System proves effective in combating *P. aeruginosa*

Horne Engineering reports on the positive reception given to its In-Line Thermal Disinfection Unit by the head of Healthcare Compliance at Skanska, who had been looking for an effective means of combating the persistent challenge of *Pseudomonas aeruginosa* in hospital water settings. The thermostatic controls specialist says he is now an enthusiastic champion of the technology.

James Donagain, head of Healthcare Compliance at Skanska UK, is relentless in his commitment to upholding rigorous and sustainable hygiene standards within healthcare facilities. His tireless pursuit led him to confront the persistent challenge of *Pseudomonas aeruginosa* contamination, in particular at the inherently vulnerable periphery of domestic water systems. Following a journey of discovery, James has whole-heartedly embraced a simple, yet ground-breaking new technology, emerging as its enthusiastic champion.

A well-seasoned chartered health and safety practitioner, and stalwart of compliance, James boasts extensive qualifications and considerable expertise in water hygiene. Throughout his career, he has discerned that *Pseudomonas aeruginosa* (PA) contamination at the periphery of water systems is often pervasive and widespread, and also potentially unavoidable. Moreover, his tenacity and strong desire to 'do the right thing' to guarantee patient safety, alongside his wealth of experience, has really shone a light on the profound inadequacies of many conventional approaches to the *P. aeruginosa* problem. So, combining an open mind with a healthy scepticism, he began exploring alternative solutions.

CPD presentation

Leading James's inquiry was a new product, the In-Line Thermal Disinfection Unit (ILTDU) from Horne Engineering, a system he first encountered while serving as Hard FM manager at a Cambridgeshire NHS Trust, during a CPD presentation: 'Engineering versus *Pseudomonas*, *Legionella*, and the retrograde contamination of domestic water services by microorganisms'. This patented technology facilitates routine thermal disinfection local to a single outlet, using the readily available system temperature hot water and, crucially, without placing excessive strain on the hot water system. The presentation and concept sparked fresh ideas in his mind, and he eagerly anticipated an opportunity to personally test the design.

The Horne In-Line Thermal Disinfection Unit (ILTDU).

A few months later, James moved into a new role with Zeta Compliance Services as Water Compliance consultant / Authorising Engineer (Water), and began advising a number of NHS Trusts and their facilities management providers. One of his first clients was King's College Hospital (KCH) in London.

Here, he was fascinated to learn that several ILTDU installations were already in progress – presenting him with an ideal opportunity to coordinate a detailed evaluation. Consequently, and with approval from KCH's Estates team, he embarked on a thorough examination of the technology's efficacy in combating *Pseudomonas* contamination.

Thorough microbiological data were systematically gathered and scrutinised, a baseline established, and additional testing and analysis undertaken over a span of six months. The data compared ILTDU-equipped installations (including taps, TMVs, and showers) with comparable 'control' installations not fed via an ILTDU.

The results were remarkable, showing clear and notably diminished *Pseudomonas aeruginosa* counts for the thermal disinfection group. The favourable findings from this assessment prompted King's College Hospital to adopt ILTDU technology as a standard specification for all forthcoming refurbishment projects, and other 'positive' outlets as they were identified. This would include installing the ILTDU as an independent unit supplying thermostatic mixing valves (TMVs) and other showers and thermostatic taps (from other manufacturers), alongside T4/T9 type showers from Horne, which are equipped with an integrated ILTDU.

Midlands Trust

At the same time, James acquired another NHS client, a sizable tertiary care NHS Trust located in the Midlands. On discussing the difficulties that the Trust's Water Safety Group (WSG) was experiencing at that time, he was not surprised to learn that they, too, were having an ongoing struggle with pervasive and recurring retrograde *Pseudomonas aeruginosa* contamination of the water system. The Group willingly provided its dataset of water sample results spanning the previous three years, along with corresponding costs, and detail on the wasted time incurred for all attempted mitigation efforts.

James sat down to examine the Midland Trust's data. His fresh eyes revealed a troubling frequency of *Pseudomonas aeruginosa* contamination incidents, alongside significant financial and operational strains linked to the organisation's conventional mitigation methods. The heart of the problem was an unsustainable dependence on ineffective consumable chemicals and point-of-use water filters, which not only burdened NHS resources, but also posed considerable environmental concerns. The excessive expenses associated with chemical treatments, combined with extended periods of downtime and frequent replacements of hardware (entire shower or wash-station replacements as a last resort measure), painted a grim picture of inefficiency and unsustainability.

An ILDTU in disinfection mode with the temporary hot water flow path shown by red arrows.

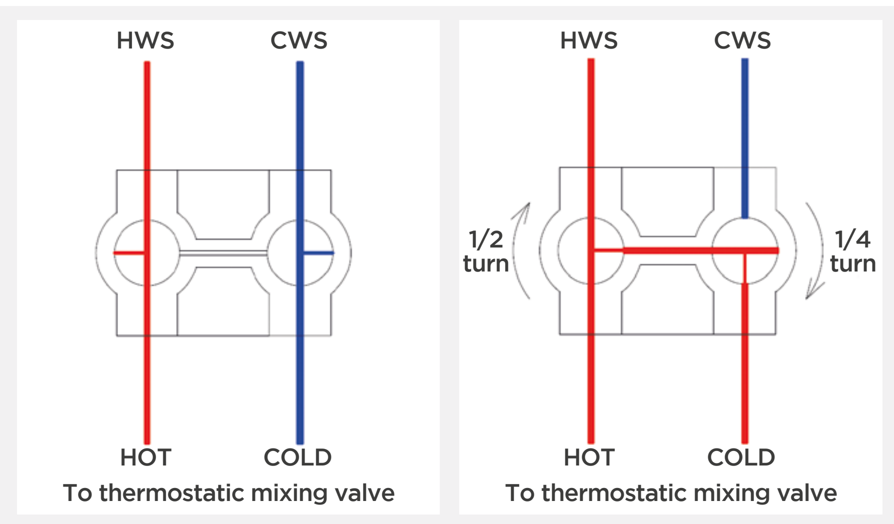
Opportunity for a full assessment

James's prior involvement at King's College Hospital now enabled him to acquaint the WSG with the idea of local thermal disinfection of water outlets utilising the readily available hot water supply. While the ILTDU presented a promising solution to effectively address the ongoing *Pseudomonas aeruginosa* contamination issue, now he also had the opportunity to fully assess the alternative operational expenses, environmental impact, and other tangible advantages.

To demonstrate the solution provided by the ILTDU, this time he was able to conduct a different trial format to his previous evaluation at King's College Hospital. A single *Pseudomonas aeruginosa* problematic outlet was selected for this trial – it was a worst-case scenario, a shower slated for complete hardware replacement, but also one that epitomised such outlets across the hospital estate, and highlighted the ineffective 'remedies' already employed. This shower fitting had been 'positive' for over eight months, despite continued remedial action; in addition to a required weekly duty flush, it had also undergone six unsuccessful treatments with Sodium Hypochlorite (NaOCl), and consumed many hours of FM time, while the costs for point-of-use (POU) water filters, chemicals, water sample collection, and analysis, racked up.

As part of the trial selection process, the hot water feed to the candidate shower was also temperature tested to ensure that it was compliant with HTM 04-01 and could achieve temperatures above 60 °C – the minimum thermal disinfection temperature recommended by Horne.

The trial in this case therefore swapped complete hardware replacement with ILTDU installation. That installation would follow the same protocol as previous new hardware installations, i.e. replacement hardware (ILTDU and any pipework), plus all the tools required to complete the task are pre-sanitised. The ILTDU was then installed across both the hot and cold water supply drops, orientated to match flow arrows with the supply flow direction, and ensuring good access to the ILTDU operation keyhole.



Schematic diagrams of the hot and cold water flow paths when the ILTDU device is in Passive and Disinfection modes.

Mounting costs

By the time of this ILTDU installation, chemically treating this single outlet unsuccessfully had already cost upwards of £750 (labour, POU filters, and sampling/analysis costs), plus an entire day of FM time, and six batches of chemicals. Standard 'last resort' mitigation would be to entirely replace the shower fitting (or tap, TMV, pipework, wash-hand basin, and trap) estimated at a further £900, plus pre-installation sanitation chemicals and three hours' labour.

The costs to install the alternative ILTDU equate to less than a third of that figure (£280), with generally comparable volumes of pre-installation chemicals and time.

James oversaw the first thermal disinfection of the shower: with the shower hose and handset directed safely away to avoid harm, the dedicated key, with its large 'Very Hot Water' warning sign, was inserted into the keyhole and rotated clockwise through 180 degrees, to shift the mechanism from Passive to Disinfecting mode.

The ILTDU operates via a simple four-way link mechanism that rotates two 3-way ball valves. The left-hand (hot side) ball valve undergoes a 180-degree rotation, allowing for a flow path to open through the bridging piece. Meanwhile, the right-hand (cold side) ball valve rotates 90 degrees, closing the cold water supply upstream, and opening a flow path from the bridging piece to the downstream cold pipework.

> **The excessive expenses associated with chemical treatments, combined with extended periods of downtime and frequent replacements of hardware (entire shower or wash-station replacements as a last resort measure), painted a grim picture of inefficiency and unsustainability**

Consequently, a temporary pathway is created for system-temperature hot water to flow down the cold pipework, into the thermostatic shower (tap or TMV) via its cold port, pass through to the outlet, and then drain away. Under these temporary conditions, the thermostatic valve reacts appropriately, with the slide valve moving to tightly close the hot port in response to expansion of the thermostatic element, while simultaneously fully opening the cold inlet port, thus passing hot water to the outlet. The cross-section schematic of the ILTDU shows the flow paths that hot and cold water follow when in Passive and then Disinfecting modes.

To minimise the volume of hot water discharged during the disinfection process, the flow rate can be throttled back at the flow control until the full shower spray pattern is just achieved (NB. the entirety of a tap/shower outlet fitting must be bathed in the hot water). Using a good quality, calibrated, digital thermometer, check the temperature of the water discharging at the outlet. Start the timer only once a minimum of 60 °C is recorded. Horne recommends a minimum thermal disinfection time of 10 minutes at 60 °C. If higher disinfection temperatures can be achieved, then the duration may be reduced slightly. Refer to the PA Thermal inactivation curve, from Spinks *et al*, to determine an appropriate and effective duration.

'Golden-coloured' water and PA reset to zero

As James had anticipated with cautious optimism, the water samples following the trial thermal disinfection yielded clear results for the first time in many months. What did take him by surprise, however, was the release of a slug of 'golden-coloured water' during the 10-minute hot flush. He interpreted this as the resident biofilm being 'cooked' off the internal pipe walls. Subsequent water sample results, as per the existing protocol, derived from HTM 04-01, taken at three days, two weeks, and six weeks following thermal disinfection, also returned PA negative, and allowed this 'condemned' shower to be restored to operational service.

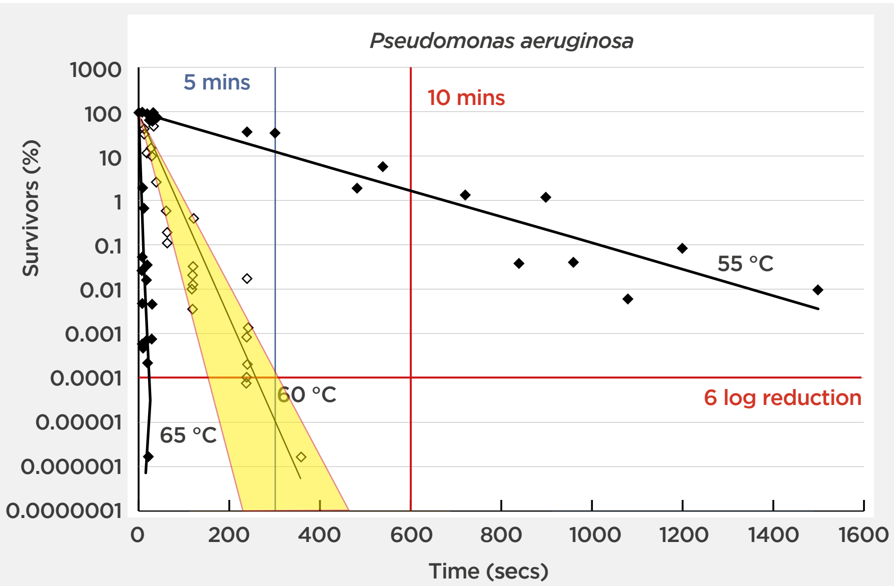
Revising the HTM 04-01 Standard Operating Procedure

Thoroughly persuaded by these findings, James commenced the overhaul of the Trust's HTM 04-01 Standard Operating Procedure, recommending thermal disinfection as the primary remedial measure. Taking it a step further, however, his updated SOP also promoted increased collaboration among pertinent stakeholders in IPC, Health & Safety, Clinical teams, and hard and soft FM providers, thus fostering shared responsibility for sustaining a hygienic water system. The revised SOP, implemented across all three hospitals within the Trust, marked the dawn of a new era in proactive water hygiene management.

Extrapolating the cost and time savings achievable by implementing local thermal disinfection as standard, James calculated the following transformative improvements: outlet 'downtime' would plummet from more than six months to a matter of days; chemical usage could become negligible (92% drop); FM time per outlet down 70%; hardware expenses (including POU filters) down 75%, while costs related to water sample collection and analysis could be reduced by 60% (or more if quarterly PPM thermal disinfection is also implemented). In essence, installing an ILTDU to facilitate regular thermal disinfection could result in savings of approximately £1000 per outlet.

Of course, James's perspective transcends financial considerations. The broader advantages of thermal disinfection are numerous, including diminished environmental footprint, enhanced patient safety, simplified maintenance procedures, and strengthened cooperation among healthcare partners.

James has demonstrated how embracing sustainable innovations such as the ILTDU can allow healthcare establishments to not only better protect public health, but also advocate for environmental conservation worldwide. **hej**



An annotated *Pseudomonas aeruginosa* thermal inactivation curve.

James Donagain

James Donagain CMIOSH is the head of Healthcare Compliance at Skanska UK. He has acted as both AE (Water) and a consultant, to a number of prestigious NHS Trusts across the UK. He has a passion for driving collaboration, sustainability, and patient safety and risk management. He provides expertise on HTM compliance, engineering, risk management, and waterborne pathogens, and has recently provided his expertise at an inquest on an emerging waterborne pathogen.