

WPR

world plumbing review

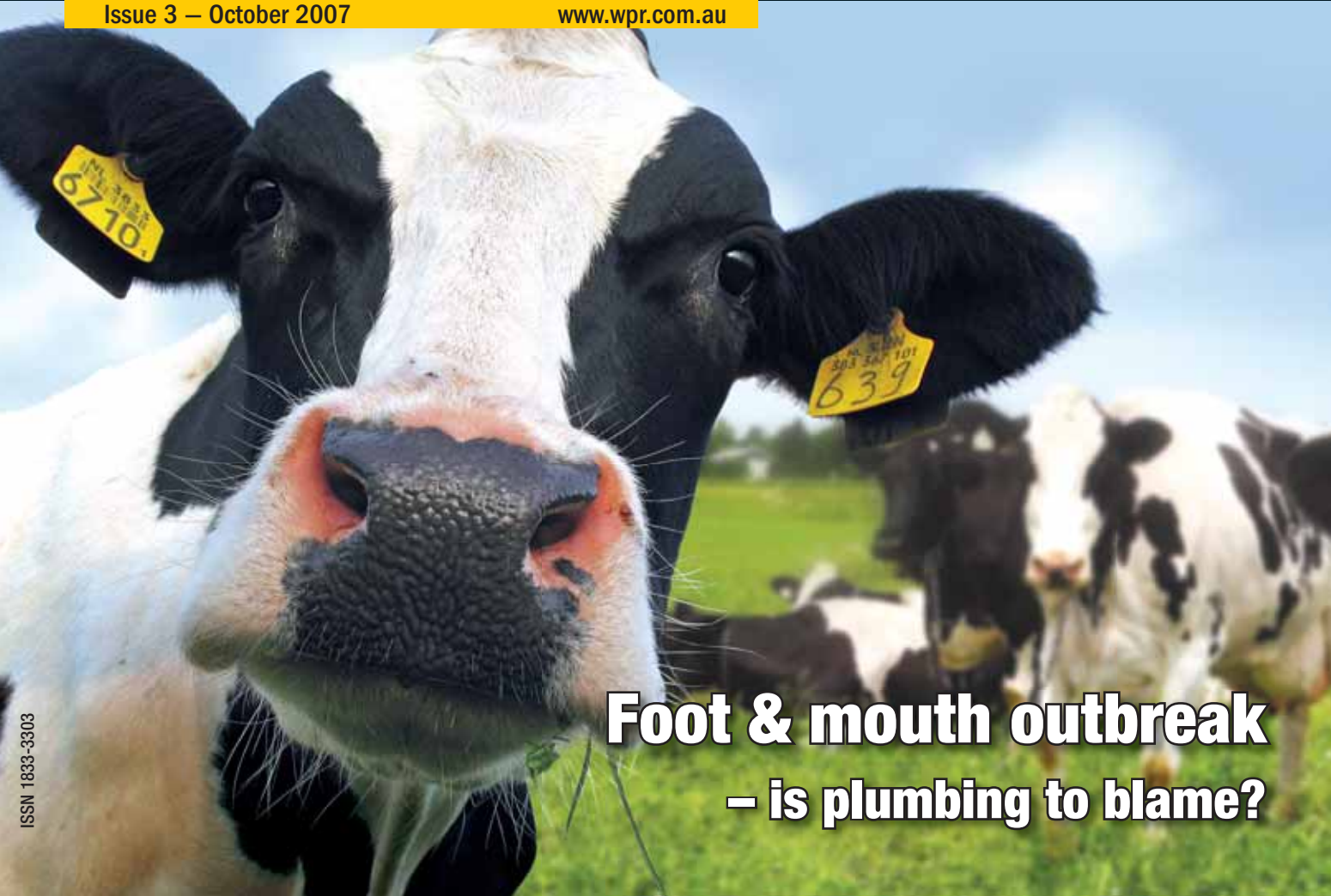
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Issue 3 – October 2007

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Foot & mouth outbreak
– is plumbing to blame?

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THE IAPMO GROUP – WORLD HEADQUARTERS

5001 EAST PHILADELPHIA STREET • ONTARIO, CALIFORNIA 91761 – USA

PHONE: +1.909.472.4100 • WEBSITE: WWW.IAPMO.ORG

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Connection
Magazines Pty Ltd
3/21 Lionel Road,
Mt Waverley, 3149
AUSTRALIA

Web: www.wpr.com.au
Email: info@wpr.com.au
Tel: +613 9542 9000
Fax: +613 9542 9090

Connection Magazines Pty Ltd is Australia's leading technical magazine publisher, with publications serving the building, plumbing, electrical, voice/data/video and home automation sectors. Visit www.build.com.au

CONTACT INFORMATION:

Publisher:
Jeff Patchell
jeffpatchell@wpr.com.au

Advertising:
Connection Magazines:
davidverlinden@wpr.com.au
Tel - +61 400 907 565

Europe – Ströbel Verlag:
peter.hallmann@stroebel-verlag.de

India – CJI Forum:
kamal@cjiforum.com

China – CCCST:
cccst@cast.org.cn

General manager:
Jeremy Sweet

Editorial:
Group editor – Jeff Salton
jeffsalton@build.com.au

Writing team/contributors –
Hartley Henderson, Susanna Nelson,
Paul Skelton, Joanna Gerentidis

Production:
Manager – David Duncan
Team – Sam Elliott, Rohan Heddle,
Kylie Mibus

Distribution:

English language edition – 33,000 copies
Chinese language edition – 8,000 copies

Copies are distributed throughout North America, Brazil, Europe, UK, India, Middle East, Southern Africa, Australia/New Zealand, S.E. Asia and China/Hong Kong.

Reprints of articles:

Web: www.wpr.com.au/reprints
Email: reprints@wpr.com.au
Tel: +613 9542 9000

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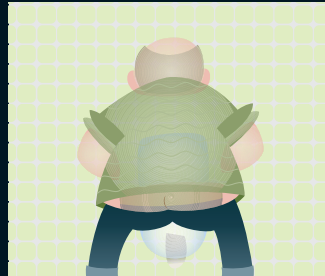
Enter our on-line survey for your chance to win a fully-paid study tour Down Under.



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Well, we attempt to recycle just about everything else, why not 'liquid gold'?



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Technological advances are keeping modern day floating prisons waterwise.



COVER IMAGE

Report blames UK foot and mouth outbreak on poor plumbing – page 16

READER NOTES:

Currency: All references are to US dollars unless otherwise stated.

Metric/Imperial: Metric measurements appear with imperial conversions. In circumstances where the same measurement is used more than once in the same article, only the first reference features an accompanying conversion. References to gallons are US values.

Trademarks/registrations: Proprietary trademarks and registrations are noted alongside initial references to selected products and companies, and not alongside subsequent practicable, are written in lower case roman lettering regardless of proprietary preferences.

WHY RE-INVENT THE WHEEL?

Maybe it's time we stepped back a little and take a good look at ourselves.

Recently, I attended a conference in Washington DC for the US Plumbing Manufacturers Institute (PMI), which brought together many of the leading suppliers and household brand names from across the sector globally.

This member organization holds these technical meetings twice a year to report on and discuss issues that affect the orderly marketing of sanitation fixtures - primarily toilets, faucets and showers.

Right now and for the foreseeable future there appears to be plenty of subject matter to discuss across this industry.

Water shortages, climate change, Standards and manufacturing constraints made for an interesting exchange among PMI members and invited guests from the US and beyond.

While the US market is an enormous one in its own right, I think it is fair to say that in the past this has led the North American supply industry to take a mostly local view of the way it goes about its business.

However, times are changing, and for the good.

What was evident at this exchange of information was a conference room full of business leaders keenly looking to learn from other continents, in order to share knowledge, experiences and research. And why not?

For decades, Europe has taken a far more responsible approach to water-saving and re-use, while the likes of Australia has more

recently experienced an unprecedented drought pattern that has brought product innovation to its market in order to solve immediate problems.

The more information we can share globally, the better off everyone will be; and that's also a foundation aim of this magazine.

THE WATER/ENERGY DEBATE

One of the interesting presentations at PMI was by energy specialist for the California Energy Commission, Gary Klein.

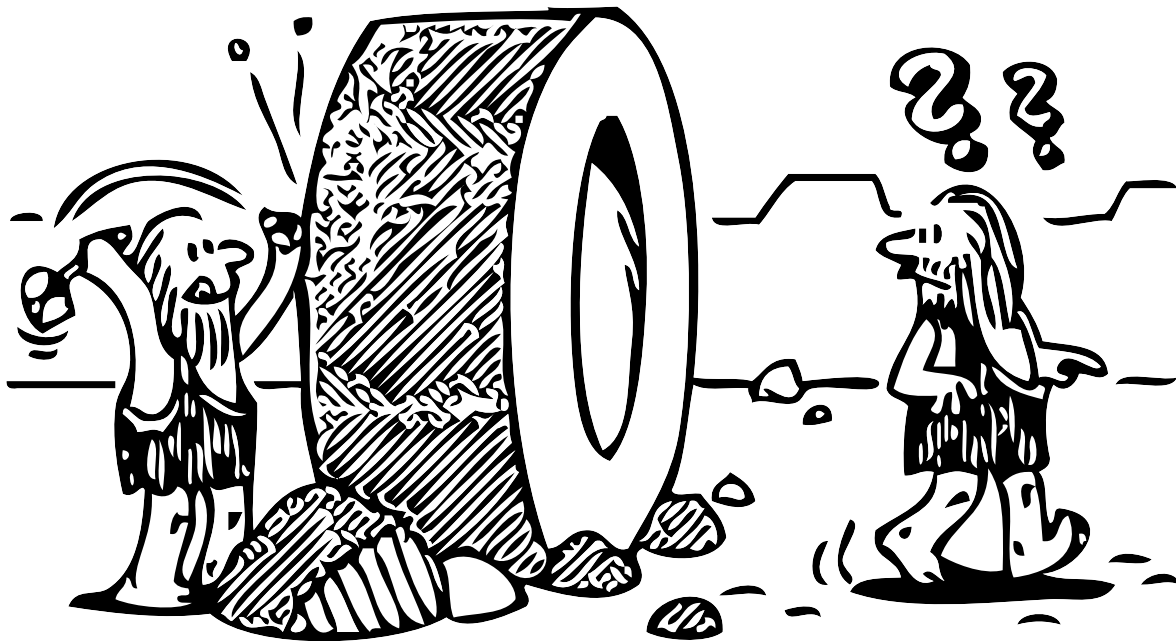
Klein is quite an evangelist on the subject of water delivery and also hot water. His presentation included some interesting charts, one of which we've replicated here.

This chart clearly demonstrates the link between water and the amount of energy required to distribute it around the State, its local use and disposal thereafter.

If you didn't see the figures for yourself it would be difficult to believe that some 25% of the electricity generated in California is actually used for water distribution.

The situation is similar in domestic residences and the more we can do to make hot water use as efficient as possible, the lower the cost for everyone and, hence, fewer greenhouse gases.

I like people who challenge the status quo and Klein is such a man. He is in a good position to stand back from the daily marketplace and observe things from a different angle.



Water-rated energy use-CA 2001			
	Electricity (GWh)	Natural Gas (Million therms)	Diesel (Million gallons)
Water supply and treatment			
Urban	7,554	19	?
Agricultural	3,188		
End uses			
Agricultural	7,372	18	88
Residential	27,887	4,220	?
Commercial			
Industrial			
Wastewater treatment	2,012	27	?
Totals	48,012	4,284	88
2001 consumption	250,494	13,571	?
Percent of energy use	19%	32%	?
CO₂e (Million metric tons)	56	50	

system as a whole – which leads to the blame game when things go wrong.

Stand back for a minute and look from outside of this industry and you may well see how hard we make it for the customer (and ourselves).

That's where the skill of a good plumbing engineer can shine through by providing the science to back up their work – and not just a few supplier brochures for reference.

To be really effective in the future, there is a profound need for closer collaboration between the various market sectors such as fixtures, piping, hot water and pumps/valves.

Individually no-one has the answers but collectively great things can be achieved.

Enjoy the interesting collection of articles in this issue.

I'm sure there are plenty of *WPR* readers who would agree with Klein when he says some of the short-term measures, such as reducing the flow in piping systems, are actually costing home/building owners more in the way of energy wastage in the long run.

He introduced the term 'structured plumbing' as a possible solution, a term that I am familiar with, from another market sector.

In a similar way, 'structured wiring' is a term that is well entrenched in the voice and

data industry, where manufacturers engineer an end-to-end solution and back it with a performance guarantee after the system is comprehensively tested.

The advantage the voice and data industry has over plumbing is that it is a relatively new sector, not with a long history trail that may cause a hindrance to new thinking.

In most plumbing systems, there are many suppliers who excel at producing their product but there is often little consideration for the

Jeff Patchell
Publisher

PATHOGENS IN THE PIPELINE

The deaths of six infants in a Canadian neo-natal ward reinforce the need for hospitals to be exceptionally vigilant about maintaining a healthy plumbing system to guard against waterborne pathogens.

The typical hospital houses large numbers of people in close confines, many with compromised immune systems and all reliant on the same water supply infrastructure.

Over time, microbes build up in the plumbing system of such an environment, and vulnerable patients are exposed to bacteria strains that would not harm a healthy person but can prove deadly to those with weakened immunity.

Between 2004 and 2005, six premature infants died in a neo-natal ward at Centre Hospitalier Universitaire (CHU) Sainte Justine in Montreal, Canada.

Following the first death, the hospital conducted an investigation and was unable to find the infection source. The ward, which had been overcrowded, was disinfected and remained open. Additional deaths over an 18-month period triggered the closure of the ward, and a subsequent investigation identified festering, blocked sinks and a corroded plumbing system as the source of a bacterial colony of *pseudomonas aeruginosa*.

It was reported by Radio Canada that 50 patients had been exposed to infection, including the six infants, and that they had contracted it from water carrying the bacterium.

Pseudomonas aeruginosa, a waterborne pathogen, thrives in harsh conditions and attacks the respiratory system, causing pneumonia and septicaemia in immunocompromised patients. The bacterium commonly exists in the environment and does

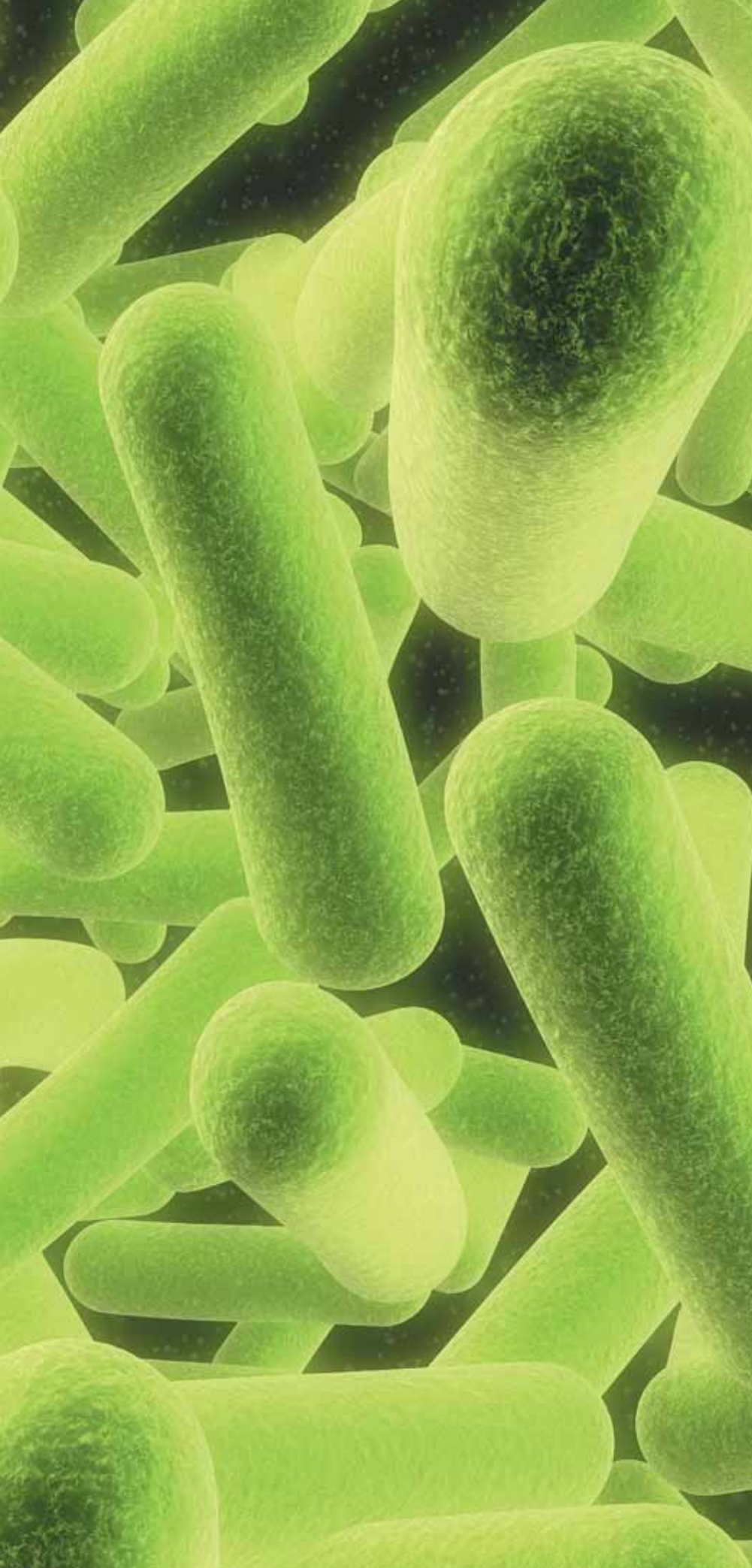
not pose a risk to healthy people. However, there is a mortality rate of up to 40% when it is transferred to newborns, the elderly and patients with immune systems weakened by illness or operation – and an incalculable cost to a hospital's reputation.

University of Pittsburgh special pathogens laboratory director Dr Janet E. Stout says patients in transplant units, haematology, oncology, burns, neo-natal intensive care and other intensive care units are at greatest risk of waterborne infections and need very high quality water.

The US-based Committee to Reduce Infection Deaths (RID) estimates that 100,000 people will die this year from infections acquired in hospital. Patients come into contact with waterborne bacteria, or pathogens, not only through ingestion, but also bathing, ice cubes for mouth sores, inhalation of shower mist or being treated with instruments washed in hospital water.

Dr Stout, an international expert on waterborne pathogens, notes that no single systemic disinfection technology can completely eliminate these micro-organisms from hospital plumbing systems. Many of the microbes live in biofilms – communities of micro-organisms that adhere to the pipes and are resistant to systemic disinfection treatments.

“We are interested in waterborne pathogens for two reasons – because they can cause infections, particularly in immunocompromised patients, and because they are increasingly



becoming resistant to antibiotics,” she says.

“About 50% of the plumbing systems of large buildings – hospitals, hotels, offices – are colonized with bacteria such as legionella and pseudomonas aeruginosa. We need to reduce point-of-source exposure to prevent these bacteria colonizing people, in order to reduce the risk of creating drug-resistant bacteria through the over-use of antibiotic treatment.”

In other words, prevention is the key.

Dr Stout believes the most effective way of protecting hospital patients is point-of-use filtration.

“The efficacy of point-of-use filtration in preventing against micro-organisms was demonstrated in a 2005 study. Mycobacteria, total heterotrophic plate count (HPC) bacteria and legionella were completely eliminated by the filter at the point of use for up to 14 days.

“Another interesting lesson from studies conducted in the last few years is that sensor-operated faucets with a hot and cold water mixing valve – which are traditionally viewed as more hygienic because there is no contact made with the faucet – can actually be a more viable breeding area for certain types of bacteria than conventional faucets.

“The reason for the problem with non-touch electronic or sensor faucets is the stagnation of water at the faucet’s electronic shut-off valves, and the heating and subsequent incubation of pathogens in those valves. The warm temperature in the mixing chamber of the faucet is conducive to the growth of bacteria.

1. Between 2004 and 2005, six premature infants died in a neo-natal ward at Centre Hospitalier Universitaire (CHU) Sainte Justine in Montreal, Canada.

2. A chlorine dioxide unit converts sodium chlorite into chlorine dioxide electrolytically, producing a small volume at a relatively low concentration. It is injected directly into the hot and cold water to control legionella and other waterborne pathogens.

3. University of Pittsburgh special pathogens laboratory director Dr Janet E Stout specializes in the study of waterborne pathogens in hospital water systems.

4. “Copper-silver ionization is a highly effective method of controlling waterborne pathogens in a recirculating hot water system,” says University of Pittsburgh director of Special Pathogens Laboratory Dr Janet Stout. However, it is important to monitor the water periodically because pathogens can develop a resistance to ionization over time.



Of 38 non-touch taps tested, 74% were contaminated with *Pseudomonas aeruginosa* and 100% with *legionella*.”

But this does not mean that sensor faucets and mixing valves don't have a place in hospitals. Good initial design is important – engineers and designers need to know the function of each ward and where various devices are used, and to factor these end-uses into their plans.

“Sensor faucets have a range of important applications in a hospital, but on wards with immuno-compromised patients it is important to minimize the likelihood of waterborne pathogens coming into contact with patients, as there are serious risks associated with these devices,” Dr Stout says.

Plumbing engineers should be aware of the sorts of modifications that need to be made to older pipework to ensure a sanitary system and good drainage. Redundant pipework and cisterns should be removed, as bacteria breed in such places.

“Waterborne microbes may be harbored by amoebae that shelter them and safely

transport them to hard-to-reach areas of the hospital's plumbing system,” Dr Stout says.

“On high-risk wards, water needs to be delivered hot, and pipe runs must be kept as short as possible to avoid the risk of water stagnating in pipes. A combination of techniques is required, and this means good plumbing design and use of materials, and regular disinfection.

“Pathogens can attach and colonize the surfaces of many materials used in water systems, including rubber, PVC and wood surfaces in high concentrations. The removal of such materials has been suggested as a means of reducing bacteria in a plumbing system, but this approach has not been scientifically validated.”

Dr Stout's team is investigating the bacteria-inhibiting effects of copper-silver ionization systems and chlorine dioxide. Copper-silver ionization involves releasing copper and silver ions, usually into a recirculating hot water system.

“Studies have shown this method to be very effective. Chlorine dioxide is a relatively

new technology whereby sodium chlorite is converted into chlorine dioxide electrolytically, producing a small volume at a relatively low concentration. It is injected directly into the hot and cold water to control waterborne pathogens. “

American Society of Sanitary Engineering (ASSE) international past president and Cleveland Clinic facilities engineer Edward Lyczko believes that regular plumbing and general maintenance is vital in the fight against infectious disease.

“In older hospitals, the drain lines must be inspected for leakage. The bacteria that infected the infants at Sainte Justine apparently came directly from the drains. Leaking drains, especially from inside walls, can also result in mould.

“Hospitals need to conduct a regular drain maintenance program to make sure there is a free flow through them. This should involve periodic dumping of an approved, non-toxic liquid drain maintainer, or periodic ‘mechanical’ maintenance such as plunging or snaking.

“When any of these methods are used,



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they must be performed inside a completely surrounding temporary approved barrier from floor to ceiling. An approved high-efficiency particulate air (HEPA) filter unit should be fitted inside the barrier. This will create negative air pressure, preventing any air contamination inside the barrier from escaping into the room. This barrier must also be used any time ceiling tiles are removed or walls penetrated.”

Routine checks should be carried out on all existing plumbing.

“All drains should be periodically swabbed and tested for bacteria,” Lyczko says.

“If there are bacteria present, an appropriate and approved germicide must be used. To protect the potability of water, the entire hospital must have an approved backflow prevention program. To prevent bacteria growth in faucets, all spout-end aerators must be removed. The entire spout should be replaced with an approved integral flow control device that will limit flow to prevent splashing without harboring bacteria.”

Lyczko recommends a holistic approach to facilities engineering to contain the spread of

bacteria in hospitals, and this extends beyond plumbing.

“In newer buildings, correctly installed fire-stopping techniques will indirectly prevent the spread of bacteria because all walls are extended up past the ceiling to the bottom of the next floor or the roof. Pipe chases are sealed at each floor and all penetrations are sealed with fire stopping caulk. This prevents any air circulation across ceilings to other rooms or up pipe chases to different floors, and it will stop the spread of disease throughout the building.

“In older buildings the necessary funds must be allocated to bring fire stopping up to modern codes and to update plumbing systems.”

Beyond regular maintenance and general hygiene, solutions should be tailored to the needs of each ward.

“System-wide disinfection may not always be the best answer,” Dr Stout says.

“A targeted approach – short-term and long-term – may meet a hospital’s needs more effectively. Filtration can be quickly

implemented in an outbreak situation and can also be used long term in high-risk areas for maximum protection.”

For CHU Sainte Justine, the problem has been hard to resolve. It is not easy to overhaul a busy 50-year-old hospital without interruptions to its vital services, and the transformation may take some time.

The Canadian Public Health Department says current immuno-compromised patients have no contact with the mains water system at the hospital at all, whether for washing or drinking. Meanwhile, the hospital is renovating the neonatal ward, which will open next year. 🌐

CONTACTS

American Society of Sanitary Engineering

www.asse-plumbing.org

Committee to Reduce Infection Deaths

www.hospitalinfection.org

University of Pittsburgh

special pathogens laboratory

www.dept-med.pitt.edu/id/clinical_practice.html

SECOND LIFE, SECOND JOB

The residents of the online community in Second Life are developing new ways of making real money. One American city engineer is helping to blur the line between reality and virtual reality.

In 2003 the world was introduced to Second Life (SL) – an online, virtual world where ‘players’ could become whomever they wanted to be. But, as the technology used in digital gaming developed, and through the addition of a free service for basic users, people started to find new ways of using the virtual world to make money in the real one.

In its original format, SL was intended to be just another online multi-player experience designed by Linden Labs in San Francisco. But SL now has more than nine million members, several of whom use the technological platform to operate or extend their real-life businesses.

The online community even has its own legal currency called the Linden. The exchange rate between the two worlds sits between 250 and 320 Linden dollars to one United States dollar.

Pam Broviak, who goes by the online alias of Pam Renoir, is the public works director and city engineer for La Salle, Illinois, in the US.

Broviak now uses her SL alter ego to help in designing new plumbing systems for her clients. She has also initiated the Second Life Public Works Resource Center – one of the first destinations in the so-called ‘metaverse’ focused on applying SL to real-world engineering.

“Right now it’s hard to make money in SL because it’s so new – the real-life business community is just starting to discover it,” Broviak says.

“I only got involved in SL to explore different ways to use it for engineering, because I believe it has a lot of capabilities and tools.

I also wanted to try creating a worldwide community of engineers that can meet and talk about engineering.”

Membership in the public works community gives you access to a new monthly magazine about engineering in the virtual world, *SLEngineer*.

Broviak says she first heard about the program at an Autodesk University – an annual conference put on by the manufacturers of AutoCAD.

“An architect gave a demonstration of it. I thought ‘wow, I can use that’, so I got involved and I’ve been with it ever since, just trying to find different ways of using it for work.

“It was ideal, because I don’t have a lot of time to travel, but I still like to know what’s going on in the industry.

“I work for a city, so I started using the program by designing a new plumbing system to show the residents how we could reconfigure their basements to prevent sewage back-up. It was so much easier to build in SL then print it out to show them than to draw it in CAD.”

Broviak has created three online groups: civil engineering, construction and public works. There are about 40 members in both the civil engineering and constructions groups, and 20 in the public works group.

“The problem I have found is that people who aren’t used to SL are just not sure about it because it looks like a game. But I suppose it’s a learning process, and it’s going to take some time for people to get used to the system.”



Second Life, a virtual world where 'players' can be whomever they want to be, is proving to be a handy tool for engineers. Not only can they create a design in a 3D environment, they can also meet online to discuss and collaborate on ideas.

1. Starting off small, Pam Broviak purchased a parcel of 'land' for just US\$5 a month. Since then, she has expanded by buying a whole 'island' for the members of her public works and engineering groups.

2. Pam Broviak's online Second Life avatar.

3 & 4. In its original format, Second Life was destined to be just another online multi-player experience. Now with a membership of more than nine million users, several SL 'residents' are using the program to operate or extend their real-life businesses.



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Starting off small, Broviak purchased a parcel of 'land' for just US\$5 a month. Since then, she has expanded by buying a whole 'island' for the members of her public works and engineering groups.

The island cost almost US\$1,700 to buy and will cost a further US\$295 each month to maintain.

"There are a few other engineering groups in SL, but we all tend to congregate on my island and have meetings."

Broviak says one of the biggest differences between SL and its competitors is that it is free to download and access. Users can join to explore, meet people, go to classes or build temporary items without paying membership fees.

Building objects in SL involves using a series of primitive 3D geometric 'prims'. Objects can contain between one and 255 prims, which

are mainly boxes, cylinders, prisms, spheres or rings.

Unlike most 3D software, SL uses parametric modeling to reduce the amount of data traveling between your computer and the SL server, which increases the speed at which the program operates.

Broviak says one of the best features of using SL is that you don't need a strong background in CAD to create realistic and interactive products in the online world.

"If you draw something with CAD, everything is just sitting on the computer. It's hard because you aren't there interacting with it: you can't touch it and you can't move around it.

"Sure you can look at it, but in SL you have a 'person' there, so you can see the size in comparison to you, walk around it, sit down to get the perspective from your sitting position, see how it looks, see how the landscaping or

flowers look and see different colors. It's much more realistic and it's much more interactive."

Broviak can't wait until the day she can go into SL when she wants to buy a pump or a valve, enter a virtual store and talk to a supplier, see all of the products and how they fit into her design right then and there. Even if the supplier is halfway across the country.

"The big thing it's going to do is help with communication and collaboration in these groups. Engineers can meet there to discuss engineering or a design in real time.

"It's a really good tool for collaborative work on designs, and I think it's a really good tool for the public. If you have a design you want public input on, you can build it there. People can visit it, leave comments and make suggestions.

"It's definitely going to connect people a lot more, potentially across the whole world." 🌐



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THE BOLD LOOK
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REPORT BLAMES POOR PLUMBING FOR UK FARM MISERY

An investigation into the causes of the recent UK foot and mouth outbreak, which resulted in the slaughter of at least 60 cattle, yields the lesson that biosecurity and high-grade plumbing go hand in hand.

Six years ago a foot and mouth epidemic in the UK crippled farms across the country, costing the economy an estimated £8.5 billion (US\$17.3 billion).

The clean-up was extensive and heartbreaking for farmers, requiring the slaughter of between 6.5 million and 10 million animals. The long-term effect was an incalculable loss of trade and confidence in the UK farming community.

This year, with farmers still haunted by the 2001 outbreak, the disease was again detected in cattle at several farms in Surrey, south-west of London. The government immediately acted to isolate the disease with a ban on the movement of livestock across the country – at a time when farmers were likely to be transporting animals in preparation for autumn and winter conditions.

National Farmers Union spokesman Anthony Gibson told the BBC the new outbreak would have severe financial implications.

“The longer we keep getting these outbreaks, the longer it will take to get the export ban lifted. And that’s costing at least £2 million (US\$4 million) a day. Since the foot and mouth outbreak was confirmed in August, we think the total cost to the farming industry is about £250 million (US\$510 million). That’s in terms of lost exports and lower meat prices.”

A recent report by the Health and Safety Executive (HSE) was able to isolate the source of the outbreak and investigate likely

causes. Poor plumbing installations at the nearby research facility Pirbright may have contributed, and the occupants of the facility were potentially in breach of strict biosecurity Standards.

The report was triggered when the Department of the Environment, Food and Rural Affairs (DEFRA) established that the foot and mouth virus that infected the cattle in Surrey was not naturally found in the environment. It was a laboratory strain and was not known to be in circulation anywhere else in the world.

This was the strain being researched at Pirbright by three occupants of the facility at the time – a government agency and two private companies.

The report investigated various ways the disease could have leaked from Pirbright, including airborne release, human movement, solid waste removal and liquid waste disposal. It found no evidence to suggest the disease was leaked from the site into the atmosphere or through solid waste disposal, as the appropriate bio-control systems were in place. But liquid waste disposal was a different matter.

Most liquid waste from the facility passed through two chemical effluent inactivation treatment processes on site before joining the public sewer. However, the report notes that wastewater from human showers was not treated before it entered the site drainage system. It was therefore possible for small



quantities of live virus to enter the plumbing from workers.

It was also possible that one on-site operator, which was testing the virus in much higher volumes than the other two, flushed waste containing the virus into the effluent sump and this passed into the drainage system. Waste in the drainage system was routinely given a final effluent treatment before release into the public sewer, and these incidents in isolation were not considered to be in breach of biosecurity regulations.

However, at some stage in the drainage process before the second and final

treatment phase (where caustic soda should have neutralised any live viruses), infected wastewater leaked out of the pipework, contaminating the surrounding soil. In other words, the report concludes, the site's plumbing network failed to contain the virus.

In its assessment of the condition of the ageing drainage system, the report noted weaknesses in the containment standard of effluent drains across the Pirbright site. These included displaced joints, cracks, debris build-up and tree root ingress.

Unsealed manholes were also investigated, and the report concluded it was very likely that

a poorly fitted and neglected manhole, with gaps around the edges, had allowed virus-laden effluent to escape and infect surrounding soil during a period of particularly heavy flooding.

An independent review presented to the Secretary of State for Environment, Food and Rural Affairs and the Chief Veterinary Officer concurred with the report, adding there had been concern for several years about the maintenance of plumbing and drainage on site, which seemed not to have had regular inspections. No money was made available for a replacement system¹.

The report considered record-keeping,

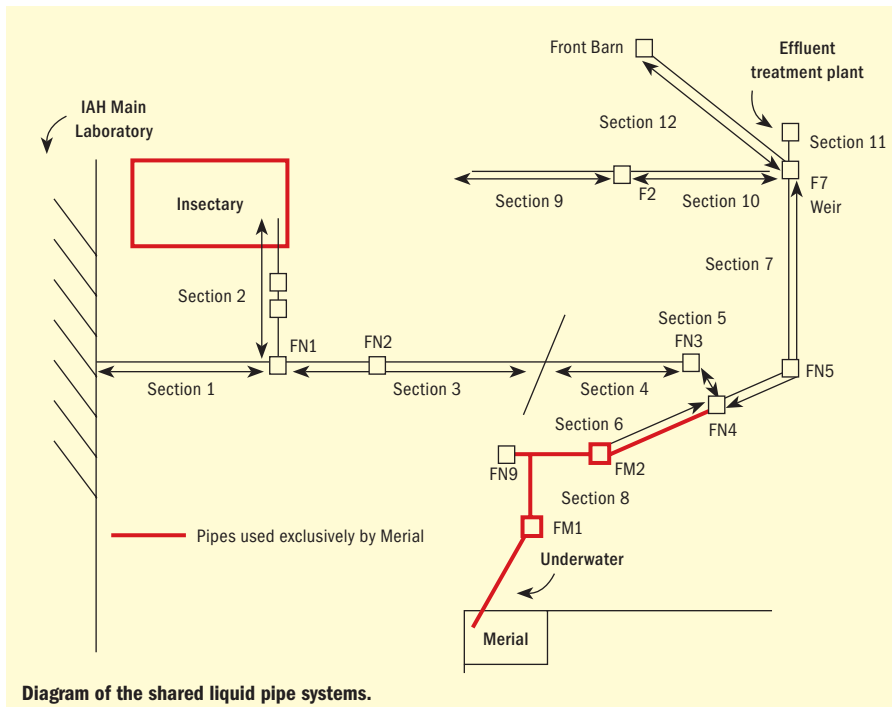


Diagram of the shared liquid pipe systems.

maintenance and inspection regimes at Pirbright to be inadequate for a biosecurity-critical facility. One of the operators was found to be using bowzers and hoses in the intermediate site effluent drains to clear blockages without a standard operating procedure, which was a breach of biosecurity even though it was unlikely that the practice caused the spread of the virus in this instance.

So how did the virus reach the farm from the Pirbright facility about 2½ miles (4km) away? At the time, roadworks were being done in the vicinity. Four 32-tonne trucks removed soil from an on-site trench and transported it along a route that included a lane close to the first infected farm and known to be used by the farmer and visitors. This coincided with a period of heavy flooding of the Pirbright site and roads in the area.

This movement took place about the time of the initial exposure of cows to the foot and mouth virus.

The report recommended that the drainage system at the facility be improved to meet biosecurity containment standards, and that better record-keeping, monitoring regimes and plumbing maintenance procedures be enforced.

Robert Burgon is World Plumbing Council deputy chairman, and director of the Scottish and Northern Ireland Plumbing Employers Federation.

“Attention needs to be drawn not only to the effects of this devastating disease but to the cause in this instance,” he says.

“This incident should provide a reminder that properly installed, well-maintained plumbing is vital to public health and good biosecurity.

“The UK is the poor relation of other developed countries when it comes to plumbing Standards and regulations. There are two issues – certification of those who install the systems, and regulations governing maintenance.

“Anyone can install a drainage system here. This makes us susceptible to poor plumbing practice, and it’s worrying that this applies to high-risk facilities like hospitals and research centres.

“The situation at Pirbright seems to have been caused by neglect of the drainage system, and it might have been avoided had regular maintenance and record-keeping procedures been in place.

“Although it is sad that it takes serious bad news to highlight the importance of good, well-maintained plumbing systems, the reality is that stories like the spread of SARS in Hong Kong and now the apparent breaches of biosecurity at Pirbright in England have raised public awareness of the consequences of badly installed or neglected plumbing.

“We hope there will be a review of plumbing practices in the UK.

“The World Plumbing Council’s mission includes raising awareness of the health and environmental roles of the plumbing industry – issues that are often taken for granted.

“It seems inadequate attention to plumbing maintenance in this episode may have been a factor in the spread of a virus from what should have been a secure testing facility. And it proves that poor plumbing can also affect economies.

“We must all hope the lessons of such events lead to a greater understanding that good plumbing and maintenance are important in every aspect of society.” 🌐

1. Independent Review of the safety of UK facilities handling foot and mouth disease virus, chaired by Professor Brian G. Spratt, 31 August 2007, page 9.

CONTACTS

World Plumbing Council

www.worldplumbing.org

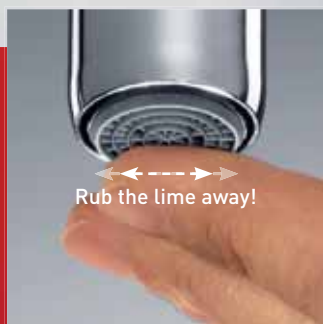
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‘SUPER’ SOLUTION

Imagine the equivalent of a large cinema crowd needing bathroom access 30,000ft in the sky. Aircraft plumbing designers are turning to distributed systems for solutions.

It is comforting to know that the giant Airbus A380 airliner has achieved a test evacuation of 853 passengers and 20 crew in just 80 seconds, but another high-speed evacuation on the aircraft will also make passengers feel more comfortable.

The passenger evacuation was carried out in the dark and only half of the aircraft's 16 exits were used. Participants did not know which emergency doors and slides would be operating.

The evacuation test was the first to be done on a double-deck plane. It was supervised by the European Aviation and Safety Agency in conjunction with the American Federal Aviation Authority.

The other A380 evacuation success is of more interest to plumbing engineers.

An Airbus factory in Hamburg, Germany, houses a three-story test rig that replicates the A380's almost 1000m of piping. Its main function is to test the effectiveness of up to 20 toilets that can be installed in the aircraft. The rig can be tilted to simulate flying conditions.

Apart from the usual considerations of flushing, extraction and hygiene, plumbing engineers must deal with the odd objects that somehow find their way into aircraft toilets.

Frank Dohrmann is head of design support

and cabin testing at the main German plant. He says passengers would not be too upset if the temperature inside an aircraft varied slightly, but if toilets were jammed they would remember it for years.

"Toilets are very important to airlines," he says. "Some people put anything down there – towels, spoons, glasses, diapers. They behave as if they were at home."

A typical A380 configuration accommodates about 550 passengers, but charter companies can specify more than 800 seats. That's a lot of people wanting to go to the toilet.

Consequently, engineers operating the test rig in Hamburg have done their best to block the toilets – then figure out how to avoid serious problems in flight. One airline is reported to have asked for socks to be stuffed into the test toilets.

Waste pipes from the 20 toilets on the rig are fabricated in clear plastic for observation purposes. The pipes in the aircraft are formed from titanium to reduce weight.

Toilet flushing is achieved by pumping air from the system, creating a partial vacuum to evacuate waste to a holding tank in the rear of the aircraft.

The engineers have proudly announced a pipe speed 'best' on their test rig of 60m per



second, which equates to more than 200kmh (125mph). Such speeds are important – the A380 is 73m (80 yards) in length, so it's a long way from the front toilets to the holding tank.

In a technical paper for the 25th International Congress of the Aeronautical Sciences late last year, Dr Michael Rempe and Dr Murat Ünlü of Airbus write that cabin systems of modern aircraft are increasingly designed as distributed systems.

With the A380 water/waste system as an example, they show how design and testing methods must cover the entire development process.

The design of aircraft water/waste systems has to reflect several requirements relating to flexibility of the cabin and options such as humidifiers and galley inserts. It also has to meet challenging 'operational interruption' targets to ensure market competitiveness.

To cope with such requirements, a basic system architecture of four independent waste sub-systems was selected for the A380. To support the general mechanical system architecture a corresponding distributed control and monitoring architecture based on a serial communication bus – the controller area network bus (CAN-bus) – was chosen.

The potable water system and the waste system are distributed systems – that

is, composed of autonomous local small computers connected by a communications network and equipped with software enabling them to co-ordinate activities and share resources.

There are four CAN-buses for the waste system – one for each side on the aircraft's main and upper decks. All waste CAN-buses are fully autonomous, that is, the system is four times redundant. This is not important for safety reasons but for functional availability.

The potable water system comprises two CAN-buses and an extra one for optional equipment. This suits the requirements of highly operational and customizable systems.

A computer integrates different functions for the water and waste system. It is the interface to the aircraft systems, cabin indications, the maintenance system, etc.

The location and number of toilets, galleys, humidifier valves, etc. depend on the cabin layout, which is customizable. Also future optional equipment must be taken into account when designing a cabin system.

The non-deterministic character of the CAN-bus and its nodes makes testing and the applicability of formal methods more problematic. Integration into the aircraft and verification requires not only a sophisticated test strategy but also lots of test equipment.

The water/waste system of the A380 has about 2,000 parameters. All system components (toilets, faucets, tanks, valves, sensors, etc.) were integrated in the test bench to replicate as far as possible the system's real behavior on the aircraft.

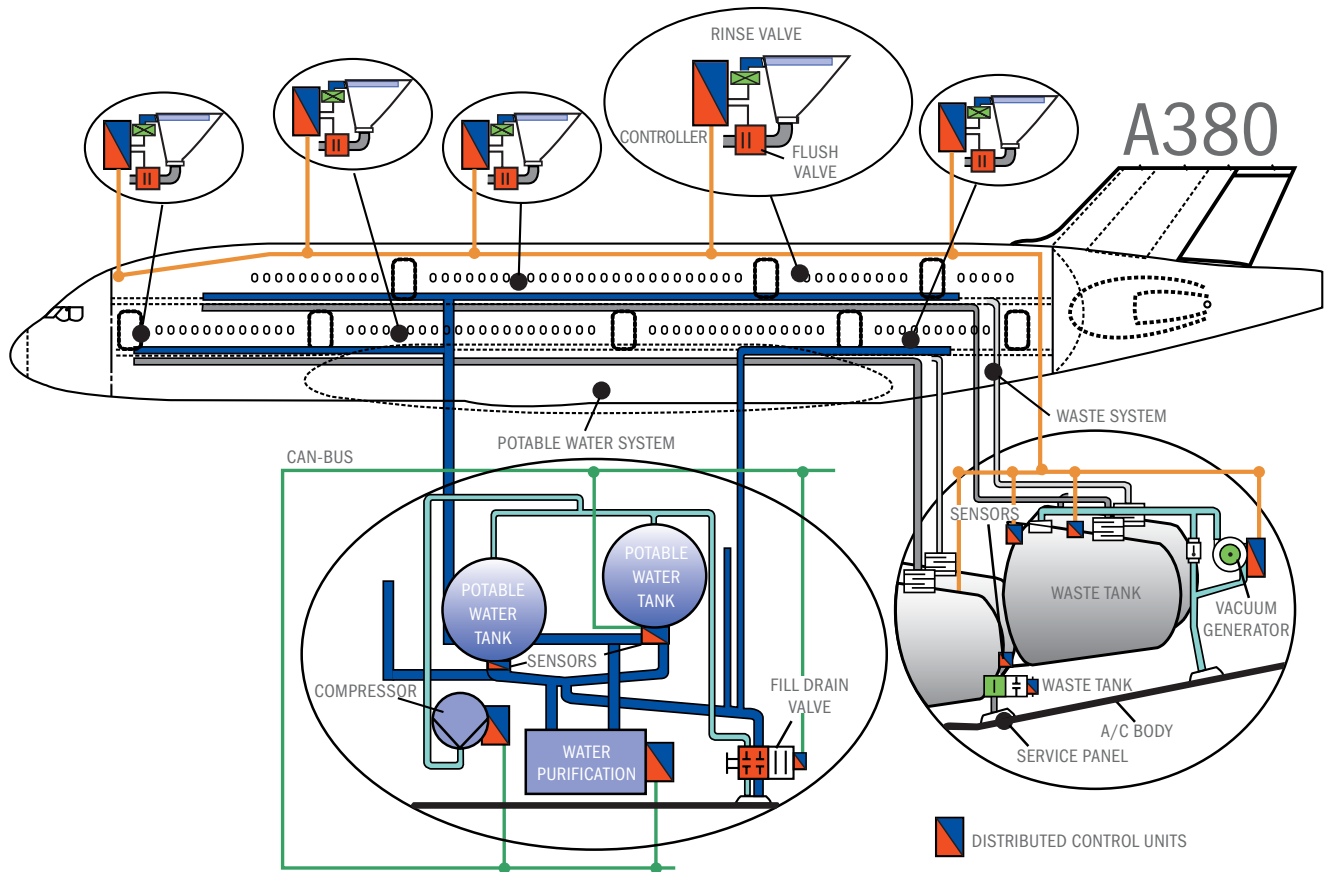
Connecting all distributed controllers and smart equipment to a central processing unit generally results in an error-prone cable 'jungle' with a lot of disturbances and a high risk of problems (wiring failures, perturbations, hardware/software failures, etc.).

The test bench is at least as complex as the actual system to be tested. Any failures under test have to be thoroughly investigated to ensure that they are not in the test bench itself.

The main result of extensive testing might be a failure-free test bench but not a failure-free system. And a complex centralized test system is also not very flexible in terms of modifying the system under test.

However, flexibility is one of the top-level requirements. Testing a distributed system with a centralized test architecture is not straightforward.

A natural approach to testing distributed systems is to apply a decentralized test strategy. The system under test can be



separated into autonomous test nodes with mainly decentralized tasks, and 'smart' test controllers perform single test tasks.

With a display and a keypad these test controllers can simulate, record and evaluate signals. Each test controller focuses on the signals and communication data of one unit.

This approach has several advantages. These test controllers can be modified easily to adapt to new equipment without extensive changes to the test bench. Also, they are portable and can be used away from the bench – in a climate chamber, electromagnetic compatibility test laboratory or on the aircraft.

This last aspect is of great importance, as the same test controllers can be used for ground and flight tests. A small test controller in combination with a laptop is a mobile, handy and smart solution.

These concepts have been applied for testing the A340 water/waste system and are also being used for the A380 water/waste system tests in the laboratory, on the ground and in flight.

The test methods allow numerous configurations. One possible configuration for

integration tests of the potable water system consists of:

- different valves to fill, drain, depress, and shut off the system;
- the potable water indication panel for servicing;
- sensors to measure the water level;
- compressors to provide pressure for potable water distribution to consumers.

The configuration contains the compressors with pressure switches, some valves and the indication panel as real hardware components. The cabin interface computer and potable water level sensors are incorporated as simulation on the test controller or the server.

The illustrated test set-up allows overwriting the real pressure values by the test controllers. In this way, the compressors can be tested by simulating different water levels, tank pressures and flight phases.

Furthermore, the potable water indication panel, which incorporates extensive logics for valve control, can be tested. For these tests it is very important that software-related aspects – like the system logic – are able to be analyzed, and also that the physical and electrical behavior of the system is in focus.

For example, the depress function, which is controlled via the PWIP by sending the corresponding commands to the smart valves, monitoring the pressure at several points in the systems is one of the main parameters.

With the methods shown, different configurations of original and simulated equipment can be set up. So incremental testing is possible, taking into account test progress, test objective, equipment delivery status, optional equipment, etc.

The same methods can be used for validation purposes. For example, in developing customizable equipment the test controllers can be programmed as simulation of the equipment and integrated into the real or partly simulated system.

Thus the specification can be validated early in the development phase to speed up the whole development process.

So, when you take your seat aboard the giant A380 Airbus in the near future and marvel that an aircraft so large can even get off the ground, let alone fly using less fuel than its predecessors, spare a thought for that 'other' engineering excellence taking place beneath your feet. 🌐



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LUXURY GOES GREEN

Hotel bathrooms have to meet guests' expectations while saving water and power.

Global economic growth is resulting in increased international travel by the corporate sector, and growing purchasing power in populations is leading to more leisure-related travel and rising demand for more luxurious accommodation.

According to a survey by MKG Consulting and reported by Hotel Online, about 150,000 new hotel rooms were opened by hoteliers in 2006. On 1 January 2007, the worldwide supply of the top 200 hotel groups reached 43,000 establishments and 5.5 million rooms.

However, this raises the question of how designers are dealing with the need to reconcile environmentally sensitive building requirements with the luxury that a growing number of people are prepared to pay for.

Hotels are big consumers of resources such as water and power. Even though there is an evident trend for ensuite bathrooms to become larger and more stylish, there is also recognition that hotel facilities must become 'greener' because of the dwindling supply and rising cost of water in many countries. Hotel customers are also becoming better informed about the importance of conserving scarce resources.

Other issues likely to confront the big hotel chains include the needs of specific groups such as aged and handicapped people, those with religious-based requirements such as Muslims, and the needs of obese people.

Hyatt Hotels vice-president of architecture and design Larry Traxler says that in general,

hotel bathing areas have been 'trending upward' over the past five years, mainly because discriminating travelers demand a larger and more luxurious grooming experience comparable to the growth occurring in residential design markets.

"In addition to increasing bathroom sizes, we are also designing in 'memory makers' that most guests do not have in their homes – like in-mirror televisions, surround-sound speakers, towel-warming racks, heated floors, steam showers, deluxe toilets and foot baths. But the biggest task we are experiencing in all of our design projects would be the shift towards 'eco-sensitive luxury' items.

"We are requiring water-efficient toilets in all rooms, and are also trying to engineer (along with our partners Hansgrohe and Kohler) rain shower heads that are much more water conscious. The shower heads in a typical guestroom are very important when you look at overall water consumption in a large hotel.

"We strongly believe we can provide a much more sustainable hotel product that seeks to conserve energy and other natural resources but still provides the guest with the feeling of luxury and pampering they are looking for in a full-service hotel.

"There is a much more focused effort on developing these sustainable plumbing products for use in the US market, but we are still way behind the rest of the world in this respect. We are drawing on our hotels and design teams from around the world to provide

us with best practice in this field and applying it to new projects in the US. It is hoped that the plumbing industry and code inspection officials can keep up with our demand for change in this regard.

“Shifts are being made in bathroom design according to guests’ needs and use patterns. In business hotels around the world, most guests are much more satisfied with a large walk-in shower than they are stepping into a small bathtub with a shower curtain. In our renovations, we are converting most of our king room bathtubs to glass walk-in showers with a bench. This conversion to showers would certainly not be a shift that we would consider in a resort environment, but it is just one way that we are responding to the evolving needs of guests.”

US-based company Kohler is a big supplier of bathroom plumbing fittings to the hotel industry around the world. According to worldwide corporate accounts manager Marshall Williams, there is a trend for bathrooms to occupy a larger percentage of the total area of new hotels and for higher-quality amenities, but there is also an increasing emphasis on water and energy conservation.

“There is a general push to find ways of delivering conservation more effectively, and significant improvements continue to be made in products such as faucets and shower heads,” Williams says.

“Reduction in the use of hot water in particular also leads to reduced energy



A typical luxury ensuite bathroom from one of the many Hyatt Hotels from around the world.



1. Tripoint Touchless Electronic Faucet from Kohler.

2. Sloan's solar-powered Solis faucet operates electronically from any natural or artificial light source and includes a 0.5gpm/1.9Lpm aerator for maximum water conservation.

3. Kohler's Tripoint Gooseneck Touchless Electronic Faucet.

4. Hotel ensuite bathrooms are a significant market for water-conserving Flushmate toilets from the Sloan Valve Company.



consumption, which means conservation of multiple resources in hotels and a significant impact on their bottom line.

"Efforts are also being made to influence people's mindsets by providing education designed to change attitudes about water and energy use. Hotels are increasingly seeking feedback from customers by using tools such as a guest satisfaction index matrix, whereby study groups are formed and questionnaires used to find out what guests want from hotel accommodation. A key aim is to build the consciousness of guests through measures such as signage in bathrooms about the importance of resource conservation.

"A Green Hospitality Conference was recently held in the US, which is an interesting sign of the times. There is an escalating trend for hotels to be marketed as green, and I believe that within 10 years all new hotel properties will be green. Efficient water use in hotels is particularly important due to the frequency of use and sheer number of people using bathroom facilities each day.

"Greater attention is being given to

the needs of specific community sectors. Recognition of ageing populations is evident in the provision of grab bars in all showers and shower/tub combinations, whereas once these might only have been installed in a small percentage of rooms to cater for the disabled. Attention to safety can also be seen in the addition of red and blue indexing, which is internationally recognized for hot and cold water outlets.

"Another interesting trend is the emergence of hotel bathrooms designed to assist guests in overcoming jet lag through the provision of whirlpool spa baths and massage tables."

Williams says manufacturers such as Kohler are responding to the need for conservation by developing new products that use less water but don't sacrifice performance.

Kohler provides a range of water-efficient products designed for hotel ensuite bathrooms, including the Ecoefficient shower head and hand shower, which the company says reduces water flow by up to 20% over conventional spray heads. Other products include touchless faucets with low-flow aerators and Tripoint

technology designed to save water, together with a range of low-flush toilets.

Scott Riggs is consumer service manager at the Sloan Valve Company in the US. He points out that because hotels are big consumers of water, they are under increasing pressure to reduce water use - by the cities in which they are located and by their own management to reduce water and wastewater bills.

"Hotel ensuite bathrooms are a significant market for our water-conserving Flushmate toilets," Riggs says.

"Also, the sheer logistics of having to service hundreds or even thousands of toilets throughout a large hotel complex makes it necessary to have fixtures that operate effectively.

"Flushmate is a pressure-assisted technology that works much more effectively than gravity-fed toilets. As a result, hotels have fewer service calls and patrons are happier with toilet performance.

"Following our policy of continuous improvement, we recently released a new flush-valve cartridge for Flushmate that has



5. The Crowne Plaza Cabana hotel in Palo Alto, California, US, has many green initiatives, including solar power and the deployment of many water-saving technologies in its restrooms and ensuite bathrooms.



6. Keeping it simple ... inside the Yotel ensuite bathroom.



7. In the hand ... the Mastershower Eco Handshower from Kohler.

an accelerated lifecycle and is designed to be quieter and require less handle torque than previous generations. The new cartridge significantly reduces the actuation force required to flush, handle kickback is minimized and the life of the assembly is extended.

“Another recent release from Sloan Valve is the advanced Solis solar-powered faucet, which operates via ambient lighting and provides the convenience of touch-free electronics while assisting energy and water conservation. Solis comes with integrated temperature control and an aerator to regulate water flow. An integrated power plant storage cell transforms light from any source into electrical energy, and back-up energy is provided by batteries that can last up to 10 years.

“Sustainable water strategies continue to emerge in building designs, and global demand for energy-efficient and water-conserving products has escalated. Hotels are recognizing the benefits of products such as the hands-free Solis, not only in relation to energy and water savings but also the customer-friendly ease of operation they offer for the elderly and those

suffering from conditions such as arthritis.”

Although there is a trend to larger and more luxurious ensuite bathrooms in many of the leading hotel chains, a UK-based company has launched an accommodation concept inspired by first-class airline cabins that provides a small but luxurious ‘cabin’ at airports for use by those facing early morning flights, unexpected flight delays or flight cancellations.

Yotel recently opened 46 cabins in the terminal building at Gatwick Airport, and there are plans for other airport locations to follow. Cabins can be booked for just a few hours, with the aim of providing flexible and convenient hotel accommodation at affordable prices.

The cabins feature an ensuite bathroom with a shower and luxury fittings, flat screen TV with more than 60 stations, and a techno wall that offers clothes storage and a pull-down work desk with charging points, network cable socket (free WiFi) and wired Internet access.

Concept founder Simon Woodroffe believes that in the 21st century luxury will be widely available at the right price, and Yotel is a taste of that future.

“Traveling can be a painful experience, so we are looking to make it as pleasant as possible for Yotel customers. We expect this radical approach to be extremely popular with a range of consumers and we are looking to expanding Yotel globally.”

Cabin sizes range up to about 10m, and prices for a standard cabin are from £25 (US\$51) for four hours and from £55 (US\$112) overnight. A premium cabin will cost from £40 (US\$81) for four hours and from £80 (US\$162) overnight. 🌐

CONTACTS

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BUGS EAT THEIR WAY THROUGH A FATTY PROBLEM

Until recently, mechanical methods have been used to clear blockages in sewerage systems caused by fats, oils and greases. But not everyone agrees. A different school of thought is biting into traditional thinking.

Build-up of fat, oil and grease in sewerage systems has become a big problem in many cities around the world, resulting in sewer overflows, health and environmental issues, and costly remedial works.

The problem can often be sourced to commercial kitchens, such as those in fast-food restaurants, where in some cases discharges directly enter local authority sewers without treatment.

Various means are used for dealing with this, including installation of grease traps and water jetting of sewer lines, but a solution that has become more prevalent in recent times is the use of bacteria to consume and disperse the fat, oil and grease – or FOG.

US-based company Environmental Biotech uses a technology known as bio-remediation to clear blockages caused by FOG in sewerage systems. Vegetative bacteria micro-organisms are injected into the system to feed on fat, sugar and starch wastes. The company has undertaken projects in several countries for a range of customers including hospitals and McDonald's restaurants.

Managing director Aziz Tejpar says bio-remediation is not new – it is nature's way of breaking down waste – but all applications do not necessarily work.

"It is important to ensure that the right bacteria are selected for individual jobs – that is the key to success with this technology.

"The cost of pump-outs and spillage clean-

ups can be substantial for water utilities and individual companies, so it is better to follow a preventive rather than a reactive strategy with FOG problems.

"We take a fully integrated approach when managing drainage systems. This includes a thorough inspection of the customer's drainage system and its effectiveness, analysing the type, volume and frequency of waste being discharged to the system, then selecting the appropriate form of bacteria and dosing method.

"Dosing is controlled by a timer to release the live bacteria into the system at an appropriate point, such as through a grease trap in the premises. Fully trained technicians carry out regular inspections of the site once dosing has commenced to ensure its effectiveness and to replenish the bacterial solution.

"Bacteria can be injected into the system up to 12 times a day, and the reservoirs containing the bacteria are replaced every 14 days. The hydrocarbon-based fats are digested by the bacteria and reduced to carbon dioxide and water, thereby ensuring that wastewater flow through the drain lines is not impeded.

"The food service industry is the largest contributor to FOG-related sewer blockages, so our bio-remediation technology is now benefiting restaurants, hospitals, schools, factory cafeterias and prisons, as well as food processing and manufacturing. Because Environmental Biotech operates on a global



level, frozen bacteria can be quickly air couriered to mobile service units operating in various countries.”

In the UK, Environmental Biotec has been carrying out bio-remediation trials over the past four years in conjunction with Anglian Water, the largest water authority in England and Wales, and the Water Research Council. This includes a trial to clear FOG from an 18" (45cm) sewer in Baddow Road in Chelmsford, Essex, where about 20 food outlets are located and there is a history of sewer blockages, overflows and odor problems.

Gary Collins of Anglian Water says the trials were conducted with the co-operation of local businesses in adopting preventive drain line management, including the installation and effective operation of grease traps to reduce the amount of FOG entering the sewerage system.

“Sewer blockages are 75% FOG driven, so it was pointed out to the food business operators that significant cost savings can be achieved through the use of an appropriate preventive system. Reactive measures, such as high-pressure water jetting, can be very expensive.

“The next step was for Environmental Biotec to introduce the bacteria to the sewer to eat the FOG. The company then monitored the project. Sewer blockages are down by 50% following the use of bio-remediation, and the big benefits have been a reduction in odor complaints, costs and pollution, together with an improvement in the general

reliability of the sewerage system.

“This technology has been used to effectively clear large sewer mains and pumping stations throughout Essex and also installed in kitchens to remove FOG. There are now plans to roll it out more generally across the Anglian Water service area.”

Tejpar says there are several biologically based solutions to FOG on the market but they have had mixed results.

“Many of the enzymes, surfactants and solvents just move the FOG further down the drain line where another blockage can occur, whereas our two-phase bacterial technology provides a lasting solution. This technology is used by a growing number of food outlets, including McDonald’s restaurants.”

UK McDonald’s building services manager Tim Bedford says the company takes its environmental responsibility seriously, including minimizing water consumption and improving the quality of wastewater discharged.

“We have adopted different biological treatment systems and products to combat the effects of FOG in our wastewater discharge. They have been used in isolation or in conjunction with grease traps/FOG separators with varying degrees of success.

“Over recent years we have introduced the Environmental Biotech system to more than 100 restaurants in the UK. These restaurants have seen a dramatic improvement in the quality of wastewater entering the drainage system. The system itself is unobtrusive and



Blocked drains and sinks like can be the cause of many environmental and health issues and result in costly remedial works.

1. An ETG aerator at work. The company says gene coding is now being adopted in Australia, and a national Standard for additives to grease traps is being considered.

2. US-based Environmental Biotech managing director Aziz Tejpar says bio-remediation is nature's way of breaking down waste.

3. The ACO programmable automated bio-chemical dosing system complete with stainless steel mounting frame and 5L of bio-chemical activator.

4. UK-based ACO Building Drainage technical manager Peter Jennings.

5. Environmental Technology Group (ETG) chief technical officer David Lee.



can be installed quickly and easily."

Australian-based company Environmental Technology Group (ETG), which also provides services in Hong Kong, Singapore, China and Malaysia, uses non-pathogenic waste-digesting bacteria to provide a continuous cleaning action in waste disposal systems.

ETG chief technical officer David Lee says regulations relating to the use of bacteria to deal with FOG blockages in sewerage systems vary from one water utility to another in Australia, but gene coding is now being adopted, and a national Standard for additives to grease traps is being considered.

"By using a biological growth formula, the effectiveness of those strains of bacteria that have been identified as best suited to a specific waste stream can be improved. Combinations of species often provide a more powerful and complete degradation of specific pollutants than individual strains applied alone.

"This is because the byproducts of one species often serve as food for another species. Only a correctly balanced formula of

bacterial strains can use this synergistic effect to completely break down pollutants to non-toxic products such as carbon dioxide, water and sulphate.

"Our biological treatment populates the wastes that accumulate inside drain pipes, and the enzymes produced by the bacteria break down grease and other organic matter, enabling the bacteria to fully digest the pollutants.

"Specific formulas are designed to solve specific problems in sewerage systems. As a FOG blockage is reduced, the bacteria die off or reproduce less often so that the population naturally tailors itself to the pollution level.

"This is the technology of the future and is being successfully used by water utilities in Australia and other countries to clean sewerage systems. Savings of 50% on energy costs for aeration can also be achieved, and this will escalate as the cost of energy increases."

The Jay R Smith Manufacturing Company in the US produces a range of grease interceptors designed to prevent blockages caused by FOG

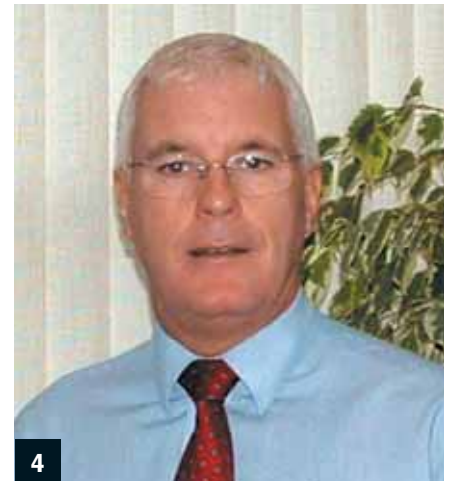
in sewerage systems. Consultant Max Weiss has reservations about the effectiveness of adding bacteria, enzymes or surfactants to clean a grease interceptor or wastewater collection system.

"Engineers painstakingly design grease waste piping, determine the optimum interceptor type for the application, size it to the facility peak flow, and argue the design selection and sizing criteria with code officials – all of which is at significant expense.

How ironic is it then to expend more money and time to select, purchase and implement use of a product designed to flush the collected grease from the interceptor?

"Grease interceptors and collection systems are not suitable environments for complete beta oxidation of polar hydrocarbons. There is a decided difference in the process and outcome of supplying an additive to a conventional system and seeding even the same additive to an engineered bio-reactor.

"Grease interceptors, whether effecting separation and retention of FOG by



hydromechanical means or gravity alone, are storage devices functioning via differing densities and viscosities of the two substances, FOG and water. Alteration of the physical or chemical characteristics of either substance, or both, such that emulsion is more likely to occur, will logically result in reduced retention of FOG.

“Simply dumping an additive down a drain will not produce the desired result of reliably and permanently altering the FOG molecule so that it no longer is capable of surface adhesion and thereby causing a blockage and subsequent system overflow. Long-term storage (30 days or more), and/or use of additives, increases the deleterious effects of FOG in the drainage system.

“Proper interceptor sizing, installation and maintenance, or application of an engineered FOG disposal system such as a bio-reactor, are better methodologies for FOG abatement. FOG problems are increasing, the molecule is becoming more complex, emulsifying cleaners are more effective, at least temporarily, and

there are no ‘quick fixes’ in sight.”

UK-based company ACO Building Drainage provides a range of drainage services including installation of FOG separators and biological or enzyme-based dosing units.

Technical manager Peter Jennings says the company has extensive experience with both technologies, having supplied a range of biologically dosed systems for more than 15 years in the UK, and EN compliant units in Europe for more than 20 years.

“The Building Regulations for England and Wales make provision for some control of FOG at the wastewater source. These regulations require commercial hot food premises to be fitted with a separator complying with BS EN 1825 or other effective means of grease removal, which can be taken to include emulsifying enzyme dosing units with or without a grease trap unit.

“It is interesting to note that while the Scottish Building Standards require facilities for the separation of FOG in non-domestic properties, they also recommend that

emulsification agents not be used, as they can cause problems downstream.

“Biological or enzyme-based units are commonplace in the UK. For the specifier, the main consideration is to what degree these competing technologies differ in performance and cost – short and long term.

“The biological process is heavily dependent on temperature, availability of oxygen and food, all of which relate to retention time in the grease trap. Once out of the trap and in the drain, the variability of these factors may reduce efficiency.”

CONTACTS

www.acobuildingdrainage.co.uk
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PEE-CYCLING

Don't flush away that golden liquid. It's more valuable than you think.

You recycle your household waste. You buy locally grown food, fit low-energy light bulbs and try not to use the car unnecessarily. Maybe you even irrigate the garden with your bath water. But you've still got an environmental monster in your house. Your toilet is wrecking the planet.

Before you point to the brick you've put in the cistern, it's not about the water - well, not entirely. The big problem is pee. Your pee. Do you flush it away without a second thought? Tsk, tsk. Lose the green halo.

At first sight urine looks like an unlikely environmental menace. What harm could come from flushing away a fluid that is mostly water, plus a smidge of proteins and salts? Surprisingly, the answer is "a lot".

The problem with urine is that it is the main source of some of the chemical nutrients that have to be removed in sewage treatment plants if they are not to wreck ecosystems downstream. Despite making up only 1% of the volume of waste water, urine contributes about 80% of the nitrogen and 45% of all the phosphate. Peeing into the pan immediately dilutes these chemicals with vast quantities of water, making the removal process unnecessarily inefficient.

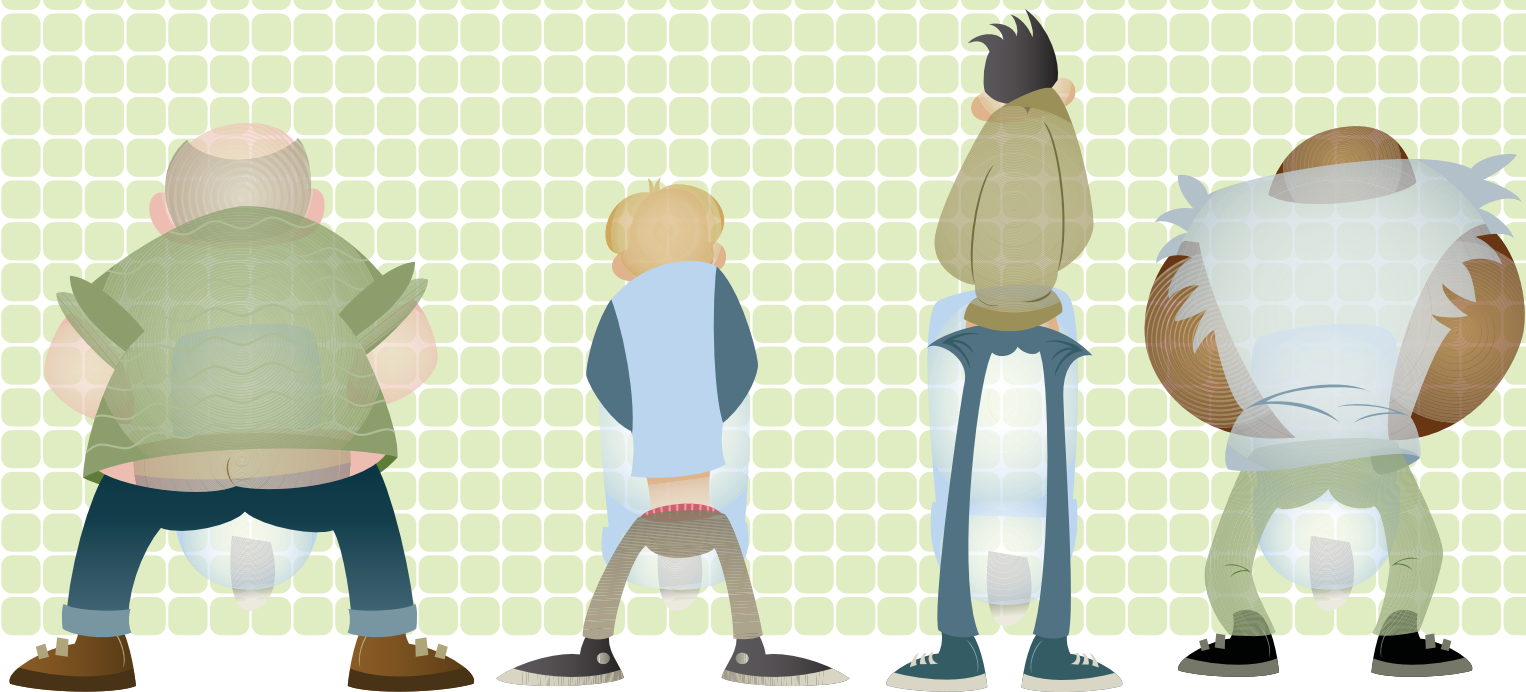
To be fair, if you use conventional western plumbing there's not an awful lot you can do about your personal pee-print right now. A lucky few, however, live or work in one of the buildings in continental Europe where you can find a future must-have eco-accessory: the

urine separation toilet. These devices divert urine away from the main sewage stream, allowing the nutrients to be recycled rather than treated as waste. They could solve all the environmental problems associated with urine and even turn sewage plants into net producers of green, clean energy.

So how do standard sewage systems deal with urine? Known in the business as 'yellow water', urine enters the sewage system and mixes with solid waste (black water), 'gray water' from household sinks and baths, and sometimes rainwater. It eventually arrives at a treatment plant, where it must be cleaned up enough to be discharged into a river.

The first step is to filter the sewage to remove large objects such as condoms, tampons and a random assortment of dead goldfish and false teeth. What remains flows into settlement tanks, to allow the faeces to sink to the bottom. This solid sludge is separated off and stored in oxygen-free tanks, which are gently warmed for about two weeks. Bacteria break it down, generating methane gas that can be burned to produce electricity. The end product is an inert solid that is usually burned or dumped in landfill.

Meanwhile, the liquid portion of the sewage flows into oxygenated 'aeration tanks'. Here microbes guzzle the nutrient-rich organic material and multiply like crazy, converting nutrients into biomass. This eventually sinks to the bottom of settlement tanks as yet more sludge, while the liquid heads off for a final,



energy-intensive 'polishing', which strips out any leftover nitrogen and phosphate that the aeration stage couldn't get rid of.

The whole process is very good at converting yellow, black and gray water into more or less clear water, but all that pumping, stirring, aeration and heating uses a lot of power - about 11.5W per head of population. That's only a tiny portion of your personal daily energy consumption, but it mounts up. In the UK, population 65 million, it means waste water treatment consumes 65,000 gigajoules a day - about a quarter of the output of the country's largest coal-fired power station. In a world where energy efficiency is ever more important, that's not to be dismissed.

According to civil engineer and urine-separation expert Jac Wilsenach, it's highly inefficient. Wilsenach spent six years at Delft University of Technology in the Netherlands working on the intricacies of sewage systems, and according to his calculations, today's methods mean we are literally flushing energy down the pan.

In a paper published last March, Wilsenach calculated that if we were to separate out just half of our urine, the microbes in the aeration tanks could eat up almost all the nitrogen and phosphate (*Journal of Environmental Engineering*, vol 132, p 331). The energy-intensive polishing stage would become completely unnecessary.

There's another, even bigger gain to be had from separating out the urine. Lower starting

levels of nitrogen and phosphate mean that the microbes in the aeration tanks can do their job much more efficiently, taking just one day compared with about 30, thus reducing the energy demand of the aeration tanks. What's more, the resulting sludge is richer in organic matter and generates more than three times as much methane. In fact, says Wilsenach, separating out 50-60% of the urine could turn sewage works from net consumers to net producers of energy to the tune of about 2.5W per person.

So far so good. But how do you stop pee from getting into sewage in the first place? The answer is to install a special WC called a 'urine-separation toilet' or often just a NoMix, after one of the leading brands.

CASUAL INSPECTION

On casual inspection a NoMix toilet looks pretty much like a normal one. But peer into the bowl and you'll see that there are two waste pipes - a small front one and a larger rear one. The front one collects urine and diverts it into a storage tank (sometimes aided by a tiny trickle of water) to await its fate. The rear works like a standard flush toilet.

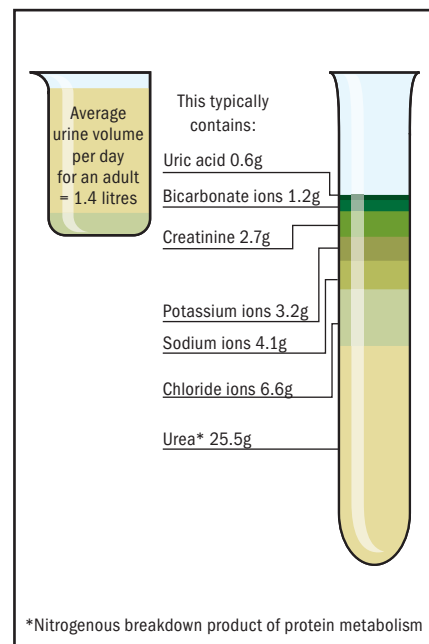
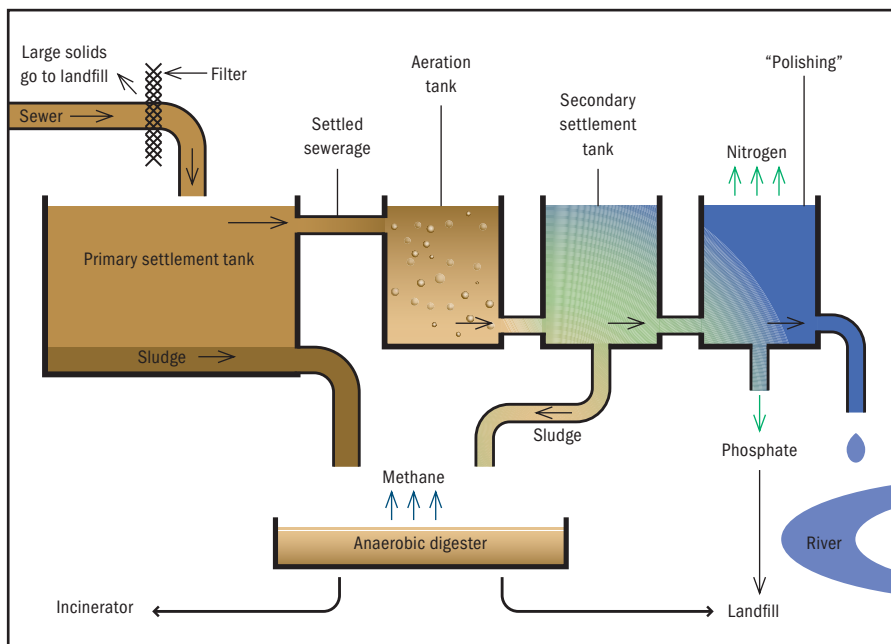
You don't even have to do anything special to make this separation happen - apart from one thing. "The toilet is constructed in a way that if a man or woman sits on the toilet most of the urine is collected," says Bjartur Swart of engineering firm Grontmij in Drachten, the Netherlands, which is conducting urine

separation trials across the country. Yep, that's right. In the urine-separating future, men will sit down to pee.

Although small-scale urine separation has been practised for centuries (pee has been used in industries ranging from textile dyeing to blacksmithing, for example), it is something of a minority pursuit today. Modern experiments started in Sweden in 1994 with the founding of two 'ecovillages' - Understenshögden in Stockholm and Björnsbyn in the far north - whose houses and apartments were fitted with urine-separation toilets. There, the urine is stored for collection by local farmers who use it as a fertiliser.

Other villages have followed suit and Sweden is now the urine-separation centre of the western world, with around 3000 NoMix toilets in use. Denmark has also set up urine-separation projects including one at the Svanholm Gods farming collective near Skibby, the largest producer of organic vegetables in the country (bear that in mind if you ever buy organic vegetables from Denmark).

The urine from all these projects ends up being sprayed directly onto fields, which works fine as long as only a few people are contributing. It doesn't take much, though, for supply to start outstripping demand. "Recycling urine directly is not feasible in cities, but that is where the focus should be because that's where the biggest amount of waste comes from," says Wilsenach, now at South Africa's national research institute CSIR in Stellenbosch.



So what to do with the urine? The answer is, recycle it indirectly - in other words, extract the nutrients and turn them into fertiliser. In the Netherlands, Grontmij trucks the stored urine to a special treatment plant where the phosphate is precipitated out as a mineral called struvite (ammonium magnesium phosphate). This is a useful fertiliser and can help reduce demand for mined phosphate, which can only be a good thing: phosphate rocks are often contaminated with heavy metals, and mining and refining them generates waste and uses lots of energy. Some estimates suggest the world's phosphate mines will be exhausted in 100 years. Yet at the moment we literally pour tonnes and tonnes of perfectly good phosphate down the drain.

GREEN HALO

The other nutrients in urine can also be turned into fertiliser. Novaquatis, a branch of the Swiss Federal Institute of Aquatic Science and Technology (EAWAG) on the outskirts of Zürich, is experimenting with extracting nitrogen and potassium in forms that can be sprayed directly onto crops. Once the urine is treated it is clean enough to go directly into a river.

Crucially, these methods of extracting nutrients directly from urine consume much less energy than dealing with its vastly diluted form in general waste water. There's an extra energy cost from trucking the urine in, but Wilsenach says it's minuscule compared with the savings.

If all these benefits weren't enough, using a NoMix toilet saves water too. According to research done by EAWAG, it reduces your use of flush water by 80%, cutting the average household's overall water use by about 25%. Bear in mind that the water that fills up the toilet cistern is clean enough to drink: "We use good quality drinking water to flush away urine," says Wilsenach.

So where next for urine separation? Grontmij and Novaquatis have set up pilot projects across the Netherlands and Switzerland, and a handful of places are now doing it for real, including the public library in Liestal, Switzerland. Swiss citizens can even buy their very own NoMix toilets and storage tanks if they want, even though the sewage system is not yet ready and the urine ends up flowing into the waste water stream as normal. Urine separation is also taking root in Austria and Germany.

In surveys, people say they would be happy

to use NoMix toilets and buy vegetables fertilised with processed urine. There is even a way round what could seem the biggest obstacle to widespread acceptance. "If a man doesn't like sitting, he can urinate just in a normal way and use the [front] hole as a target," says Swart.

One day we may look back at our habit of flushing pee away with drinking water as staggeringly wasteful. "Water and waste are two of the greatest challenges the world faces at the moment," says Jacob Tompkins, director of Waterwise, a London-based water efficiency campaigning group. "Anything that looks at our low-efficiency way of dealing with the waste stream is extremely important."

Of course it would take time and money to convert existing sewage systems. But even if urine separation isn't coming to your area any time soon, that's not an excuse for inaction. Keeping urine out of the waste stream any way you can pays dividends. So what are you waiting for? Next time you need to take a leak, give the bathroom a miss and head straight for the flower beds. Then you can replace your green halo. 🌍

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thinking bathrooms

O2

OVERCOMES, TOO

Initially it posed a problem for developers, but it wasn't long before the redevelopment of London's O2 Arena provided a huge hurdle for plumbing engineers to overcome.

It has attracted its fair share of criticism over the past few years, but the Millennium Dome, built originally as a temporary structure for the millennium celebrations in Greenwich, London, UK, has developed into an amazing permanent venue.

The Millennium Dome was intended initially to have a one-year lifespan, but was quickly considered for a long-term purpose and ultimately renamed The O2. Although it sat idle for six and a half years, it was given a multi-million-pounds injection by its new owners and now ranks among the world's most exciting sports and entertainment precincts.

The O2 has an overall diameter of 365m (400 yards), an internal diameter of 320m (350 yards), a circumference of 1km (.6 mile) and is 50m (54 yards) high at its central point.

Apart from the huge music and sports arena with a seating capacity of 23,000 (which has already hosted some of the biggest rock bands from around the world), The O2 includes a massive 667,000 sq ft of restaurants, bars, retail outlets, night clubs, even a skating rink and exhibition space. There is also an 11-screen cinema complex, an indoor beach, two concert halls and an exhibition space that is currently home to Tutankhamun's treasures - all housed under the huge tented roof.

When at full capacity, the entire building will be able to hold 60,000 patrons.

The O2's owners, AEG Europe, claim to have alleviated the '50-minute queue for the loo' by installing 548 toilets; and there lies part

of the problem faced by some of the UK's best plumbing engineers.

For the massive redevelopment, the local Greenwich Council dismissed the used of open stacks within the tented area because of perceived threats of SARS and other airborne viruses.

Enter Studor - a global manufacturer of a range of products which offer solutions for venting buildings' drainage systems, eliminating the need for roof penetrations.

"Basically, the entire structure underwent a complete rebuild, says Studor technical manager Steven White, "and this introduced a drainage design problem. Originally it was designed as a temporary structure for the millennium celebrations, having open stacks terminating within the structure. With the new design, there weren't many options left to the developers but to run ventilation to the outside - which happens to be around 180m (196 yards) away - the equivalent in height of a 60-story building. With the Studor System we were able to offer a solution which avoided the need to penetrate the clean lines of the building's exterior with vent pipes to the atmosphere, providing the sealed drainage system required."

Normally, vent stacks stabilize the air pressures within the soil stack to maintain it at near atmospheric pressure and help to reduce the incidence of negative and positive transient pressures which have the potential to cause induced siphonage of trap seals within the



system – the only barrier between the drainage system and the living space. In extreme cases positive transient pressures can lead to trap water-seals blowing out of or bubbling within the fixture and leaking sewer gases into the building’s interior.

The solution to this has been to use AAVs (Air Admittance Valves) and P.A.P.A.s (Positive Air Pressure Attenuators). Originally developed for high-rise buildings and comprising a large bladder within a cylinder, the P.A.P.A. unit acts like a shock absorber, attenuating pressure waves and stopping them affecting the plumbing system, hence eliminating the need for vent piping and, in the case of The O2, roof penetrations.

Studor, together with the Drainage Research Group at Heriot-Watt University in Edinburgh, Scotland, led by Prof. John A. Swaffield, worked together to develop a suitable system for The O2 and to prove to building control that the system would work.

It was a difficult project because this was breaking new ground for all parties - this type of project hadn’t been done before so no typical model existed.

A major design concern was the potential sewer gas build-up when the arena area was not in use. White explains how the problem was overcome.

“The university team determined that any gas build-up would follow the water flow. By placing all urinals on a 12-hour flush cycle this greatly alleviates the potential of any gas build-up problem. We (Studor), in conjunction

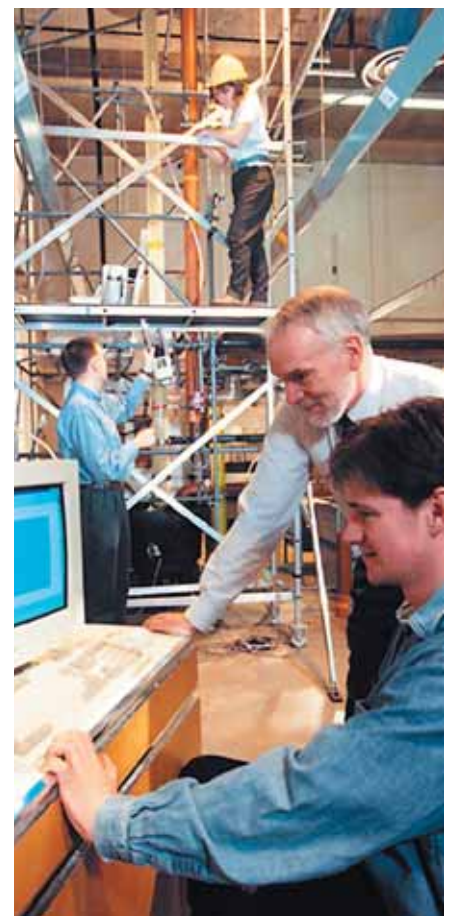
with Heriot-Watt University, proposed the sealed system solution to M&E (consulting engineers for the project). Together we worked on this unique design, analyzing system operation and also fault occurrences to ensure a safe drainage system design. Inside The O2 all vent terminals are sealed within the structure. However, outside pump stations are situated in external structural pillars with open vents, spaced 300m (328 yards) apart to dispense any odours and utilized to relieve sewer gases generated within the complex. With The O2 being planned as a major world-class music, entertainment and sports venue, no expense was spared to ensure building services were of the highest quality and functionality.”

PLAYING THEIR PART

Prof Swaffield explains the university’s role in the system.

“We have developed a concept of a sealed building drainage and vent system that relies on both active control by AAV and P.A.P.A. as well as allowing diversity of discharge to multiple sewer connections to provide airflow paths to vent the system. These considerations allow roof terminations to be dispensed with. The proposed technique was described in a paper titled: *Swaffield J.A. Sealed building drainage and vent systems – an application of active air pressure transient control and suppression.* *Building and Environment*, 41 (October 2006) pp1435-1446.”

Prof Swaffield confirms that the project was



Prof John Swaffield (standing at computer) analyzes data output by the Heriot-Watt University drainage lab. In the background, engineers study downflows in building drainage networks using the lab’s vertical stack test rig.

The O2 in London, UK, presented many hurdles to developers and engineers alike. But a combination of thorough research and testing, clever thinking and implementation overcame the toughest challenges.



unique. “We believe this is the first time that open roof terminations have been rejected for a system that incorporates planned active control of air pressure transient propagation in response to appliance discharge within a building and drainage system.”

Proving to building control and the Greenwich Council that the system would work was a considerable challenge in itself.

“We simulated the operation of the network under load conditions. The major challenge was adequately representing the boundary condition to represent the range of sewer connections.”

Active control is a relatively new concept. Prof Swaffield says that while AAVs have been

available for around 25 years to deal with negative transients, a whole system had to await the development of the Positive Air Pressure Attenuator – a variable volume containment device that reacts to positive air pressure transients within the system – of the sort propagated following a surcharge either at an offset or at the base of the stack.

The success of the modelling and the entire project is reflected in the way the system currently operates at O2.

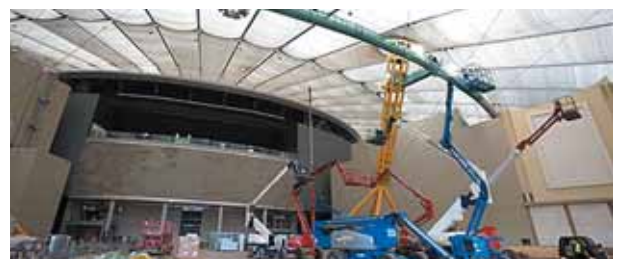
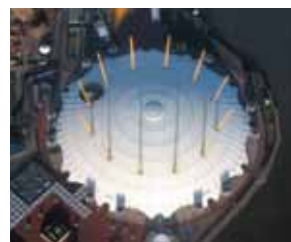
“Our development of simulation techniques and a reliable computer model allows us to consider a range of system conditions that would not be assessable otherwise without

extensive laboratory test rigs. The availability of these simulations does allow us to look at a range of cases not otherwise possible and we do this at regular intervals for a range of clients. In addition we used our simulations to model the SARS event in Amoy Gardens which demonstrated the applicability of the model to forensic post-event investigations.”

Prof Swaffield is constantly engaged in actively working with industry on other applications. 🌐

CONTACTS

Studor: www.studor.net



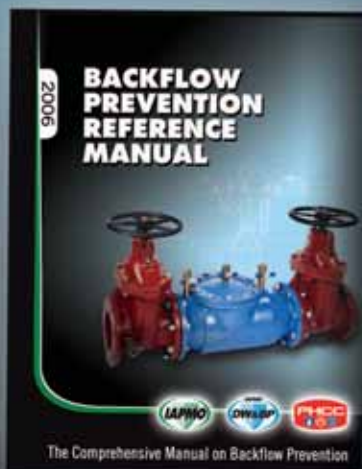


DRINKING WATER & BACKFLOW PREVENTION

DRINKING WATER & BACKFLOW PREVENTION REFERENCE MANUAL

IAPMO DW&BP announces the Backflow Prevention Reference Manual. IAPMO developed the publication jointly with the Plumbing-Heating-Cooling Contractors-National Association (PHCC). This collaborative effort resulted in the first-of-its kind manual for the industry, which contains concepts and lessons that boast international relevance. The unique, 300-page publication contains full-color illustrations in real-world field settings, and is a truly comprehensive book on the subject of backflow prevention. The manual contains sections relating to installation, testing, cross-connection control, repair, and inspections, and can also be used as a text-book for these areas. Additionally, Backflow Prevention Reference Manual can be used by regulatory agencies as a guide to determine what type of valve can be used in a particular case. With information on the history of backflow prevention as well as chapters written from the regulatory perspective, Backflow Prevention Reference Manual is an important resource for system designers, urban planners, and utility companies – professionals “on both sides of the water meter.”

Now just U.S. \$75.00



DRINKING WATER & BACKFLOW PREVENTION MAGAZINE



Have you ever opened a water tap and got something other than clean, safe water?

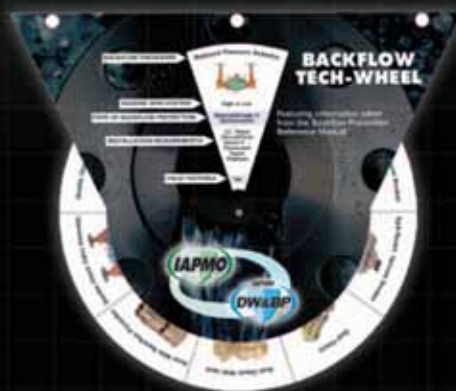
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PLUMBING GIVEN THE RESPECT IT DESERVES

For a country that is not under pressure to conserve water, Sweden takes its plumbing industry extremely seriously.



Sweden is a country slightly larger than the State of California (about 3,731 square miles or 49,964km²) with a population of about nine million.

The capital is Stockholm, which has about one million inhabitants. Sweden favors a constitutional monarchy in which King Carl XVI Gustaf is head of state and Fredrik Reinfeldt the head of government.

Sweden is a highly industrialized country enjoying low inflation and strong economic growth, although unemployment hovers about 6%.

The average rainfall is 22" (560mm), and agriculture used to account for nearly all of Sweden's economy. However, that sector now employs less than 2% of the workforce.

The replacements are mining (iron ore), hydroelectric power and large areas of forest which, through the use of technology, have helped position Sweden as a leading exporting nation.

About 80% of the Swedish workforce is unionized. Operating alongside most unions are counterpart employer organizations. The unions and employer groups are independent of the government and political parties.

According to Roine Kristianson, chief executive of the plumbing and heating organization in Sweden, VVS Företagen, the Swedes take their plumbing very seriously. Entry qualifications for a plumber are extremely high – greater than for an engineer and on the same level as someone wishing to enter the medical profession.

Courses for training installers are also very popular, Kristianson says.

VVS Företagen, an employer and industry association, has about 1,400 companies as members. It is a part of the big Swedish trade organization Svenskt Näringsliv, which caters to a range of companies in plumbing, heating, air-conditioning, refrigeration, ventilation, insulation and sprinkler installation.

"In Sweden we have VVS-konsulter (technical engineers) who design plumbing. Some of the big plumbing companies have their own in-house designers, but the plumbers carrying out the installations often complain about the quality of the technical drawings and must do several corrections to the plans."

Sweden is in a very strong financial position. Gross domestic product grew 3.6% in the second quarter of 2007, placing it in the top five countries in Europe.

Kristianson says environment protection is a big business in Sweden and everyone is talking about it. Companies like Sweco, WSP and AF have built an excellent international reputation.

VVS Företagen members employ about 20,000 staff. The three biggest companies are Bravida, YIT and NVS. All three have more than 1,000 employees. Most plumbing and HVAC (heating, ventilation and air-conditioning) companies employ between one and 10.

According to a large national survey, the plumbing and HVAC business sector grew 14% in 2006.

"It's fantastic," Kristianson says. "Now our turnover is equivalent to US\$3 billion a year."

The market is still growing, and the



Above. VVS Företagen CEO, Roine Kristianson.



Right. Preemraffs refinery in Lysekil, Sweden. A major project with 3,000 tons of pipes to be installed. The Swedish contractors and plumbing firms couldn't compete with imported labour and piping installations which were done by Thai installers and service contractors. Photo: Anneli Megner.

Government has offered large financial incentives to stimulate energy efficiency and modernization of the housing stock. The development of new housing is high.

Kristianson says the plumbing sector has undertaken a huge campaign in Sweden called 'Säker Vatteninstallation'. The concept translates to 'guaranteed safe water installations in all types of buildings'. Nearly 10,000 plumbers have been educated and licensed, and the program has had positive feedback from insurance and real estate companies.

"Even the Government has applauded the initiative," Kristianson says. "This year Säker Vatteninstallation won the top award in the building sector in Sweden - Innovation of the Year, 2007."

A big problem for the plumbing sector is the low charging rate for labor, and many plumbing companies complain of poor profitability.

In Sweden debate rages in the building sector about how to reduce costs. The Government has stepped in, saying it also wants to see lower prices.

Large Swedish building contractors Skanska, NCC and Peab have indicated they will build bathrooms in their factories. Naturally, plumbers don't like it: maybe in future they will only 'plumb in' the installations. Kristianson doesn't see this as progress.

Heat pump technology is a big business in Sweden, which is a leading country in heat pump equipment. The big manufacturers are NIBE, Thermia, IVT and CTC. It was a record year

in 2006 for manufacturers, which sold a total of 127,000 units. Air-air heat pumps dominate with a market share of 41%, but the water heat pump industry is experiencing rapid growth at 42% over the previous year's figures.

In Sweden there is a very influential group of plumbers called Comfort. The group sells and installs bathroom, heating, water and plumbing products and has an annual turnover equivalent to US\$525 million.

It seems many installers are dealing directly with the manufacturer, a practice in operation for some years but now gaining in popularity. Kristianson says some of the bigger installers are buying directly from overseas manufacturers - a growing trend.

The biggest wholesalers are Dahl, Ahlsell and Onninen.

There are many globally recognized manufacturers in Sweden, such as Gustavsberg (now owned by Villeroy & Boch), and Sanitec, which owns Ifö Sanitär and Ido Badrum. There is also the Finnish company Uponor, which has many factories in Sweden and maintains a strong position in the market.

Mora Armatur and FM Mattsson are two big companies in sanitation (shower products and bathroom faucets). Now they have the same private equity owner and work closely together to produce their product range in the same factory.

The Danish company Danfoss has bought heat pump manufacturer Thermia. Danfoss has the ambition to be the largest heat pump

manufacturer in Europe. The German company Bosch Gruppe has bought IVT, the biggest Swedish heat pump company.

Two other big Swedish brands in the HVAC sector are Alfa Laval and Nibe, both listed on the Stockholm Stock Exchange.

Like other developed countries, Sweden is suffering from an ageing workforce and, through VVS Företagen, is undertaking a recruitment and education drive as a priority.

Kristianson says the local plumbing sector has to attract and train more than 1,000 people a year to service the country's growing needs. At present, this is a popular career choice and the plumbing sector media are playing an important role in maintaining the momentum.

"You can always get a job as a plumber," Kristianson says. "Now it is four or five candidates for every training place. To be a plumber is more attractive than becoming an engineer, and on the same level as becoming a doctor."

One enormous plumbing project is the Preemraffs refinery in Lysekil, in the west of Sweden. The US\$1 billion project began in 2005 and was unique in the huge amount of piping and tubes it required. More than 200 installers/service men were needed to construct and assemble the 3000 tonnes of piping.

Kristianson believes the plumbing and HVAC sectors will continue to have high status among

Our thanks go to Lars Roselius for his assistance with this article.

POISONED WATER THREATENS DEVELOPING COUNTRIES

Drinking water in Bangladesh is making millions of people sick due to arsenic contamination and may be killing as many as 3,000 a year.

Arsenic is widely distributed through the earth's crust and is present in almost all waters in very small amounts.

However, in certain areas there are dangerous levels of this toxin in drinking water. One of the most serious cases is Bangladesh, where thousands of wells cause mass poisoning of the population.

Arsenic is a known carcinogen, and when constantly consumed it can affect the gastrointestinal, respiratory and vascular systems, often resulting in cancers of the skin, lung and bladder.

During the 1990s, 900 million people around the world gained access to an improved water supply, yet 1.1 billion people in rural areas and urban slums still rely on unsafe drinking water from rivers, lakes and open wells.

Children, in particular, suffer from water-related illnesses. Each episode of diarrhoea can reduce their appetite and lower their calorie and nutrient uptake. Persistent diarrhoea, and severe diseases such as typhoid and dysentery, jeopardize children's healthy development. Every year, nearly two million children die as a result.

It is believed that arsenic in Bangladesh originated in the Himalayan headwaters of the Ganges and Brahmaputra rivers, and remained dormant and embedded in the land.

The poisoning began as enormous quantities of water were pumped out from deep

underground reservoirs. Water levels dropped and exposed arsenic-bearing pyrite to air, leading to oxidization – a reaction that flushed arsenic into the remaining water.

The combined high probability, moderate probability and low probability contamination zones cover about 60% of the country's total area.

In the 1970s, international agencies headed by the United Nations Children's Fund invested millions of dollars of aid money into digging shallow tube wells in Bangladesh. Due to a lack of facilities the water was never tested for arsenic.

With groundwater consumption increasing over the next two decades, the water from more than a million tube wells began to slowly poison Bangladeshi villagers. The World Health Organization says large-scale withdrawal of ground water from an estimated 10 million tube wells may be the main cause of arsenic contamination in Bangladesh.

Control of arsenic is more complex where drinking water is obtained from many sources – such as hand-pumps and wells – as is common in rural areas. Low-arsenic water is needed only for drinking and cooking. Arsenic-rich water can be used safely for laundry and bathing.

Discriminating between low-arsenic and high-arsenic sources by painting hand-pumps green or red can be an effective and low-cost way of rapidly reducing exposure, when accompanied by effective health education.

Several initiatives have been set up in



Arsenic contamination of groundwater has led to a huge epidemic of poisoning in Bangladesh and neighboring countries. It is estimated that about 57 million people are drinking groundwater with arsenic concentrations above World Health Organization levels.

Bangladesh to investigate water quality testing and control with a view to supplying arsenic-free drinking water. One positive outcome has been the testing of new types of treatment technology.

Only a few proven sustainable options are available to provide safe drinking and irrigation water. These include obtaining low-arsenic groundwater from shallow systems or deeper aquifers (more than 200m or 220 yards approx), rainwater harvesting, pond-sand filtration, household chemical treatment and piped water supply from safe or treated sources. But cost is once again the negating factor.

Alternative low-arsenic sources such as rainwater and treated surface water may be a valid solution in some circumstances. However, arsenic removal technology for piped water is costly and requires technical expertise. It is inapplicable in some urban areas of developing countries and in most rural areas worldwide.

New types of treatment technology – including co-precipitation, ion exchange and

activated alumina filtration – are being field tested, but there are few proven methods of removing arsenic on a grand scale at high-risk water collection points.

Some studies have reported preliminary success in using packets of chemicals for household treatment, and some mixtures combine arsenic removal with disinfection.

One example – developed by the Pan American Health Organization’s Center of Sanitary Engineering and environmental science organizations in Lima, Peru – has been successful in Latin America, but the problem is still widespread.

Christina Galitsky, chemical engineer at the Lawrence Berkeley National Laboratory in the US, says the big problem in Bangladesh is not food – it is drinking water.

“In the 1970s, UNICEF dug wells all across the country so that Bangladeshis could stop drinking contaminated surface water. The motives were pure, but the wells were not. Most were in areas with high concentrations of

arsenic – in some cases more than 100 times the level deemed safe by the World Health Organization.

“It has been called potentially the largest mass poisoning in the history of the world.”

Together with Ashok Gadgil, a senior scientist at the laboratory, Galitsky saw an opportunity. With a US\$250,000 grant from the California Energy Commission and US\$100,000 from the American Waterworks Association Research Foundation, they are developing a filtration system.

The system extracts nearly all the arsenic in a beaker of contaminated water. The researchers concede there is a lot of work to do, as they need to figure out how water should pass through their hybrid ash-and-iron substrate, and determine what real-world conditions might interfere with its performance.

But they believe filters made with their new medium could comply with stringent safety standards and still be affordable enough for Bangladesh households.

1. From left, Prof Vigi Vigneswaran and his colleagues, PhD student Vin Nguyen and Dr Huu Hao Ngo.

2 & 3. With his colleagues, Prof Vigi Vigneswaran has developed an absorption system – a sponge coated with iron oxide – that removes arsenic from water. In Hanoi he conducts tests on arsenic removal.

4. The team's testing has shown that an iron-coated sponge packed in a PVC column can deliver an effective method of providing safe water in domestic situations.



On the other side of the world, researchers at the University of Technology, Sydney, in Australia have developed an innovative absorption system – a sponge coated with iron oxide – that removes arsenic from water and can be used in any home.

Professor of Environmental Engineering Vigi Vigneswaran says the sponge is an ideal material because it is very porous and its surface facilitates arsenic absorption.

Vigneswaran says a sponge is cost effective, does not require large amounts of infrastructure to make and can be supplied to small communities as well as developing countries.

“Through extensive research and testing, it was found that the amount of arsenic absorbed onto the sponge was higher than for other materials.

“A typical calculation based on the field experiment showed that 0.6kg of iron-coated sponge packed in a PVC column 25cm in diameter and 80cm in height can provide safe water for a family of four people for three months before the iron-coated sponge becomes exhausted.

“The attractive feature is that the iron-coated sponge can be used by soaking in a

bucket of water – enclosed in a PVC pipe with water poured through it – or added to a filter on a tap, making it easy to use anywhere.”

The project and research by Vigneswaran, Dr Huu Hao Ngo and PhD student Vin Nguyen was funded through the Australian Research Council's ‘discovery and linkage’ program, which fosters collaboration and networking between Australia-based and overseas researchers.

Extensive laboratory testing suggested that by weight of material the iron-coated sponge was more effective at removing arsenic than other filtering materials. Vigneswaran says the method is ideal for developing countries like Bangladesh and Vietnam, where communities use groundwater that is highly likely to be contaminated with arsenic.

“This is a familiar product, which is available in the market. The particular sponge we use is manufactured by Adform Australia. However, we believe any sort of sponge with enough pores and sufficient retaining capacity for iron oxide coating can be used. The cost is minimal, as the technology is aimed at small communities in developing countries.”

Researchers at the University of Edinburgh in Scotland concur, and have genetically modified

the bacterium *E. coli* to detect trace amounts of arsenic in drinking water. They claim the bacteria-based technology will eventually lead to safe, precise and easy-to-use field test kits.

Professor of Microbial Biotechnology Chris French says such tests could be as easy to use as home pregnancy tests and would not require a trained technician.

The Edinburgh group says *E. coli* has two unrelated genetic sequences that in combination allow effective arsenic detection. They hypothesized that when arsenic comes in contact with the modified *E. coli*, it activates the ‘arsenic switch’, whose gene in turn activates the breakdown of lactic acid.

After a while, the water turns red or yellow, depending on the presence or absence of arsenic. A potential drawback is the time lag – the biological interactions take about five hours.

In Australia arsenic is not a national problem. Some has been detected in groundwater and soil in Victoria, but mainly it is found in the outback. Research indicates groundwater sources in the Northern Territory are marginally affected by arsenic, but this needs to be verified.

In rural Victoria, concentrations of up to



2



3

16,000mg/kg of soil on residential properties, and 0.008mg/L and 0.22mg/L in groundwater and surface water have been reported. These exceed the National Health and Medical Research Council guideline of 0.007mg/L in drinking water and 300mg/kg in soil.

In recent years there has been a concerted effort to map the distribution of arsenic and identify contaminated wells in Bangladesh.

In some cases, scientists and aid workers have sent water samples to be tested in labs using fluorescence techniques – an expensive and time-consuming process. In other cases, they have used portable test kits. However, most of these field tests require training, and they produce toxic chemicals such as arsine gas.

Although 27% of shallow tube wells are known to be contaminated nationally, in many areas more than 90% are contaminated. The problem has been magnified because tube wells with high levels of arsenic are in areas where the percentage of contaminated wells is high. 🌐

CONTACTS

www.technologyreview.com.au

vigid@eng.uts.edu.au



4

LAUNCHING PAD FOR INNOVATION

When 60 of the world's leading plumbing sector researchers and academics from 17 countries came together for their annual meeting, there were sure to be interesting results tabled from their laboratory and field work during the previous 12 months.

Add to that the issue of climate change and a profound shift of attitude sweeping society in terms of sustainable development and you have an ideal environment for engaging presentations and ideas.

The 33rd International Symposium for Water Supply and Drainage for Buildings – CIB W062 – was held in September in Brno, Czech Republic.


Over the years, the scientific program at this two-day conference has been the launching pad for many important innovations (and the research and scientific proving behind them) in plumbing systems, which many people take for granted.

The CIB platform offers young researchers

additional exposure and recognition in front of industry peers, and this year there was an obvious passing of the baton to many dedicated young people from research establishments, universities and industry keen to demonstrate their theories, discoveries and validations.

In all there were 40 presentations over the two-day symposium.

Planning is under way for the 2008 CIB, which will take place in Hong Kong from 8-10 September.

Full details of how interested parties can register for the symposium will be published in the next edition of *World Plumbing Review*. 

Organizations and companies interested in joining CIB W062 should contact:

Karel De Cuyper
Co-ordinator of CIB W062 Water Supply and Drainage for Buildings
Belgian Building Research Institute
B 1000 Brussels Belgium
karel.de.cuyper@bbri.de

HIGHLIGHTS

The topics presented, and the presenters, were many and varied. Some of the presentations were:

- From China – Demand analysis of fresh water supply for restaurants;
- From Brazil – Design flow-rate simulation using probabilistic and empiric methods for water sub-metering; systems in multi-family buildings;
- From Japan – A study on water and energy consumption in nursing homes for the elderly;
- From Portugal – Safe water supply in buildings, the importance of risk prevention;
- From France – Graywater reuse in buildings;
- From Germany – Flush quality of WC pans;
- From Britain – Active air pressure suppression of drainage systems, from research to the market.



1. Larry Galowin from the National Institute of Standards and Technology, USA, (left) with symposium organizer, Dr Ladislav Barta from the Brno University of Technology. **2.** From left: Prof Armando da Silva Afonso from the University de aveiro, Portugal; Prof Orestes Goncalves, Escola Politecnica University – Sao Paulo, Brazil, and Prof Noriyoshi Ichikawa, Tokyo Metropolitan University, Japan. **3.** Dr Michael Gormley (left) with Prof John Swaffield, both from Heriot-Watt University, Scotland. **4.** Karel De Cuyper, BBRI – coordinator of CIB W062, Belgium, with Prof Fumitoshi Kiya, Kanagawa University, Japan. **5.** Ms Gulsen Disli, an engineer from Turkey.

review



"Uniting the world plumbing industry to safeguard and protect the environment and the health of nations."

INDIAN AWARDED 2007 WPC SCHOLARSHIP

The WPC Scholarship for 2007 has been awarded to Subhash Deshpande of Pune, India. The scholarship, which now has a value of up to US\$10,000, is awarded to an individual involved in plumbing industry training and allows them to visit a country of their choice to examine industry training arrangements.

Subhash, who was the unanimous choice of the WPC's scholarship panel, is 52 and is an executive director of Deolaliker Consultants Pty Ltd in Pune. A chartered engineer, he has studied in India and Canada and has worked on projects throughout India and in Iraq. He is actively involved in the Indian Plumbing Association (IPA), being chairman of the Pune Chapter and also acts as a trustee of the recently established Indian Plumbing Institute.

Subhash is passionate about plumbing industry training and has been instrumental in establishing courses for unemployed, generally uneducated rural young people in the Pune area. In the absence of any formal structured plumbing industry training in India, he wishes to see much more done to ensure that plumbing industry personnel have access to appropriate training facilities.

He is working on behalf of the IPA to create an appropriate syllabus and training courses. He has chosen to use his scholarship funding to visit Australia where he plans to look at training



Subhash Deshpande of Pune, India, has won the WPC Scholarship for 2007 and is heading off to Australia to study training and research methods.

syllabuses and to research delivery methods, all of which he plans to utilise in developing appropriate systems for use in his own country.

Scholarship panel chairman Robert Burgon commented that "although the panel was disappointed at the relatively low number of applications for the 2007 scholarship, we were unanimous in coming to the view that Subhash Deshpande is a most worthy winner and will be an excellent ambassador for the WPC. The visit to Australia is likely to lead to real benefits in India, a country which has very little formal plumbing industry training but which is very enthusiastic about providing such training.

"This is now the fifth year that the scholarship has been awarded and the panel has commenced a comprehensive review of the process for consideration by the WPC. It is likely that some changes in the arrangements will be made before the announcement of the 2008 scholarship."

WPC ANNUAL MEETING AT WORLDSKILLS VENUE

At the time of printing, the 2007 World Plumbing Council annual meeting was being held in Numazu City, Shizuoka Prefecture, Japan on 19-20 November, coinciding with the biennial WorldSkills competition week in the same city.

The annual meeting, held in Japan for the first time, had a number of important issues to consider including a proposal that, following the retirement of Andy Watts

as secretary in 2008, his role and that of treasurer be amalgamated into one, possibly remunerated, person or organisation. Also to be discussed were future arrangements for the WPC Conference, after 2011; the Council's relationship with WorldSkills and how this might be expanded; the WPC website and its future; important changes to the WPC Byelaws.

More details will follow in our next issue.

WORLD PLUMBING CONFERENCE 2008

Water - Our Life; Our Business; Our Responsibility!

Plumbing industry professionals from across the world will be heading for Canada next September when the World Plumbing Council stages its triennial World Plumbing Conference.

To be held in Alberta from 24 to 27 September, the conference will feature a host of technical presentations as well as a comprehensive social program. The organising committee, comprising the Mechanical Contractors Association of Canada, Mechanical Contractors Association of Alberta, and the Canadian Institute of Plumbing and Heating, has set the theme for the conference as "Water - Our Life; Our Business; Our Responsibility!"

Chairman of the committee, James Derksen, said: "We are thrilled to be the hosts of this auspicious conference which will be held in the city of Calgary in the unbelievably beautiful province of Alberta."

Running alongside the conference will be the CIPHEX West trade show and the program of events allows time for delegates to visit this.

More details about the conference and show are available from:

Hans Tiedemann
Executive Director
Mechanical Contractors Association of Alberta,
Canada

Phone: +1 40 325 072 37

Fax: +1 40 329 105 51

Email: hans@mca-alta.com

and information will also be posted on the WPC website at www.worldplumbing.org/2008.html



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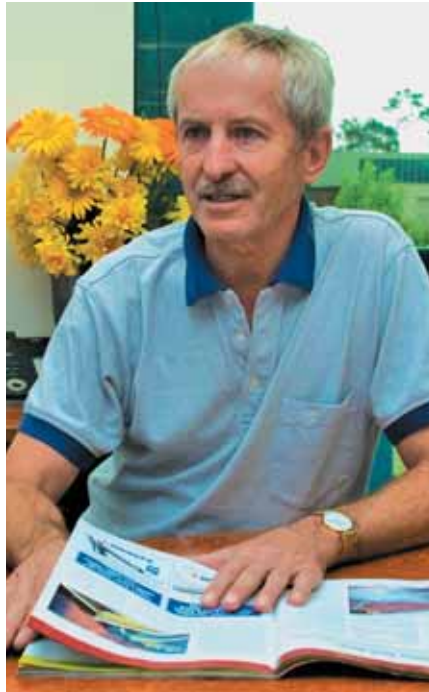
Recognising the need to promote safe water supply and sanitation in developing countries, the World Plumbing Council (WPC) has appointed a liaison officer to collaborate with the World Health Organisation on a series of related projects.

John McBride, who has worked with the Australian Plumbing Commission for the past 10 years, will help to coordinate development of these projects, starting with a training package for plumbers to be used by educational institutions anywhere in the world.

The WPC is recognised by the World Health Organisation (WHO) as a 'Non-Governmental Organisation' and last year these two bodies jointly published a handbook, *Health Aspects of Plumbing*, which has been widely accepted as an international reference for safe plumbing practice. This document will provide the base information for the jointly-produced training package.

McBride's role, which is being totally funded by the WPC, is planned to extend to work with WHO on the establishment of emergency-response criteria for major disasters, together with a roster of volunteer experts in the water supply and sanitation field.

McBride was manager of Industry Standards, Training and Information Services for the



John McBride has been appointed a liaison officer, to collaborate with the WHO.

Australian Plumbing Industry Commission from 1997 to 2007. In this role he advised the Victoria State building and plumbing commissioner on both technical and policy matters in areas of plumbing safety, durability,

and water and energy sustainability.

He has also worked in an advisory capacity on the development of a plumbing code for East Timor, developed working papers for tsunami relief and has undertaken overseas studies of the regulatory models in France, the United Kingdom, Japan, Germany and the United States.

George Bliss, chairman of the World Plumbing Council commented: "We have long felt that it is vitally important for the whole world to benefit from latest plumbing principles and Standards. Our global community had a wake-up call a few years ago with the SARS outbreak, the spread of which was traced to poor plumbing, and could so easily have turned into a pandemic. If we want to help prevent something like that happening again, we have to help developing nations improve their knowledge of basic plumbing principles.

"Through our close links with WHO, we are now in a position to make a real contribution to the improvement of plumbing standards worldwide, and in John McBride we believe we have the right man to head up this initiative. His immense knowledge of international best practice in plumbing regulations and of plumbing education means he is ideally suited for this vital project."

WORLDSKILLS UPDATE

Members attending the WPC annual meeting had the opportunity to visit the 39th WorldSkills competition. More than 800 entrants from 45 countries competed in 38 skills categories, one of which was plumbing. Each category's competitors were accompanied by an 'expert' with a chief expert overseeing the entire contingent which for plumbing includes 24 experts.

For the second time, the chief expert for plumbing was John Smartt from Ireland who was also the winner of the World Plumbing Council's inaugural Trainers Scholarship in 2003.

At the 2005 WorldSkills competition, the World Plumbing Council presented all competitors and experts in the plumbing category with specially struck medals and this was repeated at the Japanese event.

More details of WorldSkills are at www.worldskills.org



WorldSkills chief plumbing expert John Smartt (right) at the 2005 Helsinki WorldSkills competition, with WPC chairman George Bliss (left) and the Irish plumbing competitor, Mark McGlanaghey.

FIRST EVER INTERNATIONAL PLUMBING EXHIBITION IN INDIA RECOGNISES INDUSTRY BOOM



WPC member organisation the Indian Plumbing Association (IPA), together with Akar InfoMedia (AIM), is organising India's first ever international exhibition of plumbing and allied products.

To be held at the Bombay Exhibition Centre in Mumbai from 11-13 February 2008, PlumbexIndia recognises the unprecedented boom in India's construction industry which has increased the demand for modern and sophisticated plumbing products.

Speaking about the aims of the exhibition, IPA president Sudhakaran Nair said: "PlumbexIndia is part of IPA's on-going endeavour to upgrade standards of the Indian plumbing industry to a level comparable to the best in developed western countries. IPA hopes that the participation of overseas manufacturers will facilitate exposure to modern, high-tech plumbing products for members of our ever-burgeoning domestic industry".

IPA and AIM are no strangers to exhibitions, having already organized 10 regional shows across a country which now ranks as the fourth largest economy in the world in terms



India's first ever international exhibition of plumbing and allied products is to be held in Mumbai next February.

of purchasing power parity. With rapid urbanization and changing lifestyles, the spending on luxury goods, including bathrooms and sanitaryware, is forging ahead, further underlining, say the organisers, the need for a show like Plumbex India.

More information about the exhibition is available from:

Mr Kamal Khokhani
Director - Akar InfoMedia Pvt. Ltd.
AIM House, 78-Pankaj Society, Anjali Cross
Roads, Bhattha, Ahmedabad 380 007 India
Telephone: +91 79 3251 5588 / 3251 5599
Facsimile: +91 79 2662 0020
Email : kamal@akarinfomedia.com
and on the website at www.plumbexindia.in/

UK FOOT AND MOUTH OUTBREAK - POOR PLUMBING TO BLAME?

A report by the UK Government's Health and Safety Executive (HSE) on the outbreak of Foot and Mouth disease in early August suggests that sub-standard plumbing installations may have been a contributory cause.

The initial release of the disease bacteria was traced back to a government and private laboratory site in the south of the country. An extensive review of the site by the HSE revealed a number of defects in the drainage and effluent pipework, which may have caused a leakage of waste material into the surrounding ground.

The situation at the time was made worse by very heavy rains and flooding which may have caused an unusual strain on the underground pipes.

WPC deputy chairman Robert Burgon, who is based in the UK, said: "An incident like this,

which has had massive financial implications for the UK's farming industry, serves to underline the necessity for the maintenance of effective plumbing standards. WPC has taken a further step in achieving this goal by the appointment of John McBride as liaison to the World Health Organisation." (See separate story)

The World Health Organisation (WHO) itself, in its World Health Report 2007, refers several times to the 2003 SARS outbreak and the continuing risks of the spread of such diseases. The spread of SARS was traced to poor plumbing in an apartment block in Hong Kong.

The HSE's full report can be viewed at www.hse.gov.uk/news/archive/07aug/footandmouth.htm while the WHO World Health Report 2007 is at www.who.int/whr/2007/whr07_en.pdf and see article in this issue of WPR.



One of the infected fields in the UK.

WORLDSKILLS AUSTRALIA APPOINTS NEW CHAIR

Following the retirement of Bob Puffet (right), WorldSkills Australia has appointed Jeanette Allen as the new Chair of the Board.

Puffet started life as an apprentice plumber and went on to become a teacher of plumbing, head of school, college principal, director of industrial relations and latterly a director of the Sydney Institute of Technology. Just prior to his 'retirement' from the public sector Bob was the assistant director general responsible for Technical and Further Education (TAFE) in New South Wales.

Puffet was awarded the Order of Australia for his contribution to Technical Education and as director of the Sydney Institute of Technology.



Recently retired chair of WorldSkills Australia Bob Puffet was awarded the Order of Australia for his contribution to technical education.

Ms Allen is currently the CEO of the Service Industry Skills Council and is responsible for managing the development and maintenance of training packages and support materials for the wholesale, retail, personal services, tourism and hospitality and sport and recreation industries. She was appointed as a director of WorldSkills Australia in 2005.

She said: "I am very honoured to have been appointed to this position. I believe that WorldSkills Australia offers a unique and very visual demonstration of the quality of our vocational education and training system and showcases the talents and skills of our young people in an enormous range of occupations."



NEWS FROM CHINA

The Plumbing Facilities Committee of CCMSA (PFC of CCMSA) of China, a WPC member organisation, held a meeting of its pipe sub committee earlier this year in Foshan, Guangdong Province.

The meeting, in cooperation with the Stainless Steel Council of China Special Steel Enterprise Association, summarized the development and current situation of stainless steel pipe in China, concluding that it has a promising future.

Other sub-committees of the PFC of CCMSA have been drafting important trade regulations, Standards and codes for products and technologies, including additive pipe pressure water supply, butterfly valves and pumps, foaming cement insulating layer for floor heating, Fountain & Water Scene engineering.

In December this year, the Fountain & Water Scene sub-committee will hold its first peak forum and new technology and products exchange meeting in Beijing. It is expected that the event will be attended by industry professionals, representatives from design institutes, engineering companies and the relevant media.



APPLICATION FOR MEMBERSHIP

Your organisation can apply to become a member of the WPC either by visiting our website <http://worldplumbing.org> or by faxing your details to us for an application form. The by-laws of the organization can also be viewed at that website.

FULL MEMBER

Applicant must be a *bona fide* representative organization in the plumbing industry, such as a trade association, professional body, trade union, registration/licensing body or association of manufacturers/wholesalers.

Annual fee is US\$500

AFFILIATE MEMBER

Applicant must be a *bona fide* organization or company in the plumbing industry that wishes to be associated with the World Plumbing Council. This could include the likes of individual manufacturers, wholesalers, service companies or publishers in the industry.

Annual fee is US\$200

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AFLOAT BEHIND BARS

With an increasing number of people being held in prisons and detention centers around the world, governments are hard pressed finding solutions to satisfactorily house them.

Public opinion varies markedly in terms of where prisoners and displaced persons should be accommodated. The attitude used to be 'so long as they aren't near me', but the growing voice of human rights supporters is demanding better conditions for society's unfortunate and underprivileged.

Water supply and sanitation are crucial for managing the health and well-being of inmates in relatively confined facilities. When one of the plumbing industry's main suppliers mentioned to WPR the important role played by plumbing electronics in detention centers, we decided to learn more about a unique facility in the Netherlands.

In that country, floating prisons that use the latest developments in plumbing technology have been constructed as alternative detention facilities. This technology includes the provision by Stern Faucets of its piezo technology for two new detention boats in Amsterdam as well as a renovated detention boat in Rotterdam.

These projects use a programmable piezo switch for different types of application. For example, a prisoner's cell has piezo switches as an interface to control water flow at the wash basin, shower and toilet. The switch connects to a latching solenoid valve to open and close the water flow, or connects to a solenoid valve incorporated in a piston flush valve for toilet flushing.

Stern Faucets director of international sales Christiaan Scholtes says the piezo button is

an important tool in the prevention of bacteria growth (that can cause Legionnaires Disease) in water supply lines by allowing showers, wash basins and toilets to flush automatically every 24 hours.

"The robust design and the fact that the button has no moving parts almost completely eliminates the need for maintenance. If necessary, remote maintenance is possible through a single wire that leads from the central service area to each piezo button in the prison cells. Maintenance and safety costs are drastically reduced, as maintenance personnel and prison guards do not need to enter individual prison cells.

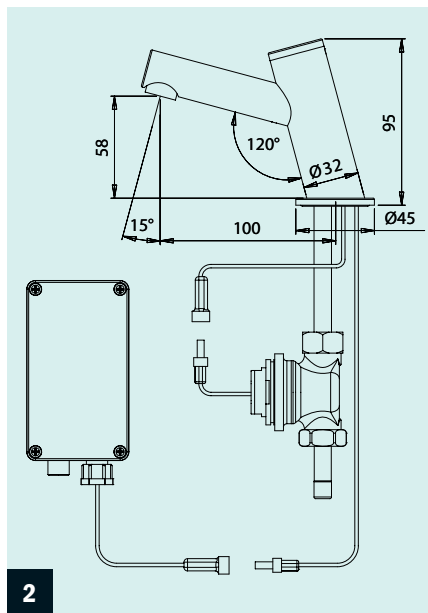
"Piezo refers to the properties of certain types of crystal that change shape with the application of electrical voltage, and which in turn produce electrical voltage as a result of these changes. The word is derived from the Greek 'piezein', which means to squeeze or press.

"Piezo-electric devices are made with these crystals, which are ceramicized, layered, and converted into elements to serve as the central units in digital devices. Advance qualities of these piezo-electric devices include great force, rapid response times, and high displacement accuracy. They are also exceptionally energy efficient and small enough to use in the thinnest, most compact locations."

Scholtes says several factors led to the Stern decision to strongly focus on piezo products and components.

Floating prisons in the Netherlands are used as alternative detention facilities. They have the latest technologically-advanced faucets and other water-saving innovations.





1. Stern's Perfect Time faucets use piezo technology to provide touch button water flow control at the wash basin. 2. Cutaway of the Stern Faucet Perfect Time. 3. Piezo technology is also used in the shower and for automatic flushing of the toilet. These specific products (pictured) are not used in detention centers.

"On one side, the market for sanitary products has a strong need for controlling water supply electronically. Water supply is still being controlled mechanically. At the same time, there's a need for a vandal-proof interface and a cost-effective solution, especially for applications such as detention facilities."

"In addition to providing accurate water flow and remote control by a building control system, piezo technology offers greater freedom of product design because it can be seamlessly integrated into products and panels."

Wout van Leeuwen of Odevi (Stern's Netherlands agent) supplied the products and advised on their installation and operation for the detention boat projects.

"These floating detention facilities, primarily used to accommodate people who have entered the country without appropriate documentation or approvals, are three stories high and built on pontoons moored to jetties in the harbour," he says.



Stern Faucets director of international sales Christiaan Scholtes says the piezo button is an important tool in the prevention of bacteria growth.

"Consisting of prefabricated steel and composite materials, they are cost effective and very easy and quick to construct. Each boat is 100m long (109 yards) and 25m wide and contains 155 cells of four by 2.5m, with a recreational area in the middle. Potable water is piped to an on-board storage, and wastewater is pumped onshore for treatment at a city facility."

"Stern's piezo technology is playing an important role in helping to conserve water on the detention boats, and the battery facility is helping to save energy by enabling the operation of wash basins, showers and toilets to be electronically controlled independently of the electricity grid."

Stern recently released the advanced piezo switch (APS) that is part of the company's new generation of programmable vandal-proof piezo switches. It allows electronic control of faucets, flush valves and showers and is designed for use in harsh and high-traffic areas.

Features of the APS include programmable flow time, automatic hygiene flushing, low-battery indication, on-off function and lock-out time. It can be programmed according to the customer's requirements, directly connected to latching and non-latching solenoid valves and operated by a battery or transformer.

Also new from Stern is its first electronically operated self-closing faucet activated by piezo

technology. Scholtes says Perfect Time is an electronic version of a regular mechanical self-closing faucet. It is operated by touch and is aimed at the high-volume market of mechanical self-closing faucets.

"It is positioned as the better alternative, while remaining in a similar budget region. The aim is to provide a cost-effective, durable and reliable solution that will fill the gap between mechanical self-closing faucets and electronic sensor faucets."

"Perfect Time provides several major advantages over regular self-closing faucets, including extra water-saving possibilities, significant reduction of maintenance costs and an anti-vandal design with a 'non-hold open' feature. Electronic features include on-site advanced flow time adjustment, lock-out time, and hygiene flush that can be switched on and off on-site. Perfect Time has very low power consumption and will easily work more than 500,000 cycles." 🌐

CONTACTS

Contact Name

www.sternfaucets.com

christiaan@sternfaucets.com

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PROVEN DESIGN REACHES FOR THE SKY

Water supply and fire sprinkler systems in the Burj Dubai tower work on gravity from tanks in upper-level plant rooms. The concept is like an umbrella – provide at one location then distribute downwards.

On what is billed as the tallest building in the world, the task of providing services was always going to be a challenge. The world records set by the Burj Dubai project extend to the services themselves, the longest lift run in the world being among them.

Rachid Ghamraoui is senior manager of mechanical, electrical and plumbing (MEP) for the project.

“One very important thing in this project is that we are using proven design that’s enhanced to suit the height and configuration of the building. All MEP equipment has been checked and calculations made for anti-seismic and anti-vibration characteristics, and to take into account deflection and movement of the building.”

Due for completion in December 2008, the Burj Tower is already one of the tallest in the Middle East, currently standing at over 100 stories. The final structure will be more than 160 stories with a floor area of 465,000m². It will include an Armani-designed hotel, apartments, boutique offices and commercial spaces.

Its shape is based on an indigenous desert flower. Three distinct wings protrude from a central core that stretches the full height of the building, the wings gradually decreasing with height to create a spiral effect.

Chicago-based architect Skidmore, Owings and Merrill designed the building for client Emaar, with Turner Construction acting as project manager. The main contractor’s role

on the project is being undertaken by a joint venture between Besix, Samsung and Arabtec.

The major MEP works for the permanent installation are being carried out by ETA, Voltas and Hitachi under a joint venture contract, with several client-nominated subcontractors carrying out other packages, such as the extra low voltage system by Johnson Controls.

The scale of the building and three-days-per floor speed of construction mean that close co-ordination between contractors is crucial, and all have been site-based from the beginning.

Ghamraoui says logistics is a very important issue. In addition to ensuring materials and labor can reach the correct height when needed, the tight space around the tower must be considered.

“Very soon the external works – comprising irrigation, landscaping and special water features – will commence, which will further limit the available space. We have to organize ourselves in order to store the material on site in a proper way or to get it stored outside and move it to the building at the right time to get it directly to the right locations.”

The heart of the building from the mechanical services viewpoint is at level B2, which feeds a main riser in the central core, and sub-risers in the building’s wings. Chilled water is supplied to the building from a district cooling plant that also serves the adjacent Dubai Mall and Lake Tower Hotel.



BURJ DUBAI: THE FIGURES

- **121,000** light fittings
- **170** pumps
- **34km** of chilled water pipework
- **4,000** fan coil units
- **140** air-handling units
- **3,600** fans
- **52** heat exchangers
- **225,000** chilled water pipe fittings
- **33,000** chilled water valves
- **86MVA** electrical load
- **1.8 million** metres of conduit
- **55km** of cable tray
- **1.5km** of busbar
- **250km** of LV cable
- **20km** of MV cable
- **71** transformers
- **5,000** facade lights
- **375km** of fire alarm cabling
- **10,000TR** cooling load

The supply of chilled water to the tower is achieved by a forced pump system. Primary chilled water is received from the EMAAR district cooling plant at 3.3°C at level B2. It is then passed through a series of heat exchangers before being pumped to a plant room at level 17, then to plant rooms at levels 40, 73, 109 and 139.

The water is then distributed from the respective plant rooms to air-handling units and fan coil units in apartments and guestrooms.

The domestic water supply and fire sprinkler system work on gravity, with water being pumped to water tanks in the upper level mechanical rooms for further distribution.

“This whole concept is almost like an umbrella – you provide at one location then distribute downwards,” Ghamraoui says.

“This is a unique concept and is achievable due to the gravity from the very high building.

“One thing that was very important to the MEP distribution was the structure of the building. With the huge thickness of walls, from a builders’ work point of view we had a challenge not to miss any of the holes or openings.”

This meant early involvement of the MEP contractors was vital, as was their co-ordination with the civil contractors.

The length of pipe runs in the main riser also meant the system design had to allow for

movement of the building as well as natural expansion and contraction of the pipes and structure. A specialist subcontractor was appointed under the MEP scope of works to study pipe movements and advise on the positioning of expansion joints and guides.

“For every single pipe we made a calculation for the vertical part, every angle and deviation,” Ghamraoui says.

Rather than a conventional gravity support system, pipe guides and ball joints are installed at various stories, thus enabling free movement of the pipework in the building, taking into account seismic, building deflection, vibration and acoustic requirements.

SUPPLIERS

AHUs: Klimak	Floor grilles: Trox
BMS: Honeywell	Flues: Midtherm
Boilers: Hurst	Heat exchangers: Alfa Laval
Cable: Ducab, Riyadh Cable	HV switchgear: ABB
Cable management: Barton, KSC	Insulation: Cape East, Kimmco
Chillers: Lennox	Lighting controls: i-Light or Dynalite (TBA)
Controls: Honeywell	LV switchgear: ABB
Control valves: Honeywell	Power busbar: Cutler Hammer, Eaton
Drainage: National Plastics, Spears	Pumps: Grundfos, KSB
Ductwork: Emirates Ducts, Weathermaker	Pressurization: Armstrong
Electrical accessories: Crabtree	Sound attenuation: Prime Tech
Electrical distribution: ABB	Sprinklers: NAFFCO
Emergency luminaries: CEAG	Standby generation: Caterpillar
Extract fans: Penn	VAV boxes: Solid Air
Fan coil units: Carrier	Water heaters: AO Smith
Fire alarm/detection: Honeywell	



Going up ... The Burj at around the halfway point was as tall as its neighbors, now it towers over them.

This design means a single stanchion at the base of the system supports the weight of the water and pipework. With a load of 140 tonnes at this point, careful design was needed.

“The elbow at the base is a very special piece ... the thickness is much higher than any elbow normally used and it is of a higher grade of steel.”

With an 84MVA total capacity to meet, supplying electrical power to the Burj called for an unusual system.

Rather than step-down transformers reducing the voltage at the HV incoming supply, an 11kV power supply is distributed throughout the building via the main riser. This is reduced to a 400V supply at substations throughout the building then distributed by busbar via sub-mains distribution boards, which finally feed local distribution boards via corridor routes.

A four-core, 180mm² cable was chosen for the HV distribution, as the flexibility of busbar tap-off points was not required. To ensure total security of supply, two main electrical risers in the building core – for standard power and emergency power – operate in parallel. Five 2200kVA generators provide further back-up to the life safety systems in the event of a total power failure.

Not surprisingly with the tower design of the building, vertical transport is a big factor in the MEP services. A total of 54 elevators and eight escalators are being installed under a subcontract package awarded to manufacturer Otis.

Included in this design is the longest lift tunnel in the world, which will have a double-deck lift running from the ground to a visitor area at levels 122 and 123 that will house restaurants, bars and an observation deck. It is one of the world’s fastest double-deck lifts, operating at 10m/s.

“This was specially developed in order to cope with the amount of people that are likely to want to visit this iconic building,” Ghamraoui says. “In a double-deck you can put more people in a limited space.”

Fire lifts with speeds of 9m/s will serve all floors of the building. Access to higher floors via the general elevators, as is standard for towers, requires users to transfer between two or more lifts to reach their destination. Speeds for these lifts range from 1.75-7m/s.

The positioning of major MEP plant at a height required careful planning due to the construction methods being used and the future replacement of plant.

“The construction of the tower is something special from the civils point of view, The whole building is under jump form, there is shuttering everywhere, so if we want to introduce equipment we cannot do it from the top. Some of the equipment weighs 10-15 tonnes, and loading platforms capable of receiving this weight will be installed at various plant room levels projecting outside the building.”

To enable the speed of construction to

continue unhindered, the MEP contractor has opted to crane in large-scale pipes from the top of the building directly into the central core.

“We are installing chilled water pipe that is 600mm in diameter and 12m in length, and the weight is around 3500kg in one piece,” Ghamraoui says.

“We found a way to make an opening in the jumping form in order to introduce those huge pipes and minimize the welding joint numbers on site. It’s a very special method using intermediate hoists inside the tower.”

Removal of the plant at the end of its lifespan has also been considered. Plant rooms are next to the service lifts, with the elevators sized to cater for the largest section of plant that must be removed – the transformers.

“It has also been looked at from a layout point of view: the routing from the plant room to the elevator is free of any equipment, so we don’t have to stop operating any installation. You just dismantle the plant and get it replaced.”

Acquiring the material quantities for the project was a task in itself – for example, more than 4,000 fan coil units were required.

“That was one of our achievements – we can say today for this project that almost 95% of the materials are approved and orders are in place,” Ghamraoui says.

“One thing that is very important in such a huge project is the team spirit. If everyone does

Geberit Pluvia – effective even on the largest roofs

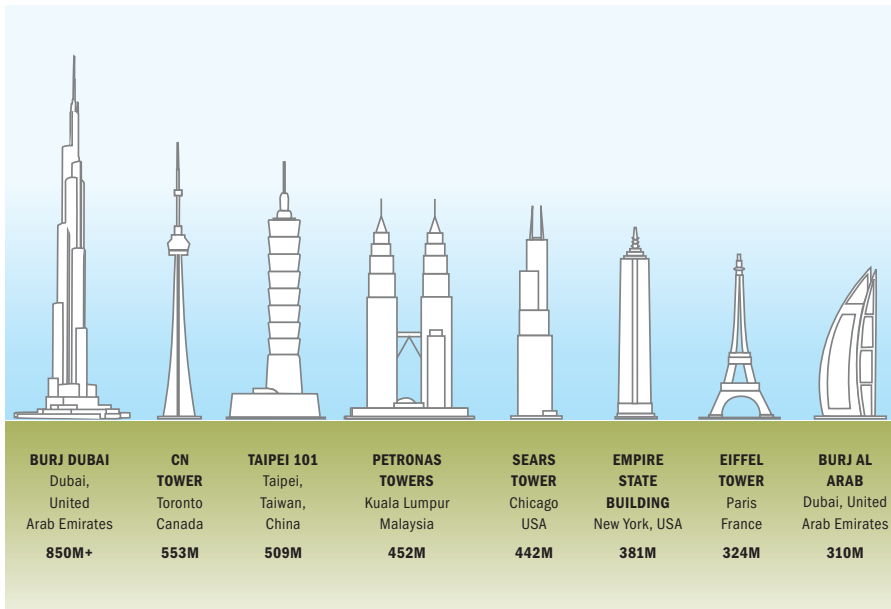


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With traditional systems, rainwater flows to the street sewers partially filling the pipes on its way. By eliminating most of the air from the system, the pipes are completely filled, which automatically creates a syphonic action. Water is literally sucked from the roof into the drainage system. Compared with a conventional system, Geberit Pluvia needs fewer roof outlets, smaller pipe diameters and significantly fewer downpipes and stacks. This reduces the related expensive underground drainage work. Choosing Geberit Pluvia means freedom in design, an optimal use of space inside buildings and a reduction of costs.

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not look to the same targets in a positive spirit we cannot achieve this project. But I can say with certainty this spirit is there.”

The final MEP installation in the Burj Tower is only half of the services story. With more than 2,500 people employed on site and 24/7 construction operations, services had to be installed from the start of the project to ensure that programs and safety Standards were met.

“Power, firefighting services and water supply should be operational 24 hours a day during construction, and it’s very important to have something safe and reliable,” Ghamraoui says. “It must also be flexible, because the building is moving, so you have to keep the power supply at the higher level even if it is under construction.”

A third demand on temporary systems is ease of operation.

“We are completing one floor every three days, so the power supply, firefighting and water supply should follow at the same speed as the construction. We started the temporary MEP works well in advance of the permanent ones.”

These temporary works are designed and installed by a separate team of operatives employed directly by the Samsung-Besix-Arabtec joint venture rather than under the MEP contractor package. This is done in order to cope with the flexibility of construction.

The size of temporary works dwarfs the final installations on many projects. Pumps of up

to 32 bar are being used for water supplies, with five 600kW and three 110kW generators, plus three 1,000kVA substations dedicated to the electrical supplies.

To get materials and labor to the areas needed, 18 of the final lifts are being used. In addition, eight external lifts of 1.6m/s and three internal ‘jumping’ lifts are being used, the latter being moved up the building with the structural formwork.

“The higher the building becomes the more time it will take to get people and material to their location,” Ghamraoui says.

The temporary water systems installed mirror those of the final installation, with operation by gravity feed. For the firefighting systems, water is pumped from ground level to two high-level 24m³ water tanks, and at every floor a fire hose reel and a landing valve are installed.

“The difficulty here is that we must also provide firefighting on all of the wooden platform jumping formwork. It is crucial for us to protect this jumping form, because it is the most important equipment in the civil works process.”

The domestic water supply follows this system also, using the same tanks to supply toilets and kitchens by gravity feed.

“At every floor we have urinals, washbasins and toilets. Also, in order to avoid people having to go down to ground level during construction, the canteen areas are located at

THE BURJ TOWER, DUBAI

Client: Emaar Properties PJSC

Project manager/management contractor: Turner Construction International

Main contractor: Samsung-Besix-Arabtec JV

Architect and designer: Skidmore, Owings and Merrill

Supervision consultant: Hyder Consulting Middle East

MEP contractor: ETA- Voltas-Hitachi Plant JV

Lighting designer: FMS

Lift contractor: Otis

ELV contractor: Johnson Controls

Contract Details

Completion date: December 2008

the intermediate floors in the building, and for that we are providing water.”

These temporary tanks will be dismantled and removed following completion of the permanent systems. It was not possible to use the final tanks during this stage: they were not available and, besides, the area in which they will be positioned is yet to be built. 🌐

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NORWAY SHOWS THE WAY IN INNOVATIVE WASTEWATER TREATMENT

An experimental decentralized urban treatment system that processes graywater from apartments in an Oslo suburb has consistently produced water pure enough to swim in.

Unlike many other countries, Norway is not confronted with water shortages – but it does have a strong appreciation of the need to conserve resources and protect the environment.

This has led to a focus on concepts such as ‘ecological sanitation systems’ whereby graywater is treated and reused, and blackwater from the toilet is separated at the source so that it can be transformed into valuable resources such as fertilizers, soil conditioners and bio-energy.

Prof Petter Jenssen of the Norwegian University of Life Sciences (UMB), believes that in future completely decentralized wastewater treatment systems will be common in urban areas.

“Graywater from sinks, showers and the laundry will be treated locally in compact low-maintenance systems that constitute attractive landscape elements, and these systems can coexist with decentralized water supply,” he says.

“In the Oslo suburb of Klosterenga, an experimental decentralized urban treatment system that processes graywater from 33 apartments has consistently produced swimming-water quality. An advanced nature-based treatment system is located in the courtyard of the building and consists of a septic tank from where graywater is pumped to a vertical down-flow single-pass aerobic biofilter, followed by a sub-surface horizontal-flow porous media filter.

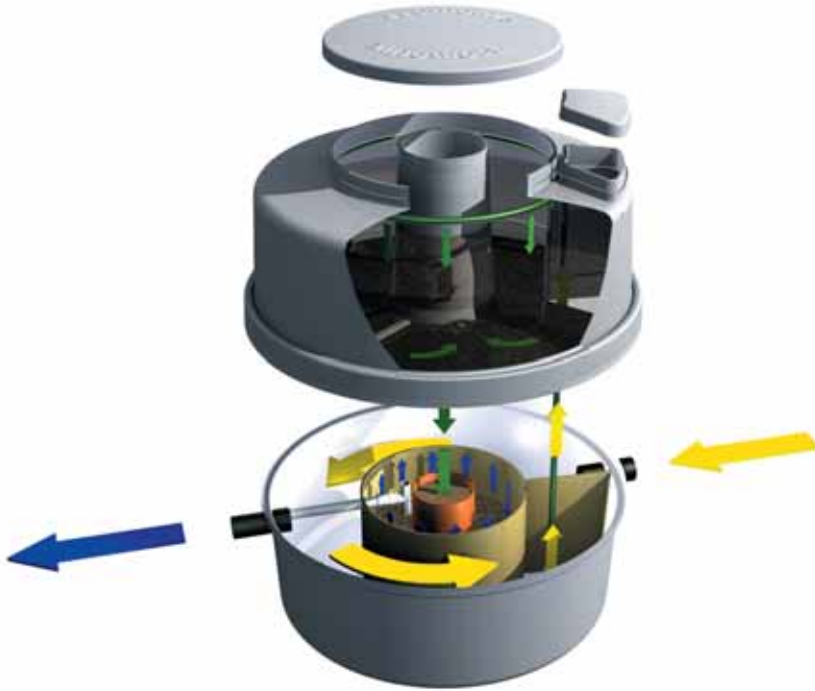
“The effluent has consistently been better than the World Health Organization drinking water requirement of 10mg/L for nitrogen, and in relation to bacteria, faecal coliforms have been in the range of zero to 10/100ml. The small area required for the system and the high quality of effluent enables a range of urban reuse options, including discharge to wetlands or streams, irrigation and groundwater recharge, as well as domestic uses such as toilet flushing and car washing.”

UMB, in collaboration with the Ecomotive company, has developed a compact plant to treat graywater from recreational dwellings, cabins and cottages. According to Jostein Grevsgard of Ecomotive, the system is designed to treat up to 1,000L of graywater a day, and for larger requirements several units can be connected in parallel.

“The system consists of two sections that fit together to form a unit with a total diameter of 1.85m by 1.55m high, which includes a septic tank,” he says.

“A small pump in the septic tank distributes graywater over a biofilter in the top section so that it percolates down to the bottom section where it passes through two more filters before being used for soil irrigation or another appropriate purpose.

“All filters in the unit consist of lightweight clay aggregates and similar porous media – no chemical additions are needed in the purification process. The most distinctive aspect of the system is how compact it is,



Above. Norwegian University's Prof Petter Jenssen believes that in the future completely decentralized wastewater treatment systems will be common in urban areas.

Left. The Ecomotive system is designed to treat up to 1,000L of graywater a day, and for larger requirements several units can be connected in parallel.

which means it is very cost effective and can be installed in a small area.

“Ecomotive has begun manufacturing the units and there are plans to market the system in a package that will include the Jets toilet system. The Ecomotive graywater system is related to the Jets toilet system in several ways. First, the Jets vacuum toilet reduces the amount of water needed for toilet flushing, as it uses less than one litre per flush. This significant reduction complements the strategy of the Ecomotive company in developing compact systems that facilitate water saving by recycling treated graywater.

“Future work will include optimization of the biofiltration part of the system, and integration of a toilet waste treatment system for the purpose of effective and hygienic resource utilization. The goal is to minimize the effect on health and the environment by increasing treatment efficiencies and reducing emissions, as well as the costs relating to water and waste treatment, and transportation. Different reuse options, for treated graywater and sludge, will be investigated as we gain experience and collect information.”

Jets toilets are available as wall or floor-mounted units in high-quality porcelain or stainless steel. The vacuum toilet system for small installations is called vacuum on demand (VOD) and is designed to accommodate up to 10 toilets. At the centre of the system is the Vacuumator, which features an inline design with a small footprint, allowing installation

flexibility and weight savings.

Jets managing director Kaare Haddal says the Vacuumator has a motor, screw and macerator on the same shaft, and the role of the integrated macerator is to grind waste to a fine pulp for optimal transport to the sewage treatment plant.

“The system has few moving parts, and the helical screw principle uses liquid to create the seal, thus minimizing mechanical wear.

“A vacuum system can be installed using pipes as small as 32mm in diameter (1¼”), which reduces costs and space requirements. The piping system is not dependent on gravity, and a big benefit is that sewage can be ‘lifted’ to a higher level if necessary. Also, because water consumption is reduced by up to 80% compared with a conventional toilet, there is less sewage to treat, so a smaller collection tank can be used.

“Because of the flexibility of the system, Jets vacuum toilets are easy to retrofit in existing buildings, and installation costs are usually lower than for conventional toilets. Energy consumption is about 4kWh per person per year, and smaller units are available in a solar-powered version.”

The Mini Jets 10NT is the latest addition to the company’s range. Haddal says it is an exceptionally compact system for small installations, with a total weight of only 18kg (40lbs).

UMB, which has played a key role in the research and development of the Ecomotive

system, is recognized as an international leader in the field of environmental technology, including developing and optimizing innovative water-saving and recycling systems for wastewater and waste.

The university’s Arve Heistad, inventor of the Ecomotive plant, says interest in graywater treatment systems is increasing in Norway.

“Based on more than 10 years of research and field experience at the university on source separating systems and constructed wetlands, we know that these systems out-compete any package treatment plant in respect to treatment efficiency on all relevant parameters.

“The only drawbacks have been the relatively high investment costs and area requirements. I wanted to create a more compact system based on the same principles, with a lower investment cost. These ideas were presented to Jets and the co-operation started.

“Since then, Ecomotive and the university have worked together on finalizing the treatment unit. The industrial experience of Jets and the close co-operation with Ecomotive have been important for the realization of the treatment unit and its competitiveness in the market.”

CONTACTS

www.ecomotive.no

www.jets.no

www.umb.no

EXPLORING MYTHS AND LEGENDS

A paper presented at CIB W062 in Brno, Czech Republic highlights lessons which can be learnt from studying the past. This is an edited version of the paper.

The 19th Century saw a flourishing of great innovations in sanitary engineering, introducing safe and practical building drainage and plumbing systems on a large scale. Many of the important aspects of maintaining a system's integrity by preventing sewer gases from entering living spaces, the water trap seal and system venting, had already been introduced and much work on improving the system's response to the inevitable pressure fluctuations encountered in a fluid transport system were well under way.

This paper explores the work of early innovators in the field and tracks developments through the 20th Century to the present day and considers how this early work has often been sidelined in favour of less scientific design techniques in codes and standards. It is hoped that this paper will highlight the early work of those attempting to create a safe, hygienic environment for people, for the first time. This work should be remembered in a favorable light, not least because of their commitment in the face of opposition, but because their observations were based on the sound engineering and scientific methods often absent from deliberations in the industry today.

INTRODUCTION

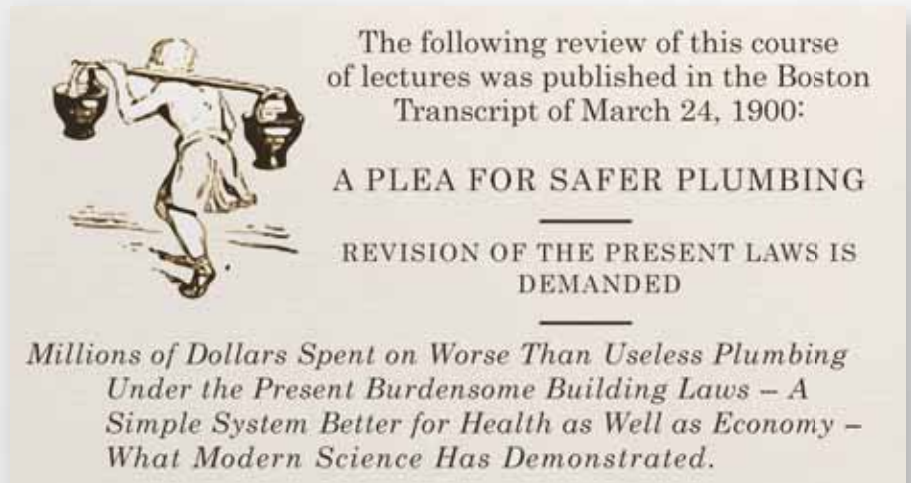
Building drainage system research and modelling is often concerned with physical phenomena on a minute scale. This author's paper contribution to the CIBW62 symposium

in Taiwan in 2006 considered the risk of trap seal depletion due to solids falling down a vertical stack, with the duration of the resulting air pressure transient measured in milliseconds. With the introduction of modern technologies such as the positive air pressure attenuator comes a need to measure performance over a very short timescale, again measured in milliseconds. In stark contrast to the flows found in public sewer networks, most flow scenarios in building drainage systems can be simulated in numerical models using total simulation times of less than one minute. Scale is an important issue in engineering science and building drainage systems are no exception. Shorter time scales and larger physical variables (such as pressure, velocity) are inevitable the closer to the point of system entry one looks.

The modelling of a building drainage system operation focuses mainly on the derivation of boundary equations for inclusion in numerical models, a process which forces the researcher to determine the relationships involved forensically and, in many cases, in an isolated manner. The combination of small time scales and the need for accurate system boundary information encourages researchers to look at a system on a 'micro' level.

This paper takes a step back from this approach and considers some of the 'macro' implications of building drainage system design, but from a historical perspective. It is hoped that this approach will highlight





Putnam's 1900 paper demands changes in the law to allow for simplified and safer plumbing.

that some of the important issues facing the drainage research team today, have faced researchers since the birth of modern sanitary engineering, arguably considered to be in the 19th Century. The myths alluded to in the title of this paper are in effect the superstitions and mis-information which have dogged this area of engineering, much more than any other. The 'legends' refer to seminal work by early investigators, often forgotten, but which have proved their worth in modern times.

It should be noted that the issue of sanitation provision follows particular cultural and geographical standpoints, and while every effort has been made to make this paper as general as possible, it is inevitably written from a European/American/Western perspective. This is in part due to the influence that modern gravity fed drainage systems have had on world sanitation, but also in part due to the background of the author.

SANITATION, DEVELOPMENT AND PROGRESS

Development is a much contested term. It describes a process of change in a society or community from one way of being to another. It is concerned with progress and is usually associated with industrialization and democratization though many others see the process as a vision. This contention has led to entrenched views on how a people should adapt to changing times and progress forward.

The process of development is inseparable from the concern with the disposal of human waste. It can be argued that a culture's approach to disposal of human waste is a good development indicator. Much has been written

on early drainage and sanitation systems. The early systems found in Turkey go back 8000 years and 4000 years in Greece. The system most of us are familiar with is the Roman system of water supply and sanitation which in many ways forms the foundation of our modern systems today. In many respects very little advancement occurred from the fall of the Roman Empire until the 15th Century with little remaining of those Roman systems.

Progress towards a modern, industrial, developed world can arguably be traced back to the beginnings of the industrial revolution, which started in Britain but spread quickly throughout Europe and the U.S. With industrialization came a rapid move from a predominantly rural, agrarian society to a predominantly urbanized, industrialized society and with this came all the problems associated with intensive living in cramped conditions with poor sanitation.

THE INDUSTRIAL REVOLUTION; SANITATION REFORM IMPERATIVE

With the industrial revolution came a dramatic shift in living. The move from a predominantly agrarian, rural society to a more urban, industrial one brought many challenges. The least of these was how to deal with sanitation on a massive scale.

The 19th Century, often referred to as 'Victorian times' after the monarch who reigned from 1837 to 1901, saw many changes in Britain. These changes in approaches to living and work were exported to many parts of the world as part of the 'imperial package' where 'development' was 'done' to the colonized for their own benefit. With this export and the

increasing influence of the super powers of the day a 'standard' was created in hygiene and sanitation with notably European origins.

It has been argued that the promotion of hygiene and sanitation followed the missionaries who inevitably followed the colonizers. That the theme of 'Cleanliness is next to Godliness' somehow pervaded the whole of Victorian thinking such that to bring the 'word of God' to a people involved bringing better hygiene and sanitation. This is the view of many commentators, notably Comaroff who considered this a further erosion of local (sometimes better) traditions in this area. There is an alternative view that the driver for sanitation reform in Victorian Britain was not so much a 'faith' based idea but an intense apostasy for reform in general.

Regardless of its origins, it is without doubt that the idea of public health reform as universally advantageous accords not only with our own sense of the desirability of sanitary techniques such as flush toilets and water-borne sewerage, which have become naturalized in the West, but also with a narrative of historical progress.

The consequences of an 'evangelization of sanitation' linked with colonialization has been a long standing connection between the colonized and the colonizer in terms of trade and progress. In terms of sanitation standards this has often meant the adoption of codes and standards which are not tailored for particular needs. For example in Hong Kong, where the use of sea water to flush WCs is wide spread, research and design codes should reflect this, but the drainage codes and design guides are based on U.K. standards which were derived

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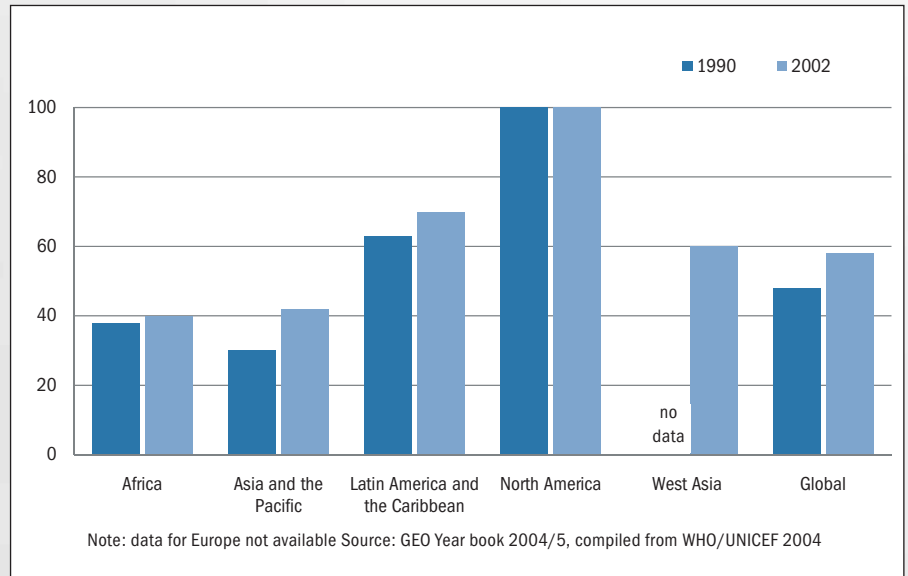


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Population with access to improved water supply (% of total) by region and global, 1990 and 2002

using clean cold water. This anomaly is just one example of how the use of standards produced for a particular place and time can be totally irrelevant to another place at another time.

EMBRYONIC CODES FOR PLUMBING

To most people the building drainage system lurking beneath their pristine ceramic and stainless steel appliances presents a mystery beyond their usual 'need to know'. How their sink full of soapy water gets from their newly refurbished kitchen island to the municipal treatment plant is of little or no interest, and likewise, few people ponder the similar journey from the WC, bath or bidet in the bathroom; until that is, they are suddenly faced with a foul smell from 'somewhere down there' or are met by a filling WC bowl which keeps on filling and pours onto the new floor covering. The mystery surrounding the drainage system suddenly deepens on the presentation of an unfeasibly costly repair bill.

The disposal of human waste is an issue the world over - cultural perspective and local taboos governing many of the practices surrounding its management. It has been conjectured that in many ways the approach taken to waste management is a very useful representative indicator of 'level of development' within a society. While a fuller discussion of this falls out of the remit of this paper it is useful to note that many of the great 'civilizations' in history are remembered

for the attention paid to sanitation.

In truth there are few real mysteries about the operation of a building drainage system. The underlying principles governing the flows of all fluids (water and air) have been well described and indeed applied to the building drainage system for both design (making the system work) and forensic analysis (finding out why it didn't work) for many years. It is worth remembering that while humans have many cultural taboos surrounding the bathroom, which have contributed to the myths surrounding the drainage system, there is a strong scientific basis for the movement of waste by means of water which has a long tradition, going back thousands of years. However the advances made in the past two centuries form the basis for our modern systems.

The age in which the innovation of safe and practical building drainage and plumbing were at the cutting edge of technology was in the late 19th Century. This work was initially carried out by scientists and notable engineers of the time. In the

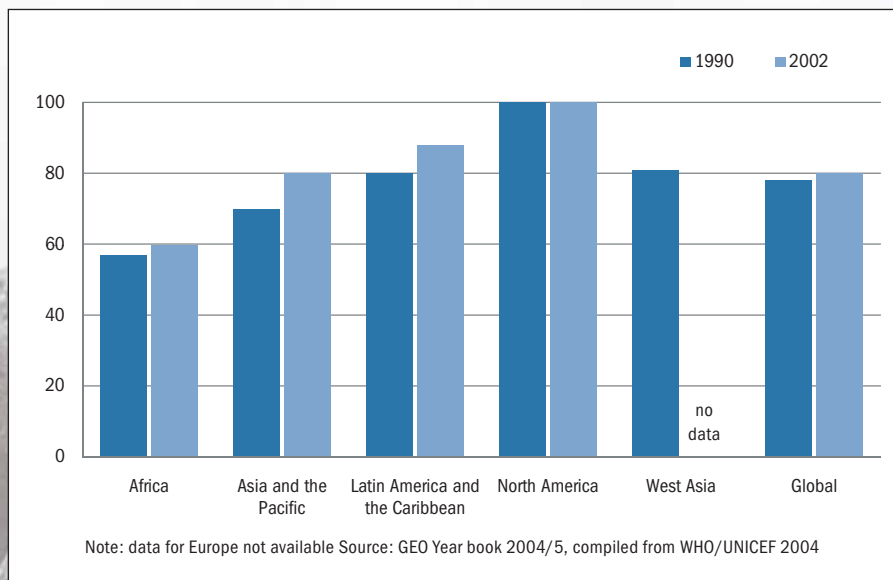
U.K. the water trap seal was invented by Cummings as early as 1775. Cummings was an Engineer and a watchmaker and resurrected the idea of a flushing WC originally invented by Harrington in the 17th Century. While much of the parts of the system had been around for some time it wasn't until the mid 19th Century that any impetus existed to sort out the poor sanitary conditions in large towns and cities.

In 1842 Edwin Chadwick, an English civil servant, published his *'Report into the Sanitary Conditions of the Labouring Population of Great Britain'*. This report initiated a process of reform which prompted investment in sanitation as a public health priority in the slum conditions created by the rapid expansion of British cities as a result of the Industrial Revolution.

Such was the importance of sanitation at the time that even the eminent scientist/engineer, Osborne Reynolds, whose work on turbulent flow was seminal and still considered central to any discussion of fluid dynamics today, was moved to write a paper on 'Sewer Gas and How to Keep it Out of the House', which dealt with sanitation in the slums of Manchester, England in the late 19th Century.

While this work was continuing in Europe, in the United States, architects, scientists and engineers were facing their own growth problems as immigration from Europe and rapid economic expansion provided the driver for a building boom. Work (reported by) a notable Engineer, George Waring in his book *'How to drain a house, practical information for householders'*, highlights the depth of knowledge available at the time.

Waring was an influential sanitary engineer in his day, an innovator in public sewage works and an advocate of the link between poor sanitation and the spread of disease. He was consultant sanitary engineer to the President of the U.S.A. at the Whitehouse in Washington DC.



Population with access to improved sanitation (% of total) by region and global, 1990 and 2002

While some of Waring's approaches are outdated, his writings did show that he had a firm grasp of the link between what was going on in the drain and its relation to fluid mechanics. The following extract illustrates this well:

“Efficiency [of the vent system] is due entirely to the admission of air fast enough to supply the demand for air to fill the vacuum caused by water flowing through some portion of the pipe beyond the trap, it is not only a question of having an opening large enough to admit air, but of having an adequate current led freely to the opening...a one inch pipe, for example may admit air fast enough, while a larger [longer] pipe of same diameter, or a smaller pipe of the same length would not do so”

Waring, 1895 pp 101-102

What Waring is suggesting here is the importance of pipe friction and the necessity to analyze the problem in a time-dependent and dynamic way. This is a crucial point and one which has driven much of the computer-based systems modeling carried out in the past 30 years. Building drains carry unsteady flows which means that they are rapidly changing and cannot be analyzed using simple calculations based on steady, unchanging flows, which are often used for the slower moving public sewer networks.

A contemporary of Waring, the Boston

Architect J. Pickering Putnam went further in his 1911 book *'Plumbing and household sanitation'* in which he doubts the necessity for any venting on properly designed systems with anti-siphon traps – he even suggests the use of mechanical air vents in close proximity to water traps in order to overcome siphonage problems.

Putnam's conclusions followed years of experimentation on water trap seals and venting arrangements based on sound fluid mechanics principles. The point raised by Waring above was further promoted by Putnam following a series of experiments on pipe friction carried out by the *Massachusetts Institute of Technology*.

Putnam's 718 page book concludes with a paper delivered to the 44th annual convention of the American Institute of Architects in San Francisco, Jan 18, 1911, entitled *'Better Plumbing at half the Cost'* in which he suggests a single pipe system for multi-storey buildings based on an economic argument and the years of experimentation and experience of the author.

It is noteworthy to mention that of the reasons cited by Putnam for the failure to adopt such simplified systems the most significant was the conservatism of the plumbing associations, and the industry in general. This work on the single pipe system was further investigated in the U.K by the Building Research Station in the 20 years or so following World War II. Again, the driver was a rapid expansion in building projects as the war torn country was rebuilt. Work published

by Wise in 1957 concluded that the single pipe system (known as the single stack system in the U.K.) was a robust, safe and economical option and that, if properly designed, building drainage systems do not require every trap to be vented.

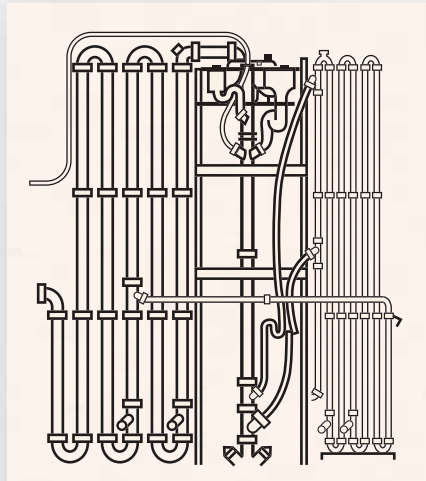
So it seems that the issues surrounding the adoption of new approaches to venting are the same today as those experienced by investigators in the late 19th Century. Much of the cynicism surrounding new approaches and techniques was a result of the intervention of plumbers and those associated with the industry for whom a move to more efficient installations posed a threat.

PLUMBERS OR SANITARY ENGINEERS

The distinction between the 'plumber' and the 'sanitary engineer' may seem an unnecessary one, however the plumber as tradesperson, artisan, wields a considerable amount of power in the industry compared with many other technicians in similar engineering disciplines. This influence is due in part to the trepidation with which most people view the whole process of removing unwanted waste from a building. The plumber is the front line for many and the one to advise on the efficiency or otherwise of particular installation options. The parodying of the plumbing profession is not new as this quote from an early American home economics text by a Mrs Plunkett shows:

“Next to the mother-in-law, the plumber is

The Test Rig at MIT (Massachusetts Institute of Technology) used to establish the importance of pipe friction in drainage system venting.



the best-abused character of the period; he is the perpetual butt of the “funny man” of the daily press, who represents him as gallivanting about Europe, while his impoverished customer wrings his hands in vain lamentations on the hither shore of an ocean he has no money left to cross.”

Mrs Plunkett goes on to defend the plumbing fraternity by suggesting that there are just as many honest plumbers as there are carpenters, masons or painters. The point she makes is that the consequences of a ‘poorly compacted joint’, as she puts it, is much more evident than the work of other trades. The point she makes is a very good one, and still relevant today. The consequences of poor plumbing are horrendous. The fear of these consequences has led to an innate conservatism among plumbers when it comes to adopting new techniques and technologies. They are perhaps right to be wary since it is their reputation that will suffer in the event of a catastrophe.

The evolution of the sanitary engineer on the other hand has been less well documented. The job of designing the drainage system is often left to a junior architect or an M&E engineer with little true knowledge of this specialist system. In stark contrast to the early innovators inspired by the need to provide safe sanitation in a changing world, the modern sanitary engineer has been encouraged to ignore the dynamism of system response in favour of a discharge/fixture unit approach which is based on probability of appliance usage and steady state design.

This combination of a fearful plumber and an ill-equipped sanitary engineer has made innovation difficult in modern drainage systems design. It has also limited the ability to apply

systems modelling to the wider challenges facing the discipline today.

FUTURE CHALLENGES

By examining the successes and failures in developments towards modern drainage system design and implementation, it may be possible to chart a course through some of the challenges facing the discipline in the near future. The challenges facing us into the 21st Century include:

- The improvement of services for the vast number of people without safe sanitation in the world today,
- Providing an adequate response to the threat of an unpredictable, chaotic climate system
- The production of codes and standards flexible enough to cope with this changing environment.

It can be argued that the most pressing of these challenges is the provision of safe sanitation to the 1.2 billion people still with inadequate provision.

The situation is improving, but only slightly, and that the poorest areas in the world still have the lowest access to both improved water supply and improved sanitation.

The impact of a globalizing economic system cannot be ignored in all of this. The increase in urban poor and the creation of slums in many big cities have produced conditions similar to those addressed by Sir Edwin Chadwick and Reynolds in Britain in the 19th Century. The imperative to apply modern engineering and organisational understanding to solving these problems has never been greater.

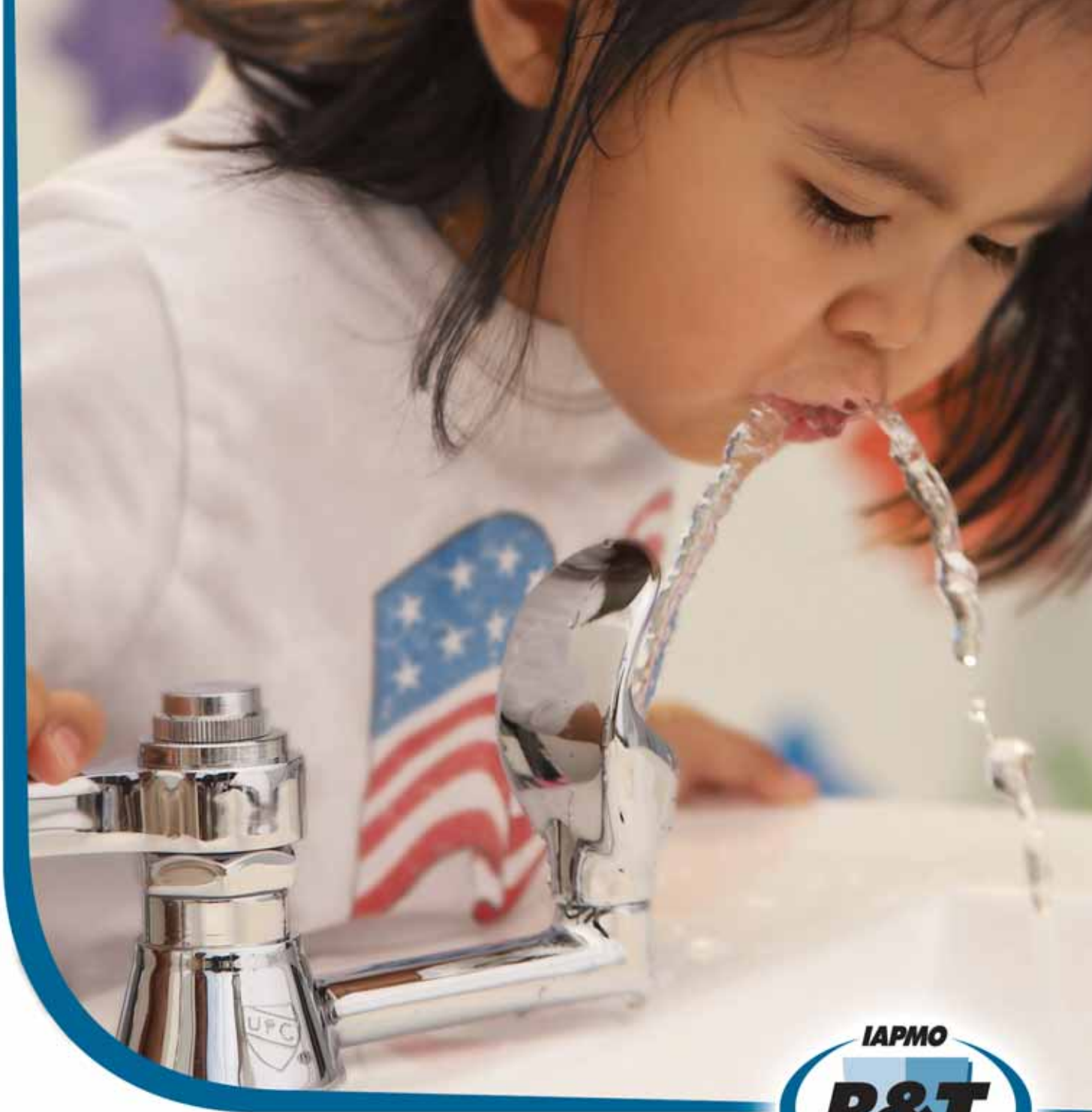
CONCLUSIONS

Much of the modern day understanding of sanitation systems engineering has been in place for a long time. The work carried out by pioneering researchers focussed heavily on the fluid dynamics of the system. This led to the conclusion that building drainage system networks could be simplified, however, resistance from others in the industry thwarted moves to have these systems adopted much earlier than they inevitably were. The strength of debate between the innovators and the conservatives led to entrenched views early on which have proved difficult to overcome since.

The expansion of European empires in the 19th Century led to the adoption of, in many cases, inappropriate technologies and techniques in places where water is acutely short. It was not only inappropriate technologies which were exported but codes and standards as well, many of which are still adopted today.

The challenges facing the discipline in the near future are not less onerous than those facing engineers and planners in the 19th Century when many European and American cities were expanding at a fast pace. Early innovators combined sound engineering fluid mechanics with a sense that they could make a real difference in the world. Our challenge is to apply modern techniques and technologies to the considerable problems still facing the world of building drainage and sanitation today. 🌐

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