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Water Distribution Systems in Buildings during Construction

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1. Introduction and Executive Summary

Water damage has become a major and increasing problem to insurers in certain markets. This paper compares the experience from some European markets and as the experience varies it tries to focus on the most important factors influencing the occurrence of water damage losses and the measures which can be taken to reduce their number and severity.

The paper has been limited to the experience from the countries of the working group members France, Sweden, Switzerland and the UK. A future update of this paper should have broader approach and cover not only some European markets.

The increasing sophistication of water distribution systems in buildings means an increasing risk of damage caused by the accidental escape of water from such systems in buildings whilst being constructed, extended or refurbished. Water damage may occur during either the construction period or the maintenance period following completion resulting in claims under CAR policies. Third party property may also be damaged.

There are numerous causes of water damage. The use of new materials, such as plastic rather than copper pipework, often requires more complex fitting procedures and there is a danger that these procedures are not rigorously followed by plumbing contractors. In certain territories, shortages of experienced plumbers can lead to the employment of operatives who lack the skills and training necessary to do the work properly and foreign workers may be employed who are unfamiliar with local standards, rules and regulations. Time pressures may lead to inadequate systems of checks and lack of supervision. The use of expensive and vulnerable materials in luxury apartment blocks, as well as designs which hide pipework and require more water-using appliances increase the cost of losses.

It is evident that the extent and nature of this problem varies by country. For example in Sweden and in the UK failures of pipe connections have resulted in substantial escape of water losses, whereas in Switzerland extraneous damage to pipe work caused by say careless drilling is more of an issue. The prevalence of design and build contracts in the UK and Sweden as opposed to more traditional contracts used in France may lead to more losses, because of fewer design and workmanship checks and need for reduced construction times. Differing insurance requirements, such as the statutory requirement in France for “dommage ouvrage” cover, and deductible levels also have an impact on the level of claims.

The objective of this paper is to:

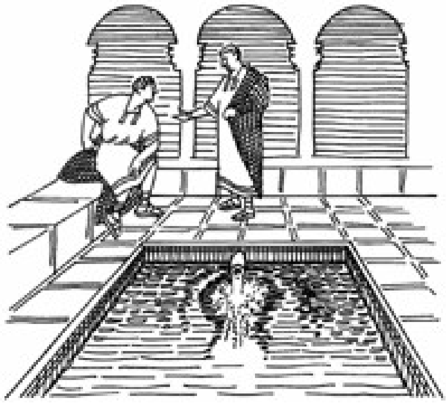
a) increase awareness amongst IMIA members and the wider engineering insurance community of the problem of water damage associated with water distribution systems during construction of buildings; and
b) propose a framework for a code of practice which could be adapted as required by CAR insurers worldwide, which would serve to reduce the likelihood of water damage during construction, thus reducing costs for both insurers and insured parties.

2. The History of Plumbing and Water Distribution Systems

The installation of water distribution systems in buildings goes back to the ancient civilisations of Babylonia, Egypt, India, China, Greece and Crete, which developed drainage and sewage disposal, toilets and baths.

4,000 years ago, the Minoan Palace of Knossos on Crete featured four separate drainage systems that emptied into great sewers constructed of stone. Terra cotta pipe was laid beneath the palace floor, hidden from view. It provided water for fountains and taps of marble, gold and silver that jetted hot and cold running water. In the palace latrine was the first flushing toilet, with a wooden seat and a small reservoir of water.

Water distribution systems really took off with the Romans. The word “plumbing” derives of course from the Roman word for lead “plumbum”, which was the favoured material for pipes. The Romans developed hot water and steam systems that evolved to service colossal structures. The baths of the Emperor Caracalla, for example, covered a site of 11 hectares. By the 4th century A.D., Rome had 11 public baths, 1,352 public fountains and cisterns and 856 private baths. In Pompeii, some homes had 30 taps. Aqueducts carried over a million cubic metres of water per day.



However when the last Roman garrisons retreated to Rome as the Empire collapsed, the secrets of plumbing design went with them. Sanitation technology reverted to its basest forms as Europe entered its Dark Ages.

Medieval sewerage was a simple affair with many larger houses and castles using a "garde robe" (changing room) built into an external wall, often near a chimney for comfort. These consisted of a bench overhanging the outside face of the wall with a drop to a river, stream or into a pit or barrel.

Even in 19th century London, the majority of houses had no running water. Water was drawn from pumps stationed in streets throughout the city, the water rationed and serving hundreds of people. The pumps were open only during certain hours of certain days and the water had to be carried home in jugs. The finer homes may have had a tin or copper bathtub.

As cities grew, rivers became open sewers. It was eventually realised that diseases such as typhoid and cholera were linked to polluted water supplies. Plumbing fixtures designed to supply drinking water and carry waterborne wastes within buildings and the first filtration systems were installed. In Britain the Public Health Act of 1848 legislated that every house should have a flushing toilet, privy, ash pit or some form of sanitary arrangement. Investments were made in sound sewer systems. The Metropolitan Water Act of 1872 was passed to guarantee an adequate supply of piped water to households in London, but some rural areas had to wait until the mid 20th century for water supplies and sewage systems.

In recent times, water usage and the need for distribution systems in buildings has increased substantially as more and more appliances, such as washing machines, dishwashers, power showers, high pressure jets, swimming pools, heating and fire protection systems have become commonplace. Plastic is replacing copper as the preferred material for piping just as copper replaced lead used by the Romans, which replaced clay used by earlier civilisations.

3. Definitions of Terms used in this Paper

Water Distribution Systems
Systems for distributing water in buildings, including pipework, fittings, equipment, appliances and temporary systems.

Water Damage
Damage to buildings and other property caused by escape of water from water distribution systems.

Escape of Water
Water accidentally released from water distribution systems as a result of extraneous damage or failure of pipework, fittings or appliances forming part of such systems.

Pipework
Pipes or tubes used to transport water around the building.

Fittings
Devices such as elbows, tees, couplings and unions used to connect straight pipe or tubing sections and valves, such as taps (faucets), used to regulate water flow.

Equipment
Equipment used in connection with the water distribution system such as meters, pumps, tanks, filters, heaters, heat exchangers, gauges and controls.

Appliances
Devices utilising the water supply including toilets, sinks, bathtubs, showers, water fountains, humidifiers, ice-makers, water heaters, washing machines, dishwashers and hydrants.

Temporary Systems
Water distribution systems used only during the construction period, such as hoses used for cleaning.

4. Materials and Installation Methods

During the 20th century, the material used for water distribution systems in buildings developed from lead to steel and copper, being replaced by plastic pipes towards the end of the century. The development varies from country to country due to climate, building traditions, building codes and standards, but it is obvious that plastic pipe systems are taking over more and more due to factors such as new building methods as well as the price of copper. When preparing this paper it became evident that plastic pipes for water distribution and so called pipe in pipe systems are by far the most common material in Sweden and Switzerland. In the UK, copper is still common but plastic pipe systems are gaining more and more market.

Materials & Types of Joint
The rising price of copper and in the UK, the insurance-led demand for reduced application of heat exposure on building projects has facilitated water distribution system manufacturers and developers to utilise heat-free fittings. The use of plastic pipes and fittings influenced by the European experience will increasingly transfer to the UK. As these have matured, new internal distribution methods have developed, reducing installation time, cost and difficulty.

Escape of water typically manifests itself at made joints. Rarely does the pipe itself fail, unless external damage has occurred during handling or installation. For commercial uses, plastic pipe can be supplied in lengths up to 50m or 100m, whereas copper pipe is in limited lengths, typically 3m. Plastic pipe is therefore attractive in supply terms, especially for commercial developments.

Two categories of jointing exist, heat and heat-free. Heat fittings require a metal agent such as solder or braze which uses a capillary action to effect a good joint. Heat-free fittings can be push-fit, press-fit (crimped) or compression joints.

<u>Water Distribution Systems Utilising Copper Pipe and Heated Joints.</u>
These have traditionally provided reliable water distribution systems and utilise the principle of capillary attraction to allow solder to fill the gap between fitting and tube to form a watertight reliable joint. The key to reliability is joint preparation and this takes time – there are no short cuts.

As the joint is heated, solder is fed into the end of the tube / joint, hence the term “end-feed capillary fittings”.

To expedite jointing, modern heat fittings may feature an internal ring of solder applied at the manufacturing stage. Thus the prepared joint is simply heated to allow the solder to flow.

Joint preparation requires clean square-cut pipe ends, which are deburred and resized, if oval, using a calibration tool. The reliability of the joint is greatly influenced by the flux used. Cleaning of the joint prior to application of flux is essential. As fluxes are somewhat corrosive, especially self-cleaning fluxes, the joint should be cleaned after soldering.

Soldered joints have a major advantage. A well formed soldered joint is robust. The installer can see as the solder flows how well the joint is made and develops a ‘feel’ for this. Problems can be rectified if evident. The process takes preparation and time and is not amenable to short cuts. Once the joint is made, its security is clearly visible via the flowed solder.

Any connector threads for subsequent fittings should use jointing compound, PTFE tape or jointing washers as appropriate.

Heated joints can also be used for chrome-plated copper pipes, but, obviously, not for plastic pipes.

<u>Modern Push-fit Fittings</u>
Push-fit can be used with copper, chromed and some plastic pipes. A pipe support liner insert may be required with plastic pipes or small diameter annealed copper pipes. Push-fittings feature a release collar / grab ring, “o” ring and tube stop.

As with heated joints, preparation is the key, but the joint itself is made in a second simply by pushing the pipe into the connector. Only when the pipe is fully pressed home (usually with a slight twist action) to the tube stop is a secure joint made. To confirm this is the case, the socket depth should be marked on the pipe outer as a guide. Usually a positive click is heard as the pipe hits the tube stop.

Because the joint can be made so quickly, preparation can be similarly rushed. A smooth clean pipe-end is essential to enable the “o” ring to provide a 100% seal, preventing any leakage. Swarf, debris, lubricant, adhesive labels or damaged pipe surfaces will prevent this.

Preferably, a rotary tube cutter is used to create a square-cut end on metal pipes or good quality shears, with a sharp blade, used for plastic pipe. Metal ends must be deburred and chamfered. If the tube is oval or damaged a re-rounding tool should be used.

Problem areas for push-fit are:

- Lack of inserted depth, hence the need to check the depth mark made on the pipe, combined with out-of-square pipe-ends.
- When using plastic pipe, the correct type and size of pipe support liner must be used.
- A damaged pipe-end will often require excessive force to push the joint home. Such joints should be investigated.

The speed of making push-fit joints, poorly prepared pipe ends and lack of visible indication during the jointing process that all is sound, renders push-fit connections more prone to problems.

<u>Press-fit Fittings (crimped using radial force)</u>
Comments made under push-fit equally apply to press-fit fittings, especially that relating to depth of pipe to tube stop. Additionally, a press tool with correctly sized jaws for the fitting has to be utilised. This crimps the fitting to grip the pipe.

Correct tool presentation and alignment is required, i.e. compressing the joint at 90 degrees with the weight of the tool taken by the operator with no side-to-side or up and down load applied to the piece. For larger diameter pipes (40mm and above) press slings are preferred which provide a more equalised pull over the circumference of the pipe than two jaw sets provide. Dry lubricant is also used to assist the crimping action. Some tools feature performance indicators.

Problem areas for press-fit are:

- Sufficient clearance around the pipe is required to place the press tool and this can present problems in confined spaces. Minimum space between fittings, projection through walls and the like to enable the jaws to fit must also be allowed. Failure to observe these details can compromise joint integrity when crimping later.
- Pipe restraint is important to prevent imposed stress on tube and joints.

For phenolic foam tube insulation it is necessary to consider moisture or condensate issues to prevent aggressive moisture, inducing corrosion. For mixed material systems, electrolytic corrosion should be considered.

<u>Compression Joints (for metal tubes and medium density polyethylene pipe ‘MDPE’)</u>
Compression joints feature a compression ring and nut on the fitting, which is tightened to apply a mechanical clamping force to the pipe. The comments made for push-fit are applicable, although to effect a secure joint the nuts are tightened, usually to a set degree of turn after initial tightening by finger.

The type of copper tube is important. This should be hard or half-hard, otherwise the tube will deform under the clamping action, unless an adapter is utilised. Stainless steel pipe can also be used.

Problem areas for compression joints are:

- Disturbance of pipework after installation can lead to joints weeping and typically the installer re-tightens the compression nut. This does not always rectify the problem and over-tightening can result.
- Typically the connectors are brass, which can suffer from de-zincification with soft water. DZ-resistant alloys must be used in such cases.

- As with press-fit, tightening nuts can be a little awkward in confined spaces and joints can look clumsy.

Stress Corrosion Cracking (SCC)
SCC can occur occasionally with brass compression fittings. For this to occur a degree of internal stress is required, either from the manufacturing process or installation and an environment containing usually ammonia or ammoniac compounds. Other contaminants such as sulphur dioxide can cause cracking. An essential ingredient in SCC is moisture on the fitting or pipework that allows the corrodent to collect and become more concentrated. Particular problems occur with chilled water installations.

To avoid SCC, brass components should not be over-tightened during installation. The risk of contamination can be minimised by wrapping or coating the fittings in a vapour barrier or impermeable paint. Use of parallel threaded adaptors helps avoid stressing female threaded ends. Brass fittings should not be used on chilled water systems.

Water Distribution Systems Utilising Plastic Pipes
One basic principle for water distribution systems using plastic pipes is to provide joint-free pipe runs from a manifold to each tap or outlet in order to:
- eliminate variations in pressure and flow
- allow each pipe run to be isolated if required
- minimise joints and centralise all connections to one accessible point.

See Appendix 1 for a sample of pictures showing the principles of plastic pipe in pipe systems

The pipes used are so called pipe-in-pipe systems where the water-carrying pipe is protected by an outer pipe (see picture) which protects the inner pipe during construction and allows the replacement of the inner pipe when and if needed. As a curiosity it can be mentioned that a patent was granted for a pipe in pipe system at the beginning of the 20th century but as there were no suitable materials available the patent was never commercially explored and expired. In 1977 the Swiss company JRG Gunzenhauser AG presented a pipe in pipe system with plastic tubes and cast iron fittings and was introduced to the Swiss market in 1978. As this system couldn't be patented other manufacturers followed and there are now a number of similar pipe in pipe systems in the market.

All pipe-in-pipe systems the working group has come across have their own installation methods and unique fixtures and fittings. Furthermore, each system requires its own unique tools for the different steps of the installation. As pipe in pipe systems are somewhat flexible, any fittings through walls for instance must observe the manufacturers instructions. Typically a complex array of components is required to fully effect a secure wall fitting and items are sometimes missed, leading to leaks later on, especially when the system has endured many hot / cold cycles with subsequent expansion and contraction.

It is obvious that training is needed for each and every system and such training programmes are offered by the suppliers. It is also evident that such training is a prerequisite for a safe and claims-free installation of this type of water distribution system.

The systems are tested and approved according to the national standards in the countries where they are used. There are a number of systems in the market and below are the web site addresses for some manufacturers and suppliers but also for more general information:

www.bsee.co.uk
www.toolbase.org
www.yorkshirefittings.co.uk

www.uponor.co.uk
www.jrgsanipex-mt.ch
www.piping.georgfischer.com

5. Risks and Exposures; Contractual Requirements; Managing Risks

The nature of water damage claims tends to vary according to country, reflecting construction practices, water distribution systems and materials utilised.

Losses may be represented by large single claims or multiple claims on a single project, which collectively may add up to a significant value.

5.1 Swiss Experience

Experience in Switzerland suggests that the majority of water damage losses on contract sites are caused by extraneous damage such as accidental drilling into pipes. Water damage losses tend not to be seen as a major issue for insurers.

Drinking water is very vulnerable to pollution. Therefore Swiss code SVGW W3 requires that only certified systems may be installed. To get certified, all drinking water installations have to pass tests. The tests are similar to the ones in Germany and include pressure, temperature, tension, bending, temperature cycle, water hammer, etc. The manufacturer usually guarantees the complete system for five years, but only if tubes, fittings and installation-tools of the respective system are used.

After market introduction of the certified pipe in pipe system by JRG in 1978 it was accepted quite well on the Swiss market. Therefore various other manufacturers followed about 5 years later and built similar systems. In order to keep its market share JRG established in 1988 a new system which is patent protected. At present there are approximately 10 different pipe systems from different suppliers available, but JRG is still market leader. All systems are well known and have been established in the market for at least 10 years. For quite a long time copper and pex-systems were used in parallel on the market. Rigid pipe systems are still installed in copper or stainless steel, but only used up to the manifold from which only pipe in pipe systems are installed nowadays. Manifolds are installed on each floor or in each apartment and from there only ‘pipe in pipe’ pipes go to the different appliances.

When the pipe in pipe system was introduced to the market by JRG, the company was only allowed to supply material to plumbers after they had passed a test. This rule had to be followed approximately until 1990 by all manufacturers/suppliers. Nowadays, the manufacturers still offer such training at apprenticeship schools or for refresher courses for plumbers and their companies, but on a voluntary basis.

Each system requires its own specifically designed tools, which tend to be quite expensive, with the result that plumbers tend to work only with 2 or 3 different systems.

The contract documents specify certified systems to be used and no mixing of systems is normally allowed, because the systems and not the single parts are certified. Usually only named sub-contractors accepted by the employer are accepted. The system has to be installed according to code W3. In many cities an official licence is required by the plumber in order to install drinking water systems. To obtain this licence the plumber must obtain a qualification known as Meisterprüfung. The installation is random checked and approved by the building authorities. In smaller towns the system is only checked when the authorities install the water meter.

When the work is finished the plumber is required to test the installed system according to W3 (pressure test of 16 bar). If any leakage is detected there will be a pressure drop, the test must be stopped and the leak located and repaired. Pressure tests are excellent, but not all failures can be detected, sometimes the damage happens only after many hundreds or thousands of temperature or pressure cycles.

Nevertheless, plumbers are human beings and not all failures can be avoided. Common failures are:

- When cutting the exterior pipe, the interior pipe may be damaged by a small cut. The pipe is still tight for the pressure test but after many temperature or pressure cycles the pipe bursts.
- Insufficient cleaning (bond-joints) or insufficient heating (heated joints)
- On some push-fit fittings systems “o” rings and nuts can be misapplied (but on some push-fit fitting systems there is almost no failure possible)
- Nuts are tightened too much
- If prescribed pipe supports and other fixtures are not used (or mixing components from different systems), the minimum bending radius is not obtained.
- If endings are not closed properly before concreting, pipes can be filled with other materials (concrete, paper, dirt, etc.)
- Sabotage

In Switzerland only pipe-in-pipe systems are used. So if a pipe is damaged from outside, usually only the external pipe is damaged. There is therefore no leak and the external pipe can be repaired or replaced. Manufacturers such as JRG have endoscope systems (length 16 m) for easy detection of damage in installed systems, if for example a screw or a nail goes through a pipe and the location is unknown.

Nevertheless, despite of the good experience, in recent years, it seems that there are some negative influences on the overheated Swiss building market:

- Under cost pressure some plumbers have started to mix systems (cheaper foreign pipes with good fittings)
- Time pressure on construction sites lead to failures (insufficient cleaning with bond systems, insufficient heating of heated joints)
- Lack of knowledge of foreign workers who are not familiar with systems used in the Swiss market

Conclusion

It seems that the slow, well regulated introduction of the pipe in pipe systems on the Swiss market, which has happened over a period of about 15 years, has led to good knowledge in the market which has helped to prevent damage. With the good apprenticeship system the knowledge level is still high, but cost and time pressure and the lack of knowledge of foreign workers could influence quality in the future.

5.2 UK Experience

Water damage losses are a significant contributor to CAR claims experience and particularly for residential apartments, hotels and student accommodation. These types of development have markedly increased in recent years as a result of increased investment in the sector, especially in major cities such as London.

The nature of these developments compounds losses given they are usually high-rise buildings. Escape of water on upper floors presents a major problem given that water damage can spread downwards, damaging other fitted-out elements of the building. Losses often occur at night or other times when the works are unattended or unmonitored. The largest losses occur near to completion when the exposed value is greatest. There is often damage to parts of the building already handed over, such as sold apartments. It is not unusual for a large number of water damage losses to occur on the same site.

A feature of luxury apartments is the use of expensive and vulnerable fixtures and fittings, such as hardwood flooring. This of course increases the cost of claims. In some cases inappropriate design of the routing of pipework and location of tanks may impact the loss.

Building construction times have reduced considerably in recent years and programme pressures may result in substantial internal works being carried out before water distribution systems have been commissioned. Time pressures may also lead to work being rushed resulting in workmanship errors and inadequate testing.

The national shortage of skilled plumbers in the UK may lead to the employment of poorly experienced individuals. The shortage also manifests itself in the employment of large numbers of foreign workers, particularly in London. Such workers may be unfamiliar with materials and systems used in the UK.

Typically the immediate causes of water damage losses are:

- Failure of joints – push-fit and press-fit joints are now usually employed. The latter are relatively new in the UK, although they have been used elsewhere in Europe for some time. Both forms of joint have the advantages of being capable of quick fitting and removing the need for hot work, thus reducing the incidence of fire, but they will of course fail if the connection is not fully made or, in the case of press-fit, not fully compressed.
- Stop ends to pipes omitted, so nothing to stop water escaping when the system is charged.
- Valves mistakenly left open prior to charging the system.

Much of the blame for these losses can be attributed to poor workmanship, lack of adequate supervision and testing and commissioning procedures.

A particular aspect of the UK construction industry which has contributed to this situation is the increasing prevalence of the design and build method of construction procurement. This, as opposed to the traditional method, can lead, without certain safeguards, to inadequate design, control and supervision of the plumbing work, which in turn leads to failures during fit-out and testing and commissioning of building services.

<u>The Impact of Design and Build</u>

The form of contract selected distributes the work, risk and remuneration between the contracting parties. Whereas all construction contracts seek to deliver the proposed works to a specific outcome, a specified quality, at an acceptable cost and in an acceptable time, there are different ways of achieving this. Typically, the contract may be a traditional one or design and build.

The traditional contract features many built-in safeguards which protect the employer. It was popular because completed designs at tender stage represented a known tender quantity for contractors, where all the work could be identified prior to the construction phase and a bill of quantities produced, which enabled contractors to price with certainty.

However, increasingly, construction clients in certain countries such as UK and Sweden, have opted for design and build contracts which offer a shortened construction time and associated cost savings. Such contracts are often at a fixed price.

To understand the influence of the change in procurement, we must briefly examine the two basic methods. Under the traditional contract the three essential parties constituting a project team comprise:-

The Client	**The Professional Design Team**	**The Professional Construction Team**
• Employer or • Principal or • Promoter **Brief →**	• Architectural Consultants • Geotechnical Consultants • Civil Engineering Consultants • Structural Engineering Consultants • Mechanical & Electrical Consultants **Tender documents→**	• Principal / Main Contractor • Sub-Contractors • Trade Contractors
The party initiating the project & benefiting from the asset	Those undertaking the actual design of the project **Design Phase**	Those undertaking the actual construction **Construction Phase**

A traditional contract followed a logical sequence:

- The client engaged professional designers which ensured good design
- The design team completed the design, thus the tender was based on known requirements
- The design was then put out to tender in a competitive environment so achieving the best price for the client
- The construction was supervised by the professional design team to ensure compliance with the contract documents. *Essentially, the employer's interests were looked after by the professionals.*

A criticism of traditional contracting was that designers were remote from the benefits an experienced contractor could apply by designing in 'buildability' to works, making use of contractors' vast on-site constructional experience. This would enable them to complete works quicker, with cheaper materials, leading to cost and time savings to the client. Thus, commercial developments benefit from earlier receipt of capital income through sales or rental revenue.

For these reasons, design and build has led the move away from traditional contracting. However some problems have become apparent. Significantly, the distribution of risk changed with the use of design and build, with contractors assuming both design and supervision risk.

With design and build, the client contracts directly with a main contractor, who engages designers to design the required works. The main contractor then undertakes construction of the works, typically sub-contracting much of the build to sub-contractors or trade contractors he knows. Many design and build contracts feature sub-contract design elements. For example, a steel frame supplier will often undertake the detailed design of the steel frame of the building for the main contractor.

Design and build delivers many projects to the required quality, in a timely fashion and to the contract price, but potential problems include:

1. A weakening of professional influences leading to a lowering of construction standards, all driven by cost reduction. The client has no direct contracts with the architect, engineer or sub-contractors, who often have design responsibility.

2. Generally, there is no design or construction supervision on behalf of the client i.e. no consultant, resident engineer or clerk of works.

3. The design process is totally governed by the main contractor whose aim is to keep costs low to maximise profit. Often there is incomplete design at tender stage, and the quality of the final design team can be open to question, or, more succinctly, its brief can be.

4. Often the design process is fragmented, many sub-contractors being utilised but with no lead consultant.

5. At building fit-out stage, many trades are competing against each other for access to install their works, which leads to competition for floor space. This leads to lack of care for others' work on large busy commercial or industrial sites. The reduced construction timeframe for design and build projects can exacerbate this problem. This problem is most acute in high-rise construction.

These problems can be resolved through the use of integrated construction supply and project teams. In the UK at least, pressures are being placed on the construction industry to improve its processes through techniques such as lean construction, partnering and supply chain management - essentially, integration.

Integration involves:

1. Changing working practices, methods and behaviour to create a culture in which individuals and organisations are able to work together more efficiently and therefore more profitably. By becoming more integrated, it becomes possible to engage the supply chain. Relationships are improved and duplication of effort is avoided. The same applies to the project team.

2. Working smart, eliminating waste by better selection of materials, specification, planning and delivery practices. Each link in a supply chain draws on the skills, products and capabilities of other links, to satisfy its own needs and clients.

<u>Managing the Risks</u>
The risks associated with water damage losses can be managed through various techniques. It is important to consider system design and specification as well as site installation and commissioning. Integration, as outlined above, can help in this regard.

<u>Selection of plumbers</u>
Ideally of course only fully qualified plumbers experienced with the types of systems to be installed should be employed. In most cases, plumbing work will be sub-contracted by the main contractor. However in countries such as the UK, there is a shortage of skilled plumbers, due in part at least to the reduction in traditional apprenticeships, and this increases the emphasis on supervision and testing procedures.

Main contractors should verify the skill levels and qualifications of proposed sub-contractors in terms of design elements and installation by employees. The proposed water distribution system design could be reviewed, certainly the specification and site drawings prior to site installation. Ideally, partnering and integrated supply team working will create a culture where known potential problems are addressed prior to on-site activities in the planning stage.

Site surveys
It is not practicable for insurers' surveyors to regularly visit every site, but the main contractor can carry out surveys to check on plumbing standards. Spot checks can be performed to verify materials, quality of installation and adherence to specification and plan.

Better design of water distribution systems
The ability to detect leaks and carry out repair can be assisted by locating pipes, joints, valves and tanks so that they are readily accessible. As constructed drawings and manuals detailing operational requirements should be handed over at completion.

Testing and commissioning
The testing and commissioning regime employed on site directly impacts the risk of water damage by determining the circumstances in which water distribution systems are filled with water. The regime should be designed so that leaks are quickly detected before damage ensues. This should entail:

- Agreed standards and a written method statement or protocol
- Being carried out floor-by-floor or apartment by apartment basis
- Sequencing of testing, so that it is carried out as early as possible
- Agreed sign-off procedures.

The use of leak detection devices
Devices can be employed to shut down the water supply if water flows exceed pre-determined parameters or give warning of burst pipes. Security guards can be trained to provide an early emergency response and shut down systems where necessary. Remote monitoring of leak and flow detection may be possible.

An increasingly influential aspect for new developments is to consider the water conservation aspect of loss minimisation and control. Some insurers have found this an effective selling point, balancing the cost of installing flow control devices to cost of lost metered water, even if just applicable during the construction phase of a project. Whilst this may not reduce the frequency of claims, it certainly reduces the severity.

5.3 Swedish Experience

The Swedish experience coincides very much with what has been experienced in the UK regarding type of and an increasing frequency of water damage losses. The main reason is faulty workmanship! One difference is that plastic pipes for water distribution systems are presently used to a much larger extent in Sweden than in the UK.

The building activities in Sweden have during the last five to ten years picked up pace and the last few years can be characterised as an overheated building market, especially for residential purposes, which has lead to a shortage of skilled labour.

In this market the plastic pipe-in-pipe water distribution systems have become more and more common and are now the standard. It is obvious that under the prevailing market conditions, with a shortage of skilled plumbers properly trained for the systems to be installed, substantial problems and a high frequency of water damage losses from escaping water were the result. It went so far that the insurance industry questioned if this type of water damage could be regarded any longer as unforeseen and thereby indemnifiable.

The response from the Swedish building industry was then swift and responsible. Headed by the trade association for plumbers, VVSI, a guideline entitled “Safe Water Installation” was developed with a focus on how to secure safe installations and avoid water damage due to faulty workmanship. A system for training and authorisation has been developed where both the company and its employed plumbers must be licensed and authorised to carry out installation of a specific system. The importance of following the suppliers' instructions in detail is stressed in the guideline.

The suppliers of the systems have taken on their responsibility and provide training and certification on their products and systems.

New contractual requirements, as an endorsement to the standard contracts used, have been developed whereby the main contractor as a contractual condition requires, when sub-contracting, trained and authorised plumbers and for the work to be performed in accordance with the Safe Water Installation guideline. After prescribed controls and pressure tests a certificate of Safe Water Installation has to be signed and handed over by the plumber.

The Swedish insurers are now starting to see the result of the measures taken. The trend is that the frequency of claims has begun to decrease and will hopefully decrease substantially from a still totally unacceptable level when the "Safe Water Installation" guideline has been fully implemented throughout the building industry.

6. Loss experience including statistics available

When investigating the claims situation and the statistics available, it was noted that in most cases the claims are not coded on a detailed level enough to search, for example, for water damage due to couplings not installed correctly (faulty workmanship). From the experience within the working group and from interviews with surveyors and loss adjusters as well as going through claims files, the following pattern emerged:

- It is not the size but the frequency of water damage losses that is the problem for the insurance industry.

- Water damage losses are more frequent during the construction phase, but the Swedish experience is that the number of claims during the maintenance period is increasing.

- The indemnity after deductible for a normal water damage loss seems to be anything from USD10,000 to USD700,000, with the highest frequency for claims in the region of USD25,000 to USD50,000.

- Deductibles seem to range from USD2,000 or even lower up to USD70,000.

- The damage to the water installation as such is normally very small, but the damage to the surrounding works is often substantial.

- There are many examples where the pipe becomes detached from the coupling on the top floor during a weekend and thereby causes substantial damage to the building structure and the floors below.

- As the damage has a tendency to occur close to completion and handing over, the project is often delayed with uninsured additional costs for the contractor and loss of revenue for the developer. There are examples where such uninsured costs are in the same region as or even in excess of the indemnity paid by the insurer.

- Depending on the contractual situation and insurance programme there might be a possibility of subrogation against the plumber.

Photos of some typical water damage can be found in Appendix 2.

7. Lessons learnt and underwriting considerations

Insurers cannot control the problem and must work on pricing, loss minimisation and raising awareness to reduce the many ways that water damage claims manifest themselves.

The increase in the number and cost of water damage claims can be attributed to a number of causes, but in the main the reason is poor workmanship and site supervision.

The use of new materials and jointing systems may be blamed, but rather it is the application of such materials and systems which presents the problem. Methods of installation such as jointing techniques may be more complex than traditional copper systems so better training of plumbers is required.

Main contractors are responsible for site activities and as such should be aware of the potential for water damage losses during the design phase, where they are responsible for design, the construction phase and during the defects liability period after handover to the client. There is a need to better manage the risk associated with water supplies. This should be done through employment of only fully trained and certified plumbers, better supervision of work and enforcement of agreed testing and commissioning standards.

A key factor in the prevention of water damage losses is the need for supervision. Contractors should regularly carry out site surveys and "spot checks" to ascertain that plumbing work is being carried out to the standards required. Site surveys by insurers are likely to be less beneficial as due to limited resources they are likely to be limited in the number and scope and by their nature can only identify risks at a specific point in time.

Insurers should examine their own experience of water damage losses. Statistics for such losses are not readily available, but it is apparent that in some territories at least water damage accounts for a significant number of losses, some of which can be of high severity. Also available data suggests an increasing trend. It would be helpful if statistics for annual contractor covers and single project risks could be viewed separately.

Where insurers hold annual covers with contractors or there is otherwise a longstanding relationship, there is the ability for insurers to work with contractors to develop risk management techniques and create a "win - win" situation. The insurer can assist the contractor by applying the benefit of wider claims experience to create awareness of the problem and develop loss prevention.

A particular feature of water damage is the potential for series losses i.e. a number of water damage losses on the same site originating from the same or similar cause. In such cases insurers may wish to introduce loss limiting clauses, which may limit the insurer's liability for losses occurring after the first such loss, possibly on a reducing scale. Alternatively the insurer may increase the deductible for second and subsequent losses on the same site. An example of clauses used in the Swedish market is attached under Appendix 3.

Increasing awareness of the water damage problem amongst contractors, developers and building owners would be beneficial. Insurers could develop literature to highlight the problem and then provide guidance on issues such as:

- Vetting of sub-contractors in relation to design and installation of water distribution systems
- Design documentation required prior to site activities
- Checking sub-contractors' skills and quality

- On-site quality assessment
- Supervision of sub-contractors on site by main contractor
- Testing and commissioning
- Loss-reducing measures such as flow control, master valves and the like
- Handover documentation
- Warranties
- Retained rights of recourse against sub-contractors.

In the end, the contractor, or his client, pays for the consequences of water damage through increased insurance premiums and retained liabilities. In particular, delays in completing the contract due to water damage may be substantial and lead to financial losses, which often may be uninsured. It is therefore of course in the best interests of contractors and clients to work towards the reduction of water damage losses.

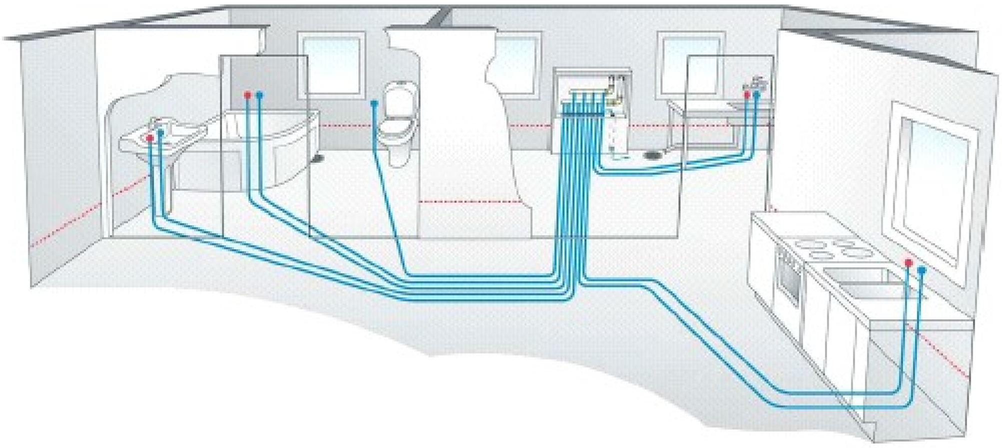
8. Conclusion

A Code of Practice for Risk Management of Installation of Water Distribution Systems should cover the following areas:

- Design to reduce the impact and severity of water damage; leakage must be easy to detect and as early as possible
- Design to make the installation practically possible in accordance with manufacturers' specifications and instructions, as well as any standards applicable
- Contractual requirements regarding safe water installations
- The choice of material and systems, to be proven and comply with building codes and national standards
- The qualifications and experience of the contracted plumber
- Training and certification of plumbers for the materials and systems to be used
- Inspections and controls
- Special concerns in an overheated building market, the shortage of trained and skilled workers.

Appendix 1: The pipe in pipe systems

The pictures below show the principles of plastic pipe in pipe systems as well as some of the components and tools needed.



The principal lay out of a pipe in pipe system with joint free runs from the manifold to each appliance.

Pipe in pipe

Tools needed for the JRG Sanipex System

The manifold

The principal lay out of an installation of a pipe in pipe system in a wooden frame house showing also a sample of the components needed.

Appendix 2: Example of some typical water damage claims

Claim no 1

A press fit coupling came loose from a manifold during a weekend on the top floor of a five storey residential building shortly before handing over. The large volume of escaping water caused substantial damage to the building structure as well as internal fixture and fittings already completed. Nine apartments had to be totally stripped and re-fitted after the concrete structure had been dried out. Handing over and taking into use delayed by eight months.

Damage caused by un-crimped coupling = faulty workmanship

Indemnity paid: USD 700,000 after the deductible USD 70,000

Uninsured costs for the contractor estimated to be a minimum of USD 100,000

In this case the subrogation against the plumber was successful and the full amount could be recovered.

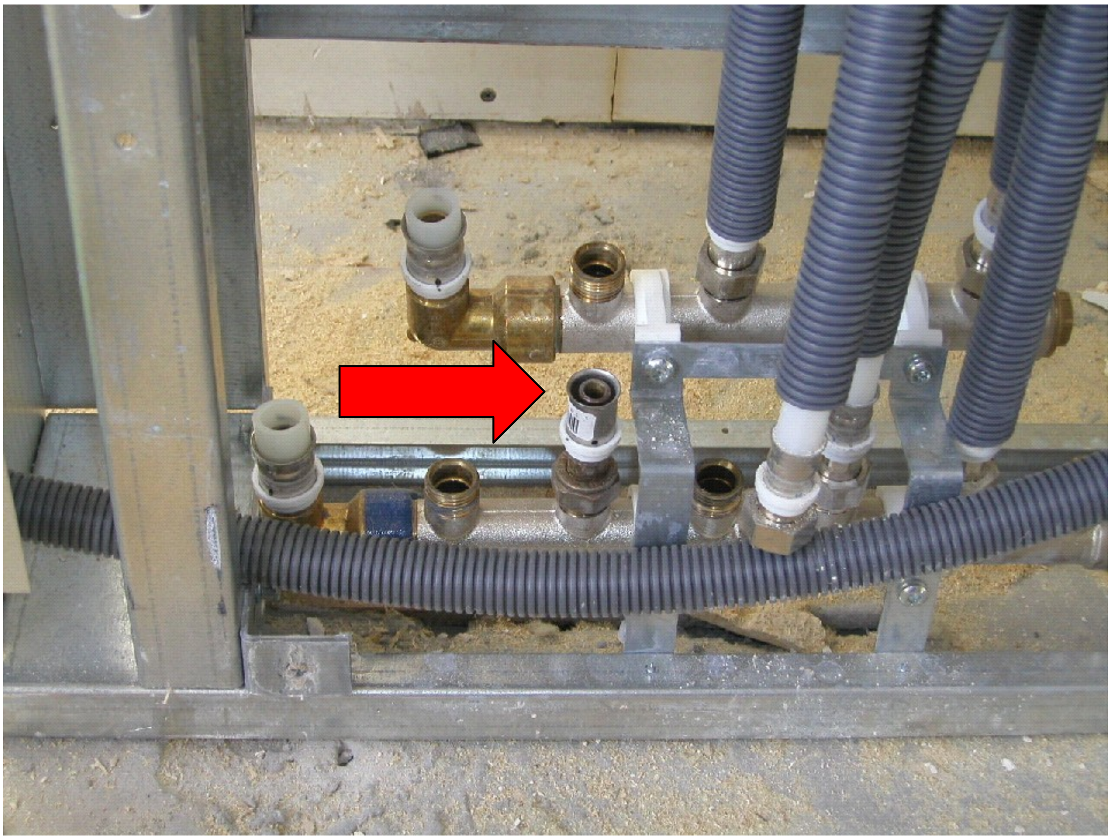
The following pictures shows the extent of damage and also the cause of loss

That Monday morning in one of the living rooms, this and eight other apartments were totally flooded.

The similar view during stripping out of internal floors and other fittings

The strip out is completed and the drying out process is ongoing

The structure was of prefabricated concrete and due to the volume of escaped water it also penetrated through and poured down the facades. The drying out of the concrete structure was complex and the hollow concrete floor structure had to be penetrated to release water and to make drying out possible.



The cause of loss, an un-crimped coupling (the red arrow) that initially withstood the water pressure. The adjacent couplings were properly crimped or tightened.

Claim no 2

The main inlet pipe (plastic) came loose from the coupling due to faulty workmanship but had initially withstood the water pressure. The water stood 25cm high on the ground floor (no cellar) when the front door was opened. As the house was close to handing over substantial damage was caused to fixture and fittings on the ground floor and had to be stripped out. As the drying process is time consuming the handing over after re-fitting was substantially delayed.

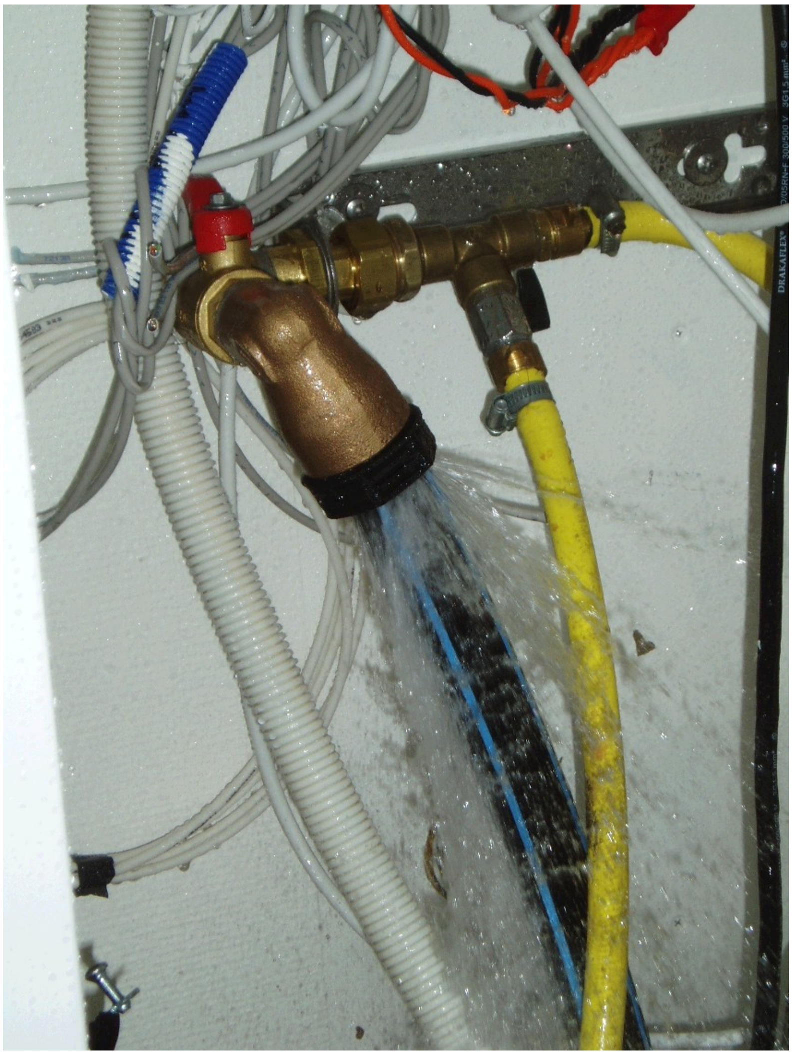
Damage caused by not correctly tightened coupling = faulty workmanship

Indemnity paid: USD 45,000 after deductible USD 17,000

The contractor’s uninsured costs are not known.

Also in this case the subrogation against the plumber was successful and the full amount could be recovered.

The water standing 25cm high was released when the front door was opened.



The cause of loss, a not correctly tightened coupling came loose due to faulty workmanship.

Appendix 3: Water Distribution systems − Conditions and Special Clauses (Example)

The following example is an extract from the Safety Regulations in a Swedish CAR/EAR wording which includes a paragraph regarding Installation of Water Distribution systems.

The paragraph reads as follows (translated from Swedish):

8. Safety Regulations

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8.7 Installation of Water Distribution systems and work in Bathrooms

Installation of Water Distribution systems in general and any work in bathrooms or the equivalent shall be performed in a professional manner and in accordance with the material supplier's manual for which Standard Approval Certificates have been granted and also in accordance with instructions issued by Trade Associations.

The work shall be performed by personnel trained and certified for the type of installation in question and the material used.

In the protocol from the Contractor's own control of works performed (contractual stipulation) it shall be verified that pressure test of the installation and any other control prescribed by Trade Associations, Authorities or material suppliers have been carried out and in a correct manner.

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In case of a loss or damage due to escape of water and if it then can be verified that the works have been performed in breach of the safety regulations as per above the indemnity will be reduced as follows:

8.9 Sanction/Consequence if Safety Regulations are not complied with

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8.9.6 Installation of Water Distribution systems and work in Bathrooms

The indemnity after deductible to be reduced by 30%, minimum SEK 20,000 (approx. USD 3,000) and maximum SEK 400,000 (approx. USD 60,000) if the Safety Regulations according to paragraph 8.7 above have not been complied with.