Traditional or low-tech replacement boiler installation;

- Multiple boilers eg 2 no each @ 66% of load for security
- Step control for boilers
- Constant speed pumps
- Large flow rates through boilers to match 82/71°C flow rate of existing system
An alternative for a replacement boiler installation;

• One truly modular boiler, full modulation, matched to load but still providing security

• An internal cascade control that maximises efficiency

• Variable speed pumps that match load and reduce electricity consumption

• A Low Velocity Header that matches boilers to system even when $\Delta T$ through boilers differs from that of the system
Multiple module arrangement
Pre-mix gas and air burners

- Gas
- Air
- Mix Air/Gas
Primary pump and Low Velocity Header
Condensing boiler operating at full load
Condensing boiler with multiple boilers each at 33% load

Part L NDHCG heat generator seasonal efficiency recognises that boilers are more efficient at part load than at full load operation
Efficiency comparison @ 30% and 100% load profiles
1 module
100 % = 48 kW

1 module
38 % = 18 kW

η (% pci)

η_{100\%} = 104.9

η_{pot.\,\,min} = 108.4

P (kW)

T. Flow = 50°C
T. Return = 30°C
T. Flow = 80°C
T. Return = 60°C
Modulating pump vs constant flow

How does reducing the flow rate affect the $\Delta T$?

CIBSE AM14 4.3.2 explains how the partial closing of a 2-port valve lowers heat emissions and reduces return water temperature;

“This reduction in water temperature can be explained by the fact that the heat emitted from a radiator does not share a linear relationship with the flow rate. As the flow rate reduces to, say, half of its original value the heat emitted to the room only reduces to 80 or 90% of the original output.
Modulating pump vs constant flow

“Using

\[ kW = \frac{\text{kg/s} \times \text{shc} \times \Delta T}{\text{kg/s} \times \text{shc} \times \Delta T} \]

“if the flow rate reduces to 50% but the heat output only reduces to 90% then the temperature differential must increase to \(90/50 = 180\%\) of its original value, i.e. a temperature difference of 10K increases to 18K.”
Modulating pump vs constant flow

Modulating pump maximises the $\Delta T$ between flow and return, keeping the boiler in condensing mode for longer.

Results can be seen in the reduced flue gas temperature and corresponding increase in overall efficiency as more heat is exchanged to the system.
Flue gas temperature comparison
Variable speed pump performance
Low Velocity Headers
Low Velocity Headers

Diagram of a system with labels for Primary Circuit, Heating Distribution Circuit, BF, HF, BR, and HR. Dimensions labeled as a, b, c, and d.
Low Velocity Headers

Clyde’s Engineering Data Sheets require the inclusion of a Low Velocity Header (LVH) whenever a condensing boiler is installed in a new or existing heating system. It ‘hydraulically decouples’ the boiler from the distribution system, allowing the boiler to operate under temperature and flow conditions that may differ from those of the system. It also enables circulating pumps to be located at different positions on the boiler side and system side of the LVH (e.g., in the return on the boiler side and in the flow on the system side) without affecting their performance.

As an alternative, a plate heat exchanger can be used to completely separate a boiler from the system rather than just ‘decouple’ it. It enables a boiler to be used when its maximum allowable pressure rating is less than the static head of the system and will protect the boiler from the deposition of system particulates and debris. However, decoupling the boiler with a LVH rather than separating it with a plate heat exchanger offers some unique and positive benefits that can be summarised as;

- Permits distribution pumps to be located on the flow, even though boiler pumps may be located on the return
- Enables effective heat exchange between boilers and the system when these are operating at different flow rates and different temperature gradients (e.g., boilers at DT20K and system at DT11K). Will protect the boiler from particulate and debris deposition if a filter or strainer is also fitted (which is a benefit common with the PHE).
Low Velocity Headers

An air separator is often mounted at the top of the LVH because the relative stillness allows dissolved oxygen to escape from the water. A baffle plate may be fitted between the boiler flow and heating flow, to divert and further reduce the water flow rate. If the LVH is also intended to act as a microbubble air separator, then a packing may be introduced into the area of laminar flow to which the microbubbles can attach and be removed by the air vent.

Most systems will have a turbulent flow (ie Re > 10,000\(^1\) - refer a typical Moody Chart). Due to the increased diameter of the main section of pipe forming the LVH, the mass flow rate of the system at this point is reduced to something closer to laminar (f [friction coefficient] = 16 / Re). The LVH diameter is calculated as a product of relative roughness (k / d) of the construction material, fluid density and mass flow rate. The ideal LVH diameter (d) is that which delivers the most suitable Re number. Taking into account the different temperatures and flow rates that may exist between the Boiler side (Primary) and System side (Secondary) of the LVH is important in determining the correct sizing. A common complaint when this is not considered is that the boiler reaches set point temperature but the system does not.
Ideal match of system to boiler – Identical $\Delta T$ both sides of LVH
$\Delta T_{20}$ on boiler side of LVH and $\Delta T_{10}$ on system side

DT = 20 K

DT = 10 K
$\Delta T_{20}$ on boiler side of LVH and $\Delta T_{10}$ on system side
$\Delta T_5$ on boiler side of LVH and $\Delta T_{10}$ on system side
\( \Delta T5 \) on boiler side of LVH and \( \Delta T10 \) on system side
Low Velocity Headers

Installing a variable speed rather than fixed speed pump on the primary side of the LVH will help maintain a constant flow rate that is ideal for minimising the $\Delta T$ and $\Delta P$ between the primary and secondary sides.

A LVH is an essential but often overlooked component when a condensing boiler is to be installed. When correctly sized for the boiler and system, it will allow pumps to be sited on either flow or return, eliminate the problems of mismatched boiler and system flow rates and temperatures, and protect the boiler for many years to come (if used in conjunction with air separators, strainers or filters).
In summary;

• Truly modular boilers offer capital cost savings by reducing the number of boilers and corresponding savings in installation costs without compromising security.

• An internal cascade control increases efficiency by running a maximum number of modules at minimum output.

• Variable speed pumps match load, increase efficiency and reduce electricity consumption.

• A Low Velocity Header matches boilers to system even when $\Delta T$ through boilers differs from that of the system.