of the project and brings with it associated costs. If this feature already exists, consideration should be given to installing leak detection within the riser.

2.2.2 Location of Water Tanks. Tanks should not be located above electrical switchrooms. All tanks should be bunded and provided with suitable drainage. Rooftop plant rooms require heating or lagging to pipes and tanks. High level alarms should be fitted to tanks. Shared plant rooms should be tanked and drained. Where possible tanks should be located in basements and water pumped upwards (though specific problems with this type of design must be appreciated; see 2.2.7). During construction works the isolation of booster pumps presents a cheap and simple method of mitigating the risk.

2.2.3 Shut-Off Valves. It is recommended that shut-off valves be fitted on every floor. This used to be the case but modern water systems do not always have these specified, mostly due to the cost implications. For very large floors, multiple valves may be required (something similar to fire zones on alarm systems). Valves should be readily accessible and clearly marked with the areas that they isolate. Consider position of isolating valves. Valve cupboards should be on a master key or access control system and readily accessible in emergencies.

2.2.4 Upstands at Riser Openings. Consider the provision of upstands (say 100mm high) at riser openings to prevent water that has escaped onto floor plates from flowing down service risers, especially those carrying electrical services.

2.2.5 Water Management Devices. A programmable device which is designed to detect extraordinary flows and automatically isolate the incoming supply. Such devices should be fitted to the incoming mains and at other appropriate strategic locations such as header tanks (depending on the design of the system). See section 7 for further details and the full benefits.

2.2.6 Routing of Pipework. Pipework should be routed to avoid sensitive areas such as data processing rooms. There is a tendency for fit-outs to be brought forward, especially in high rise buildings, exposing high value IT infrastructure. Pipework running through, or above, IT areas should be avoided or appropriate safeguards installed. Where unavoidable, the early use of drip trays and leak detection within the trays should be employed. Many failures are gradual rather than sudden so it is essential that access is available to all pipework after the construction of the

building has been completed. This may involve reconfiguring pipework runs or providing access hatches / removable panels where pipes are concealed behind walls and partitions.

2.2.7 Pressurised Systems. In order to free up lettable space at the top of a building, there is a tendency for designers to locate water tanks at basement level and distribute water via pump sets. In these “closed system” situations, minor interruptions or temporary disturbances to supply may allow air into the system (may be the result of a drain down or maintenance work). Failure to purge the pipework may result in a significant build up of pressure once the pumps are re-engaged. Careful design, supervision and the timely production of operating manuals may avert potentially catastrophic failures when excess pressure finds the weakest point of an installation.

2.2.8 System Selection. Careful consideration is required when selecting plumbing systems. This should be based on a risk assessment with relevant considerations to include the following: the standard of fitters likely to be employed; the level of on-site supervision; the potential for water damage; the location and accessibility of pipes once installed and the post loss mitigation measures planned.

3.0 Materials / Systems Selection

3.1 The Systems

The problems associated with the systems below are rarely down to manufacturer failure and primarily due to poor workmanship. However, failures are more prevalent in certain systems and this may be partly attributable to an assumption that they are so easy to use as to be almost foolproof: the truth is; they are not.

3.1.1 Plastic Glued Pipe Systems. Whilst this is a relatively new type of plumbing system, there is already a loss history associated with jointing failures. This is fundamentally a workmanship issue with work sometimes being entrusted to “unqualified personnel”. Problems may be caused by pipes not being fully engaged in joints, pipes being damaged prior to installation or insufficient quantities of glue being employed / insufficient coverage of glue (it is understood that joints should be rotated to ensure this occurs). The opportunities to carry out visual checks once the joints are formed are limited.

A large number of problems occur because the pipe end inserted into the fitting has been damaged in some way; this can create a leak pathway via the scratch or indent for water to pass. This type of damage can occur at various points throughout installation, right up to the final commissioning of the system and beyond.

3.1.2 Copper Crimped Joints. Pipes are inserted into a copper collar with an integral “O” ring which provides the water-tight seal; pressure is then applied to complete the joint. Generally this type of jointing performs better than the plastic types available (subject to installation and system design) though can fail if the tube is not inserted to the correct depth. The marking of pipes before the joint is made allows visual inspection of the finished joint to ensure pipes are inserted to the correct depth. Bespoke press-fit tools such as those produced for the “Yorkshire XPress” system allow even pressure right around the joint and have in-built fail-safe mechanisms which will indicate if insufficient pressure has been applied or the machine is incorrectly calibrated. Routine calibration ensures consistency. Problems can occur where pipes are inserted to insufficient depth and insufficient pressure applied to the full diameter of the joint. The Xpress system has a “Leak Before Press” feature meaning that assembled joints which have not been pressed will exhibit a leak during system testing which enables omissions to be rectified prior to commissioning.

3.1.3 Copper Compression Joints. The tendency is for plumbers to over-tighten threaded brass fittings, which rely on mechanical connection in order to achieve water-tightness. There is also the belief that a weeping joint can be overcome by simply nipping up the nut, which may solve the problem in the short term but can expose the system to failure further down the line. Over-tightening deforms the integral brass olive and also has the propensity to create stressing in the nut. In environments where condensation or moisture are likely to be present, chemically-induced cracking to the stressed brasswork arises resulting in sudden failure.

3.1.4 Plastic Push Fit Plumbing (and the plastic/metal interface). Poor workmanship (often due to the use of unskilled labour) is a major contributor with badly cut pipes, insufficient pressure applied around the full diameter of the joint, failure to engage the pipe to sufficient depth and inadequate testing being the primary causes of failure. Current loss history indicates that the plastic systems and also the interface of plastic and metal, are the most susceptible to failure.

The Hepworth system (the most common in the UK) which utilised a metal grab insert to secure the end of the pipe and an "O ring to create a watertight seal was subject to a number of failures due to insufficient insertion of the pipe into the joint. A redesign of the joint requiring the pipe to be pushed through the metal ring and then into to the "O" ring seems to have eliminated this cause of failure.

When copper pipes are fitted to plastic systems it is important that any work at the other end of the copper / plastic junction, i.e. the non-plastic end, is carried out before the copper / plastic connection is made. If not, heat from soldering may be conducted to the plastic 'O' ring in the joint, or corrosive flux may flow down and contaminate the 'O' ring. In both situations, the 'O' ring is likely to hold initially but degrade with time, leading to a leak forming after a few hours, days or weeks.

3.1.5 Threaded and Welded Joints. No significant loss history associated with joints that are either welded or threaded. These are generally found in pipes of larger diameter or in sprinkler systems with steel pipes.

3.1.6 Soldered Joints. Usually not as vulnerable to sudden or catastrophic failure; problems are more likely to manifest themselves as a gradual leak, which may be a problem if undetected for a long period of time. Problems can occur if the solder is not heated evenly, resulting in gaps in the joint, or overheating leading to solder flowing out of the joint and leaving gaps. A particular site experienced a series of leaks caused by a plumber who assembled copper systems (or rather sub-assemblies of copper systems) without soldering them as he went, then went back later and soldered them - when he was sure everything would fit; some were missed. The flux that was used dried out before the system was tested and was strong enough on its own to resist the short duration constant pressure test with cold water that was done during the commissioning phase. Later, when the system was in use (but prior to handover), either the fluctuating pressures in the pipes, or the heat from the hot water that the system was designed to carry, or a combination of both, caused the unsoldered joints to fail. In such circumstances, a system, or procedure, is required to verify that all joints have been soldered, particularly if systems (or parts of systems) are assembled before the soldering is carried out.

3.1.7 Thrust Blocks on Pressurised Systems. Right angled bends on pressurised water systems should be provided with a 'thrust block' to relieve the pressure on the bend. Failure to provide these, either in the design or omitting them on site, can result in the pipe pulling out of the nearest joint. This often occurs after the system has been pressurised & de-pressurised several times (a typical scenario during the testing and commissioning stage).

3.1.8 General. Other common errors include mixing components between piping systems. At a basic level, leaks might then be due to poor fit. However, less obvious issues include adhesives and lubricants designed for one system that actually degrade or corrode components in another system, again leading to delayed leakage. Incidents of copper pitting corrosion have

been found where sub-contractors have failed to flush out the line after final testing and the introduction of a chemical inhibitor to purge the system.

3.2 Solutions

3.2.1 Appropriate System Selection. Plumbing system selection should be subject to a risk assessment at the design stages, as would any other building system or material. Account should be taken of the building occupancy, the building's susceptibility to water damage (type and quality of finishing to be employed), the height of the building, drainage points, the quality of tradesmen to be employed, design input & supervision, testing/certification procedures and the presence of mitigation features (e.g. water management devices, bunding and leak detection). In-built system safety features should also be considered such as the Xpress "Leak Before Press" feature which causes the joints to weep, when tested, if they have not been crimped.

3.2.2 Competent Resources. Only professionally qualified plumbers should be permitted to work on water distribution systems (see 4.2). Where new systems are employed using different techniques or bespoke machinery, all operatives should be fully trained by the manufacturer supplying the system. Many of the suppliers of piping systems will come to site to deliver training free of charge. Training records should be kept for all trained personnel. On-site inspection and certification throughout the process, either by main contractor or an independent third party, is critical.

3.2.3 Quality Control. Pipes should be marked so that it is clear when they have been inserted to the correct depth. This applies to all push-fit, crimped and glued systems. Pipework can then be subject to a visual quality check prior to pressure testing. Pipes, whatever the material, should be cut with proprietary tools and all burrs removed prior to assembly of the joint. Sharp edges can damage water seals and "O" rings.

3.2.4 Off Site Fabrication. The welding of rising mains and other sections of pipework in a controlled environment off site should be considered.

3.2.5 Design Life of Plastic Systems. Plastic is prone to degradation over time and certain types can become brittle. Whilst this type of system is relatively new, failures resulting from degradation may become more common. System selection should take into account the operating environment (this should be factored into the risk assessment).

3.2.6 Standard Torque Values. Torque wrenches and torque settings should be used for all compression joint fittings. Where crimped systems are employed, only properly calibrated bespoke tools should be used in the assembly.

3.2.7 Pressurised Systems. Pipes can fail when subjected to undue stresses as a result of being filled with water. Ensure that there are adequate supports between joints and that thrust blocks are employed, especially at 90 degree bends. The design and future operating/maintenance procedures should allow for the removal of air to prevent excessive pressure build-up.

3.2.8 Visual Inspection / Leak Detection. All joints should be subject to a visual inspection following commission. In areas where access is not possible for visual inspection, consideration should be given to leak detection at strategic points e.g. at the feet of service risers. This should form part of a formal, documented procedure which should also include testing of the pipework, commissioning and, ideally, third party certification.

3.2.9 Compression Joints. Where these joints are found to be leaking, the use of hemp packing, in an attempt to rectify the problem, should be avoided as it merely clogs the thread and increases the stress level: the joint should be dismantled and refitted.

3.2.10 Plastic Pipe Installation. To avoid physical damage when installing plastic pipe systems, ensure the following:

- Take care in how and where the product is stored, retain pipe in protective packaging until it is to be used
- Never use an open bladed knife to remove the pipe packaging
- Always use the attached shielded blade tool to remove packaging and cut on the inside of the coil, thus enabling the pipe to be contained within the packaging until the last metre.
- When threading pipe through holes in stone, brick and block walls always use a pipe sleeve or alternatively a small piece of foam pipe insulation to protect the pipe from the rough surface
- Ensure exposed first fix pipework is protected after initial installation if further connections are to be made to the pipe. By simply pushing a temporary end protector onto the pipe, it ensures that no debris will enter the pipe and furthermore it will protect the pipe end from damage
- The melting point of polybutylene is approximately 125°C; direct contact with any naked flame, electric fire, or hot flue pipe, etc. will cause the pipe to melt
- Ensure long, horizontal runs of pipework are supported at appropriate centres. This is to avoid sagging (when filled with water) and rotation at the joint

3.2.11 Compatible Fittings. Only compatible components should be used as directed by the manufacturer. Combining UK and European approved parts has resulted in incompatibility and failure. Also, all components used should be listed in the Water Regulations Guide to be regarded as acceptable (some overseas components are not listed).

3.2.12 General. Only recommended chemicals, lubricants and jointing materials should be used. Unapproved, unspecified or untested materials often react unfavourably with the piping materials to bring about degradation of the material or failure of the mechanical joint.

4.0 Standards of Workmanship

4.1 The Problem

In contrast to work involving gas or electricity, there is neither statutory regulation of the plumbing industry (with the exception of mains pressure and unvented hot water systems) nor common acceptable standards against which to judge competency. It is believed that the standards of training within certain parts of the construction industry may be falling, with an influx of foreign workers and a reduction in the number of apprenticeships being offered possibly contributing to the decline. In addition, there appear to be no consistent installation or commissioning standards against which to judge best, or even acceptable, practice. Standards worked to are advisory rather than mandatory and, despite the requirement that the local Water Authority is bound to inspect all works, it is still not possible to identify every defect or deviation from accepted standards. Another important factor is the emergence of a myriad of new plumbing systems, each with its own merits, but also with its own set of inherent risks. Failure to follow the manufacturer's installation guidelines has been a major cause of failure in recent years.

Designers and main contractors have a role to play by ensuring that all personnel working on their project are adequately vetted & trained and their work subject to independent certification.

Addressing the problems associated with poor workmanship is one of the most difficult challenges facing both the construction and insurance industries and, until the government introduce licensing of plumbers and make the industry subject to statutory enforcement (as for gas fitters), the problems are likely to continue.

4.2 Solutions

4.2.1 Qualifications. The construction industry has made moves to improve skill levels through, for example, initiatives such as the Construction Skills Certification Scheme (CSCS) skills card system. The CSCS scheme is affiliated with a number of Industry bodies which means that it should be possible to employ appropriately skilled operatives in the relevant trade sector. For plumbing activities there are eight different skills categories, some with Blue and Gold levels requiring NVQ qualifications. On a cautionary note it appears that this requirement for qualifications can be circumvented by an endorsement from the employer.

There are a number of routes to obtaining a CSCS card;

1. Trainee card (registered for NVQ/SVQ)
2. Achieving NVQ levels 1 to 5
3. Completing indentured or employer based apprenticeship
4. Experienced worker route
5. Experienced technical, supervisor or manager route
6. Professional membership route

For plumbing activities there are 8 different skills categories, the applicable CSCS certification ranging from Gold (skilled worker or supervisor) down to Blue (experienced worker, skilled worker and experienced manager). The Red (trainee) and Green (basic site skills) would not be regarded as a sufficient measure of competence.

The Engineering Services SKILLcard (ESS) is affiliated to the pan-industry Construction Skills Certification Scheme (CSCS). The terms of affiliation ensure that the Engineering Services SKILLcard complies with the requirements and standards of CSCS and, therefore, there is no need for separate registration with the CSCS.

It is important that the appropriate level of qualification is sought (see 4.2.9) and that the skills of the operative match the nature of work that they are being employed to undertake.

4.2.2 Professional Affiliation. Industry bodies such as the Institute of Plumbing and Heating Engineers (IPHE), the Institute of Plumbing (IP), the Association of Plumbing and Heating Contractors (APHC) and the Heating and Ventilation Contractors Association (HVCA) are voluntary organisations which promote professional standards in their membership and provide assistance with training and development. The HVCA members are also subject to assessment and third party inspection to ensure their technical and commercial competence. Membership of such an organisation should be an indication of the quality of workmanship that can be expected.

4.2.3 Approved Contractor Schemes. Schemes such as the IPHE Approved Contractor Scheme and the Water Industry Approval Scheme (WIAPS) are voluntary and a similar guide to the quality of a company as is individual affiliation. Similar schemes are also run by some of the larger Water Authorities which also serve to indicate a level of professionalism. In Scotland and Northern Ireland SNIPEF is a government licensed scheme designed to increase the professionalism of Plumbers. In the absence of UK-wide statutory licensing (as found in other industry sectors), membership of these organisations should be regarded as a minimum standard when engaging Plumbers and Heating Engineers.

4.2.4 Apprenticeships and training. It is recognised within the industry that there are fewer and fewer apprenticeships available for all trades, including plumbing and heating. However, this route to competency is generally accepted as the best method. Those operatives undertaking apprenticeships will also have achieved NVQ level 3, City and Guilds Advanced Craft in plumbing, or equivalent qualification

4.2.5 Third Party Certification. At present there does not appear to be a route for third party certification of water distribution systems similar to that which exists for other systems such as sprinklers or fire detection. A process of either in-house (by the main contractor) or independent third party certification throughout the installation, testing and commissioning should be instigated. This is of particular importance where sub-sub-contractors may be engaged at a second or third tier level to execute much of the installation work and may lack the appropriate skills. Any procedure should be documented and auditable. Self-certification is no certification.

4.2.6 Industry Installation Standards & Codes. These should be regarded as minimum standards and should be clearly defined in all work specifications and contractual documents (the list below is not exclusive):

4.2.6.1 Water Supply (Water Fittings) Regulations 2000. The provisions of these regulations are explained in the “*Water Regulations Guide including the Water Byelaws 2000 Scotland*”. This document is the main guidance for the plumbing industry and should be regarded as a minimum standard for both component selection and standards of installation.

4.2.6.2 BS6700:2006 Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages : specification. This standard is referenced in the Water Supply Regulations and compliance with its provisions with regard to hot and cold water distribution will demonstrate compliance with the Water Supply Regulations. To be revised in the new BS EN 806.

4.2.6.3 HVCA Good Practice Guides. Work involving heating and ventilation should be carried out in accordance with the guidance documents produced by the Heating and Ventilation Contractors Association (HVCA).

4.2.6.4 CIBSE (Chartered Institute of Building Services Engineers) publish standards for various aspects of M&E work. They are an accepted industry standard and should be specified for the areas of work to which they are relevant.

4.2.7 Manufacturer’s Installation Standards. Strict compliance with design guidelines and manufacturer’s installation manuals should be observed. Any operatives working on a system should have received on-site training by the system supplier. Training records should be maintained by the main contractor. No matter what the nature of the system, installation work must only be carried out by qualified and trained personnel. Standards specified by the manufacturer often go beyond those laid down in the British Standards and other guidance documents so can often be regarded as “best practice”. The training courses will often be vetted by bodies such as the IPHE.

4.2.8 Equivalent Qualification. A major problem associated with the influx of foreign workers is comparing their skills and qualifications to those of the UK construction industry. UK NARIC is an organisation that maps equivalent world-wide qualifications (see section 8). Whilst this will allow a comparison of qualifications, it does not ensure that overseas workers have sufficient knowledge of UK regulations and standards. Water Authorities run training courses on the relevant UK regulations to be applied and this should be considered as a minimum requirement when overseas workers are employed.

4.2.9 *It is strongly recommended that persons employed to work upon water distribution systems have, as a minimum, a NVQ level 3 (or equivalent) and are affiliated to an industry body such as the IPHE, APHC or HVCA (see below). Where lower skilled workers are to be employed it is recommended that they at least hold a NVQ level 2 and have 18 months experience and also that they are supervised by more qualified personnel (a ratio of 1 to 4 is recommended). Stringent management standards are advised to ensure that contractors are in compliance with the appropriate, recognised standards; that all operatives understand the codes to which they must work and, finally, that a robust system of independent check and certification is in place to verify on-site standards of work. Management should ensure that the individuals or organisations that they employ are suitably qualified for the work they are undertaking (especially within niche areas of the market).*

5.0 Programme Management

5.1 The Problem

Weather-related losses are occurring due to contractual time pressures and the tendency to commence internal fit-out works prior to the completion of the external envelope.

Many of the water damage problems arise through a lack of awareness. Insurers, via the claims process, are notified of all water damage losses, receive full details from the loss adjuster's reports and consequently have extensive knowledge on how many of these incidents can either be avoided in the first place or, mitigated should they occur.

5.2 Solutions

5.2.1 Insurer Input. Involving the Insurer at the initial design stages rather than when systems are being installed and design features cannot be changed, will help to ensure that the optimum solution is achieved, not only for the construction period but also over the life of the building. Unfavourable features can be designed out and suitable systems, appropriate for a particular type of building, specified.

5.2.2 Phasing of the Works. Consider the phasing of works in relation to areas such as roofs, cladding, bunding, alarms and detection. Roof and cladding; internal works are more often being carried out prior to the building being watertight which causes problems, especially in high winds. Drainage is often installed early but is not always fully operational or connected to the mains in the early stages. Full functionality should be mandatory in vulnerable locations. Ensure bunding is complete and drainage from plant rooms connected before tanks are filled. Detection and alarms; aim to achieve early commissioning of sump pump alarms, leak detection, water management devices and also enabling of the facility to monitor these (often the Building Management System).

5.2.3 Water Management Plan. Establish a Plan for bringing in, handling and discharging temporary and permanent water supplies in the buildings under construction.

Water Management Plans should include designated water discharge points/routes, and should include supply/discharge of water from the following:

- Roof drainage systems (permanent & temporary)
- Sprinkler systems (filling, discharge, cleaning & flushing)
- HVAC systems (filling, discharge, cleaning & flushing)
- Temporary Welfare & Accommodation Facilities where set up inside the building

Temporary rising mains for use of wet trades should be tightly controlled with lockable discharge points. Water butts can be used to ensure only limited quantities of water are available inside the building. Wherever possible, a permanent supply should be installed in preference to a less reliable temporary mains e.g. through utilising a fire fighting water supply. Temporary water discharge pipes must not be placed in electrical (or other water-susceptible) service risers.

5.2.4 Switch Off Water Supply Outside Working Hours. It is good practice to switch off water supplies to a building outside of working hours and at night. In order to do this, a master valve should be located at an accessible location and a responsible person nominated to perform the task.

Security guards should also be made aware of the location of this valve so that they can check it is turned off outside working hours. In the event of unintentional discharge, they will also be able to cut off the supply by shutting the valve.

Where a boosted supply is installed, the booster pumps can be isolated, though consideration should be given to the effects of thrust pressure when these are turned back on: an engineering solution such as pressure reducing valves may be appropriate.

5.2.5 Drainage systems. Water surcharge often occurs where drains are blocked during the construction period. Consider the use of CCTV surveys before a reliance is placed on the downpipes and ground drains.

6.0 Commissioning

6.1 The Problem

There are variations in the standards for testing and commissioning of pipework and systems. AC systems are tested live, often unattended and at night time. Failure of joints at this stage have resulted in large amounts of water discharge and, in the absence of early warning or on-site monitoring, damage has been extreme.

6.2 Solutions

6.2.1 Installation standards. There are many standards relating to the various aspects of plumbing, heating and ventilation systems. The two primary guidance documents are the Water Supply (Water Fittings) Regulations 2000 (applicable to plumbing systems) and the HVCA Good Practice Guides. These should be used in conjunction with manufacturer's installation guides (and on-site training) to achieve the optimum solution.

6.2.2 Pressure Testing. Unfortunately, it is not possible to be prescriptive regarding pressures to be employed and the duration of testing required. Each system will have its own specific testing criteria to be met. However, the following general guidelines should be observed:

- Pipework should be subject to an initial air test followed by hydraulic testing
- Account needs to be taken of the daily variation in mains pressures when determining the "normal working pressures"
- Failure to test an installation to the correct pressure for the required duration may nullify the manufacturer's warranty (this applies to pressures and duration being too low as well as too high)
- Tests should never be conducted unattended
- Pressure testing should be witnessed by the main contractor or a nominated third party
- All sections of pipework should be certified to have met the test standard.
- Certificates should be issued for each section of pipework tested. There should be a third party responsible for auditing this paperwork

Industry recognised guidance documents should be regarded as the default position if manufacturer's guidance is not forthcoming e.g. **The Guide to Good Practice Site Pressure Testing of Pipework** produced by the HVCA and also **BS6700**. The HVCA produce a full range of guidance documents covering many aspects including testing procedures for a wide range of systems (see section 8 Useful Links)

6.2.3 Commissioning Procedures. Full commissioning tests should be carried out on systems in their entirety including all equipment and fittings at their working pressure, in line with equipment supplier's guidelines. A minimum commissioning period of 8 hours is recommended which should be attended for its full duration. It is also strongly recommended that water management devices are installed with audible signalling to provide a warning of failure in any part of the system. Commissioning should be carried out during the day when there is more

chance of a leak being detected and swiftly dealt with. Commissioning of systems when the building is vacant should be avoided at all costs.

6.2.4 Hot water. Systems designed to carry hot water will be subjected to enhanced thermal movements. Cold water tests may be insufficient to uncover leaks when the pipes are subsequently subject to thermal expansion induced by hot water.

6.2.5 Documentation. Once a system is complete there should be a full audit trail of all components used, the testing regime, commissioning procedures and approval certificates. The Water Authority will inspect all new-builds and issue a certificate of compliance which should be made available for third party audit.

7.0 Post Loss Mitigation

7.1 The Problem

Given that it is very difficult to fully verify the standards of workmanship prior to commissioning of water systems and check all joints, we also need to focus our efforts on limiting the extent of the damage once an incident has occurred. The problem of water damage is undoubtedly worsened by leaks going un-noticed for extended periods of time.

7.2 Solutions

7.2.1 Water Management Devices. Devices are available that can be programmed to shut the water supply down if water flows exceed pre-determined parameters; they can also be set to shut off water supplies outside working hours or when very small flows are detected. They have the facility to monitor normal water usage over a time period and can then be programmed to allow water to be shut-off at a very precise, pre-determined flow rate outside of the normal usage parameters. They are ordinarily fitted at the foot of large risers but can also be installed on a floor by floor, or a flat by flat, basis. There is also some benefit of installing them on header tanks of enclosed AC or heating systems. They are often fitted to individual flats as a water economy measure and can therefore provide protection to individual flats prior to occupation. Any device incorporated should be fitted with a battery back-up to ensure that it is effective during the testing and commissioning stage when power is often isolated for long periods. The cost of installation as part of the system design is minimal, retrospective installation is slightly more costly but still economic. A typical system is supplied by WaterGuard www.waterguard.co.uk The use of these devices is endorsed by many of the UK's largest Insurers.

7.2.2 Leak Detection. Leak detection can give effective early warning of burst pipes. Consideration should be given to early installation and commissioning, with temporary alarms, in areas such as bunds, the bottoms of risers, equipment rooms, around AC units and in vulnerable cable trays. In an unattended building, alarms should be linked to pagers and an emergency response plan put in place.

7.2.3 Emergency Procedures. Security guards can be trained to provide an early emergency response and shut down systems where appropriate. Un-manned sites may be able to benefit from remote monitoring of leak and flow detection. Guards are often left out of emergency planning procedures, even for fire. They need to be trained in how to respond to a number of situations. They may be able to see water damage occurring but do they know how to deal with it? Also required are: clear site plan and well defined emergency procedures, a call out list & knowledge of, and access to, isolation valves. Consider spill kits and pumps on site.

7.2.4 Routine Patrols. On-site security guard's duties should be extended to check for escape of water where wet services are live.

7.2.5 Remote Monitoring of unmanned sites. Leak detection and flow devices linked remotely where sites unattended overnight.

7.2.6 Post-loss Investigation. All incidents of water escape or water damage should be fully investigated and documented. This information should be shared with the Insurance Company and, where possible, remedial measures put in place to prevent a reoccurrence. In all instances advice should be sought from the Insurer as to the most appropriate course of remedial action.

8.0 Useful Links

Institute of Plumbing and Heating Engineers	www.plumbers.org.uk
Association of Plumbing & Heating Contractors	www.competentpersonsscheme.co.uk
Heating and Ventilation Contractors Association	http://www.hvca.org.uk/
Construction Skills Certification Scheme	http://www.cscs.uk.com
Engineering Services SKILLcard	http://www.skillcard.org.uk
JIB for Plumbing and Mechanical Services	http://www.jib-pmes.org.uk
Government Approved Licensing Scheme	www.snipef.co.uk
Builders Merchants Federation	www.bmf.org.uk
Industry & Product News	www.plumbingpark.co.uk
Intelligence on Overseas Qualifications	www.naric.org.uk