OLD BUILDING, NEW BOILERS

Late last year, AIRAH's ACT division conducted a site visit to the boiler room of Old Parliament House, now home to the Museum of Australian Democracy. The building's boilers have recently been upgraded, adding another chapter to the history of heating equipment used on the site.

Designed by John Smith Murdoch, the Commonwealth government's first architect, Old Parliament House (OPH) in Canberra served as the home of Australia's federal parliament from 1927 until 1988.

Reflecting the "stripped classical style" that was popular during the 1920s and 1930s, it was originally intended as a provisional building – neither temporary nor permanent, but rather one that would suffice for 50 years.

Rendered in white concrete, the three-storey brick building's façade features strong, horizontal lines and extensive glazing that, along with the use of skylights and light wells, flood the interior with natural light.

However, OPH was not without its detractors when completed in 1926. Many believed its design, including the sweeping verandas and sequence of columns, was not befitting of the nation's most important building.

Although relatively modest, the building's design was nonetheless functional, catering for its few hundred occupants with its own post office, library, carpentry workshop, bars and dining room. Only the Speaker of the House, the President of the Senate, the Prime Minister, the Leader of the Government in the Senate and ministers were provided with their own offices.

The building went on to serve the nation for 61 years (11 more than was originally intended), during which time the House of Representatives grew from 76 to 148 members, and the Senate grew from 36 to 76 members.

Installing the new chimney flues. *Photo: J. Sainsbury*

Numerous extensions were completed over that time, but by the 1980s the building's capacity had been well and truly exceeded. As a result, today's Parliament House was constructed on the site opposite, on Capital Hill.

The last sitting of Parliament in OPH occurred in June 1988, after which time it was left vacant while a decision was made about its future.

In 1992, the building became the temporary home of the National Portrait Gallery. And in May 2009, it was opened as the Museum of Australian Democracy at Old Parliament House (MOADOPH).

THE BOILER ROOM

The South Wing of OPH is a historically important section of the building featuring dining and recreational facilities.

This wing also houses the essential ancillary services of the building, including the boiler room.

Building plansdating to 1926 identify the current location of the boiler room as housing boilers, as well as providing access to chimneys and an area for coal storage.

According to Edwina Jans, manager of Heritage and Collections at the museum, the original heating for OPH was supplied by hot water boilers that fed radiators distributed around the building, with air circulation provided via a ventilation system.

"Originally, there were four boilers – two for heating and two to supply the kitchen equipment," Jans says. "The boilers were powered by coal, and there was a coal storage area at the back of the boiler room."

These four boilers were converted to oil in 1957. In 1978, they were replaced by electric boilers.

Two gas-fired steam generators were added after reticulated natural gas became available in Canberra in the 1980s. The site's electric boilers were then replaced by gas-fired boilers in the early 1990s.

"The room currently features evidence of the electric boilers," Jans says. "Only the modified brick chimney remains as evidence of the coal-fired era."

IMPROVING EFFICIENCY

In 2012, consideration was given to the replacement of the aging gas-fired atmospheric type boilers. Although the system was providing sufficient heating capacity for the building, the age and reliability of the plant suggested it was nearing the end of its useful life.

Upgrades to heritage sites must change as much as necessary but as little as possible. *Photo: J. Sainsbury*

Furthermore, the museum had embarked on a strategic plan to reduce energy costs and the emission of greenhouse gases. A target was set of a 5 per cent per year reduction in energy consumption under the Australian government's Energy Efficiency in Government Operations (EEGO) program.

Canberra-based consulting engineering firm GHD was engaged as design consultant to investigate available options for the heating system upgrade and to provide recommendations.

According to AIRAH ACT division president Lasath Lecamwasam, M.AIRAH, principal engineer with GHD, on first inspection it was apparent that the existing boilers were approaching the end of serviceable life and were inefficient compared with modern technology.

The heating water system comprised of three gas-fired atmospheric boilers, each with a heating capacity of 505kW. Each boiler was flued into a common brick chimney to allow fumes to be discharged outside.

Heating hot water from the plant room was distributed through a primary-secondary system. The primary circuit consisted of the three boilers and two circulating pumps. The secondary circuit consisted of three circulating pumps, two of which were controlled by variable-frequency drives (VFDs) in lead/lag mode. The third was used as a stand-by pump.

GHD found the distribution system to be operating inefficiently, with the pumps operating continuously at high speed, resulting in a substantial waste of electricity.

The heating system was controlled by a BMS, with space heating provided by a combination of the original wall-mounted radiators and AHUs with hot water heating coils that had been installed subsequently.

The heating plant was required to operate around the clock to provide temperature and relative humidity conditions to preserve paintings and other artefacts located throughout the building. This resulted in approximately 15,000GJ of natural gas being consumed each year at an annual cost of over $132,000. Even in January, when heating requirements should be very low, the boilers were operating at an average load of 290kW.

A review of metering and gas bills showed that the majority of the building's gas consumption was from the three boilers, with the gas consumption from other uses such as domestic hot water and the kitchens remaining comparatively small.

"We estimated that the heating system accounted for 94 per cent of the building's total gas usage, and 52 per cent of the building's total energy consumption – gas and electricity," says Lecamwasam.

He says the energy efficiency of the atmospheric boilers was poor compared to modern condensing-type boilers, especially at low load, where the boilers at OPH should be operating for the majority of the time.

A number of options were analysed, including the use of conventional boilers only, condensing-type boilers only, solar preheat of the heating water system, and cogeneration.

However, following a cost-benefit analysis of these technologies, a combination of one condensing boiler supported by two conventional, forced-draught boilers proved the most suitable.

"Unlike an office-type building, OPH has long periods of low heating demand because of the need for humidity control in areas where artwork is housed," says Lecamwasam.

"Therefore, the decision was made to install a condensing boiler that would cater for most of the heating energy demand, backed up by conventional-type boilers for use during very cold periods when the heating demand is high."

He says that for condensing boilers to operate at their most efficient, the heating water return temperature is required to be below 55°C – the dew point of the flue gases.

This required a controls system to be programmed to ensure these conditions are satisfied as much as possible.

"For relatively short periods of the year, when the heating demand cannot be satisfied by the low water temperatures, the set-point is automatically re-adjusted upwards and the condensing boiler operates as a high-efficiency conventional boiler," Lecamwasam says.

Boiler upgrade showing newly installed boilers in 2014. *Photo: Kopievsky, M.AIRAH, Museum of Australian Democracy collection.*

VISITING THE OLD PARLIAMENT

AIRAH's ACT division visits Old Parliament House.

AIRAH's ACT division visited the Old Parliament House (OPH) boiler room as part of a site visit held late last year.

Led by ACT division president Lasath Lecamwasam, M.AIRAH, from GHD, Mick Holmes from the museum, the site tour explored 90 years' of that boiler room's history.

The site visit provided insight into a project that faced many challenges, including its heritage listing, connection to the original chimney and the integration of modern condensing boiler technology, while maintaining business-as-usual for the thousands of visitors. Drawings of the original heating systems were on display, along with examples of some of the previous equipment that was installed.

Top of the chimney with new flues installed, in 2013.
Photo: Steve Kopievsky, M.AIRAH.

Good water treatment was also essential for the condensing boiler, particularly given the age of the building where debris exists in pipework. The heating system pipework and heat exchangers feature a combination of different metals.

Therefore, a dirt separator was installed and water treatment chemicals were replenished.

"Since condensate from the condensing boilers is acidic, to protect the copper sewer pipes in this heritage building, acid neutralisation was also installed," Lecamwasam says.

HERITAGE PARAMETERS

Although a boiler replacement would normally be considered a straightforward project, the heritage values of OPH made it anything but simple.

OPH is a National Heritage-listed building because of outstanding heritage values relating to its history, design, location, collection of movable items, social values and associations.

"All nationally listed sites must have a management plan that dictates how a place is to be used, conserved, and how the values or stories about the place are to be communicated to the public," says Jans.

"The Old Parliament House Heritage Management Plan outlines the policies and procedures under which change, such as equipment or plant upgrades, is managed while ensuring conservation of the values."

Such plans recognise the importance of maintaining facilities to ensure safety and meet building code and environmental benchmarks. But as much of the original fabric of the building as is possible must be retained during any renovation.

The entire project was therefore conducted in accordance with the site's Heritage Management Plan and the Australia ICOMOS (International Council on Monuments and Sites) Burra Charter.

The Burra Charter provides guidance for the conservation and management of places of cultural significance. It sets a standard of practice for making decisions about, or undertaking works to such places.

"The Old Parliament House Heritage Management Plan uses the Charter principles as the basis for policies on conservation and use," Jans says.

"It advocates an approach to works of changing as much as necessary but as little as possible, and respecting existing fabric, use, associations and meanings."

Given the constraints of the boiler room space, it was agreed upon that some pre-1988 equipment could be removed, but only where representative samples remained. The equipment that was installed after the building ceased being used as a Parliament House in 1988 was also removed.

PROJECT AT A GLANCE

Project team

Client: Museum of Australian Democracy, at Old Parliament House

Consulting engineers: GHD Consulting Engineers

Mechanical contractor J. Sainsbury

Equipment

Condensing boiler: Rendamax (ACT Boiler & Burner Service)

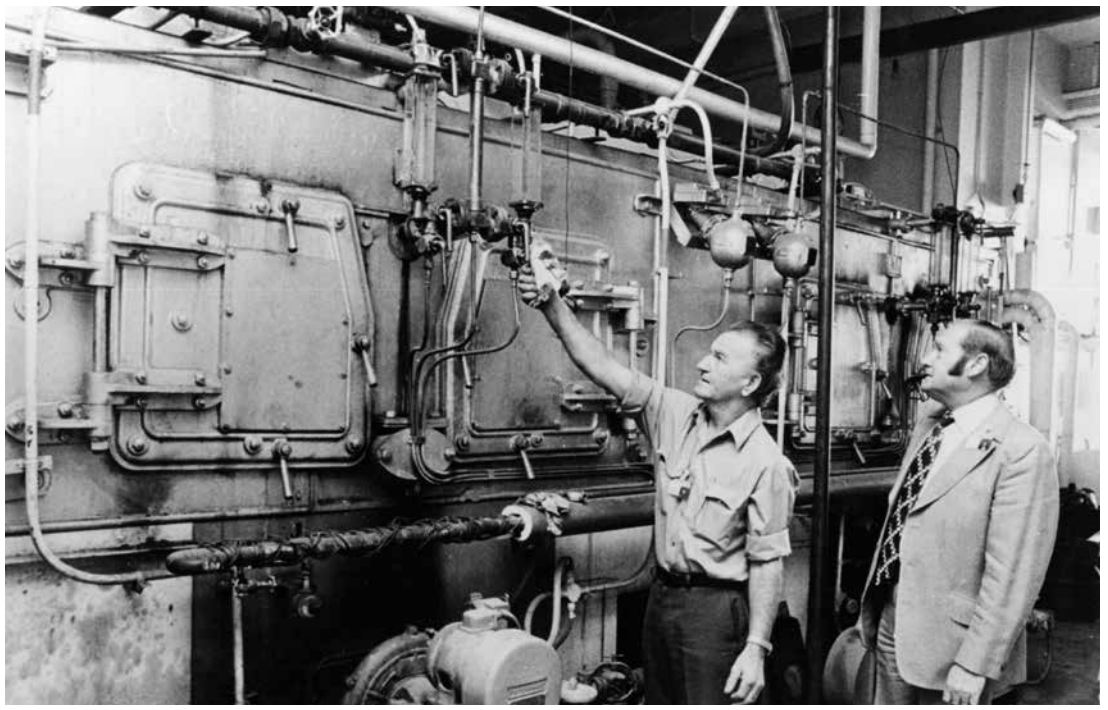
Conventional boilers: Hunt Boilers (ACT Boiler & Burner Service)

Dirt and air separator: Duralflex (Automatic Heating)

Expansion tanks: Duralflex (Automatic Heating)

Pumps: Grundfos (QMAX Pumping Systems)

VSDs: Danfoss



Boilers after the 1957 conversion to oil firing, c.1970. *Both photos: Museum of Australian Democracy collection.*

Electric boilers, c.1985.

Jans says that in this project, the original use of the space as a plant room was able to be maintained, thus maintaining the use and meaning of the space within the building.

"While we undertook some adaptation of the space, we were able to preserve the original fabric – by keeping equipment in situ – to ensure that the historic layers of the space's use remain legible and visible," she says.

"The museum's policy is to acknowledge the entire history of the building from 1927 to 1988, and not privilege one particular period over another. Therefore, ensuring a layered story is told is important."

MANAGING INSTALLATION

GHD proposed a number of works as part of the project.

These included the removal of the existing three boilers, and the installation of one 550kW condensing boiler and two 500kW conventional forced-draught boilers.

It was proposed to replace the existing primary and secondary circulating pumps, as were the existing VFDs, with energy-smart controls functions programmed into the BMS.

Additionally, it was necessary to line the original 1927 brick chimney with new stainless steel flues.

According to Steven Kopievsky, M.AIRAH, assistant facilities manager at the museum, this presented some challenges for the mechanical services contractor J. Sainsbury. It was important to ensure minimal impact to heritage values while meeting current legislative requirements under AS/NZA5601:2010 (Gas installations) and local gas regulations.

Led by Mick Holmes and Adam Kendall, the J. Sainsbury team successfully installed three new stainless steel flues within the internal space of the existing chimney, estimated from original 1926 drawings to be just 1530mm x 980mm in size.

Additionally, the design was able to meet the requirement that the flues did not breach the top of the existing chimney to maintain the current vista.

During these works, steel plates installed within the chimney were identified for the first time. Thought to have been installed when the building was first built in the 1920s, they had remained undiscovered for more than 80 years.

As they were required to be removed to allow for the installation of the new flues, extensive documentation including measurements, photographs and sketches were completed to ensure that the original building configuration was captured.

Holmes says that beyond the obvious obstacles created by the site's heritage values, which were made clear during the tender process, the other challenges related to the installation were relatively typical. These included the installation of a temporary ramp to allow for the removal of equipment, the craning in of equipment, and access to high-level works.

Works were carefully staged to allow the building to remain open to the public during the project, and to ensure conditions within exhibition and storage spaces were not adversely affected.

21ST CENTURY EFFICIENCY

Originally forecast by GHD to deliver a greenhouse gas emissions reduction of 690 tonnes CO2-e annually, and a 9 per cent total energy reduction, the savings have been substantially greater since the project was completed and new boilers commissioned in April 2013.

According to Kopievsky, a 22.2 per cent reduction in gas consumption was recorded in 2013 compared to the previous year.

This figure is expected to be even greater in 2014, once a full-year of operation is completed under the new heating system. Additional savings are expected to be achieved through the optimisation of the controls strategies following a BMS upgrade planned for the near future.

As well as saving energy, the project's retention of evidence of previous technology has contributed to OPH's heritage values, and of the museum's ability to tell a coherent story of the building's use and the evolution of parliament. ▲

BOILER EFFICIENCY

For more information about the application of boilers and boiler efficiency, the April edition of HVAC&R Nation will include a boiler efficiency Skills Workshop, featuring a fact sheet made available by the Australian Government Department of Industry as part of HVAC HESS (High Efficiency Systems Strategy), a program that aims to drive long-term improvements in energy efficiency of HVAC systems Australia-wide.

GHD's Lasath Lecamwasam, M.AIRAH, was a major contributor to the fact sheet.