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IHEA
Institute of Healthcare Engineering, Australia

HEALTHCARE FACILITIES

THE NATIONAL EVENT FOR HEALTHCARE FACILITY MANAGEMENT AND DESIGN PROFESSIONALS

FEATURED INSIDE

Don't hold your breath for too long.

Cold-Plasma Technology
Unique sanitizer

No filters. No waste. No maintenance.

Cold-Plasma devices can be used safely in:

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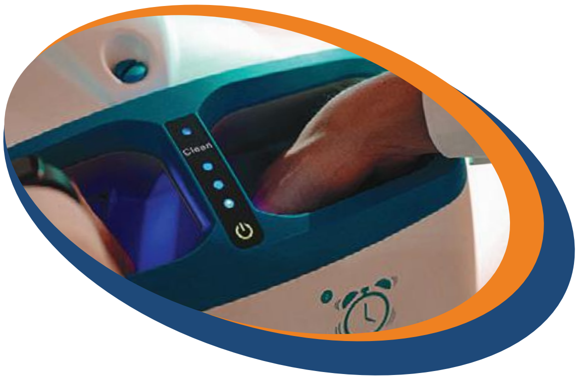
Cold-Plasma Different versions for any situation related to transport, large and small rooms.

- PlasmoCar
- PlasmoAir
- PlasmoLight
- PlasmoHands



No filters. No waste. No maintenance.

Eliminates for entire interior:

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- Odours
- Enveloped viruses (including SARS, COVID-2 and Monkey Pox

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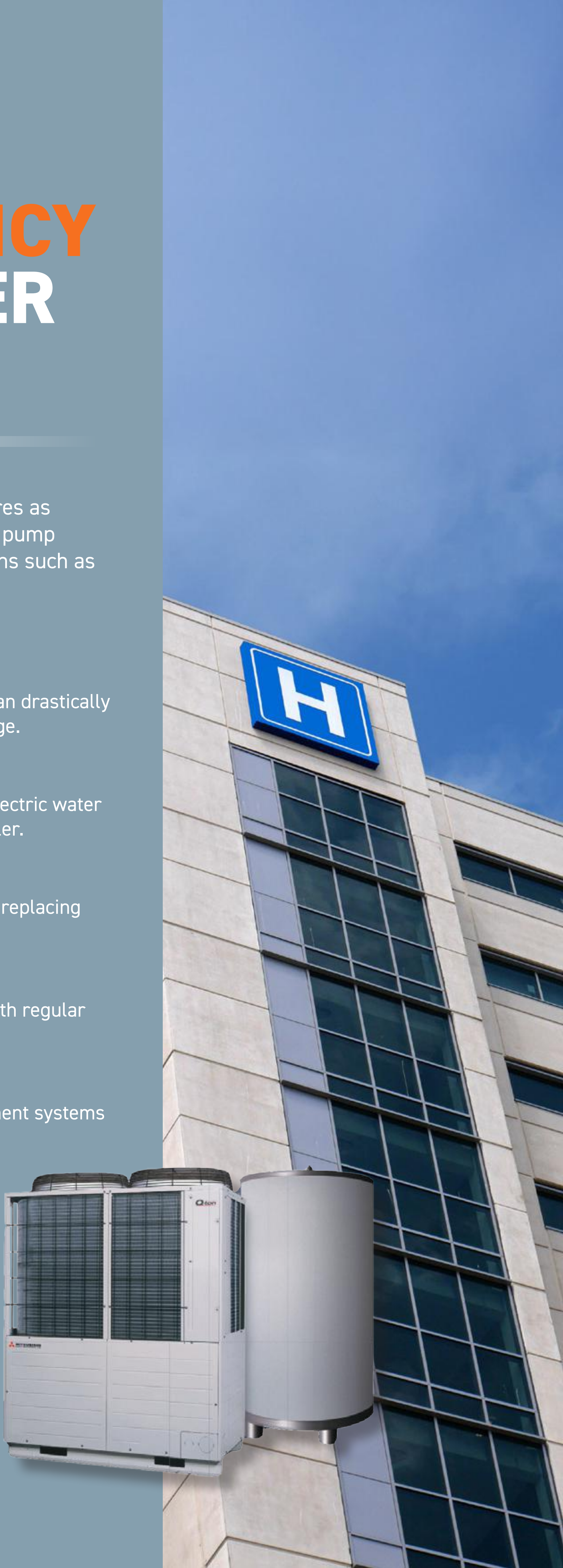
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IHEA NATIONAL OFFICE

Direct: 1300 929 508
Email: ihea.members@ihea.org.au
Website: www.ihea.org.au

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IHEA ADMINISTRATION

Membership
Vanessa Gallina:
ihea.members@ihea.org.au

Editorial
Fred Foley
ihea.editor@ihea.org.au

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IHEA MISSION STATEMENT
To support members and industry stakeholders to achieve best practice health engineering in sustainable public and private healthcare sectors.

ADBOURNE PUBLISHING
PO Box 735, Belgrave,
Victoria 3160
www.adbourne.com

Adbourne PUBLISHING

ADVERTISING
Robert Spowart
T: 0488 390 039
E: robert@adbourne.com

PRODUCTION
Sonya Murphy
T: 0411 856 362
E: production@adbourne.com

Editor's Message

APRIL 25TH IS a special day in Australia and New Zealand. It is a day of reverence, a day of reflection, a day of thanks.

The famous stanza from Laurence Binyon's 1914 poem "Ode of Remembrance"

"They shall not grow old, as we that are left grow old.
Age shall not weary them, nor the years condemn.
At the going down of the sun and in the morning'
We will remember them, Lest We Forget."

embraces the honour and respect due to those who paid the ultimate sacrifice in the name of God and Country. Those of us who live in Australia and New Zealand today, owe these brave people a debt, a debt we can never repay, yet they would all cringe at being labelled heroes. Each would say they were just doing what needed to be done.

This got me thinking about heroes, people who, according to the modern definition, inspire others by their courage, selflessness, noble qualities, and who are willing to take risks or make sacrifices to help others or achieve a noble goal. I am talking about those men and women, who by their everyday actions help maintain our lifestyle, a lifestyle hard won on the battlefield and the envy of many.

There are many modern-day heroes, past and present. To name but a few, there is our military personnel, our police force, our firefighters, our ambulance teams, our doctors and nurses, our teachers and our volunteers. I am sure you can name a few more but the one thing they all have in common is that the beneficiaries of their actions are not themselves but others, many of which they do not know. They just go about their business day in and day out without song or glory. I am not one for Americanisms but there is one I wholeheartedly agree with. The next time you have an interaction with a modern-day hero give them a heartfelt "Thank you for your Service". A few simple words that have a big impact.

The world today appears to be on a path of political and social self-destruction. With what we see and read in our media, our workplaces, our shopping centres and even on our roads it seems there is no time like the present when we need the services of our Heroes.

Remember You too can be a modern day Hero!

With respect and kindness
Frederick Foley – Editor

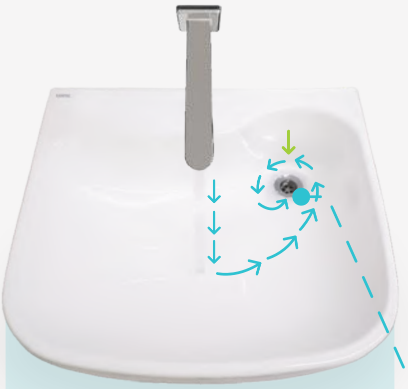
Make Good Choices, When Safety Matters.

Choose Products that Eliminate Risk.
Don't Work Around It.

4 Trusted, Innovative Infection Control and Legionella Prevention Solutions for Healthcare Type A and Type B Wash Areas

SOLUTION #1
STERISAN® Basins with Rear Offset Waste

- Rear offset waste – Reducing airborne bacteria
- NANO glazing
- Protect hands against bacteria and biofilm build-up in the waste
- Sloped surfaces in the bowl area to drain water effectively to rear offset waste



→ : Water flows on the surface, not directly into the waste

→ : Soap flows directly into the basin

SOLUTION #2
GRATE SEAL® One-Way Valve

- GRATE SEAL® provides a seal between the basin waste and the basin bowl to seal off any possible aerosol of bacteria and biofilm into the hand wash area

SOLUTION #3
Thermostatic Mixing Valves

Thermal Flush – Easily adjusted by using a multi-purpose tool

- Lead Free – Mandatory in 2026
- Built-in Thermal Flush capability
- Easy in-situ servicing
- Low cost – both initial and on-going maintenance
- Built-in isolation valves, strainer, and non-return valves
- Easily replaceable and compatible with existing installations
- NSW Health Approved

SOLUTION #4
Thermostatic Mixing Taps

Thermal Flush – Easily adjusted by using a multi-purpose tool

- Lead Free – Mandatory in 2026
- Built-in Thermal Flush capability
- Point-of-use thermostatic tap
- Removable spout for hygienic cleaning
- Supplied with strainers and non-return/ isolation valves
- Laminar flow outlet – Reduces aerosoling and splashback
- NSW Health Approved

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National President's Message

AUSTRALIA'S HEALTHCARE INFRASTRUCTURE is undergoing a significant transformation, marked by unprecedented investments and innovative projects aimed at enhancing accessibility, sustainability, and technological integration. This evolution reflects a nationwide commitment to delivering world-class healthcare services tailored to the diverse needs of communities across the country.

In Queensland, a historic $14 billion infrastructure pipeline is set to redefine the state's healthcare landscape, adding another 3,300 beds over the next 5 years. Spearheaded by Health Infrastructure Queensland, this initiative encompasses the construction of new hospitals and healthcare facilities, the expansion of others, and the introduction of cutting-edge technologies to improve healthcare delivery across Queensland's vast geography.

Victoria is also at the forefront of healthcare innovation. The Victorian Health Building Authority (VHBA) is overseeing 66 projects statewide, focusing on modular construction and digital integration to expedite delivery and enhance patient outcomes.

At the recent IHEA Conference in Sydney, we learnt about the New South Wales Government's $12.4 billion investment in health infrastructure, including funding for the Bankstown Hospital development, the new Rouse Hill Hospital, and a new statewide pathology hub. These projects aim to improve service delivery and reduce wait times across the state.

In South Australia, a new design team has been engaged to deliver the $3.2 billion new Women's and Children's Hospital, and a further $300 million has been committed to a HealthCARE Centre in Bedford Park. This 10-storey facility will offer advanced clinical services and serve as a training ground for over 1,300 health professionals annually, strengthening the region's healthcare workforce.

Western Australia is allocating $839 million towards health infrastructure, focusing on expanding hospital capacity and integrating advanced digital health systems to improve patient care.

In this context of super-investment in healthcare infrastructure, the recent 2025 IHEA National Conference in Sydney brought together industry leaders, innovators, and experts from around the country. This successful conference focused on future-proofing healthcare building systems, emphasizing the importance of getting the basics right. I received some excellent feedback from sponsors, exhibitors and attendees and we are grateful to the committed team from the NSW/ACT branch and Iceberg Events who worked tirelessly to deliver another great Conference. Attendees engaged in insightful sessions, interactive discussions, and valuable networking opportunities, leaving inspired and equipped to help shape new infrastructure planning and delivery, and to share learnings and integrate innovations into their existing operating environments.

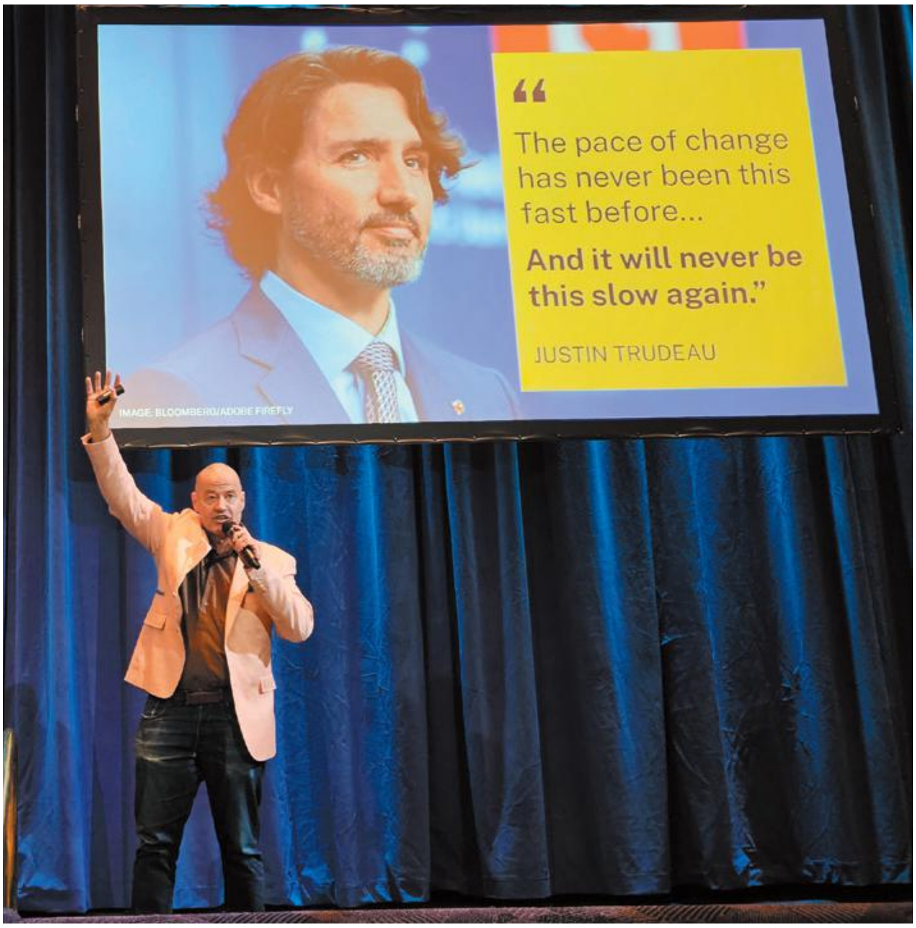
I have also recently returned from the Council meeting of the International Federation of Healthcare Engineering in Antwerp, Belgium, held in conjunction with the 11th IFHE-EU Conference on Healthcare Engineering. Key on the IFHE Council agenda was the ratification of a number of standing orders that had been collaboratively developed prior to the meeting. These standing orders affect governance of the organisation and how IFHE works hand in glove with each of its members, including the IHEA. Meetings to resolve the remaining standing orders are continuing, and Darryl Pitcher and I continue to represent your interests in those meetings.

We live in interesting and exciting times for the healthcare industry. We are always better together than apart and the IHEA is here to support you on your professional journey. If you have ideas about how we can do this better, please reach out to your local branch or me directly ihea.president@ihea.org.au.

Best regards,
Michael Scerri

Schneider Electric

IHEA National Conference



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An interactive showcase of innovative and inclusive bathroom solutions for high risk and high care environments.

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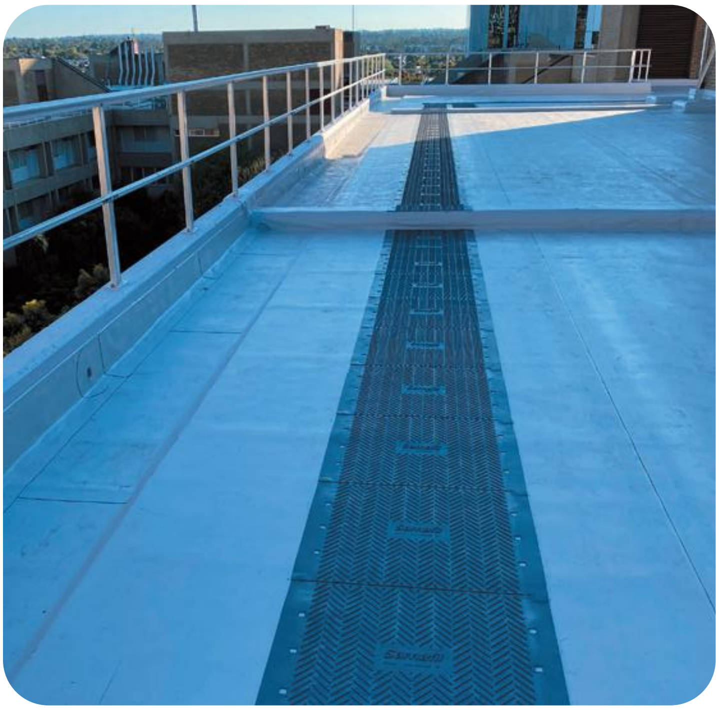
The Waterproofing Experts

Danrae Group recently participated in the 2025 Institute of Healthcare Engineering Australia (IHEA) Conference in Sydney, engaging directly with healthcare and facilities professionals to showcase their specialised waterproofing solutions. Danrae had the opportunity to discuss critical asset protection strategies and share real-world project insights with attendees.

With their expertise in managing large-scale waterproofing projects for hospitals, aged care, and commercial facilities, demonstrating commitment to safety, compliance, and long-term value.

From PVC metal sheet overlay systems to comprehensive maintenance programs, their stand was designed to communicate the depth of offerings from assessment and remediation through to lifetime guarantee support.

The IHEA Conference was an excellent opportunity to reinforce Danrae Group's position as the trusted waterproofing partner for the healthcare sector and they look forward to supporting more healthcare providers with tailored waterproofing solutions that ensure durability and peace of mind.



South Australia/Northern Territory

ON THE 4TH of June, the SA/NT branch in conjunction with Tier 1 builder Besix Watpac, hosted an exclusive behind-the-scenes pre-opening site tour of the Eastwood Private Hospital in Adelaide, offering members a first-hand look at the state's newest healthcare development. The fully subscribed event provided attendees with insights into the hospital's innovative design, sustainability features, and patient-centred approach.

Eastwood Private Hospital, a six-storey facility, is poised to become a leading centre for orthopaedic surgery and specialized care in South Australia. Upon opening, the hospital is expected to admit more than 7,000 patients annually. It will house six integrated orthopaedic theatres, a 51-bed ward, and comprehensive radiology, pathology, and allied health services. Designed by HSPC Health Architects, the facility emphasizes a boutique, doctor-led model, aiming to provide integrated specialized care.

A notable aspect of the hospital's design is its commitment to sustainability. The project targets a 4-star Green Star rating, incorporating energy-efficient solutions, sustainable materials, and environmental best practices to minimize its ecological footprint. The design also features a grand foyer and café, fostering an engaging street presence and a strong public connection within the prominent streetscape.

IHEA members had the opportunity to engage with the project team both during the tour and afterwards at a networking drinks function hosted by Besix Watpac. Discussions highlighted the challenges encountered during the construction phase, including clever construction staging to manage the constrained site.

Later the branch hosted a State Special Meeting to discuss the future of the SA/NT branch and capitalise on the group's enthusiasm. We have some great events lined up for the rest of 2025 and look forward to rebuilding our committee and delivering more relevant and exciting sessions.

All the best,
Michael Scerri

New South Wales/ACT

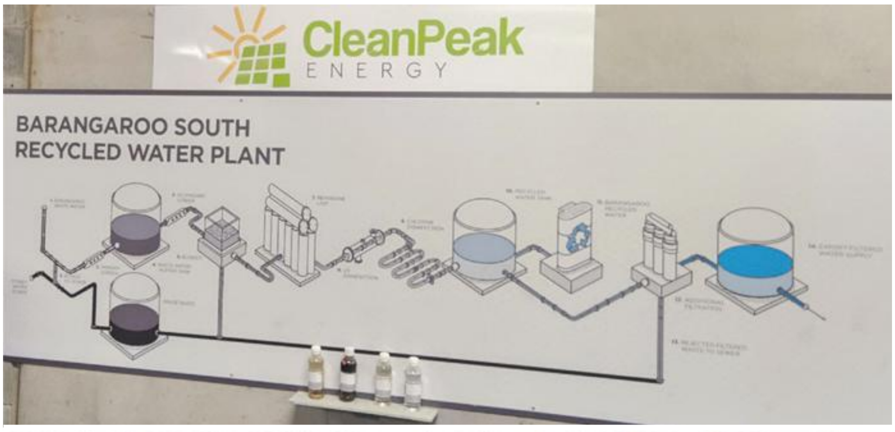
AS WE ENTER the second half of 2025, I'd like to take the opportunity to reflect on the achievements of the past quarter and share some highlights from our recent activities and engagements.

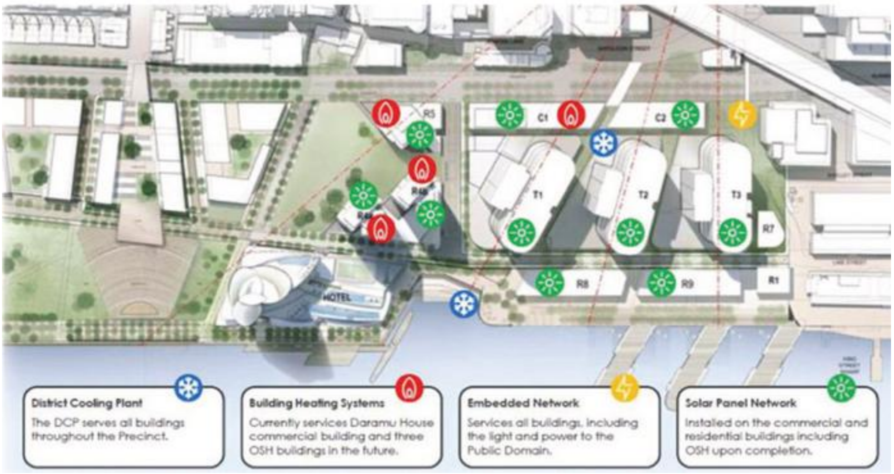
IHEA 2025 National Conference – Sydney Masonic Centre

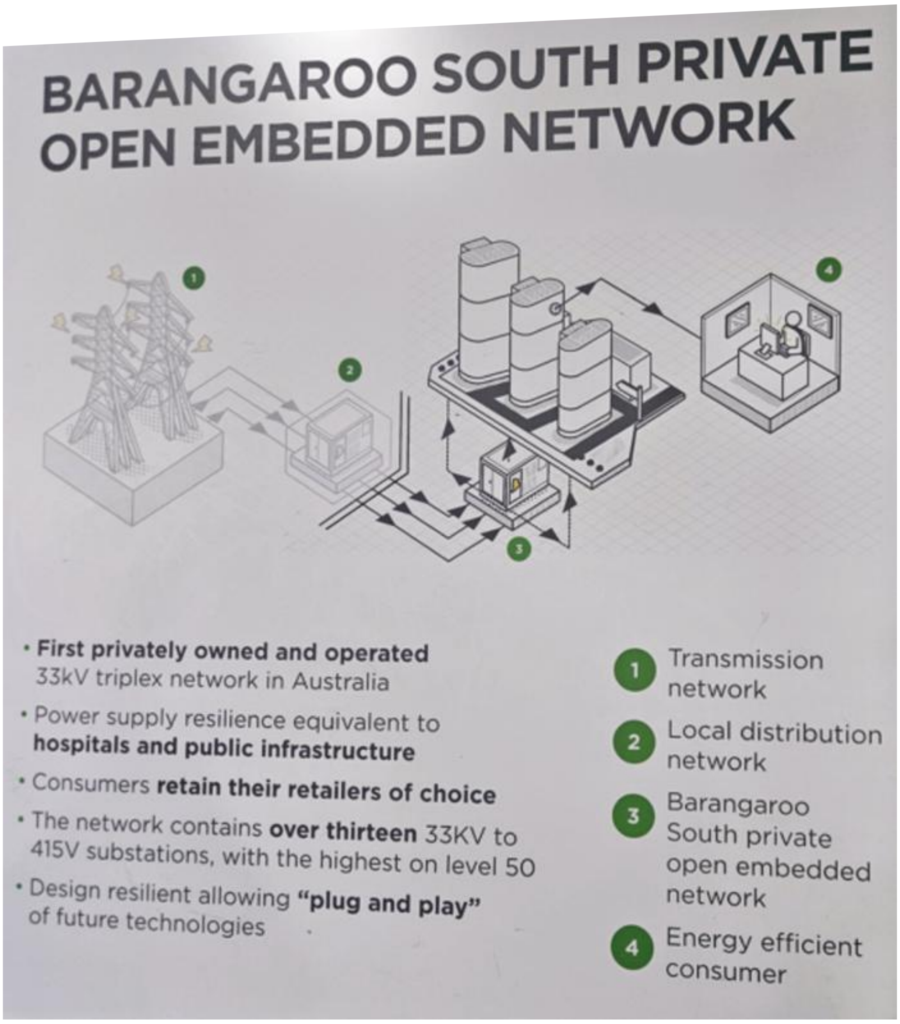
A key highlight for the quarter was the IHEA National Conference, held from 26–28 May 2025 at the Sydney Masonic Centre. It was a great honour to host this significant event in our region, and I'm pleased to report that the feedback from delegates, sponsors, and exhibitors has been overwhelmingly positive.

The trade exhibition hall was full of energy, showcasing an impressive range of products and services from our valued sponsors. Personally, I thoroughly enjoyed engaging with attendees and exploring the latest innovations—it's always a valuable learning experience. I encourage all members to attend future conferences; you'll always leave better informed and inspired.

This year's theme, *"Future-proofing healthcare building systems: getting the basics right"*, sparked meaningful discussion around sustainability, digital integration, compliance, and best practice in healthcare facility design. I extend sincere thanks to all speakers, sponsors, exhibitors, and delegates for making the event such a success. A special thank you goes to the organising committee, whose months of preparation delivered a seamless and insightful experience for all involved.







Technical Tours

This year's technical tours were a standout feature, each offering a unique perspective on healthcare and infrastructure.

- **NSW Heritage Stoneworks**: Led by Meenal Sharma, this tour offered a fascinating insight into the skilled restoration of heritage sandstone—an often-overlooked but essential part of our hospital infrastructure. Delegates gained an appreciation for the craftsmanship involved in preserving the history embedded within NSW's healthcare buildings.
- **Barangaroo Sustainability Precinct:** Organised in partnership with CleanPeak Energy, this tour showcased how an intensive energy, water, and waste-generating site can be transformed into a carbon-neutral facility. From harvesting harbour water for cooling to fully recycling grey and black water, the precinct exemplifies innovative, scalable sustainability. Having visited countless plant rooms across the country, I can confidently say I've never seen a facility of this scale and sophistication, yet so well-hidden from public view.

I do hope one day that our hospitals will be able to integrate systems like these into our facilities. I believe the up-front costs would be paid back over the lifetime of the buildings and its definitely the path our governments should be taking rather than their bare basics, run at full capacity with no contingencies thinking. Maybe this is a discussion we need to have.

- **Royal Prince Alfred Hospital**: This tour offered exclusive access to the Fire Safety Simulation Centre, a review of the temporary helipad, and an update on the CPB construction site where the new billion-dollar tower will stand. It was a valuable behind-the-scenes look at one of our leading hospital facilities.

Conference Keynote – Adam Spencer on Artificial Intelligence

One personal highlight was keynote speaker Adam Spencer's engaging session on Artificial Intelligence. His insights were eye-opening and inspiring, shedding light on how AI is set to transform both our personal lives and professional practices. From streamlining routine tasks to enabling groundbreaking innovation, the potential of AI is immense—and I, for one, will be making an effort to integrate it more into my daily work (and maybe a little less mucking around with photos!).

Branch Activities & Engagement

Thank you to Rick Dyer and the team for once again delivering a successful Annual Charity Golf Day at Ryde-Parramatta Golf Club. This year's event raised essential funds for *Backpack Beds for the Homeless* and provided a fantastic opportunity to reconnect with colleagues and sponsors—despite a few wayward shots on the course! I sincerely thank all our sponsors for your continued support and generosity.

At the branch level, we remain committed to supporting healthcare infrastructure professionals across both metropolitan and regional areas. We encourage all members to actively participate, share their ideas, and help shape the future direction of IHEA. If you have something to contribute or want to get involved, please reach out—this is a collective effort, and your voice matters.

Closing Remarks

To all our NSW/ACT members—thank you for your continued dedication to excellence in healthcare engineering and facility management. I encourage you to stay connected, share your feedback, and participate in our upcoming initiatives.

Warm regards,
Cameron Ivers
President – NSW/ACT Branch
Institute of Healthcare Engineering, Australia

Queensland

WINTER IS HERE and I am running out of new things to say about how the seasons change for each journal! As my visiting NZ family would say, it's a wee bit chilly and a tad dry - we can breathe a sigh of relief up here in the "North" as our HVAC systems are not pushed to their limits and as our roofs don't leak. With winter also comes EOFY and we have probably recently been told to either "spend it or lose it" and/or paradoxically been told to reduce spending as budgets become tight ("others" do know how to spend). With the new FY though many of us are probably now in a holding pattern as we wait for new budgets to be approved – ready, get set and …. wait.

On another note, congratulations must go to the NSW committee for a successful 2025 conference in Sydney – the masonic lodge was quirky but very effective. It was great to see over 16 Queenslanders making the journey down south to attend - go the maroons!!! (For the ill-informed and uncultured among us it is State of Origin season - another winter thing).

The Queensland committee has been busy getting ready for the midyear state conference, gearing up for the 2026 National Conference and planning our PD afternoons and socials. Stay tuned for updates as they come out.

Midyear Conference, 31 July 2025

As this journal hits your desk or inbox, the Queensland midyear conference will be soon happening (or has happened) at the Brisbane Convention and Exhibition Centre on 31 July 2025. This year's theme is "Intelligent Asset Management – Innovation, Prioritisation, Optimisation". Managing our assets and the associated risks (that change with the seasons) consumes a big chunk of our working lives and any way that this can be done smarter and easier is always welcomed. Hope to see you there.

National Conference, SeaWorld March 2026

The 2026 National Conference is coming to Queensland in March 2026 and will be held at SeaWorld on the Gold Coast. Planning for the event is ramping up – start packing your thongs, surf boards togs, swimmers, bathers, board shorts and budgie smugglers and get ready for what will be a unique Queensland experience. Enjoy the dolphins, polar bear, penguins, seals, sharks and lots of sunshine (even in winter and I am ignoring the drizzle that is happening as I type). There are also the rides, but the sponsors, speakers and your boss will want you to have a look in at the conference at some point.

November 2025 PD and others

Please keep an eye out for information that will be forthcoming on our PDs via email and as published on the IHEA website. We are currently actively planning an event at Schneider's Brisbane office and the PD/Christmas breakup in November.

2026 Joint NSW and Qld Golf Day

In conjunction with the NSW committee, we hope to put rivalries aside (Go the maroons!!) and have a combined Golf Day sometime in 2026. Thanks to NSW for the great idea.

Committee of Management (COM)

Again, nothing happens without the assistance and support of the COM.

President	Danny Tincknell
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Treasurer	Michael Ward
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State National Board Representative	Nic Coffey
COM member	Christopher Aynsley-Hartwell
COM member	Mark Fasiolo
COM member	Mark Collen
COM member	Adrian Duff
COM member	Liam Duller
COM member	Linda Jordinson

If you would like to communicate with the QLD Branch via email, please do so at ihea.qld@ihea.org.au . We would greatly appreciate feedback on our events and welcome any ideas for topics that you are especially interested in.

Wishing you all a warm and toasty winter. If any of you are having Christmas in July (another winter thing) – safe travels and have a great time with friends and family.

Danny Tincknell
President, QLD Committee of Management

Victoria/Tasmania

THE VICTORIA / Tasmania Branch continues its popular monthly Lunch + Learn professional development sessions, offering key insights on industry standards and safety practices.

Branch Activities

Lunch + Learn Sessions:

- **Managing Dangerous Goods Work Health and Safety Risks and Regulatory Compliance**
  Date: 14 May 2025
  Dr Paulo Da Silva, who conducted his tertiary education at the University of New South Wales, graduating with a Bachelor of Science, with Honours degree in 1999. During Dr Da Silva's undergraduate education, he conducted 2 small Summer Scholarships during the summers of 1997/1998 and 1998/1999.
  Following completion of his Post Doctoral studies Dr Da Silva continued at the University of New South Wales as an Associate Lecturer (Mar 2006-Jun 2009) before joining CETEC as a field consultant in June 2009.
- **Enhancing Safety Through Dynamic Exit Signage in Healthcare Facilities**
  Date: 18 June 2025
  In the recent IHEA Lunch and Learn session, "Enhancing Safety Through Dynamic Exit Signage in Healthcare Facilities", Clevertronics, Nathan Hull delivered an insightful presentation on the role of dynamic exit signage in improving emergency egress outcomes. Drawing on real-world case studies and research, Nathan explored how Dynamic Exit Signs can significantly improve evacuation efficiency during critical events. Attendees learned how features such as directional pulsing LEDs and positive / negative enhancement strategies help guide occupants more effectively than traditional static signage. Key benefits highlighted included reduced evacuation times, improved occupant compliance, and the ability to support staged or zoned evacuation strategies—particularly valuable in complex healthcare environments. A key takeaway for facility managers was to assess current egress strategies and consider how dynamic signage technology can be integrated into existing emergency lighting infrastructure to enhance both compliance and patient safety.
- **Premise Plumbing Systems – Legionella and other opportunistic pathogens.**
  Date: 18 June 2025
  Date: 25 June 2025
  The first session of the Premise Plumbing Series was well received with over 110 registered attendees. The series offers update to date research and evidence-based findings relating to premise plumbing pathogens, chlorine-based disinfectants, infection control and hygiene issues and potential unintended consequences of current plumbing design services. Overall, the series aims to provide practical considerations for designer and healthcare facility operators to improve healthcare water service design, maintenance and operation.

Look Ahead Activities

- **AS 1668.2-2024 Lunch + Learn (2 July 2025 Time: 12:30 – 1:30 pm)**
  With 90 members registered, this session will cover critical updates to ventilation standards for healthcare, focusing on operating theatres, isolation rooms, and energy efficiency improvements aligned with the latest technology and air quality guidelines.
- **Enhancing Compliance and Readiness: Emergency Planning for Healthcare Facilities (20 August 2025 Time: 12:30 – 1:30 pm)**
  Also with 90 members registered, this session highlights the benefits of outsourcing emergency planning to reduce risk and streamline hospital compliance efforts.
- **Vic Site Tour – Clevertronics Factory & Training Facility, Scoresby (10 September 2025)**
  Members and colleagues are invited for a behind-the-scenes tour of Clevertronics, leaders in emergency and energy-efficient lighting solutions.
  Schedule:
  Arrival: 8:45 am
  Tour Start: 9:00 am
  Morning Tea & Networking: 11:00 am
  Presentation / Q&A: 11:15 am
- **Site tour / meeting – Austin Hospital (IoT and others new products in Vic market): late 2025.**
  IoT sensors working on pumps, fans, motors, The IoT sensor supplier will complement our presentation.
  Medical Air compressor skid in AT B3 from BeaconMedaes, Atlas Copco Australia. The equipment supplier will complement our presentation.
  Smardt Chiller No 5 in LTB Podium L4. The equipment supplier will complement our presentation.

Branch Committee of Management 2025

Michael McCambridge – Branch President / Board Representative
The Royal Melbourne Hospital
Michael.mccambridge@mh.org.au
John Mihalinac – Treasurer / Board Representative – Victorian Health Building Authority
John.Mihalinac@health.vic.gov.au
Steven Ball – Committee of Management
sball2532@gmail.com
Pablo Perez-Reigosa – Committee of Management – Ventia
pablo.perez-reigosa@ventia.com
Michael Goodman – Committee of Management – Clevertronics
m.goodman@clevertronics.com.au

Committee meetings are held monthly on the 2nd Wednesday at 9:30 am via Teams. Branch members are welcome to attend—email for an invite.

Michael McCambridge
Vic/ Tas Branch President

Western Australia

IN THE FANTASY Game of Thrones, the House of Stark had the motto "Winter is Coming", well I have news for them; Winter is here and for Western Australia it could not have come sooner. You see, up until the end of May, unlike our eastern states colleagues, Perth had not seen precipitation of a quantity that could be defined as rain. I am 67 years WA born and bred and I can say with confidence that our seasons have changed over the decades. Being an Engineer and not a Scientist I do not know the intricacies of meteorology, but there has to be something pretty serious afoot with climate change and the multiple once in 100, 200 or 500 year events occurring across our great land. It is time we all took stock of what is going on around us and do something about it.

On a beautiful clear and dry Thursday evening in April 2025, 15 fortunate members and guests met at the Royal Australian Air Force Association (RAAFA) Retirement Village located in the southern suburb of Leeming. I must have passed this place a 1000 times, well maybe I exaggerate a bit, so let us say a 100 times and seeing the spitfire each time, I always thought I must go in and visit the museum, but you know what I never did. It is not a secret that I have a passion for trains, planes and automobiles and when committee member Mr David Chokolich arranged a site visit, I made sure that this was one professional development session I was not going to miss. There is however, a real danger of disappointment when expectation collides with reality.

Were we disappointed? Absolutely not! This "retirement" village would rival any 5 star holiday resort. We initially met in the club room where we indulged in a table of delicious finger food all washed down with a few cool drinks.

The group was marshalled and we were escorted throughout the facility by Capital Works Manager Mr Liam Jackson and Property and Sustainability Manager Mr Phil Bedford. Our ambulatory tour visited the lawn bowls playing fields, the gymnasium, the swimming and hydrotherapy pools peppered with insights into the excellent living quarters.

We walked through the manicured grounds, all noting the silence and serenity in spite of the facility being just metres from the very busy Leach and Roe Highways. One could easily confuse that you were not in the metropolitan area and in the south west of WA.

The site is currently undergoing a significant redevelopment program

The Iconic Spitfire

The Museum

The Club Room Buffet

The Club Room Dining Room

with aged infrastructure being replaced with modern, energy sustainable and affordable living. There is a solid focus on renewable and sustainable energy.

While we meandered through the complex we were gifted with a rolling commentary about the site and their works program with Liam and Phil answering our questions and explaining in detail how they undertake such a large project whilst keeping the facility operating. Our site walk around ended at the Alice Ross-King Care Centre, where we visited the back of house operations. Full marks go to Liam and Phil for operating such a first class facility and to David for arranging the visit. Now I have to commit to visiting the aircraft museum.

During May, we had the National Conference in Sydney, where a few WA members took the initiative and attended. Their feedback has been exemplary. I was not able to attend this year due to a previous commitment, however WA chapter President, Jana Simpson and National Treasurer Mr Rohit Jethro made the journey east on behalf of the Executive. Apart from enjoying the site visits, conference plenum sessions and social events, they had executive duties to perform by meeting with the other national board members on the Monday morning and then participating in the Annual General Meeting.

May also saw the culmination of the WA Health Department Licencing and Regulatory Unit's (LARU) 2025 Western Australian Health Facility Guidelines for Engineering Services review workshops. These workshops arose out of a public consultative process initiated by the

Lawn Bowls

New Construction

The Gardens by Day and Night

Alice Ross-King

Alice Ross-King Bldg Plant Rooms

LARU team and in cooperation with the Western Australian IHEA executive.

The guideline review commenced in 2023 culminating in a 2024 draft published for public comment. Your IHEA ran a series of workshops in 2024 inviting members and interested parties to come together to first hear explanations of the proposed changes and then later to pose and register their concerns.

In early 2025 the LARU team then created a series of genre specific workshops where registered delegates met with subject matter experts to deal with each concern in detail. The first meeting was held at the East Perth Department of Health Headquarters on the 1st of May for Hydraulics, then each week thereafter for the other genres such as Electrical, Mechanical, Medical Gases and Fire

This has been a first for these critically important guidelines and from all accounts has proven to be a success. These workshops have opened a way forward for a continuous improvement process to evolve for initiatives and recommendations to be registered as they occur instead of having to wait until the next formal review.

Public and Private Health Facilities across Western Australia vary greatly due to their geographic location, patient demographic, delivered clinical services and age. Consequently the delivery of high quality services and maintenance can be equally as challenging. Healthcare Facility Managers need engineeringly sound and achievable standards on which to base their management strategies upon.

Our congratulations go to the LARU Executive, especially to Project Lead and Chair Ms Karen Zegglar, the subject matter experts and to the attending delegates for coming together to develop this critical document in a practical and cooperative manner.

On Tuesday 24th of June, we will meet at the Shoe Bar in Yagan Square to join with HFM once again, to hear a presentation on ASRS sustainability reporting requirements.

Jana and the Dulux Dog

Barangaroo Recycled Water Plant


LARU Meeting

Then in late July we will be meeting with Norman Disney & Young to hear a presentation of hydraulic sustainability in design (date and location to be confirmed). Also in July and on the 30th our members have been invited to attend the Facility Management Association's Western Australian Annual Conference at the Pan Pacific Hotel, Perth. There is a lot of common ground between Health Facilities and the general building environments. There is a lot we can learn from one another. Please make an effort to attend. Registration can be made via the FMA website.

The next couple of weeks should prove to be eventful, entertaining and educational. Please save the dates and support your IHEA Chapter and our supporters.

August brings our Special General Meeting into play on Friday the 29th at 5:30pm. This year we will be revisiting the newly revamped Melville - Palmyra Tennis Club House. We have invited Dr Nicholas Mabbott BPsych (Org) PhD. Fatigue Risk Management Specialist to deliver a presentation on the dangers of sleep deprivation. I had the pleasure of listening to Dr Mabbott when he delivered a master class at the 2022 National Conference in WA. Healthcare Facility Management can inflict a high demand upon oneself, especially in the area of getting a continuous good night's sleep. I can highly recommend Dr Mabbott's management technique. Save the Date!

IHEA Committee(s) need innovative people who are passionate about bringing the IHEA into a new place in line with the 21st century. Please give your participation some serious thought, it is not that intrusive on your time as you may believe. We meet via Teams once a month for 1 hour. Nomination forms are available on request.

Kindest regards
Frederick Foley

CONFERENCE PAPER

Koolangka Bridge The Kids' Bridge, Perth Children's Hospital

Designing Safe, Accessible, and Inclusive Healthcare Precincts

Alice Vincent and Rebecca Cadorin

Executive Summary

Healthcare precincts are community hubs where individuals work, access services, conduct research, and engage in learning. Operating around the clock, these precincts demand seamless connectivity, accessibility, safety, and comfort for a diverse range of users throughout the day and night.

This paper highlights the value of intentionally designing healthcare precincts for safety, inclusivity, and accessibility. It outlines the benefits for healthcare operators and details Arup's approach, drawing on insights from recent work with the Randwick and Westmead Health Precincts.

Arup is a global engineering and consulting firm driven by a commitment to shaping a better world through sustainable, human-centred design. Guided by our core values of quality, creativity, integrity, and social usefulness, we apply a holistic "Total Design" ethos—bringing together diverse disciplines to solve complex challenges in an integrated, collaborative way.

Introduction

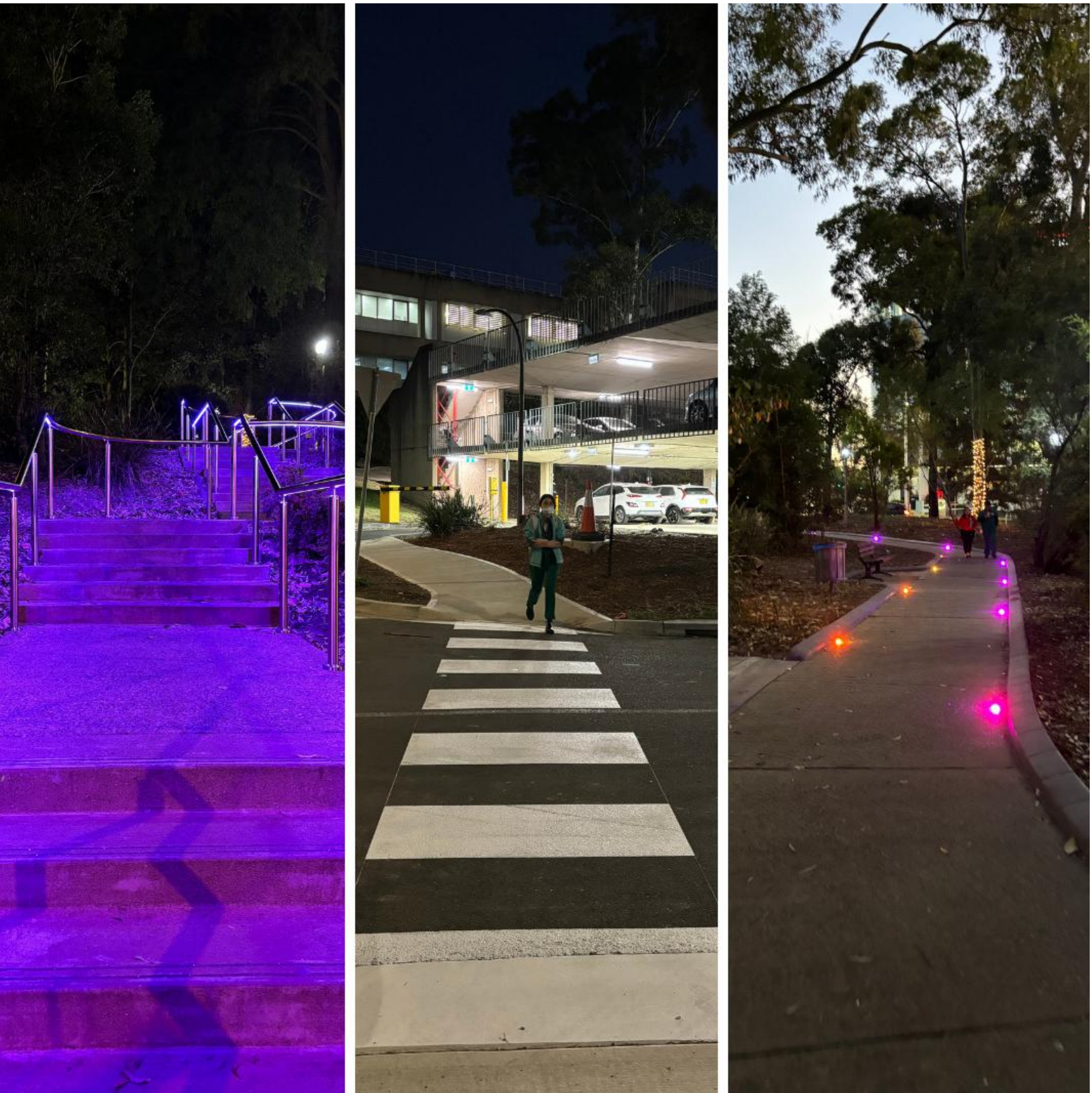
Why design for safety, accessibility and inclusivity in health precincts?

Health precincts are 24/7 environments that serve a wide range of users — including doctors, nurses, students, patients, visitors, porters, and caterers. Given their continuous activity, often extending into the night and early morning, these spaces operate as essential public realms. The health workforce is predominantly female; for instance, 88% of Registered Nurses and 77% of Aged and Disabled Carers in Australia are women.[1] However, safety concerns can limit how these spaces are used. In New South Wales, 42% of women report feeling unsafe in public places after dark.[2] The same survey found that 72% of people would walk, use public transport, and go out more often if they felt safer. These findings underscore the need to prioritise safety in the design of health precincts, ensuring they remain welcoming, accessible, and fully functional for everyone who depends on them.

Our Approach

To create safer and more accessible health precincts, we adopt an integrated approach that blends technical expertise with community-led co-design. By focusing on the needs of more vulnerable users, we improve the overall experience for

Lighting and pathway interventions, Westmead Health Precinct




Public artwork and lighting interventions, Randwick Health and Innovation Precinct

everyone. Our collaborative process assesses critical elements of the built environment—such as lighting, urban design, acoustics, and Crime Prevention Through Environmental Design (CPTED) principles—and combines it with real-world user insights.

The following sections outline our approach at Arup in more detail.

Codesign: Co-design, or participatory design, is a collaborative process that brings together stakeholders to develop solutions that truly reflect end-user needs. Participants may include nurses, doctors, students, community members, security, and facilities staff. As part of this process, we conduct "walkshops" through the precinct during both day and night, asking participants about their personal experiences and perceptions of safety to inform and guide design improvements.

Technical Assessments

Lighting: We go beyond standard lighting codes to consider how lighting influences perceptions of safety and comfort. While most regulations prioritise driver visibility, they often neglect the pedestrian experience—leading to uneven, poorly lit environments that can feel unwelcoming after dark. Our approach focuses on warm, uniform lighting that minimises harsh contrasts, improves visibility, and enhances the overall sense of comfort. We illuminate signage to support nighttime wayfinding and use vertical lighting to remove dark corners and dead ends. Additional enhancements like vegetation uplighting, along with integrated light-based artworks, help activate spaces—creating a more inviting, engaging, and safer environment for pedestrians.

CPTED: We apply the four key principles of Crime Prevention Through Environmental Design (CPTED) to assess and improve the safety of health precincts. These principles—surveillance, access control, territorial reinforcement, and space management—help us evaluate how design can deter crime and enhance user confidence. Our approach combines these Principles with contemporary best place-making practices, focusing on activation, safety, accessibility, and maintenance.

We assess each space during both day and night to understand how safety perceptions and risks shift over time.

Urban design: Urban design plays a critical role in shaping perceptions of safety. Narrow pathways with uneven surfaces, trip hazards, and ambiguous spaces—where the purpose or ownership is unclear—can create discomfort and deter use. Inadequate wayfinding and signage can heighten feelings of insecurity and disorientation, especially for those navigating health precincts at night or with reduced mobility. Clear, intuitive wayfinding enhances confidence, improves accessibility, and supports safer, more predictable movement through these spaces.

Acoustics: We also consider how soundscapes influence perceptions of safety and inclusivity. Loud traffic, industrial or construction noise, and acoustically harsh architectural features such as underpasses can cause disorientation and discomfort. Loud noise can be felt to mask distress calls, contributing to a sense of isolation—particularly at night.

While increased activation often improves safety perceptions, it's equally important to provide quiet spaces for respite and relaxation. Successful design balances vibrancy with calm, offering peaceful zones without sacrificing connectivity.

Integrating natural sounds—like birdsong, flowing water, or rustling leaves—can make spaces feel more welcoming, while minimising harsh, mechanical noise. Acoustic design can also enhance wayfinding and storytelling, such as through sound-activated public art or voiced hospital introductions that orient and guide visitors on arrival.

Case Studies

Designing for safety means ensuring that everyone in the precinct is not only safe in a literal sense due to an absence of crime or other safety risks, but that they feel safe – especially after dark.

Individuals have differing perceptions of safety based on personal factors and their unique lived experience. These perceptions can influence behaviour: the routes they choose, their means of travel, and overall sense of mobility. This has a strong impact on productivity and enjoyment for precinct users, and can be the difference between a bustling social hub and an uninviting or even fearful space that users dread entering.

At Westmead Health Precinct, female nurses told us they couldn't find parking close to the hospital first thing in the morning when their shift started. They were forced to park further away in areas that the nurses labelled as "ok in the morning" but were perceived as unsafe after dark. At lunchtime they would walk back to their car and bring it closer to the hospital, so they didn't have to walk to the unpleasant and unsafe place in the dark once their shift finished.

On this project interventions included footpath widening, improved lighting between carparks and service buildings, and green space upgrades. Survey results indicated a significant increase in participants' sense of safety at night, from 9% pre-intervention to 75% post-interventions.

Designing for inclusivity means creating environments that enhance the experience of all community members by addressing the often-overlooked relationship between human behaviour, social needs, and the built environment. People of different genders, ages, and cultural backgrounds engage with space in diverse ways, shaped by distinct norms, expectations, and requirements. Inclusive design recognises that urban environments are rarely neutral—it actively seeks to redress this imbalance by identifying and responding to the specific needs of varied user groups.

Whilst not an Arup project Perth Children's Hospital offers an excellent inclusivity anecdote: *When the Hospital was first built, access to Kings Park was very poor. Pedestrian crossings were far from the central campus and required navigating five or nine lanes of traffic. When consulted, children and parents expressed that easy access to the Park would provide them with much-needed respite and distraction from the rigors of medical treatment and a reprieve from the clinical environment.*

Perth Children's Hospital also attracts many people from across the State for treatment, including numerous individuals from First Nations communities who live on Country. The hospital found that many patients were leaving earlier than their scheduled discharge times. During the project's development, consultations revealed that people felt disconnected from Country during their time at the hospital.

These co-design processes and consultation revealed important needs experienced by users, and as a result, a footbridge was included in the design to connect the hospital precinct directly with Kings Park.

Designing for accessibility means meeting the diverse needs of all users—across ages, abilities, and circumstances. Accessibility extends beyond individual buildings to include wayfinding, public transport connections, and everyday features that make spaces more usable and supportive. This can include pram- and wheelchair-friendly pathways, priority parking for families, rest areas for calls or work, and nearby playgrounds that support caregivers balancing multiple roles. These thoughtful elements can significantly improve the manageability and productivity of daily life.

At the Randwick Hospital Precinct, we observed that some footpaths were too narrow for people to walk side by side or comfortably pass one another. The area was heavily car-dominated, and focus groups noted a lack of public art or distinctive architectural features to help with orientation or create welcoming meeting points. Security managers also reported that when incidents occurred, it was often difficult for people to describe their exact location—underscoring a lack of clear spatial cues.

In response, we developed a nighttime masterplan for the Randwick Health Innovation Precinct and collaborated with a local artist to design integrated lighting installations. These improvements not only informed future priorities for lighting commissions, laneway upgrades, and broader precinct redevelopment, but also had measurable impact: before the installations, 48% of co-design participants felt unsafe at night. After implementation, 83% reported that the lighting interventions had improved their sense of nighttime safety in the precinct.

Conclusion

Safety, inclusivity, and accessibility are not one-size-fits-all solutions—they must be rooted in community insights and shaped by the unique context of each place. Our ethos is to bring everyone into the process: clients, developers, architects, operators, caregivers, patients, visitors, and key workers. We act as translators, listeners, and collaborators—ready to learn, adapt, and respond to evolving needs. This inclusive approach helps create precincts where diverse priorities are reflected in both the built and natural environment—places where people feel seen, safe, and supported.

For healthcare operators, the benefits are tangible: higher staff productivity, better retention, and more positive experiences for patients and visitors. By getting the fundamentals right—understanding site context and user needs from the outset—projects can significantly improve connectivity, wayfinding, and perceptions of safety. Ultimately, this supports more accessible, welcoming environments for working, healing, learning, and discovery across health precincts.

References

1 Australian Bureau of Statistics – 2021 Census

2 Safer Cities Survey Report: Perceptions of safety in public places and transport hubs across NSW

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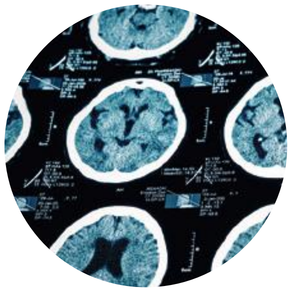

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How a 600kW Temporary Chiller Kept a Victorian Hospital Running During a Cooling Crisis

A private hospital in Melbourne faced a critical cooling crisis after its permanent chiller system failed during peak summer. With patients relying on climate-controlled environments and sensitive medical equipment at risk, the situation required immediate action. Further complicating the response was the lack of rooftop space for installing temporary equipment, demanding a creative ground-level solution to restore essential cooling.

EVALUATION AND ENGINEERING

Aircon Rentals responded swiftly, assessing the hospital's urgent needs and physical constraints. With no rooftop space available, our team designed a ground-based solution using a 600kW air-cooled temporary chiller. The temporary system had to integrate seamlessly with the hospital's infrastructure while maintaining continuous operation throughout the high-demand period.

A key element of the solution was the use of approximately 80 metres of Victaulic pipework and flexible hoses, connecting the chiller to the hospital's mechanical system across a two-storey distance. A water pump was included to ensure stable water flow and system pressure.

DEPLOYMENT AND INSTALLATION

To meet the critical 48-hour turnaround requirement, Aircon Rentals coordinated the logistics, equipment delivery, and on-site setup rapidly. The temporary chiller was installed in the hospital's parking area, with minimal disruption to normal operations.

The system was fully commissioned and tested, ensuring reliable performance. Remote monitoring capabilities were also deployed, allowing real-time oversight of cooling performance and enabling fast response to any fluctuations.

COMMISSIONING AND OPERATION

Once installed, the system operated seamlessly for 8 weeks, providing uninterrupted cooling to patient rooms, operating theatres, and equipment areas. Continuous monitoring ensured consistent system performance.

DE-COMMISSIONING AND DE-MOBILISATION

When the hospital's new permanent chiller became operational, the temporary system was gradually de-commissioned. Aircon Rentals worked closely with the hospital's engineering team to transition the load in stages, ensuring no disruption to patient care. The site was fully restored following the equipment removal.

SUMMARY

This project showcases Aircon Rentals' ability to respond to high-pressure situations with tailored, engineered cooling solutions. Despite space limitations and time sensitivity, we delivered a reliable, cost-effective system that kept the hospital fully operational. Our expertise helped avoid downtime, maintain critical healthcare services, and meet regulatory standards—reinforcing our position as a trusted partner in the healthcare sector.

Project Highlights

- Proposal Turnaround Time: 48 hours
- Duration: 8 weeks
- 1 x 600kW air-cooled temporary chiller
- 80m of Victaulic pipework and flexible hoses
- Pump for water flow management
- Installation in ground-level parking area
- Rapid commissioning and full system integration
- Real-time remote monitoring
- Phased de-commissioning and full site restoration

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Legionella and Beyond

The Complex Interplay Between Water Hygiene and Corrosion in Healthcare Building Systems

Dr Surani McCaw
SOUTHLAND FILTRATION

Tom Wise
WSCE

SUMMARY

This paper explores the often overlooked yet critical relationship between water hygiene and corrosion within healthcare building systems. It highlights that simplistic models, like the Langelier Saturation Index (LSI), fail to account for the complex, interrelated stressors that drive system failures. These include physical, chemical, and microbiological factors that, when combined, can lead to accelerated corrosion, microbial colonisation, and premature infrastructure degradation.

The authors highlight Assimilable Organic Carbon (AOC), Microbiologically Influenced Corrosion (MIC) and erosion corrosion as key failure modes, emphasising that biofilm formation and poor system design, such as stagnation points or deadlegs, exacerbate microbial risks. The paper critiques the overreliance on chlorine disinfection, noting its limitations against biofilms, warm water, and microorganisms in the Viable But Non-Culturable (VBNC) state, such as *Legionella pneumophila*.

A significant contribution to the field is the "Woolies Law" framework, introduced by Phil Woolhouse in 2024, which proposes that multiple minor issues within water systems interact multiplicatively rather than additively, amplifying risk and accelerating failure. This model reinforces the need for a holistic, system-wide perspective, one that integrates engineering, microbiology, operations, and proactive maintenance to ensure long-term resilience and hygiene in healthcare water infrastructure.

Ultimately, this paper highlights that achieving resilient, hygienic healthcare water systems requires moving beyond chemical indices and adopting a multidisciplinary, proactive approach that addresses both microbial and material vulnerabilities before they escalate into health risks or structural failures.

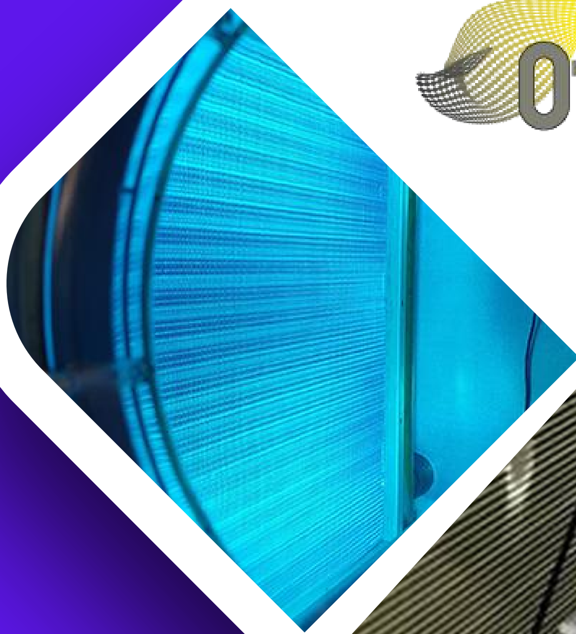
Introduction

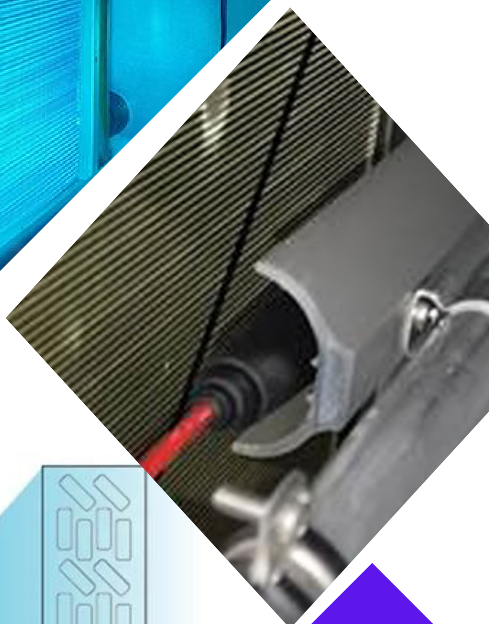
In healthcare environments, the relationship between water quality, system design, and material degradation is often under-appreciated. While theoretical indices such as the Langelier Saturation Index (LSI) are frequently used by engineers and consultants to assess corrosion risk and guide water treatment strategies, these models do not fully capture the multifaceted nature of real-world conditions.

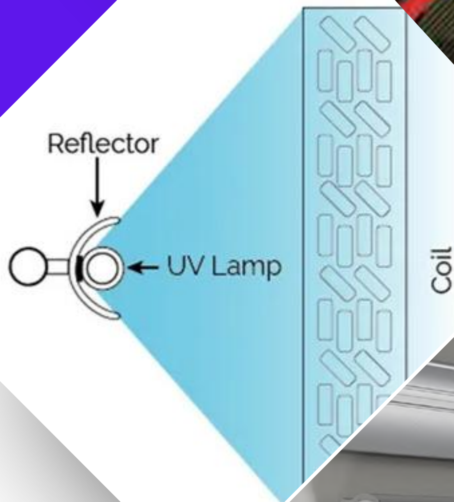
Failures in water service components or pipelines are rarely due to a single factor. Instead, a combination of stressors, such as elevated water temperatures, restricted thermal expansion, harmonic resonance, entrained air, cyclic or transient pressures, oxidising agents, high-velocity flow, cavitation, and chemical parameters (e.g. pH, chloride, and sulphate concentrations), interact to accelerate corrosion processes.

Other contributors, such as calcium and magnesium scaling, which can lead to microbiologically influenced corrosion or MIC, introduce further complexity. Carter, G. *et al.* (2003) demonstrated that *Mycobacterium avium* establishes more stable biofilms in the presence of calcium, magnesium and zinc but not iron. MIC driven by microbial activity including biofilm-forming bacteria, presents serious challenges to both water hygiene and infrastructure longevity.

WE ALWAYS USE PROTECTION







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This paper presents preliminary insights into the interplay of these variables and cautions against over-reliance on simplistic water quality assessments based solely on scaling indices. In particular, it highlights the risks of overcompensating with chlorine disinfectants, an approach that may compromise pipework integrity, especially since chlorine is often ineffective in warm water, against biofilms, or against *Legionella* in a viable but non-culturable (VBNC) state.

Understanding Key Corrosion Mechanisms in Piping Systems

Two primary forms of corrosion are commonly encountered in healthcare water systems:

- Pitting corrosion, which manifests as localised spots leading to perforations
- Erosion corrosion, characterised by widespread material loss in scalloped patterns

These corrosion types can co-occur within the same system, influenced by different stressors at different locations. For example, pitting may result from aggressive or unstable water conditions (e.g. low pH, oxidising agents, or chloride presence), while erosion corrosion may stem from mechanical stressors such as entrained air, high flow velocity, and cavitation.

Although metallic pipes are typically engineered to endure hundreds of thousands of pressure cycles, studies show that fatigue failures can begin to occur between 10,000 and 100,000 cycles under standard operating conditions. In corrosive environments, where fatigue is significantly accelerated, these failures may develop much earlier, potentially reducing the service life to less than 10 years.

Pitting Corrosion

Pitting corrosion is often mis-attributed solely to chemical factors such as elevated chloride levels, high free chlorine concentration, an unfavourable chloride-to-sulphate mass ratio

Figure 1 Typical soft water pit from Evans Head, NSW, showing coarse cuprous oxide *(photo courtesy of Dr David M. Nicholas)*

(CSMR), or LSI imbalances. While these parameters are influential, they do not represent the complete picture. A commonly overlooked contributor is microbial activity in the water. MIC, particularly from biofilm-forming organisms, can play a central role in initiating and accelerating pitting, especially in stagnant or low-flow areas. Ignoring microbial involvement can lead to misdiagnosis and ineffective mitigation strategies.

Microbiologically Influenced Corrosion (MIC)

Water hygiene is often mistakenly reduced to simply maintaining residual chlorine levels. However, this narrow focus overlooks the complex, multi-factorial nature of microbial proliferation and corrosion within water systems. Effective control strategies must consider the interplay of environmental, chemical, mechanical, and operational conditions that promote biofilm formation and microbial activity.

In most cases, significant microbial growth and subsequent material degradation are not caused by a single issue, but rather by the accumulation of numerous minor factors acting in concert. This layered vulnerability creates the conditions necessary for MIC to take hold.

MIC involves several distinct corrosion mechanisms (Figure 2, Knisz, J. R. *et al*, 2023), including:

- Alteration of electrochemical reaction kinetics by microbial activity
- Extracellular electron transfer, where microbes accelerate corrosion through redox processes
- Localised crevice corrosion, often initiated by microbial colonisation in pits and joints, zones typically worsened by the accumulation of chloride and other aggressive ions

Bacteria multiply rapidly via binary fission, with populations capable of doubling every 20–30 minutes under ideal conditions. This exponential growth means a single cell can lead to over a billion bacteria within 10 hours, resulting in robust biofilm formation. Once established, biofilms are highly resistant to disinfectants and can be extremely difficult to eradicate (Madigan *et al.*, 2018).

Erosion Corrosion

Erosion corrosion affects both metallic and plastic piping systems under high-velocity flow. When water, particularly if containing suspended solids, air, or turbulence, moves rapidly through a system, it can strip protective surface films. In metallic systems, this exposes bare metal to electrochemical attack. In plastics, mechanical wear increases surface roughness, compromising long-term performance.

This form of corrosion commonly occurs at points of flow disruption, such as elbows, tees, reducers, and valves. Moreover, temperature and velocity, when combined, significantly increase corrosion rates (see).

Another key contributor to system damage is cavitation, the formation and collapse of vapour bubbles caused by rapid local pressure drops below the vapour pressure of water. This phenomenon is often observed near press-fit fittings, pressure-reducing valves, and similar disruptions in hot water systems as temperature influences the vapour pressure of water. Cavitation is sometimes called a "silent killer" because it causes significant material erosion without immediate visible signs. While poor air management in both cold and hot water systems can influence cavitation conditions, the phenomenon primarily results from pressure fluctuations. Cavitation damage is frequently misdiagnosed as corrosion or other forms of erosion.

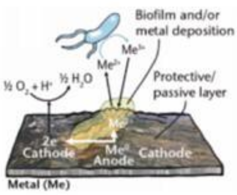
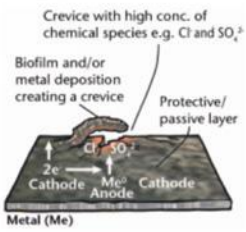
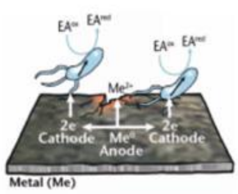
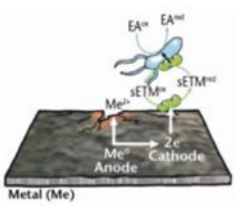
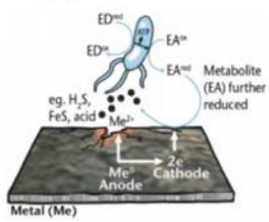
The Link Between Corrosion and Hygiene

The degradation of plastic and metallic components in water systems can unintentionally promote microbial growth by releasing Assimilable Organic Carbon (AOC), a biologically available fraction of dissolved organic carbon (DOC) that provides a direct nutrient source for micro-organisms. AOC plays a pivotal role in the formation and re-growth of biofilms within water supply networks. Unlike conventional disinfection byproducts such as Trihalomethanes (THMs), AOC serves as a nutrient source for Legionella bacteria, facilitating their proliferation and biofilm formation (McCaw, S., 2024).

Plastic piping systems may release AOC through the leaching of plasticisers and unreacted monomers, especially in newly installed networks or under elevated temperatures. Metallic pipes, in contrast, can introduce trace levels of divalent cations, such as iron, copper, molybdenum, nickel, and zinc, through corrosion or mechanical wear. These metals not only serve as microbial nutrients but also enhance biofilm stability and resistance.

Because AOC is challenging to detect and quantify, it often acts as a silent "intruder" in healthcare water systems, particularly those with stagnation zones or thermal fluctuations. In response, operators may resort to reactive measures such as increased chlorine dosing. However, excessive disinfection can lead to unintended outcomes, including material degradation in low-use areas where disinfectants concentrate. This degradation fosters crevice formation and creates ideal environments for microbial colonisation and MIC. Once established, MIC initiates self-reinforcing corrosion feedback loops, where microbial growth and infrastructure decay continuously accelerate one another.

Figure 2 Brief description of the main mechanisms associated with MIC of metals.

MIC mechanisms	Description	Diagram
Under deposit corrosion, oxygen gradient corrosion	A type of "localized corrosion associated with, and taking place under, or immediately around, a deposit of corrosion products or other substance" (ISO 2020), e.g. biofilm or metal deposition by metal-oxidizing bacteria that is formed in a patchy arrangement.	
Crevice corrosion	A type of "localized corrosion associated with, and taking place in, or immediately around, a narrow aperture or clearance formed between the metal surface and another surface (metallic or non-metallic)." (ISO 8044) The accumulation of chloride and other aggressive anions in the pit accelerates corrosion.	
Electrical MIC (EMIC)	Corrosion caused by extracellular electron transfer by microorganisms.	
Direct EMIC	Corrosion of metals achieved by extracellular electron transfer by microorganisms in direct contact with the metal surface. Electrons are taken up by cell surface enzymes or membrane redox proteins.	
Indirect EMIC	Corrosion of metals accelerated by soluble electron transfer mediators released from microorganisms that use the electrons gained from the metal for respiration.	
Metabolite MIC (MMIC)	Corrosion of metal achieved directly or indirectly by metabolites released by microorganisms both in aerobic and anaerobic conditions.	

Me: metal, EA: electron acceptor, ED: electron donor, ox: oxidized, red: reduced, sETM: soluble electron transfer mediator, MeOB: metal oxidizing bacteria.-Test

The Role of Water Age

One of the most critical yet overlooked factors affecting both hygiene and corrosion is water age, the time water remains stagnant within the system. Higher water age is associated with:

- Increased microbial proliferation (aerobic, microaerobic and anaerobic depending on the oxygen demand of the resident microorganisms)
- Disinfectant decay or loss
- Biofilm development

Water age is influenced by factors such as pipe diameter, system complexity, deadlegs, low-use outlets, ambient temperature, and organic material presence. In areas with elevated water age, especially in warm conditions, chlorine residuals degrade rapidly or disappear entirely.

Biofilms: The Hidden Majority

Roughly 90% of micro-organisms in water systems exist within biofilms adhered to internal surfaces; only 10% are planktonic (free-floating). Standard water sampling techniques often miss biofilm-associated microbes, leading to underestimation of microbial risk and delayed interventions.

Figure 3 'Scalloped' surface of copper tube with perforation of the pipe. *(photo courtesy of Dr David M. Nicholas)*

Figure 4 Deeply 'scalloped' pipe surface, typically near pipe joint. *(photo courtesy of Dr David M. Nicholas)*

Limitations of Chlorine Disinfection

While chlorine remains effective against planktonic bacteria, it has notable limitations under certain conditions. Specifically, chlorine may be ineffective against:

- Biofilms, which shield microbial communities from disinfectants
- Elevated temperatures, which accelerate chlorine decay and reduce its residual concentration
- Micro-organisms in the Viable But Non-Culturable (VBNC) state, and protective hosts such as Acanthamoeba cysts, which can harbour pathogens like *Legionella pneumophila*

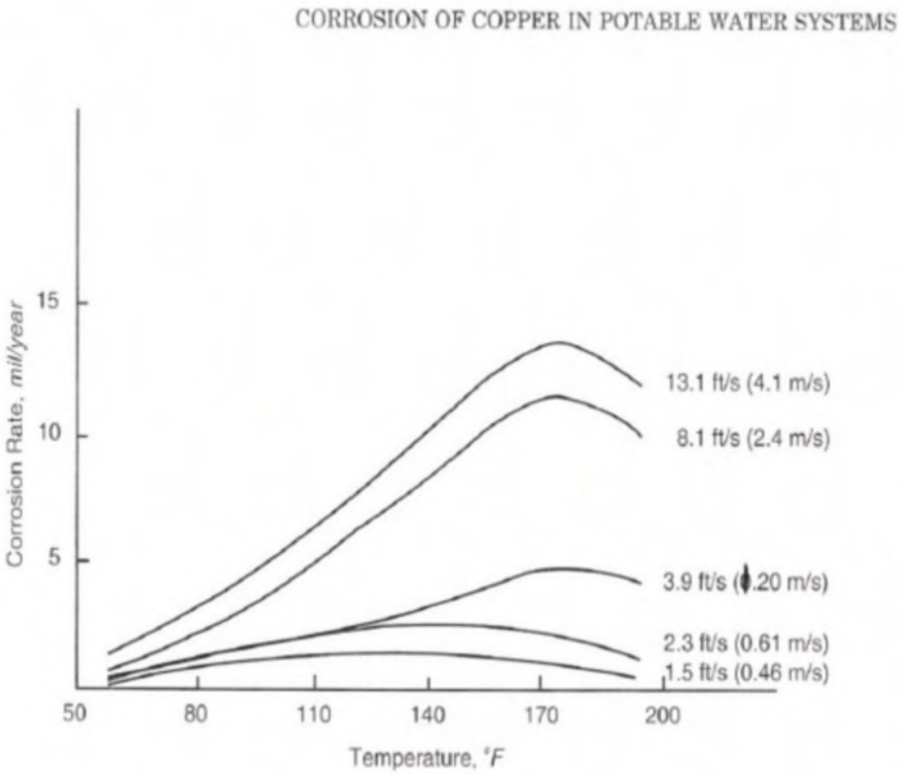


Figure 5 Corrosion rate vs. temperature for a series of water velocities (Extracted from AWWARF, 1985 quoting Obrecht and Quill, 1960. Correction by Dr David Nicholas on flow conversion error.)
Note: 1 mil = 0.0254 mm

In the VBNC state, *Legionella pneumophila* remains infectious yet undetectable by standard culture-based methods. Molecular techniques such as PCR or quantitative PCR (qPCR) are currently used to detect Legionella DNA. However, qPCR can overestimate microbial presence, as it detects genetic material from both viable and non-viable cells (Dietersdorfer, E. *et al.*, 2018; Whiley, H. *et al.*, 2016).

To more accurately assess microbial risk, further research is needed to improve detection and quantification methods for Legionella in the VBNC state. Without accurate identification, disinfection efficacy may be overestimated, and the potential threat to public health may be underestimated.

Due to these detection challenges, organisations such as the U.S. Centers for Disease Control and Prevention (CDC) do not recommend routine environmental testing for *Legionella pneumophila.* Traditional culture techniques can yield false negatives or inconsistent results, leading engineers to either underestimate the risk or assume that control measures are effective when they are not.

Given these risks, experts increasingly advocate for shifting away from a reliance on periodic grab sampling. Instead, a risk-based approach, focused on system design, operational monitoring, and proactive maintenance, is recommended to ensure long-term safety and resilience in water systems (Whiley, H., 2017).

Holistic Approach to Microbial Risk in Healthcare Water Systems

Achieving safe, durable water systems in healthcare settings requires a holistic approach. While systems may tolerate individual stressors, vulnerabilities arise from the cumulative effects of design flaws, operational oversights, and environmental conditions. Localised weaknesses are particularly prone to compounding stressors like entrained air, thermal expansion, stagnant flow, and pressure transients.

Figure 6 The distinctive appearance and location of these marks suggest they result from cavitation events rather than typical erosion-corrosion *(photo courtesy of Phil Woolhouse)*

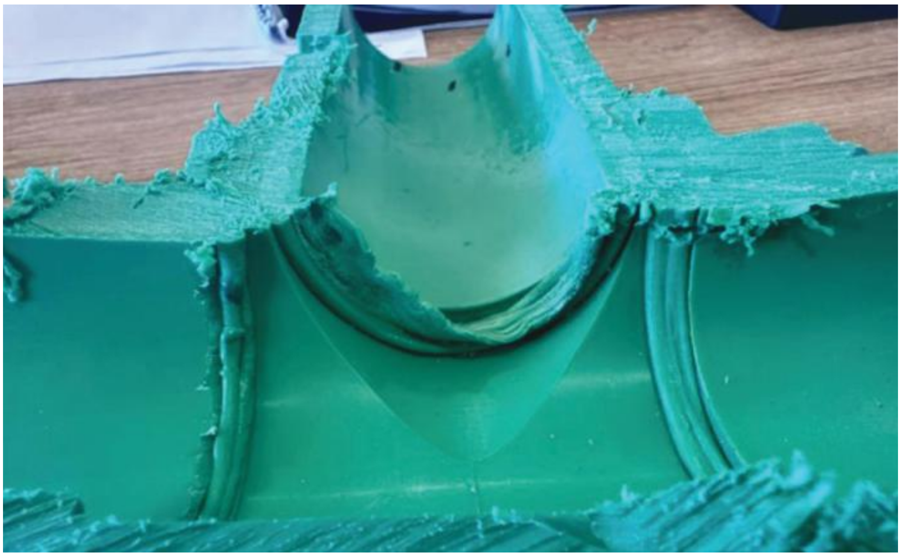


Figure 7 Cavitaton can cause significant damage to polymer pipes *(photo courtesy of Phil Woolhouse)*

Woolies Law: A Multi-Factor Framework for Risk Amplification

Woolies Law, proposed in 2024 by Phil Woolhouse in WA, introduces a model for understanding how stressors in water systems interact. Woolhouse identified eleven critical issues that do not merely add up, they multiply each other's effects. The law underscores that failures in water service systems are rarely the result of a single fault, but the compounded outcome of multiple minor issues occurring simultaneously and repetitiously, applying the same approach to amplitude and frequency that Miner's rule does.

Key Factors Affecting Microbial Proliferation in Water Systems

1. Environmental Factors
    - Temperature – most micro-organisms growth range between 20°C and 45°C. Activity is minimal below 10°C, and many are inactivated above 65°C. However, chlorine decays more rapidly at higher temperatures.
    - Nutrients – natural organic matter serves as a nutrient source for bacteria. Higher organic content directly increases microbial density.
4. Mechanical & Design Factors
    - Internal surface area (linked to pipe diameter and length)
    - Flow rate and usage frequency (stagnation, also linked to pipe volume)
    - Deadlegs and complex geometry
    - Air ingress
    - Surface susceptibility to biofilm formation (materials that minimise microbial colonisation)

10. Water Chemistry Parameters

- Electrical conductivity
- Chloride
- Sulphate
- Turbidity
- pH
- Residual disinfectant (e.g. chlorine, monochloramine)
- Water hardness
- Metals that assist organism growth (ferrous iron (Fe^{2+}), copper (Cu^{2+}), molybdenum (Mo^{2+}), nickel (Ni^{2+}), and zinc (Zn^{2+}))

Individually, these parameters influence microbial risk. In poorly designed or maintained/operated systems, they can combine to encourage biofilm formation and pathogen persistence, and relationship based corrosion risk.

Detecting and Responding to Mic

MIC indicators may include elevated metal concentrations (e.g. copper, lead etc.) in water and visible signs of internal corrosion. While selective culturing can detect some organisms, routine sampling often misses biofilm-residing microbes. A comprehensive, system-wide assessment, considering hydraulics, microbial ecology, and water chemistry, is essential, especially in stagnant or low-flow zones.

Conclusion

The relationship between corrosion and microbial risk in healthcare water systems is complex, dynamic, and often underestimated. This paper underscores that effective water hygiene cannot rely solely on residual disinfectant levels, nor can corrosion be addressed through simplistic indices or material upgrades alone, instead, a multifaceted approach is required to effectively manage these interconnected multifactor challenges.

Corrosion mechanisms such as MIC and erosion corrosion rarely occur in isolation. They are typically driven by overlapping, reinforcing stressors. *Woolies Law*, which frames these interactions as multiplicative, offers a valuable lens through which to view water system vulnerabilities.

In healthcare settings, where *Legionella pneumophila* and other pathogens pose serious risks, water systems must be managed as living ecosystems. Success depends on multidisciplinary collaboration across engineering, microbiology, operations, and maintenance. Monitoring must move beyond standard metrics to include biofilm surveillance, usage pattern analysis, and system design review.

Ultimately, resilience in healthcare water infrastructure depends not just on chemical balance or material strength, but on an integrated approach that anticipates risk, monitors performance holistically, and acts early, before degradation leads to health threats or costly failure.

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PROFESSIONAL BIOGRAPHY

Dr Surani McCaw is a Chemical Engineer with over 25 years industrial experience, specialising in water treatment in the Healthcare and Pharmaceutical Industries.

Surani holds a Bachelor of Engineering (Chemical) degree and a Doctor of Philosophy degree in water treatment from University of NSW, Kensington, NSW.

Dr McCaw has been involved in the implementation of National Healthcare Standards/Practices for both CSSD and Renal Dialysis since 2008 with the intention of evaluating and implementing risk managed and cost-effective water treatment technologies that are ft for the Australian ecological and demographical environment.

Tom Wise is a healthcare designer specialising hydraulic services, with a focus on water services design for both drinking and hygiene purposes.

Tom holds a building services qualification from University of Sydney NSW, along with a diploma in engineering.

Tom has been involved in over 100 healthcare engagement, including water hygiene advisory. Tom serves as the technical lead for the Australian Building Codes Plumbing Code of Australia Technical Reference Group, as well as the technical lead for the 815 Water Supply Standard for the International Code Council. Additionally, Tom assists with the development of the AusHFG suite and is a part author/contributor of some of the State and Territory healthcare engineering guidelines.

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Smart Cleaning, Smart Money: How Tech Helps Healthcare Clean Better

For healthcare facilities across Australia, the pressure to deliver exceptional patient care while navigating complex budgetary constraints and evolving operational demands is higher than ever. Every investment must show clear returns. Cleaning, once viewed purely as a cost, is now key to both efficiency and strategic value.

The old saying "time is money" holds especially true in healthcare. Modern decision-makers need solutions that maintain hygiene, use resources wisely, boost productivity, and improve the bottom line. This push for "Greater Efficiency" is leading many to rethink traditional cleaning.

Precision Where It Matters Most: The Deep Clean Advantage

While some tasks lend themselves to automation, the demands of healthcare hygiene, particularly in complex areas, require human-operated precision. This is where the "Deeper Clean" delivered by purpose-built machinery becomes a must-have.

Duplex's Floorscrubbers are built for these vital jobs. Their advanced machines are perfect for tight spaces like patient bathrooms, busy treatment rooms, and various floor types. Duplex's unique contra-rotating brush technology provides a powerful yet safe clean, reaching deep to remove embedded contaminants vital for infection control.

Crucially, Duplex's Jetsteam and Jetvac cleaning machines, using clever Tecnovap technology, elevate detail cleaning to a new level. Unlike most "commercial" steam cleaners offering inconsistent steam pressure or limited continuous operation, these professional-grade systems deliver **180 degrees superheated dry steam at consistent high pressures** direct to the surface. This means they truly clean and disinfect high-touch points, sensitive equipment, grout lines, and hard-to-reach crevices where traditional methods fail.

This strong ability means Jetsteam/Jetvac machines effectively kill bacteria, viruses, and mould without harsh chemicals. This greatly cuts chemical costs and makes things much safer for patients, visitors, and cleaning staff. Tecnovap's strong industrial components also ensure continuous high-performance operation in demanding healthcare environments, offering reliability and efficiency far beyond what lesser machines provide. In Jetvac models, the mix of high-heat cleaning and instant vacuuming means surfaces are left hygienically clean and dry fast, ensuring rapid room turnaround times – critical for operational flow.

Smarter Staffing: The Power of Next-Level Intelligence

Once critical precision cleaning is in place, the next step is to make bigger, repetitive jobs better. Where every staff hour is precious, automating regular floor maintenance becomes a game-changer. This is where the "Next-Level Intelligence" of robot cleaning truly revolutionises the landscape.

Companies like FloorBotics deploy smart robotic scrubbers that work non-stop across vast floor areas like long corridors, expansive waiting rooms, and large common spaces. By precisely mapping their environments, these intelligent machines deliver consistent, comprehensive cleaning without constant human supervision. This directly contributes to operational ROI by:

- **Optimised Workforce**: Empowering staff for critical, complex cleaning and patient-facing roles, improving job satisfaction and reducing burnout.
- **Reduced Operational Costs**: Significant savings on labour hours and related budget relief.
- **Consistent Performance**: Robots deliver a consistent quality of clean, reducing variations and ensuring hygiene compliance.
- **Data-Driven Decisions**: Robotic systems provide precise reports on cleaning coverage and efficiency for audits and continuous improvement.

The Future Looks Clean: A Smart Investment for Care

Forward-thinking healthcare facilities understand the optimal cleaning approach is synergistic. It combines the adaptable, detailed precision of human-operated, high-performance machinery – including advanced scrubbers and powerful Jetsteam/Jetvac systems – with the tireless, intelligent efficiency of autonomous robotics.

This integrated strategy promises not just a cleaner place; it means a smarter, more cost-effective way to work. It enables healthcare leaders to reallocate precious human capital, streamline workflows, reduce operational costs, and bolster compliance. By embracing "THE FUTURE [that] LOOKS CLEAN," Australian healthcare facilities achieve a great return for their money, not just in hygiene, but in operational excellence and, most importantly, in elevating care quality.

Emergency Training Courses for Healthcare and Aged Care Facilities

Effective emergency preparedness is essential in healthcare and aged care facilities. When emergencies like fires, chemical spills, or other unexpected events occur, swift and informed action can mean the difference between containment and catastrophe. With more than 135 years in fire protection and safety, Wormald delivers nationally recognised emergency response training tailored to the complex challenges of these environments.

Wormald's specialised training programs go beyond theory to build real-world capability. These programs equip staff with the knowledge, confidence, and practical skills to respond decisively in critical moments. Designed in line with Australian Standards, Wormald's training modules address the unique needs of healthcare and aged care facilities, where patients may be immobile or cognitively impaired and where calm, coordinated action is vital.

Here are six core training courses Wormald offers healthcare professionals and facility teams:

1. Emergency Officer Training

This two-hour, in-depth training is designed for Emergency Officers. It blends theory with practical exercises, teaching participants to identify risks, understand the structure of Emergency Control Organisations (ECO), and respond to incidents quickly and effectively. Topics include evacuation procedures, fire/smoke spread, and an overview of fire protection equipment. With up to 20 participants per session, it ensures key responders are thoroughly prepared.

2. Emergency Coordinator Training

Designed for those in leadership roles during a crisis, such as Emergency Coordinators and their deputies, this one-hour course focuses on effectively coordinating the Emergency Control Organisation (ECO), communication systems, and strategies to protect at-risk individuals. It prepares key personnel to lead with confidence and clarity when every second counts.

3. Practical Fire Extinguisher and Awareness Training

Ideal for facilities using online theory training, this 35–45 minute session focuses on practical application. Participants learn to identify different types of fire extinguishers and how to use them correctly. This hands-on component complements theoretical knowledge and reinforces effective response strategies in a real-world setting.

4. Emergency Desktop Walk-Through

This short (35–45 minute) session helps teams visualise emergency response plans through a guided, site-specific desktop simulation. It's ideal for reinforcing roles and procedures in a low-pressure environment and ensuring all team members understand their responsibilities.

5. Fire Safety Officer (Accredited Training – NSW/ACT only)

For facilities in New South Wales and the ACT, Wormald offers a two-day accredited course that meets the NSW Health Policy Directive PD2010_024. Delivered by certified trainers through Wormald's Registered Training Organisation (RTO Code 2839), participants gain critical competencies through nationally recognised units such as responding to emergencies, leading an ECO, and confining minor emergencies. With a maximum of eight participants, this course provides focused, intensive training for those responsible for fire safety compliance.

6. Wormald VR Training (Currently offered in NSW/WA only)

Harnessing the power of cutting-edge technology, Wormald VR Training places staff in over 50 realistic fire scenarios without real-world risks. Trainees use fire extinguishers in a safe, immersive VR environment to respond to simulated chemical, paper, fuel, and oil fires. The system is fully customisable, offering measurable results, improved learner retention, and enhanced engagement. Plus, it aligns with Australian Standards and environmental policies, making it practical and sustainable.

Prioritising preparedness

Partnering with a trusted training provider that understands the unique risks and layouts of healthcare and aged care facilities creates safer environments for all building occupants. Wormald has:

- Customised training for addressing unique industry risks and layout
- Accredited trainers with real-world experience
- Nationally recognised courses for regulatory compliance
- Group training options for efficient team preparedness
- Proven results through consistent, measurable training delivery.

For further information, visit: www.wormald.com.au/fire-safety-training/


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Why Flooring Matters in Healthcare Design

Healthcare environments are among the most demanding spaces to design. Every material must work hard, not just aesthetically, but functionally, to support the needs of patients, staff, and visitors. Among these decisions, flooring plays a particularly critical role.
It impacts hygiene, safety, comfort, and even the emotional tone of a space.

At Polyflor, we understand that flooring is more than a surface; it's a foundation for health, care, and performance.

Across hospitals, clinics, and aged care facilities, the right flooring can help reduce the risk of healthcare associated infections, streamline cleaning, and improve safety. Polyflor's vinyl flooring is designed to meet these demands. Its seamless sheet format eliminates dirt traps, while its water- and slip-resistant properties support safer movement in high-traffic or moisture-prone areas. These features make it an ideal solution for clinical settings where hygiene and efficiency are paramount. But function is only part of the story. Flooring must also contribute to a calm, welcoming environment. Evidence-based design tells us that visual cues such as zoning through colour and texture aid in direction and reduce anxiety for patients.

Acoustic performance, underfoot comfort, and non-institutional finishes also contribute to the overall experience. That's why material selection is a balance between clinical performance and human-centred design.

Safety remains a core consideration.
Slips, trips, and falls are a major concern in clinical settings, so flooring must offer a stable, compliant surface with minimal transitions and consistent slip resistance. Texture, finish, and durability are all tested rigorously to meet healthcare standards. With Polyflor, specifiers can be confident they're choosing surfaces that support both compliance and care.

Sustainability is another growing priority.
Polyflor actively supports recycling and environmentally conscious manufacturing, helping healthcare facilities reduce their environmental footprint and meet accreditation goals. Choosing sustainable materials contributes not just to environmental targets, but also to the long-term futureproofing of healthcare assets.

A recent upgrade at Knox Private Hospital in Victoria brings all of these principles together.

As part of a major clinical area refurbishment, a suite of Polyflor products was selected to meet strict performance and design criteria across staff stations, corridors, and patient rooms.

Beyond function, the project showcased how thoughtful product specification can enhance the healthcare experience. Zoning supported intuitive navigation, while seamless installations simplified maintenance protocols. Importantly, the flooring also contributed to the hospital's sustainability efforts through the inclusion of recycled content and waste-reduction initiatives.

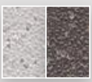
In every healthcare facility, flooring is a quiet yet powerful element, supporting infection prevention, enhancing comfort, and enabling staff to perform their roles safely and effciently. For hospital engineers, architects, and facility managers, selecting the right flooring system is one of the most impactful decisions in the design process.

With Polyflor's proven performance, sustainable options, and healthcare specific solutions, the path to better care really does begin from the ground up.

POLYFLOR PRODUCTS USED

Polysafe Quattro PUR
5765 Granite Sky

Ideal for wet areas, this high-performance flooring provides assured slip resistance and is easy to maintain, ensuring safety without compromising on style.



Polysafe Verona PUR
5231 Rock Salt, **5234** Americano

These soft, neutral tones introduce a sense of warmth and refinement, helping to elevate the clinical environment with a more welcoming feel.

Expona Flow PUR
9860 Light Industrial Concrete

With its sleek, contemporary aesthetic and exceptional durability, this design brings a modern, non-institutional character to high-traffic zones.

Smart water analysis driving safer and sustainable Hospitals

A SOUTHWESTERN SYDNEY LOCAL HEALTH DISTRICT HOSPITAL WATER EFFICIENCY REVIEW

Jason Hinds
Research Manager
ENWARE

Co Author
James Xi
Data analyst researcher
ENWARE & FLINDERS UNIVERSITY

Contributor
Andre Boerema
Sustainability Lead
SYDNEY WATER

Contributor
Wendy Hird
Sustainability Manager
SWSLHD

NSW Health stands as the largest water consumer in New South Wales, with a significant portion of this usage attributed to its extensive hospital network. Previous research by Sydney Water estimated that approximately 22% of water consumed in healthcare facilities is lost through leaks—representing an annual cost of around $450,000. To advance more efficient water management practices in healthcare environments, Sydney Water partnered with Enware and the South Western Sydney Local Health District (SWSLHD) to conduct a detailed investigation into water usage and wastage within a metropolitan hospital setting.

This study leverages data from floor-level submeters and Enware's Smart Flow™ monitoring systems installed across two multi-storey hospital buildings. By applying advanced data mining techniques, the project analyses water meter readings to uncover usage patterns, map consumption within hot water recirculation loops, and assess water flow through thermostatic mixing valves (TMVs). The primary goal is to identify opportunities to reduce water consumption while maintaining safety and service quality. The insights gained are expected to establish a benchmark for hospital water use, inform water risk management strategies, and contribute to the development of updated best practice guidelines for sustainable water management in healthcare infrastructure.

Research Objective.

This collaborative study between Sydney Water, Enware, and SWSLHD audits hospital water use over 12 months using submeters, smart monitoring, and data mining techniques. Still ongoing, the research aims to uncover usage patterns, support improved water management, and validate sustainable design and operational practices. Initial findings offer actionable insights, with long-term goals to reduce consumption, enhance leak detection, and establish benchmarks for ongoing water efficiency and risk management across the Local Health District.

Research Background

NSW Health is the largest water consumer in the state, prompting Sydney Water to plan for future demand. In 2014, it released *A Practical Guide to Water Efficiency in Hospitals*, based on audits of 35 hospitals. Key findings included 34% of use in public amenities, 18% in cooling towers, 7% in RO systems, and 22% lost through leaks.-see figure 1 (1).

NSW Health water consumption equates to 4.28M (Klt) and over 40% of the states total water consumption. If 22% of this water is wasted and not actually being used for hydration, sanitation and hygiene etc, there isn opportunity to recover this demand for future needs (2).

Ten years after the release of *A Practical Guide to Water Efficiency in Hospitals*, Sydney Water is re-engaging with hospital operators to reassess current practices and validate earlier findings using modern technologies. The goal is to provide updated, evidence-based recommendations that drive more sustainable outcomes. A key part of this initiative was selecting a benchmark site—one that had been recently constructed and equipped with advanced monitoring technologies aligned with the original guide's suggestions. The intent was to compare its water performance against previously audited hospitals and explore operational strategies that could be supported by data, reduce consumption, and maintain high water quality and safety standards.

A collaborative research study was launched with NSW Health, focusing on the South Western Sydney Local Health District (SWSLHD), chosen for its infrastructure diversity and the strong sustainability leadership of Wendy Hird. Campbelltown Hospital which opened in 2023, was identified as a prime candidate due to its extensive submetering and monitoring systems for boilers, sterilisation units, and cooling towers. The facility also included advanced water monitoring technologies that could enhance audit data and be tested for retrofitting

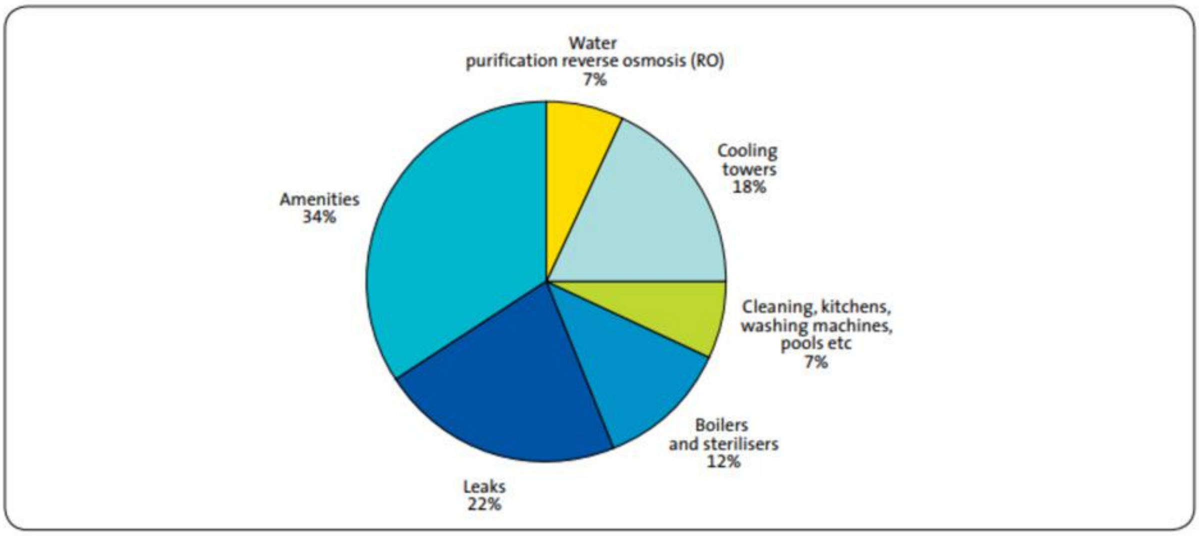


Figure 1 Water end use in hospitals audited by Sydney Water (average daily use including leaks)

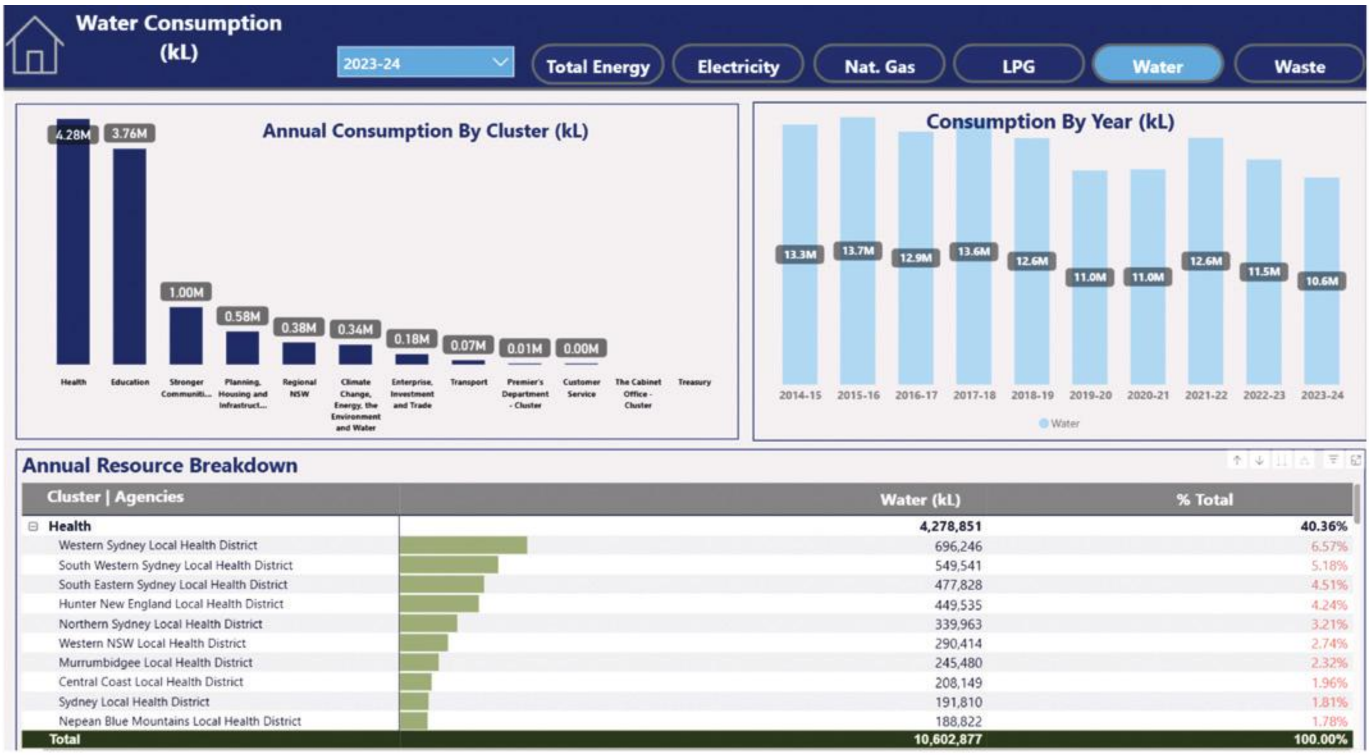


Figure 2 CASPER – Dashboards (water consumption)

on older sites. The ongoing study aims to validate design practices, support sustainability benchmarks, and guide improved monitoring for water reduction, leak detection, and risk management.

Research Site

South Western Sydney Local Health District (SWSLHD) covers the southwestern metropolitan area of Sydney and manages a network of seven hospitals and associated healthcare facilities. This district has implemented submetering across a range of sites, both new and older developments, particularly for critical systems such as cooling towers, potable water systems, and sterilising units. The data collected from these meters will play a pivotal role in the ongoing water audit and provide valuable insights for validating theoretical findings, especially in pre- and post-site assessments.

Several SWSLHD facilities, including Bowral and Campbelltown hospitals, have adopted Enware's Smart Flow™ monitoring systems to manage their thermostatic mixing valves (TMVs), which are essential for preventing scalding risks by blending hot and cold water. Under NSW Health Policy, TMVs are required to be tested monthly, a practice that traditionally demanded significant time and water usage. However, the Smart Flow system has shown to be highly effective in improving efficiency. At these hospitals, the system has reduced the labor required for testing by 85% and significantly cut water and energy consumption associated with compliance checks.

Smart Flow's real-time remote monitoring enables the automatic verification of TMV performance, ensuring that compliance is maintained without the need for manual checks where devices are operating within specification. This shift not only enhances safety by offering continuous oversight but also frees up skilled staff to focus on more critical tasks.

For facilities like Camden Hospital, where the system has not yet been implemented, monthly testing of 99 TMVs requires two full days of labor. The district plans to address this inefficiency by expanding the Smart Flow deployment across all facilities.

The primary focus of the water audit and data analysis study was Campbelltown Hospital, particularly Building A and Towers 1 and 2. With its newer infrastructure and advanced water management technologies, Campbelltown was an ideal site for the audit. The building is equipped with 75 mechanical water meters covering various systems, including the primary building supply, potable water, cooling towers, and CSSD systems. Each level has cold water submeters and separate hot water meters for the hot ring mains supply and return. Building A, Towers 1 and 2 also feature 487 TMVs, all connected to provide detailed water use data. Tower 1 spans 12 floors with 355 TMVs, supporting a range of services, including Emergency, ICU, Surgery, and leased mixed businesses. Tower 2, with 10 floors, houses 132 TMVs serving Renal, Cardiology, Mental Health, and Maternity units

The insights and learnings of this study at Campbelltown provide opportunity to implement at Camden which can further test and validate finding and strategies discovered.

Research Collaborator and capability

Enware is a leading plumbing supplier for healthcare facilities, offering solutions such as clinical handwashing tapware, thermostatic mixers, sensor tapware, and toilets. They also specialize in smart water products like ultrasonic meters and Smart Flow monitoring systems, providing healthcare facilities with enhanced visibility into plumbing system performance, water usage, stagnation, and hidden risks.

In NSW alone, Enware has over 40 monitoring systems installed across healthcare facilities, with more than 20,000 connected plumbing assets collecting data every 1.5 seconds. Enware's research on water use and sustainability led to collaborations with Sydney Water and SWSLHD. Previous studies focused on the costs and duration of leaks detected through smart meters in commercial water systems, analysing data from 830 smart meters across eight facilities over six years, including two aged care centres.

The study found that only 4% of meters experienced leaks, but when leaks occurred, they often went unnoticed for over a year, leading to losses of more than 2000 kLt and $5000 each time. Additionally, plumbing systems—regardless of size or building type—are likely to experience leaks approximately 500 days after becoming operational, with the risk continuing to grow. Early detection is crucial, as the research revealed that fixing leaks within 30 days could prevent 79% of water loss and associated costs

Research data sources and analysis methods

This study adopted a field-based empirical research approach using a quantitative, data-driven methodology. Sensor data were collected from two primary sources within Building A:

- **Water consumption data** from the Control Work metering system
- **Temperature data** from thermostatic mixing valves (TMVs), recorded by the Enware Smart Flow System

The water consumption data were collected from 75 meters installed across Building A, with readings recorded at 15-minute intervals over the period from **1 June 2023 to 1 June 2024**. TMV temperature data were collected from 487 TMVs between **1 January 2024 and 1 June 2024**. These temperature readings were sampled at intervals ranging from 1.5 to 3 seconds. A data point, consisting of a timestamp and temperature value, was recorded only when a change greater than 0.5°C was detected, reducing data



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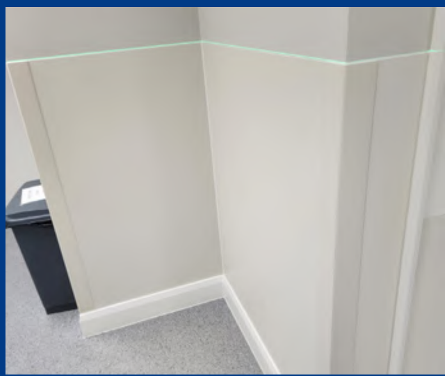

Interior spaces are designed to be aesthetically pleasing. They are decorated to be functional as well as beautiful, but the signs of wear and tear can start to show fast, especially in high-traffic areas. All too often the hard work and expense of decorating is diminished by scratching, rub marks and holes in the walls and corners.

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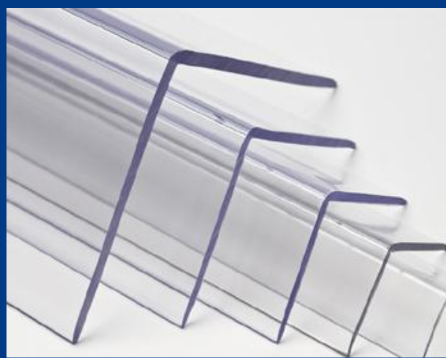

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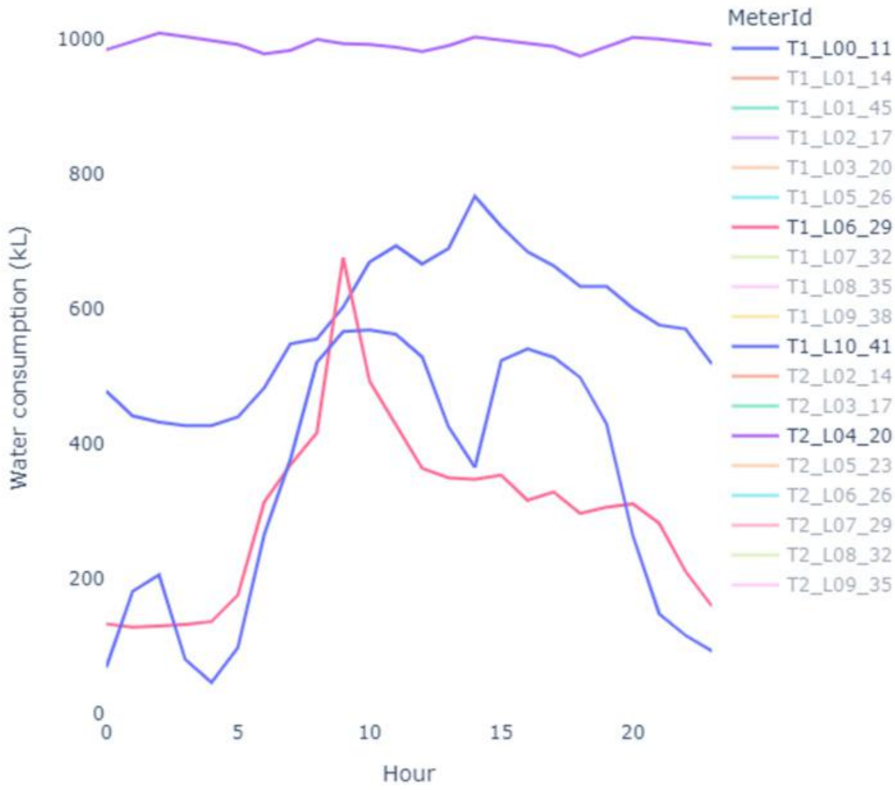

Figure 3 Typical average water consumption pattern by Floor

redundancy while preserving significant variations.

Data Processing and Analysis Environment

All data processing and analysis were conducted using **Python** in **Microsoft Visual Studio Code**. The analysis utilized the following libraries:

- pandas for data manipulation and transformation
- numpy for numerical computations
- scikit-learn (sklearn) for preprocessing and analytical utilities
- plotly for interactive and spatial data visualization

Data Analysis Workflow

Data Cleaning

Initial data cleaning was performed to ensure the reliability and accuracy of both the metering and TMV datasets. This process included:

- Handling missing values through imputation or removal
- Detecting and filtering out outliers
- Resolving inconsistencies in timestamp formats and sensor readings

Data Preprocessing

Preprocessing steps were carried out to prepare the data for detailed analysis. These included:

- Calculating flow rates and total water consumption based on the spatial assignment of meters
- Extracting TMV activity patterns using proprietary algorithms developed by Enware R&D
- Identifying potential cross-flow issues to generate reliable TMV usage data

Temporal Analysis

Temporal analysis focused on identifying patterns and trends over time. Data were resampled into hourly, daily, and monthly intervals. Time-based correlations and periodic usage patterns, such as peak water demand hours and seasonal variations, were analyzed to better understand the temporal dynamics of water use.

Spatial Analysis

Spatial analysis aimed to evaluate water consumption and TMV usage across different physical zones within Building A. This involved:

- Mapping cold and hot water consumption to TMVs based on location
- Comparing recorded consumption against actual TMV usage
- Visualizing spatial usage trends using 3D scatter plots and heatmaps to identify high-use areas and link these patterns to the functional purposes of the spaces

Research Findings

By analysing data from submeters on every floor and Enware's Smart Flow monitoring system for thermostatic mixing valves (TMVs) scattered throughout the two towers of the building, the research has captured a rich hydrology of how, when, and where water is being used.

From Cooling Towers to Warm Showers: Where is Water Used

Cooling Towers: Accounting for 29.5% of total water consumption, cooling towers were a much higher consumer than expected. Their use spiked in summer, directly mirroring ambient air temperatures, proving their demand is temperature-driven. With the earlier research suggesting cooling tower make up water should be closer to 18% , this data does provide evidence that further investigation is needed on this water system to look for efficiencies which will form a separate research project.

Potable Water: Daily water consumption peaks is aligned with the start of hospital operations, particularly in winter months when consumption was highest. Each floor follows its own pulse. In Tower 1_Level 10, a renal ward's water use is high but shaped by the needs of reverse osmosis treatments. In Tower 1_Level 06, a standard patient ward, water use peaks predictably at 9:00 AM as patients

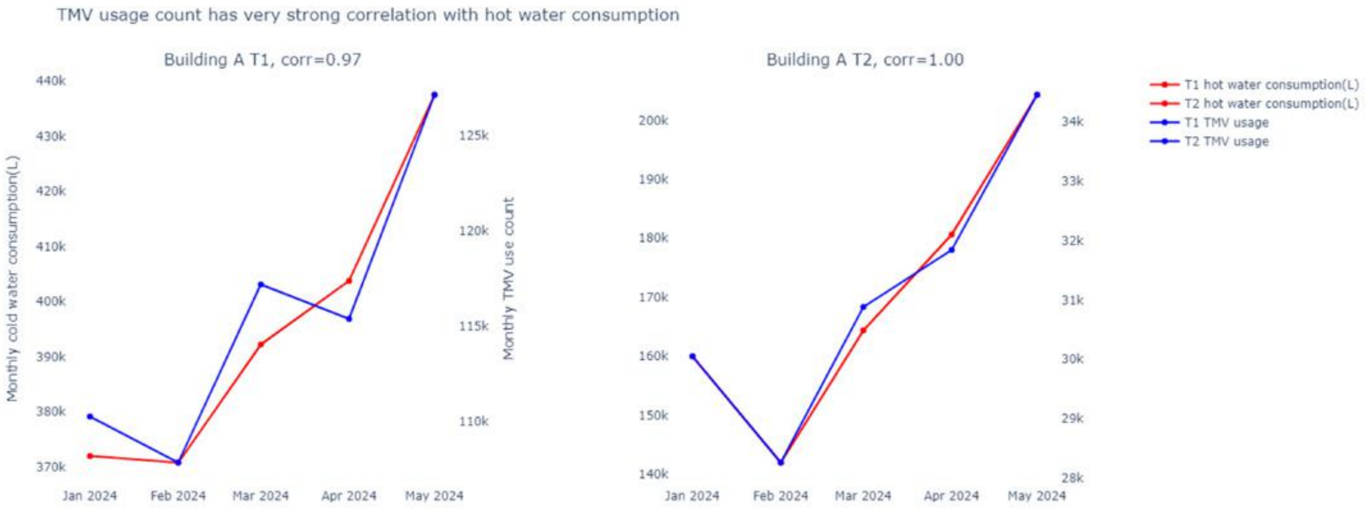

Figure 4 TMV usage count review against monthly hot water total consumption

shower and ready themselves for rehabilitation. This regularity is not just comforting—it's powerful.

Predictable daily and seasonal patterns can guide infrastructure planning and help anticipate future needs. These patterns are not just data—they are signatures of behaviour, processes, and/or problems. While most floors followed expected use patterns, some anomalies raised red flags.

Floors that uncover hidden truths — Leaks and outliers

Not all parts of the hospital consume water equally. Tower 2_Level 04 stands out like a flashing warning light, using over 23,000 litres per day with a constant minimum flow between 9 - 15 L/min and no downtime or periods of the day when flow reduces to typical levels experienced on other floors . This persistent pattern of water use hints at a significant leak, mechanical issue or a fixtures running continuously.

In contrast, Tower 1_Level 00, the emergency department, also uses large amounts—but here, the story matches the setting: it's a hub of constant human activity.

The review of water consumption and usage per floor throughout the day, provided insight into typical patterns of water use behaviour where different times of the day experience fluctuations of use – *ref Figure 3.*

By better understanding usage patterns of behaviour, we uncover where efficiency falters or functionality thrives.

Hot Water, Cold Data: The Breakdown of Mechanical Meters

Each floor across both hospital towers was fitted with mechanical turbine meters on the hot water ring main supply and return lines. These meters were originally specified to provide granular visibility into hot water usage per floor and support proactive management of water quality and risks associated with heated water services. Their inclusion in this study aimed to enhance understanding of TMV supply dynamics and help pinpoint high-demand areas or potential leak points across the facility.

However, during the analysis phase, a significant discrepancy was identified between the flow and return meter readings—raising concerns about data validity. Follow-up investigations using clip-on ultrasonic flow meters confirmed the issue: over 50% of the mechanical meters were delivering unreliable data and could not be used in the study. The root cause? The turbine-style meters proved ill-suited for high-temperature hot water systems, calling into question their effectiveness in this application and presenting a new challenge—how to accurately monitor hot water usage at a floor level in real time

Turning TMVs Into Telemetry

Behind walls and fixtures, thermostatic mixing valves (TMVs) control the blend of hot and cold water, and their activity turns out to be highly correlated (Pearson Coefficient r > 0.9) with hot water use. They mirror cold water patterns too, making them reliable proxies for understanding how water flows throughout the building.

It has been discovered that the monitored TMVs provide additional insight beyond the ongoing temperature performance of the valve. The data can be used to tell us where water is used, how, and when, within the functional areas of the facility.

A Pareto review on the daily usage activity counts of all TMVs demonstrates that 80% of water is consumed through only 42% of the TMVs- *ref Fig 4*. Meanwhile, 7.6% of the TMVs on site show no activity at all proving likely dead legs or stagnant zones, posing a risk of microbial growth. This information is valuable for proactively managing water quality risks and ensuring all unused tapware is flushed every 7 days.

In the absence of reliable Hot water meter data, we reviewed TMV daily usage counts per floor with cold water consumption per floor. The mirror graph (fig 5) demonstrates a close association to cold water consumption and TMV usage which further supports this data as a proxy for hot water usage. Looking for significant discrepancies between cold water consumption and TMV usage counts per floor also highlights potential leak risks or abnormal usage where water efficiency actions focus.

Usage Patterns and Potential Problems

Some TMVs stand out for their frequent daily activations. In the staff lounge near TMV 13-3, or the busy corridor near TMV 12-5, usage is high but expected. Clinical stations and patient amenities drive consistent demand in TMVs 56-7 and 65-2 – *ref Fig 6*.

These are not red flags in relation to water waste but rather evidence of infrastructure serving its purpose effectively.

Clustering analyses of TMV usage count data grouped TMVs into behavioural use patterns. Most followed logical operation of tapware or showers where usage peaks tied to meal and hygiene routines. But outliers, like TMV 82-8—which ran continuously for six days is a behavioural anomaly requiring further analysis.

Further investigation into TMV usage data with extended duration periods greater than 1 hour was explored as a theoretical classification of abnormal activity – ref Fig 7. This analysis grouped the activities further into 3 groups associated to:

1. Behavioural -normal fixture use but extended beyond normal behaviour,
2. Operational - crossed flow within the TMV during or associated to fixture usage.

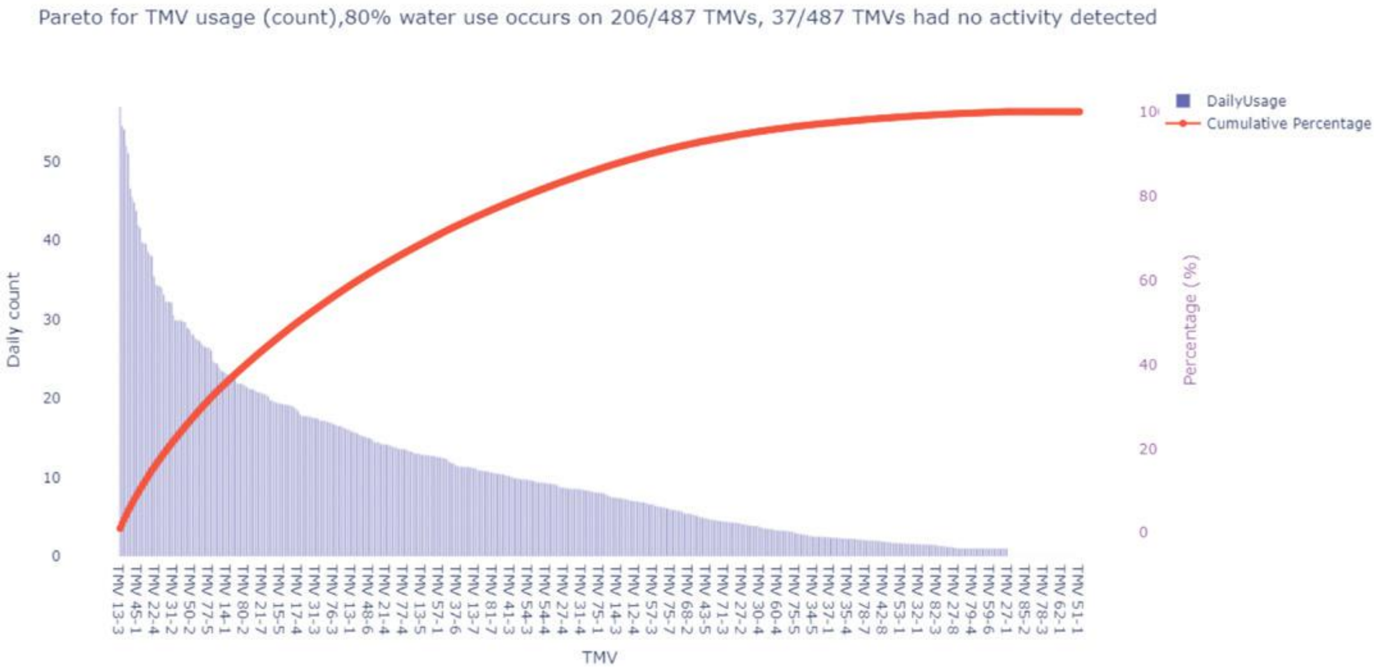

Figure 5 Pareto chart of TMV activation counts per day.

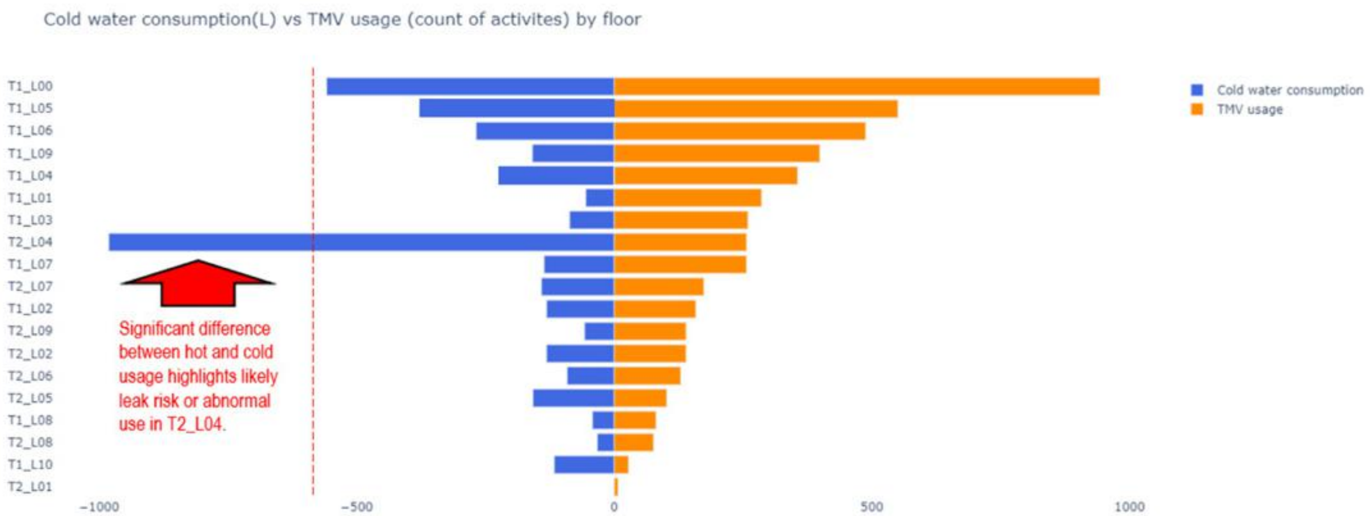

Figure 6 Mirror graph of cold-water consumption versus TMV usage count per floor

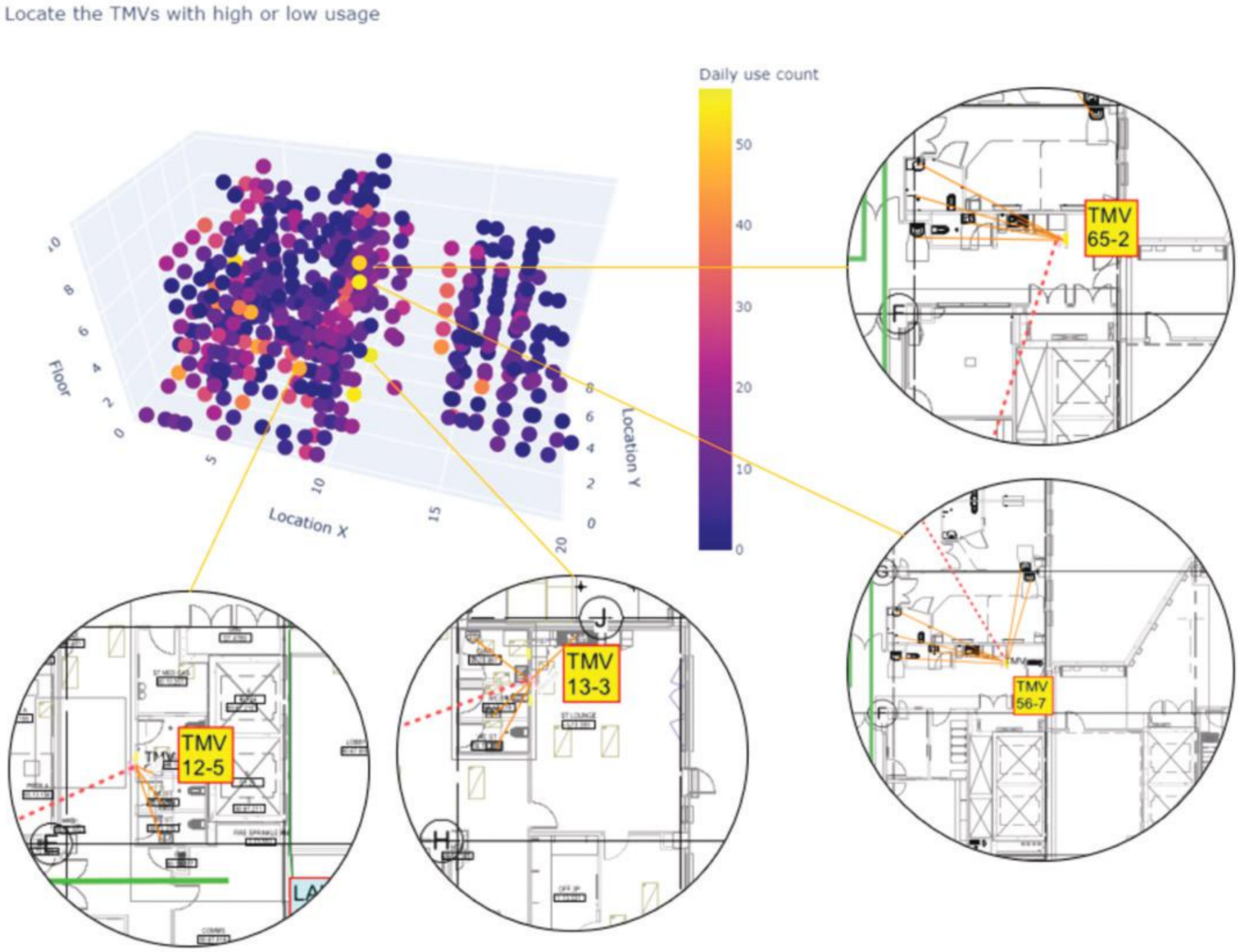

Figure 7 3D scatterplot Graph of TMV daily use count

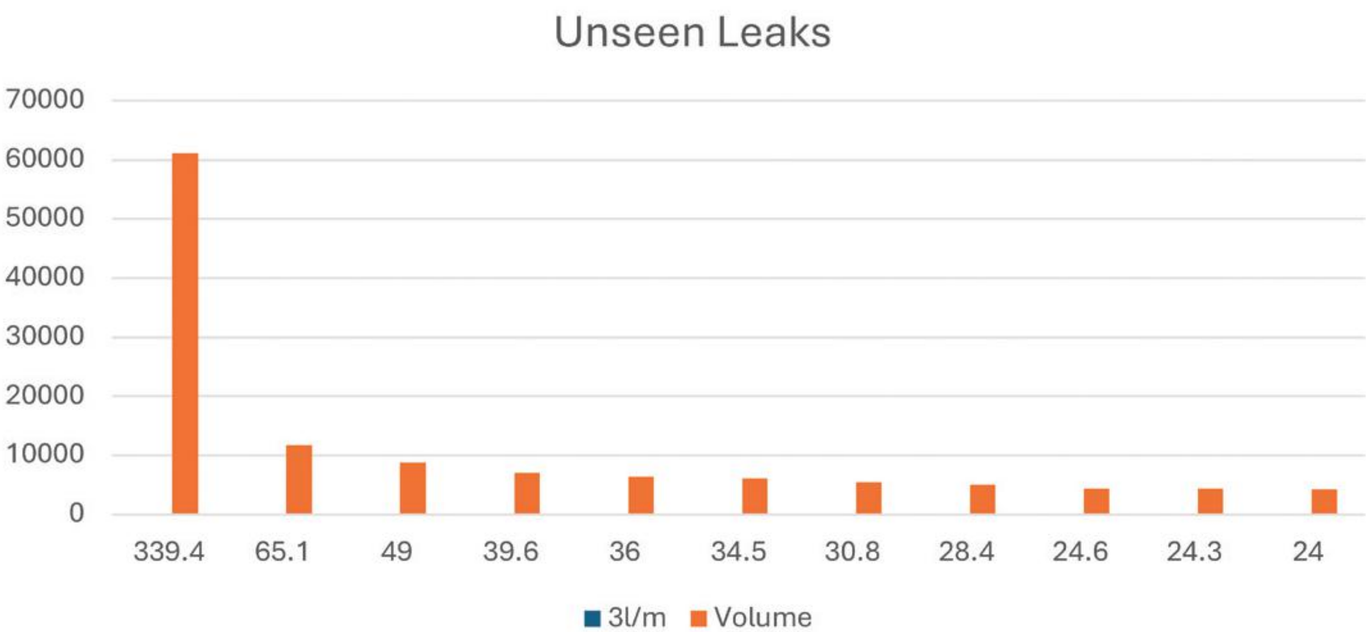

Figure 8 Histogram of TMV activity continual duration longer than 24Hr.

3. System - crossed flow within the TMV than occurs without fixture usage.

The data could see if a fixture was potentially left on or used beyond normal behavioural patterns. The higher-than-normal use in fixtures within T2_L04 Mental health floor could have prolonged use for therapeutic reasons or potential vandalism or self-harm. The data revealed it could identify when the check valve within the TMV failed potentially due to debris or fluctuations in pressure causing hot water to cross into cold lines - raising both energy bills and health risks. These failures were more common on lower floors, likely due to higher gravitational pressure.

We than explored what findings we would see if we applied a typical leak alert function commonly found in smart meters looking for continual usage duration longer than 24 hours. This hypothesis suggests such usage is a significant leak within the system that is unseen and therefore pose the greatest threat.

13 different TMV activities occurred longer than 24Hours within a 6 month period. Two of these were activities associated to cross flow through the TMV which if left unseen and not fixed would continue to create significant health risks and water and energy waste. 11 of the activities were classified as Behavioural based off normal operational data where the water simply did not stop flowing suggesting taps were left on or the leaked beyond the TMV. If we take a nominal flow rate volume of 3L/m, one of these activities equated to 61Klt. If the engineers on site were privy to this data at the time of each event and managed to fix the cause, the total water saved could be 156Klt – *ref Fig 8.*

Conclusion and Recommendations

The hospital's water story is one of predictability, complexity, and occasional surprise. From cooling towers responding to the summer sun, to TMVs signalling silent leaks or active care zones, each data point speaks. This report presents an initial perspective on the analysis of water consumption patterns at Campbelltown Building A, focusing on cooling towers, potable water systems, and thermostatic mixing valves (TMVs). The data reveals strong seasonality, usage predictability tied to hospital operations, and potential inefficiencies. Several indicators of leakage, water mis use, stagnation risks, and behavioural trends have been identified, providing actionable insights for facilities management and sustainability planning.

Key Lessons

- Water use follows the function—predictable by season, hour, and hospital workflow.
- Outliers in the data reveal opportunities for early intervention.
- TMVs are more than mixing valves—they are rich sources of data into where water is uses and mis used and as well as system performance insight.

Further Research

- Audit Tower 2_Level 04 to confirm excessive water use locations/ and correct potential leaks.
- Investigate inactive TMVs and address stagnation risks.
- Use TMV activity data to guide water demand modelling and leak detection.
- Improve monitoring systems to prevent data loss and prolonged unnoticed failures.
- Retro fit the system and associated learnings on older infrastructure to help validate the findings and inform future sustainability and water risk management planning.

Water doesn't just flow—it tells a story. Campbelltown water audit study is a story we can now read, interpret, and use to make smarter, safer, and more sustainable decisions.

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Clean Air, Safe Care: Why Filter Maintenance Matters

In today's healthcare environment, air quality is not a luxury — it's a critical component of infection control, patient recovery, and staff wellbeing.

With the increasing reliance on high-performance air purifiers like the INOVA range, healthcare facilities are investing in cleaner, safer indoor air. But investment alone is not enough. The key to unlocking the full benefits of your INOVA air purification system lies in one essential practice: regular filter maintenance.

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INOVA systems, renowned for their Australian-engineered medical-grade filtration operate at their highest efficiency when well maintained.

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Asset Management in Healthcare Facilities

OPTIMISING LIFECYCLE COST FORECASTING AND ENSURING REGULATORY COMPLIANCE

S Safi (PhD, FIEAust, CPEng, CAMA)
COVARIS PTY LTD

Future-proofing healthcare facilities requires robust methodologies to accurately forecast asset lifecycle and maintenance costs while ensuring compliance with statutory obligations. This research presents innovative approaches derived from a comprehensive benchmarking study aimed at predicting asset lifecycle and maintenance costs in healthcare facilities.

Central to the research is the development of an Asset Lifecycle and Maintenance Cost Model, which employs a detailed bottom-up approach, utilising the healthcare facility's asset register to forecast costs for preventive and corrective maintenance, lifecycle replacements and refurbishments, as well as the remediation of known issues and non-compliance across the facility.

The processes outlined in this paper also ensure compliance with statutory obligations for maintenance delivery. This is achieved by establishing a line of sight from statutes to regulations, asset classes, and maintenance job plans. The approach provides asset managers with the visibility needed to understand maintenance requirements for each asset type, thereby ensuring compliance across the entire asset portfolio.

Introduction

Healthcare facilities require regular and effective maintenance of their physical assets to ensure a safe and secure environment for patients, staff, and visitors. Asset maintenance is a crucial aspect of the facility's asset management process, involving both planned and unplanned maintenance activities. The main requirement of the maintenance strategies is both assuring equipment reliability and compliance with statutory obligations. The process presented in this paper ensures statutory compliance by providing a line of sight from statute to regulation to asset class and then to maintenance job plans.

The lifecycle costs include asset replacement and refurbishment. The primary objective of this study is to establish a cost model to support healthcare facilities in planning, budgeting, and forecasting. The study aims to forecast both capital and recurrent costs to enable lifecycle planning. The findings will serve as a tool for healthcare facilities in their forward planning, including forecasting maintenance and capital expenditures within their Asset Management Plans. The model presented here uses a bottom-up approach to calculate these costs for healthcare facilities. This paper outlines the process for cost modelling and presents the initial findings from the cost modelling for a healthcare facility.

Methodology

Figure 1 illustrates the elements of the cost modelling for a healthcare facility. This section presents the steps involved in developing the cost model, which covers a modelling period of 25 years. The cost model uses a bottom-up approach based on the asset register from the healthcare facility's asset management information system to calculate both maintenance and life cycle costs.

The modelling covers maintainable building and facility assets. The accuracy of the results produced by this model depends on the accuracy of the hospital's asset register. If the facility's asset register is inaccurate, an asset data validation exercise may be required prior to cost modelling.

The final component of the cost model involves estimating the cost of proposed works to remediate identified chronic issues. These issues are identified through workshops with the healthcare facility asset management team, site visits to identify non-compliance or issues, and reliability analysis of work order history records from the hospital's asset management system.

Asset Register and Asset Classification Reference Date

The first step in the cost modelling of a healthcare facility is to identify the list of assets which is used for the bottom-up modelling approach. The required asset data are:

1. Asset Details: asset id, asset name, asset classification as a minimum plus additional asset details if available (e.g., manufacturer name, model number …);
2. Asset Lifecycle Details: in service date, purchase cost / replacement value; and
3. Asset Condition Assessment (if available): observation date, Condition Rating, Current Usage, Operating Environment, Criticality. If asset conditions were not available, asset condition was assigned based on the age of the facility.

An asset reference data library is required for building and facility assets to enable the modelling of maintenance costs for healthcare facilities. The reference data have been developed for all asset classifications used in the hospital's asset register. This information drives the calculation of maintenance costs and includes the following:

1. Identifying the maintenance strategy for assets with applicable asset classifications. All assets will be identified as requiring planned maintenance or unplanned maintenance.
2. Price Book: This important reference data provides the current replacement value for assets. If the healthcare facility asset register has accurate purchase cost/ replacement value, these values will be used in the calculation of refurbishment and replacement costs. If cost data is not available, the average price from the price book for the applicable asset classification will be used.
3. Life Expectancy (years): Provides the expected life by asset classification. Assets will be replaced when they reach the end of their expected life (see Table 1).
4. Planned Refurbishment (years): The expected frequency of the refurbishment by asset classification (see Table 1).
5. Planned Refurbishment (%): The percentage of the asset cost required for the planned refurbishment (see Table 1).

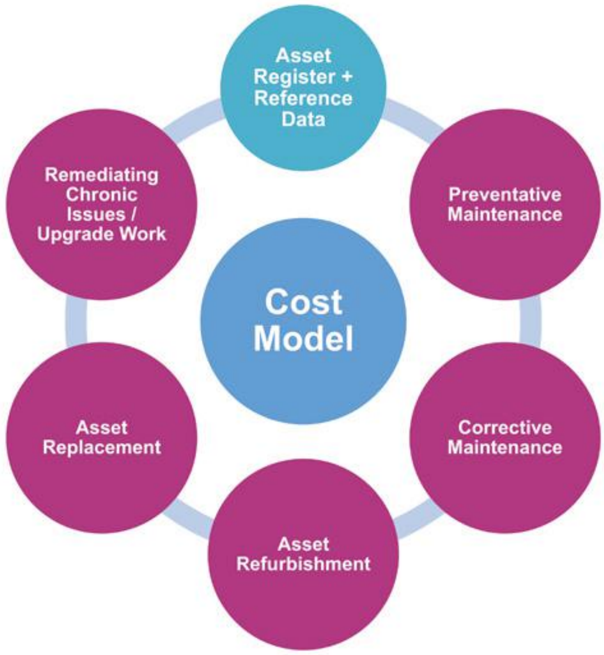

Figure 1 Cost Model Elements

Compliance with Statutory Maintenance Requirements

Before estimating the cost of preventive maintenance delivery, it is necessary to ensure that the maintenance strategies for all maintainable assets comply with statutory obligations. The process presented here ensures the statutory compliance by providing the line of sight from statute to regulation to asset class and to maintenance job plans. It provides the asset manager the visibility of the requirements of maintenance for each asset type and ensures the compliance on the maintenance requirement of the asset portfolio. The process follows the following steps:

1. Ensure we have a current asset register with the required attributes including asset types.
2. Identify the applicable Acts, Regulations or Codes of Practice for the asset types which exist in the facility.
3. Identify the applicable Australian Standards, technical standards, such as industry or sector regulations, with regards to the maintenance of the asset types have been identified.

Table 1 Sample Asset Reference Data Library.

Asset Classification Name	PM Strategy Name	Life Exp. (yrs)	Refurb. Freq. (yrs)	Refurb. Cost as a % of Replacement Cost	Library Minimum Cost	Library Maximum Cost	Library Average Cost
Chilled Water Pumps	Centrifugal Pump	15	5	25%	$1,900	$19,200	$8,041
Chillers	Screw Chiller	15	10	30%	$65,000	$288,000	$97,600
Cooling Towers	Cooling Tower	20	10	30%	$35,495	$180,000	$119,297
Distribution Boards	Distribution Board	20	10	20%	$2,400	$250,000	$16,434
Goods Lifts	Lift	25	10	20%	$200,000	$356,600	$242,960
Fire Doors	Fire Doors	20	5	5%	$300	$2,500	$877
Fire Hose Reels	Fire Hose Reel	10	5	20%	$250	$5,000	$459

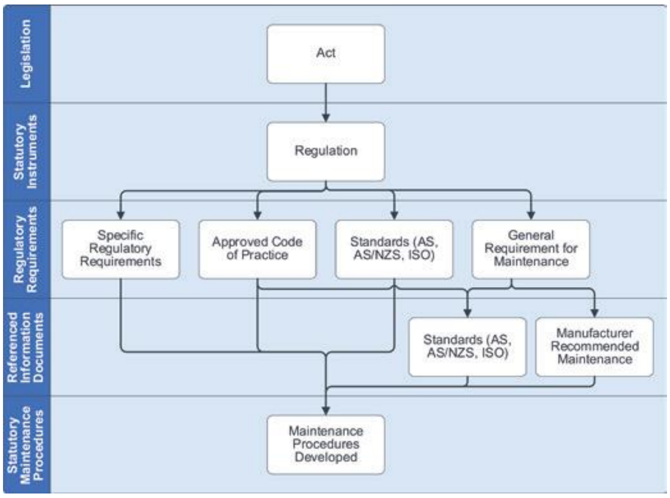

Figure 2 Statutory Maintenance Procedure Development Process

4. Establish a clear tracking of work to statutory obligations for each asset type by
   a. Listing of known statutes
   b. Alignment with asset classes based on their need to be compliant with the regulations referred
   c. Alignment with maintenance job plans
5. Establish a clear tracking of statutory maintenance obligations for individual assets.

Figure 2 details the process for identifying statutory maintenance requirements and developing the statutory maintenance procedures for each equipment type. Figure 3 shows an example for the development of statutory maintenance procedures for fire hose reels.

Estimated Cost of Preventative Maintenance

The first cost component in the model is developing the bottom-up budget for preventative maintenance. This includes calculating the preventative maintenance cost for all maintainable assets using the following steps:

1. Allocate Maintenance Type to each asset: At the end of this stage, each asset will have a type of maintenance allocated (planned or unplanned) based on the asset reference data library.
2. Develop Asset Maintenance Plan: This stage involves developing an Asset Maintenance Plan for all assets identified with a planned maintenance type, based on the developed Planned Maintenance Service Plans. The maintenance service plans are aligned with the statutory maintenance requirements for the applicable asset classification. At the end of this stage, the Asset Maintenance Plan developed will contain a detailed maintenance schedule and resource requirements.
3. Indicative Costs for PM Delivery: Develop an annual PM maintenance cost forecast for all assets in the site-specific asset register. This includes calculating the annual cost of PM delivery based on the estimated duration and hourly rate of the required resource. PM delivery costs include trade resource hours, work quality checks, administrative support, supervisor/building manager, and spares cost.

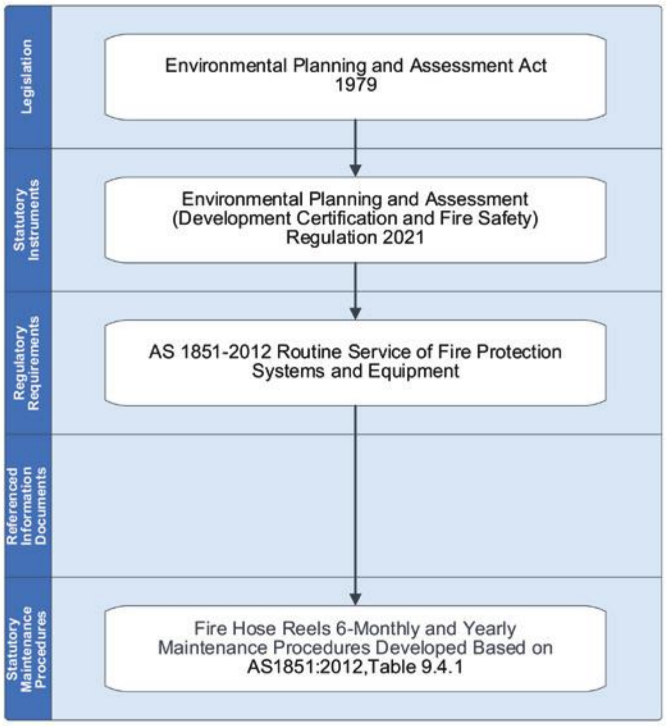

Figure 3 Statutory Maintenance Procedure Development for Fire Hose Reels

Expected Cost of Corrective Maintenance

The second cost component in the model is developing the budget for corrective maintenance, which is estimated based on the asset condition across the site using the following steps:

1. Rate of CM/PM: Corrective maintenance annual labour hours are estimated as a percentage of calculated PM labour hours based on the asset condition.
   - The ratio for CM labour hours as a percentage of PM labour hours is estimated at 30.3% for new assets/facilities. This ratio was identified from actual data provided by a maintenance services provider over a three year period for a hospital less than 10 years old.
   - The ratio for CM labour hours as a percentage of PM labour hours is estimated at 40% for assets/facilities with average asset condition.
   - The ratio for CM labour hours as a percentage of PM labour hours is estimated at 60% for assets/facilities with poor asset condition.
   - The CM/PM labour hourly rate is 125% (on average, the hourly rate for corrective work is 25% higher than the preventive work hourly rate).
2. Indicative CM Material Costs: The estimated cost of materials for CM work is estimated at 20% of the CM labour hour costs.
3. Indicative costs for delivery: Develop an annual corrective maintenance cost forecast for all assets in the site-specific

asset register. CM delivery costs include trade resource hours, work quality checks, administrative support, supervisor/building manager, and spares cost.

Life Cycle Replacement

The third cost component in the model is the Life Cycle Replacement cost which is calculated for all assets included in the site-specific asset register based on the following steps:

1. Life Expectancy (years): Expected life of each asset is identified based on the asset classification. The expected life for the applicable asset classification is identified in the asset reference data library.
2. Installed date and Replacement Value: Identify the installed date and asset replacement value from the asset register. If the data is not available, identify the installed date by consulting healthcare facility asset managers or the age of the facility. The replacement value can be estimated based on the asset classification and the replacement value for the applicable asset classification as identified in the asset reference data library. If the healthcare facility asset register has accurate purchase cost/replacement value, these values will be used in the calculation of refurbishment and replacement costs.
3. Annual Replacement Cost: Develop an annual life cycle replacement cost forecast for the life of the assets for the site-specific asset register. For the 25-year Cost Modelling, assets may be replaced multiple times based on their expected life.

Life Cycle Refurbishment

The last cost component in the model is the Life Cycle Refurbishment cost which is calculated for all assets included in the site-specific asset register based on the following steps:

1. Refurbishment Frequency (years): The refurbishment frequency of each asset is identified based on the asset classification as identified in the asset reference data library.

Table 2 Cost modelling results for a sample hospital.

Year	Preventative Maintenance	Corrective Maintenance	Asset Refurbishment	Asset Replacement	Remediating Work	Grand Total
2025	$1,717,545	$965,681	$770,747	$714,173	$2,065,208	$6,233,355
2026	$1,736,120	$976,125	$145,904	$863,425	$3,192,173	$6,913,747
2027	$1,717,545	$965,681	$713,834	$1,212,457	$3,914,064	$8,523,582
2028	$1,782,557	$1,002,234	$522,617	$769,298	$3,999,419	$8,076,126
2029	$1,736,120	$976,125	$317,568	$5,510,589	$16,752,628	$25,293,030
2030	$1,717,545	$965,681	$626,816	$577,057		$3,887,099
2031	$1,717,545	$965,681	$522,050	$4,207,312		$7,412,588
2032	$1,736,120	$976,125	$149,663	$5,609,002		$8,470,910
2033	$1,782,557	$1,002,234	$1,443,401	$2,180,851		$6,409,043
2034	$1,717,545	$965,681	$563,448	$685,219		$3,931,894
2035	$1,736,120	$976,125	$9,290	$8,169,335		$10,890,870
2036	$1,717,545	$965,681	$38,794	$689,521		$3,411,541
2037	$1,717,545	$965,681	$426,592	$606,548		$3,716,366
2038	$1,801,132	$1,012,677	$374,008	$12,673,676		$15,861,494
2039	$1,717,545	$965,681	$451,705	$8,540,615		$11,675,546
2040	$1,717,545	$965,681	$327,471	$417,664		$3,428,362
2041	$1,736,120	$976,125	$101,891	$8,662,116		$11,476,251
2042	$1,717,545	$965,681	$156,171	$630,048		$3,469,446
2043	$1,782,557	$1,002,234	$1,677,111	$5,023,845		$9,485,747
2044	$1,736,120	$976,125	$444,003	$1,595,194		$4,751,442
2045	$1,717,545	$965,681	$445,381	$996,591		$4,125,199
2046	$1,717,545	$965,681	$176,911	$100,261		$2,960,398
2047	$1,736,120	$976,125	$200,417	$9,104,996		$12,017,658
2048	$1,782,557	$1,002,234	$768,180	$1,365,467		$4,918,439
2049	$1,717,545	$965,681	$883,752	$3,135,188		$6,702,166
Grand Total	$43,412,287	$24,408,346	$12,257,724	$84,040,447	$29,923,492	$194,042,296
Annual Average	$1,736,491	$976,334	$490,309	$3,361,618		$7,761,692

2. Installed date / Refurbishment Value: The installed date is identified from the asset register, if available. If the data is not available, the installed date is identified in consultation with healthcare facility asset managers or the age of the facility. The refurbishment value for each asset is a percentage of the replacement value of the asset based on the applicable asset classification as identified in the asset reference data library.
3. Annual Refurbishment Cost: Develop an annual lifecycle refurbishment cost forecast for the site-specific asset register. For the 25-year Cost Modelling, assets may be refurbished multiple times based on their refurbishment frequency.

Remediating Chronic Issues / Upgrade Work

This cost component covers the development of recommended solutions to address reliability issues and non-compliance across the healthcare facility. The issues and corresponding initiatives are developed in consultation with the healthcare facility asset management team and should be aligned with the health service requirements. Figure 4 shows the methodology for developing this cost element.

As part of this component, known issues are itemised, and a top-level cost estimate is developed to support budgeting for the specified issues. In addition to the estimated cost to remediate each issue, a priority level and recommended start date are assigned in consultation with the healthcare facility asset management team. An example of this type of work is the remediation of mould in sections of the hospital's HVAC ductwork.

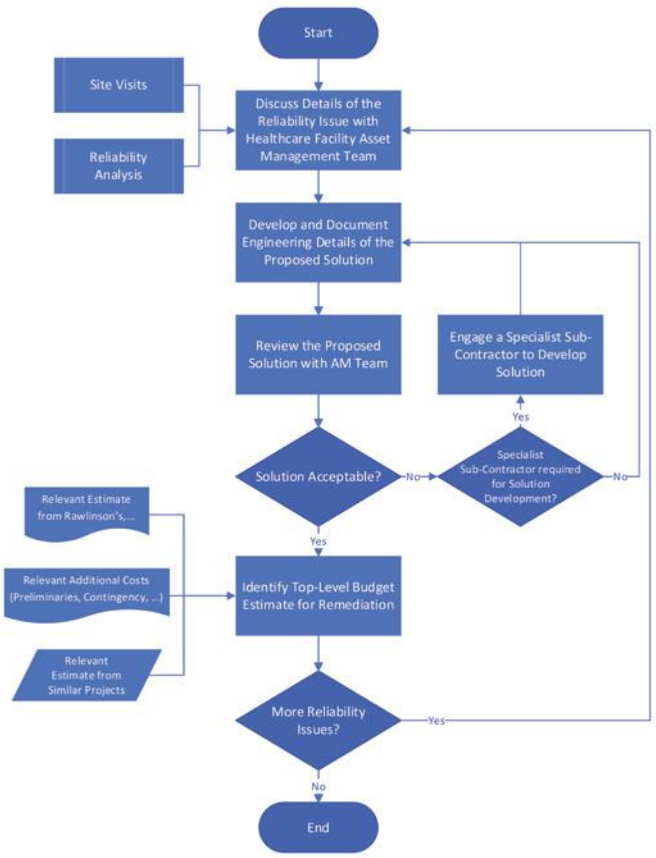

Figure 4 Methodology for Developing Costed Solutions for Chronic Issues

Findings

Cost Modelling Limitations

It is important to note that the cost model may underestimates full amount required for maintenance and capital costs of the hospitals for the following reasons:

1. The modelling only covers maintainable building and facility assets recorded in the asset management information system. If assets are not recorded in the asset management information system, the modelling underestimates the required costs across all maintenance categories.
2. The modelling excludes fixtures, fittings, furniture, and equipment.
3. ITC & digital assets were excluded from the modelling.
4. Fleet, food services, and laundry services assets were also excluded from the modelling.
5. Biomedical assets were not included in the modelling.

The cost models exclude the following cost components:

- Replacement of buildings at the end of their useful life.
- Grounds maintenance.
- Soft services.

Conclusions

In conclusion, the Asset Maintenance and Lifecycle Cost Model represents an advancement in forecasting asset lifecycle and maintenance costs for healthcare facilities. The study employed a bottom-up approach to develop the cost model, which was applied to selected healthcare facilities. The model calculates preventive and corrective maintenance costs, as well as lifecycle replacement and refurbishment costs over a 25-year period. This paper presented initial findings from the cost model for a sample hospital. The cost model has the potential to assist healthcare facility managers in their forward planning by providing accurate expenditure forecasts within their Asset Management Plans.

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Compressed Air in the Pharmaceutical Industry

MINOR MEASURES – MAJOR BENEFITS

THIS IS PART 2 OF THE ARTICLE THAT APPEARED IN THE AUTUMN 2025 ISSUE

KAESER

Overview
A great deal can often be achieved with just a few measures to increase efficiency and cost savings of the compressed air supply. The second part of this series describes the key points to observe in the process of renovating an existing or planning a new system, and provides some tips on optimisation.

Introduction

Energy costs account for the lion's share of total compressed air supply costs. For an optimised compressed air supply produced by a new station with air-cooled compressors, the cost profile is divided as follows: commissioning and training of maintenance staff account for around just one percent of total costs; the same goes for condensate treatment. Installation expenses and the cost of controllers and process control systems come in at seven, and procurement of treatment equipment at five, with that of compressor equipment at around 13 percent. Maintenance of compressors accounts for three, whilst treatment system maintenance comes in at one percent. The largest cost block by a huge margin derives from energy expenses to supply compressors and treatment equipment, however, at 69 percent (Image 1).

This striking figure makes clear how energy performance is one of the most important indices for evaluating compressors.

Years ago as part of its "Efficient Compressed Air" campaign (2000-2004) the Frauenhofer Institute established certain benchmarks that remain relevant today: for example, at a pressure of 6.5 bar (7.5 bar absolute), the specific power requirements should be between 5.5 and 7 kW m³/min. Energy consumption values above 7 kW m³/min are not cost effective, whilst those under 3.3 kW m³/min are technically impossible to achieve with current technology.

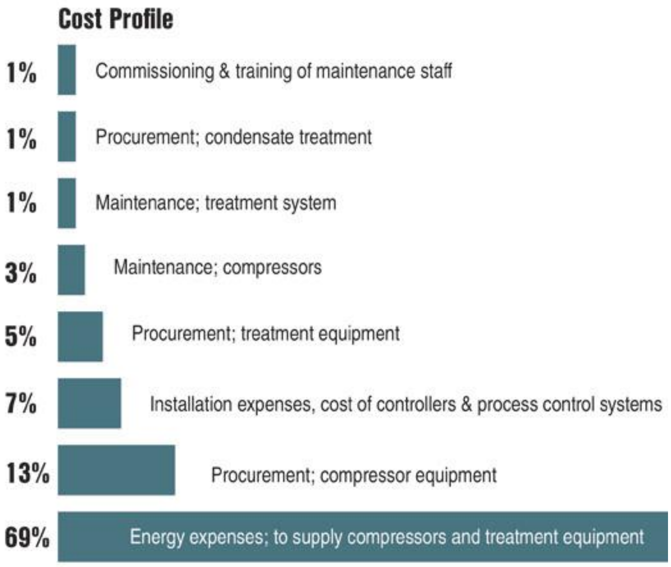

Image 1; Cost profile for an optimised compressed air supply produced by a new station with air-cooled compressors.

Image 2; The air demand can be precisely calculated and evaluated using modern measuring devices such as the ADA data loggers from KAESER (for analysing compressed air duty cycles).

Energy efficiency considerations therefore play a central role in system planning, which always begins with a thorough analysis of the current air demand situation – for both new systems as well as renovations of existing ones. The audit can be carried out either by an external expert or the operator can take on the task internally. Leading providers in the compressed air sector additionally offer services in which an expert examines the system in detail using modern measurement and planning technology, then makes optimisation recommendations.

To facilitate the planning of new compressed air stations, the future operator is given a specialised planning questionnaire. This makes it possible to calculate the expected compressed air demand and the equipment necessary to achieve it – with the help of an experienced compressed air consultant. The questions cover all the key aspects to ensure a cost-effective and environmentally friendly compressed air supply.

In contrast to new projects, expansion proposals offer sufficient existing points of reference for determining a layout in accordance with demand. The expert shares measurement methods and tools with the user that make it possible to precisely determine the air demand in relevant parts of the company at various times. In this regard, it's important to determine not just average values, but maximum and minimal values as well.

It's also recommended with existing stations to occasionally determine – using computer-assisted analysis systems – whether the load on the compressors is (still) appropriate, whether the customer's air demand has changed or whether the leakage rate remains within tolerances.

Analysis programs should also be employed whenever old compressors are replaced with new ones. This offers the opportunity to replace potentially incorrect performance values with correct ones, improve compressor operating performance (especially in the partial-load range) and to plan for an optimised master controller. An expert should also be consulted whenever usage conditions change. After all, in many cases significant cost savings can be achieved simply by adapting the treatment equipment or pressures in the system.

To measure pressure and air consumption, the operation of the compressed air station and of the entire system is analysed for a period of at least 10 days using modern data logger technology (Image 2).

The data logger collects the relevant measured values and transfers them to a computer, which generates a detailed consumption diagram.

This includes, pressure drops, pressure and consumption fluctuations, idling behaviour, load and compressor standstill times as well as each individual compressor's contribution in supplying the compressed air consumed. To complete the picture, leaks are also determined during measuring. This requires specifically blocking off certain parts of the distribution network during the weekend; leaks will be covered in more detail further on.

To optimise a station, the technical data of the installed compressors and potential new variants are entered into the computer. A specialised program then calculates the optimal configuration and cost saving potential. This analysis goes beyond determining energy consumption at intervals at a certain compressed air demand: rather, it's possible to obtain a precise picture of the specific power performance of the compressor station during its entire run time. This means weak points in the partial-load range are identified and remedied well in advance. The overall result is a clear statement of the achievable cost savings and amortisation details.

Performing analysis independently

Operators who wish to plan their own compressed air supply are advised to begin the analysis at the end of the system, i.e. with the consumers, and work backwards step by step to the compressed air production itself.

The first aspect to consider is the compressed air quality and how this will be achieved. Naturally, the compressed air quality levels required at the consumers depend first and foremost on the needs of the individual company; the relevant requirements and classifications are defined in ISO 8573. VDMA Guideline 15930-2 provides purity class recommendations by application type and was specially developed for the pharmaceutical industry.

The decisive factors are determining the quality required at the consumer, deciding how this is to be achieved and identifying potential weak points.

In some cases, especially for companies that have grown organically over time, unnecessary treatment may be taking place. For example, this applies when a user has recently installed a treatment system for the sole purpose of removing contaminants that have entered the compressed air due to soiled compressed air networks or unsuitable pipeline materials – although the central compressed air station is capable of delivering the required compressed air quality. Additional treatment means constant additional pressure loss, extra energy costs and higher maintenance costs.

In a case such as this, renovation of the compressed air network can be a sensible investment, especially if the consumers also require several different pressures and the company's distribution infrastructure is ineffective. For example, if 80 percent of the consumers function at 6 bar and only 20 percent at 10 bar, the entire network would have to be operated at 10 bar – although this is completely unnecessary. Every additional bar of pressure in the system increases energy costs by around 7 percent without any additional benefit. The greater the potential for reducing system pressure, the greater the potential savings. Moreover, this measure also reduces pressure drop and leakage losses. It may therefore make sense to install two separate networks.

Pipes: material, connection, joining

The pipelines themselves are the next system component upstream of the consumers. The important criteria here are: manner of laying the pipe, material, manner of compressed air distribution throughout the company and the method for joining the pipes to one another and to the components.

The pipeline system should be laid in as many straight lines as possible to save energy. Bends, such as those around support pillars, can be avoided by laying the pipeline in a straight line next to the obstacle. Sharp ninety-degree corners cause major pressure loss and can be easily replaced with generously dimensioned 90-degree arcs. Instead of the commonly used water shutoff units, ball valves or flap valves with full – not reduced – diameter should be used.

In the portion of pipeline upstream of dryer (wet), which in a modern compressed air station means just in the compressor room, the inflows and outflows of the main line should be laid upwards or at least laterally. The main pipeline should have a gradient of 0.2% and a means of condensate separation should be provided at the lowest point of this line. On the other hand, the lines can be laid horizontally and the pipeline outflows can lead directly downward in the dry portion of pipeline downstream of drying.

Image 3; The pipeline system should be laid in as many straight lines as possible to save energy.

Since the pharmaceutical industry generally has very stringent compressed air quality requirements, pipeline material should be selected with a view to avoiding contamination.

The correct joining technique is also very important. Pipeline parts should either be connected to one another by welds, adhesive or using a combination of screws and adhesive. Crimped connections can also be a solution. Although the ability to disconnect the parts suffers, one can be sure that such joints will reduce potential leaks to a minimum. Hemp-sealed line systems present an especially elevated risk of leaks since the hemp paste dries out over time, compromising the tightness of the pipe joints. This problem is exacerbated where very dry compressed air is required. Hemp-sealed line systems should therefore be successively replaced.

Leaks

Leaks in the system are the most active causes of energy waste in a company since they're at work around the clock, 8760 hours per year; unsurprisingly, they therefore represent the most significant source of loss in the majority of systems. Studies demonstrate that between 25 and 60 percent of the compressed air produced is lost due to leaks, and leaks occur regularly even in carefully maintained systems. Paying extra attention to building a tight, leak-free system is therefore always good advice (Image 4).

But what is an acceptable range? A leak value of around 5 percent of total volume is now regarded as the maximum level within tolerance; in contrast, values of 10 percent or more absolutely require action. Leaks in the system cause compressor run times and operational costs for energy to rise whilst increasing the frequency of maintenance intervals.

In a compressed air system with a complex pipeline system, it's recommended to determine the leak value before attempting to locate the leaks.

Hole diameter corresponding size	Air consumption at 6 bar(g) m^3/min	Loss	
		kW	$/year*
● 1 mm	0,065	0,39	512,-
● 2 mm	0,257	1,54	2.026,-
● 4 mm	1,03	6,18	8.120,-
● 6 mm	2,31	13,86	18.202,-

*Electricity price 15 cents per kW/h

Image 4; The real cost of compressed air leaks.

A simple method is available: first all compressed air consumers are switched off and the compressor switch-on times are measured over a defined period. The leak rate can then be calculated based on this measurement using the following formula:

$$VL = \frac{VK \times \sum t_x}{T}$$

Legend:
VL = leak rate (m^3/min)
VK = flow rate of the compressor (m^3/min)
$\sum t_x$ = t1 + t2 + t3 + t4 + t5

Time during which the compressor was running under load (mins.) T = total time (mins.)

It can also be checked during compressor operation.

It's advisable to locate leaks when the compressor is running but there is no air demand (e.g. on the weekend) or if it runs outside of production hours for more than 10 percent of the time.

The simplest method of locating leaks is to use an ultrasound measurement device (Image 5) since the location of leaks can then be pinpointed during production hours. Such a device can be rented from all leading providers in the compressed air sector, if an expert is not specifically engaged to perform this task. Problems can also result from pipes with excessively small dimensions since this can lead to high pressures, which translates into high energy losses.

There should be a maximum of 1 bar pressure loss between the consumers and production.

Treatment and compressors

Once the focus has shifted to the compressed air station itself, the compressed air treatment becomes the first area to consider. Key criteria include the layout of compressed

Image 5; Leaks should be measured regularly. Pictured above an Ultra Sonic Leak Detector (USLD).

air dryers as well as the state of their technology. Older models such as hot gas bypass dryers necessarily run continuously and are unable to switch to a standby mode when not needed. Conversely, modern energy-saving dryers can – which means they consume significantly less energy. Moreover, the layout of the dryers may no longer reflect actual conditions if the ambient temperatures or conditions have changed, for example.

When it comes to compressors, basically every type of compressor is capable of producing the quality levels required in the pharmaceutical industry. Whether the compression process is oil-free or oil-injected makes no difference since compressed air is nothing other than the ambient air in compressed form – and ambient air always contains contaminants. This means treatment is always necessary to meet the high requirements of the pharmaceutical industry.

The interplay between the compressors can, however, have a definite effect on energy consumption if it is inefficient, such as when the settings no longer match the current demand profile.

Do the compressors frequently switch back and forth between load and idle operation? Is the variable-speed compressor consistently operating in the upper or lower flow rate range? These are indicators that the existing compressed

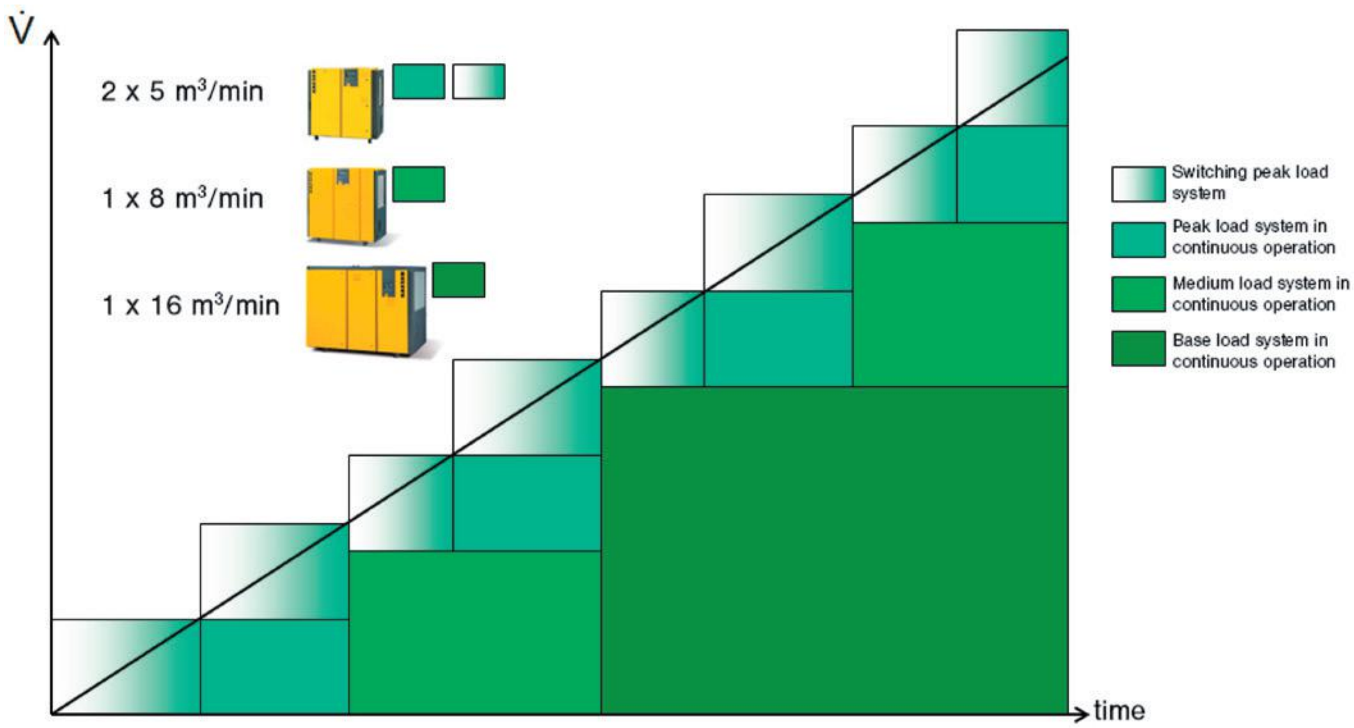

Image 6; For truly efficient compressor operation, a combination of base load and peak load machines is essential.

air system does not match the consumption profile and/or the interplay between the compressors (usage sequence) is not configured optimally. In systems with up to two compressors, correct controller settings can usually be configured by an experienced system mechanic. For larger systems with three or more compressors, it's advisable to also consult an experienced technical expert.

In most cases, a precisely coordinated configuration of compressors with different capacities turns out to be the ideal solution. This usually consists of large base load and standby machines, combined with smaller peak load machines (Image 6). The master controller is responsible for coordinating production of the required compressed air with maximum cost efficiency.

To do so, it must have the capability of switching automatically between the most favourable combination of base load and peak load compressors at any given time – within a pressure fluctuation range of only 0.2 bar for up to 16 compressors. Intelligent control systems can perform this highly challenging feat using a bus system to exchange data with compressors and other components, such as condensate drains, dryers, etc. These can then be connected to a central process control system to which all operating data are forwarded where they can be used for advanced energy management, for example.

Conclusion

Measuring points and management

Without follow up, even the best renovation and optimisation of a system will fail to yield benefits, since the conditions of the consumers will also change in the future. This is why it's important to plan in measurement points for constant monitoring of the compressed air supply as part of optimisation measures as well as new systems.

'Modern master compressed air management systems enable analysis and recommendations to ensure constant optimisation'

Modern master compressed air management systems not only enable real-time monitoring, but also enable analysis and recommendations to ensure constant optimisation.

If all of these steps are followed, the compressed air supply will not just be efficient, cost-effective and reliable – it will also be compatible with future developments.

To read more on this topic access using the QR Code

Active Power Factor Correction (APFC) for Hospitals

A RELIABLE POWER SOLUTION

Sahil Vellani

EBM-PAPST

Hospitals demand an exceptionally reliable and high-quality power supply to ensure the continuous operation of life-saving equipment and critical services. Active Power Factor Correction (APFC) is a technology that significantly enhances the reliability and efficiency of a hospital's electrical infrastructure.

What is Active Power Factor Correction (APFC)?

APFC is a technique used to improve the power factor of electrical systems, by correcting the current phase shift and power distortion caused by non-linear electrical load. Figure 1 indicates current waveform without PFC and corrected waveform with Active PFC.

Power factor is a measure of how effectively electrical power is being used. It is the ratio of "active power" to "apparent power" and is ideally 1. A low power factor means that power system components including generators, distribution panels, energy meters, power wiring etc. do not only have to cater for active power that can be used by loads like fans, but also for reactive power. Such reactive power oscillates between power source and power consumer, causing disruption and compromising reliability of the electrical infrastructure.

Therefore, by improving the power factor of an electrical system, power distortion and harmonics are significantly reduced, reducing capital costs for power generation and improving power reliability for the hospital.

Why is APFC Important for Hospitals?

- Sensitive Equipment: Modern hospitals rely on advanced medical equipment (MRI, CT scanners, life support systems) that are highly susceptible to power disturbances like voltage sags, swells, and harmonic distortion. These disturbances can cause capital equipment malfunction, data corruption, and inaccurate diagnostic results.
- Uninterruptible Operation: Power outages are unacceptable in hospitals, as they can endanger patient lives. APFC helps ensure the seamless operation of Uninterruptible Power Supplies (UPS) and backup generators by reducing stress on these systems.
- Power Quality Standards: Hospitals must meet stringent power quality standards to ensure the safe and reliable operation of medical equipment.

Benefits of APFC in Hospitals:

- Increased Reliability: APFC reduces harmonic distortion and voltage fluctuations, protecting sensitive equipment from damage and it helps maintain the stability of the electrical system, minimizing the risk of equipment failures and downtime.
- Lower Embodied Carbon Footprint: By improving the power factor, power system components no longer have to be oversized to cater for not only active power but also the oscillating reactive power. This leads to reduced investment cost and lower embodied carbon footprint.
- Extended Equipment Lifespan: Reducing stress on electrical components through APFC can extend the lifespan of equipment, minimizing maintenance costs and reducing the need for premature replacements.
- Optimized UPS and Generator Performance: APFC reduces the load on UPS systems and backup generators, allowing them to

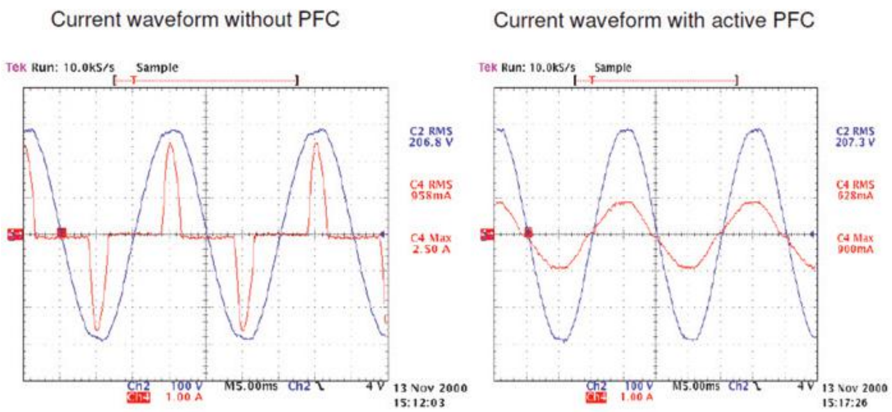

Figure 1. Current Waveform, comparing without PFC and with Active PFC

operate more efficiently and reliably. It also reduces the need to oversize these backup power systems, saving capital costs.

Active vs. Passive PFC

Power factor correction can be done with passive components (passive PFC) and active components (active PFC). While passive PFC can improve power factor to some degree it is still quite limited. Active PFC on the other hand offers superior performance. ebm-papst active PFC products achieve a power factor close to 1 and THD(i) values <5% on loads over 10%. This results in reduced power distortion by harmonics, reduced embodied carbon footprint, and improved voltage stability, making it the preferred choice for demanding applications slike hospitals.

Conclusion

Active Power Factor Correction is a crucial technology for ensuring the reliability and efficiency of hospital electrical systems. By mitigating power disturbances, optimizing UPS and generator performance, and reducing carbon footprint, APFC helps hospitals deliver reliable, uninterrupted, high-quality patient care. Investing in APFC is an investment in the safety, reliability, and sustainability of the hospital's critical infrastructure.

Hospitals Deserve Better—And So Do We

Australia's hospitals are under immense pressure to deliver quality care amid rising costs, staffing challenges, and evolving patient needs. In this environment, the systems that support clinical operations—from climate control to energy management—must be as reliable and intelligent as the people who use them.

Unfortunately, many healthcare facilities still rely on outdated infrastructure that slows progress, complicates maintenance, and increases risk. It doesn't have to be this way.

Smart, integrated Building and Energy Management Systems (BMS/EMS) are transforming the way hospitals operate. These platforms do more than monitor—they empower. With real-time data, hospital staff can ensure optimal air quality, temperature control, and energy use without compromising patient care or safety. And when everything works in harmony, the impact is profound: smoother operations, better outcomes, and healthier work environments.

At a time when every second counts and every resource matters, hospitals deserve systems that are proactive, not reactive. Systems that safeguard patient wellbeing, reduce energy waste, and give staff the tools they need to excel.

As the country's largest independent provider of BMS and EMS under full Australian ownership, we are proud to support hospitals across the nation in building safer, smarter, more resilient environments.

Because great healthcare doesn't start at the bedside—it starts with the infrastructure that makes care possible.

Scan to learn more

Breathe Easier in Healthcare with Opira and Air Restore's UV Air Disinfection Solutions

In healthcare settings, where air quality directly impacts patient outcomes, infection control, and staff wellbeing, **Opira** and its sister company, **Air Restore**, are leading the way with advanced air purification solutions. The latest innovation? Air Restore now spearheads the installation of **Sanuvox UV air disinfection systems**, setting a new benchmark for cleaner, safer healthcare environments.

Sanuvox is a trusted name in **UV-C technology**, offering a proven method for neutralising airborne pathogens—including viruses, bacteria, and mould spores—without the use of harsh chemicals. This makes it an ideal solution for hospitals, clinics, and aged care facilities where infection control, patient safety, and environmental responsibility are paramount.

With decades of experience in **HVAC hygiene** and i**ndoor environmental risk management**, the Air Restore team ensures each system is installed with precision and tailored to the specific needs of healthcare facilities. From operating theatres to waiting rooms, every installation is designed to support the highest standards of air quality, compliance, and performance.

This collaboration between Opira and Air Restore ensures **seamless project delivery**, **ongoing support**, and **robust quality control**, helping healthcare providers maintain a consistently healthy indoor environment.

While not mandated, Sanuvox systems offer a proactive and strategic approach to infection prevention—supporting safer spaces for patients, staff, and visitors alike.

Take the next step toward a healthier facility. Call Opira on 1300 157 969 to schedule a consultation and discover how UV air disinfection can elevate your infection control strategy.