

Specification for the design, installation and commissioning of gas fired central heating systems in domestic premises

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Foreword

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 37 and a back cover.

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1 Scope

This Product Assessment Specification specifies requirements for the sale, design, installation and management of a complete gas fired central heating system, incorporating the boiler, system and temperature control devices.

In addition to the definitive requirements, this Product Assessment Specification also requires the items detailed in clause 4 to be documented. For compliance with this Product Assessment Specification, both the definitive requirements and the documented items have to be satisfied.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Product Assessment Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).*

BS 143, *Specification for malleable cast iron and cast copper alloy threaded pipe fittings.*

BS 715, *Specification for metal flue pipes, fittings, terminals and accessories for gas-fired appliances with a rated input not exceeding 60 kW.*

BS 759-1, *Valves, gauges and other safety fittings for application to boilers and to piping installations for and in connection with boilers — Part 1: Specification for valves, mountings and fittings.*

BS 864-3 (Obsolescent), *Capillary and compression tube fittings of copper and copper alloy — Part 3: Compression fittings for polyethylene pipes.*

BS 1010-2, *Specification for draw-off taps and stopvalves for water services (screw-down pattern) — Part 2: Draw-off taps and above-ground stopvalves.*

BS 1212-2, *Float operated valves — Part 2: Specification for diaphragm type float operated valves (copper alloy body) (excluding floats).*

BS 1212-3, *Float operated valves — Part 3: Specification for diaphragm type float operated valves (plastics bodied) for cold water services only (excluding floats).*

BS 1256, *Specification for malleable cast iron and cast copper alloy threaded pipe fittings.*

BS 1289 (all parts), *Flue blocks and masonry terminals for gas appliances.*

BS 1387, *Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.*

BS 1566-1, *Copper indirect cylinders for domestic purposes — Part 1: Specification for double feed indirect cylinders.*

BS 1566-2, *Copper indirect cylinders for domestic purposes — Part 2: Specification for single feed indirect cylinders.*

BS 1740-1, *Specification for wrought steel pipe fittings (screwed BS 21 R-series thread) — Part 1: Metric units.*

BS 2767, *Specification for manually operated copper alloy valves for radiators.*

BS 2871 (all parts), *Specification for copper and copper alloys — Tubes.*

BS 2879, *Specification for draining taps (screw-down pattern).*

BS 3198, *Specification for copper hot water storage combination units for domestic purposes.*

BS 4213, *Specification for cold water storage and combined feed and expansion cisterns (polyolefin or olefin copolymer) up to 500 L capacity used for domestic purposes.*

BS 4814, *Specification for expansion vessels using an internal diaphragm, for sealed hot water heating systems.*

BS 5154, *Specification for copper alloy globe, globe stop and check, check and gate valves.*

BS 5258-1, *Safety of domestic gas appliances — Part 1: Specification for central heating boilers and circulators.*

- BS 5258-8, *Safety of domestic gas appliances — Part 8: Combined appliances: gas fire/back boiler.*
- BS 5258-15, *Specification for combination boilers — Part 15: Specification for combination boilers.*
- BS 5440-1, *Installation of flues and ventilation for gas appliances of rated input not exceeding 60 kW (1st, 2nd and 3rd family gases) — Part 1: Specification for installation of flues.*
- BS 5440-2, *Installation of flues and ventilation for gas appliances of rated input not exceeding 60 kW (1st, 2nd and 3rd family gases) — Part 2: Specification for installation of ventilation for gas appliances.*
- BS 5449, *Specification for forced circulation hot water central heating systems for domestic premises.*
- BS 5482-1, *Domestic butane- and propane-gas-burning installations — Part 1: Specification for installations at permanent dwellings.*
- BS 5615, *Specification for insulating jackets for domestic hot water storage cylinders.*
- BS 5955-8, *Plastics pipework (thermoplastics materials) — Part 8: Specification for the installation of thermoplastics pipes and associated fittings for use in domestic hot and cold water services and heating systems.*
- BS 5970, *Code of practice for thermal insulation of pipework and equipment (in the temperature range -100 °C to +870 °C).*
- BS 6332-1, *Thermal performance of domestic gas appliances — Part 1: Specification for thermal performance of central heating boilers and circulators.*
- BS 6332-3, *Thermal performance of domestic gas appliances — Part 3: Specification for thermal performance of combined appliances: gas fire/back boiler.*
- BS 6500, *Specification for insulated flexible cords and cables.*
- BS 6700, *Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.*
- BS 6759-1, *Safety valves — Part 1: Specification for safety valves for steam and hot water.*
- BS 6798, *Specification for installation of gas-fired hot water boilers of rated input not exceeding 60 kW.*
- BS 6891, *Specification for installation of low pressure gas pipework of up to 28 mm (R1) in domestic premises (2nd family gas).*
- BS 7074-1, *Application, selection and installation of expansion vessels and ancillary equipment for sealed water systems — Part 1: Code of practice for domestic heating and hot water supply.*
- BS 7291-1, *Thermoplastics pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings — Part 1: General requirements.*
- BS 7291-2, *Thermoplastics pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings — Part 2: Specification for polybutylene (PB) pipes and associated fittings.*
- BS 7291-3, *Thermoplastics pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings — Part 3: Specification for crosslinked polyethylene (PE-X) pipes and associated fittings.*
- BS 7593, *Code of practice for treatment of water in domestic hot water central heating systems.*
- BS 7671:1992, *Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition.*
- BS 7860, *Specification for carbon monoxide detectors (electrical) for domestic use.*
- BS 8600, *Guide to complaints management.*
- BS EN 215-1, *Thermostatic radiator valves — Part 1: Requirements and test methods.*
- BS EN 297, *Gas-fired central heating boilers — Type B 11 and B 11BS boilers fitted with atmospheric burners of nominal heat input not exceeding 70 kW.*
- BS EN 442 (all parts), *Specification for radiators and convectors.*
- prEN 483, *Gas-fired central heating boilers — Type C boilers of nominal heat input not exceeding 70 kW.*
- BS EN 625, *Gas-fired central heating boilers — Specific requirements for the domestic hot water operation of combination boilers of nominal heat input not exceeding 70 kW.*

prEN 677, *Gas-fired central heating boilers — Specific requirements for condensing boilers with a nominal heat input not exceeding 70 kW.*

BS EN 1254-1, *Copper and copper alloys — Plumbing fittings — Part 1: Fittings with ends for capillary soldering or capillary brazing to copper tubes.*

BS EN 1254-2, *Copper and copper alloys — Plumbing fittings — Part 2: Fittings with compression ends for use with copper tubes.*

BS EN 12098-1, *Controls for heating systems — Part 1: Outside temperature compensated control equipment for hot water heating systems.*

BS EN 60730-1, *Specification for automatic electrical controls for household and similar use — Part 1: General requirements.*

BS EN 60730-2-7, *Specification for automatic electrical controls for household and similar use — Part 2: Particular requirements — Section 7: Timers and time switches.*

BS EN 60730-2-8, *Specification for automatic electrical controls for household and similar use — Part 2: Particular requirements — Section 8: Electrically operated water valves, including mechanical requirements.*

BS EN 60730-2-9, *Specification for automatic electrical controls for household and similar use — Part 2: Particular requirements — Section 9: Temperature sensing controls.*

BS EN 60730-2-15, *Specification for automatic electrical controls for household and similar use — Part 2: Particular requirements — Section 15: Automatic electrical water level sensing controls of the float or electrode-sensor type used in boiler applications.*

BS EN 60730-2-16, *Specification for automatic electrical controls for household and similar use — Part 2: Particular requirements — Section 16: Particular requirements for automatic electrical water level operating controls of the float type for household and similar applications.*

BS ISO 11922-1, *Thermoplastics pipe for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series.*

3 Terms and definitions

For the purposes of this Product Assessment Specification, the following terms and definitions apply.

3.1

customer

person purchasing the central heating installation and/or the property owner

3.2

installer organization

organization, company or individual entering into a contractual arrangement to provide the product

3.3

installer

individual engineer installing the product on behalf of the installer organization

3.4

product

whole service provided by the installer organization in relation to the central heating installation, from the point of initial enquiry to completion of the after sales service provision

3.5

subcontractor

skilled personnel acting on behalf of the installer organization to carry out any work in relation to the central heating installation

3.6

supplier

third party organization which supplies products, materials or services, in relation to the central heating installation, to the installer organization

3.7

contract

contractual arrangement between the installer organization and customer

3.8

boiler

gas fired central heating boiler installed as the primary heat source for the heating system

3.9 installation

3.9.1

central heating installation

system, boiler and associated equipment

3.9.2

gas installation

gas pipework from the primary gas meter outlet, or emergency shut off valve on the low pressure stage of an LPG installation, to the gas boiler isolation valve

3.10

low temperature hot water (LTHW)

water used as the heating medium, maintained at 100 °C or less throughout the system, whether open or sealed

3.11

open system

central heating system incorporating a water circuit that is open to the atmosphere through a feed cistern and open vent pipe

3.12

sealed system

central heating system incorporating a water circuit that is not open to the atmosphere

3.13

domestic premises

property used solely as a dwelling

3.14

bathroom

room designed to contain a bath or shower

3.15

boiler compartment

enclosure designed or adapted to house a gas fired boiler

3.16

ventilation

process of supplying fresh air to, and remove vitiated air from, a room or internal space

3.17

air vent free area

unobstructed cross-sectional area of an air vent, i.e. the arithmetic sum of the area of individual apertures

3.18

quality assurance

verification that the product or service conforms to the requirements of this specification

3.19

complaint

expression of dissatisfaction with the product provided which fails to meet the requirements set out within the scope of this specification

3.20 operational terminology

3.20.1

boiler rated output

rate at which heat is transferred to water flowing through the boiler when working at its rated heat input under standard conditions

3.20.2

routine maintenance

planned work carried out to ensure that the boiler, controls and equipment are cleaned, adjusted and inspected as appropriate to ensure reliable, efficient and safe operation

3.20.3

breakdown service

service available to the customer to deal with breakdowns, arising from an inability of the system to operate in its entirety or a failure of the system that is likely to lead to water damage

3.21 equipment terminology

3.21.1

combination boiler

appliance designed to provide central heating hot water and domestic hot water without the need for additional secondary storage

3.21.2

condensing boiler

boiler designed to make use of the latent heat of combustion products by condensing water vapour within the appliance

3.21.3

open flued boiler

appliance designed to be connected to an open flue system, its combustion air being drawn from the room, space or enclosure in which it is installed

3.21.4

room sealed boiler

appliance in which the combustion air supply and flue system is not open to the room, space or enclosure in which it is installed

3.21.5

storage combination boiler

boiler with an internal hot water store of capacity at least 15 l but not exceeding 70 l

3.21.6

heat emitter

equipment emitting heat for the purposes of space heating

3.21.7

radiator

unit for space heating that warms the air by convection and provides radiation

3.21.8

air vent

non-adjustable purpose-made grille designed to allow the passage of air at all times

3.22 control terminology

3.22.1

timeswitch

device which switches the central heating system on and off at a prescribed time

3.22.2 optimizer control

device which starts and stops the central heating system at the latest possible time to achieve the desired internal temperatures, dependent upon external conditions

3.22.3 compensating controls

device which adjusts the LTHW flow temperature in relation to external temperatures

3.22.4 control valves

device which controls the flow of LTHW, dependent upon the demands of the heating and hot water system

NOTE Devices may be either mixing valves or diverting valves.

3.22.5 comfort conditions

internal environmental conditions that are acceptable to the occupants by varying clothing or physical activities

3.22.6 internal air temperature

average air temperature within the heated space

3.22.7 resultant temperature

combination of inside air temperature, mean radiant temperature and air velocity

3.23 HWS

hot water service

4 Items to be agreed and documented

The following items to be agreed between the contracting parties are specified in the clauses referred to and the processes to fulfil such agreements shall be fully documented and recorded as applicable. For compliance with the specification both the definitive requirements specified throughout the specification and the following documented items shall be satisfied before a claim of compliance with the specification can be made and verified.

- a) rated output of the boiler, see 5.1;
- b) delivery date of equipment, see 7.4;
- c) installation commencement date, see 7.4;
- d) estimated duration of installation, see 7.4;
- e) installer organization identification, see 7.4;
- f) installation design, see 7.3;
- g) pipework routing, see 7.4;
- h) routing/location of flue pipes, see 7.4;
- i) location of heat emitters, see 7.4;
- j) location of controls, see 7.4;
- k) the proposed sequence of installation, see 7.4;
- l) protection of the customer's property, see 7.4;
- m) resolution of any potential installation difficulties, see 7.4.

5 Central heating systems

5.1 General

All systems shall have the following:

- a) electrical supply: a suitably rated electrical fused spur, installed local to the boiler position, to provide electric isolation for the whole central heating installation;
- b) gas isolation valve, fitted local to, or integral with, the gas fired boiler;
- c) time control of the heating and domestic hot water supply as appropriate;
- d) thermostatic control of the heating and domestic hot water supply;
- e) carbon monoxide (CO) detector local to the boiler if appropriate, or in accordance with the detector manufacturer's recommendations.

All gas appliances shall be CE marked.

Boilers shall only be fitted with external control devices approved by the boiler manufacturer.

Boilers shall be selected with a rated output at least equal to the heat requirements which have been agreed between the installer organization and the customer.

Gas installation pipework shall be designed and installed in accordance with BS 6891.

Electricity supplies shall be installed in accordance with BS 7671.

Boilers shall be installed in accordance with the boiler manufacturer's installation instructions.

5.2 Flues and ventilation

The connection of a boiler to a flue system shall be in accordance with BS 5440-1.

The air supply for the installed boiler shall be in accordance with BS 5440-2.

Where external sources of noise may create a nuisance in specific circumstances, consideration shall be given to the siting of ventilation grilles and/or noise insulation techniques.

5.3 Automatic operation

The LTHW control systems shall be designed for automatic operation, without the need for manual intervention by the occupant.

5.4 Control equipment

5.4.1 Safety equipment

Safety controls shall operate in such a way that in the event of failure, the equipment fails in a safe manner. Safety controls shall be included within a LTHW system to guard against the following:

- a) excessive pressures arising in the system or associated equipment;
- b) excessive temperature arising in the system or associated equipment;
- c) fire or explosion;
- d) the effects of frost (where applicable), see **10.4.2**.

NOTE Attention is drawn to CIBSE Guides A to C [1].

5.4.2 Operating ranges

The operating ranges of sensing elements and controllers used within the installation shall be suitable for LTHW central heating systems.

5.4.3 Accuracy

The accuracy and repeatability of each individual component within the control system shall be such that, when operating influences are taken into account, the system or space temperature remains within the specified tolerances.

5.4.4 Control types

5.4.4.1 Time controls

Timeswitches shall be incorporated into central heating systems which allows the user to pre-set on/off periods. Time controls shall be able to continue to operate in the event of power failure by incorporating battery back up.

NOTE Such controls may be overridden in the event of low ambient temperature for frost protection.

5.4.4.2 *Temperature controls*

Temperature control shall be maintained within one of the following systems:

- a) energy conversion system;
- b) distribution system;
- c) internal temperature control.

5.4.4.3 *Energy management controls*

Building management controls shall be incorporated into the system, to provide a greater level of control and conserve energy usage. These may be incorporated as part of the time control system and shall consist of one of the following:

- a) optimized control, which serves to start the heating at the latest possible time, whilst achieving the desired temperature at the occupancy time;
- b) weather compensated control, which serves to modify the system operating temperature, in relation to the external temperature, whilst achieving the desired internal temperature.

5.5 Claims for compliance

The system record for an installed system, claimed to comply with this specification, shall be endorsed with the installer's company name and the number and date of this Product Assessment Specification.

6 Equipment and fittings

6.1 Unvented hot water storage systems

Where unvented hot water storage systems with a capacity of more than 15 l are being installed, only equipment product certified by an independent organization, e.g. BSI Kitemark or British Board of Agreement certification, shall be used.

6.2 Central heating systems

6.2.1 *General*

The components of central heating systems shall conform to an appropriate British Standard, a national standard implementing a harmonized standard or a draft harmonized standard in accordance with Table 1.

6.2.2 *Quality assurance*

Preference should be given to the purchase of components and parts from independently quality assured and certified sources, for example with the BSI Kitemark. In the absence of such quality assured sources, either, the suppliers should be subject to assessments and monitoring or supplied components should be subject to a statistically based goods receiving inspection and test regime to confirm conformity to this specification.

6.2.3 *Thermal insulation*

Thermal insulation shall provide protection from freezing in accordance with BS 6700.

NOTE Attention is drawn to the Water Supply (Water Fittings) Regulations 1999 [2], see A.2, and Building Regulations [3], [4] and [5], see A.1.

If a pipe is losing any heat that is not contributing to the useful heat requirement of a room or space, then that pipe shall be insulated.

Insulation thickness shall be either:

- a) in accordance with Tables 2 to 4; or
- b) different to that specified in Tables 2 to 4, in which case an equivalent thermal efficiency shall be maintained.

Hot water storage cylinders shall be pre-insulated in accordance with BS 1566 or BS 3198. Insulation jackets applied after manufacture of hot water storage cylinders shall conform to BS 5615.

For plastic pipework, the appropriate insulation thickness, generally of equal thickness to the outside pipe diameter, shall be applied dependent on the pipe size used as defined in BS 2871 or BS ISO 11922-1.

Table 1 — Central heating components and their relevant British Standards

Central heating components	British Standards
Central heating boilers	BS 5258-1 or -8 or -15; BS 6332-1, or -3; BS 7074-1; BS EN 297; prEN 483; BS EN 625, prEN 677
Control components <ul style="list-style-type: none"> – automatic electrical controls – outside temperature compensated control equipment – timers and timeswitches – electrically operated water valves – temperature sensing controls – automatic water level sensing controls – thermostatic radiator valves – carbon monoxide detectors 	BS EN 60 730-1 BS EN 12 098-1 BS EN 60 730-2-7 BS EN 60 730-2-8 BS EN 60 730-2-9 BS EN 60 730-2-15, -16 BS EN 215 BS 7860
Valves <ul style="list-style-type: none"> – draw off taps and stop valves – float operated valves – manually operated valves – drainage taps – copper alloy valves 	BS 759 BS 1010-2 BS 1212-2 or -3 BS 2767 BS 2879 BS 5154
Pipes and fittings <ul style="list-style-type: none"> – pipe threads for tubes and fittings – malleable cast iron and copper alloy threaded pipe fittings – capillary and compression copper and copper alloy fittings – compression fittings for polyethylene pipes – screwed and socketed steel tubes – wrought steel pipe fittings – copper and copper alloy tubes – plastic pipe and fittings 	BS 21 BS 143, BS 1256 BS EN 1254-1 and -2 BS 864-3 BS 1387 BS 1740 BS 2871 BS 7291
Radiators and convectors	BS EN 442

Table 1 — Central heating components and their relevant British Standards
(continued)

Central heating components	British Standards
Tanks (feed and expansion tanks up to 500 l capacity)	BS 4213
Cylinders	
double feed indirect cylinders	BS 1566-1
single feed indirect cylinders	BS 1566-2
hot water storage combination units	BS 3198
Pressure vessels (diaphragm expansion vessels for use on sealed systems)	BS 4814
Safety valves	BS 6759-1

Table 2 — Copper pipework including insulation (thermal conductivity of 0.04 W/(m·K) at 0 °C)

Dimensions in millimetres	
Pipe size	Insulation thickness
15	32
22	25
28	25
35	13

Table 3 — Plastic pipework including insulation (thermal conductivity of 0.04 W/(m·K) at 0 °C) up to or equal to the pipe sizes specified

Dimensions in millimetres	
Pipe size	Insulation thickness
20	32
25	25
32	25
50	13

Table 4 — Heating and hot water pipework (copper) (thermal conductivity of 0.045 W/(m·K) at 0°C)

Dimensions in millimetres	
Pipe size	Insulation thickness
15	15
22	22
28	28
35	35
NOTE For plastics pipework, where thermal insulation is used it should conform to the recommendation of BS 5970.	

6.2.4 Open flue systems

Metal flue pipes, fittings, terminals and accessories shall conform to BS 715. This shall include the following:

- external flue pipe systems;

- internal flue pipe systems;
- flue linings;
- prefabricated flue boxes.

Factory made insulated chimneys shall conform to BS 1289.

6.3 Customer feedback

The central heating installation shall be assessed by post installation feedback. This shall be achieved by post installation quality inspection and a customer feedback monitor as follows.

a) *Post installation quality inspection*. Each installation shall be inspected within 28 days of completion of the installation. This inspection shall verify customer satisfaction with the following:

- 1) installer organization performance;
- 2) operation of the system;
- 3) appearance of the installation;
- 4) compliance with the original requirements;
- 5) system performance.

b) *Customer feedback monitor*. The installer organization shall carry out a sample feedback mechanism from a minimum of 2 % of customers where an installation has been provided and is stated as being in compliance with this Product Assessment Specification.

Documented evidence shall be available to demonstrate customers' feedback on the following:

- 1) installer organization performance;
- 2) operation of the system;
- 3) appearance of the installation;
- 4) compliance with the original requirements;
- 5) system performance;
- 6) product reliability;
- 7) after sales service.

The above feedback shall be analysed and trends established. Where required corrective actions shall be taken and where issues that are related to product quality are showing adverse trends, the product shall be re-evaluated in conjunction with the manufacturer.

The procedure for handling customer complaints shall conform to BS 8600.

6.4 Product defects

The installer organization shall have a provision for the monitoring of product defects. The monitor shall ensure that the performance of primary installation elements will highlight significant trends in product failures and product reliability.

The installer organization shall systematically monitor and analyse adverse trends in product reliability. Where appropriate, corrective actions shall be taken to ensure that the installation functionality is maintained for the customer and work shall be carried out in conjunction with the manufacturer to rectify the specific problem.

Where issues that are related to product quality continue to show adverse trends, the product shall be re-evaluated in conjunction with the manufacturer.

6.5 Product recall

The installer organization shall have a provision for the recall of any boiler or integral component in which a suspected or established safety risk has been identified. The provision shall be operated in conjunction with the manufacturer's own systems.

7 Information exchange

7.1 Initial enquiry

The potential customer shall be provided with the facility of making general enquiries in relation to the products and services offered without any obligation or charge.

Where a potential customer requests a salesperson or designer to visit the customer's premises to provide recommendations or advice they shall be informed of:

- a) the name and status of the person visiting;
- b) a mutually agreed appointment;
- c) any charges that may be applied.

All persons visiting the customer on behalf of the installer organization shall possess and present a means of identification and authority from the installer organization.

7.2 Sales stage

7.2.1 During the sales discussions the customer shall be provided with all relevant information in order that they may evaluate appropriate options available to them in relation to the following:

- a) central heating boiler types;
- b) heating equipment alternatives;
- c) location of the boiler, associated controls, heat emitters and associated tanks/cylinders;
- d) the relative benefits and limitations of boiler selection, controls and systems;
- e) energy usage and efficiencies;
- f) total cost of the product;
- g) payment options;
- h) total cost of any financial package;
- i) exclusions;
- j) any "cooling off" periods;
- k) availability of the product and timescales;
- l) whether an asbestos risk assessment needs to be carried out.

7.2.2 Where a combination boiler is being recommended or requested by the customer, the sales person shall point out the particular differences between conventional systems utilizing hot water and those systems using a combination boiler. Specifically:

- a) the hot water flow rate;
- b) any potential time delay in "hot" water delivery;
- c) the priority given to hot water supply and the implications on heating if domestic hot water demands are high;
- d) the suitability of the boiler to any existing shower installations.

Where a combination boiler is to be installed as part of the system, adequate pre-installation checks shall be carried out in order to verify suitability of the appliance being considered. The mains cold water supply shall be tested to verify that the minimum working pressure, aligned to the design flow rate, meet those specified by the boiler manufacturer. The sales person shall also confirm with the customer that there is no history of water pressure problems to the property.

7.2.3 The potential customer shall be advised of the method of contacting the installer organization in case of further queries.

7.3 Design stage

The designer shall discuss, consider and agree the following essential matters with the potential customer:

- a) thermal characteristics of the building;

- b) the potential for improvements to energy conservation;
- c) position of the boiler;
- d) flueing requirements, including the type, location, dimensions, construction and suitability of the flue and termination and the potential for plumbing;
- e) ventilation requirements, providing air supplies for combustion, ventilation and cooling;
- f) position of feed and expansion tanks, expansion vessels or hot water storage cylinders as appropriate;
- g) the facilities for filling and draining the system;
- h) domestic hot water requirements;
 - i) the type and position of heat emitters;
 - j) system control of heating and hot water;
- k) requirements for frost protection or night set back;
- l) the route and method of installing system pipework;
- m) requirements to comply with relevant legislation, Water Supply (Water Fittings) Regulations 1999 [2], British Standards and associated Codes of Practice.

Where particular customer requirements differ from the recommendations being offered by the designer, these variations and any performance implications shall be recorded and retained on file. However, the designer shall not agree to any variation which may affect safety or is contrary to statutory requirements.

The designer shall use established competencies to provide the potential customer with technically sound advice based on their skill and experience. This advice shall only be used in the best interests of the customer.

7.4 Installation of the system

Prior to installation the following items shall be agreed between the installer organization and customer:

- a) delivery date(s) of equipment;
- b) installation commencement date;
- c) estimated installation duration;
- d) installer organization identification;
- e) confirmation of the installation design, as specified in **7.3**;
- f) pipework routing;
- g) location of controls;
- h) the proposed sequence of installation;
- i) protection of the customer's property;
- j) resolution to any potential installation difficulties.

In situations where the installer organization establishes problems in complying with the original design specification agreed with the customer, due to unforeseen circumstances, the installer organization shall immediately bring this to the attention of the customer. Changes shall be agreed with the customer and documented prior to continuing with the work.

7.5 Hand over of the system

On completion of the installation, all necessary final tests and commissioning, the installer organization shall hand over the system to the customer. Hand over shall consist of imparting the following information:

- a) how to operate the boiler;
- b) the use and setting of the control system;

- c) simple remedial actions which may need to be taken by the customer;
- d) method of venting the system;
- e) the requirement for regular servicing;
- f) gas safety information;
- g) boiler instructions;
- h) controls and equipment;
- i) users' instructions.

In every case the installer organization shall ensure that the customer fully understands how to operate the system, boiler and controls in order to achieve the safe and efficient manner.

A check list shall be completed by the installer organization verifying that all commissioning and customer hand over tasks have been completed. Verification that the customer is satisfied with this process and the system installation as a whole shall be obtained.

7.6 After sales

Following completion of the installation, the customer shall be contacted within 28 days to verify complete satisfaction with the installation process and system performance.

8 Design

8.1 General

The following thermal conditions shall be assessed before designing the central heating system, see annex B:

- a) thermal inertia of the building fabric;
- b) natural ventilation;
- c) artificial ventilation;
- d) air leakage;
- e) solar effects.

NOTE See CIBSE Guides A to C [1] for further information. For guidance on design air temperature, see annex B.

Central heating systems shall conform to BS 6798, BS 5449 and BS 6700.

8.2 Design air temperature

The following resultant temperatures shall be used for design purposes in domestic dwellings (see Section A.1 of CIBSE Guide A [1]):

- living rooms: 21 °C;
- bedroom: 18 °C;
- bathroom/shower room: 22 °C;
- toilets: 18 °C;
- hallway: 16 °C;
- kitchen: 18 °C;
- study: 20 °C;
- dining room: 21 °C;
- utility room: 18 °C.

8.3 Air movement and draughts

The installation shall be designed incorporating the following ventilation rates, see annex B:

- living rooms: 1.5 air changes/h;
- bedroom: 1.0 air changes/h;

- bathroom/shower room: 2.0 air changes/h;
- toilets: 2.0 air changes/h;
- hallway: 1.5 air changes/h;
- kitchen: 2.0 air changes/h;
- study: 1.5 air changes/h.

Where specific ventilation losses are evident the above figures shall be modified to reflect the actual air change rate.

8.4 Design methodology

8.4.1 When designing LTHW central heating systems for domestic dwellings the following factors shall form the basis of design:

- a) system capability;
- b) external environment;
- c) internal environment;
- d) building fabric thermal properties;
- e) primary domestic hot water demand.

8.4.2 System capability

The system shall be capable of satisfying the maximum heating demand and operate as required under partial load conditions, including frost protection where required. The system shall also be capable of providing comfort conditions within the limitations of a heating system.

8.4.3 External environment

The external temperature used in establishing the heating load shall be selected with due regard to local weather conditions and proposed overload capacity of the system.

An external design temperature of $-1\text{ }^{\circ}\text{C}$ shall be used as a base temperature, however this shall be adjusted to take account of known historical trends and/or geographical considerations.

8.4.4 Internal environment

The dry resultant temperature defined in 8.2 shall be used to establish fabric heat losses and ventilation heat requirements.

8.4.5 Building fabric thermal properties

Heat loss calculations shall be based on steady state energy balances unless a high intermittency pattern can be established. The thermal transmittance factors used in establishing heat losses through the building fabric shall be based on the elemental calculations of thermal resistances or the values specified within BS 5449.

NOTE Attention is drawn to the building structure and Building Regulations [3] to [5] for established set minimum standards of insulation in buildings, see A.1. Calculation of heat losses will be affected where such Regulations did not apply at the time of construction.

Intermittent operation is likely in most domestic situations and therefore some additional capacity (overload capacity) shall be required to ensure that the desired temperature is established, within a defined pre-heat period, following overnight or weekend cooling. In domestic premises a pre-heat period of 120 min shall be used as a basis of design unless otherwise specified by the customer.

NOTE In such cases, the desired pre-heat period should define the overload capacity factor used within the design calculations.

8.5 Primary domestic hot water demand

8.5.1 Domestic hot water storage capacity

A separate LTHW circuit shall be provided to serve the HWS requirements, with appropriate controls, to ensure that the system is thermally efficient during the summer and heating of radiators, due to residual heat transfer, is avoided.

The hot water demand shall be in accordance with Table 5, unless otherwise specified by the customer.

Heat recovery rate shall be based on a 40 °C temperature rise within the stored capacity over 2 h continuous operation.

Table 5 — Domestic hot water demand

Household type	Rooms	Occupants	Storage capacity l
Small	2 bedrooms 1 bathroom	1-2	100
Average	3 bedrooms 1 bathroom	3-4	125
Large	Up to 4 bedrooms 2 bathrooms	3-5	150

8.5.2 On demand domestic hot water

"On demand" domestic hot water shall be provided by the use of combination boilers. The selection of a combination boiler and its capability in domestic hot water delivery shall be dependent upon the customer's requirements and expectations.

NOTE Combination boilers deliver DHW with a specified temperature rise in relation to flow rates. The performance will be dependant upon the temperature of the incoming water supply and the type of usage of the hot water.

Consideration shall be given to the following, when selecting the most appropriate condensing boiler:

- a) pattern of usage (see annex C);
- b) customer requirements;
- c) boiler performance for DHW supply (see annex C);
- d) seasonal variations in water supply temperatures.

8.6 Heating system pipework for small bore systems

Heating system pipework shall be designed so as to provide the following:

- a) a velocity of water that does not create excessive noise within the system and does not exceed 1.5 m/s for copper pipes and 3.0 m/s for thermoplastics;
- b) frictional and pressure losses within the system fall within the performance criteria and design conditions of the circulating pump;
- c) sufficient mass flow rate of water to provide the required heat transfer capability to the system in order to achieve the design air temperatures, see 8.2;
- d) 20 °C temperature differential between the boiler flow and return for condensing boiler installations and 11 °C for conventional boiler installations.

NOTE Refer to the manufacturer's instructions for specific temperature differentials.

8.7 Gas installation pipework

Gas installation pipework shall be designed to allow a pressure loss of not greater than 1 mbar between the primary gas meter and the boiler inlet connection.

8.8 Design verification

The method of design utilized by the installer organization shall be subject to a formal verification process in order to check the output design against the input data.

Verification shall include the following.

- a) A skilled building services engineer independent from the main stream design processes shall carry out sample checking of the design outputs.
- b) Comparative methods of design and calculation against a similar or test installation designs.
- c) Trial to check that computerized models conform to particular inputs.

8.9 Design validation

The design outputs utilized by the installer organization shall be subject to a formal validation process in order to check the output design against the input data.

The design process shall be validated against the expected range of operating conditions and situations of use.

Validation shall include the following:

- review of the design requirements by appropriate design/development team, one member of which shall include a skilled building services engineer;
- simulation exercises against defined test models;
- field sampling measurement and examination.

Design configuration and calculations shall be documented.

Design and development changes or modifications shall be documented, reviewed and approved by an authorized manager, prior to implementation.

9 Installation

9.1 General

The installation shall conform to BS 6798, BS 5449, BS 7671 and BS 6700.

NOTE Attention is drawn to the following regulations: The Gas Safety (Installation & Use) Regulations [6]; The Health & Safety at Work etc. Act 1974 [7]; The Water Supply (Water Fittings) Regulations 1999 [2], see A.2; The Building Regulations [3] to [5], see A.1.

9.2 Central heating boilers

The boiler shall be installed in accordance with the manufacturer's instructions.

The boiler shall be installed in a position to provide ready access for inspection, repair and maintenance. Clearance dimensions defined by the manufacturer shall be adhered to.

Boilers used in sealed systems shall be specifically approved by the manufacturers for this purpose.

All installations shall be provided with a carbon monoxide detector located adjacent to the boiler and in accordance with detector manufacturer's recommendations.

9.3 Roof space installations

Where boilers are installed in roof spaces the following shall be provided:

- a) a non-combustible base of at least 12 mm thickness and extending 25 mm around the appliance outer case;
- b) adequate supports for the boiler equipment, associated pipework and equipment, as defined by the manufacturer's installation instructions, see Tables 6 and 7;
- c) a permanent means of access to the boiler installation;
- d) fixed lighting;
- e) electrical isolation and time controls located in the dwelling area.

9.4 Garage installations

Where boilers are located in garages, the boiler shall be of the room sealed type and the position of the flue terminations shall ensure that there is no risk of products of combustion re-entering the garage, and associated pipework shall be provided with adequate protection against frost (see 6.2.2).

9.5 Understairs/compartiment installations

Where boilers are installed under stairs or in compartments, the following additional provisions shall be made.

- a) Air supply for ventilation, and where necessary combustion, shall be in accordance with BS 5440-2. Ventilation openings and routings shall be in accordance with BS 5440-2.
- b) The area provided shall be of adequate size, as defined by the manufacturer's installation instructions, to allow inspection, servicing and removal of the boiler.
- c) A minimum of 75 mm, or the distance specified by the manufacturer, shall be maintained between the boiler and combustible surfaces.
- d) A warning notice shall be displayed prohibiting the blockage of air vents and the use of the compartment for storage.

9.6 Flueing

9.6.1 General

Flues shall be installed in accordance with BS 5440-1 and the manufacturer's instructions.

9.6.2 Open flue boilers

Double wall metallic flue pipes shall be used with corresponding flue connectors and fittings. The flue pipe shall take the most direct practicable route consistent with structural stability, appearance and termination.

NOTE Single wall metallic flue pipes may be used in circumstances where surface temperature or ambient temperature will not adversely affect safety or flue performance.

Terminals shall conform to BS 715 and BS 1289.

Terminals shall be positioned in accordance with the manufacturer's installation instructions and BS 5440-1.

Open flued boilers shall only be installed where the installation of room sealed boilers is not practicable. In such cases, the boiler shall incorporate a suitable protection device preventing its operation in the event that the flue becomes partially or completely blocked.

9.7 Balanced flue boilers

The boiler shall be installed with the terminal provided by the manufacturer. Alterations shall not be made to the manufactured component.

Terminals shall be fitted in a location that provides adequate clearances around the flue terminal and ensures that products of combustion are dispersed effectively, in accordance with the manufacturer's installation instructions.

9.8 Condensing boilers

Materials selected for the flueing shall be suitable for use with condensed products of combustion and of the type specified by the manufacturer. The routing and termination of condensate pipework shall ensure that condensate is removed via the soil waste or rainwater disposal.

NOTE Attention is drawn to The Building Regulations [3] to [5], see A.1.

9.9 Flue liners used in existing chimneys

All existing chimneys shall be lined using a flexible stainless steel liner. Where an existing liner is installed this shall be checked for integrity and if more than 5 years old it shall be replaced with a new one.

The liner shall be installed in a single length. Joints shall not be used within the chimney.

The chimney shall be sealed at the top using a proprietary sealing plate, secured and weatherproofed, and at the bottom using either a sealing plate or approved sealing method.

Liners shall not extend more than 150 mm outside the chimney structure and shall be connected to the boiler using a twin wall stainless steel flue pipe and proprietary fittings. Prior to installation, checks shall be carried out to ensure the following:

- a) routing of the chimney is suitable;
- b) termination can meet the requirements of BS 5440-1;
- c) the chimney is complete and unobstructed;
- d) that there are no restrictions or dampers;
- e) cross-sectional area of the chimney is of sufficient size to accept the liner to be used;
- f) that the chimney is dedicated to the boiler being installed.

9.10 System pipework

9.10.1 The heating system pipework shall be installed in accordance with the boiler manufacturer's installation instructions, including pipework configurations and the requirement for control and regulating valves. Plastic pipework shall not be directly connected to the boiler or within the boiler casing. A suitable metal to plastic transition piece shall be used in accordance with the pipework manufacturer's instructions.

Pipework configurations shall be such as to prevent pump cavitation.

Pipes shall be installed in neat arrangements and concealed wherever practicable when specified by the customer. Surface run pipes shall be protected and covered by a purpose-made duct where appropriate.

All pipes passing through brickwork and masonry shall be sleeved in order to prevent corrosion and to allow movement. Such sleeves shall be sealed with a non-setting sealant to prevent the passage of fire or smoke.

Pipes shall not be run in solid floors or walls unless they are installed within accessible pipe ducts.

9.10.2 All capillary joints used on pipework serving the domestic water supply shall be made using lead free solder.

All screwed joints used on metallic pipework serving the domestic water supply shall be made using suitable materials, e.g. PTFE tape.

NOTE Attention is drawn to the Water Supply (Water Fittings) Regulations 1999 [2], see A.2.

9.10.3 Thermoplastics pipework and associated fittings, which may be used as an alternative to copper pipe, shall conform to BS 7291. Selection of materials shall be appropriate for LTHW central heating systems. Class H thermoplastics shall be used for domestic vented central heating installations and Class S thermoplastics shall be used for domestic unvented central heating installations (sealed systems). In both cases, the pipework can be supplied with an oxygen barrier construction. The installation of thermoplastics systems shall conform to BS 5955-8.

9.10.4 Condensate pipework shall be installed in accordance with the manufacturer's specific instructions. Pipework shall be run with the shortest route and with a minimum fall of 2.5° to prevent condensate being trapped or re-entering the boiler.

Terminations of condensate pipework shall be provided with a minimum 22 mm trap with 75 mm condensate seal. External terminations shall minimize the risk of blockage due to freezing.

Condensate shall either be disposed of within the property's sanitary or rainwater system, or where this cannot be achieved a condensate absorption point shall be provided.

9.10.5 Pipe fixings and supports

Pipework shall be supported securely throughout the installation in accordance with Tables 6 and 7.

Table 6 — Dimensions of metal pipes

Nominal pipe size mm	Interval (vertical runs) m	Interval (horizontal runs) m
>15	2.0	1.2
22	2.5	1.8
28	2.5	1.8

Table 7 — Dimensions of plastic pipes

Nominal pipe size mm	Interval (vertical runs) m	Interval (horizontal runs) m
>15	0.5	0.3
22	0.8	0.5
28	1.0	0.8
32/35	1.2	0.9

9.11 Valves

Valves shall not be fitted between the boiler and the point of discharge in the expansion vent pipe.

Unless the boiler manufacturer's installation instructions state there is no requirement, a by-pass valve shall be installed on installations where all radiators and the hot water cylinder are controlled by means of thermostatic valves.

Balancing valves shall be fitted on the return leg of an indirect cylinder or insertion heating element and shall be of the lockshield type.

All high points in the system shall be fitted with an air bleed facility.

Drain points shall be fitted at the lowest points of the system.

Circulation pumps and system control valves shall be fitted with suitable isolation valves to facilitate maintenance and replacement.

Where boilers are operating at mains pressure a suitable check valve shall be installed in order to prevent system water re-entering the public water supply.

NOTE 1 Reference should be made to the Water Supply (Water Fittings) Regulations 1999 [2], see A.2.

An isolation valve shall be installed on the inlet to the feed and expansion tank to facilitate maintenance and replacement of the float valve.

NOTE 2 Reference should be made to the Water Supply (Water Fittings) Regulations 1999 [2], see A.2.

Each heat emitter shall be provided with isolation valves, the return connection being of the lockshield type. In addition each heat emitter shall be fitted with a suitable air release valve.

9.12 Heat emitters

Heat emitters shall be of the following types:

- a) steel panel radiators;
- b) low surface temperature radiators;
- c) fan convector radiators;
- d) towel rails;
- e) towel radiators;
- f) custom designed radiators.

Each heat emitter shall be fitted so as to provide adequate clearance for maintenance, replacement and the release of air.

The siting of the heat emitter shall be selected in order to effectively counteract the effects of draughts, cold radiation or cold zones, within a room.

Aesthetics and customer preferences may define the position of radiators, however customers shall be made aware of the most effective arrangements. Where customer preferences prevail this shall be documented in the design submission, see 7.3 i).

Radiators shall be installed such that air can freely circulate, with a minimum of 100 mm between floor level and the base of the radiator.

9.13 Circulation pumps

Circulation pumps shall be installed in accordance with the manufacturer's specific instructions.

The location of the pump shall be selected so as to avoid "cavitation".

NOTE Generally this will require the feed and expansion tank to be installed in a position in order to provide a minimum of one third of the maximum head produced by the pump.

Pumps shall be fitted so as to provide adequate access and clearance for maintenance and replacement.

9.14 Cylinders and tanks

In feed and expansion tanks, the float valve and overflow pipe shall be fixed so as to accommodate volume expansion.

NOTE 1 Attention is drawn to Water Supply (Water Fittings) Regulations 1999 [2], see A.2.

The grade of cylinder used shall be appropriate to the head of water on the cold water supply, in order to withstand the working pressure, as follows.

- less than 10 m: grade 3;
- 10 m to 15 m: grade 2;
- above 10 m: grade 1.

The thermal performance of combination tanks shall be in accordance with BS 3198.

Unvented hot water storage systems shall only be installed by competent persons, who have successfully completed training and are registered installers.

NOTE 2 Attention is drawn to the Building Regulations G3 in England and Wales [3] or Building Standards (Scotland) Regulations [4] or The Building Regulations (Northern Ireland) [5], see A.1.

Unvented hot water storage systems shall normally be installed where the flow rates into the property are equal to a minimum of 20 l/min at a water pressure of 2 bar. In cases where this flow rate cannot be gained, consultation with the manufacturers of the equipment and the local water supply company shall take place in order to verify that any installed equipment can operate at the prevailing water supply conditions.

Adequate clearance shall be provided around the unvented hot water storage unit and controls for maintenance purposes.

Protection against excessive temperatures from unvented hot water storage systems shall be provided.

NOTE 3 Attention is drawn to the Building Regulations G3 in England and Wales [3], see A.1.

9.15 Electrical works

All electrical work carried out as part of the installation shall be in accordance with BS 7671.

Power points for the installation shall be either:

- a) a 13 amp unswitched socket outlet with a plug having a fuse rating of 3 amp, unless specified as otherwise by the boiler manufacturer; or
- b) a switched fused connection unit with double pole switch and a 3 amp fuse, unless specified as otherwise by the boiler manufacturer.

The cable used from the power point to the boiler shall have a rating at least equal to that of the fuse. Flexible cords, used as final connection to the boiler, shall be a maximum of 2 m in length, where it is unprotected.

All cabling shall be 1 mm², three core PVC insulated and sheathed flexible cords in accordance with BS 6500. In situations where heat resistant cables are required they shall be rubber insulated for 85 °C, heat and oil resisting, flame retardant sheathed flexible cord.

All wiring in the central heating system shall be 0.75 mm² PVC insulated and sheathed flexible cords in accordance with BS 6500, construction reference 318nY.

Wiring installed within the building fabric, walls, ceiling or floors, shall be installed in accordance with BS 7671:1992, Regulation 522-06 Impact (AG), in order to reduce the risk of accidental damage.

All wiring installed in accessible locations shall be neatly clipped every 250 mm horizontally or 400 mm vertically.

Wiring shall be installed at a minimum distance of 150 mm away from heat sources or covered with a heat resistant sleeve.

The electrical installation shall be checked for the presence of a main equipotential bonding at the electrical network termination/service entry points. If this is not present a MEB conductor shall be fitted in accordance with BS 7671 at the time of the installation.

9.16 Gas installation

9.16.1 All pipes passing through brickwork and masonry shall take the shortest practicable route and be sleeved and/or protected in order to prevent corrosion and to allow movement. Sleeves shall be sealed with a non setting sealant.

9.16.2 Gas pipework installed in solid floors shall be minimized. However, where no other practicable route can be used the pipework shall be installed in a suitable duct of 10 000 mm² cross-sectional area or the following shall be adopted:

- a) the pipework shall be protected against corrosion;
- b) a minimum of 75 mm screed shall be used;
- c) joints shall be avoided or kept to a minimum.

NOTE Attention is drawn to the Building Regulations [3] to [5], see A.1.

9.16.3 Gas pipework shall not be installed in the following situations:

- a) cavity walls;
- b) under foundations of a building;
- c) under the base of a wall or footing;
- d) within 25 mm of an electrical cable or other piped services;

NOTE Where these requirements are impractical, suitable electrically insulating material should be wrapped around the pipe or placed between it and the electrical services or other piped services.

e) where the gas supply is LPG, the pipework shall not be:

- 1) installed in ventilation ducts;
- 2) in contact with or exposed to leakage from water surfaces;
- 3) exposed to leakage from drainage surfaces.

9.16.4 Gas pipework installed externally shall be protected from mechanical damage and corrosion.

9.16.5 Underground gas pipework shall be installed at the following minimum depths:

- a) under open soil, lawns, drives or gravel paths: 375 mm; or
- b) under slabs, pavings or concrete subject only to pedestrian traffic: 40 mm.

NOTE Attention is drawn to the Gas Safety (Installation & Use) Regulations [6], see A.3, with respect to access to a gas control valve or emergency valve.

9.16.6 Boilers fired by LPG shall not be installed in cellars or basements. Where the installation is carrying LPG, the installation shall meet the requirements of BS 5482-1.

9.17 Ventilation

Provision of sufficient permanent ventilation shall be provided in accordance with the manufacturer's instructions.

NOTE 1 Attention is drawn to the Gas Safety (Installation & Use) Regulations [6], see A.3.

Air paths shall be selected to prevent draughts.

Siting of air vents shall take due consideration to prevent the spread of smoke in the event of a fire. Where vents are fitted on internal walls they shall be located less than 450 mm above the floor.

Air taken from a ventilated underfloor or roofspace shall be treated as an internal space for sizing purposes. This method shall not be used if the space communicates with an adjacent property.

Where the roofspace is provided with ventilation in accordance with the Building (Amendment) Regulations 1981 or the Building Regulations 1985 [3], see A.1, then it can be treated as outside air and ducts shall be sized accordingly.

Air vents shall not be located adjacent to flue terminations or extract fans.

Air vents fitted in cavity walls shall incorporate a wall sleeve.

Where an extract fan or ceiling fan or both are fitted in any room or internal space containing an open flued boiler, the operation of the flue shall be checked to ensure that its performance is not adversely affected.

NOTE 2 In such cases, additional ventilation provision may be required to counteract the depressurizing effects of the extract fan.

10 Commissioning

10.1 General

Commissioning shall be carried out in accordance with the boiler manufacturer's instructions, BS 6798 and BS 5449.

All testing and measurement equipment used in relation to the specification and commissioning work shall be regularly checked for accuracy and calibration within a formal process operated by the installer organization. The extent of the checks shall be in relation to the criticality of the measurement or test being undertaken.

The process shall prevent testing and measurement equipment from being used where the calibration results fall outside defined tolerances.

10.2 System cleaning and charging

The cleaning and charging of the system shall be carried out in accordance with BS 7593.

Prior to commencing cleaning of the system, the system shall be filled and a thorough check for water leaks carried out on all pipework, heat emitters, water tanks, the boiler and any other ancillary water carrying components. The test shall be left for no less than 30 min. Any leaks shall be repaired prior to commencement of the system cleaning.

The system shall initially be flushed with cold water in order to remove dirt and scale. All isolation valves, motorized valves and radiator valves shall be in the fully open position during this operation. The system shall be filled and all high points of the system vented. The system shall be flushed through a full bore drain tap located at the lowest practicable point in the system.

The system shall be re-filled and a chemical cleaner added in order to dissolve fluxes, greases and oily contaminants. The boiler shall then be commissioned. Following the venting of all high points, the circulating pump and all radiators the boiler shall be operated in order to reach its normal maximum working temperature, with the system running, in order to circulate the system water and ensure even temperature distribution. A further inspection for leaks shall then be carried out, followed by the flushing of the system through the drain tap, in order to remove residual dirt and excess fluxes.

The system shall be re-filled adding the appropriate inhibitor via the feed and expansion tank. The inhibitor shall be selected to match the boiler manufacturer's stipulated requirements.

NOTE 1 Boilers with aluminium heat exchangers and condensing boilers will have specific inhibitor requirements.

Inhibitor dosing shall be matched to the system size. Following completion of the system fill, the system shall be vented as described above. A notice shall be attached to the boiler stating the date the system was charged with inhibitor and the type of inhibitor used.

In the case of sealed systems, the following additional filling methods shall be adopted:

- a) the system shall be filled to its normal operating pressure;

- b) the fill indicator shall be adjusted;
- c) the system shall be filled using the appropriate filling kit for sealed systems.

The filling loop shall be disconnected on completion of commissioning.

NOTE 2 Attention is drawn to the Water Supply (Water Fittings) Regulations [2] , see A.2.

10.3 System balancing

The completed system shall be balanced in order to achieve the correct proportion of total system flow through various parts of the circuit.

The system shall be allowed to reach its normal maximum operating temperature.

Non-automatic by-pass valves shall be set such that the boiler operates quietly at all flow temperatures. The by-pass valve shall not be left in the fully closed position.

Each radiator lockshield valve shall be adjusted and, initially on the index circuit, the flow of water balanced in order to give an equal temperature to all radiators and the required differential temperatures. The design temperature drop shall be used as a basis for commissioning unless otherwise specified by the manufacturer of the heat emitters or by the specific design specification issued.

Where appropriate, the balancing valve shall be adjusted on the domestic hot water circuit to provide an adequate flow of water through the cylinder, in order to achieve the temperature differential between flow and return, see 8.6 d).

10.4 Control system

10.4.1 Individual controls shall be commissioned in accordance with the manufacturer's instructions adopting the following general principles. Electrical controls shall only be commissioned following the appropriate electrical safety checks, as defined in 10.5.

Compensating controls shall be checked by the measurement of external and internal sensor resistances. The control shall be set to take into account the building fabric structure and the occupancy pattern. The set point shall be established in order to maximize energy efficiency. Reference shall be made to the manufacturer's commissioning instructions.

Optimizing controls shall be set to ensure that the compensator schedule is set to take into account the building fabric structure and the occupancy pattern. The pre-heat setting shall match customer requirements and system utilization. Where necessary frost protection devices shall be set to the appropriate value dependent upon location and intermittency of use. Reference shall be made to the manufacturer's commissioning instructions.

Time controls shall be checked for normal time operation, programme switching and manual override control. Where appropriate, night set back facilities shall be linked to space temperature or system flow temperatures.

10.4.2 Thermostatic controls shall be set at the required temperature defined by the customer. In particular, controls shall be set in order to provide the required system output values, optimum energy efficiency and system protection.

Thermostatic controls shall be set to provide general control over the following:

- a) domestic hot water supply temperature;
- b) air temperature in the living space;
- c) primary circuit temperatures;
- d) boiler operating temperature.

Additionally, thermostatic controls may provide the following protection to the system:

- overheat protection;
- frost protection (where applicable).

NOTE Frost protection may be provided on specific request of the customer, advice from the installer organization or may be integral with the boiler control system.

Frost protection shall be provided in all cases where the boiler is located outside the main building fabric, (e.g. garage, outhouse, external compartment, etc.). The frost protection shall provide for space, boiler and system pipework protection.

10.4.3 Control valves shall be checked for correct operation by the simulation of appropriate control signals, primarily:

- a) heating and hot water demand;
- b) heating only demand;
- c) hot water only demand;
- d) no demand;
- e) frost protection demand.

Valve operation shall also be checked where systems are designed to provide either heating or hot water priority functionality.

Pressure controls shall be checked to ensure that they operate at the set point.

Flow switches or differential switches shall be checked for correct operation with the boiler and system in operation.

10.5 Safety

The completed installation shall be checked for safety in relation to the following:

- a) electrical installation safety;
- b) gas installation safety;
- c) emissions and combustion;
- d) ventilation;
- e) flueing.

Electrical safety checks shall be carried out on the installation in accordance with BS 7671. The following tests shall be carried out:

- a) circuit continuity;
- b) insulation resistance;
- c) polarity;
- d) earth fault loop impedance.

The test results shall be recorded and an appropriate Small Works Certificate issued. Only calibrated test equipment shall be used to carry out these checks.

In addition, the main equipotential bonding of the gas, water or other services shall conform to BS 7671. Where such bonding does not exist or is unsatisfactory, the customer shall be advised of remedial action to be taken.

Supplementary bonding shall be used to form an extra bonded zone within the main zone which is covered by the main equipotential bond, as appropriate.

10.6 Gas installation

The installation shall be pressure tested in accordance with BS 6891 or BS 5482-1 for LPG installations.

Once the appropriate temperature stabilization period has been achieved, in accordance with BS 6891 or BS 5482-1, the following tests shall be carried out on the gas installation:

- a) a meter control valve let by test;
- b) a pressure test for the appropriate period;
- c) validation of the test result from appropriate tables.

NOTE Attention is drawn to the Gas Safety (Installation & Use) Regulations [6] with regard to pressure testing, see A.3.

Following such tests, the installation shall be purged in accordance with BS 6891.

In addition to the pressure test, all connections beyond the gas control tap of the boiler shall be tested for gas escapes with a suitable leak detection fluid.

10.7 Emissions and combustion

Following commissioning of the boiler, the combustion shall be checked to ensure that the carbon monoxide level shall be no more than 0.1 % on a dry, air free basis, as defined by BS EN 297, when the boiler is operating at its normal maximum working temperature.

The results of the tests shall be documented.

The carbon monoxide detector shall be checked to verify correct operation.

10.8 Ventilation

Ventilation shall be provided in accordance with the boiler manufacturer's instructions and BS 5440. The vent(s) shall be checked to verify that it is not likely to become blocked or contaminated air can re-enter the building.

Where a depressurizing extract fan is fitted in the same room as an open flued gas appliance, the operation of the appliance shall be checked in order to verify that there are no adverse affects on the operation of the flue. If the operation of the flue is affected, additional ventilation shall be provided and the system retested.

10.9 Flueing

Specific manufacturer's instructions shall be followed in relation to any tests on the operation of the flue system. The operation of the flue shall be checked in order to verify that all combustion products are removed effectively.

Open flued appliances shall be checked for the potential of down draught.

Balanced flue appliances shall be checked for adequate casing seals.

Fan flued boilers shall be checked to ensure that in the event of fan failure, the boiler is prevented from operating.

10.10 Central heating boiler

The boiler and integral controls shall be fully commissioned in accordance with the manufacturer's instructions.

The installer shall ensure that the gas installation and appliance is purged of all air and gas in order to remove the potential for an explosive mixture being present. Purging operations shall conform to BS 6891.

Gas connections made or situated after the boiler control tap shall be tested with proprietary leak detection fluid. The test shall be carried out with the burner lit during the test.

The boiler and connections shall be checked for water leaks with particular attention to sealed systems.

The boiler electrical system shall be checked for the following:

- a) earth continuity;
- b) short circuit;
- c) resistance to earth;
- d) mains voltage and polarity.

The flame picture shall be checked across the operating ranges of the boiler, particularly where the boiler is of the modulating type.

The flame picture shall be checked to verify that there are no indications of flame impingement or vitiation.

The operating pressure and gas rate shall be checked and set in accordance with the manufacturer's instructions across all operating ranges.

Each integral control shall be checked for correct operation. The flame supervision device shall be checked for adherence to the required reaction timings and fail safe condition.

Where the boiler cannot be commissioned fully and satisfactorily, the boiler shall be disconnected from the gas supply and the customer advised of the actions required prior to bringing the boiler into operation. An appropriate warning label shall be attached to the boiler.

10.11 Hand over

The installer organization shall ensure that the customer is provided with the manufacturer's instructions for operating the boiler (user's instructions) and the manufacturer's installation and servicing instructions.

The installer organization shall record the following commissioning details and provide to the customer for their records:

- a) boiler details;
- b) system flushing and inhibitor details;
- c) heating and hot water operating mode measurements.

The correct operating procedure for the boiler and associated controls shall be demonstrated by the installer organization on completion of the commissioning work.

Instructions shall include advice on maximizing energy efficiency from the system by effective use of temperature and time controls.

The customer shall be advised of any precautions necessary to prevent damage to the boiler and system in the event of the system remaining inoperative during freezing conditions.

10.12 Documentation

The installer organization shall fully complete all job documentation and provide the customer with a copy. The document shall confirm that the following has been satisfactorily completed:

- a) pre-installation checks;
- b) initial safety checks;
- c) customer satisfaction with the installation design;
- d) commissioning checks;
- e) site clearance;
- f) customer information provided.

10.13 Customer acceptance

The customer shall be provided with the opportunity to confirm satisfaction with the central heating installation and the product as a whole.

Customer acceptance shall be confirmed by the signing of an Acceptance Certificate.

Where the customer expresses any dissatisfaction with the central heating installation, the Acceptance Certificate shall not be signed off until all outstanding concerns have been dealt with satisfactorily, by the installer organization.

Such concerns and issues shall be handled within a formal after sales and/or customer complaints handling process, operated by the installer organization in accordance with BS 8600.

11 Quality management

11.1 General

The installer organization shall operate a formal quality management system to ensure that key elements of product management and the requirements of this specification are fulfilled. These elements shall focus on the following:

- a) planning;
- b) control of purchased products;
- c) control of subcontractors;
- d) contract management;
- e) quality assurance;
- f) customer satisfaction;
- g) continuous improvement.

11.2 Subcontractor controls

The use of subcontractors for installation of the central heating system or associated specialist installation works shall be controlled in such a way as to ensure that the subcontractor conforms to this Product Assessment Specification. Control of subcontractors shall include the following:

- a) the evaluation of subcontractors;
- b) the selection of subcontractors;
- c) verification of qualifications and competency;
- d) the evaluation of subcontractor performance;
- e) quality assurance arrangements.

11.3 Selection of subcontractors

Selection shall be based on a formal supplier acceptance process. The process shall clearly inform the subcontractor of installation standards, company procedures and minimum competencies required in the performance of the contract.

Selection shall be based on the following:

- a) ability to comply with the above requirements;
- b) relevant experience;
- c) a record of providing quality service;
- d) statutory and industry approvals, see 11.4.

11.4 Verification of qualifications and competency

It shall be verified that all subcontractors utilized on installation work demonstrate competence and suitability based on appropriate training, qualification and experience and have the following qualifications and experience as a minimum:

- *for gas installation work*: individual membership of CORGI or other approved accreditation body;
- *for electrical work*: membership of NIECIC, ECA or other approved accreditation body; in addition each individual shall have successfully completed appropriate training, qualifications and experience;
- *for central heating work*: subcontractors shall have evidence that all installers have successfully undertaken Industry Standards approved training.

NOTE The subcontractor organization should be a member of an approved heating and ventilation trade association.

- *for building work*: subcontractors shall have evidence that all specialist trades have successfully undertaken Industry Standards approved training.

The installer organization shall have a formal system of ensuring that all installers are adequately provided with tools and equipment to operate effectively and safely in relation to work defined within this Product Assessment Specification.

11.5 Contract management

11.5.1 Management of all processes linked to the fulfilment of the contract shall be carried out by trained staff. The responsibility of staff shall be clearly defined and understood.

11.5.2 Procedures in relation to the management of processes shall be documented and accessible to all appropriate staff.

11.5.3 Documentation returned at each stage of the contract shall be reviewed for completeness. The documentation shall be checked to ensure that customer requirements can be met.

11.5.4 Purchasing and manpower planning shall be carried out in order to ensure that agreed contract requirements can be met. The planned schedule shall be monitored and controlled in order to confirm that the parameters set are achieved.

11.5.5 The required skilled manpower shall be established and allocated to the contract.

11.5.6 The criteria for workmanship and design shall be clearly defined to the engineers carrying out the installation work.

11.5.7 The supervisory management shall be notified of the contracts being carried out within their sphere of control in advance, in order that contract can be made with the customer at the pre-installation, in progress and post installation stages.

11.5.8 The contract file shall only be closed when the following critical checks have been completed satisfactorily and received:

- a) job documentation;
- b) commissioning work certification;
- c) signed customer Acceptance Certificate;
- d) Small Electrical Works Certificate.

11.5.9 Records of contracts shall be retained by the installer organization for a minimum of 18 months.

11.6 Supplier control

11.6.1 The installer organization shall have defined purchasing processes to ensure that purchased products for use within the central heating installation shall conform to the defined requirements.

11.6.2 The installer organization shall evaluate and select suppliers based on their ability to supply product in accordance with the requirements set out within this specification.

11.6.3 Supplier performance shall be monitored in relation to the following:

- a) product compliance;
- b) product delivery standards;
- c) compliance with purchased requirements.

11.6.4 Purchase orders shall clearly define the product schedules, including any specific approvals or product certification.

11.6.5 The installer organization shall review and approve purchase orders for adequacy prior to release.

11.6.6 The installer organization shall ensure that any changes to the specification are notified to the supplier in an appropriate manner and confirm that the original schedule for delivery will not be affected. Any changes to the scheduled delivery shall be notified to the customer, installer and other interested parties.

11.6.7 The installer organization shall have a defined process for verification of the purchased product. The verification process shall include a formal process for dealing with non-conforming products.

11.7 Quality assurance

11.7.1 The installer organization shall provide a formal system of quality assurance. This will be achieved by a supervisory manager providing the following:

- a) initial contact with the customer on the installation start date;
- b) interim visits during the installation as appropriate;
- c) a post inspection quality inspection.

11.7.2 The initial contact shall involve introducing the manager to the customer, advising that they will be responsible for the installation through to completion and to arrange a suitable date to carry out the quality inspection. The supervisor shall provide a means of contact for the customer.

11.7.3 Interim visits shall take place to deal with any issues or concerns of the customer during the installation work.

11.7.4 The quality inspection visit shall take place on every installation within 28 days of completion. The inspection visit shall confirm:

- a) that the installation has been fully completed to the satisfaction of the customer;
- b) the central heating system and controls operate correctly and efficiently;
- c) the customer understands the operation of the system and its controls;
- d) to carry out a technical assessment of the work carried out.

The above components of the visit shall be documented and the customer requested to confirm satisfaction with the installation and central heating product.

11.7.5 The installer organization shall have a formal system of ensuring that the performance of the engineers meet prescribed standards.

These assessments shall cover both work in progress and completed installations.

The assessment shall cover the following elements:

- a) appliance installation;
- b) system installation;
- c) supplier performance;
- d) customer satisfaction;
- e) health and safety.

Where the assessment highlights areas where improvements or corrective actions are required, the assessor shall ensure that the installer is provided with feedback and where necessary additional training is carried out.

The person carrying out the assessment shall be trained and hold the appropriate qualifications as an assessor.

Assessments shall be carried out by line management and supported by independent assessors.

The results of assessments shall be monitored by the installer organization in order to identify any trends and provide a basis for improvement across the organization.

11.8 Complaint handling

The installer organization shall provide a formal customer complaint handling process in accordance with BS 8600. The complaints management processes employed shall provide the following:

- a) management involvement and commitment to resolving customer complaints by adequate resourcing and training;
- b) recognizing and protecting the rights of the customer;
- c) providing customers with an open and effective complaints management system;
- d) facilitate the use of an independent review body;
- e) monitor complaints in order to improve the quality of service;
- f) an effective corrective and preventative action process supporting the customer complaints handling system;
- g) an effective audit system that verifies the effectiveness of the complaint handling system;
- h) established standards of service in handling customer complaints.

11.9 Waste management

On completion of the installation the installer organization shall remove all waste associated with the installation. This shall include:

- a) packaging and wrapping;
- b) residual materials not used;
- c) scrap metal;
- d) controlled waste which shall be removed by a licensed person.

Agreement shall be reached with the customer on the timing of the removal and shall be within 48 h of the completion of the work.

The removal of any asbestos shall be arranged by the installer organization.

NOTE 1 Attention is drawn to the Waste Management Regulations [8] and The Control of Asbestos at Work Regulations, see A.3.

NOTE 2 Compliance with BS EN ISO 9001 is recommended as a means of complying with clause 11.

12 Warranties

The installer organization shall provide 12 month warranties on the boiler, system, associated controls and equipment. The warranties shall not affect the customers statutory rights.

13 Maintenance and records

13.1 General

The installer organization shall provide maintenance support to the central heating system throughout the duration of the product warranty period.

A formal record of customer details, including a history of work done and customer contacts shall be retained by the installer organization.

13.2 Routine maintenance

The installer organization shall ensure that the customer is aware of the need for regular maintenance of the boiler, system and associated equipment. Maintenance shall ensure that the following aspects are dealt with:

- a) safety;
- b) operational reliability;
- c) operational efficiency;
- d) system efficiency;
- e) preventative maintenance;
- f) emissions from the boiler.

The boiler and associated equipment shall be inspected and maintained to ensure compliance with all statutory requirements.

13.3 Breakdown service

The installer organization shall provide a service support system in order to deal with any failures to the boiler, system or associated equipment during the warranty period.

NOTE Requests to repair gas escapes or suspected leakage of products of combustion may only be considered if the appropriate Emergency Service has visited the property and made the installation safe.

The service provision shall be capable of visiting any reported failures within 24 h.

The installer organization shall ensure that trained personnel deal with incoming calls from customers and are able to deal effectively with any reported gas escapes or suspected leakage of products of combustion.

13.4 Records

Maintenance visits shall be effectively planned and scheduled. Each visit to carry out repairs and maintenance on the boiler, system and associated controls shall be recorded within a customer record system.

The customer record system shall provide the following details:

- a) the customer name and address;
- b) customer contact details;
- c) details of service agreements held;
- d) details of previous visits;
- e) details of parts and components fitted;
- f) details of any customer complaints.

The record shall be retained for a minimum of two years.

Annex A (informative)

Legal issues

A.1 Building regulations

A.1.1 *England and Wales*

The Building Regulations made by the Secretary of State for the Environment under the Building Act 1984 cover health and safety of persons in and about buildings. Requirements are not included for the direct supply of public utilities, such as water, gas or electricity although (six) specified items are related to water installations.

The requirements for these items are made under regulations 4, 5 and 6 and listed in schedule 1 of the regulations to cover:

- provision of wash basins in conjunction with water closets and a suitable installation for the provision of hot and cold water to wash basins and provisions for effective cleaning of water closets and urinals (G1);
- provision of a bath or a shower bath and a suitable installation for the provision of hot and cold water to the bath or shower bath (G2);
- provision of sufficient precautions against explosion in unvented hot water systems (G3);
- requirements for controls on certain space and water heating installations and insulation of hot water heating and supply pipes, warm air ducts and hot water storage vessels (L1).

The requirements apply to the construction or installations work and there is no on-going requirement for maintenance or inspection. They are written in a functional form. The regulations are a statutory instrument; guidance on ways of meeting the requirements is given in approved documents.

Control of building work under the regulations is a matter for local authorities or approved inspectors. Local authorities also have the powers under other sanitation and building legislation such as Public Health Acts. Local Authorities and approved inspectors also have powers to inspect work during construction. Disputes regarding a local authority's application of the regulations may have to be decided ultimately in a court of law; it is not always appreciated that contravening building regulations is a criminal offence.

Building work generally involves more than one statutory instrument; any person undertaking water installations or other works should be aware of the relevant requirements in such statutory or guidance documents as building regulations, Water Supply (Water Fittings) Regulations 1999 [2], gas regulations and electrical wiring regulations.

A.1.2 *Scotland*

In Scotland the Building Standards (Scotland) Regulations, made under the Building (Scotland) Act 1959, apply in respect of:

- drainage and sanitary facilities (M);
- requirements for unvented hot water systems (P);
- insulation of hot water storage vessels and pipes (J).

A.1.3 *Northern Ireland*

In Northern Ireland the Building (Northern Ireland) Regulations, made under the Building Regulations (Northern Ireland) Order 1979, apply in the respect of:

- drainage and sanitary facilities (N);
- unvented hot water systems (P);
- conservation of fuel and power (F).

A.2 Water Regulations

A.2.1 *England and Wales*

In England and Wales, all new consumers' installations supplied by a water company, both domestic and non-domestic, are regulated by the Water Supply (Water Fittings) Regulations 1999 which replaced the water companies' byelaws on 1 July, 1999, for the prevention of waste and contamination of water supplied. In effect, compliance with the Regulations is a condition of supply. Failure to comply with the Regulations can result in legal action, with a prescribed scale of penalties.

The water companies have a statutory duty to enforce the Regulations.

If an innovative product is developed which does not conform to Regulatory requirements, water companies may, if they consider it warranted, seek a relaxation from the Department of the Environment, Transport and Regions. A relaxation could permit a field trial so as to evaluate a product.

A.2.2 *Scotland*

In Scotland, water byelaws are made under section 70 of the Water (Scotland) Act 1980. The arrangements in Scotland are similar to those in England and Wales except that the water authorities are the water undertakers. However, there are differences in detail between the byelaws operating in Scotland and the Water Supply (Water Fittings) Regulations 1999 operating in England and Wales.

The Building Standards (Scotland) Regulations require an adequate supply of water available within the house. The majority of other types of buildings are required to have a water supply for sanitary purposes.

A.2.3 *Northern Ireland*

In Northern Ireland, water regulations have been made under Article 40 of the Water and Sewerage Services (Northern Ireland) Order 1973. The general purpose is to prohibit the use or connection of fittings that are likely to cause or permit waste, undue consumption, misuse, erroneous measurement or contamination of water supplied by the Department of the Environment for Northern Ireland.

A.3 The Health and Safety at Work etc. Act 1974

This act makes provisions for securing the health, safety and welfare of persons at work, for controlling the keeping and use of dangerous substances and for controlling emissions into the atmosphere. The Workplace (Health, Safety and Welfare) Regulations are made under this act and regulate the provision of drinking water and sanitary accommodation at places of work. The Gas Safety (Installation and Use) Regulations regulate the installation of gas appliances and systems. The provision and method of using asbestos containing materials is covered by the Control of Asbestos at Work Regulations which are made under this act.

Annex B (informative) Environmental conditions

B.1 Comfort conditions

A wide range of external environmental conditions can affect comfort conditions, these include:

- a) temperature;
- b) air movement;
- c) humidity.

In addition, personal factors such as physical activity, age and clothing worn can affect comfort conditions.

It is impractical to cover all aspects of comfort conditions by the provision of a central heating system, however the system may contribute to all or some of these conditions dependent upon external temperatures and humidity. The factors that can be controlled by the design of a central heating system are:

- a) resultant temperature;
- b) air movement/draughts;
- c) infiltration and natural ventilation;
- d) humidity;
- e) solar effects;
- f) noise and vibration.

B.2 Design air temperature

Resultant temperature index is recommended as the basis for design within the UK. Resultant temperature combines the inside air temperature, mean radiant temperature and air velocity providing a single measure, known as the dry resultant temperature.

Generally, occupants will not experience any significant increase in dissatisfaction provided that the actual air temperature is within ± 1.5 °C of the design temperature. This tolerance takes into account unavoidable non-uniformity and temporal variations in room temperature.

B.3 Air movement and draughts

Air movement within the building is desirable in order to contribute to a continuous supply of fresh air, however excessive air movement will lead to draughts and complaints of discomfort from the occupants. Although a heating system cannot influence air movement, it is possible to reduce the effects of the uncomfortable effects of draughts, by the following means.

- Positioning heat emitters beneath windows can reduce the effects of draughts due to the effect of cold window surfaces on vertical temperature gradients;
- The use of forced convection heat emitters (fanned convectors) can provide a controlling effect on the temperature of air entering the heated space. The location and direction of such units, are important factors and therefore these should be considered carefully at the design stage.

B.4 Humidity

In the UK, the humidity within the heated space will not usually fall outside the range of 40 % to 70 %, outside of which thermal comfort becomes significantly affected. Very high levels of ventilation or very low levels of ventilation combined with high moisture release from the occupants, will result in problems with humidity.

B.5 Solar effects

The effects of solar radiation through windows can cause discomfort to the occupants. However, solar gains need not be taken into account when designing a central heating system within a domestic dwelling, unless the extent of glazing is significant in the space being considered. Typically, this may include areas such as conservatories.

Annex C (informative)

Data for combination boilers

Tables C.1 and C.2 provides guidance on typical performance data in relation to sanitary appliances and combination boilers.

Table C.1 — Approximate water demand of water appliances

Appliance	Demand l/min
Shower	9
Bath	18
Basin	9
Sink	12

Average flow rates and temperature rise from combination boilers are given in Table B.2. However, specific manufacturer's data should be checked to verify actual performance for given conditions.

Table C.2 — Average flow rates and temperature rise for 24 kW combination boilers

Temperature rise °C	Delivery l/m
30	10
35	9.5
40	8.5
45	7.5
50	6.5

System adequacy can be measured against a typical provision of 45 l (equivalent to one bath) of hot water at 55 °C in a relatively short period of time.

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