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IHEA
Institute of Healthcare Engineering, Australia

HEALTHCARE FACILITIES

FEATURED INSIDE

MASTER SYSTEM INTEGRATION IN HEALTHCARE

ILLUMINATING THE PATH TO SUSTAINABILITY

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Cover: Delegates from the 2024 IHEA National Conference – Marvel Stadium, Melbourne.

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

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EDITOR'S MESSAGE

The Winter edition of Healthcare Facilities is a celebration of the IHEA National Conference held at Marvel Stadium in Melbourne in early June. This event was superbly organized and anybody who attended would most certainly have benefited from the shared wisdom and experience from members and stakeholders. The contribution of our industry partners and their willingness to share and educate was outstanding and we thank all of them.

The 2024 Best Conference Paper was awarded to Michael Goodman of Clevertronics, and it is available to read in this edition of Healthcare Facilities. We also thank Clevertronics for the site visit they facilitated, allowing delegates to see their world-class manufacturing facilities.

We also feature the paper presented by Octo Moniz, long-time IHEA WA Branch member. It was fantastic to have a presentation from a hands-on healthcare facilities IHEA member, and Octo has been involved at Royal Perth Hospital in Emergency Management for many years and was well able to share his experience with delegates.

I'm sure you will agree with me as you digest this edition, that the quality of the technical content largely from the national conference, has reached new heights, and we thank everybody for their contributions.

We especially thank the contributors from each of the branches who have shared their activities with you and provide ideas for other branches to replicate with technical PDs and networking events.

It was fantastic to have Kevin Miller with us from New Zealand representing NZIHE and presenting on behalf of Aurecon on alternative standy-by fuel solutions, and we will feature his paper in a coming edition. We value the connection with our colleagues across the Tasman and look forward to keeping the connections alive through our newsletters and journals.

Finally, at the Annual General Meeting of members a vote was taken to support the distribution of material from the International Federation of Healthcare Engineering (IFHE) to IHEA members via email. The newsletters from IFHE provide an assortment of relevant and interesting articles from the global network we share with 35 other countries through the Federation, and we encourage you to keep an eye out for coming IFHE newsletters and connect with and respond to the initiatives that IFHE often promotes.

Regards
Darryl Pitcher – Editor

NATIONAL PRESIDENT'S MESSAGE

At the recent IHEA Conference in Melbourne I humbly received the National President's baton from Darryl Pitcher, IHEA's highly-regarded, and now immediate past president.

It was a cause for reflection on IHEA's achievements for its members since inception, under the competent leadership of many that have come before. Those hands have directed the ship through its best years and carefully navigated some of its more challenging, most recently through the COVID era. The Institute has continued to evolve into the organisation it is today, being well respected both nationally and on the world stage through connection with the International Federation of Healthcare Engineering (IFHE) and, by extension, organisations like the UN's World Health Organisation (WHO).

In my forthcoming term, the board will continue to strive to deliver greater value to our membership in the shape of targeted professional development and networking events. We will explore further opportunities to connect with our local, national and international communities through partnership with other established benevolent organisations. I applaud the recent contributions of the NSW Charity Golf Day to Backpack Bed, a national homeless charity. IHEA is also proud to be supporting Monash University's study Transitions to Sustainable Health Systems. And on the global stage, IFHE has invited IHEA members to join a working group as external reviewer of a WHO Guide to Climate Resilient, Low Carbon Healthcare Facilities – please consider whether you can contribute to this important initiative. In October I will continue to foster these connections at the global IFHE Conference in South Africa.

My thanks to the organising committee, event managers, sponsors, exhibitors and attendees for all your contributions to a very successful 2024 IHEA Conference. National conferences are important vehicles for networking, collaboration and information exchange and we look forward to the 2025 Conference in Sydney – keep a look out in the coming months for further information through the usual channels.

There has been no better time for you to share the wealth of information you hold as experts in your field – for the betterment of other healthcare facilities, both in Australia and the world.

Michael Scerri,
National President

IHEA National Conference

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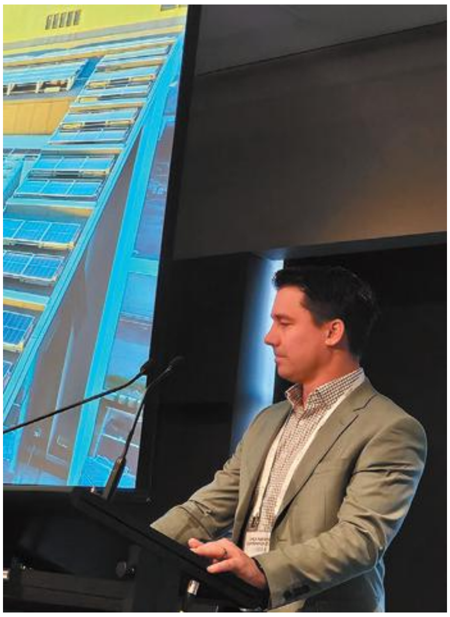

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- Front access for maintenance
- Power consumption at just 0.33 kWh per cycle

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QUEENSLAND BRANCH REPORT

I hope everyone is enjoying the cooler weather. It is a busy time of year for many due to all the planning and negotiations for the start of a new financial year - hopefully this process has been as pain-free as possible. Limited funds, resources and time often finds us juggling immediate infrastructure needs with the requirement to optimally sustain our assets (or those of our clients) throughout the full lifecycle. Tweaking this successfully can be a challenge and often is made more complicated by the nature and design of the facilities we manage – smart design can make a big difference and future proof our facilities.

New Members

I would like to welcome all members from Queensland that have joined recently. We look forward to catching up with you at upcoming events and sharing your insight and journey through healthcare engineering.

Afternoon Professional Development Seminars

A PD seminar has not been held since the last edition of the Journal – as the Queensland Committee has been primarily focused on planning for the mid-year conference. After the conference though, planning will start in earnest for a combined PD and Christmas breakup to be held most likely in late November. Please keep an eye out for information that will be forthcoming via emails and will be published on the IHEA website.

Mid-year Conference – Thursday, 18 July

As this journal goes to print, I am hoping to catch with as many of you as possible at the Queensland mid-year conference and tradeshow on 18 July 2024 at the Brisbane Convention and Exhibition Centre. The theme of *"Smart by Design: Pioneering Solutions for Future-Proof Infrastructure"* has generated a lot of interest and the event is being well support by both delegates and sponsors. Special thank you to COM members and sponsors for making this event possible.

National Conference 2024

The Queensland contingent was a lot quieter this year at the National Conference held in Melbourne in early June – a few less by numbers but definitely quieter in terms of volume at the conference dinner! The national conference was a huge success – congratulations to the team who brought it all together. The event underlined for me the nuggets of information and ideas that can be taken away from either a presentation, exhibition, site visit or catching up with colleagues. These nuggets can have a big impact when implemented.

Committee of Management

I am always greatly appreciative of the Queensland team with their assistance in running our local events and the many hours they give up, to make them happen. After the Annual Special Meeting at the mid-year conference, we will be able to confirm the make-up of the committee for 2024-25 but I can confirm though that Adrian Duff has stepped down as the representative on the National Board. Adrian is still planning to be on the committee, but I would like to thank him for his contribution that he has made in his different roles over the years.

President	Danny Tincknell
Vice President	Michael Campbell
Treasurer	Michael Ward
Secretary	Josiah Padgett
Qld National Board Representative	Adrian Duff
Committee member	Christopher Aynsley-Hartwell
Committee member	Matt Smith
Committee member	Arthur Melnitsenko
Committee member	Mark Fasiolo
Committee member	Mark Collen
Committee member	Nic Coffey
Committee member	Liam Duller

If you would like to communicate with the QLD Branch via email, please do so at ihea.qld@ihea.org.au .

Looking forward to catching up with everyone at the midyear conference.

Danny Tincknell
President, QLD Committee of Management

NSW/ACT BRANCH NEWS

Hello everyone from the NSW/ACT Branch and welcome to another edition of Healthcare Facilities.

I would like to congratulate the Vic/Tas Branch for hosting a great National Conference at which I had a great time catching up with other delegates and sponsors. I would also like to congratulate Michael Goodman from Clevertronics for the best paper at the National Conference and thank you Michael for the tour of your factory as part of the tech tours. Very enlightening.

The NSW/ACT Branch will be hosting the National Conference in Sydney, starting on the 26th of May 2025, at the Masonic Convention Centre. There will be plenty of options for hotels which are easy to get to by various transport options so open up your calendars and book this in. If you're flying in, a short 12-minute train trip and a short walk will get you easily to the venue.

Darling Harbour, China Town, the Sydney Opera house, Theatres, The Harbour and everything else that Sydney has to offer are all easily accessible by light rail so make it an unforgettable trip, making sure to bring your partners to enjoy this great city.

NSW/ACT Branch Meeting

The NSW/ACT Special Branch Meeting will be held via Teams, on the 6th of August 2024 at 12 pm, and invitations will be sent out shortly so keep an eye out for the email.

If anyone is interested to join an excellent working group in the Committee of Management, please put your hand up and we welcome your involvement keeping the branch activities happening. There is not too much work involved and we can make a difference in building up our branch, having bigger and more informative events plus having a bit of fun on the way.

I would like to thank Rick Dyer, Vice President and Jackie MacCullagh Secretary, NSW/ACT Branch for organising our first golf charity day at Ryde Parramatta Golf club on the 9th of May 2024. The rains held back as we all started in the water-soaked track and chased that little white ball. There were a couple of exceptional players and there were the likes of myself who desperately need some improvement, but we can start practicing for next year's event.

We raised enough funds to purchase 10 Backpacks for homeless. These Backpacks include a fire-retardant sleeping bag and provide much needed comfort and protection for homeless people in need. You can see what we donated if you check out this link www.backpackbed.org A certificate of appreciation has been received from the charity providing this and we thank the IHEA team for their support.

I would like to thank our sponsors for the event and for each of the holes. It was a great catch up for IHEA colleagues, an excellent social event, supporting a worthy cause and we are looking forward to next year's event.

We are getting lots of positive feedback from those involved in last year's PD Day and Sydney Harbour boat cruise and recommendations that we should be doing it again so I and the team will be looking into this and will be advising you soon.

Finally, I would like to thank and congratulate Darryl Pitcher, our outgoing National President who held the reins of the IHEA over the years. I commend him for his active service for making this organisation run and it would not be where it is now without his leadership and behind the scenes work.

Thank you, Darryl, and lets welcome Michael Scerri as the new National President.

Best regards
Cameron Ivers
NSW/ACT Branch President


A recent gathering of NSW-ACT members at a PD event

Higgins
Better painting management

VIC/TAS BRANCH NEWS

The Victoria / Tasmania Branch had a busy quarter, with the highlight being the successful hosting of the National Conference for 2024! The event was packed with engaging content and memorable experiences for attendees.

Here's a summary of the key highlights:

1. **Technical Tours:** Participants had the opportunity to visit several notable locations, including the Clevertronics Factory, Marvel Stadium, the New Footscray Hospital, Swinburne University's Factory of the Future, and the Victorian Comprehensive Cancer Centre. These tours provided valuable insights into cutting-edge technologies and facilities and were really appreciated by the attending delegates.
2. **Conference Presentations:** The three days of presentations featured a diverse range of topics, keeping attendees engaged and informed. Highlights included keynote speeches by James Hird and Yasmin Grigaliunas, known for their insights and expertise in their respective fields.
3. **MC Mike Larkins:** Mike Larkins played a crucial role as the Master of Ceremonies, ensuring the conference ran smoothly and on schedule. His weather updates, sharp wit and occasional "Dad-joke" added a personal touch to the proceedings, keeping everyone informed, engaged and a little light hearted.
4. **Logistics Management:** The Icebergs team, led by Katie and Mikhaela, local content by the organising committee of Steve Ball, John Mihalinac, Julien Colangelo & me, handling the logistics seamlessly, ensuring that everything from planning to execution was well-managed. A special thanks to everybody involved.
5. **Looking Ahead:** The conference attendees are already anticipating the next National Conference in New South Wales in May 2025.

The conference not only met but exceeded expectations in organizing a successful and impactful conference. The combination of insightful content, well-executed logistics, and engaging presentations contributed to making the event a memorable experience for all involved.

BRUCE GILPIN – 50 YEAR MEMBER

The Victoria / Tasmania Branch would like to recognise and celebrate Bruce Gilpin's remarkable 50-year journey as a member of IHEA, a testament to his dedication and expertise. Bruce began his career at Australian Paper Mills in Fairfield at just 17 years old, later transitioning to their research labs until 1972.

He then took on the role of Chief Engineer at Mordialloc Hospital, followed by Frankston Hospital in 1974, where he not only pioneered Victoria's first ice storage system and natural gas engine chiller for healthcare but also found his life partner, Shirley.


Bruce & Shirley Gilpin

After an impressive 29 years at Frankston Hospital, Bruce briefly retired in 2001, only to be quickly recruited to Royal Melbourne Hospital as a project manager. His notable projects there include overseeing the installation of emergency diesel generators affectionately named "Bruce & Shirl" and designing the Infectious Diseases Ward, featuring Victoria's first Viral Haemorrhagic Fever (VHF or Ebola) suite.

Even after 22+ years at Royal Melbourne Hospital, Bruce continues to contribute his expertise one day a week. His involvement with IHEA has been equally impactful, serving in various capacities including on the then-National Council and as Secretary of the Victoria/Tasmania branch. He was recognized as State Branch Engineer of the Year in 2012 and awarded Best Paper at a national conference.

Bruce's service was recognized at the recent National Conference at Marvel Stadium in June, and it was a pleasure to have Bruce and Shirley there to celebrate and amazing milestone with IHEA. Special thanks to Shirley for her continued support of Bruce through all his working and volunteer input to healthcare and IHEA,

At fifty years of service Bruce is in good company, with the following members also celebrating more than 40 years of membership in IHEA.

Bill Trost, Queensland, joined 1961 has been a member for 63 years

William Reed, West Australia, 1968, for 56 years

James (Jim) Meldrum, New South Wales, 1973 for 51 years

Sergio Adofaci, Victoria, 1973, for 51 years

Bill Geerlings, Victoria, 1975, for 49 years

Roy Aitken, West Australia, 1976, for 49 years

George Fricker, Queensland, 1978, for 45 years

Frank Woods, West Australia, 1978 for 46 years

Glenn Cottee, Victoria, 1979 for 45 years

Stephen Chia, West Australia, 1979, for 45 years

Don Little, New South Wales, 1982, for 42 years

The Victoria/Tasmania Branch extends heartfelt congratulations to Bruce (and Shirley) on his incredible 50-year milestone with IHEA.

Michael McCambridge
Vic/Tas State Branch President

WA BRANCH NEWS

On 23 April 2024 the WA branch held a professional development session on the topic of *"Waste Organics and Safety Initiatives at FSH"* held at Fiona Stanley Hospital in Murdoch. The event included a presentation and later site tour by the FSH Waste Team Leader, Jeremy Thwaites.

Jeremy's presentation showcased an amazing sustainability achievement of the FSH Waste Organics diversion program. At the time of presentation over 90% of organics were diverted from waste disposal (landfill) to an external processing facility capable of separating organics from non-organics, creating a compost product which FSH intends to return to the Hospital gardens in the future. The presentation included descriptions of the many bin movements and QR code scanning system that tracks performance of each area of the Hospital.

We also learned about the practical innovative engineering solution for multi-bin movements to reduce injury risk and improve efficiency developed and deployed by the Waste Management team, via a bespoke multi-bin lifter trolley system fabricated and deployed at the Hospital. The multi-bin lifter can move 4 large 240 litre bins without lifting, and also handles 120 litre bins. The innovation is both a safety improvement and an efficiency improvement, allowing staff to collect and manage more bins with less movements. A video is available for this innovation at the following URL: https://www.youtube.com/watch?v=JFZ60b34PFs

The site tour allowed a behind-the-scenes peak at the Waste Team facilities, considered by the team to be the "other beating heart" of every Hospital. We saw the bin storeroom, as well as the automated bin washer facility, and QR code scanning station that weighs and records waste by area/location from which it was collected. All of these technologies and innovations are assisting towards a more sustainable future where we both reduce waste, and divert waste from landfill.

Many thanks to Jeremy and his manager Gerard Green who assisted with some explanations of the contractual arrangements requiring negotiation to achieve the Waste Organics Diversion program. IHEA WA thank sponsor Serco at FSH for the light refreshments following the presentation, and for the Serco team members Jeremy and Gerard's awesome presentation and tour. Jeremy has since gone on to receive Awards for this program's performance and given this inspirational presentation to other teams and interested groups.

On 23 May the WA branch held a professional development session on the topic of *"Cyanosis Lighting in Hospitals"* held at the offices of NDY in Perth and hosted online via MS-Teams. The event included a panel discussion moderated by our host Alex Roger (NDY), bringing together members in Healthcare lighting supply chain, engineering design consultancy, architectural practice, facility management and also a clinical perspective. The topic was approached from these diverse perspectives seeking responses to the question *"Do we still need cyanosis lighting?"*

The panel members who generously participated in this discussion included:

- Grant Sheppard – Principal, Stantec (Electrical Engineering Consultant)
- Ian Johnson – Director, Eagle Lighting (Melbourne)
- Dr Jean Du Plessis - Consultant Neonatologist (FSH & SJOG Murdoch)
- Stephen Barrett – Associate Director, NDY

What transpired was one of the most informative and balanced discussions on any subject in recent history at an IHEA WA branch meeting. We first journeyed about 50 years back in time to understand the origins of the requirement for cyanosis observation lighting, being a particular Australian criteria adopted following an altruistic study by a lawyer whose family was impacted by poor cyanosis diagnosis due to the lighting standards at the time.

The criteria has propagated through various subsequent revisions to the WA Healthcare guidance. We then explored the engineering codification of the technical rules surrounding cyanosis observation compliance, learning about the importance of lighting colour and averaging of intensity across light frequencies. This was well complemented by the history of lighting technologies up to modern LED lights of today, showing the versatility and greater control and quality of lighting able to be delivered.

Serco at Fiona Stanley Hospital - Multi Bin Mover from Innovation Video

The fluorescent lighting tube ban in the EU heralds the beginning of the end for fluorescent tube spares availability in Australia, and the need to transition to LED for legacy fluorescent systems.

[far left] IHEA WA President Jana Simpson. [left of screen] Moderator Alex Roger. [Right of screen] Panel members Ian Johnson, Stephen Barrett, Grant Sheppard.

[left of screen] Moderator Alex Roger. [Right of screen] Panel members Ian Johnson, Stephen Barrett, Grant Sheppard.

Captivated audience in spite of delicious refreshments!

The perspective of clinical practice highlighted the ease of simple, modern, cost-effective blood oxygen saturation monitoring equipment (just slip it on a finger) as the routine clinical front-line tool, in the clinical identification of cyanosis. Improved blood gas analysis is also now available as a precise confirmation tool of cyanosis. The clinical plea was more about "just keep the lights on please" rather than concerns around light quality required to underwrite a purely visual identification of cyanosis subject to the inherent challenges associated with human perception alone.

Audience participation was encouraged by our moderator, who teased out some of the fine nuances and challenged apparent conclusions across these available perspectives. The panel showed fine composure and a very deep knowledge and expertise to withstand such cross-examination - all done in good humour. By being drawn into providing further context and more rationale to support their advice, all audience members gained a much deeper understanding of the topic.

IHEA WA was pleased to invite Licensing and Regulatory Unit (LARU) members Karen Ziegler, Carol Austin, and Julie Preston who all attended, and we trust they took lots of notes to consider within their imminent revision to the Western Australian Health Facility Guidelines. IHEA WA plans to workshop these draft guidelines with interested members once released, aiming to provide a consolidated response of consensus feedback on behalf of the IHEA WA branch.

When the event concluded all agreed it had been enlightening and fun, with many members staying to enjoy light refreshments and network and chat with panel members and their colleagues. The IHEA again thanks our talented moderator and host Alex Roger at NDY, who has confirmed he will make the event video recording available to IHEA members in the very near future.

The WA Branch intends to schedule the Annual Special Meeting on 22 August 2024 from 5:00pm at Royal Perth Hospital (booking confirmation pending) and encourage all members to nominate for the new Committee of Management when nomination forms are distributed.

We are also looking forward to our WA State Conference on 6 September 2024 at Frasers Suites in Perth (same as last year). State conference papers and sponsors are welcome to approach ihea.wa@ihea.org.au to abstracts and/or expressions of sponsorship interest.

The IHEA WA branch members offer their condolences to Fred Foley and his family, on the sudden passing of his son Jesse on Thursday 21 March 2024. Fred has stepped back from the IHEA executive roles but remains in our thoughts at this difficult time. We also thank Alex Foster who has stepped in and accepted the interim role of IHEA WA Vice President.

Kind Regards
Andrew Waugh
WA Branch Secretary

HEPA Filters: What you need to know.

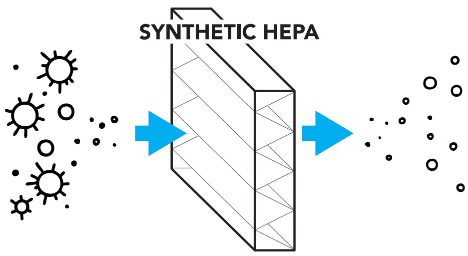
At its most basic level, an air purifier is only going to perform as well as the filters inside. When you are dealing with filtering viruses from the air, you need to select an air purifier with a medical-grade HEPA filter. Medical-grade refers to top-tier H13 or H14 efficiency-rated filters that will capture a minimum of 99.95-99.99% of particles @ 0.3 microns (PM 0.3) or larger. These are the same filters relied upon in infection control isolation rooms and operating theatres.

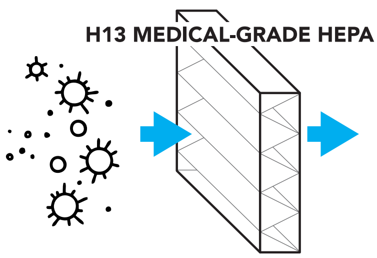
HEPA Filter Types

HEPA air purifiers commonly use either a synthetic pleated HEPA type filter or medical-grade, EN1822-rated HEPA paper.

HEPA 'type', commonly synthetic filters are made from polypropylene media with an electrostatic charge, the charge improves filter efficiency so the filter media will let through fewer particles. Synthetic filter media is used for 2 reasons; it's lower cost to manufacture and it creates less pressure drop, so the fan in the air purifier can be smaller.

The electrostatic charge on the filter media essentially magnetises the filter material to hold and capture more dust and particles, however, the caveat is the charge dissipates over time and causes the efficiency to reduce. In tests performed on synthetic filters we have seen a reduction from 99.95%, down to less than 75% during six months of use.





Synthetic filters usually cannot be certified as some ultrafine particles will penetrate the filter and therefore fail the stringent EN1822 efficiency tests. By contrast, HEPA paper, also known as glass paper, maintains the same very high efficiency for the life of the filter.

Key Points

The majority of air purifiers are not medical-grade filters (H13/H14 efficiency) and contain synthetic filters with lower E11 - E12 efficiencies.

Buyer Beware: synthetic HEPA-type filters using materials like polypropylene do not maintain the stated efficiency for the life of the filter, HEPA paper is the only material guaranteed to maintain efficiency for the life of the filter. Synthetic filters use an electrostatic charge on the filter material which assists efficiency but over time the charge is lost and so is the efficiency.

Bigger is better: the larger the size of the filter surface area (usually measured in m^2) increases the efficiency of the filter due to a larger contact area. When comparing air purifiers look for the largest filter in size.

Air purifiers that direct airflow in all directions tends to recirculate their air at lower speeds making them less effective.

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Mike Dowling

Director of Technology

Operational Intelligence – A Divison of Oberix

Over the past five years, you may have noticed that property technology in healthcare is evolving at an increasing rate.
Modern buildings now come equipped with comprehensive ICT networks for building services, public Wi-Fi infrastructure, a high density of devices, advanced sensing, control systems and cloud applications. However, this technological proliferation introduces challenges, particularly regarding system compatibility, connectivity and cohesive project completion.

Historically, each product supplier handles integration and networking independently, often leading to siloed systems and outcomes. Today, the systems' increasing complexity and interconnectedness necessitate a coordinated approach. This is where the role of a Master System Integrator (MSI) can become critical.

An MSI is an expert in both operational technology (OT) and information technology (IT), ensuring seamless integration and networking across various systems.

Operational Intelligence (OI), an Australian Master System Integrator (MSI) with experience in complex integrated precincts internationally shares insight in regards to Best In Class practices to ensure clients' systems are integrated and functioning seamlessly and for cohesive delivery.

Procurement Review

While experts in their field, the supply chain may not always have the big picture necessary to understand what is critical outside the siloed product. An MSI ensures that all procured technology products comply with design documentation and other project technology requirements. This critical step guarantees that each product is supplied

with the correct parts and firmware necessary for project connectivity.

Detailed Design Coordination

The MSI takes an owner and operator perspective about outcomes and from that position incorporates requirements into the design of the engineering ICT network. MSIs assist design teams by organising network addressing, VLANs, cyber rules, and network compatibility. For example, the determination of the number of data ports needed by the Building Management System (BMS) and the exploration of secure and cost-effective methods to connect to the ICT network.

Bench and Factory Acceptance Testing

Before installation, MSIs facilitate offsite testing to ensure different technologies can communicate effectively. For example, testing the interaction between security access and lift systems allows the project team to resolve issues before commissioning. For example, sometimes custom integrations or firmware updates will need to be applied. By applying a factory testing procedure these bugs can be ironed out well in advance of the installation and commissioning of various technologies.

Commissioning and Witness Testing

MSIs provide the oversight and management of the commissioning process to ensure the technology functions as per design intent. When thousands of devices are involved, a comprehensive process for validation and recording the location and operation of these devices is crucial for a facility's ongoing, effective operations. This can incorporate resolving issues not traditionally found in construction such as firmware lockout dates, the latest technology deployment and change management planning for post deployment support.

Change Management and System Maintenance

Post-handover, MSIs manage firmware updates, network monitoring, cyber protection, and change management. MSIs ensure that ICT technologies remain secure, structured, and reliably documented throughout the property's operational life.

MSI expertise can assist stakeholders in healthcare facilities navigate the complexities of modern technology to ensuring robust, secure and efficient operations.

Voted best paper at the 2024 IHEA National Conference

ILLUMINATING THE PATH TO SUSTAINABILITY

Integrating Environmental Responsibility with Emergency Lighting Management

Michael Goodman

Clevertronics

Emergency and exit lighting is a life safety requirement that requires ongoing testing and reporting to ensure legal compliance. Without the right solution, it can be costly and inconvenient to manage, with manual logbook entry and, unfortunately, a significant number of fitting replacements occurring on a six-month basis.

However, many opportunities exist to address and better manage compliance challenges and improve the lifecycle of emergency lighting. Many sustainability initiatives can be adopted to reduce the carbon footprint of healthcare facilities; these include:

- Replacing old technology luminaires with new low-energy and long-life alternatives
- Using more environmentally friendly battery technology like Lithium Nanophosphate
- Reducing the amount of fittings required with a lighting audit and design
- Moving to a fully remotely managed testing and monitoring system
- Installing a wireless system to remove cabling requirements
- Using paperless and remote commissioning

The good news about these initiatives is that they can be implemented easily as incremental changes rather than a full upfront investment. Many facilities persist with inferior solutions, spending significant money on maintenance to stay compliant and continuing to support an emergency and lighting solution that is working against a low-carbon future.

Let's look at these initiatives in more detail:

Luminaire technology

Selecting products that are designed to provide maximum life is crucial in compliance-based applications, especially in hospitals where the interruption of patients and access to sterile areas is best avoided. The key areas to consider around lifetime include:

a. The Design life of the product and the parameters used to determine lifetime. This is critical as many products assume an ambient temperature lifetime, but this doesn't consider the environments these products operate in, hence why 40 degrees is a far more important measure to benchmark against. Check the testing credentials of your products, not just the warranty.

b. Then there is the battery component, which is very well known in the emergency lighting world as a fitting's Achilles heel. This is about the battery's characteristic of retaining charge and then discharging correctly over time. Battery technology like Lithium Nanophosphate has proven to outperform the life of other components of the luminaires by a significant value. This type of technology is no longer a maintenance burden. Older battery technologies like NiCd and NiMH have inferior performance but are also manufactured with toxic heavy metals that are harmful to the environment.

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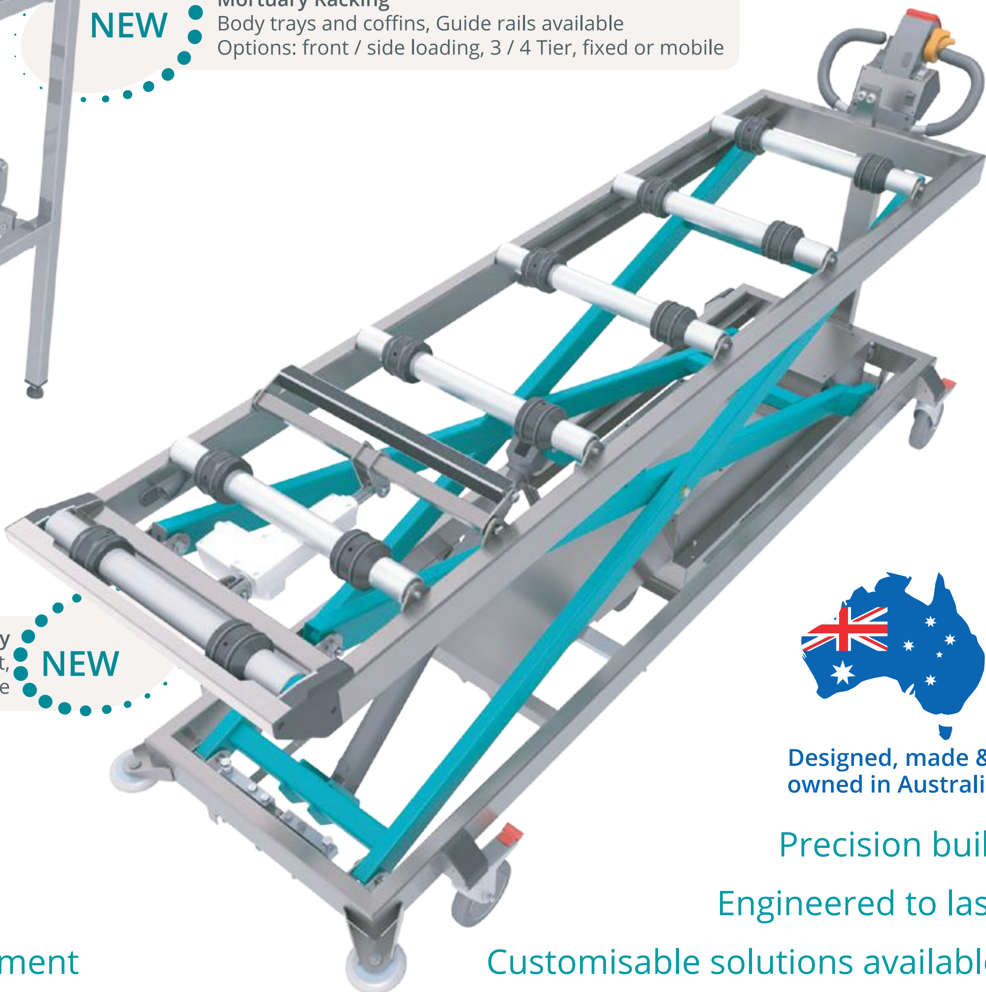

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c. There are opportunities to reduce energy in emergency lighting luminaires, especially with existing installations using fluorescent tubes or LED fittings with poor Lumen/Watt efficacy. This is most prevalent in car parks, stairwells, and back-of-house areas that use batten and circular-type fittings. Improvements in LED lifetimes and drivers have resulted in significant energy savings.
d. Different classifications of emergency and exit luminaires provide opportunities to optimise the design and installation, ensuring the least amount of fittings are used within the building. Ask for an emergency lighting audit and design to determine the best solution.

Emergency lighting testing and monitoring systems

The majority of emergency lighting installations need to be manually tested every six months, which is where most compliance issues originate. These include:

a. Inefficiency and added travel - Manually tested systems require you to flick a switch at a switchboard or a key switch to test and inspect each fitting every 6 months manually. This requires a person or team to be onsite for the 90-minute duration test and mark the logbook with the testing result. This inefficiency means it can take weeks to complete all the testing on a large site, causing unnecessary travel. Fortunately, with recent advancements in technology, there's a solution to these problems. An automated testing system can help maintain compliance, ensuring all your fittings are tested regularly and records are automatically updated in the system. It will highlight any luminaires that need maintenance repairs so you can ensure that all your fittings are ready to operate when needed - all with minimal effort and risk, at the lowest possible price.
b. Wireless RF systems—With the advancement of RF wireless technology, hard cabling the emergency lighting system to each fitting is no longer required. Advanced systems now run off one controller to wirelessly connect up to 1000 fittings. Fewer cables result in less embodied carbon being added to each facility. After installation, the commissioning of the system can be completed remotely without the need for paper documentation once again, reducing the need for additional travel to and from a site.
c. Using data to inform decision-making - Monitored systems can make it easier to manage and track fitting lifecycle because of the data retained within the system. Information such as fitting commissioning dates, service activities, and battery performance over time all help to provide information to the facility engineer. Assessment of the data can then enable them to more accurately plan replacement activities and provide opportunities to extend the luminaire operation rather than simply replacing them after a set operating period.
d. Use existing infrastructure – Monitored systems require software to operate which traditionally means the installation of a dedicated server computer on-site that has network cabling to the monitoring system controllers. By utilising a building's existing network infrastructure and a common or shared server environment (either on-site or in the cloud), the installation, operation, and management of the dedicated server hardware can be eliminated thus saving power and lifecycle replacement (typically every 4-5 years).

Another consideration to ensure the long-term performance of emergency and exit lighting is the support for your chosen products and system. Access to spare parts will mean that damaged fittings or failed components can be replaced so that the fitting service life can be maintained for as long as possible. From a systems perspective, it's important to consider backwards and forward compatibility. Forward compatibility means that you can keep operating the system that is in place while taking advantage of new technologies and features with minimal or no additional infrastructure investment – delivering continuous operation of the system over a long period of time.

Implementation—Compliance is expensive when you rely on old luminaire technology and manual testing processes. The more time it takes to test and maintain your emergency lighting system, the more it will cost. Fortunately, recent technological advancements have provided a solution to

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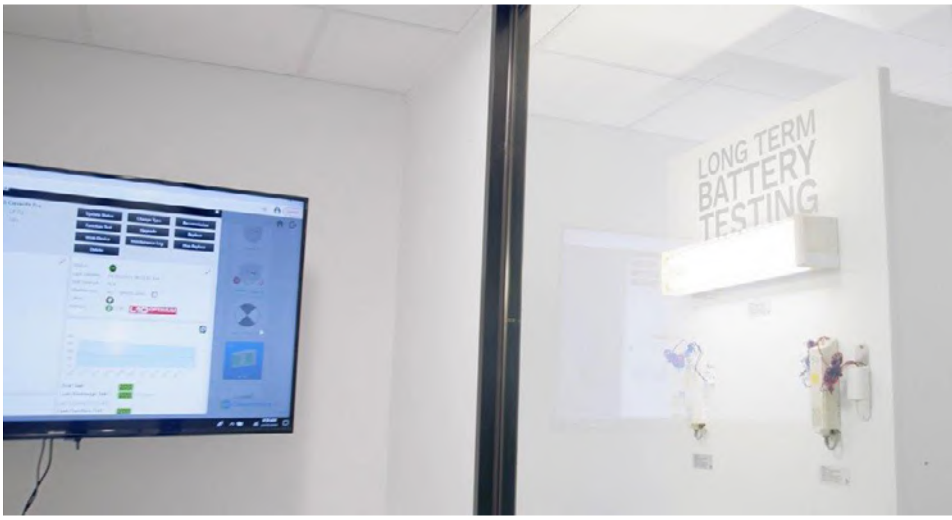
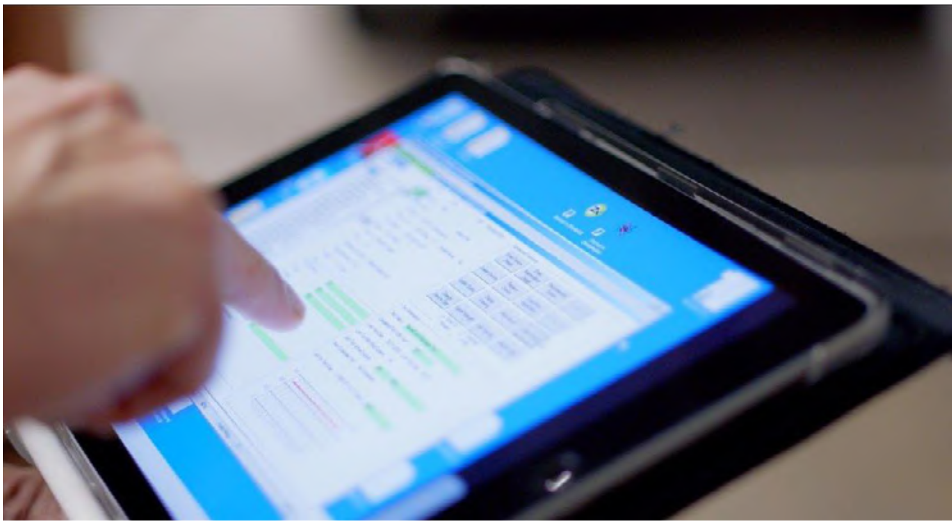
With older emergency and exit lighting luminaires and testing systems, each six-month test will result in repairs and replacements, and this is the time to begin an incremental upgrade to a new sustainable solution.

The system will be fully upgraded by progressively replacing fittings using repairs and maintenance budgets with long-life fittings with automatic testing capability over 2 -3 years. This, combined with the simple addition of a controller, will mean the site has a fully automated testing and monitoring system with no additional cabling, luminaires with a maintenance-free profile of 12 years, and reduced operating energy across the site.





The sustainability outcomes are measured by:

- A reduction in energy consumption
- A reduction in fitting replacements going to landfill
- A reduction in travel to the site for six monthly testing
- No toxic metals are being used in batteries
- Less cabling required for wireless testing systems

This is also the time to make sure that the contractor doing the work is following best practices with the disposal of any end-of-life product. The recycling rate for end-of-life emergency lighting batteries is unknown but is likely to be very low – it is estimated to be just 5%. Programs such as Exitcycle and Flurocycle have been set up to assist with ensuring that end-of-life emergency and exit lighting batteries and fluorescent tubes are collected, recycled, and processed. Have a conversation with your contractors and suppliers to ensure that end-of-life product is disposed of appropriately.

Real-world insight

Many healthcare facilities are already addressing their emergency lighting challenges through automated testing and implementing strategies for progressive upgrades using fittings that increase efficiency and reliability. One such case is Sutherland Hospital in NSW, Australia.

The Sutherland Hospital and Community Health Service is approximately half an hour's drive south of Sydney, in the suburb of Caringbah. Established in 1958, it is a major metropolitan hospital and teaching hospital with 375 inpatient beds. As with many hospitals, it has undertaken many extensions and renovations over the years, resulting in various emergency lighting products and systems being used within the building. These ranged from manually tested fittings to various automated systems. A modern monitored emergency and exit lighting system was first introduced to Sutherland Hospital in the Stage 1 capital works upgrade and has proven to be the system of choice for Stage 2 works. ACIA Electrical Services was tasked with conducting this latest upgrade and the remaining buildings with an expansion to the system.

Before the upgrades, the hospital's emergency and exit lighting systems were outdated and inconsistent with current standards. The existing lighting fixtures were inefficient and unreliable and posed potential risks in an emergency. Recognising the importance of maintaining a safe environment for patients, staff, and visitors, the hospital management invested in a modern, technologically advanced solution.

The Challenge

Complete emergency lighting upgrades of large or multiple buildings require significant planning and budgeting and can sometimes be financially out of reach. Sutherland is no different, so the ability to incrementally upgrade was important. The biggest challenges for Sutherland were multiple systems, testing regimes, spare parts and replacement products, and general support for the incumbent systems.

Emergency lighting systems are notorious for being inoperable if they are not supported with training and know-how. Sutherland has been constantly challenged around baseline data, managing the constant maintenance of older NiCd battery-powered fittings, and maintaining testing and compliance records. The goal was to remove the burden around emergency and exit lighting compliance and reduce ongoing maintenance costs. Cameron from ACIA commented, "For something like emergency lighting, you must make it simple for installers and facility managers to understand. If it's complicated, compliance and testing won't happen without a whole heap of pain and money". "At the end of the day, Sutherland Hospital needs to have confidence that we are leaving them with a system that does what it is supposed to do and is supported when required". He added.

For Mark Deluca, Sutherland Hospital Engineering and Maintenance Manager, "Patient and staff safety are paramount to the Hospital. However, the challenge of rising emergency and exit light fitting failures meant that getting replacement parts was becoming more difficult, and maintenance costs continued to increase. We needed a reliable and easy solution within the constraints of a busy operating hospital".

Solution

After carefully evaluating available options, the hospital upgraded its emergency and exit lighting systems to a monitored system utilising RF communication technology between fittings. The system offered several advantages over traditional systems, including:

- **Advanced automatic testing capabilities:** The luminaires continuously monitor their performance and report issues in real time, ensuring compliance and reliability.
- **Energy efficiency:** The LED technology used in the luminaires consumes significantly less energy and have a longer design life than previous emergency lighting, resulting in cost savings and reduced environmental impact.
- **Easy installation and maintenance:** the systems innovative design simplifies installation and maintenance tasks, minimising disruptions to hospital operations.
- **Longevity and reliability:** the luminaires are built to withstand the rigours of a healthcare environment and are backed by comprehensive warranties and lifetime support for peace of mind.

Stage one of the Sutherland Hospital Emergency Lighting upgrade was completed with a lithium battery-backed exit, emergency luminaires, and a sophisticated software testing system with excellent results. The advantage of the RF system selected is that each new upgrade extends the system, allowing the hospital to continue building the system with less complexity and more certainty around emergency lighting compliance. "The support around commissioning and ensuring the system works 100% is vital in installing emergency lighting", says Cameron. "Support from vendors is critical as it ensures we deliver to Sutherland Hospital the best outcome, both installation-wise, the final outcome, and how the system operates on an ongoing basis".

So far, over 800 RF emergency luminaires have been installed across two stages. Because additions to the communications infrastructure are so easily achieved, future stages will be rolled out following compliance testing of existing luminaires and planned capital works. This allows the hospital to reduce capital budgets because fittings will be replaced gradually as part of the hospital's day-to-day maintenance operation.

Results

Cameron from ACIA Electrical found the overall process seamless. "It was important to have the manufacturer support to complete this project with limited interruption to the hospital. This was achieved by planning the installation and commissioning and not requiring additional cabling or backbone hardware. We have now installed a state-of-the-art emergency lighting system for Sutherland Hospital that has simplified compliance testing and set the hospital up for further system expansion"

The upgrade to the RF-monitored emergency lighting technology has yielded significant benefits for Sutherland Hospital:

- **Enhanced safety:** The new emergency lighting system provides reliable illumination in an emergency, ensuring the safe evacuation of patients, staff, and visitors.
- **Improved compliance:** The system's automatic testing capabilities help the hospital comply with relevant safety regulations and standards.
- **Energy and maintenance savings:** The reliable and efficient LED technology of the lithium-backed luminaires has reduced energy consumption and lowered the hospital's operating costs.
- **Minimal disruptions:** The seamless installation process minimises disruptions to hospital operations, allowing critical services to continue without interruption.

Mark Deluca, Sutherland Hospital's engineering and maintenance manager, says, "The implementation of a modern RF emergency and exit lighting system as an upgrade has been relatively painless, especially given that we have a busy aging hospital. The minimal infrastructure requirements and factory support provided to ACIA gave us great comfort to undertake the emergency lighting upgrade as part of our operational maintenance strategy". He goes on to say, "We are already seeing the results with simplified compliance testing and the reassurance that we have long life fittings that won't need to be touched for many years to come".

The upgrade of Sutherland Hospital's emergency and exit lighting system to modern RF emergency and exit lighting technology represents a significant investment in safety, compliance, efficiency, and sustainability. By leveraging the advanced features of a modern RF emergency and exit lighting solution, the hospital has enhanced its ability to provide a safe environment for patients, staff, and visitors while realising cost savings and ensuring compliance with regulatory requirements. These successfully staged upgrades serve as a model for other healthcare facilities seeking to modernise their emergency lighting infrastructure.

Conclusion

In conclusion, the implementation of modern emergency and exit lighting systems presents a pivotal opportunity for healthcare facilities to enhance safety, improve compliance, and advance sustainability efforts. This paper has underscored the critical role of emergency lighting in ensuring life safety and legal compliance within healthcare settings while also highlighting the challenges associated with traditional manual testing methods and outdated technology.

However, amidst these challenges lie numerous opportunities for improvement and innovation. By embracing sustainability initiatives such as transitioning to low-energy, long-life luminaires, adopting environmentally friendly battery technologies like Lithium Nanophosphate, and implementing wireless monitoring systems, healthcare facilities can meet compliance requirements and reduce their carbon footprint and operating costs.

Moreover, the paper has outlined a strategic approach to implementation, emphasising the feasibility of incremental upgrades over time rather than a significant upfront investment. By progressively replacing outdated fittings with modern, automated solutions, facilities can streamline testing processes, reduce maintenance burdens, and achieve long-term sustainability goals.

Real-world examples, such as the successful emergency lighting upgrade at Sutherland Hospital, further demonstrate the tangible benefits of modernising emergency lighting infrastructure. Enhanced safety, improved compliance, energy savings, and minimal disruptions to operations are among the key outcomes observed, reinforcing the value of investing in advanced technologies and solutions.

Overall, this paper serves as a call to action for healthcare facilities to prioritise the modernisation of their emergency lighting systems. By leveraging innovative technologies, strategic planning, and industry best practices, facilities can ensure the safety and well-being of patients, staff, and visitors and contribute to a more sustainable future for healthcare environments.

Unlocking the Future of Healthcare: Revolutionary Compressed Medical Air System at Westmead Hospital

In a groundbreaking leap for Healthcare innovation, Westmead Hospital is now home to a state of the art Compressed Medical Air System and a newly built stand alone plant room, a turnkey project meticulously executed by Goldman Plumbing Services, redefining the standards of medical infrastructure.

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The system boasts four Medical Compressed Air Compressors complete with advanced heat of compression dryers, featuring two water-cooled and two air-cooled compressors, ensuring 100% redundancy. This combination guarantees a continuous and dependable supply of medical compressed air.

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The design incorporates a fully automated room ventilation and compressor cooling system. The systems control panel regulates fan usage based on operational room temperatures, optimising energy consumption for maximum efficiency and cost-effectiveness.

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A dedicated Medical Air Alarm System receives digital signals from compressors and pressure sensors, promptly alerting system operators to any critical alarms or warnings. Real-time insights into operational parameters are provided through Building Management System connectivity with high level interface.

Resilient Design for Unmatched Reliability

The Medical Compressed Air Plant and Mechanical Services control centre comprises four individual modules, showcasing a commitment to reliability. Each module is dedicated to supplying specific plant and equipment, allowing the system to fully operate during maintenance periods or partial system failure.

Holistic Approach to Project Success

Goldman Plumbing's holistic approach extends beyond the medical compressed air systems design and installation. Goldman Plumbing also designed and constructed the dedicated stand alone plant room. Not only does this approach provide a single point of accountability for the entire project, it also ensures seamless translation of the systems design intent into fully functional and reliable Healthcare infrastructure.

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The Compressed Medical Air System not only meets but surpasses all relevant Australian Standards and modern Healthcare facility expectations. This project signifies a stride towards excellence in medical facilities, where innovation meets reliability and the future of healthcare infrastructure is now a reality.

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Key Outcomes

By reading this paper you will understand how to do the following.

• Clearly define the scope of sustainability analytics for a hospital

• Understand what engineering services are required to connect data to an analytics platform

• See an example of a sustainable building management approach using analytics

Overview

It is well understood today that buildings generate about 28% of the global greenhouse gas emissions today. The United Nations Global Status Report projects that buildings need to be at least 30% more energy efficient to achieve Paris Agreement goals. Coupled with these larger global pressures, building occupants want the assurance that the indoor environment is healthy and being monitored with health and safety in mind. Both these pressures global and local pressures are being felt by those who operate healthcare facilities.

To ensure a given healthcare facility can address sustainability initiatives at scale and on the floor, analytics are needed. What is often difficult for both facilities managers and property portfolio managers alike, is how to implement standardized analytics in a standardised way. In this paper we will provide an approach that Grosvenor Engineering uses, in conjunction with VerdeOS to provide a Sustainable Building Manager analytics service. This approach can serve as a guide to consider what it will take to ensure your healthcare facilities are on track to be more sustainable than they are today.

The Challenge

Where do you get started on transforming a healthcare facility or a portfolio of facilities to be more sustainable? It can be difficult to know where to get started in even defining what a sustainable building is for your organization. There are some great guidelines that can be followed from organizations like NABERS and Greenstar. However, these guidelines don't provide you with the operational analytics you need to show the business and your patients what you're doing to better manage the sustainability of your properties.

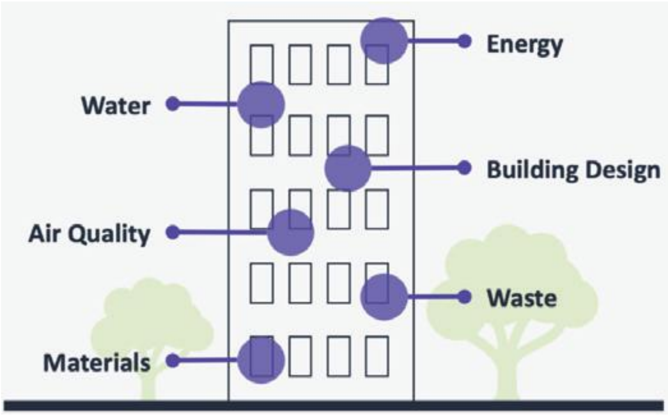
The Solution

To get started, it's important to work backwards from the analytics you want to show to your stakeholders. The data you will need is provided by building infrastructure, sensors and even utility invoicing. These next few sections will show you how to pull that all together.

Sustainable Buildings Defined

The specific definition of what a sustainable building is, is still evolving. Historically it has referred to the design and construction of a Green Building and organizations like LEED's would certify a given property based on that. More comprehensive ratings systems like NABERS look beyond just the design and focus on operations as well.

For this paper we will primarily focus on the operations of the building and how data on energy efficiency and environmental quality metrics can help healthcare operators demonstrate their commitment to sustainability. We will show how leveraging data collection (IoT sensors, BMS, Databases), AI & Machine Learning can ensure buildings are operating at maximum efficiency to reduce carbon footprint while ensuring the health of occupants is being considered.



The Scope of Transformation

It's important to remember, the emissions that come from your building result from energy usage, primarily electricity. The carbon intensity of the grid that provides this electricity differs regionally. It is important to consider that your best returns on

efforts to reduce emissions will come from the regions with the high carbon intensity (Figure 1).

Next, consider the fact that your buildings don't use any energy at all, they just keep the rain of the things that do. It's

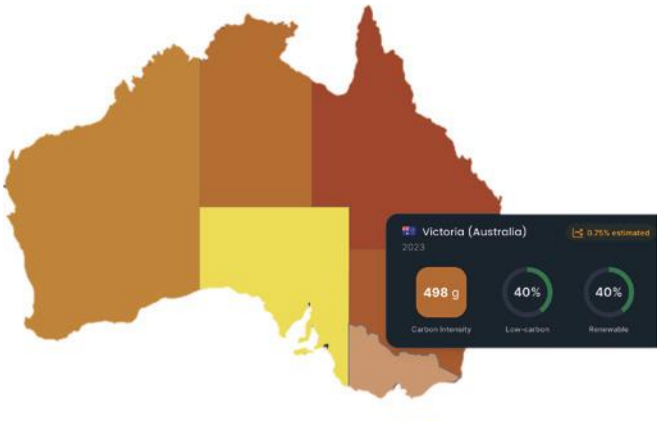


Figure 1 – Regional Emissions Intensity
Source: Electricitymaps.com

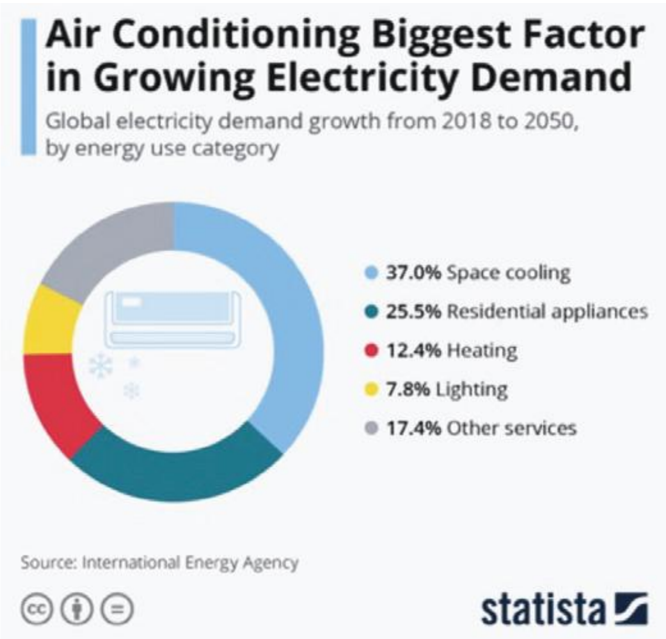


Figure 2 – Emissions Are Driven by Energy Usage in Buildings

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*..air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Figure 3 – Air Quality Reporting is Easier Than Ever
Source: OSXdaily.com

the HVAC, lighting, medical equipment, pumps, and other infrastructure within the buildings that are consuming energy. When you look at the breakout of where this energy is typically used, the biggest consumer by far is HVAC (Figure 2).

HVAC units are central to a building and constitute roughly 50% of a building's energy consumption. As a result, they are well instrumented and generally follow a rules-based approach. The downside: this approach can lead to many false alarms and building managers rely on manual inspection and occupants to communicate important faults that require attention. Building managers and engineers focus significant time and budget on HVAC systems, but nevertheless HVAC system faults still can account for 5% to 20% of energy waste.

Focusing on HVAC and making sure your facilities teams or your building services partners know how to optimize your HVAC systems is a great place to start. A secondary focus is lighting and not just changing from low efficiency to high efficiency but implementing lighting control systems. These two steps alone will set you well on your way to meeting or exceeding best in class efficiency targets.

In addition to driving emissions reductions, many healthcare operators are also implementing environmental quality monitoring (Figure 3). There are many new options available to monitor and report Indoor Air Quality (IAQ). Including AQI data in your scope of analytics provides operators with the option to show patients and visitors that their health is being looked after in a comprehensive way. This data can be derived from sensors that can be deployed within your buildings today.

The Scope of Engineering Services

Driving energy efficiency and reporting on environmental quality analytics requires planners to understand the bigger picture. Effectively implementing and data-driven strategy to transforming your facilities to be more sustainable comes from a focus on infrastructure and data. Most healthcare operators don't have the expertise on staff to do both and some help from specialists is usually required.

Grosvenor Engineering's VerdeOS analytics services works with transformation planners to provide fully managed services at each step of their journey. To help plan for the engineering services that are required, we typically start with and end to end scope (Figure 4). This helps us have a blueprint to follow to take the necessary steps to extract the right data from the right systems to deliver the right analytics to the right people.

If you're approaching a portfolio of buildings, its typically better to

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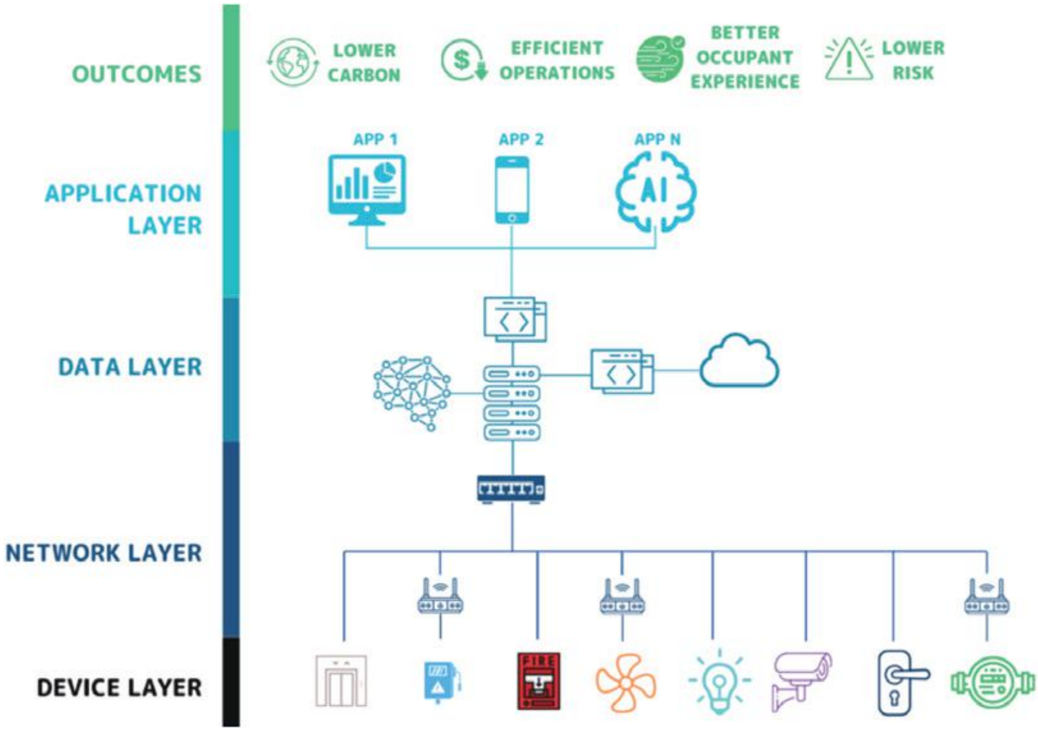

Figure 4 – Scope of Infrastructure, Data and Applications
Source: Nexus Labs

Figure 5 – The Sustainable Building Manager Application

start with specific outcomes in mind. If you can identify a set of outcomes that is important to all your facilities, you can work backwards to standardize everything that supports them. This approach will not only modernize the systems that provide data but will usually reduce your costs related to data services. A similar approach can be used for a single facility but some of the efficiencies gained at scale may not be achieved.

For either approach, you will generally want an experienced building services company that can help optimize your HVAC, lighting, and electrical systems.

These building engineers will need to work effectively with systems integration teams as the building systems that need to be connected may communicate through different protocols than modern IT networks. Finally, both these engineering teams will need to work with data, building optimization and analytics engineers.

This many specialists can be a complex endeavour to manage in piece parts. This is where engaging a partner that can support you end-to-end through your building transformation journey may be preferrable. This is why Grosvenor Engineering has established VerdeOS as a solution provider that can deliver all these services and analytics products in support of desired outcomes.

Data-Driven Sustainability

Similar to the concept of data-driven maintenance, sustainability is an outcome that once defined, can be supported through analytics, delivered to the right people to take the right actions. Sustainability is typically reported by a sustainability team but actual reductions in energy and emissions need to be supported by a real estate team. Historically there have been few tools available for these teams to work together on to track the efficacy of their joint efforts. New approaches are now available.

In support of Grosvenor Engineering's thousands of customers with more than 20,000 buildings under management, the VerdeOS Sustainable Building Manager (SBM) is now available (Figure 5). The SBM enables building operators to proactively manage the energy, emissions, water, gas and air quality within their buildings. This product further comes with all the engineering services that are required to deploy, integrate and maintain a data-driven sustainability program.

Conclusion

Healthcare operators have many new options to drive sustainable transformations across properties. The approaches detailed in this paper provide a high-level overview of where to get started. We recommend you reach out to a sustainable buildings solution provider today to achieve new sustainable outcomes.

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Anthony Guiragossian – Siemens Ltd

Executive Summary

The heating, ventilation and air conditioning (HVAC) systems of a hospital are a major contributor to hospital energy consumption and are often operated very inefficiently, to support the Australian Government commitment of 43% reduction in carbon emissions by 2030 all sectors including Healthcare must take action to reduce energy consumption.

The retrofitting of existing air-handling units (AHUs) with electronically commutated (EC) fans provides a cost effective solution for extending the life of existing HVAC capital equipment, whilst also providing improvements in energy efficiency, noise and air delivery performance.

At St.Vincent's Hospital in Fitzroy, Melbourne, a retrofit of new EC fans within AHUs was undertaken, resulting in a 33% reduction of electricity consumption against baseline amounting to energy savings of 178,084 kWh and approximately 164 tonnes of CO2 equivalent (tCO_2e).

Introduction

In order for Australia to reach its 2030 target of 43% reduction of CO_2e, all elements of the economy must take high impact steps to reduce their energy consumption, including the Healthcare sector. The recent introduction of the NABERS for Hospitals rating process in Victoria has highlighted to hospital operators the poor energy efficiency of their facilities.

The heating, ventilation and air conditioning (HVAC) systems of a hospital are a major contributor to hospital energy consumption and are often operated very inefficiently.

The purpose of this paper is to outline the reduction of energy intensity and running costs of ventilation systems (notably air-handling units - AHUs) and improvement to fresh air delivery for patient safety to reduce hospital acquired infection. This can be achieved by retrofitting existing AHUs with electronically commutated (EC) fans. EC fans are a fully integrated technology that consists of a brushless DC motor with onboard control electronics, which have demonstrated benefits in HVAC applications. EC fans provide a modular, low-noise and energy efficient solution in HVAC systems without compromising on air delivery performance or patient comfort.

This paper also outlines a case study for St Vincent's Hospital in Melbourne, Australia where two existing AHUs were upgraded from belt driven double-width double-inlet (DWDI) fans to EC fans manufactured by ebm-papst.

EC Fan Technology

EC motors are permanent magnet synchronous motors with in-built electronics which generate the commutation of the motor. EC motors in principle are brushless DC (BLDC) motors, with a rectifier embedded in the electronics to convert incoming AC current to DC current. Fans that utilise EC motors typically used in HVAC systems come with an external rotor motor design, where the rotor is directly mounted onto the stator. This allows the form factor of EC fans to be compact by design.

The integrated control electronics on EC motors allow for direct speed control without the requirement for external devices such as variable speed drives. Precise air volume control via speed setting on EC fans make them well suited for HVAC systems, including within variable air volume (VAV) and air handling units (AHU).

EC fans utilised in HVAC systems, particularly in AHUs, are typically backward curved centrifugal fans due to the moderate-high static pressure requirements (i.e. 300 Pa and above). The design of EC backward curved centrifugal fans, commonly referred to as EC plug fans, allow for the plenum that the fan is situated in to be pressurised, resulting in uniform airflow across the heat exchanger coils. Additionally, due to the lightweight and compact

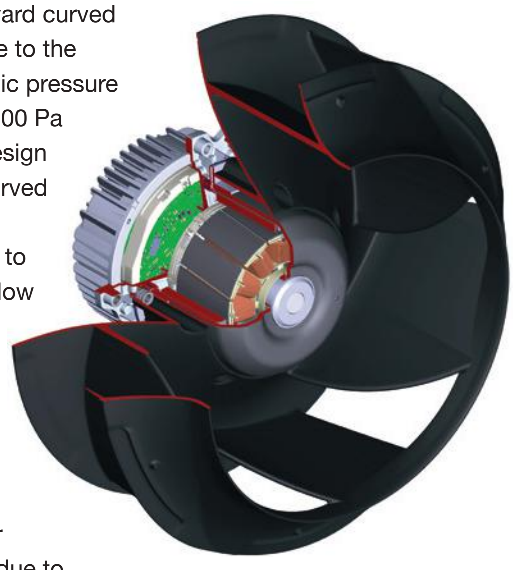

Figure 1: Internal cross-section of an EC motorised impeller

design of EC plug fans, multiple fans can be used in an array configuration (FanGrid) when a singular fan solution is not sufficient to meet the duty requirements.

The FanGrid configuration also poses an added redundancy benefit when in the event where a fan in the array fails, the operational fans will continue to operate and will compensate for the performance of the lost fan. This allows for HVAC capital equipment that utilise multiple EC fans to remain operational in the event of a fan failure on site.

Retrofitting with EC Fans

The replacement of end-of-life inefficient fan assemblies with EC fans provide a more cost effective solution for extending the life of existing HVAC capital equipment on site, compared to like for like replacements. Additional benefits are also achieved, such as higher energy efficiency, lower noise and improved air performance. In terms of energy efficiency, it is not uncommon to achieve energy savings of 30-70% by retrofitting with EC fans. Additionally, retrofitting with EC fans provides an opportunity to reduce maintenance costs in HVAC systems, which require periodic component replacements. The combination of the longevity and energy efficient nature of EC fans comes as a straightforward solution when it comes to extending the lifetime of HVAC capital equipment.

EC fans provide a plug-and-play solution, where existing building controls can be connected directly to the fans via onboard electronics. EC fans come with two control options, 0-10VDC/PWM and MODBUS-RTU. For buildings that utilise a BACnet protocol, a MODBUS-BACnet gateway can be utilised. The direct control capability of EC fans provides ease of commissioning and negates the need for external third-party equipment to be utilised, which usually contributes to the added costs and efficiency losses in HVAC capital equipment. In addition to direct control, the onboard electronics on EC fans provide alarm status communication to the existing building management system for ease of troubleshooting when required.

Due to its benefits, there is an upward trend in the need to upgrade existing HVAC capital equipment with EC fans as the demand for more energy efficient HVAC systems increases. In the past where the primary motivation for upgrading existing fan assemblies to EC fans is due to end-of-life, there is a proactive shift in the demand to upgrade fans to achieve better energy efficiency in buildings. The availability of government incentives such as the $31 million Victorian Business Recovery Energy Efficiency Fund (BREEF) program is an example of this. Other examples of this are the Victorian Energy Upgrades (VEU) scheme and the Emissions Reduction Fund (ERF).

St Vincent's Hospital Case Study

As part of the BREEF program, the Energy and Performance Services division at Siemens has undertaken energy efficiency upgrades for St Vincent's Fitzroy Hospital in Melbourne, Australia. Part of the upgrade is the replacement of existing belt driven DWDI fans with EC plug fans.

A preliminary site inspection was undertaken to determine the specifications of the existing belt driven DWDI fans, in order to appropriately select EC plug fans that can perform at the required duty for the existing AHUs. The AHUs investigated are as follows (see Table 1).

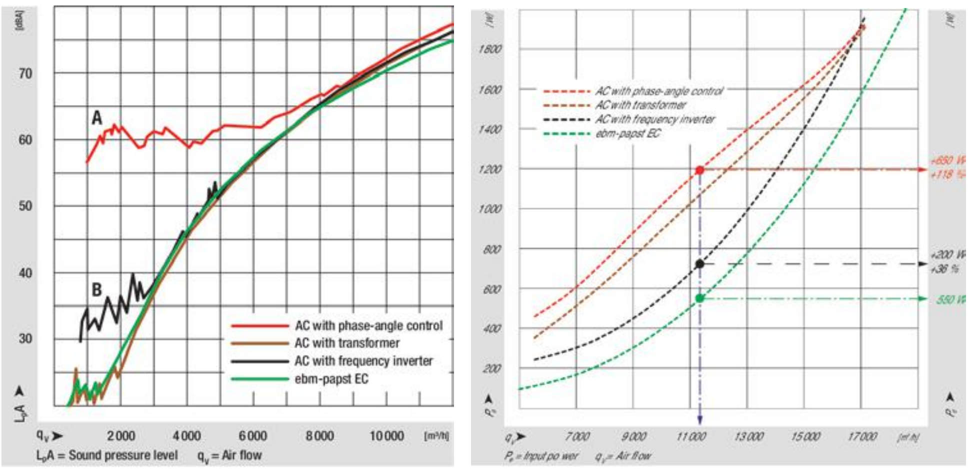

Figure 2: Noise and power consumption comparison

The airflow and static pressure values were determined from undertaking site measurements and having available data on the existing belt driven DWDI fans. Both AHU 4.1 and AHU 4.2 use 402 DWDI Pitstock Pheonix Fans with 37kW CMG 3-phase AC induction motors.

The selected EC plug fan array (FanGrid) consists of eight (8) 560mm backward curved centrifugal fans K3G560PB3103. The plug fans utilised aluminium impellers with aerofoil blades for

Table 1: Determined airflow and static pressure figures with the selected EC plug fans

Plant ID	Required Airflow	Required Static Pressure	Selected EC Fans	Quantity
AHU 4.1	19,350 litres/second	580 Pa	560mm EC plug fan K3G560PB3103	8 pieces
AHU 4.2	19,350 litres/second	580 Pa	560mm EC plug fan K3G560PB3103	8 pieces

maximising fan static and overall efficiency and minimising noise.

Siemens worked with EC fan manufacturer ebm-papst through fan selection and for supply of the high efficiency EC fan units. The existing belt driven DWDI fans were dismantled, after which the construction of the fan array was undertaken. Overall, the mechanical works took 2 days to complete per AHU. Once completed, the fans were wired direct to the existing building management system (BMS) which control field pressures and zone dampers to achieve the desired airflows.

The project was completed in June 2022. In order to determine the savings achieved, the following baseline/operating conditions were defined:

- Baseline fan energy usage has been annualised based on one snapshot taken at start of project delivery phase in January 2022. Fans operate 24/7 and at constant speed.

Figure 3: EC plug fan array configuration (FanGrid) versus a DWDI belt-driven fan blower

Figure 4: Before and after photos of the EC fan upgrade for AHU 4.

- Operating data based on Siemens Navigator trends in place since project completion in June 2022. The average hourly energy usage from project completion until January 2023 was extrapolated to derive annual values.

Based on the electricity rates at the time of retrofit ($0.163 per kWh peak and : $0.101 per kWh offpeak) , the AHU upgrade achieved savings of $23,187.00. See summary in Table 2 below.

The resultant energy savings from this retrofit was 33% against baseline. The total savings of 178,084 kWh of electricity was realised, equivalent to 164tonnes of CO_2 equivalent (tCO_2e).

Due to updated air flow requirements introduced during the COVID19 pandemic, to maximise air quality, the hospital is now running fans with 100% fresh air only, which changed the fan operating curves and required some design changes during the implementation phase.

Conclusion

Retrofitting existing fans with EC technology provide a low risk, cost effective solution in extending the life of existing HVAC capital equipment. Modular EC fans for retrofits provide a unique solution that offers energy efficient operation, lower maintenance and operating costs, low noise, and better performance.

As the case study at St Vincent's Fitzroy Hospital has shown, undertaking EC fan retrofits has demonstrated the potential for energy savings in the healthcare sector by focusing on improving its facilities, whilst also to ensure patient health and wellbeing are prioritised with the delivery of fresh air to the indoor environment.

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Table 2: Summary of energy and dollar savings

Asset Info	**Baseline Conditions**		**Post Project Completion**		**Savings**					
Plant ID	**kWh Peak**	**kWh Off-Peak**	**kWh Peak**	**kWh Off-Peak**	**kWh Peak**	**kWh Off-Peak**	**kWh Total**	**Peak ($)**	**Off-Peak ($)**	**Total ($)**
AHU 4.1	123,012	136,023	99,752	110,303	23,260	25,720	48,980	$3,780	$2,598	$6,377
AHU 4.2	132,777	146,821	71,467	79,027	61,309	67,794	129,104	$9,963	$6,847	$16,810
Total					84,569	93,514	178,084	$13,743	$9,445	$23,187

OPTIMIZING ENERGY SAVINGS
in Operating Theatres and the Key Considerations for Successful Implementation

Cole Krisko

Technical Sales Engineer – Critical Environments

Holyoake by Price

Introduction

Australia wide there is an initiative to optimize energy savings in healthcare facilities, therefore it is integral to analyse the highest energy consumption spaces such as operating theatres. Operating theatres have high energy consumption rates due to the unique environmental requirements to adequately keep staff and patients safe. The most common energy saving method in operating theatres is the implementation of an unoccupied or setback mode and it is a practice that has been around for decades. Unoccupied or setback mode is an energy saving technique that permits a non-operational operating theatre to reduce the air change rate(ACH), and may permit the temperature and humidity set points to drift. Unoccupied or setback mode can allow for considerable energy savings for a healthcare facility but a systematic approach must be taken to achieve a successful and functional result.

This article outlines the key considerations prior to implementation, control strategies, and controlling factors such as air change rates, pressure relationships, humidity, and temperature.

Implementation Considerations

Before implementing setback mode in a facility a feasibility assessment must be performed to weigh the energy savings versus the up-front implementation costs. A feasibility assessment also has the ability to determine the method of setback that offers the best solution for each individual facility. The key factors to consider are outlined below.

1. Vacancy Rate

Assessing the vacancy rate of operating theatres is crucial to determining the potential benefits of implementing setback mode. Healthcare facilities can start by analysing historical data of operating theatre occupancy and utilisation. A performance audit report completed by NSW Ministry of Health compares actual versus target theatre utilisation rates. Figure 1 displays the utilisation comparison.

On top of analysing data the facility management team must work closely with operating theatre staff.

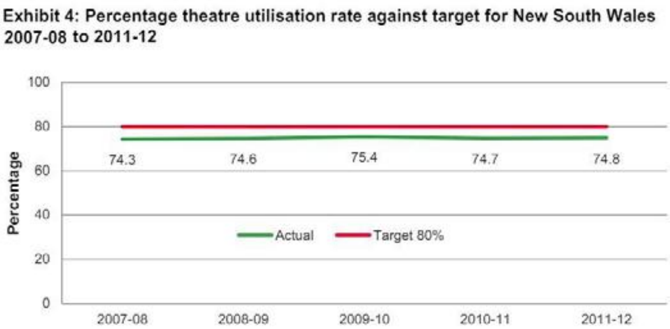

Figure 1: Percentage theatre utilisation rate against target for NSW

This can include conducting surveys or interviews with staff to understand scheduling patterns and identifying downtime.

Additionally, vacancy rates can vary between facilities so it is integral to analyse the cost implications of maintaining full operational capacity versus implementing setback mode during low-demand periods.

2. System Design (New Build or Retrofit)

Determining whether to implement setback mode greatly differs between a new build versus retrofitting existing healthcare facilities.

For new builds it is much easier to implement a setback mode because the system can be designed to accommodate all necessary mechanical and controls components. With proper system design setback mode in the operating theatres can be integrated flawlessly.

Retrofitting existing facilities may require modifications to HVAC systems, control systems, and infrastructure to support setback mode. There are always limitations when it comes to a retrofit project and an assessment on whether the mechanical/control system can accommodate a setback mode should be completed.

A cost-benefit analysis should consider the upfront investment versus long-term energy savings and operational efficiencies. This can determine the expected pay-back period of implementation.

REGISTRATION IS OPEN

Registration is open for the 28th IFHE International Conference 15–17 October 2024 in Cape Town, South Africa.

IFHE 2024 Programme Chair Denton Smith has the following to say:

“The quality of speakers and abstracts this year is going to be phenomenal. We have some incredible keynote speakers on the bill, including Dr Paul Soko, who sits on the Board of the Hospital Association of South Africa (HASA) where he chairs the Clinical Sub-committee, and storyteller extraordinaire Rob Caskie.

“We have a line-up of 72 speakers from 17 countries spread over five continents. Presentations under the broader theme of Patient Centred Healthcare Engineering Design will be geared towards tackling some of the bigger challenges that the industry currently faces, including how design and hospital maintenance tie in with the prevention of infection and infection control. The intention is to open attendees’ eyes and minds to how we are looking at and adapting to healthcare engineering holistically.”

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Apart from the knowledge gained during this three-day, three-track event, you will have ample opportunity to network with fellow like-minded professionals.

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All refreshment breaks and lunches, as well as the Welcome Cocktail Reception, will take place in the Exhibition Hall where you can expect to visit more than 40 exhibitors during the three-day event.

Register and download the programme
https://sbs.Co.Za/ifhe2024/

3. Room Pressure Regime

It is important to ensure compliance with space pressurization requirements between the operating theatre and adjacent spaces when implementing setback mode.

Proper design is integral for implementing control strategies to adjust airflow rates and maintain appropriate pressurization levels during setback mode. This is to ensure that setback mode does not compromise patient safety or increase the risk of airborne contamination.

4. Operational and Personnel Training

Successful implementation of setback mode requires adequate training for operating theatre personnel.
This training includes:

- Training staff on the concept of setback mode, its objectives, and operational procedures.
- Providing instruction on monitoring and adjusting environmental parameters such as temperature, humidity, and airflow.
- Conducting drills and simulations to ensure staff readiness to a situation where a setback operating theatre requires use during off hours.

The feasibility of implementing setback mode in operating theatres depends on various factors, including vacancy rate, system design, space pressurization requirements, and personnel training. A comprehensive analysis considering these factors is essential to assess the potential benefits, challenges, and risks associated with implementing setback mode. Further research and pilot studies may be necessary to validate findings and optimize implementation strategies.

Operating Theatre Environmental Requirements:

The controlling factors or operational environmental conditions in an operating theatre must be understood before implementing a setback mode. Based on the VHHSBA Engineering Services Guide there are operational requirements for room temperature, air change rate, relative humidity, and room pressurization. These operational requirements are detailed in Table 1.

In an operating theatre, maintaining optimal conditions is crucial for ensuring the safety of patients and healthcare staff. The main factors influencing environmental conditions are humidity, temperature, air change rate and room pressure regime. It is critical to understand the importance of these factors and there effect on implementing a setback mode in an operating theatre.

1. Room Temperature

Temperature control is paramount as it directly affects patient comfort and staff productivity. Surgical procedures require a stable and comfortable temperature to prevent patient discomfort, reduce the risk of complications such as hypothermia or hyperthermia, and maintain sterile conditions.

The temperature requirements of the operating theatre may affect the temperature setback strategy used. Typical design temperatures range between 18-24 degrees Celsius. Selecting a setback mode temperature range is a balance between energy savings and the time required to bring the room temperature back within operational requirements.

There is guidance from the VHHSBA Engineering Services Guide when it comes to temperature setback in operating

Table 1: VHHSBA Engineering Services Guide Environmental Requirements

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	Design Relative Humidity (k, aa)) %	Design Temperature (l)
Operating Room (m,o,d)	Positive	10	20	30-60	18-24
Cardiac OR (m,o,d)	Positive	10	20	40-60	16-24
Operating Room Burns / Plastics (m,o,d)	Positive	10	20	50-90	20-28
Hybrid Operating Room (m,o,d)	Positive	10	20	40-60	20-24
Operating / surgical Cystoscopic Rooms (m,o,d)	Positive	10	20	30-60	20-24
Peri-operative circulation space / corridor	neutral	2	6	30-60	22-26
Cardiac Catheterisation laboratory (m,o,d)	Positive	3	15	40-60	20-24
Procedure Room (m,o, d)	Positive	4	15	30-60	21-24

theatres. Section 4.145 states that "The system will be capable of operation in a set-back mode when the operating theatres are not in use. In set-back mode the operating suite will: widen temperature dead band to 14°C to 30°C"

2. Room Air Change Rate

The air change rate determines the frequency with which air in the operating theatre is replaced, affecting indoor air quality and infection control. High air change rates help minimize the concentration of airborne contaminants, including bacteria and viruses, reducing the risk of surgical site infections. Adequate ventilation also dilutes anesthesia gases and other airborne pollutants, promoting a safer working environment for healthcare personnel.

Local and state codes govern the amount of outside and total air changes in an operating theatre, typical 50% outside air and 20 air changes per hour in the space. Table 1 defines the air changes required for the different types of operating theatres in Victoria.

CSA Z 317-15 provides guidance on setting the unoccupied room air change rate. It states that "Air-handling systems for Type I areas may be operated at a reduced level when the space is unoccupied. The air circulation system should maintain at least six air changes per hour unless the space is continuously monitored for temperature, humidity, and (where applicable) relative pressurization and airflow. Where circulation systems maintain less than six air changes per hour, these parameters shall be kept within the design ranges specified"

This can be used as a guideline when designing the setback air changes per hour in the operating theatre. Local and state codes must also be considered when selecting the setback air change rate.

3. Relative Humidity

Humidity control is essential for maintaining a comfortable and hygienic environment. Maintaining appropriate humidity levels is still critical for preventing the growth of mold and bacteria, preserving the integrity of surgical supplies and equipment, and ensuring the comfort of patients and staff. Inadequate humidity control can lead to dryness, discomfort, and potential complications during surgery, such as desiccation of exposed tissues.

The humidity requirements of the operating theatre may affect the humidity setback strategy used. With the typical design humidity ranging between 30-60 % relative humidity. There is strict guidance from the VHHSBA Engineering Services guide when it comes to humidity setback in operating theatres. Section 4.145 states that "The system will be capable of operation in a set-back mode when the operating theatres are not in use. In set-back mode the operating suite will: always maintain full humidity control within the limits set in Reference Table 1 Operating theatre system hierarchy". This allows for no deviation outside of the required humidity ranges.

4. Room Pressure Relationship

Maintaining proper room pressure in an operating theatre is critical to prevent the entry of airborne contaminants. Positive pressure ensures that air flows out of the room, preventing contaminants from entering, while negative pressure prevents contaminants from escaping the room, particularly important for infectious diseases. This helps create a clean and sterile environment necessary for surgical procedures to minimize the risk of infection.

The room pressure relationship must be maintained when reducing the room air changes per hour in an operating theatre. It is this requirement that makes operating theatre setback strategies more complicated than setback strategies for non-critical spaces. This pressure differential should be controlled, monitored, and locally displayed to ensure the room pressure relationship is always being met.

5. Control Hierarchy

Section 4.146 and 4.147 of the VHHSBA Engineering Services Guide lists requirements on the control hierarchy that facilities should follow from most critical to least critical. This hierarchy changes between normal operation and setback mode.

4.146 In normal operation, the following system hierarchy will apply:

1. Air Flow Regimes and Filtration
2. Temperature Control
3. Humidity Control

4.147 In setback mode, the following system hierarchy will apply:

1. Air Flow Regimes and Filtration
2. Humidity Control
3. Temperature Control

The most is important is always airflow regimes and filtration which directly corresponds to the overall room pressure regime. Setback mode for airflow can be achieved through many different system design methodologies.

Design Options – Setback Airflow Control

There are many different design approaches to effectively achieve setback mode in operating theatres. When implementing setback it is recommended to consult with mechanical design experts. This article outlines two design options for setting back the airflow while maintaining room pressurization.

1. Setback mode is achieved through a Variable Speed Drive (VSD) on the air handling unit (dedicated AHU) with an in-stream velocity grid sensor to maintain airflow. Single AHU serving one operating theatre detailed in Figure 2.

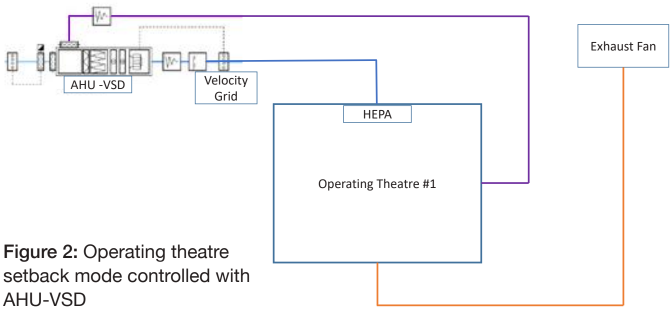

Figure 2: Operating theatre setback mode controlled with AHU-VSD

This design utilises the VSD on the AHU to reduce airflow when the operating theatre is unoccupied. The pressure in the space is maintained via the exhaust fan with a direct room pressure measurement via a differential pressure sensor. This option can be more costly as it has a dedicated AHU per operating theatre in the facility.

2. Venturi Valves or Airflow Control Devices to achieve setback mode. With one air handling unit (AHU) to serve two operating theatres detailed in Figure 3.

   This design utilises the venturi valves to reduce airflow when the operating theatre is unoccupied. The venturi valves use volumetric offset control between the supplies, exhausts, and return air. The room pressure is field balanced to meet the room pressure requirements in both the operational and setback modes. The pressure in the space is monitored via a differential pressure sensor and displayed locally.

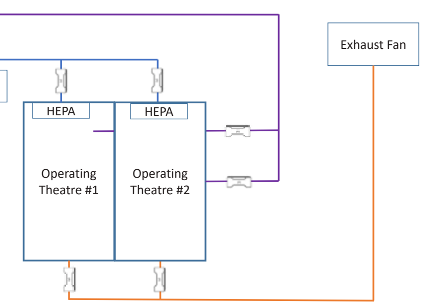

Figure 3: Operating theatre setback mode controlled with airflow control devices

Potential Energy Savings

Based on the data provided in the technical article "Safety and Energy Implications of Setback Control in Operating Rooms during Unoccupied Periods" the expected annual energy savings for one operating theatre reach 15,884 kWh of natural gas and 5498 kWh of electricity. Using these figures we are able to calculate the approximate energy savings per operating theatre.

Electricity Rate Victoria = 28 c/kWh
Total Energy Savings = Electricity Savings (kWh) * Electricity Rate Victoria (c/kWh)
Total Energy Savings = (15,884 + 5498) * $0.28 = $5986.96
Extrapolating the data to 10 operating theatres there would be an energy savings of $59,869.6 per year.

NOTE: Calculations have been done with only the cost of electricity as per electrification initiative of hospitals in Australia.

Conclusion

In conclusion, utilizing a setback mode for operating theatres is a proven method of energy savings in a healthcare facility. However, it is critical to understand the requirements of each facility either new build or retrofit to determine if it is feasible to implement setback mode operation. There must be adequate systems in place to setback an operating theatre and bring it back within operational conditions in a reasonable period of time. This can be achieved with proper mechanical system design, modern controls, and building management system technologies. Setback modes allow for more energy conscious healthcare facilities and progress towards a more sustainable future.

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EMERGENCY PROCEDURES IN HEALTHCARE FACILITIES

Beyond Red and Orange

Octo Moniz

Emergency Management Unit (EMU)

Royal Perth Hospital

Introduction

I intend in my paper titled "Emergency Management and Procedures in Healthcare Facilities – beyond the red and orange' to showcase how the legislative responsibility at Royal Perth Hospital 'Emergency Management' (EM) is dynamically addressed and managed through the hospital's emergency management unit which was established in 2002.

The reference made to 'beyond red and orange' identifies there are additional emergency category types that could occur within a healthcare facility as referenced in Australian Standard 3745-2010. All the 7 listed emergency categories must be managed safely, effectively, and efficiently to reduce risks mitigation ensuring staff, patient, and visitor safety.

RPH is in Perth's CBD. Our site spans over 2 large city blocks with a footprint of 4,379 square meters (m2) of covered space.

RPH is one of the 3 x large tertiary hospitals in WA. The other two are Fiona Stanley Hospital and Sir Charles Gairdner Hospital.

There are 25 buildings on the site. Many of the buildings are heritage listed, being over 100 years old whilst the most recent was built 1987.

RPH is the lead hospital within Perth's East Metropolitan Health Service sector. It is the states designated referral centre for Trauma and Cardio Thoracic services.

It operates a busy emergency department and supports 460 inpatient beds.

Our 2024 establishment reflects the following –

- A 7017 headcount or 5411 FTE
- A 1143 headcount for new staff recruitment
- A 1576 headcount for staff that ceased work at RPH.
- A 324 headcount of new start doctors who are on an annual rotational program and
- A 397 headcount for new start Nurses to date.

The stats provided above are purely to appreciate the spread of staff working across our site as well as the large number of staff that need to undergo mandatory 'emergency procedures and evacuation training' every year whilst the hospital is also required to achieve a 90% to 95% staff training completion rate every year. This is needed to be done in a demonstrable and transparent manner.

Pic 1

We have always managed to successfully achieve this high target rate - to reach out, train and record completion dates for all trained staff. We now have access to the hospital's 'learning management system' (LMS) which automatically tracks and records all the mandatory training needs for staff, and it also sends out reminders, when re-training is due.

Appended above is Pic 1, which shows the RPH footprint retrieved from google maps. The Blue line indicates the spread of the hospital and the numerous buildings and carparks located within.

The Emergency management set-up and structure at RPH

The hospital's comprehensive emergency procedures manual (EPM) – was written up to mirror and incorporate the principles and guidelines encapsulated within the following documents.

– Australian Standards AS 4083:2010 - Planning for emergencies - Health care facilities
– AS 3745:2010 - Emergency control organization and procedures for buildings, structures, and workplaces

- Australasian Inter-service Incident Management System (AIIMS)
- WA Work Health and Safety Act and Regulations – 2022
- The (non-governmental) Australian Council for Healthcare Standards and
- AS/NZS ISO 31000:2009 Risk management – Principles and guidelines
- AS/NZS 5050:2010 Standard - Business continuity management

An Emergency Control Organisation (ECO), headed by the Hospital's Chief Executive as the Executive Sponsor was established. The ECO is made up of:

- An Emergency Management Committee (EMC) which is chaired by The Director of Nursing (DON) (who takes up the position of Hospital Incident Commander (HIC) in a confirmed emergency) and which includes other Key stakeholders who are recorded within the EMC terms of reference and reports to the Hospital's peak governance body.
- The Emergency Management Unit (EMU) which is tasked to oversee and manage 'All' emergency related incidents within the Hospital, including the management of the Heliport, but not the Code Blue emergency response, as this is independently managed by a separate 'clinical' structured team, which also reports to the hospital's peak governance body. Hence

For operational simplicity, we have just two 'delineated' emergency response teams (ERT) that attend the incident scene when a code alert is called. These are –

- The code blue - specialised team of a mix of at least 6 doctors and nurse, who attend to all 'code blue' – medical and / or cardiac arrest emergency alerts and
- a generalist team of 7 headed by a Senior Nurse, the shift engineer, security officers and patient care assistant whilst.
- the Emergency Operations Centre (EOC) is also activated for most alerts and headed by the assistant-HIC, to support the respondents and the Area Warden at the incident scene.

In a confirmed emergency the AHIC contacts the HIC, who then decides if the Incident Management Team (IMT) must be paged to attend the EOC. The IMT is made up of key trained Senior Staff who attend the EOC and take on their designated role to

- support the needs of those staff, patients and others who have evacuated to their designated Assembly Area

All ERT and IMT members are trained to promptly respond to a paged emergency, to follow their respective action cards held in the emergency procedures manual (EPM)

Further, the hospital's Switchboard Operators are also trained to contact the relevant hazard management agency (HMA) i.e., DFES (department of fire emergency service) or WAPOL (WA Police) when an alert is phoned thru on 55.

The WA Work Health and Safety Act and Regulations – 2022 requires all hospital employee to annually:

- be taught the hospital's emergency procedures and
- every workplace is to conduct an evacuation exercise every year +

ACHS (Australian council for healthcare standards) requires the hospital to demonstrate a 90% to 95% training completion rate every year.

In considering this important and challenging task of training more than 5000 employees every year, the following approach was taken to achieve the targeted results.

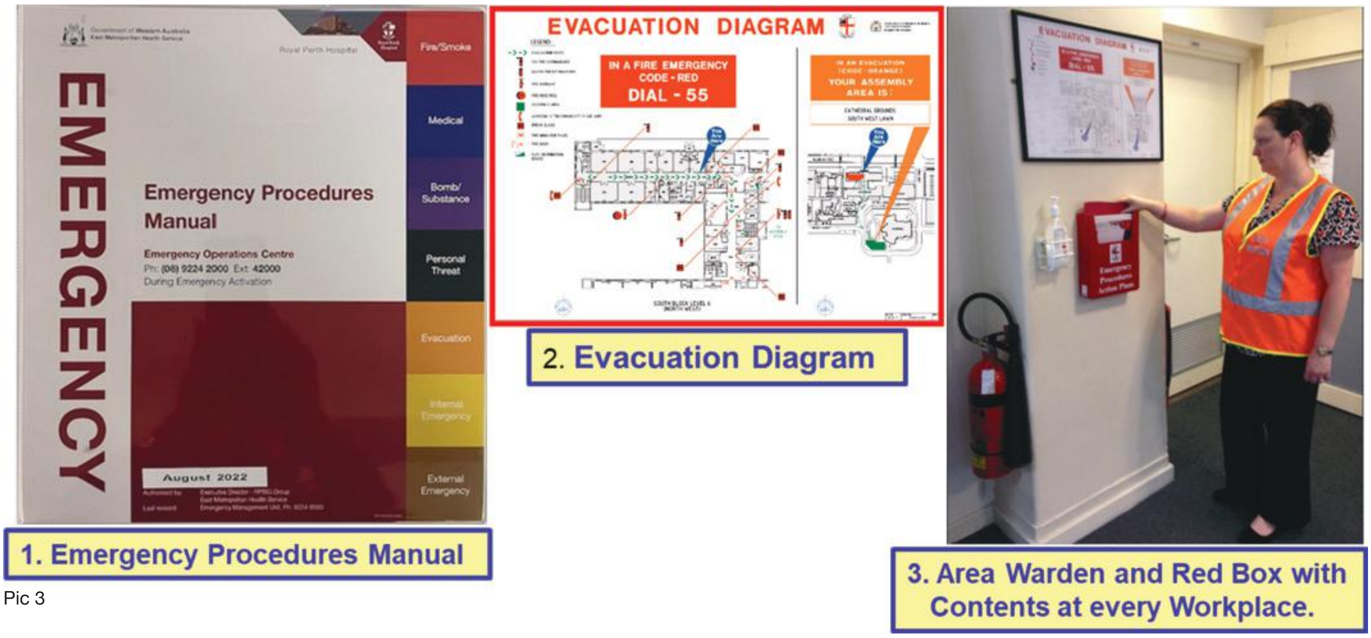
1. Training of Staff begins at employee induction where staff are introduced emergency management and taught about the 7 categories of 'Emergencies' that could occur within a (large) healthcare facility. They are also taught to Phone '55' from the nearest hospital phone to raise an emergency alert. Then provide Switchboard with - the emergency type, the building and department name and a brief description of the emergency. This information is soon paged to the ERT.

   The 7 identified emergency categories noted in the Australian Standards AS – 4083, 2010 and AS – 3745, 2010 are listed below. These, for simplicity of identification and naming purposes are each allocated a distinct 'colour code' i.e.

   1) RED for a Smoke or Fire related emergency
   2) BLUE for any medical emergency
   3) YELLOW for an Internal emergency –
   4) PURPLE for a Bomb or Substance emergency
   5) BLACK for Personal Threat/Aggression/Self Harm. Code Black also covers.
      a. Code Black - Alpha (for child abduction) and
      b. Code Black - Bravo (for an active shooter incident)
   7) ORANGE for Evacuation and
   8) BROWN for an External emergency incident

Pic 2

2. All staff are provided with the following:
   An EM sticker (Pic – 2) is attached to the personal ID badge of every employee.
   All employees are required to access and annually complete an emergency procedures eLearning package via the hospital's – Learning Management System (LMS).



Pic 3

Area Warden (AW) Training is provided so that every independent workplace within the hospital has a trained AW.

a. AWs are authorised to conduct the annual Evacuation Exercises and to record staff training dates on LMS.
b. If required EMU provides Area Wardens with assistance and
c. EMU periodically monitors progress with training completion percentages on LMS.

3. Every independent workplace is set up with the following: (Pic 3)
   a. Web access to the EPM
   b. An Evacuation Diagram and Red Box and
   c. A Trained Area Warden

The ‘Challenges’ faced, and ongoing improvements made to reduce the number of avoidable alarm activations! (Pic 4)

4. Risk mitigation measures applied to reduce the high number of “Code Red - false fire alarms” activations at the hospital.

2021	2022	2023	Australian Standard 4083
72	75	103	Fire/Smoke (False)
6	4	6	Fire/Smoke (Confirmed)
2540	2328	2660	Medical
0	0	0	Bomb/Substance
4878	4976	5000+	Personal Threat
3	1	5	Evacuation
71	70	58+74 - (OC & MHU)	Internal
1	1	0	External

Pic 4

a. Every activated fire alarm is root cause analysed by EMU and measures are undertaken thru facilities operations, to mitigate / eliminate the risk of a recurrence.
   Some of the measures introduced were i.e.

✓ The installation of ‘tag locked’ screech alert boxes over the MCP to (Pic - 5)
- deter malicious activation of manual call points (MCPs).
- This move effectively reduced malicious MCP activation incidents by 95%.

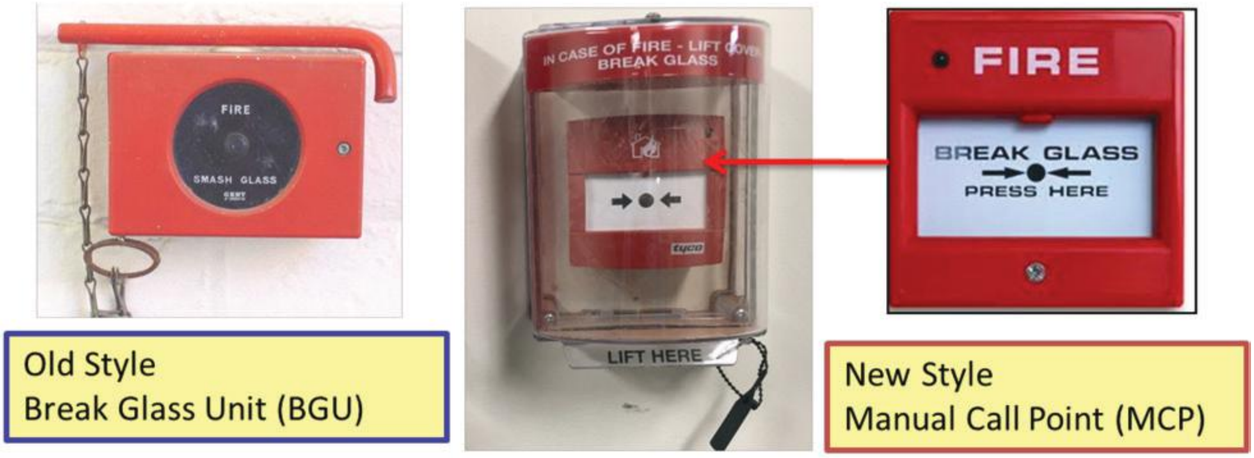
✓ The changeover of the electrical powers supply to the emergency paging and communications systems from essential power supply to ‘un-interrupted power supply’ (UPS).

✓ The Installation of signal repeaters / enhancers at key locations on site has
- fully restored the reliability and availability of this very important Communications tool by eliminating all identified ‘dead spots’ on Site.

✓ The recent “Vaping” in public toilets scourge, causing false fire alarm activations.
- sought brigade approval to replace smoke detectors with thermal detectors.

✓ Spurious activation of a detector for ‘no apparent reason’.
- sought brigade approval to introduce ‘AVF’ or alarm verification facility at the FIP inter-phase. AVF automatically introduces a 20 second delay before the DBA gets activated. Also, the DBA will not be activated when re-checked, if the alarm clears within the maximum allowed 20 seconds delay.

Other staff and patient safety enhancement and risk mitigating measures introduced against other emergency colour codes.



Pic 5

Code Yellow (internal emergency) Alert:

A. Missing patient alert
   - ✓ The installation of an early warning 'wandering patient' alarm linked to the Ward's nurse all system.
   - ✓ The introduction of a pre-code yellow - missing patient alert activation procedure, aimed at resolving the incident primarily at the Ward level prior to its full escalation as
   - ✓ The full code yellow activation involves a high draw on the lean availability of additional staff resource bank. It also requires the ERT to respond to facilitate a 'Grid Search' of the hospital site, whilst the incident also gets escalated to
   - • To WAPOL to conduct a look out, external to the hospital for the missing person.
   - • This procedure, has proven to be a success, resulting in enhanced Patient safety and the discrete use of staff to conduct a grid-search.

B. Lift Entrapment – for person(s) trapped in a lift.
   - ✓ Now drilled down to the ERT lead attending Switch upon notification, to liaise with the person(s) trapped in the lift, whilst.
   - ✓ The Shift Engineers contacts the Lift services for the lift technician's ETA and keeps the ERT Lead informed.
   - • The brigade is called in to pry open the Lift doors, if there is a 'code blue' medical emergency in the lift that remains failed.

Code Black (aggression / self-harm emergency) Alert:

A. Staff are trained to care for their own personal safety 1st in the workplace, as by doing so, they will be better positioned to look after the safety of others and support their respective Area Warden to carry out assigned task(s)

B. Staff are made aware that code black alerts may either be activated by phoning 55 or where installed, by discretely activating the Duress alarm. However, security control recommends the activation of the duress alarm, as it goes direct to security control, which reduces security response times.

C. The more recent approach taken towards patient aggression management is for early identification of the potential of a patient to becoming aggressive and to then manage the behaviour thru clinical intervention rather than through code black activation and Security Officer(s) intervention.

D. All our frontline health services providers – i.e., Nurses and Doctors are required to complete API (aggression prevention intervention) Training to enhance one's personnel on-the-job safety and to mitigating the risk of injury thru patient aggression.

E. Our security control – use the hospital's 'CC Television' network of cameras effectively and efficiently to better manage the limited security officer resource, especially when more than one code black alert is called, by using the camera network to view and prioritise the response, to the most needed alert.

F. Security control utilises the embedded artificial intelligence (AI) programs to detect and flag abnormal person(s) behaviour – for example in our multideck carpark when there was a spate of car break-ins and / or utilise the facial recognition 'Search' feature, in case of missing patient tracking.

Staff are trained and reminded to Phone 55 for any observed Code Black – Alpha and / or Code Black – Bravo emergencies concerning – child abduction or an active shooter incident respectively and to importantly, focus on one's continued safety by moving from harm's way.

Similar actions are proposed to be taken by staff in case of a Code Purple – bomb threat / substance emergency.

The emergency management process followed post a significant emergency incident.

Our hospital emergency procedures require the following to be implemented post a significant emergency incident in the hospital. Soon after the incident is stood down.

– A hot operational debrief is held, to capture and record important matters that may require prompt attention and follow-up. Importantly,

- ✓ This also ensures that any staff adversely affected by the incident, may receive professional counselling services, which is cost-free and is available – round the clock, via thru - “People Sense” contracted by the Department of Health – WA, for all health employees to avail off.
- – A formal operational debrief, to which all external and internal respondents to the incident are invited, so that any gaps, improvements, and successes may be recognised and recorded for follow up action and sign off.
  - ✓ The list of recommendations / actions drawn up are included in the latter section of the major incident report which is written up for any confirmed major incident and held on record. The list of recommendations also gets periodically checked by the Emergency Management Unit to ensure affirmative progress is being made towards completion.

Finally, All Staff are trained to “stay calm” in any emergency and follow the hospital emergency procedures, to raise an alert, by Phoning ‘55’ from the nearest hospital phone and to follow directions from the Area Warden and / or the Emergency Scene Coordinator, who is the Emergency Response Team Lead.

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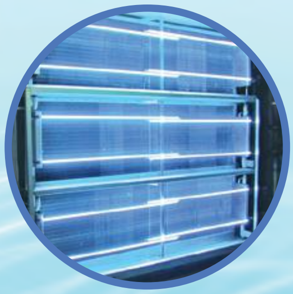

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SUSTAINABLE HEALTHCARE FACILITY MANAGEMENT

Insights from an Asset Lifecycle and Maintenance Benchmarking Study

S Safi, N Lyon and R Platfoot

Covaris Pty Ltd

This paper describes the processes developed as part of a Benchmarking Study aimed at advancing healthcare facility asset management practices. The primary goal of the study is to provide a comprehensive set of recommended benchmarks for asset lifecycle and maintenance costs, critically important for refining asset maintenance planning and budgeting strategies.

To achieve these objectives, an innovative Asset Maintenance and Lifecycle Cost Model has been developed and applied to a selected group of public sector hospitals. Employing a bottom-up approach, the model utilises the asset register of each health facility to calculate maintenance costs, encompassing preventive and corrective maintenance, as well as lifecycle replacement or refurbishment costs. The paper presents findings derived from the application of the cost model across twelve hospitals.

Following the development of the asset maintenance and lifecycle cost models, two methods for establishing recommended benchmarks have been introduced. The first method presents the calculated annual costs as a percentage of the health facility's Asset Replacement Value. The second method presents the calculated annual costs per square meter of the gross floor area of the health facility.

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 lifecycle management process, involving both planned and unplanned maintenance activities, as well as asset replacement and refurbishment. The primary objective of this study is to establish cost benchmarks to support healthcare facilities in planning, budgeting, and forecasting. The study aims to set benchmarks for both capital and recurrent maintenance to enable lifecycle planning and TOTEX considerations. These benchmarks 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 is the first step in establishing a set of recommended benchmarks for asset lifecycle and maintenance costs. It uses a bottom-up approach to calculate these costs for health facilities. Twelve facilities were selected for this study, and the Building & Facilities (B&F) assets of these hospitals were modelled. This paper outlines the process for cost modelling and presents the initial findings from the B&F Cost Modelling (BFCM) for 12 health facilities.

After developing the cost models, two methods have been proposed for establishing recommended benchmarks for asset lifecycle and maintenance costs:

1. Calculating the maintenance and lifecycle costs for B&F assets as a percentage of the Asset Replacement Value (ARV) and
2. Determining the lifecycle costs for B&F assets per square meter of the Gross Floor Area (GFA).

Literature Review

To assist the development of the maintenance cost modelling, literature from various sources was considered and is documented in this paper. This includes a review of international and inter-state benchmarks utilised by other health entities.

Of all the literature reviewed, Shohet's work is the closest in alignment with this subject. Shohet has been a leading researcher in hospital maintenance benchmarking for many years, and their publications are widely cited in the field. Specifically, Shohet's work from 2003 (Shohet, 2003) and (Shohet et al., 2003) includes modelling where the maintenance budget for hospital buildings was reported to be 2.22% of the reinstatement value.

In the US, medical equipment management and maintenance costs are benchmarked by a subcommittee of the Association for the Advancement of Medical

Instrumentation. Wang et al. (2008) conducted a study in which they collected data from 253 hospitals in 2006 across seven categories of clinical equipment.

1. General biomedical (physiological monitors, suction units, electrosurgery, cardiac defibrillators).
2. Specialised biomedical (anaesthesia machines, ventilators, dialysis units, laser devices, ophthalmological devices, prosthetics, video systems).
3. Imaging (radiography, nuclear medicine, tomography scanners, magnetic resonance, ultrasound, linear accelerators).
4. Laboratory (clinical laboratory devices).
5. Beds and mechanical (general mechanical devices and patient beds).
6. Non-medical (telecommunications, computers, entertainment devices, office equipment).
7. Technology management activities (procurement, project management, consultation, education, research).

The total cost of managing and maintaining the equipment was compared to the capital cost of the devices, and a benchmark average of 4% of the total capital acquisition was reported as being spent on management and maintenance.

Methodology

Figure 1 illustrates the process for B&F Cost Modelling for a health 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 each health facility's asset management information system to calculate both maintenance and life cycle costs. The definitions of the cost elements are shown in Table 1.

The modelling covers maintainable building and facility assets. If assets are not recorded in the asset management information system, the modelling may underestimate the required costs across all cost categories. Site visits and/or virtual meetings with asset managers of the hospitals included in the study were carried out to validate the accuracy of the asset data. Adjustments were made following the review of the modelling findings and consultation with healthcare facility stakeholders. For example, during a site visit to one of the hospitals, it was identified that some statutory fire protection assets (such as fire extinguishers and smoke detectors) were not recorded in the hospital's asset register. To improve the accuracy of the models, the hospitals' asset registers were reviewed against the asset registers of similar hospitals with accurate asset registers, and adjustments were made based on the following steps:

- Recently commissioned hospitals with comprehensive asset registers were selected as reference hospitals.
- The number of fire extinguishers, smoke detectors, and so on, from the reference hospitals were identified.
- New records were added for these asset classes to the hospital's asset register based on the proportion of the gross floor area of the hospital under review to the gross floor area of the reference hospital.

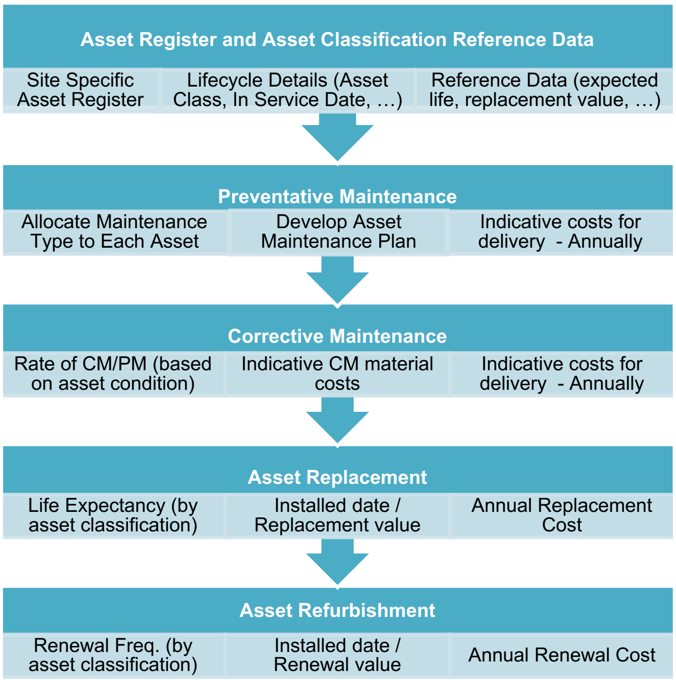

Figure 1 Cost modelling process

Asset Register and Asset Classification Reference Date

The first step in the cost modelling of a health facility is to identify the list of facility 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 …);

Table 1 BFCM cost elements.

Cost elements	Accounting treatment	Building elements / Engineering systems
Preventative	Recurrent (operating)	Planned/Scheduled Preventative Maintenance
Corrective	Recurrent (operating)	Corrective Maintenance (Planned & Unplanned)
Asset Replacement	Capital	Planned New/Replacement
Asset Refurbishment	Capital	Planned Refurbishments

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/retail price, 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).
4. Planned Refurbishment (years): The expected frequency of the refurbishment by asset classification (see).
5. Planned Refurbishment (%): The percentage of the asset cost required for the planned refurbishment (see).

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 and manufacturer recommendations. 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.

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 overall asset condition across the site using the following steps:

Table 2 Sample asset reference data library.

Asset Classification Name	PM Strategy Name	Life Expectancy (yrs)	Renewal Frequency (yrs)	Renewal Cost as Proportion 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

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 (the ratio for CM labour hours as a percentage of total maintenance hours is 23.3%). These ratios were 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 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.

Table 3 Cost modelling results for a sample hospital.

Year	Preventative Maintenance	Corrective Maintenance	Asset Refurbishment	Asset Replacement	Grand Total
2024	$2,057,787	$904,089	$187,774		$3,149,649
2025	$2,057,787	$904,089	$218,640		$3,180,515
2026	$2,057,787	$904,089	$337,049		$3,298,924
2027	$2,057,787	$904,089	$540,446	$18,492	$3,520,814
2028	$2,057,787	$904,089	$1,981,283	$47,619	$4,990,778
2029	$2,057,787	$904,089	$349,144		$3,311,019
2030	$2,057,787	$904,089	$194,406	$368,151	$3,524,432
2031	$2,057,787	$904,089	$536,513	$2,996,945	$6,495,333
2032	$2,057,787	$904,089	$570,355	$4,298,347	$7,830,577
2033	$2,057,787	$904,089	$3,466,360	$11,830,573	$18,258,809
2034	$2,057,787	$904,089	$242,936		$3,204,812
2035	$2,057,787	$904,089	$383,569	$63,492	$3,408,937
2036	$2,057,787	$904,089	$207,619		$3,169,494
2037	$2,057,787	$904,089	$688,916	$1,487,102	$5,137,893
2038	$2,057,787	$904,089	$1,390,879	$14,130,063	$18,482,818
2039	$2,057,787	$904,089	$205,365	$5,048,021	$8,215,261
2040	$2,057,787	$904,089	$260,698	$314,003	$3,536,577
2041	$2,057,787	$904,089	$644,537	$3,262,878	$6,869,291
2042	$2,057,787	$904,089	$271,509	$3,499,961	$6,733,346
2043	$2,057,787	$904,089	$1,756,182	$21,304,686	$26,022,743
2044	$2,057,787	$904,089	$323,144	$368,151	$3,653,170
2045	$2,057,787	$904,089	$195,108		$3,156,983
2046	$2,057,787	$904,089	$515,345		$3,477,220
2047	$2,057,787	$904,089	$651,509	$2,770,878	$6,384,263
2048	$2,057,787	$904,089	$483,557	$7,550,456	$10,995,888
Grand Total	**$51,444,669**	**$22,602,215**	**$16,602,842**	**$79,359,818**	**$170,009,544**

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.
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.
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 renewal 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.

Findings

Cost models were developed for building and facility assets across twelve hospitals. The modelling period was 25 years. However, it can be adjusted to any modelling period as required to align with health entities' requirements, such as their asset management plan reporting requirements. shows the modelling results for a sample hospital.

Table 4 presents the B&F annual costs from BFCMs as a percentage of the building asset replacement value. The average total maintenance cost for building and facility assets across the 12 hospitals, based on the BFCMs, is 1.72% of the building ARV (0.97% maintenance and 0.75% replacement/ refurbishment).

Cost Modelling Limitations

It is important to note that the benchmark values from BFCMs 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

Table 4 Cost model benchmarks (% of building ARV), B&F assets.

Hospital	Preventative Maintenance	Corrective Maintenance	Refurbishment	Replacement	Grand Total
Hospital 1	0.53%	0.31%	0.08%	0.52%	1.44%
Hospital 2	0.55%	0.32%	0.09%	0.51%	1.46%
Hospital 3	0.82%	0.48%	0.10%	0.74%	2.13%
Hospital 4	0.74%	0.32%	0.24%	1.14%	2.44%
Hospital 5	0.76%	0.44%	0.12%	0.69%	2.02%
Hospital 6	0.82%	0.36%	0.11%	0.57%	1.85%
Hospital 7	0.55%	0.24%	0.12%	0.63%	1.55%
Hospital 8	0.80%	0.35%	0.11%	0.49%	1.76%
Hospital 9	0.60%	0.35%	0.11%	0.60%	1.66%
Hospital 10	0.84%	0.49%	0.20%	0.94%	2.47%
Hospital 11	0.83%	0.48%	0.10%	0.94%	2.34%
Hospital 12	1.07%	0.62%	0.16%	1.06%	2.92%
Weighted Average	**0.63%**	**0.34%**	**0.11%**	**0.64%**	**1.72%**

Table 5 Cost model benchmarks (cost per GFA), B&F assets.

Hospital	Preventative Maintenance	Corrective Maintenance	Refurbishment	Replacement	Grand Total
Hospital 1	$26.02	$15.09	$3.77	$25.44	$70.33
Hospital 2	$35.42	$15.56	$11.43	$54.65	$117.07
Hospital 3	$32.51	$18.86	$5.17	$30.40	$86.94
Hospital 4	$28.62	$16.60	$3.46	$25.62	$74.31
Hospital 5	$59.56	$26.17	$7.88	$41.64	$135.26
Hospital 6	$39.87	$23.12	$6.52	$36.14	$105.65
Hospital 7	$41.17	$18.09	$9.05	$46.51	$114.82
Hospital 8	$45.98	$20.20	$6.28	$28.17	$100.64
Hospital 9	$61.23	$35.51	$11.41	$60.38	$168.53
Hospital 10	$40.34	$23.40	$9.62	$44.87	$118.23
Hospital 11	$38.94	$22.59	$4.55	$44.26	$110.35
Hospital 12	$38.89	$22.56	$5.77	$38.32	$105.54
Weighted Average	**$34.84**	**$18.58**	**$6.30**	**$35.09**	**$94.81**

categories. For example, the hospitals' asset register records sliding doors and fire doors, but internal doors are not recorded.

2. The modelling excludes fixtures, fittings, furniture, and equipment.
3. The modelling excludes building fabric assets, such as roofs and windows.
4. ITC & digital assets were excluded from the modelling.
5. Fleet, food services, and laundry services assets were also excluded from the modelling.
6. Biomedical assets are not included in the modelling.

The cost models exclude the following cost components:

- Replacement of buildings at the end of their useful life (note: replacement of buildings after their useful life is subject to a business case).
- Replacement of medical equipment at the end of its useful life.
- Upgrade work.
- Ground maintenance.
- Soft services.
- An uplift factor has not been included in the asset replacement cost. The uplift factor is for preparation, demolition, and making good to receive new work, over and above the basic installation cost. The uplift factor should be considered by the health facility asset managers on a case-by-case basis when they carry out an Annual Review of their asset management plans and define the detailed scope of the project, including site-specific costs.

Table 5 presents the calculated annual cost of maintenance from BFCMs per square meter of GFA. The average total cost for B&F assets across the hospitals, based on the BFCMs, is $94.81 per square meter of GFA.

Conclusions

In conclusion, the Asset Maintenance and Lifecycle Benchmarking Study is a significant step towards establishing recommended benchmarks for asset lifecycle maintenance costs. The study has used a bottom-up approach to develop a Cost Model and applied it to a nominated list of healthcare facilities. The model calculates preventive and corrective maintenance costs, and lifecycle replacement and refurbishment costs for a modelling period of 25 years. This paper presented the initial findings from the cost models across twelve hospitals, including the two methods proposed for the development of recommended cost benchmarks. The first method calculates the annual costs as a percentage of the health facility's Asset Replacement Value, while the second method presents the calculated annual costs per square meter of the gross floor area of the health facility.

The Cost Model has the potential to assist healthcare facility managers in their forward planning by forecasting expenditure within their Asset Management Plans. Therefore, the study has provided a comprehensive approach to benchmarking asset maintenance and lifecycle costs that can be applied to other healthcare facilities in the future.

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