

# Heating System Design Specification

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1. Project Overview and Design Basis                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | 2.1 Heat Source Capacity                                                                                                                                                                                                                                                                                                                                                                                                                  |  | 4.2 Zoning Scheme of Circulation Circuits                                                                                                                                                                                                                                                                                                                                            |  | of 70°C exceeds the critical condensing temperature of 55°C, so condensing energy-saving performance cannot be exerted. For long-term operation, conversion to a low-temperature working condition of 60°C supply / 40°C return is recommended. The thermal efficiency can be raised to 105%~107%, gas consumption can be reduced by about 15%, and the circulation flow rate will drop significantly, allowing main pipes to be downsized to DN20 and cutting pipe material costs;                                                                                                                                                                                                                                                  |  |
| 1.1 Project Overview                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | After summarizing zonal heating loads, the total building heating demand is approximately 38.40kW. A single boiler running at full load can maintain the indoor constant temperature of 18°C under extreme low temperature weather.                                                                                                                                                                                                       |  | 1 Large halls: Independent reverse return circuits, with no more than 14 radiators per circuit to realize automatic hydraulic balance and reduce commissioning workload.                                                                                                                                                                                                             |  | thermal efficiency can be raised to 105%~107%, gas consumption can be reduced by about 15%, and the circulation flow rate will drop significantly, allowing main pipes to be downsized to DN20 and cutting pipe material costs;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| This project is located in Manchester, UK, with a church as its building function. It contains multiple large open halls, auxiliary office rooms, washrooms, stair buffer rooms and other functional areas. The designed indoor heating reference temperature is 19°C. A closed hot water heating system with steel column radiators is adopted, with a 42kW condensing gas boiler as the heat source. The designed supply and return water temperatures are 80°C / 70°C. |  | 3. Specification for Heat Source Equipment Selection and Parameters                                                                                                                                                                                                                                                                                                                                                                       |  | 2 Other scattered small rooms: Reverse return parallel circuits, with no more than 8 radiators per circuit.                                                                                                                                                                                                                                                                          |  | 2 Time and zonal temperature control. Each independent circuit shall be equipped with a programmable time thermostat to lower the set temperature during non-service hours of the church and reduce invalid heat loss;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | 4.1 Gas Boiler Parameters (Consistent with Attached Equipment Data Sheet)                                                                                                                                                                                                                                                                                                                                                                 |  | 3 Independent circuits shall be arranged for frost protection areas such as stairwells and plant rooms, which can be kept open 24 hours a day; other areas can be shut down periodically for energy saving;                                                                                                                                                                          |  | 3 Building fabric complementary energy-saving measures: Air curtains shall be installed at main entrance doors, and sealing strips shall be fitted to all windows and doors to reduce cold air infiltration load, which can lower the design heating load index to 35W/m2 and reduce the total number of radiator sections.                                                                                                                                                                                                                                                                                                                                                                                                          |  |
| 1.2 Local Applicable Mandatory UK HVAC Standards                                                                                                                                                                                                                                                                                                                                                                                                                          |  | 1 Rated heating output power: 42,000W (14.3,300BTU/h);                                                                                                                                                                                                                                                                                                                                                                                    |  | 4 Manifold assemblies shall be installed at the central position. Each circuit shall be equipped with a ball isolating valve, Y-type strainer and automatic air vent, allowing maintenance of a single circuit without interrupting heating supply to other zones.                                                                                                                   |  | 4 Destratification fans shall be applied for worship hall and second hall to force warm air trapped at high ceilings down to the floor level to reduce the heating waste.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| 1 CIBSE Guide A 2024 – Standard for Building Heating Load Calculation                                                                                                                                                                                                                                                                                                                                                                                                     |  | 2 Gas input power: 44.46kW;                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 2 BS EN 12831 - European Standard for Calculation of Building Heating Loads                                                                                                                                                                                                                                                                                                                                                                                               |  | 3 Thermal efficiency under high-temperature operating condition (80/70°C): 92%~94%;                                                                                                                                                                                                                                                                                                                                                       |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 3 BS EN 442 – Specification for Thermal Performance Testing of Steel Radiators                                                                                                                                                                                                                                                                                                                                                                                            |  | 4 Domestic hot water capacity: 17.18L/min under temperature rise ΔT=35°C;                                                                                                                                                                                                                                                                                                                                                                 |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 4 BS 5449 – Code of Practice for Design and Hydraulic Balancing of Hot Water Heating Systems                                                                                                                                                                                                                                                                                                                                                                              |  | 5 Applicable gas source: Mains natural gas, convertible to LPG;                                                                                                                                                                                                                                                                                                                                                                           |  | 4.3 Design for Pipeline Air Venting and Noise Reduction                                                                                                                                                                                                                                                                                                                              |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 5 Part L 2021 – England Building Regulations on Energy Conservation (Efficiency Requirements for Condensing Boilers)                                                                                                                                                                                                                                                                                                                                                      |  | 6 Power supply standard: 230V/50Hz, complying with UK civil power supply standards.                                                                                                                                                                                                                                                                                                                                                       |  | Automatic air vents shall be installed at the highest point of all circuits; All large-diameter pipes (DN25/DN40) shall be wrapped with sound-absorbing thermal insulation layers to reduce flow noise and satisfy acoustic requirements of church buildings.                                                                                                                        |  | 7 System Operation and Maintenance Instructions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 6 BS EN 677 – Safety and Energy Performance Standard for Gas-Fired Condensing Boilers (Efficiency Requirements for Condensing Boilers)                                                                                                                                                                                                                                                                                                                                    |  | 3.2 Hydraulic Parameters of 80°C Supply / 70°C Return High-Temperature System                                                                                                                                                                                                                                                                                                                                                             |  | 5 Special Design for Radiator Arrangement                                                                                                                                                                                                                                                                                                                                            |  | 1 System flushing, air venting and hydraulic balancing commissioning shall be carried out every year before the heating season;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 7 Local meteorological parameters of Manchester. Design outdoor heating temperature -4.8°C, designed indoor heating temperature 19°C. (Efficiency Requirements for Condensing Boilers)                                                                                                                                                                                                                                                                                    |  | Calculation formula for hot water circulation mass flow: $m=Q/(c \times \Delta T)$                                                                                                                                                                                                                                                                                                                                                        |  | 1 General layout principle: All radiators shall be preferentially installed below external window sills to form a warm air curtain to block cold air infiltration, complying with CIBSE heating layout specifications. Radiators shall be installed with a minimum clearance of 100mm above finished floor and 50mm away from finished walls to reserve sufficient convection space. |  | 2 Scale inhibitors shall be injected into the high-temperature hot water system every 2 years to prevent scaling and blockage of pipelines and radiators;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| (Efficiency Requirements for Condensing Boilers)                                                                                                                                                                                                                                                                                                                                                                                                                          |  | Full-load heating circulation flow rate of the boiler: 60L/min (3600L/h), temperature difference ΔT=10K. The system features high circulation flow and relatively high overall pipeline resistance. Low-noise high-lift circulating pumps shall be selected, and static balancing valves shall be fitted to all circuits to meet the mandatory hydraulic balancing requirements of BS 5449 of 33°C under extreme low temperature weather. |  | 2 Optimization for large halls: Multiple radiators shall be evenly arranged along ground-floor window sills. Supplementary heating units at mid-height may be installed if necessary to reduce vertical temperature stratification in large spaces, avoiding overheating at ceiling level and insufficient temperature at ground level where people stay;                            |  | 3 The boiler shall be inspected and its combustion condition calibrated annually by a Gas Safe registered engineer in the UK to guarantee gas safety and rated thermal efficiency.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | 4. Piping System Design                                                                                                                                                                                                                                                                                                                                                                                                                   |  | 3 Rooms with high heating load (floor area>20), shall be equipped with multiple split radiator sets. A single radiator assembly shall not exceed 12 sections to guarantee protective railings shall be fitted to radiators in high-footfall areas to eliminate scald hazards to the elderly and children exposed to 80°C hot surfaces;                                               |  | 4 Frost protection circuits shall remain open all year round to avoid pipeline freeze damage in winter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| 2. Design Specification for Heating Load Calculation                                                                                                                                                                                                                                                                                                                                                                                                                      |  | 4.1 Pipe Material and Diameter Classification (Diameters decrease sequentially from heat source to terminal ends)                                                                                                                                                                                                                                                                                                                         |  | 5 Radiators inside plant rooms shall be placed with sufficient clearance from electrical control cabinets to reserve safe maintenance space.                                                                                                                                                                                                                                         |  | 8 Design Conclusion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| 2.1 Heating Load Index                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  | 1 Main boiler supply and return pipes: DN40 (DN32 can be used temporarily for pipe runs shorter than 10m), to counteract high flow velocity and pipeline noise caused by large flow rates;                                                                                                                                                                                                                                                |  | 6. Energy Saving and Compliance Optimization Recommendations (Complying with Part L 2021)                                                                                                                                                                                                                                                                                            |  | This heating system fully complies with local CIBSE, BS and Part L series specifications in Manchester, UK. Load correction and hydraulic piping design are completed targeting the special working conditions of the church, including 4m extra-high floor heights and severe cold air infiltration. The hot water radiator heating system can meet the basic demand of maintaining indoor temperature at 19°C, yet there are shortcomings with the single 42kW boiler heat source. It is recommended to add a second identical boiler for parallel connection, or optimize the system to the low-temperature 60/40°C condensing working condition, to further improve heating stability and long-term operation energy efficiency. |  |
| The initial preliminary heating load index is 42W/m2.                                                                                                                                                                                                                                                                                                                                                                                                                     |  | 2 Main pipes for reverse return circuits of large open halls: DN32;                                                                                                                                                                                                                                                                                                                                                                       |  | 1 Water temperature optimization for higher energy efficiency. This boiler is a condensing unit. At the 80°C supply / 70°C return working condition, the return water temperature                                                                                                                                                                                                    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 2.2 Principles for Zonal Load Calculation                                                                                                                                                                                                                                                                                                                                                                                                                                 |  | 3 Main pipes for zonal circuits of offices, stairwells and other low-load areas: DN25/DN20;                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 1 Large Halls (274.77, 295.55, 60.31): Radiators shall be evenly arranged at multiple points along external walls. A reverse return piping system shall be adopted for large halls to offset hydraulic imbalance caused by long pipe runs. Hot air blowers / space heaters (Water-to-air heat exchangers) shall also be adopted.                                                                                                                                          |  | 4 Terminal branch pipes for radiators: Uniform DN15;                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 2 Small auxiliary rooms, stairwells and washrooms: Reverse return parallel piping shall be applied. Each radiator shall be equipped with an independent thermostatic radiator valve to realize separate room temperature control.                                                                                                                                                                                                                                         |  | BS-standard PPR special hot water pipes with a continuous heat resistance temperature of no less than 95°C shall be adopted. Insulating pipe sleeves shall be installed where pipes penetrate walls and wooden components, to eliminate risks of scalding and thermal damage to wooden structures induced by 80°C hot water.                                                                                                              |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 3 Special heated towel radiators shall be installed in washrooms to meet both heating and towel drying demands, complying with special washroom heating requirements of BS 5449.                                                                                                                                                                                                                                                                                          |  |                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 4 Independent frost protection circuits shall be set for stairwells and buffer rooms to maintain basic heating all year round and prevent pipeline freezing.                                                                                                                                                                                                                                                                                                              |  |                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |