THE OFFICIAL JOURNAL OF AIRAH

APRIL 2016 · VOLUME 15.3

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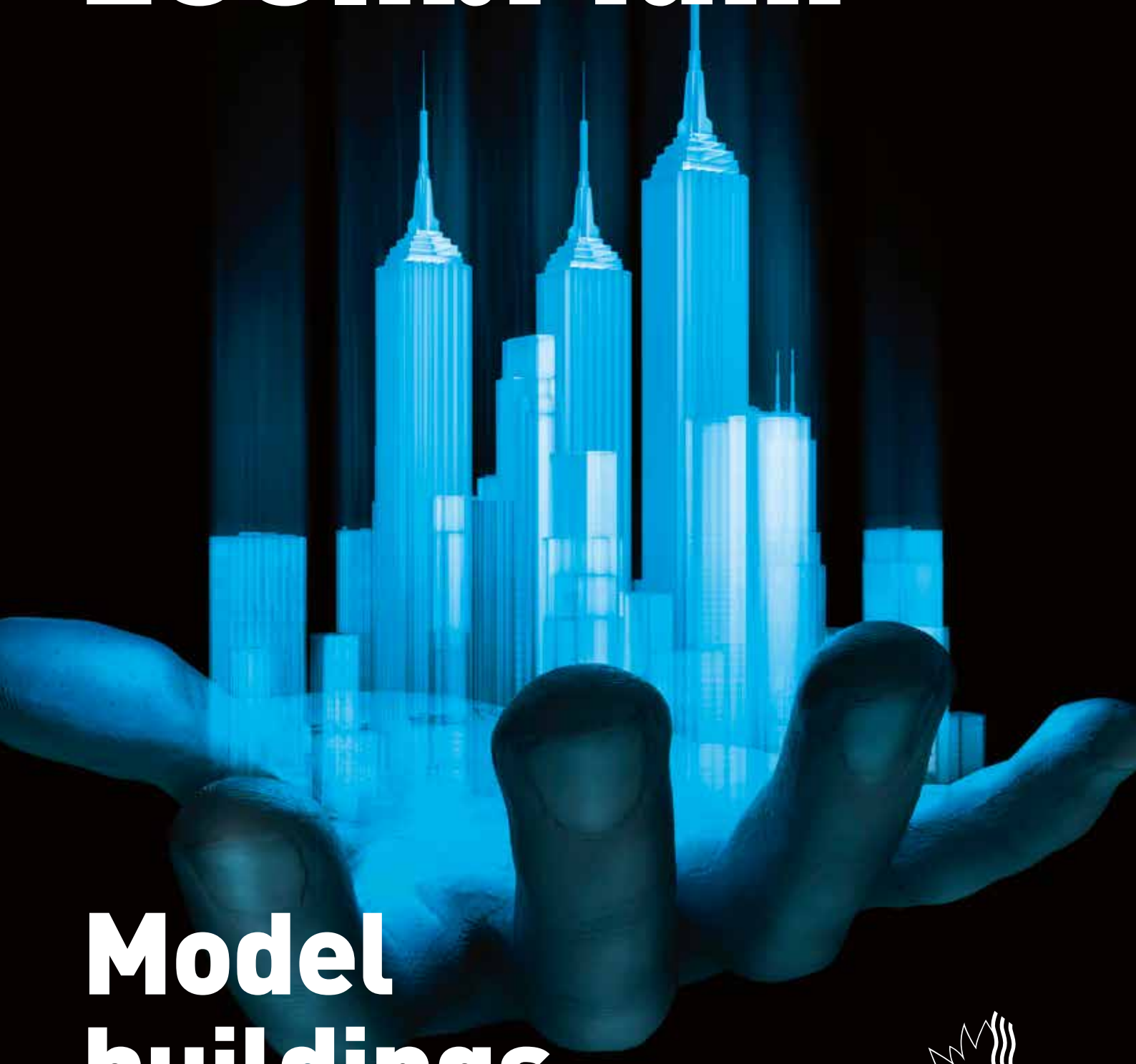

Model buildings

How BIM is becoming business as usual.

AIRAH

PRINT POST APPROVAL NUMBER PP352532/00001

Not just another office building

As the first building in Queensland to achieve a 6 star Green Star Design v3 rating, 180 Brisbane (also known as 180 by Daisho) is symbolic of a city in the midst of significant change. **Sean McGowan** reports on how a unique approach to trigeneration and stand-by power has delivered one of Australia's most sustainable workspaces.

> Located on a uniquely shaped site, the Ann Street address posed various challenges to the design and construction team

There's very little that is standard about 180 Brisbane (180 by Daisho) – a new 34-level, premium-grade commercial office building in the heart of Brisbane.

From its uniquely shaped site on Ann Street, to a striking façade featuring a depiction of the Brisbane River, to the clever use of trigeneration and stand-by power generation – it's obvious this was never meant to be just another office building.

Indeed, its official launch by Japanese property developers Daisho Group, featuring a traditional sake barrel and taiko drummers, said as much.

"Our vision when commencing this project was to set a new benchmark for Queensland commercial office accommodation solutions through the creation of an office tower that features striking architectural design, smart technology, exceptional environmental sustainability and comprehensive

The use of pre-fabricated pump skids helped minimise the on-site installation times at 180 Brisbane. Image: A. Gatland, AE Smith.

> Low-temperature VAV systems can be optimised for indoor air quality, thermal comfort and acoustics, and provides excellent flexibility for tenant changes

amenity for our tenants," said Daisho founder Katsumi Tada, partway through construction.

180 Brisbane was also the first commercial office project to be built speculatively in Brisbane since the global financial crisis.

"When we chose to develop 180 Brisbane, it was a demonstration of Daisho's confidence in the Brisbane CBD property sector and the wider state," Tada says.

Not long after Crone Partners began the architectural design of the building in 2011, Brisbane-based sustainable building consultants and AIRAH company member Floth was approached by Daisho Group and appointed as the ESD, mechanical, electrical, fire, and hydraulics consultants.

Originally engaged to provide a design that would achieve a 5 star Green Star Office Design v3 rating, as well as a 5 star NABERS Office Energy rating, the sustainability objectives soon changed.

"Halfway through the design development, the client decided to target a 6 star Green Star Office Design v3 rating, and a 5.5 star NABERS Office Energy rating in response to market demand," says Floth managing director Glenn Ralph, M.AIRAH.

This led Floth to collaborate closely with the architect on the energy performance of the façade design. This resulted in a review of the glazing and shading systems, which would contribute to achieving the building's energy-efficiency goals.

"On all our projects, we typically make early recommendations on glass performance parameters," Ralph says, "and later review the impact of proposed selections, and the final design on the Green Star and NABERS energy models."

Located on a uniquely shaped site, the Ann Street address posed various challenges to the design and construction team.

Among these were an existing rail tunnel beneath the site, and a requirement to maintain a portion of the site's existing carpark. Additionally, construction was required to be carried out next to the neighbouring building, which is located on the same site.

"The basement carpark of the tower straddles an underground rail line that feeds into Central Station," says Ralph. "And the new carpark floors were required to align with the existing carpark floors under the adjacent building on the site."

This configuration required the services reticulation and substation to be designed in a highly constrained area. Structural consideration was also given to the location of the lift shaft, which could not be situated directly above the rail tunnel.

With few options, the lift shaft was positioned on one side of the tower. By doing away with a central core, large floor plates were created to provide tenants with greater flexibility for their fitout.

Soon after construction was awarded to Watpac, AE Smith was engaged by the builder as the project's mechanical services contractor on a traditional "construct and commission" contract.

Having shared a collaborative working relationship across a number of highly successful delivered projects, Floth shared its 3D building services model with AE Smith. This assisted with final coordination and plant installation strategies of the building services.

"Both companies value innovation and focus on delivering quality solutions," says AE Smith's engineering team leader John Bourne. "There is a good level of trust and shared values, which helps to contribute to the successful delivery of projects like 180 Brisbane."

A GOOD FIT

A key feature of the building services design of 180 Brisbane is the central, low-temperature VAV (variable-air-volume) system.

LESSONS FROM THE CONTRACTOR

We've all heard stories of trigeneration systems being incorporated into buildings, only to not operate for a variety of reasons – among them oversizing. AE Smith's John Bourne offers an insight into how they are best-sized for commercial office buildings.

"Problems can arise when a trigeneration system is oversized," says Bourne.

He says this can be the result of untenanted spaces, seasonal changes and simply the daily load profile of commercial buildings.

"In reality, gas-fired engines – or turbines – should be sized to ensure optimum utilisation throughout the entire load profile of a facility."

"The size of the trigeneration plant (1000kW) at 180 Brisbane relative to the NLA (approximately 58,000 sq m) of the building should see good utilisation of this trigeneration plant."

A popular system in sub-tropical climates such as Brisbane, it offers excellent dehumidification performance leading to improved indoor conditions. It is also highly reliable and low in energy consumption.

"The original 5 star Green Star, 5 star NABERS design utilised a low-temperature VAV mechanical solution that has already proven the ability . . .to easily achieve these sustainable design targets," says Ralph.

Ralph says low-temperature VAV systems can be optimised for indoor air quality, thermal comfort and acoustics, and provide excellent flexibility for tenant changes.

"Compared to more exotic alternatives, it also offers excellent cost-effectiveness," he says.

With spatial constraints and difficulties ever-present on this project, the adoption of low-temperature VAV in lieu of a traditionally designed VAV allows for a reduction in air-handling plant, risers and ductwork spatial requirements.

The trigeneration systems' 1MWe gas generator, located on level 33. Image: A. Gatland, AE Smith

"The location and size of the services risers meant that access to install pipework at the back of the riser was difficult," says Bourne.

LESSONS FROM THE CONSULTANT

Floth's Glenn Ralph, M.AIRAH, describes how experience proved integral to the 180 Brisbane building services design.

"This project is the culmination of knowledge obtained from 10 years of continuous sustainable office building design by Floth," Ralph says.

"Each project iteration has resulted in continued evolution of design to incorporate lessons learnt on previous projects, including the latest design nuances and technologies where appropriate."

He says an example of this is the integration of a single-effect absorption chiller in lieu of the exhaust gas-drive double-effect type.

"Having all services drafted in 3D was a necessity, and the site team did a great job under difficult conditions while ensuring the safety of the workers."

JOG SPEED

One of the key features of the mechanical services design is the use of air-handling units (AHUs). These incorporate the latest-generation multiple-plug fans with energy-efficient, electronically commutating (EC) motors.

These direct-drive fans effectively replace the VSD (variable-speed drive), fan belt and pulley to provide spatial savings in the AHU and ductwork compared to conventional centrifugal fans.

Although the use of EC fans in AHUs is not unique in itself, the size of the units at 180 Brisbane is said to be impressive. A single internal AHU has up to 12 EC fans contained within it.

However, one aspect of this design that is unique is the ability to run the EC fans in fire mode at a "jog speed".

"Before this project, there were no AHUs on the market (with EC fans) that could run in fire mode, with internal safeties disabled, at a pre-commissioned jog speed," says Bourne.

LATE ADDITION

When Daisho Group decided to improve the building's Green Star rating from the original 5 star rating to 6 stars, Floth immediately proposed the integration of a trigeneration plant.

According to Ralph, the trigeneration plant provided the opportunity to target three specific Green Star credits. And

LOW-TEMPERATURE VAV

Low-temperature VAV systems are often compared to chilled beams, but AE Smith's John Bourne says studies have shown the former, with chilled-water temperature reset, supply-air temperature reset, supply-air static pressure reset and CO_2 control of ventilation, to be more efficient and provide optimum occupant comfort.

with a major gas pipeline located in the street adjacent to the site, a low-cost gas supply was easily achievable.

"The trigeneration gas generator was also proposed to be used to provide the building with Property Council of Australia Grade A stand-by power supply, by replacing the diesel generator," he says.

Naturally, the addition of trigeneration so late in the design phase created a number of challenges – available space being one of the main concerns.

"Getting it into a building envelope that had been substantially developed, with the space requirements for the plant almost locked in, was a challenge," Ralph says.

The plant was sized to produce 1000kW of electrical power so that, in conjunction with a 99kWe solar PV array installed on the rooftop, up to 40 per cent of the base building's electrical maximum demand could be met.

But where to place it? The answer was to add it to the rooftop plant.

"Installing a small power plant on the roof of a commercial building enters the realms of industrial engineering," says Bourne.

"This required a very high quality of controls, testing, safety and documentation – far beyond what is provided for traditional building services. Trigeneration systems require an immense amount of coordination between all building services trades, and this has been an area of difficulty in the past."

Because the plant sits above an office space with a noise criteria of 40dB(A), AE Smith engaged Vipac Engineers to carry out an acoustic and vibration assessment report to verify that this noise criteria could be achieved.

This involved measuring the natural frequency of the slab and comparing it to the frequency of the generator.

Based on this data, a vibration isolation solution was designed using specially designed mounts.

The Floth-specified risk assessment and hazardous area classification were carried out by AE Smith.

"Ordinarily this would be completed during the design phase of a project, although very few projects actually go to this extent at all," says Bourne.

"The risk assessment determined the safety integrity level (SIL) of various gas safety systems. Additional gas detection and layers of protection were required as a result."

Unlike most trigeneration systems in commercial office buildings, the 180 Brisbane system makes use of a single-effect lithium bromide absorption chiller.

Where two-stage absorption chillers have traditionally been used due to their higher efficiencies, Bourne says that they are more difficult to control and have had a greater tendency towards crystallisation, in practice.

"When the heat input into the absorber changes, the temperature and concentration of the lithium bromide is impacted, which can change the point at which crystallisation occurs," he says.

"For this reason it is important to provide a stable flow of heat into the absorber."

Although the single-effect absorber is slightly less efficient, it is expected to offer greater reliability and stability under varying load.

MULTIPLE CONTROLS

Late in 2014, with construction well under way, a 2250kVA diesel engine generator was also added to the project following a request by major tenant, the Commonwealth Bank of Australia. The CBA wanted to provide 700kVA of stand-by power to their tenancy.

This system met the Property Council of Australia's Premium Grade base-building stand-by power requirements.

The gas-fired trigeneration plant and the dedicated stand-by diesel generator have been designed to be run in parallel. Yet the addition of the diesel generator required a complete rewrite of the generator controls in a very short space of time to allow for additional modes of operation.

Bourne says as the detailed design progressed, various scenarios would arise that had to be addressed.

THE AHU FANS

The AHU fans used at 180 Brisbane are the first in the world to boast the functionality they possess, and AE Smith worked closely with the AHU and fan suppliers to develop this solution specifically for this project.

During normal operation, the fans within the AHUs provide efficient movement of air across the building. But in the event of a fire where smoke becomes a hazard, the internal temperature management of the fans automatically switches off and they operate independently of the speed setting for normal operation.

By automatically overriding the fan's self-protecting features, the fan runs at maximum speed for as long as possible to keep fire escape routes smoke-free – either until fire mode is removed or the motor fails.

The integration of fire mode in this way provides significant cost savings over traditional smoke extraction systems by eliminating separate components such as fan, motor, VSD and bypass to guarantee a safe environment.

> Having all services drafted in 3D was a necessity

"For example, there is a system in the fire control room that allows the fire brigade to take control of all the main switchboard circuit breakers," Bourne says. "As you can imagine, this is not ideal when your generator control system is trying to distribute stand-by power to essential services."

There were also additional scenarios required to accommodate the failure of one generator in stand-by mode.

"There are four main switchboards – two base-building boards and two tenant boards – which are provided with stand-by power. The generator control system operates differently if one, all, or any combination of main switchboards loses their mains electricity supply," Bourne says.

Other stand-by modes are also available, depending on whether the trigeneration system was running at the time of the power failure.

The custom generator control system is broken into three separate segments: the GGCS (gas generator control system), the DGCS (diesel generator control system) and the SGCS (supervisory generator control system).

An independent emissions-control system is also provided to reduce the NOx (nitric oxide and nitrogen dioxide) emissions from the gas generator.

Also, a chiller-management system (CMS) provides complete control of chilled-water generation, including control of the building's cooling towers, chilled-water and condenser-water temperature reset strategies, and operation of the chillers in stand-by mode.

This CMS also monitors the chiller compressor data to determine the set-point reset.

Of course, 180 Brisbane's building management system (BMS) provides a conduit for all the various control systems and interfaces with lifts, the fire system, security, hydraulics, generator controls, and the energy management system (EMS).

180 Brisbane reached completion in late 2015, with the Commonwealth Bank of Australia having already taken occupancy, and another major tenant, Tatts Group, recently committing to a long-term lease.

Among a host of new developments in Queensland's capital, 180 Brisbane appears to have set a new direction for the city – and perhaps in how trigeneration might be used to help power the next generation of Australian commercial office buildings. ▮

PROJECT AT A GLANCE

The personnel

- **Architect:** Crone Partners
- **Building services:** Floth Sustainable Building Consultants
- **Developer:** Daisho Group
- **Contractor:** WATPAC
- **ESD:** FLOTH Sustainable Building Consultants
- **Independent commissioning agent:** VAE
- **Mechanical contractor:** AE Smith

HVAC equipment

- **Absorption chiller:** Carrier
- **AHUs:** Air Design
- **AHU fans:** Ziehl Abegg
- **BMS:** Leading Edge Automation – Optergy
- **Condensing boilers:** Automatic Heating – Eurogen
- **Diffusers:** Holyoake
- **Electric chillers:** Carrier
- **Emission controls:** Exhaust Control Industries – Steuler
- **Fans:** Air Design – Fantech
- **FCUs:** Dunnair and Mitsubishi Electric
- **Grilles:** Holyoake
- **Solar PV:** Infinity Power
- **Sub-metering:** VRT
- **Trigeneration:** Caterpillar (gas and diesel)
- **Trigeneration controls:** Energy Power Consulting Engineers
- **VAV system:** Celmec