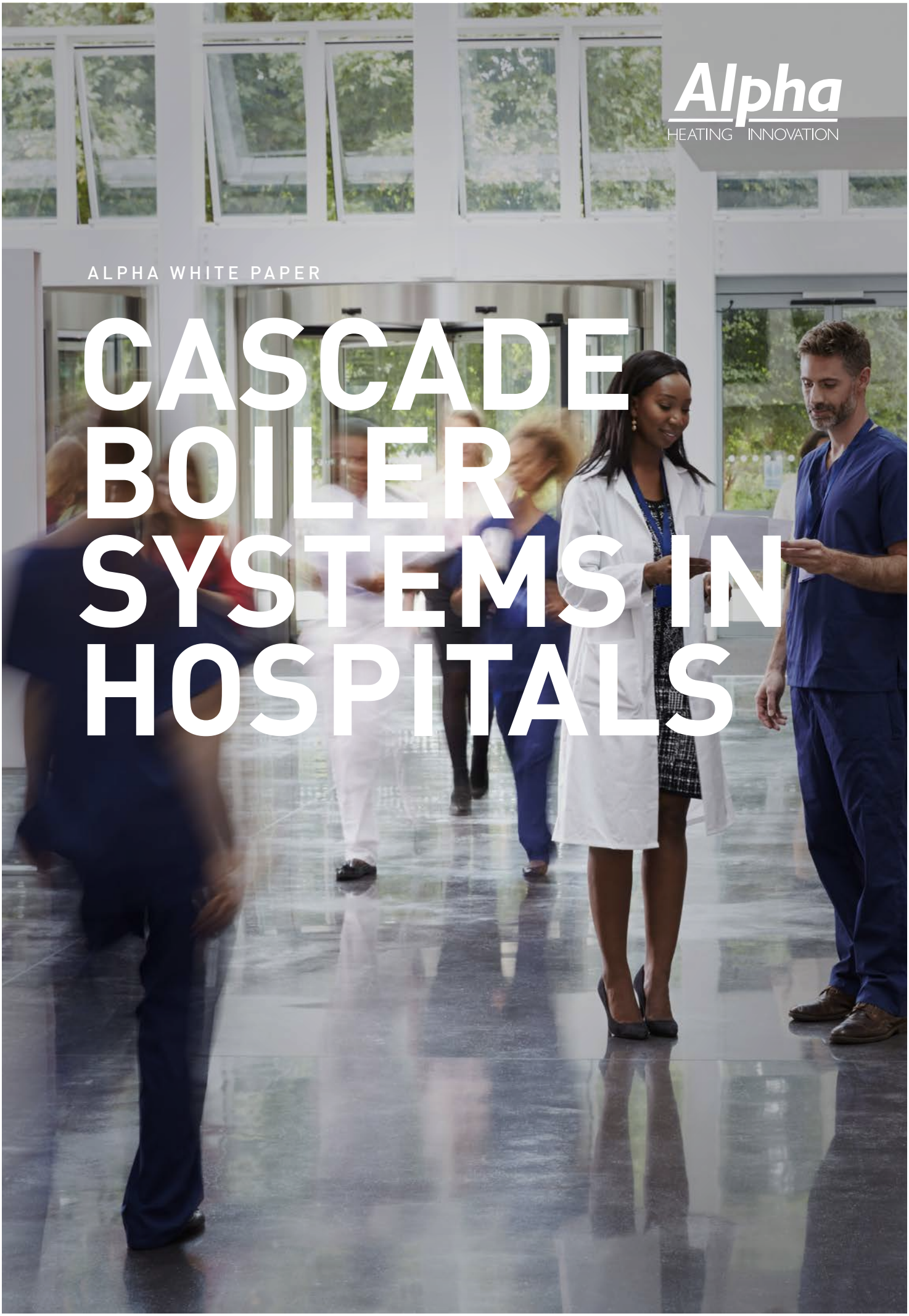

Alpha
HEATING INNOVATION

ALPHA WHITE PAPER

CASCADE BOILER SYSTEMS IN HOSPITALS

With energy consumption growing steadily and NHS budgets getting tighter, it is becoming imperative that Hospital Trusts find new ways to make their buildings more energy efficient.

Hospitals will always have disproportionately high energy costs because of the large amounts of medical equipment used, all of which rely on electricity to run, but despite this their heating can still account for as much as 60% of a typical hospital's energy bill, according to the Carbon Trust.

Reducing energy usage and becoming more efficient allows NHS Trusts to divert the money saved to frontline medical costs, as well as significantly improving comfort levels for patients, doctors and nursing staff alike.

With the government drawing up league tables ranking NHS Trusts by their efficiency levels, and setting mandatory efficiency and budgetary saving targets that they expect hospitals to meet, making heating systems more efficient is a logical way for Trusts to start reducing their spending levels and make budgets go further.

Upgrading a heating system may bring with it significant upfront costs, especially if the hospital is of considerable size, but the long-term efficiency savings that are possible should more than cover the initial expense.

CHANGING REGULATIONS

NHS Trusts looking to improve the efficiency of their older, existing heating systems, or who need to replace broken or irreparable appliances, will find that the technology available to replace their existing appliances has changed significantly in recent years.

The government is keen for the UK's building stock to operate as efficiently as possible to help it meet its carbon reduction obligations, and so it has introduced a number of new regulations over the past decade to encourage building owners of all kinds, and particularly in the commercial and public sector, to improve their energy efficiency levels.

The Energy-related Products Directive (ErPD), introduced to the UK on 26th September 2015, established minimum energy performance standards for all energy-consuming products, including boilers, with outputs between 70kW and 400kW. The directive states that the useful efficiency of these boilers when operating at full capacity shall be no less than 86%, and at 30% load the useful efficiency should be 94% or higher.

The non-condensing boiler technology typically installed in hospitals before this date is unable to meet these standards, and so has been phased out and replaced with condensing appliances instead. Now, NHS Trusts who are looking to upgrade their heating and lower their energy costs must consider installing a new system based on condensing boiler technology, rather than relying on the same technology that they have previously had.

For those commercial Gas Safe registered-installers being asked to upgrade or retrofit hospital heating systems, cascade boilers offer a practical solution to ensure they comply with the new regulations, while also providing the high efficiencies that their clients require.

A cascade heating system comprises a number of condensing boilers connected through hydraulic and gas pipework, linking each boiler and flue together. The engineer then uses modern controls to ensure they operate efficiently in sequence, providing peak load heat outputs when needed, and modulating down as much as possible when they are not required. Cascade boilers can be wall-hung or freestanding, or supplied pre-fitted into purpose-built freestanding frames to make them faster and easier to install.

This is of particularly importance for hospitals because it means new boilers can be installed quickly which is integral if they are unable to accept patients, or must close down certain wards, while the heating system is being renovated. Considering the vital work that hospitals do for the community, anything that can be done to minimise disruption to patients and staff should be considered as a matter of urgency.

While each individual boiler offers a certain level of central heating output, when several boilers are sequenced to work together in cascade, they can create a system with a total heat output that is far higher. For example, the ProTec Plus range from Alpha Heating Innovation includes condensing boilers with outputs between 54.8kW and 121.7kW but, when up to eight boilers are used in cascade, installers can create cascade systems of over 970kW – more than enough to supply sufficient heat for most good-sized hospitals.

A STEP-CHANGE IN EFFICIENCY

The main benefit of specifying a new cascade system for a hospital comes from the step-change in efficiency that it can offer.

In older buildings, the heating system could easily have been in situ for 30 years or more, still relying on old technology that was relatively inefficient when installed (although it may have been considered high-tech at the time), and has likely become more inefficient over the years as components have aged and potentially been insufficiently treated.

Modern condensing cascade systems are significantly more efficient on first installation, offering 96% efficiencies, compared with the lower efficiencies offered by older boilers that could have been as little as 50% to 60%. This means that even a like-for-like installation in terms of potential output would improve the hospital's overall efficiency substantially.

Installing like-for-like systems used to be a popular choice in retrofit situations, because the engineer could be reasonably sure that the system would provide sufficient warmth for the hospital, so long as the original installer had correctly calculated the system load and the occupants had not already been experiencing problems with insufficient heat.

However, the new requirements of the ErPD mean that, in many cases, like-for-like appliances will no longer be possible. Even if these appliances were still on the market, specifying a simple 'like-for-like' installation is no longer considered best practice, especially in a hospital that has been open for a long time, as it fails to take full advantage of just how efficient commercial condensing boilers can be when fitted in cascade.

There are two main reasons why engineers will need to do more than just swap out the boilers. Firstly, while modern condensing boilers are significantly more efficient than the boilers they are likely to be replacing, to take full advantage of that potential, the system must be designed so that the boilers operate in condensing mode for as long as possible. This may require wider changes to the system design that would not have been necessary when the original system was installed. Condensing boilers will only operate in condensing mode, and therefore at peak efficiency, when the return temperature of the water (also known as the Dew point) is 55°C or lower.

GET THE SYSTEM SIZE RIGHT

A key consideration when designing an efficient cascade boiler system is the fabric of the hospital building itself.

The existing system may have been first designed decades ago, and it is highly likely that the hospital will have been altered and upgraded substantially in the years since, with new wards added and new specialist units introduced as other hospitals are closed down, or the needs of the local community change. These changes could have increased the required heat load of the hospital and as a result change the type of system needed to meet that load.

Conversely, if the hospital has been upgraded in that time, perhaps being fitted with new windows that have better u-values, or a new roof or wall insulation has been installed, then there may be less heat loss through the fabric of the building than was present when the system was first built, meaning the current system is already over-sized.

Even if the building fabric has not changed, there used to be a tendency to oversize heating systems as a matter of course, which will make it more difficult to get the new boilers to operate in condensing mode.

These are all things that the installer needs to consider when designing a hospital's cascade heating system. The first thing to do is to get as much information about the building and the way it is used as possible. Installers should find out when the building's energy usage is likely to be at its highest, and under what circumstances, to best calculate its peak heat demand during the coldest time of the year.

This may require them to spent time with the NHS Trust and facilities or building maintenance department to work out exactly when the system is most likely to need to operate at full capacity. Is it during weekends when the Accident & Emergency

Department is likely to be at its busiest? Or does this hospital specialise in planned, routine operations, in which case weekdays during office hours are likely to be busier. How does the heating system need to react to changes in occupancy patterns?

Then, the installer must assess how much heat is lost through the fabric of the building, and factor that into their system design.

The system must be able to satisfy the building's peak heat demand at the coldest time of the year, while still being able to modulate down to lower temperatures and operate more efficiently, when that heat demand is reduced.

The temptation may be for the installer to still deliberately oversize the system. After all, an undersized system is unlikely to be able to meet the building's heat demand at peak load, and this can be very difficult – and expensive – to put right once the system has been installed, whereas there are always ways to remove excess heat from a system if necessary.

Many older systems were deliberately oversized by as much as 30% to be sure that the system would always meet the peak heat load, and yet deliberate oversizing brings its own problems, reducing efficiencies significantly and causing the system to be far more expensive to run over its lifetime.

Careful and accurate system sizing will result in lower running costs and higher long-term efficiencies for the hospital. When you consider that capital installation costs can be as little as 20% of a system's overall lifetime costs, it is in the hospital Trust's best interest, and therefore the installer's, to size the system accurately to make it as efficient as possible. Even if that extra work increases the upfront costs slightly, it will be more than paid-back over the years the system is in use.

It is, however, equally possible that accurate sizing could result in lower capital costs, if it results in several smaller kilowatt output boilers being installed in cascade, rather than a larger output boiler that may offer a higher heat output than is actually required.

The Non-Domestic Building Services Compliance Guide recommends keeping any over-sizing to a maximum of 15%, and only following a detailed assessment of the heat load.

Where cascade boiler systems really come into their own is in their modulation, or turndown ratios.

Older boilers only had one mode of operation and so, when they were in operation, they could only run on full, even if that generated more heat than was needed. Modern condensing boilers are able to modulate, which means they have multiple firing rates, and will only fire as much as is needed to satisfy the heat demand.

The ProTec Plus 50 condensing boiler from Alpha, for example, has a modulation range of 1:10. This means the maximum possible output of 55kW can be reduced down to just 5.5kW if there is a lower system demand. For a cascade installation of five such boilers working together, the modulation range improves five-fold, resulting in a possible modulation of 50:1.

This high modulation ratio means the boilers can be commissioned to operate at part load for longer, matching the system demand far more closely at all times. This means each boiler is less taxed, reducing the wear and tear on the components.

For example, a heat load requirement of 90kW could be satisfied using a cascade system of four 50kW Alpha ProTec Plus boilers, each modulated down to operate at 22.5kW. With each boiler running at part-load, fuel efficiency rates would be high. Alternatively, if the hospital does not have the budget to install four boilers at once, a

two-boiler cascade system could be fitted instead, with one 70kW model operating at full load, and the second boiler modulated down to 20kW.

A cascade system can only provide heat that closely matches the changing heat load using the correct controls, to ensure they modulate together to match the load and keep the boilers in condensing mode for as long as possible.

With a carefully designed system of controls to monitor the energy demand and ensure that the design temperature differential between the flow and return water temperatures is maintained, the cascade boilers will accurately respond to the exact heat demand placed on them by the occupants, delivering impressive efficiencies at all times.

Purchasing a cascade system from one manufacturer means the installer can be confident that all the components and controls will work together seamlessly, rather than trying to build a system themselves from disparate products that are not designed to work together.

Even distribution of the heating load across all the boilers also helps spread wear and tear on the components, preventing one boiler from deteriorating before the others because it has been in use more.

Cascade boiler systems are inherently more reliable because they offer built-in redundancies. Instead of a single boiler which, if it fails, must be repaired before the heating system will work again, if one of a series of five boilers fails, then the system will compensate for the loss and continue to provide heat using the other four boilers, ensuring that the hospital can remain open until engineers can visit and carry out the necessary repairs. This is vital for hospitals, whose closure would put a significant strain on other local NHS resources and cause a considerate amount of disruption to patients and the local community.

The more boilers present, the better the redundancy provided. Technically, a cascade system can comprise of just two boilers sequenced to work together, but if one of those two boilers fails for any reason then only half the output is left, which is far less likely to be able to cope with the building's heat demand at peak times. If the required output is spread over more appliances, however, then if one fails less of the overall performance is lost.

PRACTICAL AND FLEXIBLE INSTALLATION

Cascade heating systems provide the installer and Hospital Trust with more benefits than just the improved efficiency they offer.

The very nature of a cascade system – multiple smaller boilers connected together – means they offer flexibility in installation that can be very useful, especially when the boiler room is on the smaller side. While some hospital boiler rooms are large and spacious, others may be smaller and difficult to access, with small doorways that a single boiler large enough to meet the building's total heat demand may not be able to fit through. Smaller output models such as Alpha's ProTec Plus range weigh between 51kg and 103kg, and are small enough that they will fit through any doorway.

The flexibility of cascade systems means it may be possible for hospitals to use a number of wall-mounted boilers, where the total required output would otherwise only be available from larger, floor-standing units. Again, this helps to make them easier for the installer to fit.

Once inside the plant room, the boilers can be combined together in a number of different configurations, such as horizontally or vertically, or even back-to-back or in an L-shape if the space available is particularly awkward.

For NHS Trusts looking for ways to improve their efficiency, lower overheads and increase profits, upgrading their heating to a cascade boiler system offers a great opportunity to make significant savings in the long term, while also enjoying the reassurance that their heating system will be reliable for years to come.

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