BS 5410-2:2013

BSI Standards Publication

Code of practice for oil firing

Part 2: Installations over 45 kW output capacity for space heating, hot water and steam supply services

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Contents

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 88, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 5410 is published by BSI Standards Limited under licence from The British Standards Institution and came into effect on 31 March 2013. It was prepared by Technical Committee RHE/13, *Oil burning equipment*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 5410 supersedes BS 5410-2:1978, which is withdrawn.

Relationship with other publications

BS 5410 is published in three parts as follows:

- *Part 1: Installations up to 45 kW output capacity for space heating and hot water supply services;*
- *Part 2: Installations of over 45 kW output capacity for space heating, hot water and steam supply services;*
- *Part 3: Installations for furnaces, kilns, ovens and other industrial purposes.*

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- condensing boilers are now included;
- boilers burning biofuels are now covered.

Hazard warnings

WARNING. Decommissioning and disposal of oil storage tanks
The decommissioning and disposal of oil storage tanks can become necessary as part of the maintenance cycle of an oil fired system. This is not covered in the present standard. It is a very hazardous procedure, and it is imperative that it is only undertaken by specialist operatives who have the right equipment and expertise. Building owners should never attempt to cut up old oil storage tanks themselves.

NOTE 1 Attention is drawn to the Contruction (Design and Management) Regulations 2007 [1], which class such work as a "demolition project".

NOTE 2 Detailed guidance on decommissioning and disposal of oil storage tanks is given in OFTEC Technical Book 3 [2].

Use of this document

As a code of practice, this part of BS 5410 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 5410 is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the following specific regulations:

- The Boiler (Efficiency) Regulations 1993 as amended by the Boiler (Efficiency) (Amendment) Regulations 1994 and the Boiler (Efficiency) (Amendment) Regulations 2006 [3];
- The Building Regulations [4], [5], [6];
- The Environmental Protection Act 1990 [7];
- The Control of Pollution (Special Waste) (Amendment) Regulations 1988 [8];
- The Control of Pollution (Oil Storage) (England) Regulations 2001 [9];
- The Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10];
- The Water Environment (Oil Storage) (Scotland) Regulations 2006 [11];
- The Water Resources (Control of Pollution) (Silage, Slurrry and Agricultural Fuel Oil) Regulations 2010 (as amended) [12];
- The Control of Pollution (Silage, Slurry and Agricultura Fuel Oil) (Scotland) Regulations 2001 (as amended) [13];
- The Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations (Northern Ireland) 2003 [14];
- The Hazardous Waste (England and Wales) Regulations 2005 (as amended) [15];
- The Hazardous Waste Regulations (Northern Ireland) 2005 [16];
- The Special Waste (Amendment) (England and Wales) Regulations 2001 [17];
- The Special Waste Amendment (Scotland) Amendment Regulations 2004 [18];
- The Building (Approved Inspectors etc.) Regulations 2010 [19];
- The Building (Forms) (Scotland) Regulations 2005 (as amended) [20].

1 Scope

This part of BS 5410 gives recommendations and guidance on the design, installation, commissioning and maintenance of oil burning installations for heating, hot water and steam supply services having a total rated output of over 45 kW and/or an oil storage capacity above 3 500 L.

This part of BS 5410 is applicable to installations burning liquid fuel conforming to BS 2869:2010+A1, including biofuels, for example those containing fatty acid methyl esters (FAME) conforming to BS EN 14214, and blends thereof.

The standard covers the provision of new installations and also gives guidance on the modernizing of existing installations. The standard also gives recommendations and guidance on the selection and installation of oil tanks associated with these installations.

This part of BS 5410 is applicable to the oil burning equipment forming part of a multi-fuel installation in which oil is not burnt simultaneously with any other fuel. It is not applicable to oil fired systems for marine installations. The standard also gives recommendations on thermal fluid heaters and on portable plants, for example those used for emergency or temporary heat supply.

The standard is intended for use by designers, specifiers, installers and building owners.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 476-21, *Fire tests on building materials and structures – Part 21: Methods for determination of the fire resistance of loadbearing elements of construction*

BS 476-22, *Fire tests on building materials and structures – Part 22: Methods for determination of the fire resistance of non-loadbearing elements of construction*

BS 799-4:1991, *Oil burning equipment – Part 4: Specification for atomizing burners (other than monobloc type) together with associated equipment for single burner and multi burner installations*

BS 799-5, *Oil burning equipment – Part 5: Carbon steel oil storage tanks – Specification*

BS 845-1, *Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids – Part 1: Concise procedure*

BS 845-2, *Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids – Part 2: Comprehensive procedure*

BS 1212-1, *Float operated valves – Part 1: Specification for piston type float operated valves (copper alloy body) (excluding floats)*

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 1710, *Specification for identification of pipelines and services*

BS 2869:2010+A1:2011, *Fuel oils for agricultural, domestic and industrial engines and boilers – Specification*

BS 5306 (all parts), *Fire extinguishing installations and equipment on premises*

BS 5410-1, *Code of practice for oil firing – Part 1: Installations up to 45 kW output capacity for space heating and hot water supply purposes*

BS 5970, *Code of practice for thermal insulation of pipework and equipment in the temperature range –100 ° C to +870 ° C*

BS 7430, *Code of practice for protective earthing of electrical installations*

BS 7671, *Requirements for electrical installations – IET Wiring Regulations – Seventeenth edition*

BS 9999, *Code of practice for fire safety in the design, management and use of buildings*

BS EN 267, *Automatic forced draught burners for liquid fuels*

BS EN 303-1, *Heating boilers – Part 1: Heating boilers with forced draught burners – Terminology, general requirements, testing and marking*

BS EN 303-2, *Heating boilers – Part 2: Heating boilers with forced draught burners – Special requirements for boilers with atomizing oil burners*

BS EN 303-4, *Heating boilers – Part 4: Heating boilers with forced draught burners – Special requirements for boilers with forced draught oil burners with outputs up to 70 kW and a maximum operating pressure of 3 bar – Terminology, special requirements, testing, marking*

BS EN 1254-2:1998, *Copper and copper alloys – Plumbing fittings – Part 2: Fittings with compression ends for use with copper tubes*

BS EN 1567, *Buidling valves – Water pressure reducing valves and combination water reducing valves – Requirements and tests*

BS EN 12285-1, *Workshop fabricated steel tanks – Part 1: Horizontal cylindrical single skin and double skin tanks for the underground storage of flammable and non-flammable water polluting liquids*

BS EN 12285-2, *Workshop fabricated steel tanks – Part 2: Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids*

BS EN 12514-2, *Installations for oil supply systems for oil burners – Part 2: Safety requirements and tests – Parts, valves, pipes, filters, oil de-aerators, meters*

BS EN 13076, *Devices to prevent pollution by backflow of potable water – Unrestricted air gap – Family A – Type A*

BS EN 13077, *Devices to prevent pollution by backflow of potable water – Air gap with non-circular overflow (unrestricted) – Family A – Type B*

BS EN 13341, *Static thermoplastic tanks for the above ground storage of domestic heating oils, kerosene and diesel fuels – Blow moulded and rotationally moulded polyethylene tanks and rotationally moulded tanks made of anionically polymerized polyamide 6 – Requirements and test methods*

BS EN 13831, *Closed expansion vessels with built-in diaphragm for installation with water*

BS EN 13959, *Anti-pollution check valves – DN 6 to DN 250 inclusive – Family E, type A, B, C and D*

BS EN 14214 *Liquid petroleum products – Fatty acid methyl esters (FAME) for use in diesel engines and heating applications – Requirements and test methods*

BS EN 14622, *Devices to prevent pollution by backflow of potable water – Air gap with circular overflow (restricted) – Family A, type F*

BS EN 55014-1, *Electromagnetic compatibility — Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

BS EN 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

BS EN 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

BS EN 60079-30-1, *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements*

BS EN 60079-30-2, *Explosive atmospheres – Part 30-2: Electrical resistance trace heating – Application guide for design, installation and maintenance*

BS EN 62271-106, *High voltage switchgear and controlgear – Part 106: Alternating current contactors, contactor based controllers and motor starters*

BS EN 60947-4-1, *Specification for low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

BS EN 62395-1, *Electrical resistance trace heating systems for industrial and commercial applications – Part 1: General and testing requirements*

BS EN ISO 4126-1, *Safety devices for protection against excessive pressure – Part 1: Safety valves*

DD CLC/TS 62395-2, *Electrical resistance trace heating systems for industrial and commercial applications – Part 2: Application guide for system design, installation and maintenance*

SAE J513:1999, *Refrigeration tube fitting – General specification*

Other publications

[N1] OIL FIRING TECHNICAL ASSOCIATION. OFS T200 *Steel oil storage tanks and tank bunds for use with distillate fuels, bio-fuels, lubrication oils and waste oils. Construction standards and test procedures*. Issue 10. Ipswich: OFTEC, 2012.

[N2] OIL FIRING TECHNICAL ASSOCIATION. OFS T100 *Polyethylene oil storage tanks and tank bunds for distillate fuels. Construction standards and test procedures*. Issue 8. Ipswich: OFTEC, 2012.

[N3] HEALTH AND SAFETY EXECUTIVE. HSG 176 *Storage of flammable liquids in tanks.* Sudbury: HSE Books, 1998.

[N4] MASON, P.A., AMIES, H.J. and G. SANGARAPILLAI, et al. *Contruction of bunds for oil storage tanks*. CIRIA report 163, 1997.

[N5] ENERGY INSTITUTE. Performance specification for underground pipework systems at petrol filling stations. 2001.

3 Terms and definitions

For the purposes of this part of BS 5410 the following terms and definitions apply.

3.1 tank chamber

enclosure of a tank consisting of structural walls, floor and ceiling or roof

NOTE The main purpose of a tank chamber is to protect the contents of the tank from a fire originating outside the tank chamber.

3.2 bund
containment vessel to hold spillage from a primary tank, or tanks, caused by leakage or overfilling

NOTE 1 A bund provides secondary containment to a primary tank and is sometimes referred to as "secondary containment".

NOTE 2 A bund is designed to contain any leakage from the primary tank or any liquid escaping in an overfill situation and so prevent pollution and the risk of fire.

NOTE 3 A bund may be provided as an integral part of an oil storage tank.

3.3 fire screen wall
imperforate wall, of fire-rated construction, provided between an oil storage tank and a building to act as a heat radiation barrier

3.4 chimney
construction to carry the products of combustion to the atmosphere having one or more passages

NOTE The passages are known as "flues".

3.5 flue duct
connection to carry the products of combustion from a boiler or air-heater outlet to the entry of a chimney

3.6 oil storage system
system for the storage of oil consisting of a manufactured, or site-built, unit comprising a primary container with its fill, venting, draw off, gauging and alarm equipment and any secondary containment provided

3.7 primary tank
vessel used for the containment of liquid fuel

NOTE This can be located within a bund.

3.8 service tank
tank that isolates the main storage tank or tanks from the burner installation

4 Work undertaken in connection with oil fired installations

The installation, commissioning and replacement of oil fired appliances and oil storage and supply installations is work covered by the Building Regulations [4], [5], [6] and the Contol of Pollution (Oil Storage) Regulations [9] [10] [11]. This type of work should be undertaken by competent technicians, subject to supervision by a registration body.

In England and Wales, if a person registered with an approved scheme is used for such work then it is not required that application is made to the local authority building control department for approval prior to the work commencing and such firms can self-certifiy compliance of their work at completion.

NOTE 1 In England and Wales, where documentation is required by the local authority to confirm competent installation work, form CD/10 [21] has been approved for use.

NOTE 2 Attention is drawn to the Building Regulations [4], [5], [6] with respect to structural alterations to buildings.

5 Liquid fuels

5.1 Types of liquid fuel

Liquid fuel conforming to an appropriate class specified in BS 2869:2010+A1, and biofuels including FAME (fatty acid methyl esters) conforming to BS EN 14214, as specified by the equipment manufacturer, should be used with the equipment covered by this standard.

The specifier of the installation and the user should consult the local authority regarding any local controls which might limit the types of liquid fuel that may be used.

5.2 Liquid fuel characteristics

Users should obtain information on the characteristics of the fuel supplied and advice on the safe storage and handling of this from their fuel supplier.

A full safety data sheet giving information required under the Control of Substances Hazardous to Health (COSHH) Regulations [22] for the United Kingdom should be obtained from the fuel supplier or from the fuel producer.

6 Application of oil burners

6.1 General

A specification should be drawn up and agreed with the purchaser, covering the performance of the oil burning equipment in terms of heat output and efficiency, in addition to all other operating and safety criteria.

6.2 Choice of class of liquid fuel

6.2.1 General

The four main factors which should be taken into account when chosing the class of liquid fuel are described in **6.2.2**, **6.2.3**, **6.2.4** and **6.2.5**.

6.2.2 Size of plant

There is a minimum boiler rating below which it is not practicable to burn residual oils. The recommended minimum boiler ratings for different classes of residual oil are as follows:

- class E: 140 kW;
- class F: 250 kW;
- class G: 400 kW;

NOTE Class H oils should only be used for special applications.

It might be necessary to arrange for a small summer-load boiler in a boiler plant consisting of larger units to be fired by class D oil in order to achieve satisfactory conditions.

6.2.3 Environment

In addition to statutory requirements, in certain areas of high population density the local authority might already possess, or subsequently take, powers whereby acceptable fuels in that area are restricted to low-sulfur bearing varieties, e.g. class D, in order to limit the sulfur dioxide emissions. In other cases where there is doubt about the effects of emissions containing high concentrations of sulfur dioxide on, for example, buildings and exposed plant, the use fuels of lower sulfur content should be considered.

6.2.4 Steam/water temperature conditions

Where boiler heating surfaces can fall below the acid dewpoint, the corrosion effect of sulfur dioxide is increased considerably. This can occur with low-temperature hot water boilers and in such cases a distillate fuel of lower sulfur content should be used to reduce the corrosion rate and increase useful boiler life.

6.2.5 Plant operating schedule

The operating schedule of the plant can affect the grade of fuel needed and the control system required. For example, where plant requirements are such that fully automatic, virtually unattended performance is required, with night and weekend shutdown and minimal maintenance requirements, a distillate fuel might be necessary. A similar plant operating on continuous load with more expert supervision/maintenance could utilize a residual oil. In the former case, the cost savings in supervision and maintenance need to be balanced against the higher costs of using a distillate fuel and additional control equipment.

6.3 Appliances

6.3.1 General

Reliable and efficient operation of a boiler installation depends upon satisfactory coordination of the designs of the boiler, the oil burning equipment and the system. New boilers are frequently supplied as packaged units in which the boiler, burner and certain ancillary equipment are supplied to site pre-assembled. This practice, which can be applied to all but very large units, facilitates pre-matching and pre-testing the boiler-burner assembly as a standardized design.

When specifying oil burners, whether for use with new appliances or with existing boilers that have previously been fired by other fuels or by other oil burners, the suitability of the proposed burner for the conditions and intended duty should be taken into account.

The classification of boilers used in this standard has been adopted to serve as a basis for consideration of factors relating to oil burning equipment and is not intended to be a general or exhaustive classification of all boiler types.

Burner units conforming to BS EN 303-1, BS EN 303-2 and BS EN 303-4, as appropriate, should be used.

NOTE Attention is drawn to the Boiler (Efficiency) Regulations 1993 as amended by the Boiler (Efficiency) (Amendment) Regulations 1994 and by the Boiler (Efficiency) (Amendment) Regulations 2006 [3].

6.3.2 Boiler sizes in relation to load requirements

Boiler sizes should be selected to match the actual load requirements. Where boilers are oversized in relation to the load, the oil burners are subjected to frequent on/off operation and long off periods that produce the following undesirable effects:

a) a reduction in overall “seasonal” efficiency of the boiler plant;

b) increased fouling of boiler gas-side heating surfaces;

c) increased danger of corrosion of boiler heating surfaces, flue ducts and chimneys;

d) increased wear and tear on control gear, contractors, motors, etc.;

e) fluctuations in steam pressure or in temperature of water flow from the boiler plant;

f) difficulties with feed-water treatment and continuous blow-down control of steam boilers.

A curve showing anticipated loadings should be produced and the boiler sizes selected such that under normal load conditions the oil burners are working within their high/low or modulating range.

A boiler should be selected which has a range of outputs, with a turn-down ratio of the burner, i.e. the ratio between high and low levels of output, as given in Table 1.

Table 1 **Recommended maximum turn-down ratios for different types of boilers**

Type of boiler	Maximum turn-down ratio
Condensing boilers	3+:1
Cast iron sectional boilers	2:1
Small shell and other steel boilers (up to 2 000 kW)	2:1
Large hot water shell and other steel boilers (over 2 000 kW)	3:1
Large steam shell boilers (over 2 000 kW)	4:1

With large water-tube boilers fitted with multiple oil burners the turn-down ratio may be extended beyond the range given in Table 1 depending upon the particular boiler and system design under consideration, but the risk of acidic corrosion at low output should be taken into account.

Annual variations in anticipated loadings should be taken into account. Special attention should be given to the summer load, which might be much less than winter demand where no process heat is required, and to schemes with a phased development, where the ultimate load might not be reached for several years.

Standby capacity should be provided either by means of a separate standby boiler or by selecting boiler units with extra capacity where this can be done in accordance with the load matching priciples above.

Where a plant consists of a mixture of condensing and non-condensing boilers, the condensing boilers should cover the base load and the non-condensing boilers should be used for peak and standby purposes.

6.3.3 Quality of boiler water

6.3.3.1 Feed water for steam boilers

Feed water for steam boilers should be pre-treated to ensure that it meets the quality limits set by the boiler manufacturer. In order to protect the boiler, the quality of the boiler feed water should be subject to continuous monitoring and control to ensure it remains within the limits specified by the boiler manufacturer. Advice should be obtained from a water treatment specialist and that advice should be followed at all times.

6.3.3.2 Water for hot water boilers

Although hot water systems are regarded essentially as “closed circuits”, make-up water is necessary, the quantity depending upon the amount of leakage from such items as pump glands and from draining down for maintenance purposes, etc.

The water for the initial fill, and the make-up water, should be pre-treated to ensure it meets the limits set by the boiler manufacturer to protect the boiler, taking into account the intended operating temperature of the system.

NOTE This treatment can range from simple chemical dosing to full demineralization with the application of oxygen scavenging and pH corrective chemicals.

Frequent checks on internal water conditions as recommended in **6.3.3.1** should also be carried out.

6.3.4 Condensing boilers

A condensing boiler utilizes the latent heat remaining in the flue gases by causing the condensation of the water vapour in these gases. Therefore these boilers are fitted with a condensate drain. Condensing operation can only be achieved when the return water temperature is low, typically around 55 °C. The lower the return water temperature, the greater the condensation and the higher the efficiency. The relatively cool flue gases lack buoyancy and therefore fans are needed to drive them out of the flue systems. Fuels with very low levels of sulfur should be used for these boilers to minimize acid corrosion from the condensate.

6.3.5 Cast iron sectional boilers

6.3.5.1 General

This clause covers boilers of cast iron construction in which the rating of the boiler can be selected, within limits, by the number of assembled sections. The usual configuration covers a horizontal combustion space, but subsequent travel of the flue gas can be via a multiplicity of passes in series and/or in parallel and arranged horizontally or vertically.

With all cast iron boilers, the associated system should be designed to maintain the water return temperature at a high enough value to minimize condensation and sulfur corrosion.

6.3.5.2 Purpose-made boilers

Purpose-made boilers use combustion spaces at a positive pressure so inter-section sealing is very important. These boilers are less sensitive to flue conditions, but the boiler manufacturer’s recommendations regarding flue conditions should be followed. In these boilers, it is essential that all flue-way doors and observation windows are gastight, and that any excess-pressure relief door is sufficiently loaded to withstand the normal operating pressure without leakage.

Owing to the higher rates of heat release from purpose-made boilers, correct circulation of the water is very important and pumps and associated equipment should be of sizes that ensure adequate circulation at all times.

6.3.6 Shell boilers

6.3.6.1 General

The term “shell boilers” is applied to a group of boilers in which the flue gases usually traverse the boiler horizontally between the burner and the off-take. One or more furnace tubes, usually of circular cross-section, are fitted and these may be arranged for through or reversed flow of the combustion gases. After leaving the furnace tube the products of combustion pass through one or more longitudinal externally water-cooled return passages before reaching the chimney gas off-take. The gas passages may consist of nests of externally water-cooled tubes or of annular spaces. This group includes:

a) economic boilers, in which the rear chambers, known as “combustion chambers”, may be refractory lined (dry-back) or water-cooled (wet-back);

b) reverse flame furnace tube boilers.

6.3.6.2 Installation design – Relevant factors

The specification of burners should be undertaken in collaboration with the burner manufacturer, or burners should be chosen from appliance manufacturer's approved listing for the equipment concerned and the liquid fuel being used.

NOTE Attention is drawn to the Clean Air Act 1993 [23] and the Clean Air (Northern Ireland) Order 1981 [24]. Chimney and flue gas ducts should be designed and matched to the requirements of the appliance manufacturer's specification.

6.3.6.3 Replacement of oil burning equipment – Burner to appliance matching

6.3.6.3.1 The specification of burners should be undertaken in collaboration with the burner manufacturer, or burners should be chosen from the appliance manufacturer's approved listing for the equipment concerned and the liquid fuel being used. When the boiler plant is supplied by the manufacturer complete with the oil firing equipment, the specifier should inform the equipment manufacturer of the fuel specification to be used.

6.3.6.3.2 In the older types of shell boilers the gas passages were so proportioned that the pressure drop experienced by the gases in passing from furnace to chimney was small, usually a gauge pressure of less than 60 mm of water. Such boilers were intended for operation under zero or negative draught pressure, and the design of smoke boxes, excess-pressure relief devices, access doors and other fittings is unlikely to be suitable for use with newer forced-draught oil burners without modification.

6.3.6.3.3 When modifying these older types of boiler, special attention should be given, particularly in the case of dry-back boilers, to the following:

a) tightness of gas joints between front and rear smoke boxes and the boiler shell;
b) sealing between brickwork or insulation and shell of smoke boxes;
c) seals of access doors;
d) suitability of excess-pressure relief devices for resisting gas leakage under forced-draught conditions including those on start-up of burners;
e) suitability of existing refractory linings covering non-water-cooled surfaces for the increased surface temperature likely with oil firing.

6.3.6.3.4 The quality of the refractory brick should be such as to withstand a temperature of not less than 1 100 °C. However, where the brick surfaces cannot reradiate heat to any nearby water-cooled surfaces a quality of refractory brick capable of operating at temperatures up to 1 400 °C should be used.

6.3.6.3.5 The use of hot-face insulating bricks for the construction of the combustion space is sometimes desirable and the boiler manufacturer should be consulted. Where the burner design makes use of a brick quarl to ensure flame stability, care should be taken to follow exactly the quarl shape specified. The burner maker's advice should be sought on the design of the burner quarl. If necessary, refractory material should be fitted to exclude heat from the burner plate, and from those parts of the furnace tube not water-cooled, particularly the weld between the furnace tube and the head plate.

6.3.6.3.6 The suitability of tube attachment at the entry end of the first tube pass to withstand the changed conditions should be considered. It is recommended that the ends of welded stay tubes and of seal-welded plain tubes should be dressed flush with the weld, and plain tubes that are not welded should be no more than 1.5 mm proud of the tube plate.

6.3.6.3.7 The suitability of water-side circulation in tubed hot water boilers to sustain the higher rates of heat transfer in the region of the first tube pass entry when changing from solid fuel to oil firing should also be examined.

6.3.6.3.8 The combustion space should be such that combustion at the maximum required output is completed within the available length of furnace tube so that the flame does not make contact with the water-cooled surface of the furnace tube. The combustion space should also be such that the fuel can burn efficiently within the volume available.

6.3.6.3.9 Special problems might arise when converting boilers of riveted construction since the changed heat distribution within the boiler might cause old riveted joints to work loose and leak. If the boiler is old, this problem can be difficult to overcome.

6.3.6.4 New equipment

Where the boiler is supplied separately from the firing equipment the recommendations given in **6.3.6.3** should be followed. When a matched boiler-burner unit is supplied, details of the requirements for the temperature and pressure of the fuel supply and draught arrangements at the boiler outlet should be obtained from the manufacturer.

6.3.7 Water-tube boilers

6.3.7.1 The oil firing of water-tube boilers requires special consideration by the specifier in collaboration with the boiler and burner makers in respect of furnace volume, rate of heat release, the number of burners and their location, their proximity to the combustion space boundaries and the length of flame. Attention should be paid to the necessity for a low rate of firing when starting the boiler from cold. This is particularly important when superheaters are fitted.

6.3.7.2 When the bottom of the combustion space is not water-cooled, arrangements should be made to limit the heat flow into the boiler room floor. This can be achieved by the provision of an air gap below the hearth, which should be adequately cooled by natural convection or by induced or forced ventilation.

6.3.7.3 The specification of burners should be undertaken in collaboration with the burner manufacturer, or burners should be chosen from the appliance manufacturer's approved listing for the equipment concerned.

6.3.7.4 Adequate standards for water treatment should be determined to meet the new conditions, see **6.3.3**.

6.3.7.5 Air leaks into the combustion chamber, gas passes and flue ducts should be reduced to a minimum.

6.3.7.6 When it is intended to use the existing fans, the suitability of their performance should be checked.

6.3.7.7 The sulfur content of liquid fuels can cause low-temperature acidic corrosion problems and steps should be taken to reduce the resulting effects. In the case of boilers fitted with economizers, corrosion can be reduced by the following methods:

a) removal of sections of the economizer;

b) recirculating feed water through the economizers;

c) increasing the feed-water inlet temperature of the economizer by external means;

d) selection of burners suitable for operation at near stoichiometric conditions over the required turn-down range.

6.3.7.8 Flue ducts should be adequately insulated to prevent low metal temperatures.

6.3.7.9 Where the replacement of a burner has necessitated the reconstruction of a combustion chamber incorporating large quantities of refractory material, it is essential to ensure that the boiler operators bring the plant slowly up to maximum working load. This is so that the refractory material is dried out slowly so as not to affect its structural integrity. When heated too quickly the surface can harden before the moisture in the deeper parts has dried. This can later boil and affect the adhesion of the refractory material onto the supporting structure and to itself. The advice of the installer or a specialist refractory engineer should be sought.

6.3.8 Instantaneous steam and instantaneous hot water generators

Instantaneous steam generators are a group of appliances characterized by pressure parts consisting of a continuous coil of pipe that provides the convected heat transfer zone and can also completely or partly surround the combustion space. Water is fed into the coil under pressure and is largely or entirely converted into steam before reaching the other end of the coil. Instantaneous hot water generators are similar but designed so that the water is heated during passage through the coil to the required outlet temperature.

Units of this type are usually supplied as fully packaged appliances. This type of equipment necessitates a degree of interlock between the water pumping rate and the firing rate; the combustion chambers are often of compact size and shape. For these reasons the appliances should be fired only by the burner supplied by the appliance manufacturer.

In certain cases it is possible to convert the appliance to use a fuel different from that for which it was originally designed but in view of the considerations outlined above such a conversion should be carried out only by the original equipment manufacturer.

The manufacturers' instructions in respect of chimney and fuel supply conditions should be precisely followed.

6.4 Warm air heaters

6.4.1 General

For the purposes of this standard, a warm air heater is defined as a self-contained appliance for supplying warm air for heating commercial and industrial premises.

NOTE The requirements for warm air heaters are specified in BS EN 13842.

The appliance is generally an enclosed unit containing a burner and a heat exchanger system. The air to be heated is circulated by a fan across the heat exchanger and the warm air is then distributed directly into the heated space or via ductwork to the space to be heated.

The heat exchanger consists generally of a metal-walled combustion chamber where the combustion of the fuel is completed and a secondary section in which further heat is transferred from the products of combustion prior to their discharge into the flue system.

Warm air heaters are designed with the heat exchanger system operating under either a negative or a positive pressure. To enable the correct condition to be achieved the chimney and flue duct should be of such size as to provide the draught specified by the manufacturer, which might involve the fitting of an induced-draught exhaust fan. This fan may be built into the heater unit or supplied as an additional item of equipment, but in either case interlocking with the burner control is essential to ensure that the burner cannot operate unless the fan is running.

6.4.2 Conversion of gas fired heaters to oil firing

It is recommended that when conversion of gas fired equipment to oil firing is required, the manufacturer of the heater should be consulted. It is possible that the heater was originally designed for either of these fuels and a simple substitution of burner and controls might be adequate to bring about the conversion.

Many manufacturers of warm air heaters use packaged gas burners supplied by independent burner manufacturers. In these cases the burner manufacturer can usually supply a suitable oil burner. If not, a suitable burner should be obtained from an independent burner supplier.

When a substitute oil burner is not available from the heater manufacturer, consideration should be given to the gas firing characteristics so that a suitable type of oil burner can be selected.

Where the gas burner has been incorporated as a special part of the heater design, physical difficulties can arise when attempting to fit an alternative oil burner. It is then advisable to consult the manufacturers of both the heater and the oil burner. It is unlikely that heaters fitted with atmospheric gas burners can be converted to oil firing.

With pre-mix units, advice should be obtained from the burner manufacturer as to the suitability for conversion.

The specification of burners should be undertaken in collaboration with the burner manufacturer, or burners should be chosen from appliance manufacturer's approved listing for the equipment concerned.

A check should be made on the heater to ensure that there is sufficient airflow across the heat exchanger to limit the air temperature rise to that recommended by the heater manufacturer.

All joints in the combustion system should be sealed to avoid any leakage of combustion gases into the warm air flow or the heater surroundings. For the same reason, it is essential to ensure correct fitting of excess-pressure relief devices.

The heat exchange system should be checked. Particular attention should be paid to inspection of the combustion chamber for any cracking or broken welds due to excessive thermal stressing, and checking of the secondary section for leakage caused by corrosion. Faulty parts should be repaired or, if necessary, replaced.

6.4.3 Installation of new warm air heaters

The specifier and/or the designer should should ensure that the size or number of heaters to be installed is sufficient to meet the maximum load requirements of the space to be heated. Over-sizing of heaters causes frequent shut-downs and long periods of inactivity, resulting in inefficient operation.

Where high/low/off heaters are to be installed, they should be selected so that the maximum designed heating load falls between the high and low flame outputs.

6.4.4 Installation design

Warm air heaters should be sited to ensure that air inlets are not restricted in any way and that there is sufficient clearance for maintenance of burner, controls, heater, and exhaust flue. Heaters should be isolated from any combustible materials or flammable vapours, see **10.6**.

Flue-gas ducts and chimneys should be designed to satisfy the draught requirements specified by the heater manufacturer and to ensure that the products of combustion cannot be re-circulated to the air inlets.

7 Selection of burners

7.1 General

The type of oil burner to be used and the mode of control of the burner should be selected so that they are suitable for:

a) the type of plant unit, e.g. shell boiler, water-tube boiler, warm air heater;

b) the class of liquid fuel to be used, see Clause **5**;

c) utilization pattern of plant, e.g. constant output, variable output such as variations in heating load.

NOTE Attention is drawn to the Clean Air Act 1993 [23] and the Clean Air (Northern Ireland) Order 1981 [24].

7.2 Types of burner

7.2.1 General

The types of burner are listed in BS 799-4 and BS EN 267, the differentiation of type being designated by the methods of atomization used. The characteristics of these types are as described in **7.2.2** and **7.2.3**.

7.2.2 Pressure-jet burners

7.2.2.1 General

In this type of burner oil is supplied, under pressure and at a suitable viscosity, to a nozzle in which some of the pressure is used to impart rotation (swirl) to the oil before it is discharged through the final orifice. On issuing from the final orifice, a film is produced which atomizes into oil droplets.

7.2.2.2 Simplex pressure-jet

In this type of atomizer the droplet size increases with reduction of oil pressure. Consequently the range of turndown is limited.

NOTE Variations of the simplex pressure-jet atomizer have been devised to overcome this limitation.

7.2.2.3 Spill return pressure-jet

This type of atomizer has flow and return oil passages. Turndown is effected by returning oil from the atomizer to the tank or other parts of the system.

7.2.2.4 Duplex pressure-jet

This type of atomizer has two flow passages designated pilot and main. It has two sets of swirl passages, a common swirl chamber and final orifice. At low flow, oil is only supplied to the pilot passages, and at high flow, the oil is supplied to both pilot and main passages.

7.2.2.5 Duple pressure-jet

This type of atomizer has two flow passages, pilot and main. It has two sets of swirl passages, two swirl chambers and two final orifices that are concentric. At low flow, oil is only supplied to the pilot passage and jet, and at high flow, the oil is supplied to both pilot and main passages and jets.

7.2.3 Two-fluid type

7.2.3.1 General

In this type of burner oil droplets are produced by promoting high rates of shear in the oil by the use of an additional fluid such as air or steam.

7.2.3.2 High pressure air or steam type

Oil is fed at a controlled rate to the nozzle where a stream of air or steam under a gauge pressure generally of over 1 bar meets the oil and atomizes it by impact.

7.2.3.3 Medium pressure air type

Oil is fed at a controlled rate to the nozzle where a stream of air under pressure meets the oil and atomizes it by impact. Burners of this class generally use air at gauge pressures from 70 mbar to 1 000 mbar.

7.2.3.4 Low pressure air type

Oil is atomized by the impact of air supplied by a fan at gauge pressures generally from 30 mbar to 100 mbar.

7.2.3.5 Spinning cup or rotary type

Oil is supplied at a controlled rate to the interior of a hollow conical cup, rotated by means of an electric motor or by a turbine driven by air or steam. Oil leaves the outer lip of the cup as a thin film under the influence of the centrifugal force. Atomization is carried out by the impact of a stream of air supplied through an annular nozzle surrounding the rotating cup.

7.2.3.6 Emulsifying type

Oil atomization is substantially effected by a nozzle, normally using air as the atomizing medium. Oil at a suitable viscosity is metered and mixed with a controlled proportion of air at the inlet to a compressor from which the mixture emerges as an emulsion, and is conveyed to the nozzle.

In some burners, oil saturated air and emulsified oil are separated from the compressor in a stabilizing chamber before remixing at the nozzle.

7.2.3.7 Steam or air assisted pressure-jet type

The air or steam is introduced concentrically with the pressure jet orifices. The air or steam is used to improve atomization and to maintain it when the oil pressure is too low. In this way the turndown range of the pressure-jet is increased.

7.3 Types of burner control

Any of the types of burner described in **7.2** may be controlled by any of the following methods:

a) flame-monitored hand control;

b) partly automatic control;

c) flame-monitored and partly automatic control;

d) fully automatic control.

These types of control are fully described in BS 799-4 and BS EN 267.

For installations where supervision by entirely competent staff (see Clause **4**) is not available a fully automatic control method, [item d)], is strongly recommended.

The control of a burner comprises three distinct systems:

1) control of starting and stopping to ensure safe conditions;

2) control during running to ensure maintenance of safe conditions;

3) control of variation (if any) in heat output.

Items 1) and 2) are burner safety controls and should conform to BS 799-4 and BS EN 267.

Variations in heat output [item 3)] can be controlled by operating the burner:

i) on/off, or high/low/off; or

ii) fully modulating over the turn-down range.

7.4 Choosing oil burning equipment – Factors to consider

The maximum output of the burner(s) has to be sufficient to meet the maximum rating of the boiler or warm air heater.

Depending upon the type of burner employed, the method of operation of the burner should be chosen from one of the following types to meet the varying load requirements:

a) on/off;

b) on/off, with transitional low-flame start;

c) high/low/off;

d) fully modulating over the turn-down range.

The flame size and shape should be such as to be confined within the combustion space of the unit under the conditions specified by the boiler or heater designer. It is often difficult to judge visually, if a flame is impinging on the surface within the combustion space or if it appears to be impinging, whether it will cause damage. If flame impingement is occurring, because of chilling of the flame, carbon will build up on the surface or it will be impossible to reduce the carbon monoxide level below a level of 0.01%, or the smoke number (Bacharach scale) of the exhaust gases may be higher than for normal operation.

NOTE Attention is drawn to the Clean Air Act 1993 [23] and the Clean Air (Northern Ireland) Order 1981 [24].

Many types of oil burners have been developed commercially to meet individual requirements for heating and steam raising. The range of burners available is very wide and even with experience, the selection of a particular type for an application can prove difficult.

Guidance on burner selection should be obtained from the burner manufacturer.

8 Oil tanks and equipment

8.1 Oil tank construction

Oil storage equipment should be selected which has been manufactured so as to provide a 20 year expected working life.

Owners and installers of oil storage equipment should obtain written confirmation that the equipment has a 20 year expected working life when correctly installed, used and maintained. This documentation should be retained by the owner for the lifetime of the installation. Records of installation (see **8.10**) and maintenance (see Clause **15**) should also be retained by the owner for the lifetime of the installation.

NOTE 1 Attention is drawn to the Contol of Pollution (Oil Storage) Regulations [9], [10], [11]. Attention is also drawn to the DEFRA Guidance note for the Control of Pollution (Oil Storage) (England) Regulations 2001 [25], which states: "It is recommended that you purchase a fixed container expected to last for a minimum of 20 years before it needs to be replaced.".

Tanks should also conform to the relevant standard listed in Table 2.

For the storage of kerosene, see **10.8**.

Table 2 **Types of oil tank and locations for which they are suitable**

Standard	Type of tank	Location
BS 799-5	Steel fabricated primary tank	Above ground, internal or external
OFS T200 [N1]	Steel fabricated primary tank or integrally bunded tank	Above ground, internal or external
BS EN 13341	Themoplastics primary tank	Above ground, internal or external
OFS T100 [N2]	Medium density polyethylene primary tank or integrally bunded tank	Above ground, internal or external
BS EN 12285-1	Steel fabricated double skinned primary tank	Below ground
BS EN 12285-2	Steel fabricated double skinned primary tank	Above ground

Concrete tanks and bunds should be designed by specialists in consultation with the engineers responsible for the layout of the oil firing and storage system. The application of linings impervious to oil, such as glass or ceramic tiles, steel or special cements, should be carried out by, or under the direct and continuous supervision of, specialists.

For liquid fuels which require heating, metallic tanks are the preferred option.

Tanks with a riveted construction, e.g. old shell boilers, should never be used as oil tanks because of penetration of oil, and eventual leakage, at the joints.

8.2 Capacity

The minimum net capacity of oil storage tanks for high volume installations should be the greater of:

a) 3 weeks' supply of oil calculated at the maximum rate of consumption; or

b) 2 weeks' supply of oil calculated at the maximum rate of consumption, plus the usual quantity ordered for one delivery.

Consultation with the oil supplier is advisable before finalizing the minimum net capacity.

The gross capacity of oil storage tanks should be sufficient to allow for:

1) minimum quantity of oil delivered at one time;
2) the additional volume (dead space) below the fuel take-off required to accommodate sludge and water at the bottom of the tank;
3) the additional volume (ullage) required as a safety allowance against overfilling, thermal expansion and dumping from rooftop tanks, see **8.14**;
4) the additional volume required to accommodate heating equipment and any other equipment fitted within the tank.

NOTE Where biofuel is to be used, consideration should be given to selecting a size of tank that will prevent large quanitities of biofuel being stored for long periods.

8.3 Selection of tanks

It is usually preferable to have a single tank, sized to meet the requirements of the installation. The use of tanks to manufacturers' standard sizes can be less expensive than using specially made tanks.

The following types of tanks are available for above ground use.

a) *Single skinned tanks*. These provide primary containment only.
b) *Double skinned tanks*. These provide primary containment only.
c) *Integrally bunded tanks*. These provide both primary and secondary containment in a single unit.

NOTE 1 Under the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11], single skinned tanks, and double skinned tanks installed above ground are required to have secondary containment and tanks that are to be buried below ground are required, as a minimum, to be double skinned.

NOTE 2 This is distinct from placing a tank below ground within an oil-tight chamber which provides secondary containment.

The following shapes of tanks are commonly available:

1) rectangular;
2) horizontal cylindrical;
3) vertical cylindrical.

NOTE 3 Other shapes can be fabricated to order.

8.4 Provision for measurement of contents of oil storage tanks

8.4.1 Tank contents control and gauging

Facilities should be provided to determine the quantity of oil in a tank in order to:

a) ascertain when a new delivery is necessary;
b) determine how much oil can be ordered;
c) determine if the new delivery can be accommodated;
d) monitor fuel consumption.

Contents measuring equipment of one of the following types should be provided:

1) electronic device for local and/or remote reading;
2) hydrostatic device for local and/or remote reading;
3) pneumatic device for local and/or remote reading;
4) mechanical device for local and/or remote reading.
5) dip stick or dip tape for local reading.

It is recommended that a calibrated dip stick or calibrated dip tape should be provided in addition to any other form of oil-level indicator in order to check the accuracy of the indicator.

Indicators marked in units of volume should have a litre scale.

The oil contents indicator should be marked "O" or "EMPTY" to show when the oil surface is level with the top of the outflow, or level with the foot valve if one is fitted.

To reduce the likelihood of overfilling, scales should be marked "FULL" at a level equivalent to 95% of brimful/gross capacity for tanks with a capacity up to and including 20 000 L and at a level equivalent to 97.5% of brimful/gross capacity for tanks with a capacity of over 20 000 L.

8.4.2 Tank contents display systems

8.4.2.1 General

A tank contents display should be provided, for use by the persons responsible for stock control and by personnel responsible for delivering fuel into the tank.

The tank contents display system(s) used should enable the tank contents level to be read easily.

Tank contents display systems should incorporate the following features, in accordance with **8.4.2.2** and **8.4.2.3**:

a) local display of contents level, i.e. on the tank; or
b) remote display of contents level, i.e. at some convenient position away from the tank; or
c) both local and remote display of contents level.

Where electronic devices are used with kerosene, the guidance given in Health and Safety Executive document HSG 176 [N3] should be followed.

8.4.2.2 Local display

Where contents display is on the tank it should be easily visible without the need to use steps or ladders. If this is not possible, permanent secure means should be provided for the access required.

Where local access is used for stock control, arrangements should be made for the contents display to be read at suitably frequent intervals.

Where delivery is made directly into the tank, local display of tank contents level should be visible from the point at which the delivery person stands to control the delivery. If this is not practicable, a remote display should be used.

8.4.2.3 Remote display

Remote display can either be by means of a permanently installed gauge or by the use of a driver-held remote reading device which can sense the tank contents level. Many remote gauging systems can accept signals from such devices, which can usually also provide an overfill warning alarm.

Remote display has the advantage of enabling the tank contents level to be read at a point which is convenient for the persons involved in stock control. This could be in an office, plant room or other suitable location.

Remote systems can also permit the tank contents level to be read via a telephone link at the oil distribution depot from which the tank is serviced. This enables an automatic control of stock to be arranged to supplement the duties of site staff or without the need for on-site staff to be involved.

8.5 Safety and environmental precautions

The Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11] require that all tanks are labelled at the fill point with the nominal capacity, and that the following precautions are taken:

a) supervision of all fuel stocks by a responsible person;

b) supervision of all fuel deliveries by a responsible person;

c) precautions against overfilling of tanks:

   1) contents indicators clearly visible from the filling point;

   2) an overfilling alarm system, or an automatic delivery shut-off device;

   3) a bund alarm;

   4) tank vent clearly visible from the filling point, or installation of an overfill prevention device if the vent from the primary tank is not clearly visible from the filling point.

NOTE Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11] regarding safety and environmental precautions.

Where night deliveries are envisaged illumination of the filling point and contents indicator, etc. should be provided.

Certain commercial applications require high level and overfill alarms in order to meet the requirements of fuel suppliers.

Requirements for overfill alarms are specified in OFS E105 [26].

Where electronic devices are used with kerosene, the guidance given in Health and Safety Executive document HSG 176 [N3] should be followed.

8.6 Filling pipes and connections

Where the filling point is outside the tank bund it should be provided with a separate bund or drip tray capable of holding a minimum of 3 L of oil plus a suitable ullage to allow the tray to be moved without spilling the contents. Fill point bunds manufactured from concrete or masonry should conform to the constructional requirements of CIRIA Report 163 [N4]. Fill point bunds manufactured from steel or plastics should conform to the constructional requirements of OFS T200 [N1] or OFS T100 [N2], respectively.

Filling pipe connections should be in accordance with BS 799-5. Where more than one grade of oil is being stored in the same installation or building, there should be a separate filling terminal for each grade and a label indicating the grade.

A separate filling pipe should be provided for each tank. Each tank and each corresponding filling pipe should be clearly numbered. If this is not convenient with a multi-tank installation storing the same grade of fuel, a common filling line may be used, provided that the following conditions are met.

a) Independent connections fitted with isolating valves are made between each tank and the common filling line. These isolating valves should be readily accessible and should indicate whether they are open or closed.

b) Each tank is clearly numbered and the same number is displayed on or close to the corresponding oil-level indicator and on the corresponding isolating valve.

Each filling pipe should be fitted, at the filling point, with a protective cap.

Filling pipes should be self-draining to the storage tank wherever possible. Where this is not possible, an isolation valve plus a non-return valve should be provided adjacent to the filling point. Filling pipes for classes F and G oils plus some biofuels containing undrained oil should be trace heated and thermally insulated.

The fill point should not be installed at a height exceeding 1 250 mm from ground level or from the level of a secure filling point stand with protective railings. It should be protected from inadvertent mechanical damage and secured against unauthorized interference.

The filling terminal should be sited to allow easy access by delivery vehicles.

Pipes should be identified in accordance with BS 1710.

8.7 Vent pipes

Vent pipes should be in accordance with BS 799-5, OFS T100 [N2] or OFS T200 [N1], as appropriate. The diameter of the vent pipe should be not less than 50 mm and not less than the diameter of the fill pipe or the outlet, whichever is greater.

NOTE Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11] which require vent pipes to be directed to discharge directly into the secondary containment.

The vent pipe should be free from sharp bends, should have a continuous rise and, while being as short as convenient, should terminate in the open air in a position where it cannot be tampered with. Wherever possible the vent pipe terminal should be visible from the filling point. The end of the vent pipe should be kept away from any zone in which the discharge of air and vapour might be dangerous or offensive.

A separate vent pipe should be provided for each tank.

Where of necessity the vent pipe rises to a considerable height, excessive internal pressure on the tank might result if overfilling occurs. To prevent possible tank failure due to such an occurrence, a vent-pipe unloading device should be provided. If an overfill alarm is fitted to the vent pipe, it should not restrict the oil flow should an overfill occur.

8.8 Drainage and de-sludging facility

The purpose of the drainage and de-sludging facility is to permit the removal of water and sludge from the tank at regular intervals; it also provides a facility for draining the dead space below the draw-off point when the tank is emptied for cleaning.

Drainage and de-sludging facilities should be in accordance with BS 799-5, OFS T100 [N2] or OFS T200 [N1], as appropriate.

Drainage and de-sludging facilities may be located at the lowest point of the tank but top mounted suction type arrangements are preferred.

Provision should be made to secure drainage and de-sludging facilities from unauthorized interference.

NOTE Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11] which preclude fitting of low level drainage valves in bunds and require oil and/or water to be pumped out of the bund from above.

8.9 Multiple storage tanks with return line connections

Where the oil burning system requires the connection of an oil return line to the storage tanks, see **9.2.2.4**, it is essential that the returned oil always passes back to the tank from which it has been drawn. If this is not arranged, overflow of the other tanks could occur.

On plants with multi-tank installations that are not under constant operator supervision and control, an interlocking valve system or similar device should be installed to maintain the correct connections when changing over from one tank to another.

Multiple tank installations should only be used when no other option is available.

8.10 Installation of oil storage tanks

8.10.1 Foundations and/or supports should be completed before delivery of the oil storage tanks, so that tanks can be installed without delay. The storage tank base or support system should be in accordance with the tank manufacturer's instructions.

NOTE 1 Details of supports for steel tanks, including spacing etc., are given in BS 799-5 and OFS T200 [N1]. For plastic tanks refer to BS EN 13341 or OFS T100 [N2].

NOTE 2 Attention is drawn to the Building Regulations [4], [5], [6].

8.10.2 The tank base, supports and foundations should be designed to support a load equivalent to that which would occur if the tank were completely filled with water, plus an additional 10%. The bearing capacity of the soil should be assessed to ensure that it is adequate for the proposed loads and the foundation should be designed to ensure correct stability. Where settlement of the foundations is likely to occur, the tank connections used should be sufficiently flexible to allow for the resulting movement.

8.10.3 Where steel tanks are fabricated on site, or where tanks made at a manufacturer's works have been altered on site or subjected to abnormal strain or damage during erection, they should be subjected to a pressure test, at the design pressure of the tank, using the method given in BS 799-5. All traces of water, welding debris, scale, and other foreign matter should be removed from inside the tank.

8.10.4 For steel tanks, provision should be made to prevent moisture accumulating between the steel plates of the tank and the supports on which they rest. Where concrete, brick or steel piers are used to support the tank, one of the following methods should be used.

a) Those surfaces of the tank that will come into contact with the supports should be cleaned and one coat of bituminous mastic solution and one thickness of a bitumen-impregnated damp-proof material should be applied.

The top surface of the supports should be spead thickly with cement mortar in order to allow for any irregularities and the treated tank lowered onto the supports.

b) Those surfaces of the tank that will come into contact with the supports should be cleaned. The top surface of the supports should be coated with a thick layer of either bitumen or pitch, and the tank lowered onto the supports.

8.10.5 Where tanks are placed directly on foundations, e.g. vertical cylindrical tanks, the foundation ring of the tank should be sealed to the foundations with a bitumen compound. This compound should be shaped or sloped upwards from the toe of the foundation ring to the side of the tank casing, thus allowing rainwater, etc. to drain off quickly and so prevent lodgement of water that could otherwise lead to corrosion at the base of the tank. With large vertical flat-bottomed tanks, the bottom should rest on a bitumen-impregnated sand layer so arranged as to provide uniform support and avoid tensile stress in the base plate.

8.10.6 Where earthing is provided it should incorporate adequate electrical conductivity in accordance with BS 7430.

8.10.7 The stability of tanks when empty should be taken into account under the following two circumstances.

a) Buried tanks might tend to lift under flooded conditions and they should be suitably anchored. For detailed information regarding buried tanks see **10.7.4** and **10.7.5**.

b) Above-ground tanks are liable to be affected by wind pressure and by floatation caused by flooding and should therefore be suitably secured to their foundations to allow for this in accordance with the tank manufacturer's instructions.

8.11 Painting and cleaning of steel tanks on site

8.11.1 Where the steel tank has not been painted by the manufacturer before delivery in accordance with BS 799-5, painting and cleaning of steel tanks on site should be in accordance with BS 799-5 and the recommendations given in **8.11.2** to **8.11.6**.

8.11.2 The external surfaces of tanks should be thoroughly cleaned and freed from rust, oil or grease and protected with a suitable rust-inhibiting primer.

8.11.3 Painting comprising at least two coats of oil-resistant paint should be carried out as soon as practicable after delivery of the tanks to the site, or after fabrication in the case of the tanks fabricated on site. Any damage to painted surfaces should be made good after erection on site.

8.11.4 Where the painting of the tanks is not the responsibility of the installer, painting requirements should be specified to those responsible for this work.

8.11.5 Internal surfaces should be wire brushed but not painted. The underside of tank roofs of large vertical cylindrical tanks should be painted with red oxide or provided with equivalent protection against condensation.

8.11.6 Before the tank manholes are secured after painting and cleaning, the tanks should be inspected and any debris removed.

8.12 Heating for oil tanks containing classes E, F, G and H oils and biofuels

8.12.1 General

It is essential that the tank manufacturer's and fuel supplier's guidance is sought on the suitability of the storage tank for containing class E, F, G and H oils, including its suitability for the required heating.

Storage and handling equipment for oils of classes E, F, G and H should be equipped with heating facilities to raise the temperature of the oil in order to reduce its viscosity suffiently to enable it to flow to the pumps and burners of the oil burning equipment. In special cases, heating of class D oil and biofuel blends might be necessary, see **9.3.3**.

The minimum temperatures should be in accordance with Table 3.

For liquid fuels which require heating, metallic tanks are the preferred option.

The heaters for steel oil storage tanks should be in accordance with BS 799-5.

Table 3 **Minimum tank, outflow and handling temperatures for liquid fuels**

Temperature	**Classes of oil** (BS 2869:2010+A1)				**Biofuels** FAME blends B50D and B75K (BS EN 14214)
	E	**F**	**G**	**H**	
Minimum temperature in tank, °C	10	25	40	45	10
Minimum temperature for outflow from tank and for handling, °C	10	30	50	55	10

The heating of the oil should be carried out by one of the following methods:

a) whole-tank heating by means of manually or thermostatically controlled steam or hot water pipe coils or by thermostatically controlled electric immersion heaters inside the tank;

b) outflow heaters provided with thermostatically controlled steam, water or electrically heated elements;

c) method b) together with partial tank heating similar to method a), particularly for classes F, G and H oils;

d) other types of electric heating e.g. trace heating.

8.12.2 Whole-tank heating only

In cases where a residual grade of oil is to be stored in a tank not fitted with an outflow heater, heating equipment of one of the following types should be used:

a) internal (immersion or submersion); or

b) external electric heating (mat or trace heating) or steam/thermal fluid coils.

In this case, the minimum temperature that should be maintained within the tank for each class of oil should be as shown in line 2 of Table 3 (i.e. the outflow and handling temperature). External thermal insulation should be used for any tank where the minimum temperature of the oil is to be maintained.

It is not good practice to store liquid fuel at unnecessarily high temperatures and on no account should the temperatures given in Table 3 be exceeded by more than 17 °C. This is particularly important for class E oils.

The following recommendations should be followed for whole-tank heating.

1) The heat supply for heating the tank contents should be calculated on the basis of the maximum volume, the type of fuel, the target fuel temperature (the mid-point of the target temperature range should be used) and the amount of insulation installed on the tank.
2) Heating coils and connections within the tank should be constructed of seamless steel tube and all joints should be welded.
3) Heating coils should be adequately supported. Steam coils should be arranged to drain freely.
4) To minimize the risk of leakage and to facilitate renewal, the heating coils at their points of entry to and exit from the tank should pass through oversize flanges or stools attached to the tank, the ends of the coils being welded to counter-flanges that in turn are bolted to the flanges or stools.

8.12.3 Tanks fitted with outflow heaters only

The use of tank outflow heaters only is not recommended for residual oils as heat input to the heater is local to the heater and not distributed to the tank contents. If the bulk contents are at a temperature which is below the minimum value given in Table 3 then there might be difficulty in maintaining fuel flow to the outflow heater when using oils of classes F, G, H and some biofuels.

Outflow heaters should be sized so as to raise the temperature of the maximum amount of liquid fuel required by the burner equipment, including oil returned from the burner equipment, from the minimum storage temperature to the minimum outflow temperature, as given in Table 3.

8.12.4 Tank heating combined with outflow heaters

To reduce heat losses from tanks the oil may be stored at a temperature lower than that required for handling, provided that it can still flow towards an outflow heater that raises the oil in its vicinity to the recommended minimum handling temperature given in line 2 of Table 3. The minimum storage temperature for the oil should be in accordance with the recommendations in line 1 of Table 3. This arrangement is the one found to be generally most satisfactory in practice for classes F, G and H oils.

In cases where the distance between the outflow heater and the farthest wall of the tank is not excessive, provision of heating over only part of the base of the tank might be adequate for classes F and G oils to ensure flow to the outflow heater at all times. This should be so arranged as also to provide heat in the vicinity of the drain valve to facilitate the periodic draining of water and sludge from the tank. The suitability of partial tank heating depends on the dimensions of the tank, the conditions of exposure to which it is subjected and whether or not it is thermally insulated.

Outflow heaters should be sized so as to raise the temperature of the maximum amount of liquid fuel required by the burner equipment, including oil returned from the burner equipment, from the minimum storage temperature to the minimum outflow temperature, as given in Table 3.

8.12.5 Other recommendations for heating for oil tanks

8.12.5.1 For electric heater elements the maximum loadings given in BS 799-4:1991, **6.6.2**, Note 1 should not be exceeded.

8.12.5.2 Where high-pressure hot water is the primary heating medium, a heat exchanger should be used so that the tank heater coils or outflow heaters can be fed with low-pressure steam or low-temperature hot water. If high-temperature hot water is used as the direct heating medium, the temperature should not exceed 175 °C.

8.12.5.3 When steam is used, it should be dry saturated and at a pressure not exceeding 3.5 bar. The use of steam at higher pressure is not recommended as control is easier at lower pressures and a larger heating surface at a lower temperature is more effective.

8.12.5.4 When siting oil tanks, account should be taken of the space required for withdrawal of heater coils and outflow heaters.

8.12.5.5 If the heat supply is by steam or hot water, and is liable to be interrupted for long periods, an electric immersion heater should be fitted in the tank or incorporated in the outflow heater. Where several tanks are installed this need only be provided in one tank.

8.12.5.6 Heating coils, electric immersion heaters and thermostats should be fixed at least 75 mm above the bottom of the tank to reduce the risk of their becoming immersed in sludge but they should be below the level of the outflow to ensure complete immersion at all times. Such heaters should incorporate a high-temperature safety cut-out, with manual reset, set at about 10 °C above the operating temperature. The control system should be such as to ensure that the heater system cannot be used when the oil level in the tank is below the heater level. The heater design should be such that the thermostats are always located above the heating element so that when fitted correctly, they detect heat rising from the element. If plastics tanks are used, the manufacturer’s advice should be sought.

8.12.5.7 To avoid fire or explosion hazards due to overheating, heating facilities and their controlling thermostats should never be allowed to become exposed when in operation. When a tank is being emptied, it is essential that the heat supply is discontinued and disconnected.

8.12.5.8 Precautions should be taken to prevent any oil contained in condensate or in circulated hot water from oil heating facilities from entering boiler systems.

8.12.5.9 Any condensate from oil heating coils or heaters should not be returned to the boiler or feed-water system because a heating coil failure could result in contamination of the system.

8.12.5.10 Condensate should be run to waste and care taken to ensure that any oil content is trapped and not discharged to drainage systems or waterways.

NOTE Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11].

8.12.5.11 If the heating medium is steam at a pressure less than the oil pressure in the tank, a non-return valve should be fitted in the steam supply line in order to prevent oil being forced into the line in the event of heater failure.

8.12.5.12 Where medium- or high-pressure hot water is used as the primary heating medium, an intermediate water/steam or water/water heat exchanger system should be used so that the heating coils or heaters are fed with low-pressure steam or hot water to eliminate any danger of oil entering the circulating mains boiler system in the event of accidental leakage.

8.12.5.13 If a condensate recovery system is used, this should include means for detecting trace quantities of oil. Proprietary devices are available to perform this function.

8.13 Service tanks

8.13.1 General

NOTE 1 Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and The Water Environment (Oil Storage) (Scotland) Regulations 2006 [11] regarding safety and environmental precautions.

Service tanks and fittings should be designed and constructed in accordance with BS 799-5 or OFS T200 [N1], as applicable, and should be no greater than 10% of the volume of the bulk tank and not exceeding 1 000 L capacity.

A service tank should be so placed that any escaping oil cannot reach hot surfaces, see Clause **10**.

An overflow pipe should be run from the service tank to the top of the main storage tank.

The vent pipe of a service tank fed by gravity should be carried to a point as high as the top of the tank supplying it. The overflow pipe and vent pipe should be in accordance with BS 799-5 and should be not less than 100% of the diameter of the fill line.

NOTE 2 Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11] which require vent pipes to be directed to discharge directly into the secondary containment.

A fire valve should be fitted on the outlet pipe of the service tank, see **9.4**.

8.13.2 Heating of service tanks

Service tank heating is necessary if the oils listed in **8.12.1** are used. For this the recommendations given in **8.12** should be followed.

It is essential that the tank manufacturer's and fuel supplier's guidance is sought on the suitability of the service tank for containing class E, F, G and H oils.

8.14 Rooftop tanks

NOTE For rooftop tanks, the advice of the local authority should be sought at the design stage in case planning approval is required.

For rooftop tanks, metallic tanks are the preferred option.

Rooftop tanks should be either service tanks in accordance with **8.13**, or storage tanks of total capacity not exceeding 10% of that of the bulk storage tank and not exceeding 3 500 L. They should only be used when there is no alternative.

Rooftop tanks should be replenished by a pumped supply from the ground level storage tank. The tank should be provided with a float control to switch off the pump automatically when the oil reaches a predetermined level. The tank should be fitted with overflow prevention device and a by-pass pressure relief valve.

The method of controlling the filling of the tank may be either manual or automatic by float control.

The rooftop tank should be equipped with an overflow pipe leading back to the ground level storage tank. The diameter of the overflow pipe should be at least equal to that the the filling pipe.

Provision should be made for the dumping of the contents of the rooftop tank back into the ground level storage tank in the event of fire or other emergency, and for sufficient extra capacity in the storage tank to accommodate the contents of the rooftop tank.

Provision for dumping should be by a connection between the base of the tank and the overflow pipe incorporating an automatic dump valve.

It is essential that the dumping arrangements are actuated by the fire valve system (see **9.4**), and also that they shut down the transfer pump from the main storage tank.

9 Oil handling systems from storage tank to burner

9.1 General

9.1.1 The function of a system for handling liquid fuel is to transfer oil from the outlet of the storage tank to the inlet of the oil burner under specified conditions of pressure, rate of flow, temperature and therefore viscosity. The system should be such that at all times it delivers correctly filtered oil to the burners within the limits of pressure and temperature required for correct functioning of the equipment. Information on the condition of the fuel required at the burner should be obtained from the burner manufacturer.

9.1.2 Distillate grades of fuel i.e. classes C2 and D to BS 2869:2010+A1, are usually handled at ambient temperatures and residual grades, classes E, F, G and H to BS 2869:2010+A1, require to be handled at above ambient temperatures. Systems for distillate fuels should be in accordance with **9.2** and systems for heated fuels should be in accordance with **9.3**.

9.1.3 Under extremely low temperature conditions, the flow properties of class D oil and biofuels can be affected. Proper siting and insulation of tanks, pipework and filters might provide sufficient protection to maintain the necessary flow properties. Where continuity of service is critical, a tank immersion heater capable of maintaining the oil in the tank at between 0 °C and 5 °C and pipeline trace heating capable of maintaining the oil in the pipeline at between 0 °C and 5 °C should be used in addition. The heating equipment should be as recommended for classes E, F, G and H oils and biofuels in **8.12**, and in accordance with **9.3.3**.

9.1.4 When deciding the route by which fuel is to be transferred from the storage tank to the burner, the possibility of mechanical damage to the pipeline transferring the oil should be minimized by avoiding points at which vehicular or other damage could occur.

9.1.5 Biofuels or biofuel blends should not be used in a system where the ancillary equipment contains rubber. The manufacturer of any equipment that might contain rubber should be contacted for advice.

9.1.6 All oil supply systems to heating appliances should incorporate a fire valve system to shut off the supply of oil to the burner in the event of a fire occurring in the vicinity of the boiler or burner. The fire valve system and its intallation should be in accordance with **9.4**.

9.2 Fuel supply systems for distillate fuels

9.2.1 Gravity supply systems

A gravity supply system is one where the oil flows directly from the storage or service tank to the oil burner(s). For such a system to work, the outlet from the tank has to be above the level of the inlet to the oil burner and a positive static pressure head needs to be provided to the burner at the maximum oil flow rate and at all depths of oil in the tank.

The maximum and minimum static pressure heads imposed at the burner inlet depend on the corresponding depths of oil in the tank, i.e. whether it is full or nearly empty. Either a burner system should be used which can function with these variations in pressure head or the pressure head should be controlled by means of a constant-level control device, a pressure reducing valve or an intermediate service tank between the main tank and the burners.

The oil supply line should preferably fall continuously from the tank. Where this is not possible, air vents should be provided at high points.

A stop valve should be fitted at the tank outlet, followed by a first-stage filter in the oil supply pipe.

NOTE Filters for use with distillate fuels, biofuels and biofuel blends are described in OFS E104 [27].

An oil cut-off valve, actuated by a sump switch in the boiler house floor or by another method of leakage detection, should be installed.

Where the oil supply line supplies more than one off-take point or burner, it should be of such size that any variation in oil pressure resulting from changes in the friction head loss does not exceed the limits of such pressure variation acceptable to the oil burning equipment at all flow rates.

9.2.2 Pumped supply systems

9.2.2.1 General

Because of the relative positions or levels of oil tanks and burners, it is not always possible to use a gravity supply system. In such instances, it is necessary to use a burner pump for transferring the oil from the tank to the burner. In some installations where the total suction head does not exceed the suction capability of the pump as advised by the manufacturer it might be possible to use the oil burner pump for this purpose in accordance with **9.2.2.2**.

9.2.2.2 Use of the oil burner pump (a sub-gravity system)

9.2.2.2.1 Single pipe system

When a single pipe suction system is connected to the top outlet from the oil storage tank an anti-siphon device should be fitted at the tank outlet and a de-aerator near the burner. A two pipe loop should be used to connect the de-aerator to the burner.

NOTE 1 Any air that might be drawn into the suction line from the oil supply at sub-atmospheric pressure is discharged at the de-aerator.

A non-return valve should not be used in the oil supply pipe.

De-aerators should normally be fitted externally to the building.

De-aerators installed inside buildings should be of fire resistant construction and should be provided with a means of taking vented air to the outside via a fire resistant vent pipe.

The flow and return pipes from the de-aerator to the burner should be clearly marked.

NOTE 2 Information on sizing single pipes for suction lift oil supply is given in OFTEC Technical Book 3 [2].

De-aerators should conform to BS EN 12514-2.

NOTE 3 See also OFTEC Standard OPS 23 [28].

De-aerators have limited fuel handling capacities. Where extra capacity is needed several de-aerators should be installed in series. The manufacturer's instructions should be followed.

9.2.2.2.2 Two pipe system

In this system the two pipe connection to the burner is run directly to and from the oil storage tank. A non-return valve should be fitted in the suction pipe close to the tank or, if the suction pipe enters through the top, a foot valve should be fitted to the end of the pipe. In the latter case adequate provision for withdrawal should be made for servicing the foot valve. The draw-off level of the suction pipe should allow for a dead space in the bottom of the tank for accumulation of water and sediment.

Oil surplus to the burner requirements is returned from the burner pump through a return line to the tank. This line should terminate at the same level as the draw-off point but away from it so as to avoid air entrainment. Return lines from multiple burners may be combined in a single return pipe In this case the return pipe should be of adequate size to take the oil surplus from all the burners and should be valved. In the case of spill-back burners the spill return should be so designed that it cannot be shut off inadvertently.

To facilitate priming, the suction pipe should rise continuously to the burner and a suitable priming point should be provided at the high point.

A stop valve should be fitted at the tank outlet, followed by a first-stage filter in the supply pipe.

9.2.2.3 Use of transfer pump

A transfer-pump pressurized "dead-leg" system is one where the oil flows by gravity, or is drawn by suction from the storage or service tank, to a transfer pump and is then pumped to the oil burning equipment. The incorporation of a pump does not affect the static head imposed by the oil in the tank. The maximum static head when the tank is full should therefore be less than the maximum permitted inlet pressure at the oil burner. Where the maximum static head is too great, a constant-level control device, a pressure reducing valve or a service tank should be installed between the storage tank and the pump.

The delivery pressure in the pipe from the pump should be controlled within the limits required for the satisfactory operation of the oil burners supplied at all dead-leg flow rates, including zero flow rateby use of either:

a) a constant-volume pump and a pressure control valve, so that the oil flow in excess of that required by the oil burners is returned to the pump suction or preferably to the oil tank; or

b) a variable-output pump controlled by a pressure-sensitive device that maintains the pressure at all required rates of flow.

In all such systems, a pressure relief valve should be installed.

Where the pipe supplies more than one off-take point or burner, it should be of such size that any variation in fuel pressure resulting from changes in the friction head loss does not exceed the limits of such pressure variation acceptable to the oil burning equipment at all flow rates.

To facilitate priming, the suction pipe should rise continuously to the burner and a suitable priming point should be provided at the high point.

A stop valve should be fitted at the tank outlet, followed by a first-stage filter in the supply pipe.

In view of the dependence of the system on the transfer pump, it is recommended that a second pump should be installed to provide back-up.

9.2.2.4 Pumped ring main systems

In these systems, oil flows by gravity or under suction from a storage or service tank to a pump and then around a circulatory system. This comprises a flow line up to the last burner served, and a return line to the pump suction or to the oil tank. The maximum static head when the tank is full should be less than the maximum permitted inlet pressure at the oil burner. Where the maximum static head is too great, a constant-level control device, a pressure reducing valve or a service tank should be installed between the storage tank and the pump.

The pressure in the ring main should be controlled, within the limits required for the satisfactory operation of the oil burners supplied, at all flow rates and under "zero" draw-off conditions by either:

a) a pressure control device of suitable size fitted on the downstream side of the last burner served; or

b) a vertical loop on the return line to the tank where the burners only require a low inlet oil pressure.

The flow rate of the pumped oil needs to be in excess of burner requirements to ensure that the correct pressure at the inlet to the burner is maintained by the pressure control device over the range of flow rate required. Spill-type burners have special requirements in this respect, and the burner manufacturer should be consulted for advice.

The burner manufacturer should be consulted about sizes for the pump and the ring main system.

High points of the ring mains should be fitted with air vents.

Pressure regulating valves should be installed with isolating valves and with a bypass valve incorporating a manual control, so that operation of the plant can continue if failure of the pressure regulating valve occurs.

Pressure gauges should be fitted at the pump outlet and immediately upstream of the pressure regulating valve and bypass valve.

A first-stage filter should be incorporated in the pump suction line.

A non-return valve needs to be fitted in the ring main return line before it enters the pump suction or the tank.

9.2.2.5 Oil suction lines

The total pressure drop in the suction pipe, filters, valves and any other fitting, plus any suction lift where the lowest level of oil in the supply tanks is below the level of pump suction, at the maximum flow rate should be within the maximum suction lift that can be provided by the burner pump or by the transfer or ring main pump. The maximum suction acceptable at the pump inlet should not exceed the pump manufacturer's stated maximum vacuum.

Suction lines should be as short as possible, with a minimum number of bends to reduce friction losses. Easy bends should be used.

To avoid air in-leakage problems, the joints in suction pipework should be welded joints as far as possible. When joints are required that can be disconnected, they should be flanged rather than screwed. For use at priming points and isolating of the inlet side of the oil pump, types of valve designed to eliminate air in-leakage should be used, e.g. ball valves or lubricated plug cocks. A gauge should be fitted near the pump inlet to enable the vacuum or pressure to be checked.

9.3 Heated liquid fuel and biofuel systems

9.3.1 Use of burner pump only

Normally this layout should be limited to class E oil because of the problems that can be experienced in maintaining heavier oils at a suitable viscosity to ensure adequate flow rate under all conditions of static head of oil in the tank and under all operating conditions and ambient temperatures.

The use of the burner pump under suction lift conditions for heated oils is not recommended because of the difficulties that can be experienced in providing a reliable supply to the burner under stop/start conditions.

For spill burners, to avoid overheating of the tank contents, the surplus heated oil should be returned to a point in the supply pipe upstream of the burner pump suction and not direct into the storage tank.

Where this system is used the following recommendations should be followed.

a) The static head with the oil tank filled should not exceed the maximum pressure permitted at the oil burner equipment.

b) The maximum and minimum static heads imposed at the burner inlet depend on the depths of oil in the tank according to whether it is full or nearly empty. Either the burner system should be capable of accepting these variations in head or the head should be controlled by means of a constant-level control device, a pressure reducing valve or an intermediate service tank between the main tank and the burner.

c) The oil line should preferably fall continuously from the tank. Where this is not possible, air vents should be provided at high points.

d) A stop valve should be fitted at the tank outlet, followed by a first-stage filter in the supply pipe.

e) An oil cut-off valve, actuated by a sump switch in the boiler house floor or by another method of leakage detection, should be installed.

f) Where the pipe supplies more than one off-take point or burner, it should be of such size that any variation in fuel pressure resulting from changes in the friction head loss does not exceed the limits of such pressure variation acceptable to the oil burning equipment at all flow rates.

g) Instruments for measuring the oil temperature and pressure adjacent to the oil burning equipment should be provided.

9.3.2 Pumped supply systems

9.3.2.1 General

For most heated oils i.e. classes F, G and H and biofuel, a pumped system should be used.

9.3.2.2 Transfer pumps

The usual arrangement is for heated oil from the tank to flow to the transfer pump, which transfers the oil to the oil burning equipment.

The drawback of this system for heated oils is the lack of circulation and the reliance upon tracing to maintain oil temperatures over any shut-down periods. A pumped ring main system is therefore preferred, see **9.3.2.3**.

In some installations, it might be necessary for the transfer pump to provide a suction lift. Suction lift conditions are not recommended for heated oils; where they are used the recommendations given in **9.2.2** should be followed.

A non-return valve should be fitted in the suction pipe close to the tank or, if the suction pipe enters through the top, a foot valve should be fitted to the end of the pipe. In the latter case adequate provision for withdrawal should be made for servicing the foot valve.

The maximum suction demanded at the pump inlet to overcome vertical lift, plus the resistance of the pipeline, valves, fittings, filters, etc., should not exceed the pump maker's recommendations when using oil at the specified viscosity, and should never exceed 0.4 bar.

Delivery pressures from the pump should be controlled within the limits required for satisfactory operation of the burner equipment at all flow rates and under no-flow conditions by either:

a) a constant-output pump with a pressure maintaining valve, returning oil in excess of the flow rates required for combustion by the oil burning equipment; or

b) a variable output pump controlled by a pressure-sensitive device to maintain pressure at all rates of flow.

A pressure relief valve should always be fitted to cater for no-flow conditions and any excess pressure due to possible malfunction.

Surplus oil from the transfer pump should be returned to the tank and not into the suction line.

The oil pipeline, including all fittings, valves, filters, pumps, etc., should be covered with thermal insulation and traced to maintain the required temperatures.

9.3.2.3 Pumped ring main system

9.3.2.3.1 In this system oil flows by gravity from a storage or service tank to a ring main pump. A circulatory system from the ring main pump delivery side comprises a flow line up to all sets of burner equipment served and a return line from the last set to the oil tank or pumped suction.

9.3.2.3.2 A pressure control device is normally fitted on the down-stream side of the last burner served to maintain the required supply pressure to all burners at all oil flow rates.

9.3.2.3.3 The ring main may incorporate oil heaters to bring the oil supplied to the burners to the required temperature, and the system can thus cater for oil supply to the burners at temperatures between oil storage temperature and atomizing temperature.

9.3.2.3.4 Sub-circulating loops can be taken from the ring main to feed oil to the burners and to return excess oil to the return side of the ring main. Burners that do not return excess oil to the return line may be connected by short dead-legs to the flow side of the ring main.

9.3.2.3.5 The ring main flow rate, operating temperature and pressure should be selected on the basis of the type of burner served and the grade of oil used and on any heater capacity provided within the burner arrangement.

9.3.2.3.6 The quantity of oil to be circulated depends upon the number of burner take-off points, the maximum demand at each point, the type of ring main pressure controller selected and the sensitivity of the burner equipment to pressure fluctuation.

9.3.2.3.7 A quantity of oil between one and a half and three times the maximum consumption rate should usually be circulated, but the quantity circulated might need to be greater for some types of burner, e.g. certain spill-type burners. This excess volume of circulated oil reduces the pressure fluctuation at the burner take-off points for varying rates of consumption and allows the pressure regulating valve to operate correctly under all flow conditions.

9.3.2.3.8 The ring main temperature (which affects the oil viscosity) should be selected to suit the temperature required at the entry into the oil burner equipment, allowing suitable margins for control fluctuations.

9.3.2.3.9 The ring main temperature needed can vary from the storage temperature when supplying oil to burners that have their own full heating equipment up to atomizing temperature when the burners supplied have no built-in heaters. Higher ring main oil temperatures permit the use of pipework of smaller diameter. Where low temperatures (high oil viscosities) are involved, the system pressure drops should be carefully considered.

9.3.2.3.10 In order to avoid water vapour pockets where classes F, G and H oils are circulated at elevated temperatures, the whole of the system should be operated at a pressure above the vapour pressure of water at that oil temperature.

9.3.2.3.11 To establish the pressure required at the burner, the calculation of resistance through pipes, fittings, filters, heaters, etc. should be made for the oil viscosity concerned at the selected oil temperature, since pressure drop is related to oil viscosity. The pipe sizes should be chosen so as to obtain an acceptable pressure drop round the system when pumping the volume of oil to be circulated at the selected oil temperature and hence viscosity. Where lower oil pressures are required at any burner off-take points, these burners should be supplied from the ring main either by sub-circulating loops or by short dead-legs, each fitted with an individual pressure reducing valve.

9.3.2.3.12 The amount of the oil flowing through a sub-circulating loop should be carefully controlled or the ring main pressure regulating valve could be rendered ineffective owing to short-circuited flow. This control should be effected by use of a secondary pressure regulating valve after the last burner on the loop or a flow control valve set at a flow rate that ensures satisfactory pressure conditions.

9.3.2.3.13 Problems can arise after a long shut-down of a ring main system because of excessive pressure rises due to cold oil. These problems can be avoided by:

a) the use of trace heating with continuous circulation of oil;

b) the use of trace heating without continuous circulation of oil;

c) complete draining of the system.

9.3.2.3.14 If the system is allowed to cool and is then reheated by the trace heating, this can be a very slow process unless the heater capacity is high. In general it is preferable when possible to circulate the oil continuously.

9.3.2.3.15 If normal circulation is at an elevated temperature, during shut-down periods the temperature may be reduced to the tank outflow temperature.

9.3.2.3.16 Particular care is necessary in determining the size and layout of the suction pipe from the tank, of the ring main return and of the pump connections.

9.3.2.3.17 Where it is evident from the design of the system that a large amount of hot oil is liable to be returned to the pump suction, the storage tank might not provide an adequate head of oil to prevent the formation of vapour pockets at the pump entry. The head of oil should be supplemented by installing an additional pump in the line from the tank to the ring main pump inlet. Alternatively, the return can be taken back to the tank if the oil temperature is not excessive for this arrangement.

9.3.2.3.18 If the pipe layout requires it, a permanent vent, connected back to the tank, can be fitted in the return line to release any air and vapour pockets.

9.3.2.4 Recommendations for oil ring main installations

Pipework should be installed with a slope of at least 1:100 so as to be self-draining.

Where practicable, cross-connections should be provided so that the system can be emptied by the pump and the oil discharged into the storage tank.

Pockets that could trap air or vapour should be avoided; if unavoidable, air vents should be fitted at all high points. Vents should consist of either a manually operated cock or an "air bottle" with an isolating valve and air cock, or an automatic float-operated air-release vessel with an isolating valve should be fitted. In the latter case the discharge should terminate over a receptacle in a safe position but where it can be observed readily. To be effective such equipment usually requires lagging and trace heating.

Branch lines from ring mains and sub-circulating loops should be as short as possible and be provided with isolating valves at the ring main connection. Valves should be provided as necessary for purging and draining.

All connections from the ring main should be from the side or bottom of the pipe to avoid withdrawal of any entrained air bubbles.

9.3.2.5 Valves

The pressure regulating valve should be installed as near as possible after the last take-off point; a valved bypass should be provided so that operation need not be interrupted if failure of the pressure regulating valve should occur.

Pressure regulating valves should be selected to maintain pressure within the required limits over the whole range of throughput. The valves should be located so as to be readily accessible for adjustment when required.

A pressure gauge should be fitted on the upstream side of the pressure regulating valve.

All components such as pumps, heaters, oil meters and filters should be provided with isolating valves and union or flanged connections to facilitate removal for maintenance.

Relief valves should be fitted in all positions where a rise in pressure might occur owing to a rise in temperature of oil enclosed within heaters, etc.

Stop valves should conform to BS 799-4.

9.3.2.6 Filters

Filters should be fitted in positions accessible for examination and cleaning. First-stage filters should be fitted to protect the pump suction and second-stage filters to protect the burner.

First-stage filters should be duplicated or be of the duplex type so that cleaning can be performed without shut-down. Filters conforming to BS 799-4 should be used.

9.3.2.7 Pumps

The pumps should be capable of delivering the maximum amount of oil to be circulated and of operating without undue noise, wear, vibration or leaks from seals, etc. Inlet and outlet connections should be fitted with plugged tappings to allow pressure/temperature measurements. Reciprocating pumps should be fitted with air bottles to limit pressure fluctuations. Facilities for charging the bottles should be provided.

9.3.2.8 Heating

The oil pipeline, including all fittings, valves, filters, pumps, etc., should be traced and lagged to maintain the required temperatures. The lagging and tracing should include dead-legs up to the burner inlet connections to avoid cold-start problems.

Oil-line heaters may employ steam, water, thermal fluids, electricity or combinations thereof as the heating media. Consideration should be given to the provision of electric heating facilities for use when steam or hot water is not available. Precautions should be taken to prevent any oil contained in condensate or in circulated hot water from oil heating facilities from entering boiler systems, see also **8.12.5.8**. Heaters should be selected to provide the necessary temperature for the circulated oil; the oil-side pressure drop depends on the oil circulation rate and the heater manufacturer's data sheets should be consulted. Heaters should be thermostatically controlled to maintain the oil at the desired temperature, as noted in **9.3.2.3.8**, and be fitted with pressure relief valves and thermometers.

9.3.2.9 Reliability

Each installation should be analysed for the potential effect on plant availability in the event of failure of the components. This should be assessed in terms of the time required for repair or replacement of the affected components. It is generally advisable to duplicate such items as pumps, filters and oil heaters to ensure continuous operation.

9.3.3 Trace heating

9.3.3.1 General

In assessing the requirements in respect of the compensation for heat losses from pipelines, account should be taken of the temperature drop and the consequent viscosity increase expected to occur under the most adverse conditions of operation. The most adverse conditions occur in suction and delivery lines when the oil flow rate is at a minimum or when the plant is shut down. In these circumstances, tracing is required if it is possible for the oil in the pipeline to fall below the minimum recommended pumping temperature. The heat transfer by the tracing medium to pipelines handling oils at pumping temperature does not require to be closely controlled. The main requirement is that the heat transfer is adequate for the worst conditions but does not become so high at any time as to cause an undue rise in the temperature of the oil in the pipeline, especially under static conditions i.e. no-flow conditions. Electric trace heating should be installed in accordance with BS EN 62395-1, DD CLC/TS 62395-2, BS EN 60079-30-1 and BS EN 60079-30-2.

The necessity for incorporating thermostatic control into the tracing system depends on the particular circumstances of the installation but as the temperature control is not always critical thermostatic control is not always required.

In the case of pipelines handling oil at burning temperature, including ring main systems, compensation for heat loss by tracing should be provided to avoid the possibility of the oil arriving at the burner at temperatures significantly below those required. Alternatively, tracing may be a convenient method of warming up the oil in pipelines after a shut-down period, thus avoiding the necessity for draining or continuous pumping.

Where steam or hot water tracing is fitted, consideration should also be given to fitting electric tracing for use when steam or hot water is not available for this purpose.

When tracing is used to maintain the oil in the pipeline at the correct burning temperature, care should be taken to ensure that the heat input is regulated accurately by thermostatic control. The location of the thermostat should be carefully selected to ensure that the temperature measured is truly representative. In other circumstances, thermostatic control is only necessary where there is a possibility of overheating the oil in the pipeline.

NOTE All traced pipelines likely to be isolated, i.e. valves shut at each end, should be fitted with a pressure relief valve, as excessive pressure could develop if the contents of the pipe are heated without room for expansion.

Tracing may be provided for pipelines and for filters, pumps, motors and valves by one or more of the following means:

a) steam or hot water pipes clipped on externally;

b) electric heating cables, tapes or blankets applied externally;

c) electric induction heating.

9.3.3.2 Steam or hot water pipes applied externally to oil lines

The tracer line should be clipped at frequent intervals so that it is in metallic contact with the oil line while permitting relative movement between the two. The layout should be arranged so that steam pipes are self-draining, all off-sets for valves and fittings are horizontal to avoid pockets, and unavoidable pockets are provided with individual drain points. Adequate provision should be made for expansion and anchoring.

Steam traps should be used for discharging condensate from each drain point. Steam tracer lines that fall continuously in the direction of steam flow should be drained every 50 m. The steam supply should be arranged at intervals not exceeding 150 m, each section being controlled independently.

Where accurate control of oil temperature is required, i.e. where the oil in the pipeline is to be controlled to burning temperature, the steam supply should be regulated automatically by a thermostat, care being taken to locate the temperature-sensitive element in a representative position.

The steam supply should be dry-saturated. Superheated steam should not be used in tracer lines. Adequate protection in the form of strainers should be provided for all steam traps and thermostatically controlled regulating valves. Where steam traps and strainers could be exposed to very low temperatures they should be insulated.

9.3.3.3 Electric tracing

9.3.3.3.1 General

This method of tracing is relatively simple and low in initial cost. It is particularly convenient for starting from cold and for this purpose it may be used in addition to steam or hot water pipes. Operating costs for continuous use can, however, be higher than for equivalent steam or hot water tracing.

Electric tracers should be applied externally under thermal insulation and should be of a type suitable for the temperatures and conditions of use. There are a number of types and full particulars of ratings and instructions for fixing should be obtained from the manufacturers. It is essential to ensure that the type selected can withstand the temperatures reached by the conductors, pipes and any other methods of tracing to be employed on the same pipe.

Examples are of the types of electrical trace heaters available are as follows:

a) twin-conductor cable, plastics- or lead-sheathed for lower temperatures;

b) mineral-insulated metal-sheathed cable either single core, twin core or multicore according to the method of temperature control;

c) “heating tapes” made up of two single cores with heat-resisting insulation that are sheathed and spaced apart by a covering material selected according to temperature or protection required.

9.3.3.3.2 Installation recommendations

If single core, the lead and return cables should be laid together to avoid magnetic loop impedance. If more than one cable or pair of cables are used for a complete circuit they should be terminated as far as possible at a common point permitting the supply from one straight feeder.

The heating cable(s) should be held in firm contact with the oil pipe by a continuous heat-insulating tape binder applied in a close spiral round the oil pipe and the steam or hot water pipe where fitted. Where two or more heating cables are used, they should be spaced apart by the tape. Care should be taken to avoid sharp bends and undue strain on the cables, and damage to the cables, before they are covered by the thermal insulation. Precautions should be taken to keep cables dry under the thermal insulation.

Where cables cross valves, flanges or other fittings, they should be protected from damage by inserting pads of lead strip, or other suitable material, between the cable and any sharp edges. To facilitate removal of valves or fittings or breaking of joints some slack should be left in the cable at such points.

Where it is necessary to accommodate additional cable length, i.e. where the watts required per metre run are greater than watts per metre run output from the cable(s), the cable(s) may be spiralled round the oil pipe or laid in a wave formation. Some waving of stiff cable can be used to allow for differential expansion.

It is necessary to balance as closely as possible the heat input of tracer cables with the maximum heat loss of the pipelines and in some cases it may be advisable to zone the tracer system. Even where thermostatic control is incorporated it is desirable that the balance should be maintained. Careful consideration should be given to the siting of the thermostat. It should be located at a point that will ensure that at no portion of the pipeline will the oil fall below the required temperature.

The tracers should be terminated with flexible insulated cold leads. Where these leads are not part of a made-up cable they should be attached to the conductors in accordance with the manufacturer’s instructions. The cold leads should be connected to the supply cables in a waterproof junction box.

Pipe joints should have equipotential bonding as specified in BS 7671, comprising copper wire not less than 4 mm^2.

The metallic cable sheath should be earth-bonded through the electrical installation. The complete pipeline should be earthed in the normal way through the electrical installation but if the tanks are far from the boiler house and the resistance of the pipeline too high, it might be necessary to use a local earth electrode or to lay an earth continuity conductor along the pipeline.

9.3.3.4 Electric induction heating

If electric induction heating is considered, specialist suppliers should be contacted and their advice and recommendations implemented. Special care is necessary throughout such installations to avoid induction loops that might be inadvertently formed with such items as supporting steelwork.

9.3.4 Thermal insulation of pipelines

Pipelines, including flexible pipes, handling oil should be insulated in accordance BS 5970. In selecting the type of insulation account should be taken of the location of the pipeline and exposure to weather and draughts. The insulation should be covered by a suitable material to minimize the absorption of moisture and/or oil and should be protected against mechanical damage. If exposed to the weather the covering should be weatherproofed.

The insulation should be so arranged that flanges or couplings are easily accessible and leakage readily detectable.

The use of rope-type insulation should be confined to short lengths of small-bore pipe and flexible pipes. It should be protected by a canvas covering sewn on.

Where steam or hot water tracing is used, care should be taken to avoid impairing the heat transfer by radiation from the tracing pipe to the oil pipe by accidental filling of the space between the two pipes with insulating material. Preformed insulating material should be used where electrical, steam or hot water tracing is employed.

It is important to check that all materials that used are compatible with the product being stored and passed through the pipelines including any biofuels. Manufacturer’s advice is to be sought as necessary.

9.4 Fire valve systems and their installation

9.4.1 A fire valve system should be fitted so as to cut off the supply of oil remotely from the heating appliance and burner in the event of an accidental fire occurring in or around the appliance. For appliances installed inside buildings, the oil supply should be shut off externally to the building. For existing installations where oil lines serving internally installed heating appliances are run so as to be built into the structure internally, the cut off point should be at the point where the line is first exposed internally. This type of layout should not be used for new installations.

9.4.2 For externally located heating appliances, the oil supply should be cut off at least 1 m away from the appliance.

9.4.3 Fire valve sensors should normally be positioned inside the appliance casing over the burner or as recommended by the appliance manufacturer. The sensor activating temperature should be selected in consultation with the appliance manufacturer so as to avoid nuisance cut outs.

9.4.4 Fire valves are sometimes incorporated within core heating chambers and in such cases special attention should be given to the location of the sensing element. The sensors used should be ones designed to trip at a higher temperature than those for use in other locations to avoid nuisance cut outs.

9.4.5 Where more than one oil burning appliance is installed, each appliance should be provided with a sensor controlling a fire valve. Each oil pipe entering the building should be protected by a fire valve.

9.4.6 Fire valve systems should either be in accordance with the following recommendations or take the form of a system as described in **9.4.8**.

a) It is essential that the system can sense a fire inside or close to a heating appliance and also shut off the oil supply at a point that enables the recommendations given in **9.4.1** to **9.4.5** to be met.

b) In the event of any part of a valve or any other component becoming damaged, it is essential that the supply of oil is closed off.

c) Manual operation should be necessary in order for oil to be passed through to the burner after the system has been thermally activated.

d) The system should be provided with a means for testing for satisfactory operation and for resetting manually.

NOTE BS EN ISO 23553-1 covers the construction and testing of shut off valves. OFS E101 [29] covers non electrically operated remote acting fire safety valves.

9.4.7 The functional features required for a fire valve system can be incorporated in one unit or provided by more than one separate component. In either case the recommendations given in **9.4.1** to **9.4.6** should be fully met.

9.4.8 Fire valve systems alternative to that referred to in **9.4.6** may take the following forms.

a) An electrically operated valve coupled to thermal fuses located as described in **9.4.1** to **9.4.5** may be fitted. The valve should be self-closing on open circuiting of the thermal fuses, and should be installed so that the oil pressure exerted by the head of oil in the tank assists closure. The thermal fuses should be of the type which remains open circuited after operation.

b) A weight- or spring-loaded valve may be used. It should be held open by a flexible cable with fusible links inserted in its length over each firing point. At all changes of direction, the flexible cable should pass over corrosion resistant metal pulleys with a diameter of not less than 40 mm.

   The flexible cables should be made of corrosion resistant, inextensible multi-strand wire, which is suitable for use with the pulleys and which does not take a permanent set.

   This type of fire valve should not be used where the run of the cable would be long or tortuous. Each fusible link should be at a sufficient distance from the pulleys, or other possible obstructions, to ensure that the metal fitting forming part of the fusible link has adequate free movement to permit complete closure of the fire valve when a link fuses.

c) A spring loaded valve held open by a flexible cable enclosed within a flexible outer sheath, terminating in a fusible link may be fitted. Excessive lengths of this type of cable or sharp bends can result in unreliable operation and should be avoided.

9.4.9 Where the sensing element is positioned external to any appliance casing it should be located at a maximum distance of 1 m directly above the burner.

9.4.10 Electrical circuits for fire valves should be independent of burner or other control circuits.

9.4.11 Where the oil supply system to the appliance involves the installation in an internal location of equipment such as constant level oil controls or oil lifters containing a reservoir of oil, they should be protected by remote acting fire valves positioned in accordance with the appliance manufacturer’s instructions.

NOTE Further guidance is given in OFTEC Technical Book 3 [2].

9.5 Rooftop systems

9.5.1 These systems incorporate the oil fired equipment at the roof level of the building. The equipment is supplied either:

a) from a tank at rooftop level, see **8.14**; or

b) directly from ground level storage by means of a pumped oil supply system.

9.5.2 In the case of **9.5.1**a), the oil handling system between the tank and the burner should be in accordance with **9.1** to **9.4**.

9.5.3 In the case of **9.5.1**b), one of the following the oil supply systems should be used, as appropriate:

a) pumped dead-leg in accordance with **9.2.2.3**;

b) pumped ring main in accordance with **9.2.2.4** or **9.3.2.3**.

9.5.4 In the case of **9.5.1**b) provision should be made for the dumping of the oil contained in the pipework back to the tank at ground level in the event of fire or other emergency (see **8.14**).

9.5.5 Where rooftop systems are installed additional precautions should be taken, where necessary, to prevent damage due to leakage, e.g. by installation of drip-trays.

9.6 Size of oil pipelines

The most economical size of gravity supply pipeline should be chosen consistent with obtaining the required pressure conditions at the burners at all rates of flow. Where the burner pump requires a flooded suction, the gravity pipe bore selected should be such that the friction loss does not prevent this requirement being met.

The following factors should be taken into account when assessing pressure drop.

a) *Viscosity*. Pressure drop is directly proportional to viscosity. Assessments should take into account the effect of any heat loss from the pipeline and the consequent increase in viscosity as the oil passes through the pipeline.

b) *Flow conditions*. Handling systems for liquid fuel should be designed to provide streamline flow conditions where steady and accurately predictable pressure conditions are essential. A velocity of flow not exceeding 2 m/s is generally suitable for viscosities above 18 cSt. Turbulent flow conditions should be avoided as a general rule, but might be acceptable with transfer or tank filling lines where close control of pressure drop or pressure conditions is not important.

c) *Flow rate*. Pressure drop under streamline flow conditions is directly proportional to the quantity of oil flowing. The effect of reduced flow rate subsequent to off-take points as compared with full flow rate throughout the full length of the pipeline when there is no off-take should be taken into account to ensure that variation in pressure does not cause excessive variation of flow through metering devices sensitive to pressure differentials, V-slot metering valves, etc. Special attention is necessary in ring main systems or in a gravity system serving several off-take points.

d) *Equivalent length of pipeline*. Pressure drop is directly proportional to the equivalent length of the pipeline that takes into account friction loss due to valves, bends, filters, fittings, etc.

9.7 Materials and construction and erection of oil pipelines

9.7.1 Materials and construction

Materials for piplines and joints should conform to BS 799-4. Where pipelines are welded or screwed and socketed, occasional flanges or unions should be used to facilitate dismantling. Pipework carrying oil within a building or above ground externally should be constructed of steel or copper or some other material with an equal degree of fire resistance except where it is inside an appliance casing which is protected by a remote fire valve in accordance with **9.4**. Plastic pipe may be used externally below ground (see **9.7.2**).

Underground plastics oil piplines should conform to the Energy Institute publication *Performance specification for underground pipework systems at petrol filling stations* [N5].

Galvanized pipe and fittings should not be used. Soft copper tube should be jointed with compression manipulative fittings conforming to SAE J513:1999. Fully annealed copper tubes should be jointed with compression fittings conforming to BS EN 1254-2:1998. Soft soldered joints should not be used

If steel pipes and malleable fittings are used these should be inspected and cleaned before use. Taper threads should always be used. Running joints, long screws or connectors should not be used.

Pipework and fittings should be oil-tight. Hemp, red lead, boiled oil and hard setting jointing compounds should not be used. Petroleum resisting compounds and PTFE (polytetrafluoroethylene) tapes which remain slightly plastic make the most satisfactory joints. However when applying these materials, care should be taken to avoid excess materials breaking away and causing a blockage. All pipework should be rigid and firmly fixed, and protected where necessary against damage.

9.7.2 Erection of oil pipelines

Oil pipelines should be as short as practicable, with the minimum number of directional changes.

Easy bends or swept tees should be used; the use of elbows or square tees should be avoided.

Pipelines should be laid with a fall to be self-draining and should be supported at intervals that are sufficiently frequent to avoid sagging and damage from any possible imposed loading.

In outside situations a suitable corrosion-resistant and weatherproof treatment should be applied.

Where oil pipelines are run underground, the advice given in OFTEC Technical Book 3 [2] should be followed.

For underground installations twin walled plastic pipe may be used, preferably laid in continuous lengths without joints. Any joints should be made within an inspection chamber. The pipework should be fitted with a continuous leak monitoring system.

9.8 Testing of the pipework installation

The complete pipework installation should be tested after erection and before any trace heating and thermal insulation are applied. Fill pipes of up to 80 mm diameter should be tested to 1 bar pneumatic pressure using the following procedure. Pressurize the pipework to 1 bar gauge pressure and leave standing for 15 min. If there is a loss of pressure expose and repair or replace pipework and repeat the test. If there is no obvious loss of pressure, repeat test and leave standing for a futher 30 min whilst observing pressure reading.

Suction lines that might be subjected to sub-atmospheric pressure should be tested under vacuum and should hold a pressure of 0.3 bar below atmospheric, i.e. 0.7 bar absolute pressure, for 30 min with a loss of not more than 0.03 bar. The test should cover the whole of the suction line from the tank draw-off valve to the pump inlet and include all valves and filters incorporated in the pipeline.

Electrical continuity checks should be made on electric trace heating before fitting the thermal insulation.

A final operational test using oil under operating conditions should be applied when all thermal insulation has been completed. This test should cover all the specified conditions of operation required for the installation.

9.9 Painting and identification

Oil, air, steam and water piping, and any gas piping in the vicinity, should be painted in the colours specified in BS 1710. A numbered disc or tag should be affixed to each valve in the system, the numbers corresponding with those indicated in written working instructions on diagrams or on record plans.

10 Design and construction of accommodation for oil fired installations

10.1 General

The recommendations in this clause apply to oil fired installations, both new and conversions of installations from use with other fuels, in both new and existing buildings; the recommendations are for the purposes of safety and good engineering practice.

10.2 Classification of buildings

For the purposes of this clause, buildings are divided into two groups as follows.

a) "Large buildings" and places of public entertainment or assembly, where a "large building" is one which:
   - exceeds 30 m in height; or
   - exceeds 24 m in height and has an area exceeding 930 m^2 on any floor; or
   - is used for purposes of trade or manufacture and has a total volume exceeding 7 000 m^3.

b) All buildings other than those referred to in a).

10.3 Accommodation for boilers

10.3.1 Location of boilers

Where commercial and industrial oil fired boilers and any associated equipment are installed in a building they should preferably be sited in a suitably constructed boiler room. Alternatively, where smaller, cased boilers are used these may be sited in another, suitable position within the building.

10.3.2 Use of boiler room

The boiler room should be used for housing only the boiler plant and such other apparatus as is necessary for its operation and that of the associated steam or hot water system. In no circumstances should refrigeration plant be accommodated in a boiler room.

10.3.3 Construction and fire resistance of boiler rooms

NOTE Attention is drawn to the Building Regulations [4], [5], [6].

Construction and fire resistance of boiler rooms, including the doors and windows, should be as given in Table 4 or Table 5, as applicable. Detailed examples of suitable of types of construction are given in Table 6.

Table 4 **Construction, and fire resistance (in hours), of boiler room enclosures, doors and windows in "large buildings" and places of public entertainment or assembly**

Location of boiler room	External wall construction	Roof construction	Doors and windows in external walls	Internal walls and floor separating boiler room from rest of building	Doors in internal walls separating boiler room from rest of building	Other recommendations
Detached from main building	Bricks, non-combustible blocks, concrete or masonry	Non-combustible materials	Where room is within 6 m of main building 1/2 h self-closing doors and 1/2 h glazing in frames fixed shut	—	—	Any doors, windows and vent openings in external walls and roofs should be positioned so as to present minimum risk to main building
External to, but adjoining, main building	Bricks, non-combustible blocks, concrete or masonry	Non-combustible materials, not less than 1 h	1/2 h self-closing doors and 1/2 h glazing in frames fixed shut	1 h	Single 1 h self-closing door (see Note 1)	Any doors, windows and vent openings in external walls and roofs should be positioned so as to present minimum risk to main building
Within the main building	Bricks, non-combustible blocks, concrete or masonry	(See Note 2)	1/2 h self-closing doors and 1/2 h glazing in frames fixed shut	1 h (see Note 2)	Single 1 h self-closing door (see Note 1)	Boiler room should be situated against an external wall. Any doors, windows and vent openings in external walls and roofs should be positioned so as to present minimum risk to main building. If not situated in lowest storey, 1 h structural supports to boiler room throughout building down to foundation should be fitted
On roof or within top-most storey of building	Bricks, non-combustible blocks, concrete or masonry	Non-combustible materials	1/2 h self-closing doors and 1/2 h glazing in frames fixed shut	1 h	Single 1 h self-closing door (see Note 1)	1 h structural supports to boiler room throughout building down to foundation should be fitted

NOTE 1 The doors should be in accordance with BS 9999. Attention is drawn to the Building Regulations 2010 [4] Part B.

NOTE 2 Where a boiler room is within a building but projects partly therefrom so that its ceiling is partly the underside of a separating floor and partly the underside of a roof, the floor portion should have at least 1 h fire resistance and the roof should be of concrete having not less than 1 h fire resistance.

Table 5 **Construction, and fire resistance (in hours), of boiler room enclosures, doors and windows in all buildings other than "large buildings" and places of public entertainment or assembly**

Total rated heating capacity of boiler (see Note 1) kW	**Roof construction**	**Walls and floors separating boiler rooms from rest of building**	**Internal access doors**
Exceeding 45 and up to and including 110	Non-combustible materials (see Note 2)	1 h (see Note 3)	1/2 h self-closing (see Note 4)
Exceeding 110 and up to and including 220	Non-combustible materials (see Note 2)	1 h (see Note 3)	1 h self-closing (see Note 4)
Exceeding 220	Non-combustible materials (see Note 2)	1 h (see Note 3)	One 1 h self-closing (see Note 4 and Note 5) or one inner and one outer 1 h self-closing (see Note 4)

NOTE 1 Total rated heating capacity means either the rated heating capacity of the boiler or the rated heating capacity per hour calculated at the rate of 30 W for each cubic metre of the building or that part of the building served by the boiler installation, whichever is the greater.

NOTE 2 A combustible roof is acceptable in existing buildings if protected to give at least 1 h of fire resistance, provided that where the roof is within 450 mm of the boiler the whole roof is protected to give at least 1 h fire resistance.

NOTE 3 The walls and floors should be in accordance with BS 9999. Attention is drawn to the Building Regulations 2010 [4] Part B.

NOTE 4 Doors that are bolted into place and are designed and intended only for means of access for the installation, removal, repair or overhaul of the appliance or its ancillary equipment need not be self-closing.

NOTE 5 The doors should be in accordance with BS 9999. Attention is drawn to the Building Regulations 2010 [4] Part B.

Table 6 **Examples of types of construction for the recommended periods of fire resistance given in Table 4 and Table 5**

Period of fire resistance	**Examples of types of construction**	
	Load-bearing walls (see BS 476-21)	***Floors and roofs*** (see BS 476-21)
1 h	90 mm concrete block, class 1 aggregate	100 mm reinforced concrete slab
2h	100 mm solid brickwork	125 mm reinforced concrete slab
4 h	170 mm solid brickwork	150 mm reinforced concrete slab
	Doors	***Glazing***
½ h	Doors constructed in solid timber not less than 44 mm finished thickness or door assemblies capable of resisting the action of fire for 1/2 h when tested in accordance with BS 476-22	Wired glass or electro-copper glazing
1 h	Door assemblies capable of resisting the action of fire for 1 h when tested in accordance with BS 476-22	—
2 h	Door assemblies capable of resisting the action of fire for 2 h when tested in accordance with BS 476-22	—

10.3.4 Boiler room floors

Boilers should be installed on a suitable base so that no part of the structural floor, foundations or ground exceeds a temperature of 65 °C. With this type of construction it is necessary to take account of transmitted heat, depending on the type and number of boilers and their distance apart. For small boilers, a layer of insulating brick of good quality might be sufficient to protect the floor. For larger boilers, insulation alone would be excessive in thickness and cost; hence it is usually more practicable to use water or air cooling.

Where a waterproof membrane is incorporated in the foundations special attention should be given to its protection from excessive downward heat transmission.

Where air cooling is used, it is possible with some designs of oil burning plant to improve the thermal efficiency by drawing the air for combustion through the air passages, so achieving some degree of preheating.

Whatever type of insulating base is used, it should be adequate to carry the gross weight of the boiler, including its weight when filled with a full quantity of operating fluid.

The floor of the boiler room should be of non-combustible material constructed or treated to prevent liquid fuel reaching any other parts of the building. Non-combustible thresholds at least 75 mm high should be provided.

10.3.5 Access and means of escape from buildings in which there is a boiler room

10.3.5.1 Means of escape

Care should be taken in the location of a boiler room within a building so as not to prejudice the means of escape for the occupants should there be an outbreak of fire involving the building or the boiler room. Locating the boiler room in a situation where the entrance door is accessed from a staircase in a single staircase building or from a cul-de-sac corridor should be avoided. Where consideration is being given to locating a boiler room within a building, the local fire and rescue service should be consulted. According to the circumstances, imperforate separation from a main staircase might be required by the fire and rescue service; alternatively, protection of such a staircase might be required, by means of fire-resisting approach lobbies or corridors that might be required to be ventilated.

10.3.5.2 Ventilation openings

Any ventilation openings serving the boiler room should not be sited within 1 m of any means of egress from the building.

10.3.5.3 Means of escape from the boiler room itself

The means of escape from boiler rooms should be designed to take account of the fire hazard presented by the equipment or contents of the room and any hindrance to the movement of the occupants; for example low headroom.

Where only one exit is provided, the maximum travel distance should not exceed 12 m.

Where only one exit is provided, or where there is danger of people being trapped, alternative means of escape such as ceiling hatches and ladders should be provided.

Where two or more exits are provided, the maximum travel distance from any point within the boiler room to the nearest exit should not exceed 25 m. Of this 25 m, the maximum travel distance in a single direction should not exceed 12 m.

Any upward means of escape from a boiler room whether by means of stairs or a ladder should be separated from the boiler room by means of a full height enclosure of 1/2 h fire-resisting construction and entered by a 1/2 h fire-resisting, self-closing door.

10.3.5.4 Plant access

There should be adequate access for the installation, removal, repair and overhaul of relevant plant. In all buildings other than "large buildings" or places of public entertainment or assembly, the plant access doors should be of the self-closing type. Alternatively, purpose built bolted access panels should be used.

10.3.5.5 Direction of opening and fastening for doors

All doors affording means of escape from a boiler room should open in the direction of the escape route, be clear of steps other than the threshold recommended in **10.3.4**, and be readily openable from inside the room without the aid of a key.

10.3.6 Smoke outlets

In boiler rooms below ground level in "large buildings" and places of public entertainment or assembly, pavement or stallboard lights should be provided to serve as smoke outlets, in addition to the ventilation openings recommended in **10.4**. They should terminate at ground level in positions accessible to the Fire and Rescue Service but not sited in positions which could interfere with the means of escape (see **10.3.5.1**). Outlets should be as large as possible and arranged to provide cross ventilation when the covers thereto (which should be of suitable breakable construction) are broken. Any necessary outlet shafts should be separated from the rest of the building, including other outlet shafts, by construction having the same period of fire resistance as that required for the enclosure of the boiler room or for the remainder of the building through which they pass, whichever is longer. The outlets should be clearly identified at ground level by notices, e.g. SMOKE OUTLET FROM BASEMENT BOILER ROOM.

In large boiler rooms below ground level in buildings other than "large buildings" and places of public entertainment or assembly, smoke outlets as described above should be provided whenever the design permits.

10.3.7 Automatic fire extinguishing installations and foam inlets

In the case of the upgrading or conversion of an old installation, where the boiler room is not satisfactorily fire separated from the rest of the building, or is difficult to access, or where the ventilation is not in accordance with **10.4**, a fixed automatic fire extinguishing installation or foam inlet might be required by the Fire and Rescue Service. The local Fire and Rescue Service and insurers should be consulted.

10.3.8 Lighting

The boiler room should be well lit by permanent electric lighting. Socket outlets should be provided for inspection lamps.

10.4 Ventilation and supply of combustion air

10.4.1 General

10.4.1.1 There should be provision for a supply of air for combustion, for combustion products dilution, where relevant, and for ventilation in accordance with **10.4.2**, **10.4.3** or **10.4.4**, as applicable.

10.4.1.2 The air supplied for boiler room ventilation should be such that the maximum temperatures within the boiler house are:

- 25 °C at floor level (or 100 mm above floor level);
- 32 °C at mid-level (1.5 m above floor level); and
- 40 °C at ceiling level (or 100 mm below ceiling level).

NOTE Where the plant is likely to be used at or near maximum capacity during the summer months, additional ventilation might be required.

10.4.1.3 Combustion and ventilation air should be provided by one of the following four methods, as appropriate.

a) Air should be supplied via one or more low-level openings and discharged via one or more high-level openings, the motive force being provided by thermal effects.

b) Air should be supplied by a fan via one or more low-level openings, and discharged naturally via one or more high-level openings.

c) Air should be supplied by a fan via one or more low-level openings and discharged by means of a second fan at a high-level opening. The fans should be selected and controlled so as not to cause a negative pressure (relative to the outside atmosphere) developing in the boiler room.

d) In the case of balanced compartment installation, air should be supplied and discharged by means of a purpose-designed (or proprietary) flueing/ventilation system based solely on high-level permanent openings situated immediately adjacent to the flue outlet.

NOTE 1 The apertures of an air opening should allow entry of a 5 mm diameter ball. No gauze or flyscreen (i.e. mesh having apertures of less than 5 mm) should be incorporated or subsequently fitted to an air vent. Such practices might compromise the free area.

NOTE 2 For a balanced compartment installation, specialist advice should be sought from the system manufacturer.

10.4.1.4 All air inlet and extract fans should be fitted with automatic controls causing at least safety shutdown of the boiler(s) in the event of the inlet or extract air fan failing.

10.4.2 Open flued boilers

10.4.2.1 General

10.4.2.1.1 The boiler room should be provided with means of ventilation to ensure a supply of air sufficient for both combustion and general ventilation when all doors and windows are closed.

10.4.2.1.2 Where the boiler room is ventilated by natural means the air necessary for combustion and ventilation should be admitted by permanent openings at low level from the open air having a free area of not less than 6.7 cm^2 for each 1 kW of installed boiler capacity. In addition, permanent openings to the open air having a total free area of not less than 3.3 cm^2 per 1 kW of installed boiler capacity should be provided at high level to effect general ventilation. These openings should have a minimum area of 120 cm^2. If a mechanical system of ventilation is necessary it should be independent of any system serving other parts of the premises.

10.4.2.1.3 In boiler rooms below ground level special ducts might be necessary to admit the air. Such ducts should be enclosed and separated from the rest of the building by non-combustible construction having the same period of fire resistance as that required for the enclosure of the boiler room or for the remainder of the building through which the ducts pass, whichever is longer.

10.4.2.1.4 A ventilation system in which air is supplied naturally via a simple opening, and extracted using a fan, should not be used since this could depressurize the boiler room/house/enclosure and cause reverse flow in the flue.

10.4.2.1.5 For the purposes of determining air supply requirements, gas and solid fuel burning appliances installed in the same room or space as oil fired boilers should be treated as oil fired appliances of a similar type and rating when specific information is not available.

10.4.2.1.6 High-level ventilation openings should be located as high as is reasonably practicable, preferably within 15% of the building height from the ceiling.

10.4.2.2 Mechanical ventilation

When the supply of combustion and ventilation air is by mechanical means it is essential to ensure that the air flow is that specified by the boiler manufacturer.

10.4.2.3 Draught control

10.4.2.3.1 Individual draught

Combustion air should be supplied to the burner at a positive pressure by means of a forced-draught fan (or fans), which may be integral with the oil burner or separate from it, supplying air to one or more burners. The choice of fan is dependent on the conditions in the combustion space. It is essential to verify that the fan is capable of supplying the required quantity of air at a pressure high enough to overcome the pressure loss through the burner together with the maximum back pressure that can occur in the combustion space.

In addition an adequate margin on the duty of the forced-draught fan, the fan should be specified to take into account the fouling of the boiler or heater gas passages likely to occur after prolonged periods of operation.

10.4.2.3.2 Balanced draught

Under all conditions of load, the combustion space should be maintained at a slightly sub-atmospheric pressure, normally by means of an induced-draught fan fitted with a control device, and the necessary combustion air should be supplied to the burners in accordance with **10.4.2.3.1**.

10.4.2.3.3 Induced draught and forced draught

The characteristics of induced-draught fans should be carefully examined in relation to the total resistance of the boiler or heater flue and chimney systems at all rates of firing, and allowances made for excess air.

In addition, allowance should be made for added resistance due to fouling of gas passages and for loss of fan performance due to build-up on the impeller during periods between cleaning. The fan manufacturer should be informed of the flue gas temperature at which the fan will operate and their advice obtained on the correct choice of fan.

The output of forced-draught and induced-draught fans can be controlled by:

a) fan speed control;

b) flue damper control;

c) inlet damper or vane control.

These controls can be manual or automatic. Electrical interlocking of the fan(s) with the burner is essential for safety and where both forced-draught and induced-draught fans are installed on a unit the forced-draught fan should not be allowed to continue running unless the associated induced-draught fan is operating correctly. A device should be incorporated (e.g. an air flow switch) to prevent burner operation in the event of failure of the induced-draught fan; this is particularly important where belt-driven fans are employed.

10.4.3 Room sealed boilers

10.4.3.1 Installation in a boiler room

The ventilation provided should be adequate to ensure that the boiler room temperature is in accordance with **10.4.1.2**, and should be not less than 2 cm^2 free-area per kilowatt of heat output both at high and at low level.

NOTE In the case of room-sealed boilers where combustion air is ducted to the appliance from outside and the combustion products ducted to the outside air, no additional provisions for the supply of combustion air or for combustion products dilution are necessary. Where a boiler is to operate in summer months, the above allowance can be expected to be sufficient, provided that it does not operate for more than 50% of the time. If the boiler is to operate for a higher percentage of the time, increased ventilation will be necessary, e.g. at 75%, 3 cm^2/kW will be needed and at 100%, 4 cm^2/kW will be needed at high and at low level.

10.4.3.2 Installation in a enclosure

Air vents should be provided in an enclosure containing a room-sealed boiler, and should be sized in accordance with Table 7, at both high and low levels.

NOTE Both high and low level vents should communicate either with the same room or internal space, or with the outside air at the same wall. The vertical distance between the high and low vents should be as great as is possible to encourage a convective air flow. Room sealed appliances in ventilated heated spaces, normally above 0.5 air changes per hour, do not require additional ventilation.

Table 7 **Minimum air vent free-area for room-sealed boilers installed in an enclosure**

Vent position	Means of ventilation	
	To room or internal space cm²/kW heat output	**Direct to outside air** cm²/kW heat output
High level	11	5.5
Low level	11	5.5

10.5 Boiler installation

10.5.1 Siting the boiler

10.5.1.1 The manufacturer’s instructions and associated data sheets should be consulted on the siting of boilers.

10.5.1.2 If the boiler is to be installed in a purpose-constructed boiler room, the room should be in accordance with **10.3**.

NOTE It is desirable that consideration always be given to the installation of boilers in purpose-constructed boiler rooms.

10.5.1.3 Where a purpose-constructed boiler room is not available, measures should be taken to protect the boiler from damage, unauthorized interference or access and to prevent extraneous material from encroaching on the manufacturer’s recommended clearances.

10.5.1.4 In accordance with the manufacturer's instructions, space should be allowed and means should be provided to give ready access for installing, operating, servicing and replacing the burner(s), controls, flue ways, waterways and any other parts that require regular attention.

NOTE Consideration should be given to the provision of adequate means of access to permit replacement of the boiler. This is particularly important in the case of roof-top and basement installations.

10.5.1.5 Clearance between the boiler and its flue and any combustible material should be in accordance with the manufacturer's instructions and with **10.5.1.6**.

10.5.1.6 The boiler installation should be so designed that it does not cause adjacent spaces to exceed their design temperatures during operation of the boiler. The boiler should be installed in such a way that its operation does not cause the temperature of any combustible material in the vicinity of the boiler and its flue to exceed 65 °C.

10.5.1.7 Boilers should only be sited on floors and walls capable of:

a) withstanding temperatures of at least 65 °C; and

b) supporting the boilers when filled with water.

10.5.1.8 If a specially prepared boiler base is required, it should be in accordance with the manufacturer's instructions.

NOTE 1 The design of the boiler base requires consideration in relation to the heat losses, the number of boilers, their distance apart, their hearth areas and shapes.

NOTE 2 The manufacturer's instructions should be consulted as to whether special protection is required.

10.5.1.9 Means should be provided for the disposal of water when the system is drained. Such means should be readily accessible.

10.5.1.10 Boilers sited at or below ground level and in low-lying areas should be provided with protection from the effects of flooding.

10.5.1.11 For boilers installed on roof-tops or intermediate floors or in multi-storey buildings, precautions should be taken to protect the buildings and the boiler houses against the effects of any water leakage from the boiler installations.

10.5.2 Connection to the water circuit

10.5.2.1 Isolation of the water supply

10.5.2.1.1 If not supplied with the boiler, a means should be provided for isolating the water supply to the boiler. In the case of water connections to modular boilers this applies to each bank of modules.

10.5.2.1.2 Valves required to isolate boilers from the system should be fitted such that isolation of the water supply is achieved safely.

NOTE Three-way valves may be used so that, with the valve isolating the boiler from the system, the boiler flow is open to the outside atmosphere through the third port.

10.5.2.2 Multiple boilers

Every boiler connected in parallel to a common flow and common return manifolds to form a multiple boiler installation should be capable of isolation from the water system.

10.5.2.3 Modular boilers

In the case of modular boiler installations, water isolating valves should be fitted either on the common flow and return manifolds of each bank of modules or on each module of the modular installation.

10.5.2.4 Safety valves for single boiler installations

10.5.2.4.1 General

Unless a safety valve or valves are already fitted, the boiler should be provided with a safety valve or valves conforming to BS EN ISO 4126-1 and set to lift at a pressure not exceeding the maximum allowable pressure of any component of the heating system. An additional safety valve should be fitted to the secondary heat exchanger of a condensing boiler when it is connected to a heating circuit separate from the primary heat exchanger. The manufacturer's installation instructions should be followed.

The safety valve(s) should be either:

a) attached directly to the boiler; or

b) fitted to the shortest possible straight length of pipe rising vertically from the boiler.

Where the safety valve(s) are not fitted directly to the boiler, the pipe on which the valve(s) are mounted should have an internal diameter not less than the bore of the valve or an internal cross-sectional area not less than the total area of all the valves mounted upon it. No other valve or cock should be fitted between the safety valve(s) and the boiler, nor should the pipe be used for any other purpose.

NOTE The fitting of the safety valve(s) directly to the boiler is preferred wherever possible.

10.5.2.4.2 Sizing of safety valves

Where a safety valveor valves are fitted in accordance with the manufacturer's instructions, these should be sized on the basis of the individual boiler rating or, for banks of boilers, the total rated output of each bank of boilers.

For boilers installed on open vented hot water systems, the size of safety valves should be not less than those given in Table 8 or should be as determined using the following equation:

$$R = 0.658 p A K_{dr} \tag{1}$$

where:

R	is the boiler output rating, in kilowatts (kW);
p	is the maximum absolute relieving pressure, in bar [1)], i.e. (boiler design pressure × 1.1) + 1;
A	is the flow area, in square millimetres (mm^2);
K_{dr}	is the derated coefficient of discharge.

1) 1 bar = 10^5 N/m^2 = 100 kPa.

Table 8 **Safety valve sizes (open vented systems only)**

Rated output kW	**Nominal size** mm	**Minimum area** (*A*) mm^2
<265	19	284
265 to 352	25	491
353 to 440	32	802
441 to 528	40	1 135
529 to 732	50	2 050
733 to 1 142	65	3 210
1 143 to 1 640	80	4 540

For boilers installed on unvented hot water systems, the size of safety valve(s) should be as determined using the following equation:

$$R = 0.329 pAK_{dr} \qquad (2)$$

where:

R, p, A and K_{dr} have the same meanings as given for equation *(1)*.

10.5.2.4.3 Setting of safety valves

The setting of safety valves should be as determined using the following equation:

$$V = 0.7 + p_b \qquad (3)$$

where:

V is the valve setting, in bar [2)]

p_b is the boiler operating pressure, in bar [2)]

NOTE 1 The operating pressure is dependent on the static head, the pressurizing equipment (where fitted) and the effect of any circulating pump. The static head, and pressurizing equipment in the case of pressurized systems, determines the maximum water temperature permissible at the point of lowest pressure, which should not exceed a predetermined level below the saturated steam temperature for that lowest pressure.

Where the boiler is connected to a hot water system not capable of withstanding the boiler design pressure, provision should be made to protect the system at its own maximum allowable pressure.

NOTE 2 The safety valve is fitted to protect the boiler and full discharge is achieved at the maximum design pressure of the boiler.

10.5.2.4.4 Discharge from safety valve

The discharge pipe from the safety valve should be self-draining and should terminate in a visible position where discharge cannot result in a hazard to any person or to the plant.

The size of the discharge pipe should be not less than the nominal size of the valve outlet.

2) 1 bar = 10^5 N/m^2 = 100 kPa.

10.5.2.5 Safety valves for multiple boiler installations

Each boiler should be provided with a safety valve or valves conforming to BS EN ISO 4126-1, and set to lift at a pressure not exceeding the maximum allowable pressure of any component of the heating system.

The sizing of the safety valve and its fitting should be in accordance with **10.5.2.4.2**.

10.5.2.6 Safety valves for modular boiler installations

In the case of modular boiler installations, each bank of modules should be provided with a common safety valve or valves conforming to BS EN ISO 4126-1, unless each module is already fitted with a safety valve conforming to BS EN ISO 4126-1.

The common safety valve(s) should be sized in accordance with **10.5.2.4.2** to suit the total rated output of the boiler bank. The pipe on which the valve(s) are mounted should have an internal diameter not less than the bore of the valve or an internal cross-sectional area not less than the total area of all the valves mounted upon it. No other valve or cock should be fitted between the safety valve(s) and the boiler, nor should the pipe be used for any other purpose.

Any module in a modular installation that can be isolated from the water supply should be fitted with a safety valve or valves conforming to BS EN ISO 4126-1, unless the module has either:

a) an integral direct-acting water-flow operated fuel shut off valve in addition to the safety temperature limiter; or

b) a three-port valve utilized as the flow isolating valve and so arranged as to open the third port to outside atmosphere when the boiler module is isolated from the system.

10.5.2.7 Open vented systems

10.5.2.7.1 Feed and expansion pipes for single boiler installations

The feed and expansion pipe should be taken directly from a feed and expansion cistern which should not supply water for any other purpose. It should be no smaller than the applicable size given in Table 9, and should be connected to the boiler or to the boiler side of any valve on the return pipe.

The feed and expansion pipe should be situated within the building and should be insulated along those parts of its length where freezing conditions or condensation on the pipe can occur (see BS 5422 and BS 6700).

10.5.2.7.2 Feed and expansion pipes for multiple and modular boiler installations

The feed and expansion connection should be either to the common return pipe upstream of the individual boiler isolating valves, or to each individual boiler return pipe downstream of the isolating valve. The feed and expansion pipe to a multiple or a modular boiler installation should be provided with a lockable isolating valve.

The feed and expansion pipe should be not less than the minimum size given in Table 9, and should be taken directly from a feed and expansion cistern, which should not supply water for any other purpose.

The feed and exapansion pipe should be situated within the building and should be insulated along those parts of its length where freezing conditions or condensation on the pipe can occur (see BS 5422 and BS 6700).

Table 9 **Feed and expansion pipe sizes**

Rated output kW	**Minimum bore** mm
60 and below	19
61 to 150	25
151 to 300	32
301 to 600	38
601 and above	50

10.5.2.7.3 Open vent pipes – General

Open vent pipes should not be fitted with isolating valves, except where the following recommendations are applied. Any valve fitted between a boiler and the open vent pipe to facilitate maintenance should be of the three-way type such that when closed to the vent pipe the boiler is open to the outside atmosphere through the third port. The valve should incorporate means of indicating the position of the open port and should have a nominal bore not less than that of the vent pipe in which it is fitted.

There should be no obstructions which could prevent safe venting of the boiler during operation or isolation.

10.5.2.7.4 Open vent pipes for single boiler installations

Single boiler installations should be fitted with an open vent pipe which rises continuously by the shortest practicable route to the venting point.

In cases where the flow pipe connection is situated in a position at the top of the boiler that permits satisfactory venting, the boiler need not be provided with a vent pipe tapping. In these circumstances the flow pipe may be utilized as part of the open vent pipe.

Each vent pipe should be sized according to the maximum rated output of the boiler it is intended to protect, and should be not less than the minimum size given in Table 10.

Table 10 **Open vent pipe sizes**

Rated output kW	**Minimum bore** mm
45 to 60	25
61 to 150	32
151 to 300	38
301 to 600	50

For rated outputs above 600 kW, the minimum cross-sectional area of the vent pipe(s), A, in square millimetres (mm²), should be as determined using the following equation:

$$A = 3.5 \times Q_R \quad (4)$$

where:

Q_R is the rated heat output in kilowatts (kW).

The open vent pipe should discharge into the feed and expansion cistern above the overflow level.

Open vent pipes should be insulated along those parts of their lengths where freezing conditions can occur (see BS 5422 and BS 6700).

NOTE As far as practicable, open vent pipes should be situated inside buildings to reduce freezing problems.

10.5.2.7.5 Open vent pipes for multiple boiler installations

Multiple boiler installations should be vented by one of the following means:

a) a common vent pipe; or

b) individual open vent pipes rising continuously by the shortest practicable route to the venting point; or

c) individual vent pipes connected to a common vent pipe, the cross-sectional area of which is equal to the total cross-sectional area of the individual pipes.

Each vent pipe should be sized according to the maximum rated output of the boiler it is intended to protect, and should be not less than the minimum size given in Table 10 or obtained from equation *(4)*, as appropriate. Any common vent pipe should be sized according to the total rated heat output of the installation.

The open vent pipes should discharge into the feed and expansion cistern above the overflow level.

Open vent pipes should be insulated along those parts of their lengths where freezing conditions can occur (see BS 5422 and BS 6700).

10.5.2.7.6 Open vent pipes for modular boiler installations

Each bank of modules in a modular boiler installation should be fitted with an open vent pipe on the common flow pipe.

The vent pipe should be sized to suit the total capacity of the boiler bank in accordance with Table 10 or equation *(4)*, as appropriate.

The vent pipe should be connected between the boiler bank and the safety valve.

Any individual module in a modular boiler installation that is fitted with a water isolating valve should be provided with:

a) an open vent pipe sized in accordance with Table 10 or equation *(4)*, as appropriate. The open vent pipe should discharge into the feed and expansion cistern above the overflow level and should be insulated along those parts of its length where freezing conditions can occur (see BS 5422 and BS 6700); or

b) an open vent pipe connecting to a common open vent, but capable of isolation to outside atmosphere via a 3-port valve; or

c) a 3-port valve utilized as the flow isolating valve and so arranged as to open the third port to outside atmosphere when the boiler module is isolated from the system.

10.5.2.8 Sealed systems

NOTE For gas cushion systems, which are not covered by this standard, reference should be made to BS 6880-2.

10.5.2.8.1 Expansion vessel

Any diaphragm expansion vessel incorporated in a sealed system should conform to BS EN 13831.

The expansion vessel should be installed in accordance with the manufacturer's instructions.

The expansion vessel should have an acceptance volume sufficient to accommodate the change in volume of the water in the system over the range of temperatures between 0 °C and the boiler's maximum allowable temperature.

NOTE 1 The diaphragms in expansion vessels are generally limited to an operating temperature of 100 °C to 110 °C. Where higher temperatures are to be used it might be necessary to make other provisions. Reference to the manufacturer's instructions should be made.

The connecting pipe between the expansion vessel and the hot water system should not incorporate any valve or other device that could prevent safe operation of the expansion vessel.

NOTE 2 Where considered necessary, an isolating valve may be fitted, provided that it is capable of being locked in the open position.

10.5.2.8.2 Provision for filling and make-up of the boiler

A sealed system should be provided with a means for initial filling which the local water supplier has stated in writing is acceptable to them.

Provision should be made for replacing water lost from the hot water system by means of one of the following:

a) a self-contained automatic unit comprising a cistern fitted with a float operated valve conforming to BS 1212-1, BS 1212-2 or BS 1212-3, as applicable, and installed to have a Family A, type A or B air gap at the inlet in accordance with BS EN 13076 or BS EN 13077, as applicable. The outlet from the cistern should feed a pressure booster that is fitted with a check valve conforming to BS EN 13959, a pressure-reducing valve conforming to BS EN 1567, and a pressure switch;

   NOTE 1 The unit might also require an expansion vessel and pressure gauge.

b) a separate primary feed cistern, used for no other purpose, from which water is taken by gravity only, provided the cistern is fitted with a float operated valve conforming to BS 1212-1, BS 1212-2 or BS 1212-3, as applicable, at the inlet and installed in the cistern to provide a Family A, type F air gap in accordance with BS EN 14622;

   NOTE 2 The connection to the primary cistern can be direct from the mains water supply or from a cold water distribution pipe.

c) a verifiable backflow prevention device offering fluid category 4 protection, such as an RPZ (reduced pressure zone) valve or some other no less effective device.

NOTE 3 The measures listed satisfy fluid category 4 requirements for backflow protection as detailed in the Water Supply (Water Fittings) Regulations 1999 [30].

The static head or boosted supply pressure should be such as to provide at least the required system operating pressure.

The cold feed should incorporate a non-return valve, and an isolating valve capable of being locked in the open position during normal operation.

An automatic air venting device should be fitted between the isolating valve and the non-return valve such that the isolating valve is between the air venting device and the system pipework.

10.5.2.8.3 Controls

A low water pressure cut-off device should be fitted to protect the hot water system against loss of water pressure due to leakage. The cut-off device should be wired in series with the boiler controls and should be arranged so as to operate to give safety shut-down and lockout. The set pressure of the cut-off device should be such as to ensure that boiling does not occur in any part of the system while the working temperature is maintained.

Where a high water pressure cut-off device is fitted, this should be wired in series with the boiler controls and should be arranged so as to operate to give safety shut-down and lockout.

10.5.2.8.4 Additional installation components

The following additional installation components should be fitted.

a) *Water pressure gauge*

   The boiler system should be fitted with a gauge that indicates the water pressure in metres of water or bars.

   The gauge should be fitted either on the boiler or on the adjacent flow pipe, and should be sited such that it can be easily read and can be replaced without draining the boiler/system.

b) *Temperature gauge*

   A temperature gauge should be fitted to indicate the temperature, in degrees Celsius, of the boiler flow water.

   It should be sited and fitted in such a way that it can be easily read and can be replaced without draining the boiler.

c) *Drain valve*

   A drain valve should be fitted, positioned to allow the boiler to be drained. This should be fitted with a removable key (see also **10.5.1.9**).

   The size of the valve should be selected having regard to the water content of the boiler. It should either be located directly over a drain or have the facility for connecting a hose. The size and arrangement of the valve should be such that draining takes no more than 30 min.

10.5.2.9 Condensing boilers

Condensing boilers should be provided with a safe and effective means for the disposal of condensate. Reference should be made to the manufacturer's instructions.

10.6 Warm air heater installations

*COMMENTARY ON **10.6***

*The recommendations in **10.6** apply to oil fired air heater installations in both new and existing buildings.*

10.6.1 General

Oil fired air heater installations may consist of either:

a) single units with individual oil storage tanks; or

b) several units with a piped oil supply from a common storage tank.

The air heaters may be arranged for local air distribution or for the delivery of air through ducting. The air heaters of either of the above types may use fresh or re-circulated air.

Unenclosed air heaters should be protected, where necessary, from accidental damage from outside sources.

The temperature of the air at the discharge points should be set so as to avoid creating a fire hazard in the surrounding areas.

10.6.2 Dangerous substances and explosive atmospheres

In any building where highly flammable liquids, gases or vapours are, or could be, present (including underground garages, see **10.6.4.1**), it is a duty of the employer under the provisions of the Dangerous Substances and Explosive Atmospheres Regulations 2002 [31] to carry out an assessment to identify the control measures necessary to eliminate or control the risk of fire or explosion. An essential component of the risk assessment process is to carry out a hazardous area classification. The purpose of this exercise is to identify areas of the building where a flammable atmosphere could be present so that all sources of ignition can be excluded. In buildings where dangerous substances are present and where warm air heating is installed or to be installed, the employer has a statutory duty to ensure the system does not present a source of ignition or prejudice the control measures to mitigate the effects of a fire or explosion. With the latter, the likelihood of the trunking acting as a conduit to spread flammable vapours during periods when the heating system is out of use have to be taken into consideration.

10.6.3 Structural arrangements

10.6.3.1 General

NOTE The degree of fire protection deemed necessary by the Local Authority and the insurer is related to the heat output of the appliance and to its design, construction and siting relative to any surrounding fire risks and/or routes of escape.

Installations in garages should be in accordance with **10.6.4**. Installations in other locations should be in accordance with **10.6.3.2**, **10.6.3.3** or **10.3.6.4**, as applicable.

10.6.3.2 Buildings and parts of buildings having a low fire risk

Buildings coming within this category include metal works and parts of buildings where only non-combustible materials are manufactured, handled or stored.

No enclosures are generally necessary, howeversome local authorities and insurers might require a non-combustible enclosure with at least 1/2 h fire resistance to be provided.

Where an enclosure is provided, access doorways should have non-combustible thresholds raised not less than 75 mm above floor level and should be fitted with a self-closing door having at least 1/2 h fire resistance.

10.6.3.3 Buildings and parts of buildings having a medium fire risk

Buildings coming within this category are office buildings and similar accommodation.

Enclosures should be provided as follows.

a) Where the heat output of an appliance is less than 300 kW no enclosures are generally necessary.

b) Where the heat output is between 300 kW and 1 000 kW a non-combustible enclosure with at least 1 h fire resistance should be provided.

c) Where the heat output of an appliance exceeds 1 000 kW a non-combustible enclosure with at least 2 h fire resistance should be provided.

Where an enclosure is provided, access doorways should have non-combustible, impervious thresholds raised not less than 75 mm above floor level and should be fitted with a self-closing door having a period of fire resistance of at least half the period required for the enclosure.

10.6.3.4 Buildings and parts of buildings having a high fire risk

Buildings coming within this category include bulk storage warehouses and workshops handling flammable materials, and or parts of buildings where flammable vapours or gases might be present.

Enclosures should be provided as follows.

a) Where the heat output of an appliance is less than 300 kW a non-combustible enclosure with at least 1 h fire resistance should be provided.

b) Where the heat output is between 300 kW and 1 000 kW a non-combustible enclosure with at least 2 h fire resistance should be provided.

c) Where the heat output exceeds 1 000 kW a non-combustible enclosure with at least 4 h fire resistance should be provided.

Doorways to the enclosure should have non-combustible thresholds raised not less than 75 mm above floor level and should be fitted with a self-closing door having a period of fire resistance at least half the period required for the enclosure.

10.6.4 Warm air heater installations in garages

10.6.4.1 Underground garages

The provisions of **10.6.2** are also applicable to underground garages.

10.6.4.2 Above-ground garages

10.6.4.2.1 General

Enclosure of the appliance is not necessary in all cases but is dependent on its arrangement and position as set out in **10.6.4.2.2** and **10.6.4.2.3**.

10.6.4.2.2 Combustion and circulating air arrangement

Air for combustion and circulation should be drawn directly from the open air through vapour-tight metal trunking or alternatively from a height of at least 1.8 m above garage floor level. Air can be drawn from 1.8 m above garage floor level in one of three ways:

a) by use of vapour-tight metal trunking;

b) by surrounding the heater with imperforate walls of fire-resisting construction carried up to a height of at least 1.8 m. Any access door in the wall should open to the outer air, or if this is impracticable, the door may be permitted in the wall, provided that it is at least 450 mm above garage floor level, is made vapour-tight and is kept clamped shut;

c) by installing the heater at a height of 1.8 m or more above garage floor level.

10.6.4.2.3 Heater arrangement

Either the outer casing of the heater including the burner and fuel pipe should be made vapour tight, or the heater should be installed 1.8 m or more above garage floor level, or the heater should be in accordance with the following provisions:

a) any excess-pressure relief for venting the combustion chamber should be arranged to discharge only into vapour-tight metal trunking terminating either in the open air or at a height of not less than 1.8 m above garage floor level; and

b) any electrical apparatus on the outside of the casing within 2 m of the garage floor should be of the type suitable for use in "Zone 2" as specified in BS EN 60079-14 and BS EN 60079-15; and

c) all electrical wiring to the heater should be run in screwed conduit made mechanically and electrically continuous and efficiently bonded to earth, or consist of armoured or mineral-insulated metal-sheathed cable with appropriate fittings.

10.6.5 Combustion air and main air supplies

Where heaters are enclosed, adequate air supplies for combustion, for heating and for ventilation of the enclosure should be drawn from an external area free of hazards or contamination by means of a duct or ducts.

The provision of air for combustion and ventilation should be as given in **10.4**. The duct should have a similar period of fire resistance to that of the enclosure or to that of the part of the building through which it passes, whichever is longer.

In order to avoid the need for ducting, a simpler arrangement is possible if the heater enclosure is located adjacent to an external wall of the space to be heated or the heater is accommodated in an external chamber, where the supply of air can be introduced through louvres in an external wall.

10.6.6 Delivery of heated air

Where the delivery of warm air from an appliance is through ducting it should be of non-combustible construction and fixed away from any combustible material. Adequate facilities for cleaning the interior of the ducting or trunking should be provided. Ducting is always required within heater enclosures.

10.6.7 Steel dampers in ducting (enclosed heaters)

Where enclosures are required for the air heaters, steel dampers should be provided in the heated air duct(s) at the point where the duct passes through the wall of the enclosure.

Dampers should have the same period of fire resistance as the heater enclosure or fire separation through which the duct(s) pass.

Such dampers should be held open by means of a temperature sensing device in the warm air stream adjacent to the damper. The device should set to operate at a temperature no higher than is necessary to prevent inadvertent operation under normal working conditions of the heater. The device should be of the manual reset type.

A damper should also be provided within any ducting or trunking where the trunking or ducting passes through walls and floors forming fire separation within the building.

In all cases means of access should be provided in the ducting or trunking to enable the damper(s) and temperature sensing device to be examined, tested and reset when necessary.

10.6.8 Automatic fire extinguishing installations and foam inlets

A fixed automatic fire extinguishing installation or foam inlet might be required by the Fire and Rescue Service. The local Fire and Rescue Service and insurers should be consulted.

10.6.9 Lighting

The air heater enclosure should be well lit by permanent electric lighting. Socket outlets should be provided for inspection lamps.

10.7 Accommodation for oil storage and service tanks

10.7.1 General

Tanks should be provided with secondary containment, i.e. a bund, and should preferably be situated externally to the building they serve, but if external location is impracticable tanks may be sited within the building subject to approval by the local building control department, Fire and Rescue Service and insurers. They should be so situated that they are as near as practicable to the oil burning appliance they serve. Tanks should also be easily accessible for receiving deliveries, but if this is not possible, an extended filling pipe will be required.

Where an integrally bunded tank is used, the clearance measurements for fire protection should be measured from the outside of the whole oil storage system, i.e. including the bunded part, if that is wider, higher or longer than the primary container.

Tanks may be situated in any of the three principal ways dealt with in **10.7.2**, **10.7.3** and **10.7.4**, i.e.:

a) above ground away from or outside buildings;

b) buried in the ground;

c) within, on, or over a building.

Wherever possible above ground installations should be adopted in preference to below ground installations.

10.7.2 Tanks above ground away from or outside buildings (other than over or upon the roof)

10.7.2.1 Where tanks are installed externally, it is essential that they are installed on or over a non-combustible base that extends out at least 300 mm from all sides of the tank, except that if the tank is closer than 300 mm to a building wall or fire screen wall which has the degree of fire protection required for the tank, the base need only extend as far as the wall.

10.7.2.2 A fire-resisting tank chamber or fire screen walls are essential, except:

a) where the tank is more than 2 m away from any building or similar structure on the same site and from any adjoining site, and the quantity of oil to be stored does not exceed 3 500 L; or

b) where the tank is more than 6 m from such a boundary and adjoining site, where the quantity of oil to be stored exceeds 3 500 L.

10.7.2.3 In all cases other than the exceptions referred to in **10.7.2.2**a) and b), protection from any building or similar structure on the same site and from any adjoining site should be as recommended in **10.7.2.4** or **10.7.2.5**.

10.7.2.4 Where the quantity of oil to be stored does not exceed 3 500 L, in all cases a fire screen wall, as described in b) below, should be provided between the tank and any adjoining site within 2 m. In addition, either:

a) the walls of any building or similar structure on the same site within 1.8 m in any direction from any part of the tank should have at least 1 h fire resistance and should be imperforate; or

b) a fire screen wall should be provided between the tank and the building or similar structure, this wall having at least 1 h fire resistance and extending not less than 900 mm beyond the ends and uppermost parts of the tank.

10.7.2.5 Where the oil to be stored exceeds 3 500 L, in all cases a fire screen wall, as described in b) below, should be provided between the tank and any adjoining site within 6 m. In addition, either:

a) the walls of any building or similar structure on the same site within a distance of 6 m in any direction from any part of the tank should have at least 2 h fire resistance and should be imperforate where they are within 1.8 m in any direction of the tank; any openings in the walls between 1.8 m and 6 m away from the tank should be fitted with 1 h fire resisting glazing or 1 h fire-resisting self-closing doors; or

b) a fire screen wall should be provided between the tank and the building or similar structure; it should have at least 1 h fire resistance and extend not less than 900 mm beyond the ends and uppermost parts of the tank.

10.7.3 Steel tanks buried in the ground

10.7.3.1 Steel tanks buried directly in the ground should conform to BS EN 12285-1. These tanks should have at least two skins and should be installed with a leak detection system.

10.7.3.2 In order to spread the load evenly and reduce the possibility of settlement it is recommended that the tank should be placed upon a reinforced concrete raft.

10.7.3.3 In districts where the water table is likely to rise above the bottom of the tank, the latter should be securely anchored by means of steel straps to its concrete raft, which should have sufficient mass to offset the buoyancy of the tank when empty.

10.7.3.4 Steel tanks should be protected against external corrosion by the application of a protective coating as specified in BS EN 12285-1. Coatings should be oil resistant paint or a proprietary polyethylene or epoxy material which is applied after shotblasting. Protective coatings are a passive method of preventing corrosive attack and if damaged during installation can leave the tank vulnerable to corrosion or degradation. Therefore, coatings should be inspected for signs of damage and areas of damage should be repaired in accordance with the manufacturer's recommendations before the excavation is backfilled.

10.7.3.5 Active protection for steel tanks against external corrosion can be achieved by cathodic protection. Other coating systems as detailed in BS EN 12285-1 can be used.

10.7.3.6 It is essential that the manufacturer's instructions are always followed when tanks are buried.

10.7.3.7 In circumstances where the occurrence of an oil leak, however remote the likelihood, might have serious consequences, the tank should be enclosed in a tank chamber. The chamber should be impervious to oil and water.

10.7.4 Tanks within, on or over a building

10.7.4.1 Metallic tanks are preferred for use inside and above buildings unless the installation is on the ground floor or below.

10.7.4.2 Tanks within, on, or over a building should be enclosed within a fire-resisting tank chamber constructed of brick, concrete or other suitable material and with the enclosure, doors and windows having the periods of fire resistance given in Table 11. Examples of suitable types of construction are set out in Table 12.

NOTE Attention is drawn to the Building Regulations [4], [5], [6].

10.7.4.3 Any tank having a capacity greater than 3 500 L within a building should, wherever practicable, be situated at the lowest level in the building. When a tank is situated at any level in a building other than the lowest, the whole of the structure supporting the tank chamber should be constructed to a standard of fire resistance not less than that recommended for the tank chamber or for the remainder of the building, whichever is the greater.

10.7.4.4 A tank chamber within a building should, wherever practicable, be situated against an external wall and be accessible from the open air.

10.7.4.5 Tank chambers should either be provided with internal bunds in accordance with **10.7.7**, or the chamber itself should be constructed so as to be impervious to oil, or the tanks within them should be of the integrally bunded type conforming to, OFS T100 [N2] or OFS T200 [N1].

10.7.5 Bunds (secondary containment)

10.7.5.1 Secondary containment bunds are essential for all above ground tanks covered by this part of BS 5410. Purpose made integrally bunded tanks to OFS T100 [N2] or OFS T200 [N1] may used but where this is not possible concrete or masonry bunds should be constructed so as to conform to the requirements of CIRIA report 163 [N4].

NOTE Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11].

10.7.5.2 The bund should be able to contain 110% of the contents of the tank under overfill and leakage conditions. In some cases additional capacity might be required, see CIRIA report 163 [N4]. Where more than one primary tank is located in a single bund, the bund capacity should be at least 110% of that of the largest tank or 25% of the total storage capacity, whichever is the greater.

10.7.5.3 The bottom surface of masonry and concrete bunds should be laid to fall to an impervious sump. The sump should be un-drained. Bunds should never be provided with drainage facilities that involve any form of opening in the bund, whether this is valved or not. It should only be possible to empty the bund by pumping the liquid out of the top of the bund.

10.7.5.4 Ventilation and pipe ducts, etc. should be arranged so as to maintain the integrity of the bund and the fire resistance period of any enclosures.

10.7.6 Siting of tank chambers within buildings with reference to means of escape and accessibility

10.7.6.1 Means of escape

All large tank chambers, i.e. exceeding 6 m in either length or breadth, should be provided with two separate unobstructed means of escape in case of fire. All doors should open outwards from the chamber and be readily openable from inside the chamber without the aid of a key. It is essential that any bolts can be operated from the inside. Where the tank chamber also acts as a bund, it is essential that any door provided is located in such a position that opening it would not affect the integrity of the bund.

The tank chamber should be so sited within the building that the presence of smoke in the event of fire would not prejudice the means of escape from the building.

It is essential to consult the local Fire and Rescue Service in all cases. According to the circumstances, imperforate separation from a main staircase might be required. Alternatively, protection of such a staircase might be required by means of fire-resisting approach lobbies or corridors which might be required to be ventilated.

Special care should be taken with regard to the siting of tank chambers in buildings provided with only one staircase, in dead-end portions of multi-staircase buildings; or where the public have access to the building or part of a building concerned.

10.7.6.2 Accessibility

Sufficient space should be provided within a tank chamber to permit access to all tank mountings and fittings and to all pipe joints. Space should be provided for painting the external surfaces of the tank. There should be sufficient space between the sides of the tank and the walls of the bund for access to valves and fittings, and for withdrawal of any heating elements. Adequate height is necessary between the tank drain valve and the floor.

10.7.7 Ventilation of tank chambers

A tank chamber should be ventilated to the open air sufficiently to prevent stagnation, independently of any other portion of the premises and preferably by natural means. Ventilation openings should be so placed as not to render any bund ineffective.

Any ventilation openings serving the tank chamber should not be sited within 3 m of a final exit from any staircase to the street, in order not to create a smoke hazard for persons escaping from the rest of the building in the event of a fire.

Any ventilation shaft necessary for the tank chamber should be enclosed and separated from the remainder of the building, including any chimney or smoke shaft, by non-combustible materials having the same period of fire resistance as the enclosures to the chamber or as required for the remainder of the building, whichever is longer.

10.7.8 Automatic fire-extinguishing installations and foam inlets in tank chambers

A fixed automatic fire extinguishing installation or foam inlet might be required by the Fire and Rescue Service. The local Fire and Rescue Service and insurers should be consulted.

10.7.9 Lighting and electrical equipment in tank chambers

10.7.9.1 Permanently installed lighting fittings of totally enclosed pattern i.e. of the bulkhead or well-glass type, should be provided in tank chambers. Only transfer pumps and such other electrical equipment as have necessarily to be installed close to the storage tanks should be within the storage chamber and all such electrical apparatus should be of the totally enclosed type. When electrical equipment is used in the vicinity of tanks storing kerosene, the guidance given in Health and Safety Executive document HSG 176 [N3] should be followed.

10.7.9.2 The wiring should be enclosed in screwed metal conduits or consist of armoured or mineral-insulated metal-sheathed cable . All electrical equipment in tank chambers should conform to BS 7671.

10.7.9.3 The controls for any electrical equipment or lighting circuit within a tank chamber should be installed outside the tank chamber.

10.8 Storage of kerosene at commercial and industial premises

Where kerosene fuel of class C1 or C2 conforming to BS 2869:2010+A1 is stored at commercial or industrial premises in tanks of greater than 10 000 L capacity, steel tanks are the preferred option.

Tanks used for the storage of kerosene should be fitted with a drop fill pipe. For these tanks the provisions of Health and Safety Executive document HSG 176 [N3] should be applied.

Table 11 **Construction, and fire resistance (in hours) of tank chamber enclosures and the doors and openings therein in "large buildings" and places of public entertainment or assembly** *(1 of 2)*

Location	External walls	Roof	Doors and openings in external walls and roofs	Walls and floors separating chamber from rest of building (including boiler room)	Doors in internal walls separating chamber from rest of building (including boiler room)
Detached but within 6 m of main building	Non-combustible bricks, blocks or concrete (see Notes 1 and 2)	Concrete not less than 1 h (see Notes 1 and 2)	Doors 1 h self-closing (see Notes 1 and 2)	—	—
External to but adjoining main building	Non-combustible bricks, blocks or concrete (see Notes 1, 2 and 3)	Concrete not less than 1 h (see Notes 1, 2 and 3)	Doors 1 h self-closing (see Notes 1 and 2)	1 h	Inner and outer 1 h doors or a single 1 h door of a type incorporating an insulating material to limit the transmission of heat (see Note 4)
Within the main building (see Note 5)	Non-combustible bricks, blocks or concrete (see Note 3)	—	Doors 1 h self-closing	1 h (see Note 5)	Inner and outer 1 h doors or a single 1 h door of a type incorporating an insulating material to limit the transmission of heat (see Note 4)
On roof or within topmost storey of building (see Note 6)	Non-combustible bricks, blocks or concrete (see Note 3)	Concrete not less than 1 h (see Note 3)	Doors 1 h self-closing	1 h	Inner and outer 1 h doors or a single 1 h door of a type incorporating an insulating material to limit the transmission of heat (see Note 4)

NOTE 1 As an alternative, the tank may be in the open if it is possible to provide effective screening from adjacent buildings in accordance with ***10.7.2.2****.*

NOTE 2 Enclosures should be imperforate except for the necessary access doors and vent openings sufficient only to prevent stagnation of air, positioned so as to present the least risk to adjacent buildings.

NOTE 3 A higher standard of construction might be required by the local building control department, Fire and Rescue Service or insurers, who should therefore be consulted.

Table 11 **Construction, and fire resistance (in hours) of tank chamber enclosures and the doors and openings therein in "large buildings" and places of public entertainment or assembly** *(2 of 2)*

NOTE 4 Where inner and outer 1 h doors are provided, the outer door should be kept locked shut and be clearly marked on the outside: OIL STORE – THIS DOOR TO BE KEPT LOCKED SHUT and the inner door next to the storage chamber should be fastened shut and be clearly marked KEEP SHUT.

Where a single 1 h door is provided it should be kept locked shut and be clearly marked on the outside: OIL STORE – THIS DOOR TO BE KEPT LOCKED SHUT.

A key for emergency use should be available in an adjacent box with thin glass front.

NOTE 5 Where a tank chamber is within a building but projects partly therefrom so that its ceiling is partly the underside of a separating floor and partly the underside of a roof, the floor portion should have a 1 h standard of fire resistance and the roof portion should be of reinforced concrete not less than 100 mm thick.

NOTE 6 Storage to be limited to a daily service tank not exceeding 10% in capacity of the bulk tank (with a maximum of 1 000 L) sited adjacent to and separated from the boiler room. In addition the supply pipe between the main storage chamber and the service tank should be within its own non-combustible 1 h duct.

Table 12 **Construction and fire resistance of tank chamber enclosures and the doors and openings therein in all buildings other than "large buildings" and places of public entertainment or assembly**

Location, and quantity of oil that can be stored	External walls	Roof	Doors and openings in external walls and roofs	Walls and floors separating chamber from rest of building (including boiler room)	Doors in internal walls separating chamber from rest of building (including boiler room)
Within, on or over a building any storage not exceeding 1 250 L	No special recommendation (but see Notes 1 and 2)	Concrete not less than 1 h (see Note 2)	No recommendation as to fire resistance (but see Note 2)	1 h (see Note 3)	1/2 h, kept shut and bolted
Within, on or over a building any storage exceeding 1 250 L but not exceeding 3 500 L	1 h (see Notes 1 and 2)	Concrete not less than 1 h (see Note 2)	1/2 h doors kept shut and bolted (see Note 2)	2 h (see Note 3)	1 h, kept shut and bolted
Within a building any storage exceeding 3 500 L	2 h (see Notes 1 and 2)	Not applicable	1 h doors kept shut and bolted and clearly marked on the outside: OIL STORE – THIS DOOR TO BE KEPT SHUT (see Note 2)	4 h (see Note 3)	Two 2 h doors kept shut, and bolted, and clearly marked on the outside: OIL STORE – THIS DOOR TO BE KEPT SHUT (see Note 4)

NOTE 1 A higher standard of construction than that recommended might be required by insurers, who should therefore be consulted.

NOTE 2 Enclosures are should be imperforate except for the necessary access doors and for vent openings sufficient only to prevent stagnation of air.

NOTE 3 Where a tank chamber is within a building but projects partly therefrom so that its ceiling is partly the underside of a separating floor and partly the underside of a roof, the roof portion should be of reinforced concrete not less than 100 mm thick.

NOTE 4 In a building or part of a building provided with two or more staircases the protection may be one 2 h door (bolted and marked as described) where the opening is between the tank chamber and an adjoining boiler room or between the tank chamber and an area of very low fire risk.

11 Chimney and flue systems

11.1 Height of chimneys

NOTE Attention is drawn to the Clean Air Act [23] and the Regulations made under it and to the the Clean Air Act memorandum on chimney heights [32], also the Clean Air (Northern Ireland) Order 1981 [24].

The height of a chimney should be such that:

a) draught is provided for the correct operation of the equipment when operating under all working conditions with either natural draught or a combination of natural and mechanical draught;

b) adequate gas dispersion is provided to limit the concentration of the pollutant content of the gas;

c) down draughts are not created within the chimney, and chimney emission does not cause a nuisance to the surroundings.

The top of any chimney which forms part of or is in close proximity to a building should be carried up clear of the roof of the building or of any adjacent building.

11.2 Number of chimneys or flues

For installations comprising more than one boiler or air heater it is recommended that individual chimneys or multiflue chimneys should always be provided.

It is essential, however, that separate chimneys or flues are used for equipment using oil and equipment using solid fuel, i.e. that the products of combustion from oil burning equipment are not discharged into flues being used at the same time by equipment burning solid fuel, or vice versa.

In the case of oil burning and gas burning equipment, reference should be made at the design stage to the suppliers of both fuels and to the insurers.

11.3 Chimney cross-sectional area

The internal cross-sectional area of the flue(s) should be chosen to take into account the pressure drop resulting from the friction of the gases and from the dynamic energy loss at the exit under all gas flow and temperature conditions.

11.4 Chimney exit

In order to prevent inversion, the exit velocity of the flue gases from the chimney should not be less than 3 m/s at minimum chimney gas flow rate. This exit gas velocity can be achieved by the fitting of a tapered head with an angle to the vertical of 13° to 15° to the chimney top.

11.5 Internal surfaces of flues

Internal surfaces of flues should be as smooth as possible so as to minimize gas friction.

11.6 Types of construction

Oil fired boilers operate at high efficiencies and have low flue gas temperatures. Therefore, it is essential to provide a well designed thermally efficient path for the flue gases to leave the appliance and be discharged safely. Single skin uninsulated chimneys and flue pipes should not be used because they are likely to be damaged by corrosion caused by condensation.

It is likely that existing chimneys will need modification if they have been previously used for solid fuel.

Types of chimney suitable for use with oil fired appliances are:

a) custom built masonry chimneys incorporating the following types of components:

   1) steel liner assessed in accordance with BS EN 1859 and conforming to BS EN 1856;

   2) clay/ceramic liner conforming to BS EN 1457 and BS EN 13063;

   3) concrete liner conforming to BS EN 1857;

   4) outer construction conforming to BS EN 12446.

   NOTE Insulation of the space between the liner and the inside surface of the chimney is recommended. The insulation should be fixed in place so that it cannot penetrate the flue liner if damage occurs.

b) prefabricated construction system chimneys of the following types: factory made insulated chimneys assessed in accordance with BS EN 1859 and BS EN 13216 and conforming to BS EN 1856 and BS EN 13069.

For special appliances, e.g. condensing boilers, reference should be made to the appliance manufacturer's instructions.

11.7 Lightning conductors

Where lightning conductors are fitted, special attention should be given to adequate earthing.

11.8 Clean-out access

A removable clean-out door should be provided at the base of all chimneys and in the individual flues in multiflue chimneys. The volume of the pocket, below the lowest flue duct entry, should, however, be kept to a minimum. For larger chimneys, facilities for entry should also be provided at the base, unless access through the flue duct is possible.

11.9 Connecting flues

11.9.1 Connecting flues between boilers or warm air heaters and chimneys should contain as few bends as possible and bends should be easy; where practicable ducts should lead up to the chimneys at an incline. Unlined brick or concrete flues should not be used.

11.9.2 Where more than one boiler connects to a chimney, a separate connecting flue run from each boiler to the base of the chimney is preferable to a common flue duct. Where a common connecting flue is used, entries from individual boilers should be inclined in the direction of the flue gas travel.

11.9.3 Where metal connecting flues enter chimneys they should not project beyond the inner surface of the chimney. Care should be taken when designing connecting flue entries to chimneys to avoid causing an excessive pressure drop; this applies particularly where there is more than one duct entry. Vertical staggering of the entry points might be an advantage in minimizing mutual interference of the flow of the flue gases. Alternatively this can be achieved by the use of a mid-feather for part or all of the height of the chimney, with the discharges from the connecting flues arranged appropriately.

11.9.4 Connecting flues should be adequately supported; arranged to allow movement for expansion without fracture or distortion; jointed with a suitable material to remain gastight under all conditions; and insulated where necessary to reduce unwanted heat emission or to prevent internal surface temperatures falling below the acid dew point of the flue gases.

11.9.5 Where soft insulation material, e.g. mineral wool, is used externally, it should be protected on the outside, preferably with metal cladding, and where necessary weatherproofed, see BS 5970.

11.9.6 Removable clean-out doors should be provided in flue ducts at intervals throughout their length and particularly at changes of direction. Depending on the size, facilities for entry might be desirable.

11.10 Dampers, draught control and combustion excess-pressure relief devices

11.10.1 Dampers located in flue ducts may be manually or automatically operated and should be positively interlocked with the oil burner controls to ensure a safe open position for purging and operating. Any closure of the damper to less than the safe open position should cause the oil burner to shut down.

11.10.2 Automatic dampers should fail safe so that in the event of a malfunction they are opened by any excess pressure of flue gas and provide pressure relief into the chimney. Butterfly type dampers should not be fitted. (Cases have occurred in which unbalanced butterfly dampers have closed as a result of excess pressure occurring in the combustion space thereby causing a restriction in the flue duct.) Automatic gastight dampers are preferable because they close whenever the burners shut down, thereby reducing loss of heat to the chimney and preventing ingress of cold air to the boiler and flue system. This in turn reduces thermal shock and any tendency for smut emission from the chimney.

11.10.3 Draught control should be provided automatically by means of damper motors operating under the control of draught sensors in the boiler combustion system, or at the boiler outlet.

11.10.4 The controlling of draught by means of the introduction of air to the flue duct or at the base of the chimney by means of a draught stabilizer is not recommended owing to its effect of chilling the flue gases and the risks of condensation in the chimney and of smut formation.

11.10.5 Detailed recommendations on combustion excess-pressure relief devices is given in **16.5**.

11.11 Induced-draught fans

11.11.1 Fans might be required in flue ducts in order to augment the natural draught provided by the height of the chimney, to overcome the friction in the flue gas system, and to meet the draught requirements at the boiler outlet.

11.11.2 The construction of fans should take into account the temperature and constitution of the flue gases. Where fans have water-cooled bearings, the cooling water should be monitored.

11.11.3 Fans may be fixed speed or, for draught control purposes, variable speed. Alternatively, draught control may be achieved by means of modulating dampers, see **11.10.3**.

11.11.4 The operation of induced-draught fans should be monitored by means of an air flow switch to verify operation before initiating burner purging and firing and also to cause shut-down in the event of malfunction of the fan.

11.12 Balanced flues

Where balanced flues integral to the boiler are used, the installation of the terminal should follow the guidance given in BS 5410-1.

12 Electrical equipment

12.1 General

Components that are electrically operated should be marked with voltage, supply frequency, number of phases and current consumption.

Electrical appliances and components should be protected from hot gases that might issue from firing or cleaning doors. The hot gases can cause tracking across insulation, which would impair the normal operation of the control system and cause electromagnetic interference. To prevent such interference, all electrical apparatus should be provided with safeguards so as to be within the limits given in BS EN 55014-1.

12.2 Wiring

12.2.1 The arrangement of circuits and wiring should be in accordance with BS 7671.

12.2.2 Wherever possible, all connections to motors and controls should be run in metallic tubing with screwed connections or in mineral-insulated metal-sheathed cable (MIMC) with appropriate glands. Flexible sections should be inserted to allow for the withdrawal of burners, controls and other devices that need to be removed for servicing.

12.2.3 Heat-resisting cable or mineral-insulated metal-sheathed cable should be used in hot positions.

12.2.4 Wiring installed near any of the oil firing equipment where spillage could occur should have insulation of a type unaffected by oil.

12.2.5 High-tension leads to ignition equipment should be separately run and terminated with high-tension connectors. Metallic-sheathed cable should not be used for this purpose. Where high-tension equipment is employed it should be clearly marked "DANGER, HIGH VOLTAGE".

12.2.6 Special attention should be given to the manufacturer's instructions for the wiring of detector devices for flame failure. These instructions might limit the length of run and indicate the need for the wiring to be run separately from other wiring, or in special cable to avoid the risk of spurious signals developing.

12.3 Electrical isolation of boilers

12.3.1 Means for the complete electrical isolation of individual boilers should be provided in an accessible position adjacent to each boiler.

12.3.2 In multiple boiler installations, care should be taken to ensure that the isolation of any individual boiler does not interfere with the correct and safe operation of the remaining boilers.

12.4 Electrical enclosures, components and cabling

It is essential that all electrical enclosures, components and cabling are suitable for the environment in which the system is situated, in particular with regard to any hazardous area classification (see Note) temperature and the effects of dust.

NOTE Attention is drawn to the Dangerous Substances and Explosive Atmospheres Regulations 2002 [31] and their supporting ACOPs, HS(L)134 [33], HS(L)135 [34], HS(L)136 [35], HS(L)137 [36] and HS(L)138 [37], and INDG 370 [38]).

In addition:

a) all electrical components, cables, etc. should be suitable for the electrical supply available;

b) all electrical components with voltage range selectors should be adjusted to the value of the voltage available at the supply;

c) all electrical components should be connected in accordance with the manufacturer's instructions;

d) any electrical component requiring removal for periodic servicing should be provided with ready means of disconnection, such as plugs and sockets, and should be sited so as to be readily accessible;

e) all earth and electrical bonding conductors should be of copper and of sufficient cross-sectional area and the insulation provided on any earth or bonding conductors should have the colour combination yellow and green; and

f) all overload earth fault and excess current protection should be appropriately rated.

12.5 Motors and motor control gear

12.5.1 Electric motors for driving burner ancillaries such as pumps, fans and compressors should, as far as possible, be of totally enclosed, fan-cooled construction.

12.5.2 Where foot-mounted motors are used care should be taken to ensure the provision of adequately strong base frames and foundations consistent with the motor power and type of drive and capable of holding under shaft shear conditions.

12.5.3 The allowed variation of the public electric supply voltage in the United Kingdom is ±6% and, as a result, motor construction normally limits the tolerable fluctuation in declared voltage to ±6%. Where variations outside these limits are anticipated, special motors might be needed and the motor manufacturer should be consulted.

12.5.4 Motor control gear should be in accordance with BS EN 62271-106 and BS EN 60947-4-1. Maintenance of motor control gear is dealt with in BS 6626.

13 Instrumentation

13.1 General

The purpose of instrumentation on oil firing equipment is to provide means of monitoring performance and efficiency. For small and simple plants, fixed instrumentation might be unnecessary and reliance might be put on the routine use of portable instruments. For large and complex plants, full instrumentation might be appropriate where staff are available to make proper use of the information provided. Regular and thorough maintenance and recalibration of instruments is essential.

NOTE Attention is drawn to the Building Regulations [4], [5], [6], the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11].

13.2 Essential instrumentation

Instrumentation should be provided for making the following measurements:

a) flue gas analysis;

b) flue gas temperature; ambient temperature; Bacharach smoke number;

c) draught/combustion pressure;

d) oil input rate.

In larger plants additional instrumentation should be provided for measuring the following:

1) steam or hot water flow-rate;

2) steam pressure and temperature;

3) feed-water temperature;

4) hot water flow and return temperatures.

13.3 Other instrumentation

To provide general information on the operation of the plant, instrumentation should be provided for measuring the following:

a) smoke density;

b) oil pressures at significant points;

c) oil temperatures at significant points;

d) oil tank contents;

e) oil tank high/low warning alarm;

f) oil tank bund leak/overfill warning alarms.

14 Commissioning, performance tests and handover

14.1 Commissioning arrangements

*COMMENTARY ON **14.1***

Correct commissioning of the oil storage and handling plant and the combustion equipment is always of great importance to ensure the successful operation of oil firing plant.

14.1.1 It is essential that responsibility for this work is determined before the order for supply and installation of an installation is placed, as indicated in **6.1**. This type of work should be undertaken by competent technicians subject to supervision by a registration body (see Clause **4**).

14.1.2 The extent of this work depends upon the size and complexity of the particular project. For large schemes a detailed commissioning programme should be agreed between the purchaser and the contractor in consultation with the suppliers of boilers or air heaters, burners, controls and other equipment.

14.1.3 For small schemes a simpler procedure in accordance with the manufacturers' recommendations for commissioning of the equipment should be agreed between the purchaser and the installation contractor.

14.1.4 Appliances should be commissioned by a competent person using the correct calibration equipment in accordance with the manufacturer's instructions. In the case of new equipment, the equipment manufacturer's instructions should be used. In the case of equipment that has been converted, the burner manufacturer's instructions should be used.

14.2 Precommissioning procedure

14.2.1 Before any part of the plant is energized or filled with oil the main contractor should co-ordinate, with the aid of specialist engineers as necessary, the examination of the whole of the oil burning installation including mechanical and electrical controls to check that they are in accordance with the design drawings, specifications and wiring diagrams.

14.2.2 Steam and water connections and gas and electrical services should be made ready for start-up as necessary.

14.2.3 The fill line and vent of the oil storage tank should be checked for accessibility and freedom from obstruction. The contents gauge should be calibrated or checked at the time of filling the tank.

14.2.4 The oil tank should be filled with sufficient oil of the correct specified grade or type for commissioning purposes. This should be enough to provide the heat load required to enable the oil burning equipment to be commissioned over the operational range.

14.2.5 A check sheet and log sheets should be prepared for use during commissioning. These should include the following items.

a) *Oil storage system:*

   1) tank installation security;

   2) fire protection requirements;

   3) bunding requirements.

   NOTE Environment Agency Oil Care Stickers are available, with a contact number to be used in the event of spillage.

b) *Oil handling system:*

   1) oil pressures and temperatures over the whole system; running currents of all motors: overload settings, etc.; running currents of electrical tracing;

   2) thermostat settings and operating performance.

c) *Combustion system:*

   1) oil pressures and temperatures at burner inlet and at the burner head; oil throughput at high flame and low flame;

   2) running current of motors: overload settings;

   3) operation and timing of safety controls: flame failure equipment, etc.; draught conditions;

   4) flue gas – CO_2 content, temperature and Bacharach smoke number or stack solids burden;

   5) fire protection system in accordance with BS 5306 where required.

14.3 Commissioning procedure

14.3.1 Oil storage system

14.3.1.1 Oil storage tanks should be checked for conformity to appropriate standards, and installation in accordance with the manufacturer's instructions.

NOTE Attention is drawn to the Building Regulations [4], [5], [6], the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11].

14.3.1.2 The identification label attached to each tank should be checked to verify that the tank conforms to the appropriate construction standard as given in Table 2.

14.3.1.3 The suitability of tank bases and supports should be checked by visual inspection.

14.3.1.4 Oil storage tank clearances from adjacent buildings and boundaries and tank chamber construction should be checked against the fire protection provisions given in **10.7**.

14.3.1.5 A check should be made that the tank venting system if installed on site conforms to OFS T200 [N1], OFS T100 [N2] or BS 799-5, as appropriate, and is in accordance with **8.7**.

14.3.1.6 A check should be made that the secondary containment system, i.e. the bund, if constructed on site is of the correct capacity and constructed as detailed in CIRIA report 163 [N4].

14.3.1.7 The correct operation of any gauges and overfill alarms/protection devices should be checked.

14.3.1.8 A check should be made that any environmental protection notices required by a statutory body are clearly visible.

14.3.2 Oil handling system

14.3.2.1 General

The oil handling system should be commissioned with the oil burning equipment valved off.

NOTE Attention is drawn to the Building Regulations [4], [5], [6], the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11].

For new installations, commissioning engineers should be provided with a certificate from the installer that a pressure test has been undertaken on the pipework in accordance with **9.8**. This is especially important for buried pipes. In the absence of a certificate, the commissioning engineer should complete the test, noting in the report that a certificate had not been made available.

14.3.2.2 Systems for class D fuels and biofuels

14.3.2.2.1 The direction of rotation of any ring main pumps or transfer pumps should be checked. Pumps should not be run dry for more than 1 s or 2 s.

14.3.2.2.2 The tank outlet valve should be opened gradually and the oil fed into the supply pipework, bleeding any air from the vents.

14.3.2.2.3 When a ring main or transfer pump is fitted without a flooded inlet, it is necessary to ensure that the oil pump is primed before starting.

14.3.2.2.4 Air venting should be completed and a check made for any oil leaks.

14.3.2.2.5 Any oil pressure controllers and pump relief valves should be checked and adjusted to give the design pressure requirements with the oil pump operating.

14.3.2.2.6 Safety equipment such as fire valves, sump switches, tank overfill devices, and dump valves should be proved. The system is then ready to feed into the oil burning equipment.

14.3.2.2.7 It should be ensured that the equipment installed is suitable for the fuel that will be contained in the fuel line.

14.3.2.3 Systems for classes E, F, G and H fuels and biofuels

14.3.2.3.1 Storage tank heaters and outflow heaters should be checked for correct operating temperatures, and controls should be adjusted as necessary, see Table 1.

14.3.2.3.2 The direction of rotation of any ring main or transfer pumps should be checked. Pumps should not be run dry for more than 1 s or 2 s.

14.3.2.3.3 Line tracing should be put into operation.

14.3.2.3.4 The oil flow outlet valve should be opened gradually and the oil fed into the supply piping, bleeding any air from the vents.

14.3.2.3.5 When a ring main or transfer pump is fitted, this should be started to circulate warm oil around the system.

14.3.2.3.6 When a line heater is fitted, it should be put into operation and checked for correct oil temperature, and the controls adjusted as necessary.

14.3.2.3.7 Air venting should be completed and checks made for oil leaks.

14.3.2.3.8 Any oil pressure controllers and pump relief valves should be checked and adjusted to give the design pressure requirements with the oil pump operating.

14.3.2.3.9 Safety equipment such as fire valves, sump switches, tank overfill devices and dump valves should be proved. The system is then ready to feed oil into the oil burning equipment.

14.3.2.3.10 Ensure that the equipment installed is suitable for the fuel that will be contained in the fuel line.

14.3.3 Oil burners

14.3.3.1 General

When commissioning of the oil handling system has been satisfactorily completed, commissioning of the oil burners should be undertaken. The detailed commissioning procedure depends upon the particular design and mode of operation of the burner. In all cases it is essential that steps be taken to ensure that the boiler or air heater is in a safe operational condition for firing.

14.3.3.2 Broad guide to procedure prior to firing

NOTE Further guidance is given in OFTEC Technical Book 7 [39].

14.3.3.2.1 The combustion chamber, flueways and chimney should be checked for freedom from obstruction.

14.3.3.2.2 Manually or automatically operated flue dampers should be checked for correct operation.

14.3.3.2.3 The direction of rotation of any forced and induced-draught fans fitted should be checked.

14.3.3.2.4 A run-through should be made of the burner electrical sequence and all safety interlocks with the fuel supply valved off.

14.3.3.2.5 The temperature and pressure of the oil supply should be checked for correctness.

14.3.3.3 Broad guide for procedure for firing

14.3.3.3.1 The burner should be fired in accordance with the manufacturer's instructions, making sure that there is adequate draught available. A check should be made that the correct flame length is obtained without impingement on heating surfaces whilst obtaining correct combustion conditions.

14.3.3.3.2 Flame failure should be simulated to check burner safety devices.

14.3.3.3.3 The operation of the control and safety devices on the boiler or air heater should be checked to ensure the safe control of the burner.

14.3.3.3.4 The oil inputs should be adjusted to suit each firing rate specified. The oil/air ratio should be adjusted to meet specified performance.

14.3.3.3.5 All oil pressures, temperatures and the other items listed in Clause **13**, should be logged, including the values obtained under conditions of maximum oil consumption.

14.4 Performance tests

14.4.1 It is essential that responsibility for this work and the method of test to be adopted are decided before the order for supply and installation is placed.

14.4.2 The performance test, performed in conjunction with the boiler or air heater to which the oil burning equipment is attached, should be in accordance with BS 845-1 or BS 845-2 as appropriate. The method used may be either direct orindirect; for the latter an assumption of radiation and other losses has to be made in order to determine thermal efficiency and to infer heat output from measurement of oil input.

14.4.3 Upon completion of all adjustments during commissioning an agreed period of stable operation should be arranged during which no further adjustments are permitted. However, before conducting the tests, the boiler or air heater combustion system may be cleaned so that the tests are conducted with clean heating surfaces.

14.4.4 Performance tests should not be undertaken until all aspects of commissioning have been satisfactorily completed and the plant is considered to be operating in a manner which will allow satisfactory performance tests to be completed without wasted effort.

14.4.5 In all cases sufficient data should be obtained to determine combustion conditions and thermal efficiency at rated output (which requires to be verified). In the case of high/low flame or modulating burners, tests should be repeated at low flame or over the modulation range as appropriate, and the turn-down ratio should be verified.

14.4.6 Independent test instrumentation should be used to allow any installed instruments to be cross-checked for accuracy.

14.4.7 Where oil burning equipment is fully automatic, no manual adjustments of oil or combustion air should be permitted during the tests, i.e. between operation at high, or low flame or over the modulation range.

14.5 Handover

14.5.1 Following the completion of all aspects of commissioning, the conducting of performance tests and acceptance of the results, the plant may be handed over to the customer.

14.5.2 During the commissioning period, all necessary instruction in operation and maintenance should have been given to the customer so that by the time of handover he or she will have had the opportunity to gain full experience.

14.5.3 Comprehensive operation and maintenance instructions incorporating manufacturers' details, wiring diagrams and spares list should be provided by the contractor to the customer.

14.5.4 The contractor should notify the customer of the periods of guarantee provided by the manufacturers for the plant that has been installed.

14.5.5 The contractor should recommend to the customer that an independently mounted carbon monoxide detector with an audible alarm, conforming to BS EN 50291, be fitted in the area containing the oil fired appliance to give reassurance to the user. However, it should be emphasised to the customer that this should not be regarded as a substitute for regular servicing and maintenance of the installation by a competent person. Where a carbon monoxide detector conforming to BS 7860 is already fitted, the contractor should recommend that it be replaced with an alarm conforming to BS EN 50291.

15 Maintenance

15.1 General

This type of work should be undertaken by competent technicians subject to supervision by a registration body (see Clause **4**).

To ensure continued safe and efficient operation of oil burning equipment, it is essential that a schedule of safety checks and plant maintenance is carried out by competent personnel at regular intervals. Responsibility for this work rests with the user (see **15.3**).

At least two responsible persons should be trained to receive oil deliveries and deal with local spillages. Most spills occur during filling and it is essential that users are able to manage safe deliveries of oil to their equipment.

15.2 Supplier's and/or installer's responsibility

15.2.1 Instructions

15.2.1.1 The maintenance instructions should be provided by the suppliers and/or the installer to the user. The instructions should include details of the required frequency of servicing and information on the individual components of the equipment where applicable. They should also include flow diagrams, wiring diagrams and other relevant data.

15.2.1.2 Whenever possible, verbal and written instructions should be given by the commissioning engineer to operators, supervisors and management. Where subcontractors are employed, the main contractor should be responsible for correlating the information required from each subcontractor into a comprehensive manual that may also include operating instructions, see, for example, BS 799-4:1991, Clause **9**.

15.2.1.3 Essential instructions should be displayed in a convenient and prominent position adjacent to the plant.

15.2.1.4 Sufficient copies of the written instructions should be provided to enable distribution to be made to all personnel concerned.

15.2.2 Maintenance facilities

15.2.2.1 The supplier and/or installer of the oil burning equipment should make provision for facilities for routine safety checks and maintenance procedures, as detailed in **15.2.2.2** to **15.2.2.5**.

15.2.2.2 Adequate working space should be provided around all equipment requiring periodic attention. When necessary, platform and access ladders should be provided.

15.2.2.3 Permanent means of identification should be provided on storage tanks and pipework, valves, controls, motors and starters, etc., for relating such items to the corresponding flow diagrams and wiring diagrams. It is essential that all identification remains clearly visible and free of over-painting.

15.2.2.4 All components driven by electric motors should be permanently marked to indicate direction of rotation.

15.2.2.5 Lists of essential spare parts and special tools should be provided.

15.3 User's responsibility

15.3.1 Routine maintenance contracts should be arranged.

15.3.2 A maintenance programme, based on information provided by the supplier or installer of the oil firing equipment, should be prepared and be made available to the maintenance personnel concerned. The programme and maintenance instructions should state the times at which servicing should be carried out, describe the procedure to be followed and list any replacement parts, tools and lubricants that will be needed.

15.3.3 Arrangements should be made for plant that requires special maintenance to be serviced by the manufacturer's staff.

15.3.4 Staff for maintenance work should be adequately trained, Training should include familiarization with the particular equipment to be employed, including the use of a personal carbon monoxide alarm monitor.

15.3.5 Essential spare parts, special tools and correct lubricants should be readily available on site.

16 Safety provisions

16.1 Oil handling system

Particular attention should be given to the following:

a) cut-off valves (see **9.2.1** and **9.3.1**);

b) oil pressure relief valves (see **8.14**, **9.2.2.3** and **9.3.2.2**);

c) route of oil lines (see **9.1.4**);

d) fire valve systems (see **9.4**).

16.2 Housekeeping

It is essential that combustible waste materials are not permitted to accumulate within oil storage and burner equipment areas and that any spilt oil is completely cleared away.

In tank farm areas, weeds and grass should be effectively controlled. Attention is drawn to the increased fire hazard associated with the use of some chemical weed killers.

16.3 Protection against combustion explosions

16.3.1 If a fault condition has occurred and the burner fails to light, and the exact cause is unknown, multiple start-ups by repeated re-setting of the lock-out button should not be attempted. The cause should be idenfied and rectified before a restart is attempted.

16.3.2 It might be possible to provide some additional protection against the effects of explosion by the provision of excess-pressure relief devices. If such devices are fitted it is essential to their effective action and to the safety of personnel that:

a) the relief opening should be sufficiently large in area, see BS 799-4:1991, Annex A;
b) the door or panel should be of very low inertia and so retained that it can give way instantly under a small pressure rise;
c) no part of the device should be able to fly off as a missile;
d) the relief opening should be in direct connection with the firing zone in order to give effective pressure relief;
e) the door or panel should be sealed against leakage of combustion products during normal operation;
f) the relief should be sited in a position where explosion products issuing from it cannot affect personnel or important equipment.

16.3.3 If relief devices are provided in flue ducts or at the base of the chimney they should be so constructed that they remain closed and gastight under all normal working conditions (including start-up of the burner) but provide an adequate free discharge area. They should be so constructed and arranged that their opening and the discharge of gas do not endanger personnel.

16.3.4 Requirements applying to pressure relief devices are often incompatible with other factors in the design and siting of boilers and warm air heaters; unless these requirements can be met fully a pressure relief device will be of little value and could be dangerous.

16.3.5 A greater contribution to the safety of personnel and equipment can often be made by:

a) ensuring that the attachment of the burner to the boiler or air heater is as robust as is reasonable;
b) ensuring that the firing zone and other parts that could be directly affected by an explosion are able to contain the pressure likely to be developed;
c) fitting duplicate oil shut-off valves to burners for class D fuels, where leakage has been known to cause explosions;
d) giving careful attention to the operation and proving of any flue gas dampers.

16.4 Fire precautions

16.4.1 Fire precautions should be discussed with the local Fire and Rescue Service.

16.4.2 The responsibility for ensuring the adequacy of the general fire precautions in the building and/or site in which the combustion appliance or the oil storage tank is situated rests with:

a) the employer occupying the building or site, where the building is being used as a workplace; or

b) in other premises and sites, the person in control (as occupier or otherwise).

16.4.3 In a building under construction, the responsibility can rest with the developer or the owner.

16.4.4 The full definitions of “responsible person” and “general fire precautions” are given in articles 3 and 4 respectively of the Regulatory Reform (Fire Safety) Order 2005 [40].

17 Biofuels

17.1 General

Biofuels are blended into mineral heating oil, or some can be used as fuels on their own, to introduce a sustainable element into the oil, to reduce pollution and to reduce import dependency. The main type of biofuel is FAME (fatty acid methyl esters) specified in BS EN 14214. Other types of biofuel might be introduced and their suitability should be checked when they are made available. The base heating oils in the blend are oils conforming to BS 2869:2010+A1.

Biofuels have an affinity for water and can readily absorb it and also scour surfaces in an aggressive way removing debris and scale attached to the inside of an oil handling and storage system. This can result in filter blockage. Biofuels can also attack certain types of material and seals should be checked for compatibility. Bacterial contamination is more likely to occur with biofuel blends than with straight mineral oil. Careful handling and housekeeping are essential when these are used.

Fuels with a biofuel content of up to 5% have been found to be relatively trouble free. Where the percentages are higher than this, however, checks should be made with equipment manufacturers to ensure that the equipment installed is capable of handling the blended fuel.

Gas oil with a 7% biofuel content is likely to be widely available and fuels with higher percentages are expected to come onto the market in the future. Kerosene with a 30% biofuel content is also expected to be made available in the future.

17.2 Oil burners

Where existing burners are to be used, the manufacturer should be contacted for advice. The manufacturer might be able to supply a conversion kit to fit an existing model for biofuel use. Where a new burner is to be installed a biofuel compatible burner should be selected.

Burner hydraulic components and flexible oil lines suitable for biofuel should be used.

Water absorbed into fuel adversely affects the operation of the burner and can damage its components. See **17.4** and **17.5** for measures to keep water and oil separate.

17.3 Oil supply system

All materials in the system from the storage tank to the burner should be compatible with the percentage of biofuel being used. Filtration is important and a biofuel compatible filter should be fitted at the tank with a similar secondary filter protecting the burner. Any seals incorporated in the system should also be biofuel compatible.

17.4 Oil storage

Where an existing oil storage tank is to be used for storing biofuel, enquiries should be made with the tank manufacturer as to the tank's suitability. Where any doubt exists the tank should be replaced.

Existing storage tanks should be inspected and checked for water contamination. All water should be removed. The tank should be cleaned and oil filters replaced before a biofuel delivery is made.

Where a new tank is to be installed, a biofuel compatible tank should be selected.

17.5 Servicing and inspection

At least twice a year, visual checks of seals, gaskets and hoses should be made, and filters replaced. At the time of inspection, any water accumulations in the storage tank should be removed to keep the bottom of the tank as water free as possible. Water should be removed by means of a suction pump and drop line system from the top of the tank. If the tank has a bottom drain-off cock, this should not be used.

NOTE Attention is drawn to the Control of Pollution (Oil Storage) (England) Regulations 2001 [9], the Control of Pollution (Oil Storage) (Amendment) Regulations (Northern Ireland) 2011 [10] and the Water Environment (Oil Storage) (Scotland) Regulations 2006 [11].

Where the system is left out of use for an extended period the burner should be put into operation at least every three months.

Any service visit to the combustion equipment should include an oil storage tank inspection.

17.6 Standby generators and dual fuel burners where oil is the standby fuel

For standby emergency power generation systems and dual fuel burners where oil is the standby fuel, it is recommended that arrangements are made with fuel companies to supply fuel with no biofuel content. However, it remains important that these types of storage and handling system are regularly maintained so as to be available for use when required.

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