Department for Education

School Output Specification

Technical Annex 2F: Mechanical Services and Public Health Engineering

November 2022

Document Control

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C01-C06	A	2016-07	n/a	Includes initial working towards OS 2017
C07	A	2017-11	n/a	Issued as OS 2017
C08	A	2019-05-11	n/a	Revised to incorporate end user feedback, evidence collected and updates to applicable standards
C09	A	2020-05-29	n/a	Amendments to natural ventilation and ventilation systems; pipework; water storage and temperature monitoring; underground drainage; and fume cupboards
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Contents

Table of Figures

Summary

Technical Annex 2F provides the minimum requirements for mechanical services including public health engineering, pipework, heating and ventilation systems, thermal comfort and drainage. It is to be read in conjunction with the Generic Design Brief (GDB) and the School Specific Brief (SSB).

Review Date

Review dates for this document shall be at 6-month intervals.

Who is this publication for?

This document is for technical professionals involved in the design and construction of school premises, as part of the Employer's Requirements of the DfE Construction Frameworks (the DfE Construction Framework 2021 and the Offsite Schools Framework (incorporating Modular and MMC delivery) (MMC)). It may also be used as the basis of similar documentation for other procurement routes using the Output Specification.

Uniclass Codes

This document captures Uniclass codes for the management of exchange of information. To access all codes and associated titles reference should be made to Uniclass 2015 | NBS (thenbs.com)

1. Introduction

1.1. Overview

1.1.1 This document is one of the Technical Annexes that forms part of the Generic Design Brief (GDB). [PM_10_20]

1.1.2 The definitions listed in GDB shall apply to this Technical Annex and all other parts of the Output Specification. [PM_10_20]

1.1.3 This document shall be read in conjunction with the GDB and all other Technical Annexes as well as the SSB, including the School-specific Annexes. [PM_10_20]

1.1.4 This document sets out the required technical standards and performance criteria for mechanical services and public health engineering. [PM_10_20]

1.1.5 The information exchange required at each stage of the design, build and completion process is detailed in the DfE's Exchange Information Requirements (EIR). [PM_10_20_28]

1.1.6 The requirements in this Technical Annex shall apply to all parts of the works; New or Refurbished. [PM_10_20]

2. Common Requirements

2.1. Overview

2.1.1 This section outlines the requirements which are common between mechanical, and public health engineering services, in particular requirements for pipework, pumps, valves, and other pipework fittings. [PM_10_20_82]

2.2. Refurbishment

2.2.1 Work required to Refurbished Buildings shall be as defined in the Refurbishment Scope of Work (RSoW), under the headings of architectural elements (including FF&E) and M&E elements (including ICT Infrastructure). [Ac_10_70_70]

2.2.2 The work shall be categorised as Renewed, Replaced, Repaired, Retained, or have 'No Work':

a) Renewed mechanical services or PHE shall be designed to satisfy the relevant outputs of the GDB, this Technical Annex (and by the code in the ADS where relevant). [Ac_10_70_70]

b) Replaced mechanical services or PHE shall be designed to satisfy the relevant outputs of the GDB, this Technical Annex (and by the code in the ADS where relevant), as far as possible within the constraints of the locations, adjacent elements and sub-structure. [Ac_10_70_70]

c) Repaired mechanical services or PHE shall comply with the specifications in any project-specific drawing issued as part of the SSB. The overall performance after repair shall be at least as good as that of the existing provision. Whole life costing shall be considered when undertaking repairs to maximise energy efficiency. [Ac_10_70_70]

d) Retained mechanical services or PHE shall be left as existing, with minimal work required unless needed to complete other Works that form part of the project, and the overall performance shall be no worse than the existing performance. [Ac_10_70_70]

e) Any element identified with 'No Work' shall be left as existing. [Ac_10_70_70]

2.2.3 In respect of Refurbished Works, the required level of compliance with this Technical Annex is set out in the RSoW. [PM_10_20]

2.2.4 The requirements in this Technical Annex refer to all parts of the Works except any mechanical services that are designated Repaired, Retained or No Work in the RSoW, or spaces designated ‘Untouched’ in the School-specific SoA. [PM_10_20_82]

2.2.5 Repaired or Retained elements shall comply to any regulations, British and European standards, and policies that were relevant to the existing provision at the time of original installation, in accordance with the system type. [Ac_10_70_70]

2.2.6 All refurbishment works shall be assessed to identify where retrospective legislation may apply and works shall be carried out to comply. [Ac_10_70_70]

2.2.7 Existing heating systems shall be flushed and cleaned in accordance with BSRIA pre-commissioning cleaning guidance before connection of new heating plant and pipework. [PM_10_20_90]

2.2.8 Where new boiler plant or other heat sources are installed, the primary heating circuit shall be hydraulically isolated from existing steel pipework via a plate heat exchanger. [PM_10_20_82]

2.2.9 Services and items such as radiators shall be fully coordinated with architectural and structural elements, FF&E, and ceiling layouts. [PM_10_20_82]

2.2.10 Drawings showing the co-ordination of building services designs with architectural, structural, and FF&E designs shall be provided as detailed in the DfE’s EIR. [PM_10_20_28]

2.2.11 Services shall be integrated with existing site-wide systems as far as possible, for example, security, fire alarm, external lighting and building energy management systems. [PM_10_20_82]

3. Pipework

3.1. General Requirements

3.1.1 This section covers the common criteria for any pipework across low temperature hot water (LTHW), domestic hot and cold-water systems and sprinkler installations. [PM_10_20_82]

3.1.2 The following requirements shall be met.

a) All pipework, insulated or otherwise, shall be identified in accordance with BS 1710 using adhesive colour bands. All visible pipework shall be finished in gloss paint to match the interior decoration. [PM_10_20_90]

b) All pipework shall be suitably insulated, using insulating materials that have a Global Warming Potential (GWP) of zero. Mineral wool pipe section insulation shall be installed in line with BS 3958-4 and BS 5422. Loadbearing pipeline supports shall be insulated. Insulation within plant room shall be protected with aluminium sheet. All external pipework shall be clad in metal or rigid UV resistant plastic to prevent damage e.g., by birds. [PM_10_20_90]

c) LTHW and domestic services distribution pipework and drainage shall not be routed in comms rooms, server rooms and electrical plant rooms. [PM_10_20_82]

d) Disinfection and water quality tests for hot and cold water systems shall comply with BS EN 806-4. Inspection and test records for water systems shall be in accordance with BSRIA BG 2/2010. [PM_10_20_90]

e) Pipework shall be free from leaks and the audible effects of expansion, vibration and water hammer. [PM_10_20_82]

f) The pipework shall be installed to prevent electrolytic corrosion from the use of dissimilar metals. Pipeline fittings shall be regularly spaced along pipeline runs and at items of equipment. Anchors are to be installed to resist axial stress transmitted by flexure of horizontal and vertical pipe runs and loading on vertical pipes. Fixings shall be provided with associated backing plates, nuts, washers, and bolts for attachment to, or building into building structure. [PM_10_20_82]

g) Inspection and testing of pipelines shall be in accordance with HSE GS 4 and at 1.5 times normal working pressure. [PM_10_20_90]

h) All copper water pipelines shall be installed in line with BS EN 1057. Copper fittings, joining materials and supports are to be provided in line with British Standards. Copper pipework shall not be used where it can be damaged. [PM_10_20_90]

i) Pre-soldered capillary fittings shall be lead free copper or copper alloy complying with BS EN 1254. [PM_10_20_90]

j) Any screwed joints to valves, gauges, or similar shall be to BS EN10226-1, BS EN 10226-2 and BS EN 10226-3 using PTFE tape to BS 7786. [PM_10_20_90]

k) Maintenance joints in copper pipework up to and including 54mm nominal size are to be copper alloy union couplings, bronze to bronze navy pattern. Flanged maintenance joints are to be used in pipework of nominal sizes greater than 54mm. Flanges are to be solid full-face copper alloy, slip-on type suitable for brazing, complying with BS 4504: PN10 or BS EN 1092 as appropriate. [PM_10_20_90]

l) Flanges used for connections to flanged equipment valves or similar are to match flanges provided on the equipment. All flanged joints shall be made with full face rubber insertion jointing rings to BS 7874 or BS EN 681 and BS EN 682 as appropriate, brass nuts, bolts and washers, complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected. [PM_10_20_90]

m) Flexible connections shall not be used on classroom ventilation units, wash-hand basins and sink taps. Basin taps shall be fitted with solid copper connections and double brass or copper backnuts to lock the taps in place. Plastic backnuts shall not be used on basins or sinks. [PM_10_20_82]

3.2. LTHW Pipework

3.2.1 All low temperature hot water (LTHW) systems provided shall meet the following requirements.

a) Pipework, valves, and ancillaries shall be readily accessible for maintenance. [PM_80_10_50]

b) Pipework drops and horizontal runs on Low Surface Temperature (LST) pipework shall be concealed or inaccessible. [Ss_60_40_37_48]

c) Main heating pipework shall run in corridors at high level and branch off to serve individual rooms. [Ss_60_40_37_48]

d) Wherever possible pipework shall run at high level and drop to low level to connect to heat emitters as required. This does not preclude emitters being served from below in the event that this is the optimum route. Where it is proposed that emitters are served from below this shall be subject to approval by the Employer. [Ss_60_40_37_48]

e) All distribution pipework shall be installed with drain down and isolating valves, such that the system can be drained in its entirety. [Ss_60_40_37_48]

f) Automatic air vents shall be provided at the top of all risers and on high points within the system. Pipework shall be laid to fall wherever possible to minimise the number of high points. [Ss_60_40_37_48]

g) Pipework shall be installed to allow easy self-venting and commissioning. The flushing of hot and cold water systems shall comply with BS EN 806-4. [PM_10_20_90]

h) Any concealed underfloor heating system pipework shall be pressure tested and witnessed before any final floor covering is applied. [PM_10_20_82]

i) All indoor AC units and DX coils shall be fitted with a condensate drain. Condensate wastes shall be connected to the main drainage system via a running trap in a waste guaranteed to carry waste regularly. [Ss_65_80]

3.3. Domestic Hot and Cold Water Systems

3.3.1 Domestic hot and cold water shall be provided to toilets, changing rooms and showers. [Ss_55_70_38]

3.3.2 Domestic hot and cold water shall be provided to kitchens and food rooms and cleaners' stores that have sinks. [Ss_55_70_38]

3.3.3 Hot water shall only be provided to sinks in Teaching Spaces where there is a clear need such as in art or food rooms. [PM_10_20_82]

3.4. Domestic Hot and Cold Water Pipework

3.4.1 The following requirements shall be met for any domestic hot and cold-water pipework provided.

a) All distribution pipework shall be installed with drain down valves to allow the system to be drained in its entirety. Automatic air vents shall be provided at the top of all risers and on high points within the system. Pipework shall be laid to falls wherever possible

to minimise the number of high points and installed to allow easy self-venting and commissioning. [PM_35_70_38]

b) The design and detailing of hot and cold water systems shall comply with BS 8558 and BS EN 806-2 and in accordance with HSE publication 'The control of legionella bacteria in water systems approved code of practice and guidance', L8. [PM_10_20_90]

c) The domestic hot water supply system shall incorporate the facility to pasteurise the system during periods when there is little or no use to prevent the growth of legionella within the system. [PM_35_70_38]

d) Calorifiers shall have de-stratification pumps. [PM_35_70_38]

e) The cold water supply shall be in line with BS 8558, BS EN 806-2. [PM_10_20_90]

f) The pipeline sizes for hot and cold water systems shall be calculated to meet simultaneous demand for the Building in accordance with BS EN 806-3. [PM_10_20_90]

g) Pipe sleeves shall comply with BS EN 1057. [PM_10_20_90]

h) Pressure-relief discharge pipework from electric water heaters shall be taken to drain. [PM_35_70_38]

3.4.2 Installation, hydraulic pressure testing, flushing and commissioning shall be in accordance with BS 8558, BS EN 806-4, BSRIA BG 2/2010 and CIBSE Commissioning Code W. [PM_70_15_96]

3.4.3 Sample points shall be provided at the main supply to CAT5 tanks, hot water storage cylinders, and cold-water storage tanks. [PM_35_70_38]

3.4.4 The following shall be produced as detailed in the DfE's EIR:

a) A Legionella Risk Assessment and Log Book for controlling the risk of exposure to legionella bacteria (in accordance with HSE approved code of practice L8: 'Legionnaires' disease. The control of legionella bacteria in water systems') to be developed in conjunction with the School. [PM_10_20_28]

b) A Water Quality Policy document setting out the guidance and strategy to protect staff, pupils, and visitors against the risk of legionella infection. It shall include the framework of the procedures designed to achieve this aim. It shall specify the management, operational and specialist responsibilities and lay down a clear

management and communication structure to ensure that it is fail-safe. [PM_10_20_28]

3.5. Gas Pipework

3.5.1 Gas pipework shall be installed in accordance with the Gas Safety (Installation and Use) Regulations 1998 and the requirements of BS 6891. [PM_10_20_90]

3.5.2 Gas pipework shall be installed in accordance with IGEM standards including IGEM/UP/11, IGEM/UP/2. [PM_10_20_90]

3.6. Refrigerant Pipework

3.6.1 All refrigerant pipework shall be installed in accordance with F-Gas Regulations 842/2008, which provides detailed requirements for refrigerant containment. [PM_10_20_90]

3.6.2 All refrigerant pipework installation shall be undertaken in accordance with IoR 'Commercial System Installation Guide – 2009' – Part 4 System Installation. [PM_10_20_90]

3.6.3 Copper tube shall comply with BS EN 12735-1. [PM_10_20_90]

3.6.4 Steel and stainless-steel refrigeration pipework shall comply with BS EN14276 – 2. [PM_10_20_90]

3.6.5 Insulation on external refrigeration pipework shall be UV resistant. [PM_10_20_82]

3.6.6 Insulation on external refrigeration pipework shall be clad in metal or rigid UV resistant plastic to prevent damage e.g., by birds. [PM_35_10_25]

3.7. Reference Standards for Pipework

3.7.1 The design and installation of any pipework provided in LTHW, domestic hot and cold water systems, and sprinkler installations shall comply with relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

3.7.1. All Pipework

a) BS 1710 - 'Specification for identification of pipelines and services'. [FI_70_85]

b) BS 3958-4 - 'Thermal insulating materials. Bonded preformed man-made mineral fibre pipe sections'. [FI_70_85]

c) BS 5422 - ‘Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40°C to +700°C’. [FI_70_85]

d) BS 8558 - ‘Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages’. Complementary guidance to BS EN 806. [FI_70]

e) BS EN 806 - ‘Specifications for installations inside buildings conveying water for human consumption. Installation’ [FI_70_85]

f) BSRIA BG 2/2010 - ‘Commissioning water systems’. [FI_70_85]

g) CIBSE Commissioning Code W - ‘Water distribution systems’. [FI_70_85]

h) HSE GS 4 - ‘Safety in pressure testing’. [FI_70]

i) BS EN 1057 - ‘Copper and copper alloys - seamless, round copper tubes for water and gas in sanitary and heating applications’ (+A1:2010). [FI_70_85]

3.7.2. LTHW pipework

a) BSRIA BG 50/2013 - ‘Water treatment for closed heating and cooling systems’. [FI_70_85]

b) BS 6880-3 - ‘Code of practice for low temperature hot water heating systems of output greater than 45 kW: Part 3 Installation’. [FI_70_85]

c) BS EN 14336 - ‘Heating systems in buildings. Installation and commissioning of water-based heating systems’. [FI_70_85]

3.7.3. Domestic Hot and Cold Water Pipework

a) HSE publication, L8 - ‘Legionnaires’ disease, the control of legionella bacteria in water systems approved code of practice and guidance’. [FI_70]

b) BS EN 806-3 - ‘Specifications for installations inside buildings conveying water for human consumption. Pipe sizing. Simplified method’. [FI_70_85]

c) WRAS approved fittings from the WRAS Products and Materials Directory available online at WRAS https://www.wras.co.uk/search/products/ [FI_70_85]

d) Water Supply (Water Quality) Regulations 2016. [FI_70]

3.7.4. Fuel Pipework

a) BS 6891 ‘Specification for the installation and maintenance of low-pressure gas installation pipework of up to 35mm (R11/4) on premises’. [FI_70_85]

b) IGEM/UP/2 ‘Installation pipework on industrial and commercial premises’. [FI_70_85]

3.7.5. Refrigeration Pipework

a) BS EN 12735-1 - ‘Copper and copper alloys - Seamless, round copper tubes for air conditioning and refrigeration Part 1: Tubes for piping systems’. [FI_70_85]

b) BS EN 14276-2 - ‘Pressure equipment for refrigerating systems and heat pumps - Part 2: Piping - General requirements’. [FI_70_85]

3.8. Pumps

3.8.1. LTHW Pumps

3.8.1.1 All LTHW pump sets provided shall be twin-head or in parallel configuration arranged for auto changeover and duty rotation. [PM_10_20_82]

3.8.1.2 Each pump set shall have hand/auto/off local control. [PM_10_20_82]

3.8.2. Domestic Hot and Cold Water Pumps

3.8.2.1 Where sufficient mains water pressure is available, a direct mains water supply can be used in accordance with appropriate and current Water Regulations and guidance to schedule 2 available on line at: https://www.legislation.gov.uk/uksi/1999/1148/schedule/2/made. [Ss_55_70_38]

3.8.2.2 In case of insufficient water pressure and/ or supply rate, a boosted cold-water supply shall be provided. [Ss_55_70_38]

3.8.2.3 Where required, the potable water supply shall be boosted from a tank to domestic water outlets via a WRAS or Kiwa KUKreg4 approved domestic water booster set. [Ss_55_70_38]

3.8.2.4 The potable cold-water service shall be distributed via ceiling level/voids and dedicated service risers to serve sanitary appliances and equipment. [Ss_55_70_38]

3.8.3. Reference Standards for Pumps

3.8.3.1 The design and installation of any pumps provided shall comply with the relevant parts of the following standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) BS ISO 2953 - ‘Mechanical vibration. Balancing machines. Description and evaluation’. [FI_70_85]

b) BS EN ISO 9906 - ‘Rotodynamic pumps. Hydraulic performance acceptance tests. Grades 1, 2 and 3’. [FI_70_85]

c) BS EN ISO 5198 - ‘Centrifugal, mixed flow and axial pumps. Code for hydraulic performance tests. Precision class’. [FI_70_85]

d) BS EN 16297-1:2012 - ‘Pumps. Rotodynamic pumps. Glandless circulators. General requirements and procedures for testing and calculation of energy efficiency index (EEI)’. [FI_70_85]

e) BS EN 16297-2:2012 - ‘Pumps. Rotodynamic pumps. Glandless circulators. Calculation of energy efficiency index (EEI) for standalone circulators’. [FI_70_85]

f) BS EN 16644:2014 - ‘Pumps. Rotodynamic pumps. Glandless circulators having a rated power input not exceeding 200W for heating installations and domestic hot water installations. Noise test code (vibro-acoustics) for measuring structure and fluid-borne noise’. [FI_70_85]

3.9. Valves, Fittings and Components

3.9.1. LTHW Valves, Fittings and Components

3.9.1.1 The following requirements shall be met for any LTHW valves, fittings and components provided.

a) A micro-bubble deaerator, dirt separator and strainer shall be installed on the common heating return pipe of all heating systems. [PM_10_20_82]

b) Micro-bubble deaerators, dirt separators and strainers shall be installed on the primary and secondary heating return pipes where plate heat exchangers are installed. [PM_10_20_82]

c) Provision for expansion/contraction of water within the system and cold water feed shall be provided either by a packaged pressurisation unit with heating system quick fill facility or a feed and expansion tank. [PM_10_20_82]

d) Quick fill units and expansion tanks shall be located and insulated so that they cannot easily freeze. [PM_10_20_82]

e) Expansion vessels shall be adequately sized for the full water content of the circuit. [PM_10_20_82]

f) Where a feed and expansion tank are installed, it shall be of sufficient capacity and in suitable condition for the proposed development. [PM_10_20_82]

g) The heating circuit design shall enable flow balancing under all load conditions. [PM_10_20_82]

h) Differential pressure control valves shall be provided on the heating supplies to groups of radiators in order to provide system stability and flow control. [PM_10_20_82]

i) Isolating valves, check valves, expansion valves and double regulating valves shall be installed appropriately to aid commissioning, giving consideration for access and maintenance. [PM_80_10_50]

j) Test points, temperature and pressure relief valves, temperature and pressure gauges and draining devices shall be provided to aid commissioning and balancing. [PM_10_20_82]

k) Automatic air vents shall be provided to aid balancing in the system. [PM_10_20_82]

l) Pipework and supports shall take account of axial expansion. [PM_10_20_82]

m) Dosing pots shall be provided in the plant room for the addition of corrosion inhibitors, biocides and other water treatment chemicals. [PM_10_20_82]

n) Adjustable valves shall be provided in break tanks to allow the storage quantity to be adjusted. [PM_10_20_82]

3.9.2. Domestic Hot and Cold Water System Valves, Fittings and Components

3.9.2.1 The following requirements shall be met for any domestic hot and cold water system valves, fittings and components.

a) Pressure gauges shall be installed in line with BS EN 837-1 and temperature gauges installed in line with BS EN 13190. [PM_10_20_90]

b) WRAS or Kiwa KUKreg4 approved pipeline strainers shall be installed. [PM_10_20_90]

c) Floats for ball valves shall comply with BS 1968 for copper and BS 2456 for plastic. Ball valves shall be brass copper alloy. [PM_10_20_90]

d) Lift type check valves shall be provided in copper alloy and in line with BS 5154. [PM_10_20_90]

e) Thermostatic mixing valves shall be installed in line with BS EN 1111 TMV3. Thermostatic balancing valves (Type A) shall be installed in line with BS 7350. [PM_10_20_90]

f) Draining taps (Type A) shall be installed in line with BS 2879. [PM_10_20_90]

g) Direct hot water storage cylinders shall be installed in line with BS 1566-1 and shall be Kitemark certified. [PM_10_20_90]

h) Immersion heaters shall be installed in line with BS EN 60335-2-73 and be BEAB Approved. [PM_10_20_90]

i) Valve tests shall be conducted in line with BS EN 12266-1. [PM_10_20_90]

j) The domestic hot and cold water systems shall be provided with draw off taps and stop valves. [PM_10_20_82]

k) Ball isolating valves and lift type check valves shall be provided. [PM_10_20_82]

l) Water meters in line with BS EN 14154-1 and Energy and meter accessories in line with BS EN 14154- 2 shall be provided as outlined in Technical Annex 2H. [PM_10_20_90]

m) Backflow prevention devices shall be provided and comply with BS EN 13959. Antipollution check valves shall comply with BS EN 14454 and hose unions shall comply with BS EN 14451 for inline anti-vacuum valves. [PM_10_20_90]

n) Copper alloy body, diaphragm type float operated valves shall be installed that comply with BS 1212-2. [PM_10_20_90]

o) Glass fibre reinforced tanks and cisterns shall be designed and installed in line with BS EN 13280 and be designed to have a minimum of one cycle per day. [PM_10_20_90]

p) Magnetic water conditioners shall be provided where the calcium carbonate content of the incoming mains water supply is greater than 200mg/l or 14 on the Clark scale. [PM_10_20_82]

q) Valves of nominal sizes, 54mm and less shall have ends screwed and threaded to BS EN 10266 or have capillary ends to BS 1254. [PM_10_20_90]

r) Larger valves shall have flanged ends, complying with BS 4504 or BS EN 1092 as appropriate and are similar to those selected for the pipework. [PM_10_20_90]

3.9.3. Reference Standards for Valves, Fittings and Components

3.9.3.1 The design and installation of any valves, fittings and components shall comply with relevant parts of the standards as listed below, and any updated versions of these standards: [PM_10_20_90]

a) BS EN 837-1 - ‘Pressure gauges. Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing’. [FI_70_85]

b) BS EN 13190 - ‘Dial thermometers’. [FI_70_85]

c) BS 2456 - ‘Specification for floats (plastics) for float operated valves for cold water services’. [FI_70_85]

d) BS 5154 - ‘Specification for copper alloy globe, globe stop and check, check and gate valves’. [FI_70_85]

e) BS EN 1111 - ‘Sanitary tapware. Thermostatic mixing valves (PN 10). General technical specification’. [FI_70_85]

f) BS 2879 - ‘Specification for draining taps (screw-down pattern)’. [FI_70_85]

g) BS 1566-1 - ‘Copper indirect cylinders for domestic purposes. Open vented copper cylinders. Requirements and test methods’. [FI_70_85]

h) BS EN 14154-1 - ‘Water meters. General requirements’. [FI_70_85]

i) BS EN 14154-2 - ‘Water meters. Installation and conditions of use’. [FI_70_85]

j) BS EN 13959 - ‘Anti-pollution check valves. DN 6 to DN 250 inclusive Family E, type A, B, C, and D’. [FI_70_85]

k) BS EN 14454 - ‘Devices to prevent pollution by backflow of potable water. Hose union backflow preventer DN 15 to DN 32 inclusive. Family H, type A’. [FI_70_85]

l) BS EN 10253-1 - ‘Butt-welding pipe fittings. Wrought carbon steel for general use and without specific inspection requirements’. [FI_70_85]

m) BS EN 10253-2 - ‘Butt-welding pipe fittings. Non alloy and ferritic alloy steels with specific inspection requirements’. [FI_70_85]

n) BS EN 10266-1 - ‘Pipe threads where pressure tight joints are made on the threads. Taper external threads and parallel internal threads’. [FI_70_85]

o) BS EN 10226-2 - ‘Pipe threads where pressure tight joints are made on the threads. Taper external threads and taper internal threads’. [FI_70_85]

p) BS EN 10226-3 - ‘Pipes threads where pressure-tight joints are made on the threads. Verification by means of limit gauges’. [FI_70_85]

q) BS 4504 - ‘Circular flanges for pipes, valves and fittings’. [FI_70_85]

r) BS EN 1092 - ‘Flanges and their joints. Circular flanges for pipes, valves, fittings, and accessories’. [FI_70_85]

4. Mechanical Services

4.1. Mechanical Services Overview

4.1.1 The following sections outline the performance requirements for the mechanical building services systems and how the Building and occupancy needs shall be met. They include requirements for the heating, cooling, and ventilation systems. [PM_40_30_52]

4.1.2 Designs shall meet the criteria for the temperatures, thermal comfort and ventilation rates given in this Technical Annex. [PM_40_30_52]

4.1.3 The plant room(s) and entrances/exits to the plant room shall be large enough for the equipment to be installed, maintained and removed safely and in line with regulations. [PM_40_30_52]

4.1.4 The day-to-day management of the installation shall be fully discussed and agreed with the Employer and School. [PM_35_10]

4.2. Plant Room Requirements

4.2.1 Designs, as far as possible, shall ensure that plant rooms are:

a) manufactured off-site to fit within the standard structural grid dimensions used in the Building [SL_90_90_64]

b) located to minimise service distribution lengths and increase system efficiency. [SL_90_90_64]

4.2.2 Plant room design shall also ensure that:

a) a connection, if available, is provided to a community/district heat source [Ss_60_40_37_22]

b) where a community/ district heating connection is not available, flow and return connections for future provision of a plate heat exchanger are provided. [Ss_60_40_37_22]

4.3. Heating Systems

4.3.1. Overview

4.3.1.1 The following section details the requirements for the design and installation of any heating systems, including associated plant, pumps, distribution systems and emitters. [PM_35_70_36]

4.3.2. Operative Temperatures

4.3.2.1 Any heating system provided shall be capable of meeting the normal and maximum operative temperatures during the heating season that are listed in Table 10.2. [PM_10_20_90]

4.3.2.2 Heating systems shall be designed such that:

a) for all pumped systems, the initial stage of frost protection enables the pumps in the event that the internal temperature of the Building drops to 5°C (this temperature set point shall be adjustable) [PM_35_70_36]

b) in the event that the temperature drops to below 2°C (this temperature set point shall also be adjustable), then the second stage of frost protection commences and the heat generating plant circulates the heating medium around the system [PM_35_70_36]

c) trace heating is provided on systems at a higher risk to frost protection (for example systems that run externally to the building fabric or in unconditioned areas). [PM_35_70_36]

4.3.3. Heat Generating Systems and Main Plant

4.3.3.1 The DfE's preferred methods of heat generating systems are (in order of preference):

a) Connection to an available existing or planned community/district heat distribution network. [Ss_60_40_37_22]

b) Ground source heat pumps. [Ss_60_40_36_35]

c) Air source heat pumps. [Ss_60_40_36_05]

d) Other Low or Zero Carbon (LZC) technologies. [PM_35_70]

e) Gas fired condensing boilers where all other options have been ruled out and only with the agreement of the Employer. [Pr_60_60_08_34]

f) If the development uses fossil fuels, then a net-zero emissions transition plan must be in place to ensure that the development achieves net-zero carbon emissions in operation by 2050. [PM_40_20_26]

4.3.3.2 In addition, in accordance with GDB Clause 2.12.2.5 the Contractor shall ensure that the School's operational costs (energy and maintenance costs) are not increased by the selection of low carbon plant and equipment. [PM_10_20_90]

4.3.3.3 The Contractor may propose an alternative form of heat generating plant, however the appropriate energy analysis, capital and running cost analysis and justification for the proposed system(s) (e.g., oil, LPG etc.) shall be provided. [PM_40_20_26]

4.3.3.4 Heating systems shall be designed and installed appropriately. This shall include:

a) Heat loss calculations. [PM_40_30_20]

b) Main plant selection. [PM_40_30_52]

c) Emitter selection and sizing. [PM_40_30_52]

d) Pipework distribution design based on max velocity 1.15m/s for pipework up to 50mm diameter and 2m/s for > 50mm diameter. [PM_40_30_52]

e) Heating system ancillaries and valve selections. [PM_40_30_52]

f) A setback temperature of 5°C shall be used for the heating systems. [PM_40_30_52]

4.3.4. Heat Sources

4.3.4.1 Liaison with the local distribution network operator shall be undertaken to ensure there is adequate utility infrastructure and supply to support the proposed installation. [PM_30_10_93]

4.3.4.2 All heat distribution systems shall operate at a maximum mean flow temperature of 43°C. [PM_40_30_52]

4.3.4.3 Weather compensation control shall be provided for heating systems with reference to external weather conditions by varying flow temperature from the heat generator relative to the measured outside temperature ensuring:

a) adjustable temperature and flow rate settings which allow reconfiguration of the weather compensation curves with only one curve for each zone regardless of zone temperature sensor quantities [PM_40_30_52]

b) external temperature sensors are correctly located for representative values [PM_40_30_52]

c) compensation control can be prevented during pre-heat periods and overridden to ensure any boost, night set back and/or boiler safety operations. [PM_40_30_52]

4.3.5. Energy Networks

4.3.5.1 Where a connection to a new or existing energy network or the use of an energy centre is to be used, the supply and design of the associated systems shall comply with all relevant current standards and regulations. [PM_40_20_26]

4.3.5.2 The availability of a local heat network shall be checked through reference to the Heat Map site. The Coefficient Calculator can be found here; https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjE1JmRlPDyAhVNZcAKHZ3QD3sQFnoECAkQAQ&url=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fgovernment%2Fuploads%2Fsystem%2Fuploads%2Fattachment_data%2Ffile%2F735089%2FDischarge_coefficient_calculator.xlsx&usg=AOvVaw1nWitjJ3ZbgzZ7M4gC0No0. [Ss_60_40_37_22]

4.3.5.3 Where a community/district heating connection is not available, flow and return connections for future provision of a plate heat exchanger shall be provided. [Ss_60_40_37_22]

4.3.6. Heat Pumps

4.3.6.1 Any heat pumps provided shall meet the following requirements.

a) Operating and maintenance guidance information and operator training shall be provided to ensure the client is prepared to accept the system. [Ss_60_40_36]

b) Heat pumps shall give a margin to allow for maintenance; to be sized as two heat pumps at 66% or three at 40% or modular units sized so that N units provide 100% capacity and N + 1 are installed. Ground source fields shall be arranged to provide similar resilience. [Ss_60_40_36]

c) Separate heat pumps or a cascade type system shall be provided for domestic hot water and heating. [Ss_60_40_36]

d) Heat distribution services shall be designed to ensure that the Seasonal Coefficient of Performance (SCOP) is maximised. [Ss_60_40_36]

e) Heat pumps shall be sited in accordance with the manufacturers' instructions with due consideration of weather protection, noise and thermal efficiency aspects. The heat pump plant room or housing shall be naturally ventilated via louvres and/ or louvred doors. [Ss_60_40_36]

f) Heat pump systems shall be designed and controlled to avoid excessive start-up cycles (e.g., three start up cycles per hour). Heat pump systems shall incorporate invertor controllers to increase efficiency and reduce starting currents. [Ss_60_40_36]

g) The installation shall comply with the F-gas Regulations. Any environmental impact as a result of refrigerant use in operation is to be minimised. The heat pump system refrigerant shall be selected to have an ozone depletion potential (ODP) of zero and the lowest global warming potential that is feasible. [PM_10_20_90]

h) Agreement shall be sought to use any refrigerant with a GWP >1500. [PM_10_20_82]

i) Heat pump selections shall be based on SCOPs for both full and partial loads in accordance with BS EN 14825:2018. [PM_10_20_90]

j) Heat pump selections shall be installed to TR/30 ‘Guide to Good Practice: Heat Pumps’ BESA, 2013. [PM_10_20_90]

k) Ensure selections are based on maximising efficiency. [Ss_60_40_36]

4.3.6.2 Where appropriate, all heat pump installations shall be Ground Source. Where evidence can be provided that the use of Ground Source is not practical then Air Source Heat Pumps shall be installed. [Ss_60_40_36]

4.3.6.3 External noise levels from any heat pump system provided shall not exceed local planning requirements in accordance with the IoA/ANC ‘School Design Guide’. [PM_35_60]

4.3.7. Ground Source Heat Pumps

4.3.7.1 Where Ground Source Heat Pumps are installed, the ecology and environmental factors shall be appropriate for the installation of such systems.

a) Closed loop systems shall be used. Justification and approval is required to use an open loop system. [Ss_60_40_36_35]

b) The circulating fluid shall be treated to protect from freezing and to prevent corrosion. [Ss_60_40_36_35]

c) Vertical ground heat exchangers provide increased efficiency and lower land requirement than horizontal ground loops and should be considered ahead of horizontal configuration. [Ss_60_40_36_35]

d) Careful consideration shall be given to the detailed design of the ground heat exchanger including issues of ground recharge requirements, annual heat extraction rates, field depletion and frost heave. [Ss_60_40_36_35]

4.3.7.2 Passive (free) cooling can be provided by circulating the low temperature fluid off the group loop via a bypass. [Ss_60_40_36_35]

4.3.8. Air Source Heat Pumps

4.3.8.1 The kW output rating of the Air Source Heat Pump (ASHP) shall be clearly stated for the appropriate design conditions and shall include defrost capacity. [Ss_60_40_36_05]

4.3.8.2 Individual ASHP modules shall have the ability to be cascaded. [Ss_60_40_36_05]

4.3.8.3 Air source heat pumps are subject to potential ice formation on the evaporator and shall therefore incorporate an automatic defrost cycle and condensate drainage. The Contractor shall ensure the appropriate measures are in place to prevent ice formation on the evaporator. [Ss_60_40_36_05]

4.3.8.4 When multiple heat pumps are applied in a sequence, a control strategy to stop simultaneous defrost cycles shall be adopted where necessary. [Ss_60_40_36_05]

4.3.8.5 ASHP connections to the primary circuit shall be via the reverse return method. [Ss_60_40_36_05]

4.3.8.6 Trace heating and weather protection shall be included to all external elements of the system. [Ss_60_40_36_05]

4.3.8.7 Air flow rates through the condenser coil shall exceed manufacturers' minimum recommendations under all operating conditions. [Ss_60_40_36_05]

4.3.9. Alternative Low and Zero Carbon Heat Sources

4.3.9.1 The following details the requirements for the preferred LZC technologies, as a primary or secondary heat source, within schools in the event that LZC technologies are required as part of the proposed Energy Strategy.

a) An Energy Strategy shall be established for the Site. Further details can be found in Technical Annex 2H. [PM_40_20_26]

b) LZC sources shall be provided with sub-meters for fuel input, power output and heat output. [PM_35_70]

c) CHP Units shall be installed to TR/37 'Guide to good practice: installation of combined heat and power'. [PM_10_20_90]

d) The controls to CHP units shall be sequenced such that they operate as the primary heat source to ensure optimum usage and run time. [Ss_75_70_52_15]

e) Where an LZC technology is being proposed to provide cooling, the cooling hierarchy in Section 8.1 still applies, and all passive and free cooling measures shall be

exploited before deployment of active equipment, reference shall also be made to Technical Annex 2H. [PM_10_20_90]

f) The design and installation of Biomass boiler systems shall be completed to all relevant current standards and regulations, including CIBSE AM15 - Biomass Heating Application Manual, 2014. [PM_10_20_90]

g) Biomass boiler units shall be installed in line with manufacturers' requirements. [Pr_60_60_08_08]

h) Safe, suitable, and efficient fuel storage and delivery and ash handling shall be in place as an integral part any biomass installation. [Pr_60_60_83]

4.3.9.2 Where LZC heat sources are provided they shall be sized as two heat sources at 66%; or three at 40%; or modular heat sources sized so that N heat sources provide 100% capacity and N+1 are installed. [PM_35_70]

4.3.10. Boilers

4.3.10.1 For any boiler provided, the following requirements shall be met:

a) Where gas is proposed, there shall be an adequate gas supply available for the proposed installation. The Contractor shall be responsible for all aspects of liaising with the utility supply company to provide the necessary gas connection. The gas supply shall be without the use of gas boosters wherever possible. [PM_30_10_93]

b) Boilers shall be provided to give a margin to allow for maintenance; to be sized as 2 boilers at 66%; or 3 at 40%; or modular boilers sized so that N boilers provide 100% capacity and N+1 are installed. [Pr_60_60_08]

c) The burner control shall be of a modulating type in accordance with AD L, and the boilers shall be controlled to optimise the efficiency of the system. [Pr_60_60_10]

d) 'Weather compensation' shall be used to vary the boiler flow rate according to the outdoor air temperature to maximise energy saving. [Pr_60_60_08]

e) Heating services are designed to a maximum mean LTHW flow temperature of 43°C:

    i) allow for connections to a low carbon heat source in the future [PM_40_20_26]
    ii) make full use of the condensing mode of the boilers during part load conditions. [PM_40_20_26]

f) The boilers have maximum NOx emissions of 40 mg/kWh unless otherwise stated in the planning application or other relevant standards documents. [Pr_60_60_08]

g) Any boiler installation shall be provided with an appropriate flue provision which is manufactured by a Member of the British Flue and Chimney Manufacturers Association (BFCMA). [Pr_70_65_30]

h) The flue shall be twin walled and insulated. [Pr_70_65_30]

i) The flue system shall be designed to manufacturers' recommendations. [Pr_70_65_30]

j) The flue system shall comply with the requirements of The Clean Air Act and the local planning authority. [Pr_70_65_30]

k) Any boilers provided shall be located in a dedicated main plant room or purpose designed and constructed boiler room. [Pr_60_60_08]

l) The plant room shall be naturally ventilated, and adequate air required for combustion purpose shall be supplied via louvres/louvred doors. The ventilation shall comply with Building Regulations, IGEM standards, British Standards and UKLPG recommendations. [SL_90_90_64]

m) Permanent ventilation openings at high and low level shall be provided to the external wall of the boiler plant room as necessary and shall comply with IGEM/UP/10 and BS 6644. See Section 9 for requirements for gas services installations. [PM_10_20_90]

n) New heating system sources shall have a minimum Seasonal Coefficient of Performance (SCOP) no worse than the requirements set out in the Non-Domestic Building Services Compliance Guide (current edition). [PM_10_20_90]

4.3.11. Heating Distribution Systems

4.3.11.1 In any heating distribution system provided, the Contractor shall:

a) Provide a heating distribution system based on a low temperature hot water (LTHW) system. [Ss_60_40_37_48]

b) Design and install a flow and return header system to separate the primary heat and secondary circuits; and include in the header system design all necessary pumps, valves, and ancillaries to allow for efficient and appropriate delivery of heat throughout the School. [Ss_60_40_37_48]

c) Ensure a Constant Temperature (CT) secondary circuit is provided to supply any installed Air Handling Units (AHUs), Fan Coil Units (FCUs) and radiant panels; and flow and return Variable Temperature (VT) secondary circuits are provided to serve any convectors, underfloor heating and radiators. [Ss_60_40_37_48]

d) Ensure the heating system is zoned and adequately controllable to give good thermal comfort in accordance with Section 10 of this Technical Annex and Section 2.4 of Technical Annex 2I. The heating system shall be zoned based on zones of the Building and occupational periods. [PM_10_20_90]

e) Ensure the header arrangement is designed to achieve a constant return temperature, with the flow of the secondary circuit intentionally greater than the flow of the primary circuit to guarantee a low return temperature for condensing boilers. [Ss_60_40_37_48]

f) Ensure that sequencing by flow temperature is achieved and boilers are brought on-line in sequence to maintain the flow temperature. [Ss_60_40_37_48]

g) Ensure that temperature dilution when there are one or more off-line boilers/heat generators is avoided. [Ss_60_40_37_48]

h) Ensure that where biomass, CHP or heat pumps are used in conjunction with gas boilers the renewable generator is the lead heat generator. [PM_10_20_82]

i) Ensure that, where a plate heat exchanger is installed in series with the return to a boiler house to allow a renewable source to be connected, the flow of the secondary circuit has a lower flow rate than the primary circuit to avoid temperature dilution. [PM_10_20_82]

j) Ensure that, where a plate heat exchanger is installed in series with the return to a boiler house to allow a renewable source to be connected, the temperature drop across the plate heat exchanger is taken account of and there is a margin of several degrees above the required temperature on the secondary circuit to account for the loss. [PM_10_20_82]

k) Ensure that heat meters are correctly installed to be accurate to 0.1°C and 0.1kg/s and installed in accordance with manufacturers' instructions. [Pr_80_51_51_37]

4.3.11.2 Where additional heating is to be retrofitted, the following requirements shall be met.

a) Where a load circuit is added, it has the same ΔT as the existing load circuit. [Ss_60_40_37]

b) Where boilers are Replaced, they are Replaced with those designed for the existing operating load circuit ΔT. [Pr_60_60_08]

c) The circulating header is sized for the existing load circuit ΔT. [Ss_60_40_37]

d) The pumps are selected to be large enough for the correct ΔT. [Ss_60_40_37]

e) Insulation is considered and its effects on the load circuit flow rates and circuit ΔTs. [Ss_60_40_37]

f) The existing load circuit flow rates are measured, and the existing and proposed circuit loads are calculated to determine the spare capacity of the existing boiler plant. [Ss_60_40_37]

g) The flow rates and temperatures on existing load circuits are reviewed to identify whether they are too high and could be reduced. [Ss_60_40_37]

4.3.12. Heating Emitters

4.3.12.1 Any space or area can be heated by one or more of the following emitter types:

a) Natural convectors and radiators. [Pr_70_60_36_73]

b) Warm air. [Pr_70_60_36_02]

c) Radiant heating. [Pr_70_60_36_71]

d) Underfloor heating. [Pr_70_60_36_49]

e) Forced convection fans. [Pr_70_60_36_30]

4.3.12.2 Detailed reasons and justification shall be provided when proposing an alternative form of heat emitter. [PM_10_20_82]

4.3.12.3 Heat emitters shall be selected based on the following requirements:

a) Heating capacity required. [Pr_70_60_36]

b) The responsiveness required due to change of use in the space. [Pr_70_60_36]

c) Thermal comfort requirements, see Section 10. [Pr_70_60_36]

d) Space available (whether space is available on the floor, around the perimeter or at high level). [Pr_70_60_36]

e) Safety requirements (including low surface temperature). [Pr_70_60_36]

f) Robustness. [Pr_70_60_36]

g) Running cost. [Pr_70_60_36]

4.3.12.4 The materials used in any heat emitters shall be appropriate for the pipework and boiler systems connected e.g., steel radiators, steel pipe, stainless steel heat exchangers. [PM_10_20_82]

4.3.12.5 Appropriate water treatment corrosion inhibitors shall be used. [Pr_60_55_96_16]

4.3.12.6 The heat emitters and system shall be selected with the ventilation and cooling strategy in mind in order to reduce energy loss e.g., heating energy lost through open windows in mid-season and wintertime. [PM_40_20_26]

4.3.12.7 An even temperature gradient shall be achieved in the room for thermal comfort and draughts shall be reduced or eliminated in the Teaching Spaces in line with the requirements set out in Section 10.3. [PM_10_20_90]

4.3.12.8 All emitters shall be accessible for cleaning, especially those mounted at high level, and measures shall be taken to prevent dust build-up in/on the heat emitters. All trench heaters shall be provided with a removable grille for ease of maintenance. [PM_80_10_50]

4.3.12.9 Heat emitters shall not create noise in the occupied space, so that the indoor ambient noise level given in BB93 for the type of space is exceeded. [PM_35_60]

4.3.12.10 Where radiators are provided in nursery provision, reception classrooms and in SEND dedicated spaces, Special Schools or Designated Units, they shall be low surface temperature (LST). [Pr_70_60_36_73]

4.3.12.11 All radiators shall be provided with lockable thermostatic valves (TRVs) or other control device which shall not allow the room to be heated more than 2°C above the normal room temperature, but also afford frost protection if the valve is closed. [Pr_65_54_95_89]

4.3.12.12 Adequate wall space shall be available to allow radiators to be coordinated with fitted and fixed furniture, allowing unobstructed heat output. [Pr_70_60_36_73]

4.3.12.13 Where trench heating is installed, it shall be of a robust nature to withstand furniture and changes of use in the space. [Pr_70_60_36_90]

4.3.12.14 Adequate protection from damage by sports equipment shall be provided where a sports hall is served by LTHW radiant heaters. [Pr_70_60_36_71]

4.3.12.15 Radiant panels shall be sized in accordance with Section 4.3.11 to demonstrate that radiant heating complies with the thermal comfort criteria for radiant temperatures. [Pr_70_60_36_71]

4.3.12.16 Any underfloor heating shall be based on a LTHW rather than an electric system to conserve energy. [Pr_70_60_36_49]

4.3.12.17 The following requirements shall be met where underfloor heating is provided.

a) Maximum surface temperatures comply with Section 4.3.14. [PM_10_20_90]

b) The floor covering is appropriate for underfloor heating to allow effective heat transfer to the room. [PM_10_20_82]

c) The design and installation are fully coordinated with other underfloor services such as drainage and electrical cables, and any fixed FF&E. [PM_10_20_82]

d) Actuators and manifolds are located in a dedicated cupboard or robust boxing adjacent to the space being heated but inaccessible to students and the public. [PM_10_20_82]

e) Pipework, valves and connections are designed in order to avoid in-screed or underfloor leaks. [Pr_70_60_36_49]

f) If the screed depth is reduced to increase the response time, consideration is given to the static and dynamic loads placed on the floor. The construction method and materials proposed to provide a reduced screed depth shall be submitted to the Employer for approval. [PM_10_20_82]

4.3.12.18 Underfloor heating shall not be installed where:

a) the room use and heating profile may change quickly since underfloor heating is a slow response system [PM_10_20_82]

b) floors may be covered with mats [PM_10_20_82]

c) regular spillages can occur, and cause hygiene and odour problems (e.g., in toilets, changing rooms or hygiene rooms) [PM_10_20_82]

d) the positions of partition walls are likely to change [PM_10_20_82]

e) fixings into the screed are required for furniture (e.g., lab benches) or equipment (e.g., in design and technology) [PM_10_20_82]

f) there is bleacher seating. [PM_10_20_82]

4.3.12.19 Fan convectors shall be designed to be robust and easily maintained to prevent dust build up. [Pr_70_60_36_30]

4.3.12.20 Where heating is provided via AHUs, LTHW shall be used in preference to electrical heater batteries. [PM_10_20_82]

4.3.13. Radiant Temperature Difference

4.3.13.1 Where the heating system incorporates overhead radiant panels, calculations shall be undertaken as described below to determine the Radiant Temperature Asymmetry (*RTA*) within each space. [Pr_70_60_36_71]

4.3.13.2 In calculating the *RTA*, $\Delta T_{pr,\ upwards}$ can be assessed directly below a radiant panel or an array of panels using the formulae in BS 7726. [Pr_70_60_36_71]

4.3.13.3 For a seated person, the difference in plane radiant temperature between the upper and lower parts of the space shall be taken with respect to a small horizontal plane 0.6m above floor level in accordance with CIBSE Guide A Section 1.6.6.4 (2015 Edition). For a standing person, a small horizontal plane 1.1m above floor level shall be taken. [Pr_70_60_36_71]

4.3.13.4 The predicted *RTA* due to the presence of radiant panels overhead shall not exceed 7K. This is particularly important when there is a sedentary activity such as people sitting at a desk. [Pr_70_60_36_71]

4.3.13.5 Where there are vulnerable pupils e.g., those with low mobility or difficulty in thermoregulation, the *RTA* shall be reduced to 5K. [Pr_70_60_36_71]

4.3.13.6 Indicative minimum panel installation heights for a seated person are given in Table 4-1 and Table 4-2 below for an *RTA* of 7K and 5K. [Pr_70_60_36_71]

4.3.13.7 These tables are based on the seated person being positioned directly below the centre of a single overhead radiant panel in a typical classroom configuration. [Pr_70_60_36_71]

Flow/Return Temperature (°C)	Assumed Emitter Temperature (°C)	Panel width (mm) 300	Panel width (mm) 600	Panel width (mm) 750	Panel width (mm) 900	Panel width (mm) 1200
50/30	40	< 2.4	< 2.4	< 2.4	< 2.4	< 2.4
60/40	50	< 2.4	< 2.4	< 2.4	2.55	3.05
70/40	55	< 2.4	< 2.4	2.55	2.85	3.4
70/50	60	< 2.4	2.45	2.85	3.2	3.75
80/60	70	< 2.4	2.95	3.35	3.75	4.45
82/71	76.5	< 2.4	3.25	3.7	4.1	4.85

Table 4-1 Minimum panel height above finished floor level (m) / Radiant Temperature Asymmetry *RTA* = 7K

Flow/Return Temperature (°C)	Assumed Emitter Temperature (°C)	Panel width (mm) 300	Panel width (mm) 600	Panel width (mm) 750	Panel width (mm) 900	Panel width (mm) 1200
50/30	40	< 2.4	< 2.4	< 2.4	< 2.4	2.85
60/40	50	< 2.4	2.5	2.85	3.2	3.8
70/40	55	< 2.4	2.8	3.2	3.55	4.2
70/50	60	< 2.4	3.1	3.55	3.95	4.65
80/60	70	< 2.4	3.65	4.15	4.6	5.4
82/71	76.5	2.6	4	4.55	5	5.85

Table 4-2 Minimum panel height above finished floor level (m) / Radiant Temperature Asymmetry RTA = 5K

4.3.13.8 For other panel dimensions, mounting heights, flow and return temperatures, the *RTA* calculator on the DfE website may be used to calculate the *RTA.* [Pr_70_60_36_71]

4.3.13.9 The design shall take account of the mean water temperature, the size of radiant panels and available mounting height. Mounting too low can result in occupants complaining of excessive temperatures above their head, and if mounted too high, occupants may not feel the full heating benefit. [Pr_70_60_36_71]

4.3.13.10 Arrangement of radiant panels shall allow sufficient separation between the units to provide an even spread of heat throughout the space whilst preventing a crossover of the radiant flow of heat between panels resulting in zones of intense heat. [Pr_70_60_36_71]

4.3.13.11 Radiant panels shall not be located directly above teaching walls or other areas where a teacher or other occupant is likely to be standing for prolonged periods of time, unless *RTA* calculations can demonstrate that the installation is suitable and would not result in excess temperature differences. [Pr_70_60_36_71]

4.3.13.12 If the radiant panels are offset from the preferred layout as part of the services coordination, the impact on *RTA* shall be assessed. [Pr_70_60_36_71]

4.3.13.13 The options of integrating luminaires and acoustic absorbers within radiant panels shall be considered. [Pr_70_60_36_71]

4.3.13.14 The surface temperature of ceiling mounted radiant panels in classrooms or offices and in normal height Teaching Spaces shall be limited to meet BS EN 16798-1. [PM_10_20_90]

4.3.13.15 BS EN 16798-1 requires that for a category III building the vertical air temperature difference in the space during the heating season shall be <2K/m in the occupied zone in order to avoid discomfort and to conserve energy. [PM_10_20_90]

4.3.13.16 Where radiant panels are used in spaces over 4m in height, measures shall be taken where necessary to reduce stratification. [Pr_70_60_36_71]

4.3.14. Underfloor Heating

4.3.14.1 Any underfloor heating provided shall be designed in accordance with the maximum floor surface temperatures given in Table 4.3. [Pr_70_60_36_49]

Type of space or activity	New Build Comfort category and Maximum floor surface Temperature	Refurbishment Comfort category and maximum floor surface temperature
Teaching Spaces and learning resource areas School sports halls (used for exams)	II (<26°C)	III (<29°C)
Community sports halls (not used for exams	III (<29°C)	IV (<31°C)
Working areas, e.g., kitchens	IV (<31°C)	IV (<31°C)
Offices	II (<26°C)	III (<29°C)
Atria, circulation, reception, and corridors - not continuously occupied	III (<29°C)	IV (<31°C)
Areas for pupils with complex health needs[a]	I (<23°C)	I (<23°C)

Table 4-3 maximum floor surface temperatures

Note a: In the case of pupils with complex health needs, the temperature shall be adjustable to cater for the needs of the pupils. In these cases, an assessment of the individual needs must be made by the Contractor in consultation with the School and the Employer. This category applies only to Designated Units or Special Schools for non-ambulant pupils or those with medical conditions.

4.3.15. Commissioning and Handover of Heating Systems

4.3.15.1 For any heating system provided, the following requirements shall be met.

a) All heating systems installed shall be fully tested and commissioned in line with all appropriate and relevant current regulations and standards, including those detailed in the DfE's EIR. [PM_10_20_28]

b) Pre-commissioning, commissioning and seasonal commissioning shall be conducted on all aspects of the heating system and main plant in line with BSRIA BG 2/2010, BSRIA BG 44/2013 and the CIBSE commissioning code, providing a minimum notice period of 1 week to the Employer's engineering representative for witnessing. [PM_40_20_15]

c) Seasonal commissioning of the heating system shall be conducted during the defects period, and control settings shall be fine-tuned. [PM_40_20_15]

4.3.15.2 The systems provided shall be run, monitored and maintained for a minimum period of one week before handover during the "soak test" that immediately follows the commissioning and testing of the heating system. [PM_70_15_82]

4.3.15.3 During the "soak test" period, the required demonstration of the system and controls shall be undertaken. [PM_10_20_82]

4.3.15.4 The results of the commissioning and performance testing shall be recorded in line with BSRIA Building Applications Guide BG2/2010 and shall be provided as part of the Operation and Maintenance (O&M) Manual documentation. [PM_70]

4.3.15.5 Full requirements for commissioning and handover are detailed in the DfE's EIR. [PM_10_20_28]

4.3.16. Hand Dryers

4.3.16.1 Electric hand dryers shall be installed in all toilets and hygiene rooms, unless paper hand towels are required in the School-specific Brief. [Pr_40_70_62_37]

4.3.16.2 The hand dryers shall have a drying time of less than 30 seconds; infrared control for no contact start; auto-off; and a noise level less than 65 dBA at 1m. [Pr_40_70_62_37]

4.3.16.3 If paper towels are required in the SSB, a paper hand towel dispenser shall be installed along with a switched fuse spur and conduit for future connection of electric hand driers by the School, as described in Technical Annex 2G. [PM_10_20_90]

4.3.17. Reference Standards

4.3.17.1 The design and installation of any heating systems provided shall comply with the relevant parts of the following standards as listed below, and any updated versions of these standards: [PM_10_20_90]

a) HM Government - ‘Non-Domestic Building Services Compliance Guide’. [FI_70]

b) BS 5546:2010 - ‘Specification for installation and maintenance of gas-fired water-heating appliances of rated input not exceeding 70 kW net’. [FI_70_85]

c) BS6644:2011 - ‘Specification for the installation and maintenance of gas-fired hot water boilers of rated inputs between 70 kW (net) and 1.8 MW (net) (2nd and 3rd family gases)’. [FI_70_85]

d) BS 845-1:1987 - ‘Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids’. [FI_70_85]

e) BS 5986:1980 - ‘Specification for electrical safety and performance of gas fired space heating appliances with inputs 60kW to 2MW’. [FI_70_85]

f) BS EN 1856-1:2009 - ‘Chimneys - Requirements for metal chimneys. System chimney products’. [FI_70_85]

g) BS EN 1993-3-2:2006 - ‘Eurocode 3 - Design of steel structures. Towers, masts, and chimneys - chimneys’. [FI_70_85]

h) BS EN 442-1:2014 - ‘Radiators and convectors. Technical specifications and requirements’. [FI_70_85]

i) BS EN 442-2:2014 - ‘Radiators and convectors. Test methods and rating’ [FI_70_85]

j) BS EN 14037-1:2003 - ‘Ceiling mounted radiant panels supplied with water at temperature below 120°C. Technical specifications and requirements’. [FI_70_85]

k) BS EN 14037-2:2003 - ‘Ceiling mounted radiant panels supplied with water at temperature below 120°C. Test methods for thermal output’. [FI_70_85]

l) BS EN 14037-3:2003 - ‘Ceiling mounted radiant panels supplied with water at temperature below 120°C. Rating method and evaluation of radiant thermal output’. [FI_70_85]

m) BS EN 16430-1:2014 - ‘Fan assisted radiators, convectors and trench convectors. Technical specifications and requirements’. [FI_70_85]

n) BS EN 16430-2:2014 - ‘Fan assisted radiators, convectors and trench convectors. Test method and rating for thermal output’. [FI_70_85]

o) BS 5141-2:1977 - ‘Specification for air heating and cooling coils. Method of testing for rating of heating coils’. [FI_70_85]

p) BS EN 1216:1999 - ‘Heat exchangers. Forced circulation air-cooling and air heating coils. Test procedures for establishing the performance (+ AMD 14280)’. [FI_70_85]

q) BAG BG 4/2011, BSRIA - ‘Underfloor heating and cooling’. [FI_70]

r) BS EN 1264-4:2009 - ‘Water based surface embedded heating and cooling systems. Installation’. [FI_70_85]

s) BS EN 14336:2004 - ‘Heating systems in buildings - Installation and commissioning of water-based heating systems’ (incorporating corrigenda January 2009 and September 2013). [FI_70_85]

t) BS EN 1264-1:2011 - ‘Water based surface embedded heating and cooling systems. Definitions and symbols’. [FI_70_85]

u) CIBSE AM15 - ‘Biomass Heating Application Manual’, 2014. [FI_70]

v) CIBSE TM51 - ‘Ground Source Heat Pumps’, 2013. [FI_70]

w) BESA TR/30 - ‘Guide to Good Practice – Heat Pumps’, 2013. [FI_70]

x) BS EN 14825:2018 - ‘Test Conditions – Part Load and Seasonal Performance. [FI_70_85]

4.4. Ventilation Systems

4.4.1. Overview

4.4.1.1 In any space, ventilation shall be provided by natural ventilation, by a mixed-mode or hybrid system, or by mechanical ventilation. The following hierarchy shall be in place for ventilation design:

a) Natural ventilation [PM_35_70_94]

b) Natural ventilation with fan assistance (hybrid) [PM_35_70_94]

c) Mechanical ventilation [PM_35_70_94]

d) Mechanical ventilation with peak lopping cooling using LZC as a source; and [PM_35_70_94]

e) VRF or split systems. [PM_35_70_94]

4.4.1.2 The Building shall be designed to employ cross-ventilation or stack effect ventilation. The design of the ventilation system shall:

a) prioritise natural ventilation over mechanical ventilation [PM_35_70_94]

b) be designed to use cross flow or double-sided natural ventilation in classrooms and large spaces; single sided natural ventilation should only be used for small single offices and server rooms [PM_35_70_94]

4.4.1.3 Peak lop cooling using mechanical systems shall not be used as the means to achieve required environmental conditions and avoid overheating. It should only be adopted in extreme circumstances, such as the London heat island, and in accordance with the cooling hierarchy in Section 8.1. [PM_35_70_94]

4.4.1.4 Where zonal ventilation is used, to reduce the risk of cross infection contamination between spaces, recirculation shall not be provided. [PM_35_70_94]

4.4.1.5 Any ventilation system provided shall be developed to provide fresh air for occupants and maintain/control the indoor air quality (pollutants, CO_2, odours, VOCs) throughout the year. [PM_35_70_94]

4.4.1.6 Ventilation shall be considered for purge and night-time cooling as part of the summertime cooling strategy. [PM_35_70_94]

4.4.1.7 VOC sensors are not required as part of the system. [PM_10_20_82]

4.4.1.8 The external noise levels from any ventilation and extract systems provided shall not exceed local planning requirements in accordance with the IoA/ANC ‘School Design Guide’. [PM_35_60]

4.4.1.9 Mechanical ventilation shall not create excessive noise. [PM_35_60]

4.4.1.10 Indoor ambient noise levels shall comply with Building Bulletin 93: ‘Acoustic design of schools: performance standards (BB93). [PM_35_60]

4.4.1.11 The design shall allow air movement to be increased during the summer through opening windows or vents, switching on fans, or increasing the rate of mechanical ventilation, in order to avoid overheating. [PM_35_70_94]

4.4.2. Indoor Source Control

4.4.2.1 There shall be no recirculation of air contaminated by things other than from normal human activity (CO_2, moisture from exhalation etc.) such as from kitchens and fume cupboards. [PM_35_70_94]

4.4.2.2 Extract outlets shall be designed to avoid risk of unintentional recirculation into a supply inlet or natural ventilation openings. [PM_35_70_94]

4.4.2.3 Extraction systems or transfer arrangements shall be designed to ensure there is a minimum possibility of back draughts from one area to another. [PM_35_70_94]

4.4.3. Radon Remediation

4.4.3.1 Risk assessments shall be carried out (including Radon measurements in appropriate ground floor rooms) where a Building in the Works is located in a Radon Affected Area, irrespective of the presence of protection measures included at the time of construction. [Ac_15_40_70]

4.4.3.2 In Radon Affected Areas the requirements of the Ionising Radiations Regulations and AD C for Radon protection in New Buildings, extensions and refurbishments shall be met. [PM_10_20_90]

4.4.3.3 Established remediation techniques, entailing building works, shall be used where necessary to reduce high Radon levels. [PM_10_20_82]

4.4.3.4 Once a building has been remediated, the indoor Radon levels shall be measured before occupation to confirm the operation of the remediation system and the records retained. [Ac_15_40_70]

4.4.3.5 Requirements for Radon remediation systems and for annual Radon measurements shall be included in O&M Manuals. [PM_10_20_82]

4.4.3.6 For buildings in high Radon areas without remediation systems, repeat Radon measurements are required before occupation after any substantial building work. [Ac_15_40_70]

4.4.4. Natural Ventilation Systems

4.4.4.1 Any natural ventilation provided shall be either:

a) Central: whole building systems utilising the stack/buoyancy and/or wind effect: or [Ss_65_40_33_56]

b) Local: individual room-based openable windows/ louvres/ vents. [Ss_65_40_33_56]

4.4.5. Mixed-mode Systems

4.4.5.1 In this Technical Annex, mixed-mode ventilation or hybrid ventilation typically means one space having both natural ventilation and mechanical ventilation installed. The two systems may work together or at different times of the year or under different conditions to provide improved thermal comfort and reduce energy use. [Ss_65_40]

4.4.6. Mechanical Ventilation Systems

4.4.6.1 Any mechanical ventilation systems provided shall be either centralised systems serving multiple rooms or local room-level systems. [Ss_65_40_33_52]

4.4.6.2 Mechanical ventilation shall be used to negatively pressurise any areas with unwanted odours, including dining areas, kitchens, food rooms, and toilets. [Ss_65_40_33_52]

4.4.6.3 Where required, ventilation systems shall be interlocked with the gas supply in accordance with IGEM/UP/19. See Section 9: Gas Services. [PM_10_20_90]

4.4.6.4 All ductwork and plenums shall be fully accessible for cleaning. [PM_80_10_50]

4.4.7. Local Extract Ventilation

4.4.7.1 For any smaller toilet area (2 WCs or less), or where all toilet cubicles open directly off the corridor, an extract system shall be provided, with the make-up air taken from the surrounding corridors and internal spaces. [Ss_65_40_33_90]

4.4.7.2 Where a toilet area is greater than two WCs, there shall be a dedicated mechanical ventilation system with supply and extract; supply ventilation shall be at 85% of extract to ensure that air is entrained into the space to avoid odours emanating from the WCs. A similar arrangement shall be adopted for any pupil changing and shower areas. [Ss_65_40_33_52]

4.4.7.3 Toilet and changing room ventilation fans shall be locally controlled. [Ss_75_70_52_94]

4.4.7.4 Where full height cubicle partitions are specified in toilets, make up air shall be provided either by a ventilation air path that preserves acoustic and visual privacy including from mobile phone cameras, or supply air shall be provided to the cubicle. See Technical Annex 2A. [PM_10_20_90]

4.4.7.5 In any school kitchen, the ventilation system (supply and extract fans) shall be fitted with an easily accessible variable speed inverter control with marked settings for ‘off, cold prep, hot prep and maximum’, attenuation and grease and particle filtration. The kitchen extract system shall be interlinked with the gas supply. The maximum ventilation rate shall maintain the kitchen temperature below 28°C with all equipment operating for hot food preparation, full occupancy and maximum summer external conditions/temperatures. For further details see Technical Annex 2I and Section 7.2. [Ss_65_40_33_45]

4.4.7.6 The design and installation shall ensure that adequate make-up air is provided where extract ventilation is used. [PM_35_70_94]

4.4.7.7 Further requirements relating to extract ventilation systems are given in Sections 6 and 7. [PM_10_20_90]

4.4.8. Ventilation Controls

4.4.8.1 Ventilation controls shall be in accordance with Technical Annex 2I. [PM_10_20_90]

4.4.9. Distribution

4.4.9.1 The following section defines the requirements for ventilation distribution systems. It covers the requirements for air distribution systems connected to main and local plant. [Ss_65_40]

4.4.10. Ductwork

4.4.10.1 Ductwork velocities shall be in line with CIBSE Guide B. [PM_10_20_90]

4.4.10.2 Ductwork shall be installed in line with BESA DW144. [PM_10_20_90]

4.4.10.3 Where ductwork is installed in ceiling voids it shall be fully accessible for maintenance. [PM_80_10_50]

4.4.10.4 Access points for cleaning of ductwork shall be provided. [PM_80_10_50]

4.4.10.5 Where ductwork is exposed, any insulation shall be protected in a robust cleanable material e.g., aluminium or plastic. Self-finish aluminium foil that can be easily damaged is not robust enough, but rigid plastic or aluminium sheeting is acceptable. [PM_35_10_25]

4.4.10.6 The ductwork installation shall be robust. [PM_35_10_25]

4.4.10.7 All fire stopping, fire dampers and fire protection shall be installed, as required, in line with the Fire Strategy and shall be documented using photographic records and included in the H&S File. [PM_35_30]

4.4.10.8 All external ductwork shall be clad in metal or rigid UV resistant plastic to prevent damage e.g., by birds. [PM_35_10_25]

4.4.10.9 Flexible ductwork shall be minimised to avoid high-pressure losses, noise and to facilitate cleaning of ductwork. [Pr_65_65_25_32]

4.4.10.10 Ductwork shall be identified and labelled in line with the relevant British Standards. [Pr_40_10_57]

4.4.10.11 All external ductwork shall be adequately fixed or held in place using suitable ballast, so as to avoid movement of ductwork due to effects of wind pressure, whilst avoiding damage to the roof finish. [Pr_65_65_25]

4.4.10.12 Ductwork including fresh air intake, supply air and extract air and external louvres shall be thermally insulated where necessary for energy efficiency and to avoid cold bridging. Where required, exhaust air from the air handling plant shall be exempt from

thermal insulation but shall be insulated for acoustic reasons if required to achieve acoustic performance. [PM_10_20_82]

4.4.11. Dampers

4.4.11.1 The following requirements shall be met for any ductwork provided.

a) Volume Control Dampers (VCDs) are installed to allow the ductwork to be balanced and commissioned. VCDs are installed such that they do not cause unnecessary noise break outs within the system. [Pr_65_65_24_95]

b) Fire dampers are provided where the ductwork passes through a fire rated wall or floor. The design and type of fire damper is in line with that specified in the Fire Strategy and at a minimum, each fire damper is rated to match the fire rating of the wall or floor it penetrates. [Pr_65_65_24_30]

c) Smoke dampers are provided in line with the School Fire Strategy. [Pr_65_65_24_80]

d) Where VCDs and fire dampers are provided, they are mounted in a position that is identified and accessible for maintenance and inspection. [PM_80_10_50]

e) Maintenance, inspection and testing requirements for fire and smoke dampers are included in draft Fire Safety Management Plan and Operation and Maintenance (O&M) Manuals. [PM_10_20_82]

4.4.12. Ventilation of Plant Rooms

4.4.12.1 Any plant rooms shall have adequate ventilation for all services and any occupants. This shall typically be provided through the use of natural ventilation louvres. [Ss_65_40_33_56]

4.4.12.2 Any electrical switch rooms shall be naturally ventilated and provided with background heating to maintain a minimum temperature in line with the switch panel manufacturer's requirements, in order to prevent condensation and to provide building fabric frost protection. [Ss_65_40_33_56]

4.4.12.3 Ventilation openings shall not be oversized and shall be provided with means to prevent entry of debris, birds and vermin. [Ss_65_40_33_56]

4.4.13. Natural Ventilation Units

4.4.13.1 Natural ventilation may be provided by the following means or through an alternative as long as full justification is provided and agreed to by the Employer.

a) Openable windows (actuated or manual). [Ss_65_40_33_56]

b) Louvers with dampers (actuated or manual). [Ss_65_40_33_56]

c) Roof mounted units that utilise the stack and wind effect (may be fan assisted). [Ss_65_40_33_60]

4.4.13.2 Any openable windows and vents provided shall be designed to avoid inhibiting the effective use of the blinds. [Ss_65_40_33_56]

4.4.13.3 The building geometry shall be designed to allow cross ventilation or stack effect ventilation. [Ss_65_40_33_56]

4.4.13.4 Attenuation of natural ventilation shall be provided where necessary to meet BB93 indoor ambient noise levels where external noise levels are high. [PM_35_60]

4.4.13.5 Restrictors shall be installed on all windows to prevent falls in line with Technical Annex 2C. [Pr_30_36_59_98]

4.4.13.6 Secure louvres or openings shall be provided for night cooling where an exposed soffit has been used as part of the thermal strategy. [PM_35_20_90]

4.4.13.7 Any openable roof lights or roof vents shall be designed for ease of use by the School staff. [Ss_30_30_73]

4.4.13.8 If openable roof lights or roof vents are automatically operated, they shall be provided with a rain sensor override, and/or provided with wall mounted, key operated override controls for use by School staff. The controls shall not be accessible by students. [Ss_30_30_73]

4.4.14. Fans

4.4.14.1 Where a mechanical or mixed-mode system is installed, the options to provide ventilation through fans include:

a) Fan assisted natural ventilation (either through a facade, atrium system or roof). [Ss_65_40_33_56]

b) Local ventilation supply and/or extract fans. [Ss_65_40_33_48]

c) Specialist Local Exhaust Ventilation. [Ss_65_40]

d) Anti-stratification fans. [Ss_65_40]

4.4.14.2 Any fans provided shall be energy efficient and shall comply with AD L. [PM_10_20_90]

4.4.14.3 Any fans mounted at high level shall be readily accessible for installation, maintenance, and removal. [PM_80_10_50]

4.4.15. Air Handling Units

4.4.15.1 Centralised mechanical ventilation shall be provided through one or more Air Handling Units (AHUs). [Pr_60_65_03]

4.4.15.2 AHUs shall include filters, variable speed fans, acoustic insulation and attenuators as necessary to meet BB93 noise levels. [PM_35_60]

4.4.15.3 The correct level of filtration shall be provided in line with Regulations including AD F, BS EN and ISO Standards and local planning requirements. [PM_10_20_90]

4.4.15.4 The AHU shall include remote filter status indication. See Technical Annex 2I. [PM_10_20_90]

4.4.15.5 Where an AHU provides mechanical supply and extraction it shall contain heat recovery, except when used for kitchens, toilets and food tech areas. [Pr_60_65_03]

4.4.15.6 Heat recovery can either be achieved through cross flow, plate heat exchanger or thermal wheel. [Pr_60_60_36]

4.4.15.7 An appropriate AHU shall be selected based on energy efficiency and space requirements. [Pr_60_65_03]

4.4.15.8 AHU requirements from BS EN 1886 shall be equal or better than:

a) Leakage Class D1(M). [Pr_60_65_03]

b) Mechanical Strength L2. [Pr_60_65_03]

c) Thermal Transmittance Class T3. [Pr_60_65_03]

d) Thermal Bridging Class TB3. [Pr_60_65_03]

4.4.15.9 Any Air Handling Units (AHU) used in centralised systems shall be located in plant rooms rather than externally mounted on roof areas, wherever possible. [Pr_60_65_03]

4.4.15.10 Where externally mounted air handling units are used, they shall be fully weatherproof units, external grade, with:

a) polyester coated galvanised steel construction [Pr_60_65_03]

b) a rigid weatherproof sloping roof [Pr_60_65_03]

c) a gutter profile allowing clear drainage [Pr_60_65_03]

d) all sections fully sealed to prevent the ingress of water through any panels [Pr_60_65_03]

e) air intake grilles with vertical labyrinth-shaped vanes that prevent snow and rain from entering the unit with the air [Pr_60_65_03]

f) outlet openings equipped with a cowl and a protective screen [Pr_60_65_03]

g) an integral plinth mounting [Pr_60_65_03]

h) a suitable fixing method appropriate to the roof structure employed and preventing water penetration of the roof. [Pr_60_65_03]

4.4.15.11 Designated walkways across the roof for access and maintenance shall be provided with the provision of electric lighting to allow safe access. [PM_80_10_50]

4.4.16. Location of Ventilation Air Intakes and Exhausts

4.4.16.1 Any exhausts or intakes provided shall be adequately separated when exhaust air is contaminated or polluted e.g., exhausts from kitchens, toilets and fume cupboards. [Ss_65_40]

4.4.16.2 In accordance with DW/172, kitchen extract discharge points shall be positioned such that the extracted air cannot be entrained into a supply system. [Ss_65_40_33_45]

4.4.16.3 Kitchen extract ductwork shall discharge at least 1.0m above any openable window or any ventilation inlet or opening. [Ss_65_40_33_45]

4.4.16.4 Flues shall be high enough above any roof to ensure that the fumes are discharged clear of any roof recirculation zones and cannot re-enter the Building or adjoining buildings. See Building Bulletin 101: ‘Guidelines on ventilation, thermal comfort and indoor air quality in schools’ (BB101). [PM_10_20_90]

4.4.16.5 For any hazardous fume exhaust systems provided, the methods described in Section 7.7.9: Fume Cupboard Exhausts shall be used to determine height and location of fume cupboard exhausts. [PM_10_20_90]

4.4.16.6 Where stack heights are limited (e.g., by planning constraints), it may be necessary to increase the plume height by increasing the efflux velocity. [Ss_65_40]

4.4.16.7 Fire dampers shall not be installed in exhaust discharge ductwork from fume cupboards, other fume exhaust systems or kitchen exhaust systems. [PM_10_20_82]

4.4.17. Air Terminal Devices

4.4.17.1 Grilles and louvres shall comply with Technical Annex 2C and Technical Annex 2D. [PM_10_20_90]

4.4.17.2 Supply air grilles and louvres shall be selected to provide even air distribution in the room and to avoid excessive temperature differences and air velocities, in accordance with Section 10.4: Local Thermal Discomfort Caused by Draughts. [Pr_70_65_04_03]

4.4.17.3 External louvres shall be coordinated with the details of external walls and windows to allow access for maintenance and adequate drainage of rainwater. [PM_10_20_82]

4.4.18. Testing of Dampers and Weather Louvres

4.4.18.1 Air leakage and thermal performance of any dampers provided shall be tested in accordance with BS EN 1751: 2014 or BS EN 1026: 2000. [PM_10_20_90]

4.4.18.2 For practical reasons where large dampers are concerned, the requirement in BS EN 1751 for the face area of the test chamber to be 7 times that of the damper may be ignored. [PM_10_20_90]

4.4.18.3 External grilles and weather louvres shall be provided to the appropriate weather and airflow ratings to prevent rain penetration as defined by BS 13030: 2001. [PM_10_20_90]

4.4.19. Reference Standards

4.4.19.1 The design and installation of any ventilation systems provided shall comply with the relevant parts of the following standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) CIBSE Guide B - ‘Heating, Ventilation, Air Conditioning and Refrigeration’. [FI_70]

b) ASHRAE 62.1:2013 - ‘The Standards for Ventilation and Indoor Air Quality’. [FI_70_85]

c) Non-Domestic Building Services Compliance Guide’ from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/453973/non_domestic_building_services_compliance_guide.pdf. [FI_70]

d) Building Bulletin: BB101: ‘Guidelines on ventilation, thermal comfort and indoor air quality in schools. Note: Technical Annex 2F includes all the requirements from Building Bulletin 101 - ‘Guidelines on ventilation, thermal comfort and indoor air quality in schools’. Where there is a discrepancy between Technical Annex 2F and BB101, Technical Annex 2F shall take precedence. [FI_70]

e) BESA DW144 - ‘Specification for Sheet Metal Ductwork DW/144’ 2013. [FI_70_85]

f) BESA TR/19 - ‘Guide to good practice. Internal cleanliness of ventilation systems. 2nd edition’. [FI_70]

g) BS 6583:1985 ‘Methods for volumetric testing for rating of fan sections in central station air handling units (including guidance on rating)’. [FI_70_85]

h) BS EN 1751:2014 Ventilation for buildings. Air terminal devices. Aerodynamic testing of damper and valves. BS EN 1026: 2000 Windows and Doors – Air permeability - Test method. [FI_70_85]

i) BS EN 13030, 2001, Ventilation for buildings. Terminal. Performance testing of louvres subjected to simulated rain. [FI_70_85]

j) http://www.hse.gov.uk/radiation/ionising/Radon.htm#legalrequirements. [FI_70_72]

k) See BRE report BR211, ‘Radon: Guidance on protective measures for new buildings’ and BRE report FB 41 ‘Radon in the workplace: A guide for building owners and managers: Second Edition’. [FI_70]

5. Ventilation of General Teaching Spaces and Learning Resource Areas

5.1. Overview

5.1.1 The following performance standards for teaching and learning spaces shall apply to the ventilation of any spaces. [PM_35_70_94]

5.1.2 In General Teaching Spaces and learning resource areas where mechanical ventilation is used or when hybrid systems are operating in mechanical mode, sufficient outdoor air shall be provided to achieve a daily average concentration of carbon dioxide during the occupied period of less than 1000 ppm and so that the maximum concentration does not exceed 1500 ppm for more than 20 consecutive minutes each day, when the number of room occupants is equal to, or less than the design occupancy. [PM_35_70_94]

5.1.3 In General Teaching Spaces and learning resource areas where natural ventilation is used or when hybrid systems are operating in natural mode, sufficient outdoor air shall be provided to achieve a daily average concentration of carbon dioxide during the occupied period of less than 1500 ppm and so that the maximum concentration does not exceed 2000 ppm for more than 20 consecutive minutes each day, when the number of room occupants is equal to, or less than the design occupancy. In addition, in New Buildings, the system shall be designed to achieve a carbon dioxide level of less than 1200 ppm (800ppm above the outside carbon dioxide level, taken as 400ppm) for the majority of the occupied time during the year. This level can be increased to 1750ppm in the case of Refurbished Buildings. [PM_35_70_94]

5.1.4 Except as described in Section 9: Gas Services, ventilation shall be provided to limit the concentration of carbon dioxide in all Teaching Spaces and learning resource areas to the levels in paragraphs 5.2 and 5.3 measured at seating height. [PM_35_70_94]

5.1.5 The design of ventilation openings to deliver these carbon dioxide (CO_2) levels shall be based on the maximum number of occupants the space is designed to accommodate. [PM_35_70_94]

5.1.6 These performance standards are based on the need to control carbon dioxide resulting from the respiration of occupants. [PM_35_70_94]

5.1.7 In General Teaching Spaces and learning resource areas, in the absence of any other major pollutants, carbon dioxide is taken to be the key indicator of ventilation performance for the control of indoor air quality. [PM_35_70_94]

5.1.8 In Practical Spaces, such as science, Design and Technology and food, higher rates are required during Practical Teaching activities. [PM_35_70_94]

5.1.9 In these Practical Spaces, higher levels of CO_2 are acceptable for the periods of time when Bunsen burners, cookers and other gas-fired appliances are in use. CO_2 levels in science spaces shall be in accordance with gas safety requirements given in Section 9. [PM_35_70_94]

5.1.10 When Practical Spaces are used as conventional classrooms, they need to provide ventilation for teaching and learning activities as described in paragraphs 5.3 and 5.4. [PM_35_70_94]

5.1.11 Additional ventilation shall also be provided in Practical Spaces for practical activities to prevent the build-up of unwanted pollutants, where identified in Section 6: Ventilation for Particular Areas and Activities. [PM_35_70_94]

5.1.12 Local Exhaust Ventilation (LEV) shall be provided in science laboratories and science studios, design technology studios, workshops and prep rooms and in any art or other Practical Spaces where specific processes or pollutant sources are to be accommodated, such as dust or fumes which pose a risk to the health and safety of users or affect their comfort, subject to risk assessments carried out under the 'Control of Substances Hazardous to Health (COSHH) Regulations' 2002. [Ss_65_40_33_48]

5.1.13 In General Teaching Spaces and learning resource areas, in extreme hot weather conditions, it shall be possible to boost the fan speed of a ventilation unit for short periods, (under local teacher control), unless there is a means of cross ventilation of the space, not including the opening of doors. In addition to these measures, ceiling or wall-mounted fans which are under local teacher control may be supplied. [PM_35_70_94]

5.1.14 The noise level from the boosted ventilation, ceiling or wall mounted fans should not exceed an IANL of 45 dBA, LAeq. [PM_35_60]

5.2. Reference Standards

5.2.1 The ventilation of general teaching spaces and learning resource areas shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) See CLEAPSS Model Risk Assessments and CLEAPSS Guide G225 Local Exhaust Ventilation in D&T. [FI_70]

b) Health and Safety Executive, Control of Substance Hazardous to Health (COSHH) Regulations 2002. www.hse.gov.uk/coshh [FI_70_72]

6. Ventilation for Particular Areas and Activities

6.1. General

6.1.1 This section gives the design requirements for particular areas and activities additional to those described in Section 5: Ventilation of General Teaching Spaces and Learning Resource Areas. [PM_35_70_94]

6.2. Office Accommodation

6.2.1 The ventilation of any offices and staff workrooms shall be in accordance with AD F which in the absence of excessive pollutants, requires the total outdoor supply rate to be 10 l/s/person. [PM_10_20_90]

6.2.2 The outdoor air-supply rate is based on controlling body odours and typical levels of other indoor-generated pollutants. [PM_35_70_94]

6.2.3 Local extract may be required as described in Section 6.3: Local Extract Ventilation. [Ss_65_40_33_48]

6.3. Local Extract Ventilation

6.3.1 This section gives the requirements for local extract ventilation e.g., from toilets, washrooms, photocopiers and printers. [Ss_65_40_33_48]

Room	Local extract
Rooms containing printers and photocopiers in substantial use (greater than 30 minutes per hour).	Air extract rate of 20 l/s per machine during use is required to eliminate pollutants. Air must be exhausted outside the Building. If located in a separate room the room must be ventilated at the rate of 10 l/s/person when occupied as for an office. These rates are those given in AD F. Cooling is required to larger reprographics machinery often found in schools (e.g., with heat loads of around 2kW in use) where its use is intensive and located in a small room. This is due

	to the high heat loads produced which cannot be dealt with by extract ventilation. Photocopiers are often fitted with active carbon filters which limit ozone emissions. Some of these are sealed for life and others require maintenance. Information about the maintenance of photocopiers can be found in Local Authority Circular: LAC 90/2.
Sanitary accommodation including toilets, hygiene rooms and changing rooms.	6 l/s per shower head/bath; 6 l/s per WC/urinal. These rates are those given in AD F. Individual facilities can use intermittent air extract but combined facilities opening off circulation areas shall have continuous extract with a peak rate of at least 6 l/s/appliance; a reduced continuous background rate of 4 l/s/appliance can be used where there is occupancy sensor control for the higher peak rate.
Cleaners' stores.	Extract ventilation shall be provided to cleaners' stores where there are sinks or where cleaning chemicals are stored. This can be added onto nearby toilet extract systems.
Food and beverage preparation areas in kitchenettes (not commercial kitchens or food rooms).	Intermittent air extract rate of 15 l/s when microwave and beverage machines are operating while food and beverage preparation is in progress. This rate is given in AD F. This is only required when located in individual rooms, not in larger open plan office or circulation spaces. IGEM/UP/11 guidance on gas safety should be consulted in preference to AD F for extract rates for gas cookers. IGEM/UP/11 requires a minimum extract rate of 42 l/s (150cfm) per Type A Cooker.

	See Section 9 on gas services and gas safety regulations.
Practical Spaces, school kitchens, fitness rooms.	See Section 7.6 on Practical Spaces for requirements for Local Exhaust Ventilation (LEV). LEV includes fume cupboards and local exhaust hood type vent systems that remove pollutants at source.

Table 6-1 Recommended minimum local extract ventilation rates

6.3.2 Extract ventilation shall be taken outside and provided with appropriate time and occupancy controls. [PM_35_70_94]

6.3.1. Reference Standards

6.3.3 Local extract ventilation systems shall comply with the relevant parts of the standard as listed below, and any updated version of this standard. [PM_10_20_90]

a) HSE (2000) Local Authority Circular 90/2 [FI_70]

6.4. Ventilation of Large and Circulation Spaces

6.4.1. Large Spaces

6.4.1.1 This section is intended to supplement BB101 and provides a minimum specification for the design and installation of the ventilation and associated systems in large spaces. [PM_10_20_90]

6.4.1.2 The general requirements for the ventilation of large spaces within schools shall be to:

a) remove contamination from the air [PM_35_70_94]

b) provide outdoor air for respiration [PM_35_70_94]

c) provide a method of limiting temperature increase [PM_35_70_94]

6.4.1.3 This section shall apply to:

a) Sports halls, activity studios and assembly halls [PM_10]

b) Atria, circulation spaces and corridors [PM_10]

c) Indoor dining rooms [PM_10]

6.4.2. Sports Halls and Assembly Halls

6.4.2.1 Secondary Schools use their sports halls for a range of sporting activities as well as exams. [PM_10]

6.4.2.2 The environmental conditions shall allow for exam use. [PM_35_70_94]

6.4.2.3 Table 6-2 provides a summary of the environmental criteria for the design of sports halls. [PM_35_70_94]

Type of Hall	Normal maintained operative temperatures in the heating season (°C)	Summertime temperatures
Sports (General)	17	Overheating Risk Assessment (ORA) (See Section 10.4) to Category III for sports use.
Examination	20	ORA to category II for the examination occupancy profile (See Table 10-5).

Table 6-2 Design parameters for sports halls / Summary of environmental standards for sports halls

6.4.2.4 For the majority of the time, there may only be one or two class groups in many halls e.g., 30 to 60 students using the space where much less outdoor air is needed to minimise CO_2 levels. The CO_2 levels for General Teaching and learning spaces given in Section 5: Ventilation of Teaching and Learning Spaces also apply to sports halls. [PM_35_70_94]

6.4.2.5 The examination period, for the purpose of the Overheating Risk Assessment, for new Secondary School assembly halls and sports halls (both used for exams) shall be taken as weekdays 09:00 to 16:00 from 1st May to 8th July, with a lunch break as described in Section 10.5. The overheating assessment and dynamic thermal modelling shall use a reasonable occupancy profile to ensure that ventilation systems are sized correctly. [PM_35_70_94]

6.4.2.6 Noise levels are important during examinations and some heating and ventilation systems are too noisy e.g., gas fired radiant heating with the burner in the space. Radiant heating can be used effectively in sports halls, but radiant temperature asymmetry (RTA) shall be considered as part of the overall design strategy, in accordance with Section 4.3: Heating Systems. [PM_10_20_82]

6.4.3. Circulation Spaces, including Atria and Corridors

6.4.3.1 If these spaces are insufficiently ventilated or overheat it can affect the whole ambience of the School and uncomfortable conditions can also spill into the other teaching areas. See further guidance on design of these spaces given in BB101. [PM_10_20_90]

6.4.3.2 This section applies to circulation areas that are typically classified as unoccupied spaces. [PM_10]

6.4.3.3 Where these spaces include break out and group spaces these should be ventilated for teaching and learning activities as described in paragraphs 5.1.2 and 5.1.3. [PM_35_70_94]

6.4.3.4 Corridors shall be ventilated. This can be provided by opening windows or vents. [PM_40_20_94]

6.4.3.5 The cold draught criteria in Section 10.4 ‘Local Thermal Discomfort Caused by Draughts’ do not apply to corridor areas where the windows or vents are under local or manual control. [PM_10_20_90]

6.4.3.6 Corridors shall not overheat in schools. Overheating usually occurs because they are landlocked and have very low ventilation rates so either this should be avoided, or adequate ventilation should be provided. [PM_40_20_94]

6.4.3.7 Overhead heating and hot water pipework shall be well insulated to avoid the overheating of corridor spaces. [PM_10_20_82]

6.4.3.8 Adequate ventilation and/or solar shading shall be provided to prevent overheating due to solar gain from glazing. [PM_40_20_94]

6.4.3.9 Heat gain into staircases shall be considered. Stair cores shall be ventilated where there are high heat gains. [PM_40_20_94]

6.4.4. Dining Areas

6.4.4.1 The smell of food from dining areas can be a nuisance. The transfer of air from dining areas to the other parts of the School shall be avoided. This can be a challenge when atria containing food areas are linked to large areas of the School. The main dining areas and the school kitchen shall be under negative pressure. It is often possible to extract from dining areas through the kitchen. The requirements for acoustic separation between the kitchen and dining area when used for other activities during the day, for example, in a multi-purpose hall shall be met. [PM_35_70_94]

7. Specialist Ventilation Systems

7.1. General

7.1.1 The following sections detail the technical requirements for a number of specialist ventilation systems within schools, for both New Buildings and Refurbished Buildings. [PM_35_70_94]

7.2. School Kitchen Ventilation

7.2.1. General Requirements

7.2.1.1 The kitchen ventilation system shall be designed in accordance with DW/172. [PM_10_20_90]

7.2.1.2 Flue heights and efflux velocities and odour control shall be either in accordance with DW/172 or the local planning requirements for commercial kitchens. [PM_10_20_90]

7.2.1.3 Maximum internal ambient noise levels shall be in accordance with BB93 50 dB $L_{Aeq,\ 30\ mins}$ for new build and 55 dB $L_{Aeq,\ 30mins}$ for refurbishment or remodelling. [PM_10_20_90]

7.2.1.4 The method set out in DW/172 shall be used for calculating the required extract airflow rate for the kitchen canopy or for a ventilated ceiling. [PM_10_20_90]

7.2.1.5 Dedicated supply make-up air systems shall be designed at 85% of the extract flow rate and leakage paths need to be properly managed. [PM_35_70_94]

7.2.1.6 The method set out in BS 6173 shall be used in order to calculate the required ventilation to support combustion for gas appliances. [PM_10_20_90]

7.2.1.7 The following requirements shall be met.

a) Sufficient ventilation shall be provided in order to safeguard against the possibility of incomplete combustion. [PM_35_70_94]

b) An interlock shall be provided between gas supply and mechanical ventilation to ensure that gas is not supplied when an inadequate airflow rate is provided. This is for safe operation of appliances and the safety of personnel. [PM_10_20_82]

c) The system shall be fully compliant with the requirements set out in in IGEM/UP/11 ‘Gas Installations for Educational Establishments’, IGEM/UP/19 and the requirements for gas services set out in Section 9. [PM_10_20_90]

d) The system shall not cause discomfort to the occupants via draughts. The incoming supply air shall be pre-heated and distributed within the Kitchen area in accordance with DW/172. [PM_10_20_90]

e) The discharge from the exhaust of the system shall be appropriately positioned. [PM_35_70_94]

f) The discharge from the exhaust of the system shall not cause discoloration or damage to any part of the building structure or any noise or odour problem to neighbouring rooms or properties. [PM_35_70_94]

g) Maintenance and cleaning schedules shall be included in O&M Manuals and a kitchen user guide shall be produced as part of the Building Users Guide. The requirements for O&M Manuals and a Building User Guide are set out in the DfE's EIR. [PM_10_20_28]

7.2.1.8 HSE Catering Information Sheet 23 details the risk assessment process that shall be applied by the Contactor for refurbishment and upgrading of installations that do not meet the requirements for new installations. [PM_10_20_90]

7.2.2. Grease Filters and Odour Control

7.2.2.1 Grease extracted by the ventilation system shall be collected and removed so that it does not accumulate in either the canopy or the ductwork system. Removable baffle type grease filters shall be installed to be accessible for cleaning and maintenance. [Pr_65_57_02_11]

7.2.2.2 DW/172 and Defra guidance summarise the available odour control, filtration, and noise control technologies. [PM_10_20_90]

7.2.2.3 The priority shall be to provide simple technologies that are easily maintained by the School and to provide adequate efflux velocity and flue height to provide good dispersal rather than to employ expensive odour control and filtration systems with a lower flue height and efflux velocity. [PM_35_70_94]

7.2.2.4 The flue shall terminate at least 1m above the roof or any air inlet at an efflux velocity of at least 10m/s as recommended in DW/172. [PM_10_20_90]

7.2.2.5 For requirements for gas services including interlocks and carbon dioxide detectors; See Section 9. [PM_10_20_90]

7.2.3. Reference Standards

7.2.3.1 Kitchen ventilation systems and associated systems shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) Building Bulletin 101 – ‘Guidelines on ventilation, thermal comfort and indoor air quality in schools’ (BB101). Note: where there is discrepancy between Technical Annex 2F and BB101, Technical Annex 2F shall take precedence. [FI_70]

b) DW/172 – ‘Specification for Kitchen Ventilation Systems’. [FI_70_85]

c) DW/144 – ‘Specification for Sheet Metal Ductwork’. [FI_70_85]

d) HSE Catering Information Sheet No 10 – ‘Ventilation in catering kitchens’. [FI_70]

e) HSE Catering Information Sheet No 23 – ‘Gas safety in catering and hospitality. [FI_70]

f) IGEM/UP/11 – ‘Gas installations for educational establishments’. [FI_70_85]

g) CIBSE TM 42 – ‘Fan Application Guide’. [FI_70]

h) BS EN 16282-2 – ‘Equipment for commercial kitchens - Components for ventilation of commercial kitchens - Part 2: Kitchen ventilation hoods; design and safety requirements’. [FI_70_85]

i) BS EN 16282-3 – ‘Equipment for commercial kitchens - Components for ventilation in commercial kitchens - Part 3: Kitchen ventilation ceilings; Design and safety requirements’. [FI_70_85]

j) Guidance on the Control of Odour and Noise from Commercial Kitchen Exhaust Systems, DEFRA, 2005. [FI_70]

7.3. Food Room Ventilation

7.3.1. Design Criteria

7.3.1.1 The following section provides a minimum specification for the design and installation of the ventilation and associated systems in any food rooms for Secondary pupils. [PM_35_70_94]

7.3.1.2 There shall be a door between the food room and any linked space such as a food preparation room to prevent contamination from dust. [PM_10_20_82]

7.3.1.3 Exhaust ventilation rates shall be calculated taking account of room size and usage. [PM_35_70_94]

7.3.1.4 During normal cooking activities, noise generated by extraction systems shall not be loud enough to prevent the students from hearing the teacher and vice versa. [PM_35_70_94]

7.3.1.5 Noise generated by extraction systems shall be kept below 50 dB or (10 dB above the maximum Indoor Ambient Noise Level of 40 dBA required by BB93) in accordance with Section 2.12.2 of the IoA/ANC ‘Acoustics of Schools: a design guide’, 2015. [PM_10_20_90]

7.3.1.6 Where this is not possible, higher noise levels of up to 55 dBA shall only be acceptable where the teaching staff have control over the ventilation system and can switch it off locally as required for teaching. [PM_35_60]

7.3.1.7 Noise levels during normal teaching and practical activities shall comply with Section 1.1.3 of BB93. [PM_10_20_90]

7.3.1.8 IoA/ANC ‘Acoustics of Schools: a design guide’, 2015 gives guidance on the higher noise levels allowed during process related Local Exhaust Ventilation, such as from cooker fume extract systems. [PM_10_20_90]

7.3.1.9 The room shall be kept under a negative pressure during cooking activities. [PM_35_70_94]

7.3.1.10 Displacement ventilation systems which extract the hot air from high level and supply cooler tempered air at low level help to remove heat gains from the occupied zone and limit the ventilation rates required during cooking activities. The ventilation rate in Section 7.3.1.11 may be reduced where displacement ventilation of high effectiveness is used, and a lower rate is shown to be adequate. [PM_35_70_94]

7.3.1.11 For ventilation of domestic cookers in food rooms where there are up to 13 cookers in the space, there shall be minimum supply and extract of 42 l/s (150m³/hr) of air per appliance, in accordance with IGEM/UP/11. [PM_10_20_90]

7.3.1.12 Exhaust ventilation may be in the form of individual extraction hoods. [Pr_60_65_94_46]

7.3.1.13 Individual extraction hoods should not obstruct student sightlines to the whiteboard. [PM_10_20_82]

7.3.1.14 Where separate canopies are used above individual appliances, they shall be designed to have a flow rate exceeding 42 l/s (150m³/hr). This figure is inclusive of the 8 l/s required for CO_2 control. [Pr_60_65_94_45]

7.3.1.15 In these spaces the assumption is that gas hobs shall not be used at the same time at their full rate and shall only be used by pupils for periods of less than one and a half hours at a time. [PM_10]

7.3.1.16 Mechanical ventilation systems shall be interlocked with the gas supply in accordance with IGEM/UP/11 and IGEM/UP/19. See Section 9: Gas Services. [PM_10_20_90]

7.3.1.17 Opening windows shall be provided with fly guards to prevent insect contamination unless there is mechanical ventilation providing filtered supply air. Fly guards are required where a ventilation system relies on natural ventilation openings at all times. In this case, the resistance to airflow of the fly guards shall be taken into account in

calculations of effective areas of openings. See Section 11.3 on calculation of effective areas of ventilation openings. [PM_40_20_94]

7.3.1.18 Where refrigerators or freezers are installed in confined spaces such as store rooms, ventilation shall be sufficient to maintain temperatures in accordance with manufacturers recommended ambient temperatures for the siting of the equipment. [PM_35_70_94]

7.3.1.19 Heat recovery on supply and extract systems may be provided to minimise heat losses associated with high ventilation rates when cooker hoods are running. [PM_40_20_94]

7.3.1.20 General room extract systems need to be positioned to avoid excessive build-up of grease with provision made for easy replacement/cleaning of filters. [PM_40_20_94]

7.3.1.21 Whilst cookers/hobs are not in operation, the ventilation standards shall be the same as a General Teaching space; see Section 5. However, during cooking, the levels of CO_2 given in paragraph 9.3.3 shall be achieved. [PM_35_70_94]

7.3.1.22 The ventilation system shall not cause discomfort to the occupants via draughts. [PM_35_70_94]

7.3.1.23 The incoming supply air shall be pre-heated and distributed within the space as per the guidance set out in DW/172. [PM_10_20_90]

7.3.1.24 The discharge from the exhaust shall not cause discoloration or damage to any part of the building fabric. [PM_35_70_94]

7.3.2. Gas Interlocks

7.3.2.1 An interlock is required between gas supply and mechanical ventilation to ensure that gas is not supplied when there is an inadequate airflow. This is to ensure the safe operation of appliances and the safety of personnel. [PM_10_20_82]

7.3.2.2 Where there are only Type A appliances i.e., there are no flued gas appliances such as deep fat fryers interlocking may be achieved by environmental monitoring of carbon dioxide as described in IGEM/UP/19, BS 6173, and Section 9.3. [PM_10_20_90]

7.3.2.3 For requirements for gas services including interlocks and carbon dioxide detectors see Section 9. [PM_10_20_90]

7.3.2.4 HSE Catering Information Sheet 23 details the risk assessment process that shall be applied for refurbishment and upgrading of installations that do not meet the requirements for new installations. [PM_10_20_90]

7.3.3. Reference Standards

7.3.3.1 The design and installation of the food technology room ventilation system and associated systems shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards: [PM_10_20_90]

a) DW/172 – 'Specification for Kitchen Ventilation Systems'. [FI_70_85]

b) DW/144 – 'Specification for Sheet Metal Ductwork'. [FI_70_85]

c) BB101 – 'Ventilation, thermal comfort and indoor air quality in schools'. Note Technical Annex 2F includes all the requirements from Building Bulletin 101 'Guidelines on ventilation, thermal comfort and indoor air quality in schools'. Where there is a discrepancy between Technical Annex 2F and BB101, Technical Annex 2F shall take precedence. [FI_70]

d) HSE Catering Information Sheet 23 – 'Gas safety in catering and hospitality' [FI_70]

7.4. ICT Server Room Ventilation

7.4.1. Overview

7.4.1.1 The following section is a minimum specification for the design and installation of the ventilation and associated systems in any server room or hub room for Information and Communications Technology (ICT). [PM_35_70_94]

7.4.1.2 See Section 4 of the GDB for ICT system requirements. See Technical Annex 2J for low energy and passive cooling approaches to be considered for new servers. [PM_10_20_90]

7.4.2. General Requirements

7.4.2.1 Typical server rooms can produce high-density heat loads which can affect ICT equipment. The environmental conditions shall be maintained in line with the manufacturer's recommendations for the equipment to be housed within, or any respective warranty requirements. [PM_35_70_94]

7.4.2.2 Security of ventilation openings in the façade shall comply with the GDB. [PM_10_20_90]

7.4.3. Ventilation Systems, Air Flow Rates and Heat Loads

7.4.3.1 The type of ventilation system required and the strategy to cool the server room is dependent on the heat loads generated by the equipment. [PM_40_20_94]

7.4.3.2 Server and Hub Rooms shall be provided with filtration to prevent dust ingress. [PM_35_70_94]

7.4.3.3 Server room cooling units shall be sized on the sensible heat loads provided by the manufacturers of the equipment to be installed allowing for diversity or the actual measured power consumption of the equipment. An additional load of 10% should be included for future expansion. [PM_35_70_05]

7.4.3.4 DX or VRF cooling shall be provided to meet the temperatures specified in equipment warranties in peak summertime periods. [PM_35_70_05]

7.4.3.5 The normal operating range (set point) shall be designed to meet manufacturers' recommended requirements. Temperatures may not exceed this range for more than 200 hours a year. The maximum temperature of the room measured at high level above the server racks shall not exceed 28°C. The minimum temperature of the supply air shall be 15°C. [PM_35_70_05]

7.4.3.6 The ventilation and cooling requirements shall be minimised. A ventilation opening to the outside or locally controlled ventilation shall be provided to allow for occupancy and battery failure. [PM_40_20_94]

7.4.3.7 Air conditioning units shall be positioned for easy maintenance and units and their pipework shall not be located above equipment cabinets in case of leakage. [PM_35_70_05]

7.4.3.8 The condensate from air conditioning units shall be taken by gravity to the nearest drain outside the room. [PM_35_70_05]

7.4.3.9 The design shall demonstrate how the position of the environmental control systems supports the cooling strategy of the server cabinets. [PM_40_20_38]

7.4.3.10 Server room power supplies shall be provided with sub-meters. See Technical Annex 2H. [PM_10_20_90]

7.5. Local Exhaust Ventilation in DT studios, workshops and DT prep rooms

7.5.1. Overview

7.5.1.1 This section includes the requirements for the design and installation of the ventilation and associated systems in workshops including fumes from heat bays and wood dust extract where provided. [PM_35_70_94]

7.5.1.2 Ventilation for DT studios, workshops and DT prep rooms shall provide controllable systems designed for dust and fumes that may be produced. [PM_35_70_94]

7.5.1.3 This section includes requirements for varying needs depending on the equipment present:

a) Wood dust extract systems [Ss_65_40_42_25]

b) Hot metal and foundry ventilation systems [Ss_65_40_42_36]

c) Laser cutting and 3D printing fume extraction systems. [Ss_65_40_32]

7.5.2. Design Criteria

7.5.2.1 The three major concerns for DT studios, workshops and prep rooms are dust, fume, and heat extraction. These pollutants can be present simultaneously. [PM_10]

7.5.2.2 Design, installation and maintenance requirements for D&T rooms shall comply with BS 4163: Health and safety for Design and Technology in educational and similar establishments. [PM_10_20_90]

7.5.2.3 A requirement for DT studios, workshops and prep rooms is to have a centralised airflow rate or the sum of the local extract flow rates of 2.5 l/s/m^2 when practical activities occur. This rate may be made up from the room's ventilation unit, the LEV or both. The LEV ventilation shall be locally controllable by staff. This area-based ventilation rate in l/s/m^2 applies to spaces of 2.7m in height or higher. The equivalent air change rate per hour (ach) can be calculated from ach = (l/s/m^2 rate) x 3.6/(Room height (m)). For spaces below 2.7m in height, the equivalent air change rate to a 2.7m high space shall be used. [PM_35_70_94]

7.5.2.4 Noise generated by extraction systems should not be loud enough to prevent the normal teacher's voice from being heard by students, or the students' voice being heard by the teacher. [PM_35_60]

7.5.2.5 It shall be kept below 50 dB or (10 dB above the maximum Indoor Ambient Noise Level of 40 dBA) in accordance with Section 2.21.2 of the IoA/ANC 'Acoustics of Schools: a design guide', 2015. [PM_10_20_90]

7.5.2.6 Higher noise levels of up to 55 dBA shall only be acceptable for LEV systems where the School staff have control over the ventilation system, and it can be switched off locally as required for teaching. This applies to all special school teaching spaces except where an acoustician advises against this, justified by the anticipated hearing needs of the pupils (e.g., in schools with a high percentage of pupils with hearing impairments). [PM_35_60]

7.5.2.7 Noise levels during normal teaching and practical activities shall comply with Section 1.1.3 of BB93. [PM_10_20_90]

7.5.2.8 It is a requirement to achieve the minimum exhaust rates given in Section 7.5.2.3 within the noise levels given in BB93. [PM_10_20_90]

7.5.2.9 In accordance with Section 5.1.14, the noise level from boosted ventilation, ceiling or wall mounted fans, provided for the hottest 200 hours of the year, shall not exceed an IANL of 45 dBA, LAeq. [PM_35_60]

7.5.2.10 Section 1.1.3. IoA/ANC ‘Acoustics of Schools: a design guide’, 2015 gives guidance on assessing and limiting the higher noise levels allowed during process related Local Exhaust Ventilation such as use of fume or dust extract. [PM_10_20_90]

7.5.2.11 Fume extraction is required for, but not limited to, the following:

a) Hot metal work and heat treatment processes. [Ss_65_40_32]

b) Laser cutters. [Ss_65_40_32]

c) 3D printers. [Ss_65_40_32]

d) Cadcam machines. [Ss_65_40_32]

e) Surface cleaning and finishing and printed circuit board manufacturing (etching). [Ss_65_40_32]

f) Soldering of circuit boards. [Ss_65_40_32]

g) For some paints and adhesives, including spray fix as used in art rooms. [Ss_65_40_32]

7.5.2.12 Dust extraction shall be provided to all fixed machines provided in all workshops, prep rooms or DT studios that produce dust. [Ss_65_40_42_25]

7.6. Local Exhaust Ventilation (LEV) Systems

7.6.1. General Requirements

7.6.1.1 LEV systems local to individual machines shall either be interlocked with the machine so that they shall not start without the LEV running or provided with a local switch adjacent to the machine. [Ss_65_40_33_48]

7.6.1.2 The effectiveness of Legacy LEV systems shall be assessed as required by COSHH and if they do not meet current standards new LEV systems shall be provided. See HSE 258. [PM_10_20_90]

7.6.1.3 LEV risk assessments and specifications should identify the processes, contaminants, hazards, sources to be controlled and exposure benchmarks. [PM_35_40_35]

7.6.1.4 Exposure benchmarks should be based on EH40 and on CLEAPSS guidance on risk assessments for science and D&T. [PM_10_20_90]

7.6.1.5 Make up air shall not create draughts or disturb the airflow into LEV hoods and fume cupboards. Ventilation openings shall be designed to minimise such effects and they shall be sited away from LEV hoods and fume cupboards. [PM_35_70_94]

7.6.1.6 Wherever dust is produced, a risk assessment shall be undertaken, a control measure shall be put in place, including for the emptying and disposal of dust from LEV systems. [PM_35_40_35]

7.6.1.7 Machine-based extract equipment shall meet HSE requirements as a minimum. [PM_10_20_90]

7.6.1.8 Clear management systems and proper, safe work routines including the use of PPE shall be included in the Operation and Maintenance (O&M) Manual and Health and Safety File, as required in DfE's EIR. [PM_10_20_28]

7.6.1.9 The following requirements shall be met:

a) LEV systems shall be designed by qualified professional suppliers. [Ss_65_40_33_48]

b) LEV systems shall be supplied with performance data on installation including filter efficiencies. This is necessary so that subsequent testing can be compared with the performance on installation. [Ss_65_40_33_48]

c) Details of the statutory 14 monthly LEV equipment 'Thorough Examination and Test' (TExT) shall be included in the O&M Manual and the Building User Guide. [PM_10_20_82]

d) All LEV systems across the D&T and science departments shall have a TExT every 14 months. This shall be carried out by a competent person. The checking of the extractor units on laser cutters, fume cupboards and other equipment shall be included in the TExTs. [PM_10_20_82]

e) A logbook shall be provided to record the results of the commissioning, the 14 monthly performance TExTs. [PM_70_85_60]

f) Workplace Exposure Limits (WEL) for wood dust and other pollutants shall be recorded in O&M Manuals and the H&S File and procedures defined to keep levels as low as reasonably practicable. [PM_35_40_35]

g) The O&M Manual and H&S File shall contain manufacturers and designers' maintenance schedules to ensure the systems perform as designed. [PM_70_85_50]

7.6.2. Laser Cutters and 3D Printers

7.6.2.1 The use of laser cutters and 3D printers can cause potential health and safety risks. Harmful fumes containing nanoparticles and Volatile Organic Compounds (VOCs) can be produced. [PM_10]

7.6.2.2 Laser cutters and 3D printers shall be housed in well-ventilated rooms and provided with efficient fume ventilation systems. [PM_10_20_82]

7.6.2.3 There are two types of systems that can be used as shown in Table 7-1. [Ss_65_40]

Ventilation system	Description
Extract to Atmosphere (ETA)	Fumes are removed by negative pressure and discharged through an external flue above roof level.
Filtration	Particulates are trapped in a HEPA filter and VOCs in a molecular gas filter. The clean air is returned into the room. These systems require regular maintenance and filter changes as recirculatory fume cupboards.

Table 7-1 Fume Ventilation Systems

7.6.2.4 Filter systems are required to be changed on average once or twice per school year, dependent on the filter size and frequency of use. This should form part of the general maintenance programme. The filter system shall be capable of removing both nanoparticles and VOCs. [PM_35_70_94]

7.6.2.5 Both types of system require LEV tests, which measure filter effectiveness, at no more than 14-month intervals. Further guidance can be obtained from CLEAPSS and HSE. [PM_10_20_90]

7.6.2.6 The requirements to change filters and carry out LEV tests shall be included in O&M Manuals and the Building User Guide, see paragraph 7.6.1.9. [PM_10_20_90]

7.6.3. Wood Dust Extract Systems

7.6.3.1 Wood dust extract systems vary, and different schools may require differing solutions. Wood dust can be hazardous and particulate matter is required to be cleared and filtered from the air. [PM_10]

7.6.3.2 Extract systems can be of centralised dust extraction type or smaller LEV units. [PM_10]

7.6.3.3 In some cases, a mixture of systems may be appropriate depending on the types of machinery and the way the spaces are used. See Table 7-2. [PM_10]

7.6.4. Centralised Wood Dust Extract Systems

7.6.4.1 Centralised Low Volume, High Velocity (LVHV) systems as wood dust extract systems shall be provided for the equipment in DT prep rooms and any adjoining workshops, unless individual machine-based extract systems are identified in the School-specific Brief. Type selection shall be considered alongside risk assessment criteria. [PM_35_40_35]

7.6.4.2 Centralised extract systems to machinery shall be designed and installed to meet the following requirements.

a) The collection unit and extract fan are located so that the unit can be used quietly and be easily emptied without disturbance of class activities. [PM_35_70_94]

b) The extract unit is located in a separate room to the teaching space, to contain the noise and dust. The shaker, fan and main branch ducts are also located in this space so that noise into Teaching Spaces is minimised. [PM_35_70_94]

c) The air inlet to the room containing the dust extract unit is acoustically attenuated to prevent noise causing disturbance to teaching areas, neighbouring properties and outside areas. [PM_35_60]

d) Vacuum hose connections are provided, and Inertia type reels for vacuum hoses are provided in the prep room and the students' work area instead of 'sweeping up' arrangement. [Ss_65_40_42_25]

e) Automatic fire dampers are provided in the extract system and the associated plant room. [Pr_65_65_24_30]

f) The system is fitted with a variable speed fan and machinery dampers and interlocks so that the system changes the flow rate when machines are switched on and off and allows hand tools to be connected. The interlocks shall provide automatic shut off to the extract system when the waste bag is full and a warning to the prep room when the bag is nearly full. [Ss_65_40_42_25]

g) A variable air flow system is provided in new installations to limit energy use and noise. Air flow depends on the number of machines in use. [Ss_65_40_42_25]

h) All branch ducts are designed for low resistance to limit noise as described in HSG 258. [PM_10_20_90]

7.6.4.3 See Section 2.21 of IoA/ANC 'Acoustics of Schools: a design guide', 2015 for guidance on operational noise. [PM_10_20_90]

7.6.4.4 Issues to consider when designing LEV systems are shown below in Table 7-2. [Ss_65_40_33_48]

Type	Characteristics	Noise	Advantages	Disadvantages
Fixed installations for whole area serving several machines	a. Inlets at each machine or dust source, preferably with dampers that can be closed when the inlet is not in use. b. Fixed ducting. c. A fixed filter or dust-collection system. d. A single fan unit. e. An outlet that might return air to the workplace or vent it to the outside. f. Dust collection unit and fans may be in the room, or in a separate room or in an external enclosure with ducting to the equipment. g. Unit may serve more than one room. h. Warning system required to tell user when dust collector needs emptying.	Depends on design. Sound levels greater than 80 dB (A) caused by fixed flow rate make verbal communication difficult. Where the noise exceeds 80 dB (A) ear defenders are required. New installations should not have noise levels requiring ear defenders. Noise can cause distractions to the teaching environment and to neighbouring buildings, depending on location. Noise can be limited if unit is variable speed and housed in	Single point of dust collection makes dust handling and maintenance easier and safer - only one filter to clean or replace. The noise is low if the fan is outside the workplace and the duct does not carry sound. Low running costs due to single point of maintenance. Low energy costs if variable speed.	Fan and filter units are large and need to be in a soundproof enclosure. High noise levels if the system is in the workplace and/or if the duct velocity is too high or ductwork poorly designed so that it transmits sound. This may lead to ambient noise problems in rooms where quiet is needed. Extra electrical controls are required to ensure that the system starts up when any machine is in use and to vary the air flow according to the number of machines in use. Users shall be trained to operate dampers and controls. If the extraction unit fails, none of the machines

	i. Units and are best located in a separate space or external to the Building for ease of maintenance and to limit noise.	separate space. Also, by good quality ductwork with smooth bends.		connected to the system can be used. Relative inflexible when needing to move machines or connect and disconnect machines.
Independent installations at each machine	a. Fan unit is close to the machine producing the dust. b. Fan and machine are often electrically linked, so that the fan is powered whenever the machine is running. c. For dust control, the filter/dust-collection system is normally mounted in the same unit as the fan. d. Warning system required to tell user when dust collection needs emptying.	Can be a problem unless each fan unit is very quiet.	Units are often compact, being designed to fit under the bench or into the pedestal supporting the machine. Automatic starting of the dust control is easy. Failure of one unit does not affect use of any other machine.	Many dust-collection bags and/or filters to attend to. Many fans can generate much noise. Dust collection units must be changed in an occupied space. The relatively small filter area and size of unit can result in the filter becoming clogged and hence a lack of efficiency. Dust collection capacity can be small requiring regular emptying. These units are unlikely to cope with large volumes of waste such as those

				produced by wood planing machines.
Portable systems	A mobile duct, filter, dust sack and fan unit, which can be moved between machines. The inlet may be general purpose or part of each machine.	A serious problem unless each fan unit is very quiet.	An economical solution for a workshop containing several machines with intermittent use.	General-purpose units are not always efficient and may not adequately control contaminants. Dust capture hoods may be ineffective unless designed for each machine. Difficult to make system and machine electrically interlocked. It is then debatable whether or not the system fulfils legal requirements. There is a high risk that LEV may not be used because of the effort in connection. Difficult to empty and disconnect and reconnect safely.
Extraction from portable power tools	A very flexible duct connected to a standalone dust collector or a small dust	Portable power tools are often noisy anyway and the extra noise associated with	Good for vocational training as this is the usual method of	The dust-collection system may make the tool difficult to control.

	bag connected to the tool.	the dust collection system may be trivial.	extraction found on site.	If a small dust bag is fitted, it can be filled after only a few minutes work and must be changed or emptied frequently. Dust capture may not be effective enough for indoor use. This type of system may not effectively protect others nearby unless used in a very well-ventilated space or an external workspace. If used inside PPE will probably be needed for those nearby as well as the user.

Table 7-2 Types of dust extraction (table adapted from CLEAPSS publication L225)

7.6.5. Reference Standards

7.6.5.1 Ensure that the design and installation of the D&T spaces, wood dust extract ventilation and associated systems complies with the relevant parts of the standards as listed below, and any updated versions of these standards: [PM_10_20_90]

a) BS 4163 – 'Health and safety for design and technology in educational and similar establishments'. [FI_70_85]

b) IGEM/UP/11 – 'Gas Installations for Education Establishments'. [FI_70_85]

c) 'Acoustics of Schools: a design guide', IoA/ANC, 2015. [FI_70]

d) HSG 258 – 'Controlling airborne contaminants at work: A guide to local exhaust ventilation'. [FI_70]

e) CLEAPSS Guidance Document L225 – 'Managing Risk Assessment in Design & Technology'. [FI_70]

f) CIBSE TM40 A Guide to Good Practice for LEV. [FI_70]

g) EH40/2005 Workplace exposure limits. [FI_70_85]

7.7. Science Fume Cupboard Ventilation

7.7.1. Overview

7.7.1.1 The following section provides a minimum specification for the design and installation of any ventilation and associated systems in science teaching spaces with fume cupboards. [PM_35_70_94]

7.7.2. General Requirements

7.7.2.1 The general requirements for the science fume cupboard ventilation systems shall be to:

a) remove contamination from the extract air caused by chemical processes [Ss_65_40_32_32]

b) provide background ventilation for the occupants [Ss_65_40_32_32]

c) ensure sufficient ventilation in areas where increased CO_2 and CO levels can be observed [Ss_65_40_32_32]

d) ensure sufficient ventilation for combustion. [Ss_65_40_32_32]

7.7.3. Design Criteria

7.7.3.1 Science laboratories and science studios can be used for conventional classroom activities and shall be designed for such use (see Section 5: Ventilation of General Teaching and Learning Resource Areas) as well as for use for practical activities, where additional ventilation is required during experiments. [PM_35_70_94]

7.7.3.2 Practical experiments are carried out in science laboratories and science studios in the open teaching space as well as in fume cupboards. [PM_10]

7.7.3.3 The ventilation design shall address the following:

a) The use of Bunsen burners. [PM_40_20_94]

b) Chemical fumes produced during experiments. [PM_40_20_94]

c) The safe and effective use of fume cupboards. [PM_40_20_94]

7.7.3.4 Table 7-3 below from BB101 gives the required minimum exhaust rates for various sized spaces. [PM_40_20_94]

Room type	**Area (m^2)**	**Minimum required ventilation rate**
Science laboratories, studios and prep rooms	>70	4 l/s/m^2
Science laboratories, studios and prep rooms	37-70	11.42 – (0.106 x Area) l/s/m^2
Science laboratories, studios and prep rooms	<37	7.5 l/s/m^2
Chemical stores	All	2 air changes per hour, 24 hours a day.

Table 7-3 Science Laboratories Minimum Exhaust Rates

7.7.3.5 The area-based ventilation rates in l/s/m^2 given in Table 7-3 apply to spaces of 2.7m in height or higher. [PM_35_70_94]

7.7.3.6 The equivalent air change rate per hour (ach) can be calculated from ach = (l/s/m^2 rate) x 3.6/(Room height (m)). [PM_35_70_94]

7.7.3.7 For spaces below 2.7m in height, the equivalent air change rate to a 2.7m high space shall be used. [PM_35_70_94]

7.7.3.8 In science laboratories and science studios, a means shall be provided to increase the exhaust rate to at least 5 l/s/m² by the use of openable windows and by boosting the extract rate to a higher rate and noise level under override control of the staff member. This purge/boost ventilation shall allow the member of staff to reduce any CO_2 levels or fumes in the room e.g., following a difficult experiment, or a spillage or if the CO_2 warning level of 2800ppm is reached. [PM_35_70_94]

7.7.3.9 Noise levels during normal teaching and practical activities shall comply with Section 1.1.3 of BB93. [PM_10_20_90]

7.7.3.10 It is a requirement to achieve the minimum exhaust rates given in Table 7-3 above for normal experimental conditions within the noise levels for practical activities given in BB93 Section 1.1.3. IoA/ANC 'Acoustics of Schools: a design guide', 2015 gives guidance on limiting the higher noise levels allowed during purge/boost and Local Exhaust Ventilation such as use of fume cupboards. [PM_10_20_90]

7.7.3.11 Mechanical or hybrid ventilation systems shall be used to provide adequate ventilation during teaching and practical activities in science laboratories to provide the minimum exhaust ventilation rates given in Table 7-3 whilst meeting the cold draught criteria, see Section 10.4. [PM_40_20_94]

7.7.3.12 The cold draught criteria do not apply during purge ventilation as described in paragraph 7.7.3.8 and 7.7.3.10 [PM_10_20_90]

7.7.3.13 The levels of CO_2 during practical lessons can be higher than those allowed during teaching activities in Section 5: Ventilation of Teaching and Learning Spaces but must comply with the gas safety requirements give in IGEM/UP/11 and paragraph 9.3.3. [PM_10_20_90]

7.7.4. Bunsen Burners

7.7.4.1 CO_2 levels can be significantly elevated by the use of Bunsen burners in a class of 30 pupils. CO_2 from 15 Bunsen burners is as high as that from respiration of 20 pupils. [PM_10]

7.7.4.2 Additional ventilation is required when the whole class are using Bunsen burners or carrying out fume generating experiments. Reference should be made to the detailed guidance in the Gas Safety (Installation and Use) Regulations 1998, Regulation 2 (6) (b) and IGEM/UP/11, 'Gas Installations for Educational Establishments'. [PM_10_20_90]

7.7.5. Fume Cupboards

7.7.5.1 Fume cupboards are needed in 1 in 3 science laboratories and science studios, and in all science prep rooms, as described in SS1: School-specific SoA and ADS. [PM_10_20_90]

7.7.5.2 Where required, fume cupboards shall be installed and operated in accordance with the guidance in CLEAPSS Guide G9 and British Standards. [PM_10_20_90]

7.7.5.3 Semi-mobile fume cupboards (and where required in the SSB mobile fume cupboards) shall be easily connected by science staff by means of docking stations and quick release service connections ideally set within the side of a teacher's demonstration desk. The connections shall not inhibit the safe use of the fume cupboards including for teacher demonstrations where students gather round the fume cupboard. [Ss_65_40_32_32]

7.7.5.4 The ventilation shall be designed so that the supply of incoming make-up air compensates for extraction when ducted fume cupboards are in use. Note: fume cupboards generally balance themselves against supply and extract from natural ventilation paths in the same room but can be adversely affected by the pressures generated by stack ventilation. With regard to mechanical ventilation, that has a balanced supply and exhaust system, it is a requirement that the supply ventilation can be increased to provide 90% of the fume cupboard exhaust rate so that the room is maintained at a slightly negative pressure. [Ss_65_40_32_32]

7.7.5.5 Fume cupboards shall be of the ducted type unless stated otherwise in the SSB. Fume cupboards shall be fixed in position in prep rooms and be able to be pulled out from the wall on flexible connections in science teaching spaces for demonstration purposes unless stated otherwise in the SSB. [Ss_65_40_32_32]

7.7.5.6 Exceptions where recirculatory fume cupboards may be used are in refurbishment or remodelling where there is no practical means to run an external flue. Where this is recorded in the SSB, at least two ducted fume cupboards shall be provided: one in the science prep room that shall be fixed in position and one in a laboratory where the School teaches 'A' level science which shall be a fixed or semi-mobile ducted type. [Ss_65_40_32_32]

7.7.5.7 If recirculatory fume cupboards are used, the rooms in which they are located shall be ventilated to the minimum exhaust rate of 4 l/s/m^2 of floor area whenever the fume cupboards are in operation, with facility to purge vent to at least 5 l/s/m^2 as described in paragraph 7.7.3.8. [Ss_65_40_32_32]

7.7.5.8 Both new and Legacy recirculatory fume cupboards shall comply with and be installed in accordance with BS EN 14175 and CLEAPSS Guide G9 standards for re-circulatory fume cupboards. [PM_10_20_90]

7.7.5.9 Recirculatory fume cupboards shall only be used as additional fume cupboards not in place of the minimum number of ducted fume cupboards required. See Technical Annex 3. [PM_10_20_90]

7.7.5.10 If a recirculatory fume cupboard is used in a science prep room, it shall have a vertical upwards discharge and the room shall have extract from high level to minimise pollutants in the occupied zone. [Ss_65_40_32_32]

7.7.5.11 A risk assessment to HSG 258 is required for all fume cupboard installations. [PM_10_20_90]

7.7.5.12 Where fume cupboards are in use, the air speed local to the sash shall be as low as practicable. BS EN 14175 - 5 requires that the velocity of ventilation air shall not exceed 0.2m/s at a zone 400mm from the fume cupboard. [PM_10_20_90]

7.7.6. Science Prep Rooms

7.7.6.1 In science prep rooms, ventilation at the minimum exhaust rate shall be continuous during normal working hours. Ventilation shall be fitted with an override function for use out of these hours. [PM_35_70_94]

7.7.6.2 In science prep rooms, additional make-up air is required when a ducted fume cupboard is switched on. [PM_35_70_94]

7.7.6.3 Ducted fume cupboards shall be used in science prep rooms. [Ss_65_40_32_32]

7.7.6.4 Airflow rates shall be high in small prep rooms and air velocity could be more than the normal face velocity of a fume cupboard in the closed position. At such high airflow rates, the fume cupboard can spill chemicals therefore a long air inlet slot and careful positioning of fume cupboards relative to windows and vents is needed in a small prep room to keep the airflow velocities down in the space and to avoid chemical fumes being drawn out of the cupboard into the room. [Ss_65_40_32_32]

7.7.7. Chemical Stores

7.7.7.1 Chemical stores require continuous ventilation 24 hours a day. Air supply shall be at low level and extract at high level. See Table 7-3. [PM_35_70_94]

7.7.8. Ventilation Controls

7.7.8.1 Air management systems with programmable controllers can accommodate a variety of room arrangements. Fume cupboard extract alongside room extract and supply shall be controlled locally to ensure airflow rates are kept at acceptable levels for varying equipment and room usage. [Ss_75_70_52_94]

7.7.8.2 Supply and extract systems supplying the normal ventilation rate i.e., when the fume cupboards are off, shall reuse the heat from the room by mixing or heat recovery to minimise ventilation heat losses. [PM_35_70_94]

7.7.8.3 Black out blinds required for physics experiments can interfere with natural ventilation paths, and therefore needs to be taken into account when designing a ventilation system. During black out experiments, the ventilation rate can be relaxed to 5 l/s/person. [PM_35_70_94]

7.7.9. Fume Cupboard Exhausts

7.7.9.1 Exhausts from fume cupboards shall discharge at a safe height above the highest part of the Building. BS EN 14175-3 gives recommendations on the installation of fume cupboards. It recommends that the discharge shall be at 1.25 times the height or 3m above the highest point of the Building and the minimum efflux velocity shall be 7m/s or preferably 10m/s. Where flues are lower than recommended the efflux velocity shall be increased to overcome downdrafts and design calculations shall prove that the flue height and efflux

velocity comply with good practice as described in the ASHRAE Handbook (See reference 7) and CIBSE design guidance. [PM_10_20_90]

7.7.10. Reference Standards

7.7.10.1 Design and installation of the science laboratory and fume cupboard ventilation systems and associated systems shall comply with the relevant parts of the standards listed below, and any updated versions of these standards: [PM_10_20_90]

a) IGEM/UP/11 – 'Gas installations for educational establishments' [FI_70_85]

b) CLEAPSS Guide G9 – 'Fume Cupboards in Schools' [FI_70_85]

c) BS EN 14175 – 'Fume cupboards. Type test methods' [FI_70_85]

d) BS EN 14175-2 – 'Fume cupboards. Safety and performance requirements' [FI_70_85]

e) BS EN 14175-3 – 'Fume cupboards. Recommendations for the exchange of information and recommendations for installation' [FI_70_85]

f) BS EN 14175-5 – 'Fume cupboards. Recommendations for installation and maintenance' [FI_70_85]

g) 2015 ASHRAE Handbook - HVAC Applications, Chapter 45, Building Air Intake and Exhaust Design [FI_90_35]

h) HSG 258 – 'Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV)' [FI_70]

i) Gas Safety (Installation and Use) Regulations 1998, Regulation 2 (6) (b) [FI_70_72]

7.8. Ventilation for SEN(D)

7.8.1. General Requirements

7.8.1.1 The following is a minimum specification for the design and installation of ventilation in Special Schools and Designated Units. [PM_35_70_94]

7.8.1.2 The design of ventilation systems for vulnerable pupils in non-ambulant Special Schools, as defined in BB104, shall:

a) minimise recirculation to mitigate risk of cross-infection (areas with complex health and hygiene requirements may require precise control of air flows with pressure regimes, depending on pupils' needs) [PM_35_70_94]

b) ensure allergen and pollutant circulation is kept as low as necessary, this may require filtration depending on the needs of the pupils and the local external air quality. [PM_35_70_94]

7.8.1.3 The ventilation for Teaching Spaces in a Special School or Designated Unit shall take account of the typical occupant density (typical occupant density is around 8 pupils compared to 30 in Mainstream School accommodation). A design rate per person is not always appropriate, although the general requirements and advice on ventilation shall be adopted. [PM_40_20_94]

7.8.1.4 An assessment of the requirements of the occupants shall be undertaken before commencing the ventilation system design. This is to ensure that any specific needs of the occupants are catered for, as the requirements of SEND accommodation vary considerably depending upon the nature of the occupants. [PM_40_20_94]

7.8.1.5 Ventilation in SEND accommodation shall provide the minimum ventilation rates given in Table 7-4. [PM_40_20_94]

Designated areas	**Minimum ventilation rate**	**Ventilation mode**
Laundries, soiled holding or waste, and cleaners' stores	3.8 l/s/m^2	Mechanical extract with provision for natural or mechanical make-up as appropriate
Toilets, showers and changing areas	7.5 l/s/m^2	Mechanically extracted to outside, provision shall be made for make-up air, which shall be heated and filtered. The systems shall be separate from any general school ventilation system.
Teaching Spaces, therapy, medical treatment and sick rooms	2.3 l/s/m^2	Ventilation systems shall be capable of controlling internal temperature and draughts. Sick rooms shall be provided with full fresh air with no recirculation.

Large spaces, including assembly halls, activity studios and indoor dining rooms	Dependent on density of occupation but based on 8 l/s/person or 2.5 ach whichever is the greater	Ventilation shall be sufficient to limit CO_2 and control odours.

Table 7-4 Ventilation performance criteria for Special Schools and Designated Units

7.8.1.6 Note: The area-based ventilation rates in Table 7-4, in l/s/m^2, apply to spaces of 2.7m in height or higher. The equivalent air change rate per hour (ach) can be calculated from ach = (l/s/m^2 rate) x 3.6/(Room height (m)). For spaces below 2.7m in height, the equivalent air change rate to a 2.7m high space shall be used. [PM_35_70_94]

7.8.1.7 Laundries, soiled holding or waste and cleaners' stores shall be ventilated by means of mechanical extract with natural or mechanical make-up air. [PM_40_20_94]

7.8.1.8 Toilets for students with complex health needs and hygiene rooms shall be ventilated by means of mechanical extract to outside, with make-up air, heated and filtered. [PM_40_20_94]

7.8.1.9 Toilets, showers, changing areas, laundries, cleaners' stores and spaces holding soiled clothes or clinical waste shall be mechanically ventilated to achieve a slight negative pressure relative to adjacent spaces. [PM_40_20_94]

7.8.1.10 Ventilation design shall not compromise acoustic performance, particularly where students have additional sensitivities to noise. [PM_35_60]

7.8.1.11 Ventilation systems shall be controllable and adjustable, according to the needs of individual students. Air conditioning shall be avoided. [PM_35_70_94]

7.8.2. Infection Control

7.8.2.1 Where there are students with complex health needs, ventilation systems shall be designed for infection control and to maintain standards of hygiene. Staff shall be able to control ventilation for comfort, and draughts shall be minimised so as not to affect vulnerable and immobile students. Legionella is a higher risk to people with complex health needs, especially the immuno-compromised. Particular attention needs to be paid to legionella prevention in domestic hot water systems in these schools. [PM_35_50]

7.8.2.2 Where mechanical ventilation is specified, filtration shall be provided, depending on external air quality and design exposure levels. [PM_35_70_94]

7.8.2.3 Some students in Special Schools or Designated Units may be very vulnerable to infection. In these cases, Health Technical Memoranda, specifically HTM 0301 Part A, published by NHS Estates shall be consulted and it is essential that infection control policies

are in place and implemented. Managing cross-infection is a complex subject, but the risks can be reduced through adequate source control. [PM_10_20_90]

7.8.3. Reference Standards

7.8.3.1 Ensure that the design and installation of ventilation and associated systems for Special Schools and Designated Units shall comply with the regulations and take into account the guidance in the following reference standards as listed below, and any updated versions of these standards: [PM_10_20_90]

a) HSE L8 – ‘Legionnaires' disease. The control of legionella bacteria in water systems’ [FI_70]

b) Health Technical Memorandum 03-01 – ‘Specialised ventilation for healthcare premises Part A: Design and validation’ [FI_70]

8. Mechanical Air Conditioning Systems

8.1. The Cooling Hierarchy

8.1.1 Teaching Spaces shall not be provided with mechanical comfort cooling, without prior approval from the Employer. [PM_10_20_82]

8.1.2 Designs shall utilise passive measures such as reducing solar gain and internal gains to eliminate the need for comfort cooling. [PM_10_20_82]

8.1.3 All other measures shall be explored, and found not to be feasible, before active cooling is proposed. This includes, but it is not limited to:

a) minimising internal heat generation through energy efficient design by:

    i) minimising heat gain due to lighting [PM_40_20_47]
    ii) reducing loads by using low energy equipment [PM_40_20_26]

b) reducing the amount of heat entering a building in summer through:

    i) orientation, landscaping, trees, and surface albedo, see Technical Appendix 2J [PM_10_20_90]
    i) optimising insulation, fenestration, and glazing G-Values [PM_35_70_92]
    ii) shading features, such as blinds, which shall not limit the air flow through windows [PM_35_70_20]

c) managing the heat within the Building through exposed internal thermal mass and increased room height [PM_35_70_92]

d) passive ventilation by cross flow and stack solutions and/or optimised high and low-level openings [PM_40_20_94]

e) mechanical ventilation, including limited periods of boost which exceed the upper indoor ambient room noise level, refer to paragraph 5.1.13 (mechanical ventilation may be proposed to mitigate the risks of cold draughts, but where the Site allows, natural ventilation should be preferred to reduce the overheating risk). [PM_35_70_94]

8.1.4 Active cooling systems (ensuring they are the lowest carbon options) shall:

a) be used for peak lopping but not full cooling [Ss_60_40_17]

b) provide interlocks to the heating and/or cooling systems to prevent heating and cooling at the same time [Ss_60_40_17]

c) provide local control [Ss_75_70_52_17]

8.1.5 Where cooling is unavoidable as a result of SEN assessments, a cooling system shall be included to provide the particular needs in specific locations identified by the assessment. The solution shall be agreed with the Employer. [PM_10_20_82]

8.1.6 A non-technical description of air conditioning or ventilation controls for summertime use shall be provided in the Building User Guide. [PM_10_20]

8.1.7 Air conditioning refers to the control of temperature and humidity in the air, however in Schools, comfort cooling without humidity control, where temperature only is controlled, is normally provided. [PM_10]

8.1.8 Where the installation of cooling is required having followed this 'cooling hierarchy', it shall have a minimum Seasonal Energy Efficiency Rating (SEER) no worse than the requirements set out in the Non-Domestic Building Services Compliance Guide (current edition). [PM_10_20_90]

8.2. Refrigerant Based System

8.2.1 Where a refrigerant based system is used, the following requirements shall be met.

a) The amount of refrigerant in the system shall be minimised to reduce the potential environmental impact. [Ss_65_80]

b) Condensing units shall be sited in accessible positions for maintenance. [PM_80_10_50]

c) The length of refrigerant pipelines shall be minimised. [Ss_65_80]

d) Pipework shall be insulated throughout its length and where exposed to sunlight shall be provided with suitable UV resistant insulation rather than a painted finish. [Ss_65_80]

8.2.2 All indoor AC units and DX coils shall be fitted with a condensate drain connected to the main drainage system via a running trap in a waste guaranteed to carry waste regularly. [Ss_65_80]

8.3. Variable Refrigerant Flow (VRF) and Split Systems

8.3.1 Where VRF or split systems are used, the following requirements shall be met.

a) Pipe lengths shall be minimised to reduce the volume of refrigerant. [Ss_65_80]

b) Leak detection shall be installed to minimise refrigerant losses and protect occupant safety. [Ss_65_80]

c) Maximum total pipe lengths from outdoor to indoor units, furthest indoor unit from the outdoor unit, maximum height difference between outdoor unit and lowest indoor unit shall all be within the manufacturer's recommended maximum lengths [Ss_65_80]

d) The equipment shall be easily accessible for maintenance. [PM_80_10_50]

9. Gas Services

9.1. General Requirements

9.1.1 The design, installation and maintenance of any bottle or mains gas installations provided shall comply with the Gas Safety (Installation and Use) Regulations (GSIUR) and shall be in accordance with the guidelines set out in IGEM/UP/11 ‘Gas installations for educational establishments’ and other applicable IGEM standards, relevant British Standards and UKLPG documents. [PM_10_20_90]

9.1.2 The use of gas in schools shall be avoided where possible with the exception of provision to science laboratories. When existing schools already have an adequate natural gas supply, this shall be the source of gas to science laboratories. Where no natural gas supply is in place, bottled gas to feed science laboratories and dedicated storage shall be designed in accordance with the IGEM//UP/11 ‘Gas installations for educational establishments’ and other applicable IGEM standards, relevant British Standards and UKLPG documents. [PM_10_20_90]

9.1.3 The following requirements shall be met.

a) Gas supplies shall be interlocked with ventilation systems as required by the GSUIR and IGEM standards. [PM_10_20_90]

b) Gas installations shall be certified on completion to comply with the GSUIR IGEM standards and British Standards and all HSE and UKLPG recommendations and requirements, as required in the DfE’s EIR. [PM_10_20_28]

c) Automatic Isolation Valves in accordance with IGEM/UP/11 shall be fitted to science gas supplies and positioned near the teacher’s desk/board, or next to main light switches or at the entrance to the laboratory. [PM_10_20_90]

d) Design and installation of emergency control valves (ECVs), additional emergency control valves (AECVs) and automatic isolation valves (AIVs) shall comply with IGEM/UP/11. [PM_10_20_90]

e) Where gas pipework runs in ceiling spaces or behind or inside furniture, a high and low level vent shall be provided to avoid a build-up of gas as described in IGEM/UP/11 and IGEM/UP/2. [PM_10_20_90]

f) The operation and maintenance associated with gas and LPG installations shall be fully discussed and agreed with the end user and include suitable training and handover documentation. [PM_70_85_25]

9.1.4 Gas appliances can be of three types:

a) Type A appliances are those that do not require a flue to be fitted to them and include Bunsen burners and flue less appliances e.g., some types of flueless gas fire and most domestic and catering cookers/ranges. [PM_10]

b) Type B appliances are those appliances that require a flue pipe and are referred to as open flued appliances such as a gas fire, a kiln or some types of larger specialist cooking appliance e.g., fish fryer ranges. [PM_10]

c) Type C appliances are referred to as room sealed (or balanced flue) and are typical of modern domestic or commercial gas boilers and may be used for heating. [PM_10]

9.2. Gas Interlocks

9.2.1 An interlock is required between the gas supply and mechanical ventilation to ensure that gas is not supplied when there is inadequate airflow. This is for safe operation of appliances and equipment and the safety of personnel. [PM_10_20_82]

9.2.2 For Type B appliances: Regulation 27(4) of GSIUR requires that any mechanical extract system that is required for safe operation of the appliances shall be interlocked with the gas supply. IGEM/UP/19 provides more detailed requirements for interlock systems. It states that:

> "For Type B appliances, environmental monitoring such as CO_2, temperature or humidity may be used in conjunction with variable speed drive (VSD) systems. However, fan flow/pressures switches or power monitoring shall always be used in conjunction with Type B catering appliances. CO_2, temperature or humidity monitoring is not acceptable as the main interlock for Type B catering appliances." [PM_10_20_90]

9.2.3 For Type A appliances: where an appliance is served by a mechanical extract system that is required for safe operation of the appliances IGEM/UP/19 'Design and application of interlock devices and associated systems used with gas appliance installations in commercial catering establishments' 2014, requires that the mechanical extract system must be interlocked with the gas supply. IGEM/UP/19 states that:

> "For new installations, CO_2 monitoring would normally be used in conjunction with either a fan flow/pressure switch or fan power monitoring but may be used alone with Type A appliances. For Type A appliances, environmental monitoring measuring CO_2 may be used in conjunction with other air quality sensors such as temperature or humidity to provide information to be included

in an interlock system. It may also be used as part of a demand control ventilation system." [PM_10_20_90]

9.2.4 Type A appliances such as domestic cookers with their associated mechanical ventilation system(s) may therefore use CO_2 detectors or fan flow/pressures switches or power monitoring interlocks. [PM_35_70_94]

9.2.5 Section 4.2 of IGEM/UP/19 describes CO_2 and other interlock systems for catering establishments and should be referred to when designing CO_2 interlocks for food rooms in schools. See also Section 7.3 Food Room Ventilation. [PM_10_20_90]

9.2.6 For Type A appliances, a common extract duct from extraction canopies can be used with a wall mounted CO_2 interlock system as IGEM/UP/19 requires the ventilation system to be interlocked and must be in operation before gas is available to cookers. [PM_10_20_90]

9.2.7 For Type B appliances a wall mounted CO_2 interlock can be used with a common extract duct from extraction canopies but ONLY **as a secondary interlock** and not as the primary interlock which shall be as described in IGEM/UP/19. [PM_10_20_90]

9.2.8 Table 9-1 summarises the choices of different types of gas safety interlocks for schools.

Appliance Type	**Interlock System Application Appliance Type A**	**Interlock System Application Appliance Type B**	**Interlock System Application Appliance Type C**	**Comments**
Flow switch or air pressure switch	Yes	Yes, as a primary interlock	Not needed	Simple system. Does not prove environmental conditions.
Mechanical ventilation fan power monitoring	Yes	Yes, as a primary interlock	Not needed	Simple system may be slightly better than above. Does not prove environmental conditions.
CO_2 monitoring	Yes	Yes, as a secondary interlock but only with a	Not needed	For legal reasons not permitted alone with Type B. Provides positive proof/control of the

		primary interlock		environment for Type A. Suitable system for Teaching Spaces in which there are only Type A appliances. Easy to apply in schools having environmental control systems.
VSD with CO_2 monitoring and control	Yes	Yes, as a secondary interlock but only with a primary interlock	Not needed	Reduces power consumption and fan noise. Demand Controlled Ventilation. Most suitable for Teaching Spaces in which there are only Type A appliances.

Table 9-1 Summary of interlock requirements according to appliance type

9.2.9 Central school catering, where provided by gas, shall comply with IGEM/UP/19 and BS 6173. [PM_10_20_90]

9.2.10 Boiler plant rooms including gas, CHP and gas fired plant shall comply with IGEM/UP/3, IGEM/UP/10, BS 6644, and other associated standards for different plant types. [PM_10_20_90]

9.3. Gas Safety Interlocking by Environmental / CO_2 Monitoring

9.3.1 Where there are only Type A appliances i.e., there are no flued gas appliances such as deep fat fryers, interlocking should be achieved by environmental monitoring of carbon dioxide as described in IGEM/UP/19. [PM_10_20_90]

9.3.2 Environmental CO_2 monitoring should be used in most food rooms (i.e., spaces that only contain Type A appliances) and in science (as Bunsen burners are classed as Type A appliances). [Ac_05_50_54]

9.3.3 In accordance with IGEM standards, gas interlocks by environmental monitoring of CO_2 shall operate as follows.

a) During practical activities, the appliances shall not cause the CO_2 level to exceed 2800ppm, which shall produce a high-level warning signal. [PM_10_20_90]

b) An automatic gas shut down shall initiate when 5000ppm of CO_2 is detected. [PM_10_20_90]

9.3.4 At CO_2 levels of 2800ppm supply and extract systems shall be automatically switched on or boosted and the teacher shall be warned that ventilation needs to be increased. Systems to control the ventilation to keep it under 2800ppm can include individual canopies vented externally, supply air fans and opening windows. Below 2800ppm these ventilation systems can be under automatic demand control with teacher or user override control so that noise levels can be easily controlled, and energy use can be minimised. Opening windows alone is not an adequate means to control CO_2 levels. [PM_35_70_94]

9.3.5 When practical activities are not taking place and gas is not in use, the ventilation in Practical Spaces shall be controlled to meet the normal CO_2 levels for teaching and learning spaces as described in Section 5. [PM_35_70_94]

9.4. Carbon Monoxide, Carbon Dioxide and Flammable Gas Detectors

9.4.1. Overview

9.4.1.1 Any carbon monoxide (CO) or carbon dioxide (CO_2) detection system shall comply with a standard suitable for its use and must be regularly maintained. [PM_10_20_82]

9.4.2. Carbon Monoxide Detectors

9.4.2.1 Chimneys/flues shall be designed and installed so that they are in an accessible position that allows for suitable inspection and checking in the future. IGEM/UP/11 recommends CO detection systems are located in any occupied spaces through which or adjacent to which chimneys/flues pass. This protects against leakage from within chimneys which may not always be totally accessible for visual and other inspections. However, for new installations, this practice shall be avoided unless suitable and detailed plans for ongoing inspection and maintenance of the chimney/flue have been developed. [PM_10_20_90]

9.4.2.2 IGEM/UP/11 recommends that CO detectors are located adjacent to kilns and positioned in accordance with the detector manufacturer's instructions. Even during normal use, kilns can produce significant levels of CO as part of the process of obtaining colours in the glazes. [PM_10_20_90]

9.4.2.3 There is no need for CO detection in boiler houses that have been correctly designed and ventilated in accordance with current industry practice (such as the guidance contained in IGEM/UP/10). Where a site-specific risk assessment identifies the need for CO detection in a boiler house, the most suitable form of CO detection equipment shall be determined and shall be installed and located in accordance with the manufacturer's instructions and compliant with relevant standards. CO alarms compliant with BS EN 50291

are specifically designed and tested for domestic and recreational spaces. This standard is not intended for detectors for use in schools or workplaces. [PM_10_20_90]

9.4.2.4 Detectors complying with BS EN 45544-3 shall be used. Note that not all the requirements of this standard may be necessary as the standard covers much more arduous industrial environments than schools. The variety of applications for CO detection within all educational establishment departments requires the selection by a competent person for the most appropriate CO sensor/detector for that location. For example, it could be that a detector declaring compliance with only some aspects of BS EN 45544-3 would be appropriate within a boiler room adjacent to a corridor. Whereas more of the standard might be relevant for a more process combustion orientated location. [PM_10_20_90]

9.4.2.5 CO detectors in new installations shall be hard wired. [Pr_75_50_76_12]

9.4.3. Carbon Dioxide Detectors

9.4.3.1 CO_2 detectors used for gas safety interlocking shall be designed to operate in commercial catering environments. These are required in catering kitchens, science labs, design and technology heat bays and food rooms. They are required to give an audible alarm and be linked with an automatic gas shut off system, which shall be fail-safe and require manual intervention in order to restore the gas supply. [Pr_75_50_76_10]

9.4.3.2 Where CO_2 monitors are used as part of the ventilation control or alarm strategy, the monitors shall be placed in an area that reflects the general CO_2 levels within the practical area or cooking area. Typically, they should be fitted horizontally between 1m and 3m from cooking or practical areas and approximately 2.5m above floor level. They shall not be located in high velocity air streams such as close to the edge of a canopy or adjacent to an air supply or extract position. [Pr_75_50_76_10]

9.4.3.3 CO_2 detectors must be hard wired and installed in accordance with manufacturer's instructions. [Pr_75_50_76_10]

9.4.4. Flammable Gas Detectors

9.4.4.1 Flammable gas detection shall be provided in the boiler room if it is LPG fired or if it is not possible to lock the boiler room. However, all boiler rooms should be lockable. Particular attention needs to be given to the selection and location of flammable gas detection systems where LPG is supplied to boiler rooms. [Pr_75_50_76_33]

9.4.4.2 IGEM/UP/2 gives guidance on boiler rooms that may require flammable gas detection. Information on Risk Assessments is given in IGEM/UP/16. [PM_10_20_90]

9.5. Gas Systems in Food Rooms

9.5.1 Where there are only Type A appliances (i.e., there are no flued gas appliances such as deep fat fryers) interlocking may be achieved by environmental CO_2 monitoring of carbon dioxide as described in IGEM/UP/19. See Section 9.3. [PM_10_20_90]

9.5.2 Reference shall also be made to Section 7.3: Food Room Ventilation and Technical Annex 2I. [PM_10_20_90]

9.5.3 Where agreed by the Employer and the School, gas free, electric based food teaching rooms may be provided. Where schools require pupils to experience a mixture of cooking appliances, traditional electric cookers and induction hobs shall be provided. [PM_10_20_82]

9.6. Science Laboratory Gas Systems

9.6.1. Overview

9.6.1.1 Gas interlocking should be achieved by environmental CO_2 monitoring as described in IGEM/UP/19. See Section 9.2. [PM_10_20_90]

9.6.1.2 Reference should also be made to Section 7.7: Science Fume Cupboard Ventilation and Technical Annex 2I. [PM_10_20_90]

9.6.2. Reference Standards

9.6.2.1 The design and installation of gas services and associated systems shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) All relevant IGEM standards published by IGEM, www.igem.org.uk including the following IGEM standards [FI_70_85]

    i) IGEM/UP/2, edition 3 – ‘Installation pipework on industrial and commercial premises’ [FI_70_85]

    ii) IGEM/UP/3 – ‘Gas fuelled spark ignition and dual fuel engines’ [FI_70_85]

    iii) IGEM/UP/10, edition 4 – ‘Installation of flued gas appliances in industrial and commercial premises’ [FI_70_85]

    iv) IGEM/UP/16 – ‘Design for Natural Gas installations on industrial and commercial premises with respect to hazardous area classification and preparation of risk assessments’ [FI_70_85]

    v) IGEM/UP/11 – ‘Gas installations for educational establishments’, the safety requirements relating to appliances and associated ventilation and interlock systems in teaching environments are covered in detail in IGEM/UP/11 [FI_70_85]

vi) IGEM/UP/19 – ‘Design, specification and application of interlock devices used within commercial and industrial applications including catering’ [FI_70_85]

vii) IGEM/UP/1101 – ‘Guidance on gas installations for the management and staff within educational establishments. This gives advice for school managers and staff which should be included in Building user guides. [FI_70_85]

viii) IGEM/UP/2 gives guidance on boiler rooms that may require flammable gas detection. Information on Risk Assessments is given in IGEM/UP/16. [FI_70_85]

b) BS EN 1266 – ‘Independent gas-fired convection heaters incorporating a fan to assist transportation of combustion air and/or flue gases’ [FI_70_85]

c) BS 6172 – ‘Specification for installation, servicing, and maintenance of domestic gas cooking appliances’ [FI_70_85]

d) BS 6173 – ‘Specification for installation and maintenance of gas-fired catering appliances for use in all types of catering establishments’ [FI_70_85]

e) BS 5440 – ‘Flueing and ventilation for gas appliances of rated input not exceeding 70 kW net’ [FI_70_85]

f) The Gas Safety (Installation and Use) Regulations (SI No. 1866) [FI_70_72]

g) HSE L56 – ‘Safety in the installation and use of gas systems and appliances’ GSIUR, ACOP and guidance [FI_70]

h) BS EN 45544-3. Workplace atmospheres – Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours – Part 3: Performance requirements for apparatus used for general gas detection. [FI_70_85]

10. Thermal Comfort

10.1. Overview

10.1.1 This section uses the comfort category descriptions from BS EN 16798-1, Table 10-1. Note that a space may have different comfort categories for different thermal comfort criteria. For example, sports activities have a category IV for cold draughts, but a category III for the summertime overheating risk assessment. [PM_10_20_90]

10.1.2 To minimise the local heat island effect, the impact of external surfaces on the local microclimate shall be considered. Extensive areas of dark surfaces shall not be situated within 10m of the Building. The colour of building material finishes and their impact on internal temperature should also be considered. For example, air intake louvres and roof coverings. [PM_35_10_13]

10.2. Thermal Comfort Criteria

10.2.1 BS EN 16798-1 thermal comfort criteria are based on the categories shown in Table 10-1. [PM_10_20_90]

Category	Explanation
I - Equivalent to Category A of BS EN ISO 7730: 2005	High level of expectation and also recommended for spaces occupied by very sensitive and fragile persons with special requirements like some disabilities, sick, very young children and elderly persons to increase accessibility
II - Equivalent to Category B of BS EN ISO 7730: 2005	Normal expectation
III - Equivalent to Category C of BS EN ISO 7730: 2005	An acceptable moderate level of expectation

IV - No equivalent category	Low level of expectation. This category shall only be accepted for a limited part of the year

Table 10-1 Categories of space and activity

10.2.2 BS EN 16798-1 gives comfort criteria for both mechanically cooled buildings and for 'free running' buildings. [PM_10_20_90]

10.2.3 A 'free running' building is defined as a building with either natural or mechanical ventilation, which is not actively heated or cooled. [PM_10]

10.2.4 The thermal comfort criteria for schools in this section are based on the adaptive thermal comfort standards for 'free running' buildings outside the heating season; PD CR 1752:1999; BS EN ISO 7730; and BS EN 16798-1; and CIBSE Guidance with local interpretation for children and schools in England. [PM_10_20_90]

10.2.5 For Refurbished Buildings and Remodelled Areas, the minimum standard is Category IV where Category III cannot be met for reasons of practicality and due to the extent of refurbishment. However, after refurbishment the criteria shall not be worse than before refurbishment in any aspect affecting thermal comfort. [PM_35_10_13]

10.3. Operative Temperature Range

10.3.1 Sufficient temperature control mechanisms shall be provided to enable the users to adjust the internal temperature, influence the environment and maintain a satisfactory level of comfort throughout the year. Temperature, ventilation and lighting controls in schools shall be classroom based and simple to operate. [PM_10_20_82]

10.3.2 Any heating system provided shall be designed to achieve the operative temperatures in the heating season listed in Table 10-2. [PM_35_70_36]

Type of space/activity	ADS Code	Normal maintained operative temperature in °C	Maximum operative temperature during the heating season at maximum occupancy in °C
Stores not normally occupied	T1	5°C	N/A

Areas where there is a higher-than-normal level of physical activity (such as sports halls) and sleeping accommodation	T2	17°C	23°C
Toilets, circulation spaces and store rooms that are normally occupied	T3	17°C	24°C
Kitchen preparation areas	T4	20°C	N/A
Spaces with normal levels of activity, including all Basic Teaching Areas (including practical and ICT-rich spaces), study and social space, learning resources, halls used for exams, admin and staff areas and prep rooms.	T5	20°C	25°C
Spaces with less than normal levels of activity or clothing including sick rooms, medical (MI) treatment rooms or therapy rooms, changing rooms and dance and activity studios	T6	21°C	26°C
Special Schools and Designated Units where pupils have physical disabilities or Profound and Multiple Learning Difficulties	T7	23°C	25°C
Where pupils or adults may be wet and partially clothed for a significant length	T8	23°C in changing rooms and no more than 1°C above or below	28°C in changing rooms and no more than 1°C above that of the

of time such as swimming pools.		that of the water temperature in pool halls subject to a maximum of 30ºC	water temperature subject to a maximum of 30°C in pool halls
Where young children or those with physical disabilities may be wet or partially clothed for a significant length of time. More rapid air movement leads to greater chilling by evaporation and to compensate a higher design temperature is required.	T9	25°C The air speed in these environments should be as low as possible and not exceed 0.15 m/s at 25°C	30°C

Table 10-2 Operative temperatures to be achieved during the heating season measured at 1.4m from the floor in the centre of the room

Note: SEND pupils can be very sensitive to temperature and it may be necessary to adjust the normal operative temperature and maximum temperature in the heating season depending on the needs of the pupils.

10.4. Local Thermal Discomfort Caused by Draughts

10.4.1. General Requirement

10.4.1.1 The design of any ventilation system provided, and its control shall avoid cold draughts in the occupied zone. [PM_35_70_94]

10.4.2. Natural Ventilation Systems

10.4.2.1 It is possible with the window opening sizes needed for cross or stack ventilation, with careful positioning of high-level openings and with adequate ceiling heights to provide natural ventilation to teaching spaces. This should be considered before adopting hybrid ventilation solutions. The design of natural ventilation openings shall be based on the temperature difference on a cold still day during mid-season with the heating system switched off. This assessment does not need to consider the velocity of the supply air plume but only its temperature. However, higher air speeds for summer daytime purge cooling of classrooms can be a nuisance (e.g., if papers blow off desks). [Ss_65_40_33_56]

10.4.2.2 When the outside air temperature is 5°C it shall be possible to have the heat emitters switched off and still deliver air to the occupied zone (at seated head height) at a

temperature not more than 5K below the normal maintained operative temperature given in Table 10-2. [Ss_65_40_33_56]

10.4.2.3 Table 10-2 Seated head height shall be taken as 1.1m above floor level for Primary School and 1.4m above floor level for Secondary School classrooms. [Ss_65_40_33_56]

10.4.2.4 For Category I spaces the temperature difference shall be less than 3°C whenever the natural ventilation system is in use. [Ss_65_40_33_56]

10.4.2.5 The line plume calculator shall be used to estimate the temperature of air from high-level openings when it reaches the occupied zone, or alternatively, measurements can be made in test rooms or CFD models can be used. [Ss_65_40_33_56]

10.4.3. Forced Draught Systems

10.4.3.1 In a mechanical system where the driving force for the supply air is a fan, the design shall meet the values given in Table 10-4 for the maximum temperature difference between the operative temperature of the room and the temperature of the supply air jet or plume and the maximum local air speed of the jet or plume for the different comfort categories for schools. [Ss_65_40_33_51]

10.4.3.2 Table 10-4 is based on the comfort criteria in BS EN 16798-1 for mechanical ventilation systems. The comfort categories for cold draughts for different spaces and activities given in Table 10-3 shall be used with Table 10-4. [PM_10_20_90]

Space / activity	Minimum recommended comfort category for draught
Stores, corridors and circulation spaces that are not normally occupied spaces.	N/A
Areas where there is a higher-than-normal level of physical activity (such as sports halls) and sleeping accommodation.	Category IV Low air speeds required for badminton competitions may necessitate ventilation systems being switched off.
Toilets, circulation spaces and storerooms that are normally occupied.	Category IV
Kitchen preparation areas	N/A
Spaces with normal level of activity, including all Basic Teaching Areas	Category III or Category IV where there is local manual

(including practical and ICT rich spaces), study and social spaces, learning resources, halls used for exams, admin and staff areas and prep rooms.	control over the ventilation rate e.g., manually opened windows or room ventilation with on/off and variable speed control.
Spaces with less than normal level of activity or clothing including sick, isolation rooms, changing rooms and gymnasia, and dance and movement studios.	Category II
Special Schools and Designated Units where needs of pupils may be complex and varied, including pupils with physical difficulties or Profound and Multiple Learning Difficulties.	Category I
Where pupils or adults may be wet and partially clothed for a significant length of time, such as swimming pools.	Category II
Where young children under 5 years old or those with physical disabilities may be wet or partially clothed for a significant length of time. More rapid air movement leads to greater chilling by evaporation and to compensate a higher design temperature is required.	Category I

Table 10-3 Comfort categories for cold draughts

10.4.3.3 Category IV shall only be used in classrooms and other Teaching Spaces where there is local control over the room ventilation with variable speed control with override control by the teacher. The air quality criteria regarding CO_2 levels shall still be met. [PM_35_70_94]

Category of space / activity	Winter ΔT (Min maintained operative temp - plume local air temp)	Winter Maximum air velocity (m/s)	Summer and mid-season ΔT (T_{room}, operative - plume local air temp) When T_{room} ≤25°C or T_{comf}	Summer and mid-season Maximum air velocity (m/s)
I	1.5	0.15	1.5	0.15
II	2	0.2	2	0.2
III	3	0.25	3	0.25
IV	4	0.3	5	0.3

Table 10-4 Recommended draught criteria for mechanical ventilation systems to provide thermal comfort

10.4.3.4 Table 10-4 assumes an activity level of 1.2 met, a clo value of 1.1 in winter, 0.9 in mid-season and 0.7 in summer, and a minimum maintained operative temperature as in Table 10-2 in winter, mid-season, and 23°C in summer. [PM_35_70_94]

10.4.3.5 The values in Table 10-4 apply to the supply air plume which delivers air to the occupied zone. The occupied zone shall be taken as from 0.6m to 1.4m above floor level. [PM_35_70_94]

10.4.3.6 Mechanical or hybrid ventilation systems shall provide adequate ventilation without cold draughts during teaching and practical activities in science laboratories and design and technology spaces. However, the cold draught criteria do not apply during purge ventilation. [PM_35_70_94]

10.4.3.7 Higher speeds and larger temperature differences are permitted in winter for boost/purge ventilation in Practical Spaces under the control of the teacher e.g., in science or food rooms. Opening windows shall therefore be provided, preferably providing cross ventilation, to food and science rooms to maximise airflow in summer peak conditions and to purge the space of fumes and heat. [PM_35_70_94]

10.4.3.8 For summertime cooling purposes, higher maximum air speeds are allowed and often preferable (draught becomes pleasurable breeze), but only under the condition that the teacher or the occupants have direct control over the openings or fans. [PM_35_70_94]

10.4.3.9 CFD (Computational fluid dynamics) modelling is not expected to estimate room air speeds. Manual calculations based on manufacturers' information can be used to predict the speeds and they can be measured with an anemometer. Grille manufacturers

supply the necessary tables to predict velocity at the occupied zone. Temperature shall be based on the temperature of the jet and the appropriate entrainment coefficients. If required to measure air velocity, it shall be measured with an omni-directional anemometer with a 0.2s time constant. [PM_40_30_20]

10.4.3.10 The criteria for maximum local air speed and minimum local temperature of the supply air plume can be related mathematically by the method given in BS EN ISO 7730 to obtain a Predicted Mean Vote (PMV) that is related to PPD (percentage of people dissatisfied). This requires the clo value of the clothing and the metabolic rate of the occupants to be known. By using this formula, equivalent conditions to those given in Table 10-4 can be obtained that give the same or a better PPD. [PM_40_30_20]

10.5. Performance Standards for the Avoidance of Overheating

10.5.1 The adaptive thermal comfort method from BS EN 16798-1 together with the guidance in CIBSE TM52 ‘The Limits of Thermal Comfort’ (Technical Memorandum) and CIBSE KS16 ‘How to Manage Overheating in Buildings’ (Knowledge Series) has been adopted by the DfE to address the problem of overheating in Schools. [PM_10_20_90]

10.5.2 The adaptive comfort criteria only apply to ‘free running’ buildings i.e., those without mechanical cooling and with means for the occupants to locally alter conditions i.e., to increase the ventilation rate by means of opening windows or by local room controls. Most schools are ‘free running’ outside the heating season. [PM_35_10_13]

10.5.3 To manage overheating successfully using adaptive thermal comfort it is necessary to allow relaxation of formal dress in hot conditions to encourage individual adaptation to conditions. Where pupils cannot regulate their temperature because of illness or physical disabilities, special measures shall be taken to accommodate their need for a closely controlled thermal environment and to help them to regulate their temperature (e.g., by providing local cooling for their specific needs). This advice shall be given to the School and included in Building User Guide. [PM_35_10_13]

10.5.4 The personal factors identified which contribute to the perception of thermal comfort cannot be directly influenced as part of the design. The provision of adequate ventilation for good indoor air quality and the perception of occupant control together can overcome some personal factors. Such factors as dress codes, activity scheduling etc., shall be considered within the briefing process and discussed with the School management team in order for them to better understand how they influence thermal comfort and to help establish policies on such matters. The School management team can then reduce the risk and impact of overheating in their buildings. [PM_35_10_13]

10.5.5 All occupied spaces shall be provided with ventilation for warmer weather, by using cross and stack flow natural ventilation or ventilation systems with equivalent ventilation effectiveness and night cooling. Cross and stack ventilation strategies normally require smaller ventilation openings than for single-sided ventilation reducing draughts and making it

easier to meet the acoustic requirements for sound insulation of the building envelope. [PM_40_20_94]

10.5.6 The design shall allow air movement to be increased during the summer through opening windows or vents, switching on fans or increasing the rate of mechanical ventilation. Ceiling fans may be used, except in a Special School accommodating pupils who are visually sensitive to the movement or flickering reflections from such fans. [PM_40_20_94]

10.5.7 Buildings shall be assessed for overheating and ventilation openings using dynamic thermal simulation and CIBSE weather files in accordance with the requirements on weather files given in Section 11.5.1. [PM_35_10_13]

10.5.8 Mechanical ventilation shall not be the sole method of summertime ventilation in occupied spaces and there shall be opening windows or vents with sufficient effective opening area. [PM_40_20_94]

10.5.9 In the absence of detailed thermal modelling, openable windows or vents for summertime ventilation shall be sized so that the effective area, A_{eff} is at least 3% of the floor area. (Note that depending on the type of opening, this can imply a physical opening area of approximately 5% of the floor area.) Some designs may result in more effective area than others and smaller effective areas may be possible if the design includes some degree of cross ventilation, atrium assisted stack ventilation or fan-assistance which shall increase the airflow through openings. In all cases, the rooms need to have enough opening area and flow to comply with the summertime overheating criteria below. See Section 11.3 for definition of A_{eff}. [PM_35_10_13]

10.5.10 There are significant differences between the ventilation effectiveness of various types of windows or ventilation openings. See CIBSE AM 10 ‘Natural Ventilation in Non-Domestic Buildings’ (Applications Manual), Section 11.3: Ventilation Opening Areas and BB101. [PM_10_20_90]

10.5.11 Controls shall be provided to temporarily override the mechanical ventilation in each room to switch it on or off. [PM_10_20_82]

10.5.12 Where internal blinds are fitted to windows, these shall not interfere with ventilation. Care shall be taken to avoid flutter caused by ventilation airflow. [PM_10_20_90]

10.5.13 This approach follows the methodology and recommendations of BS EN 16798-1:2019 to determine whether a building overheats or in the case of an Existing Building whether it can be classed as overheating. The criteria is based on a variable temperature threshold that is related to the outside running mean dry-bulb temperature. [PM_10_20_90]

10.5.14 The design shall include an Overheating Risk Assessment (ORA) of ‘free running’ designs by following the procedure set out in this section which is based on CIBSE TM 52 and BS EN 16798-1. [PM_10_20_90]

10.5.15 The design of mechanically cooled buildings shall be in accordance with the CIBSE guidelines for air-conditioned buildings. [PM_10_20_90]

10.5.16 The design shall include calculations of the indoor operative temperatures for each of the months where the Building is in free-running mode on a frequent (e.g., hourly or half-hourly) basis. [PM_40_30_20]

10.5.17 The simulation tool used shall be capable of calculating Operative Temperature, T_{op} and Running Mean Temperature, T_{rm}. T_{op} and T_{rm} are defined in TM52. [PM_40_30_20]

10.5.18 T_{rm} is a running mean of external air temperature and changes on a daily basis. [PM_40_30_20]

10.5.19 Calculations shall realistically account for the occupancy pattern of the Building, heat loads of equipment and the adaptive behaviour of the occupants. See Section 11 for design criteria to be used in ORA calculations. [PM_40_30_20]

10.5.20 The performance standards are based on the adaptive thermal comfort standards described in BS EN 16798-1, CIBSE TM52 and CIBSE KS16. [PM_10_20_90]

10.5.21 For all 'free-running' School buildings, the ORA shall be carried out based on the Categories given below in Table 10-5. [PM_10_20_82]

Type of Space or Activity	**New Build**	**Refurbishment**
Teaching and learning, drama, dance, exams, multi-purpose halls	II	III / IV
Practical activities such as cooking	N/A	N/A
Sports halls not used for exams	III	IV
Working areas e.g., kitchens	N/A	N/A
Offices	II	III/IV
Atria, circulation, reception and corridors	III	IV

- not continuously occupied		
Areas for pupils with complex health needs	I	I

Table 10-5 Adaptive thermal comfort category to apply

10.5.22 In the case of pupils with complex health needs, an assessment of the individual needs shall be made. [PM_10_20_82]

10.5.23 Adaptive comfort thresholds may not be applicable for pupils with complex health needs and fixed temperature thresholds may need to be used. [PM_35_10_13]

10.5.24 Category I for areas for pupils with complex health needs applies only to Designated Units or Special Schools for non-ambulant pupils or those with medical conditions. [PM_35_10_13]

10.5.25 The values for the maximum acceptable temperature (T_{max}) being calculated from the running mean of the outdoor temperature (T_{rm}) and the suggested acceptable range, as given in Table 10-6 below, are as follows: [PM_40_30_20]

$$T_{comf} = 0.33T_{rm} + 18.8$$

and $T\_max = T\_comf + (acceptable\ range\ ^{o}C)$

10.5.26 Therefore, for category II as defined in Table 10-6 below, where the acceptable range is 3°C:

$$T_{max} = 0.33T_{rm} + 21.8$$

(See CIBSE KS16 or TM52 for definition of T_{rm}).

Category	Explanation	Suggested acceptable range in °C
I	High level of expectation and also recommended for spaces occupied by very sensitive and fragile persons with special requirements like some disabilities, sick, very young children and elderly persons to increase accessibility.	+2 / -3°C

II	Normal expectation.	+3 / -4°C
III	An acceptable moderate level of expectation.	+4 / -5°C
IV	Low level of expectation. This category should only be accepted for a limited part of the year.	>+4 / <-5°C

Table 10-6 Suggested applicability of the categories and their associated acceptable temperature range for 'free running' buildings (from BS EN 16798-1: 2019)

10.5.27 The three criteria for overheating are all defined in terms of ΔT, the difference between the actual operative temperature in the room at any time (T_{op}) and T_{max} the limiting maximum acceptable temperature. ΔT is calculated as: [PM_40_30_20]

$$\Delta T = T_{op} - T_{max} \ (^{o}C)$$

ΔT is rounded to the nearest degree (i.e., for ΔT between 0.5 and 1.5 the value used is 1°C, for 1.5 to 2.5 the value used is 2°C and so on)

10.5.28 Three criteria have been developed to indicate when overheating is likely to be problematic. These criteria shall be applied outside the heating season and for the hours of 09:00 to 16:00 Monday to Friday from 1st May to 30th September, including the summer holiday period as if the School was occupied normally through the summer (a lunchbreak between 12:00 and 13:00 with no internal heat gains during this period may be allowed for in classrooms). The three criteria are:

a) The number of hours for which an adaptive thermal comfort threshold temperature is exceeded (total hours of exceedance) [PM_35_10_13]

b) The degree to which the operative temperature exceeds the adaptive thermal comfort threshold temperature (daily weighted exceedance) [PM_35_10_13]

c) The maximum temperature experienced at any occupied time (upper limit temperature) [PM_35_10_13]

10.5.29 The first of these criteria (Criterion 1) defines a minimum requirement for the Overheating Risk Assessment (ORA). [PM_35_10_13]

10.5.30 The two additional criteria (Criterion 2 and Criterion 3) are primarily measures of short-term discomfort and should be reported for information only. [PM_35_10_13]

10.5.31 If a School design fails to meet Criterion 2 or Criterion 3 then designers should consider potential overheating mitigation measures and indicate which are viable for the project. [PM_35_10_13]

10.5.32 The use of these three performance criteria together aims to ensure that the design is not dictated by a single factor but by a combination of factors and allows a degree of flexibility in the design. [PM_35_10_13]

10.5.33 Criterion 1 - Hours of Exceedance (H_e): For Schools, the number of hours (H_e) that ΔT is greater than or equal to one degree (K) during the period 1st May to 30th September for the defined hours inclusive shall not be more than 40 hours. [PM_35_10_13]

10.5.34 Criterion 1 provides an understanding of how often a building in any given location is likely to exceed its comfort range during the summer months (1st May to 30th September). It can provide useful information about the Building's thermal characteristics and potential risk of overheating over the range of weather conditions to which it shall be subjected. Simple hours of exceedance are something that designers are familiar with and provide a good assessment of acceptability over the summer. The defined hours used are the entire period from 1st May to 30th September for the defined hours of 09:00 to 16:00 excluding weekends. Full occupancy is assumed through the holiday period. [PM_35_10_13]

10.5.35 Criterion 2 – Daily Weighted Exceedance (W_e): [PM_35_10_13]

To allow for the severity of overheating the weighted Exceedance (W_e) shall be less than or equal to six in any one day.

Where $We = \sum h_e \, x \, wf = (h_{e0} x \, 0) + (h_{e1} e1 \, x \, 1) + (h_{e2} \, x \, 2) + (h_{e3} \, x \, 3)$

Where the weighting factor $wf = 0$ if $\Delta T \leq 0$, otherwise $wf = \Delta T$ and h_{ey} = time in hours when wf = y

10.5.36 This criterion sets an acceptable level for the severity of overheating and sets a daily limit of acceptability and is based on Method B – 'Degree hours criteria' in BS EN 16798-1:2019. It is the time (hours and part hours) during which the operative temperature exceeds the specified range during the occupied hours, weighted by a factor which is a function depending on by how many degrees the range has been exceeded. The value of the weighting factor is based on the observed increase in the percentage of occupants voting 'warm' or 'hot' on the ASHRAE scale (overheating risk) with each degree increase in ΔT, the temperature above the comfort threshold temperature. [PM_35_10_13]

10.5.37 The value of six is an initial assessment of what constitutes an acceptable limit of overheating on any single day. This initial assessment was made from observations of the temperature profiles from case studies of a range of 'free running' buildings that are perceived to perform well at one end of the range and poorly at the other in regard to limiting overheating. For further information, see CIBSE TM 52. [PM_10]

10.5.38 Criterion 3 - Upper Limit Temperature (T_{upp}): [PM_35_10_13]

To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4K.

10.5.39 Criterion 3, the threshold or upper limit temperature sets a limit beyond which normal adaptive actions are sufficient to restore personal comfort and the vast majority of occupants shall complain of being ‘too hot’. This criterion covers the extremes of hot weather conditions and future climate scenarios. [PM_35_10_13]

10.5.40 These criteria should be the basis of the thermal modelling of the Building, with Criterion 1 defining the minimum requirement for assessing the risk of overheating of School designs. [PM_35_10_13]

10.5.41 In addition, the asymmetric radiation from hot ceilings in single story Teaching Spaces shall be less than 5K in summertime. In order to achieve this hot air shall not be trapped at ceiling level and there shall be an adequate means to extract hot air from the ceiling zone. For example, cross ventilation can provide adequate airflow across the ceiling and prevent a layer of hot air from building up beneath the ceiling. [PM_35_10_13]

10.5.42 Where, after consideration of such measures and taking account of other factors that could restrict the use of natural ventilation (e.g., air pollution, traffic noise etc.) the designer deems that the heat load is such that cooling is required, the designer should consider low carbon cooling systems in preference to conventional air conditioning. Such systems could include using cool water from boreholes or drawing in air through earth tubes. [PM_35_10_13]

10.5.43 Schools shall be designed without the use mechanical cooling in General Teaching Spaces. [PM_10_20_82]

10.5.44 The spaces shall be designed to accommodate ICT equipment heat gains of up to 10W/m² in classrooms or 25W/m² in Practical Spaces without the use of mechanical cooling. [PM_10_20_82]

10.5.45 Practical Spaces are generally larger and have a lower occupancy gain per square metre than General Teaching Spaces which helps to compensate for a higher equipment heat gain. [PM_10]

10.6. Assessment of Performance in Use

10.6.1. Overview

10.6.1.1 Air temperatures rather than operative temperatures shall be used when communicating with the School and to assess thermal comfort in buildings in use as these are easier for the occupants and the facilities management team to understand. If failure

occurs using the criteria based on air temperatures described below then the Contractor or a heating expert should be asked to consider if the Building is overheating. This shall require investigation of operative temperatures and comparison with design predictions. [PM_80_10_60]

10.6.1.2 The Contractor is required to monitor the indoor environment by recording temperature and CO_2 as well as energy consumption as described in Technical Annex 2I. [PM_10_20_90]

10.6.1.3 Performance in use temperatures for assessment of summertime conditions shall be monitored in typical north, south, east and west facing classrooms and in other key spaces such as: atria, dining spaces, libraries, learning resource centres, admin and head teacher's offices, server rooms and reprographics rooms and recorded as part of Building Performance Evaluation. See GDB Sections 2.12.6: In Use Monitoring, 2.13.1.5 and Technical Annex 2K. [PM_10_20_90]

10.6.2. Performance in Use Standard for Overheating

10.6.2.1 The following performance in use (PIU) criteria shall be used.

a) It shall be possible to demonstrate within spaces that are occupied for more than 30 minutes at a time that, during the school day, the average internal air temperature does not exceed the average external air temperature measured over an occupied day by more than 5ºC; both temperatures being averaged over the time period when the external air temperature is 20ºC, or higher, except when the diurnal temperature range (lowest temperature from the previous night to the maximum daytime temperature the following day) is less than 4ºC. [PM_80_10_60]

b) The buildings shall be able to achieve temperatures within the acceptable range, in accordance with the ORA, when windows, fans and ventilation systems are operated to reduce summertime temperatures and the space has the intended number of occupants, numbers and types of computers, data projectors and other ICT equipment. [PM_80_10_60]

c) Note: these overheating criteria are for the thermal comfort of occupants and are not applicable for equipment such as in server rooms. [PM_35_10_13]

d) The extra heat loads from cookers in food and Bunsen burners in science that occur intermittently should be considered separately. [PM_80_10_60]

10.6.2.2 If a space fails the PIU criteria above and the internal recorded air temperatures exceed T_{max} for Cat III, the Contractor shall examine the temperature records and investigate whether or not the Building is overheating and if the Building is performing as designed. [PM_80_10_60]

10.6.2.3 Operative temperatures shall be measured as well as air temperatures in order to compare predicted design and measured temperatures. This can be done using a small black bulb thermometer or specialist electronic instrumentation. See CIBSE KS16 for further information. [PM_80_10_60]

10.6.2.4 The Contractor shall inform the facilities management team that there may be a difference between the air temperature measured in a room and the design temperature (operative temperature). [PM_80_10_60]

10.7. Thermal Comfort for Special Education Needs

10.7.1 For comfort conditions for people with special requirements such as those with physical disabilities, BS EN ISO 7730 refers to BS EN ISO/TR 14415:2005. [PM_10_20_90]

10.7.2 Where pupils have special needs that affect their temperature response, or for very young pupils, an assessment of their particular needs is required which may mean that higher categories of comfort criteria are needed in particular areas of a School or across a whole School. [PM_35_10_13]

10.8. Reference Standards

10.8.1 Thermal comfort performance standards and calculations shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) The clo is a measure of the thermal insulation of clothing. 1 Clo = 0.155m2K/W [PM_10]

b) The diumal temperature is typically 7^{o}C and is >4^{o}C on approximately two thirds of nights i.e., except when there are anti-cyclonic conditions [PM_10]

11. Design Calculations for Ventilation and Thermal Comfort

11.1. Overview

11.1.1 Ventilation and thermal comfort design for teaching and learning activities shall be proved by modelling for the occupied period. [PM_35_10_13]

11.1.2 The modelling assumptions affect the calculation results significantly. For this reason, DfE projects are required to use the following default assumptions regarding the internal conditions in the occupied spaces of the School:

a) Occupied hours: assumed 09:00 to 16:00 Monday to Friday [PM_35_10_13]

b) Occupancy, lighting and small power: set to zero during lunch hour (12:00 to 13:00) in all classroom areas [PM_35_10_13]

c) The School is assumed to be occupied throughout the summer period for modelling of overheating (this provides a degree of future proofing) [PM_35_10_13]

d) An external ambient CO_2 concentration of 400ppm. [PM_35_10_13]

11.1.3 At the detail design stage for New Buildings and major refurbishment or Remodelling, dynamic thermal simulation tools shall be used to assess ventilation, energy performance, summertime overheating and the effect of night cooling. These form part of the Environmental Strategy Report and the Design Calculations described in the DfE's EIR. [PM_10_20_28]

11.2. Ventilation Calculations

11.2.1 CO_2 levels shall be below the required values given in Section 5: Ventilation of Teaching and Learning Spaces. [PM_35_70_94]

11.2.2 Ventilation calculations at concept design stage and scheme design stage need to be carried out for summer, winter and mid-season design conditions to prove that the building can operate satisfactorily throughout the year. [PM_40_30_20]

11.2.3 In addition to the ventilation design for normal teaching and learning activities, the ventilation for specialist needs such as science or DT shall be considered. [PM_35_70_94]

11.2.4 For a natural ventilation system, the design steps given in CIBSE AM10 shall be followed. [PM_10_20_90]

11.2.5 Designs shall provide sufficient openable areas in suitable locations for winter, mid-season and summer conditions; and means by which the occupants can control the openable areas shall be provided. [PM_40_20_94]

11.2.6 The designer should consider the results of the overheating analysis, which may show that higher airflow rates are required for either daytime or night-time cooling at certain times of the year. [PM_40_20_94]

11.3. Ventilation Opening Areas

11.3.1 There are two types of ventilation openings in the thermal envelope of a building, those that are intentional, known as 'purpose provided openings' (PPOs) and those that are unintentional, known as 'adventitious openings'. [PM_10]

11.3.2 Successful ventilation design requires the correct sizing and location of PPOs provided for natural, hybrid and mixed mode ventilation systems. In order to do this the Contractor shall determine the effective area of PPOs. [PM_40_20_94]

11.3.3 For clarity, this specification and BB101 adopt the definitions recommended by the CIBSE Natural Ventilation Group for free area, effective area and equivalent area. See BB101 Annex D: Definition of opening areas. [PM_10_20_90]

11.3.4 Effective area shall be used for the sizing of ventilation openings. [PM_40_20_94]

11.3.5 Effective area (A_{eff}) shall be stipulated on design drawings and ventilation specifications as required in the DfE's EIR. [PM_10_20_28]

11.3.6 Manufacturers should report A_{eff} as a matter of Good Industry Practice to aid selection of the most appropriate PPO. [PM_10]

11.3.7 The effective area of windows and ventilators is obtained by testing the appliances in accordance with BS EN 13141 (2004) and should be quoted by manufacturers. [PM_10_20_90]

11.3.8 In the absence of empirical data from manufacturers, a calculation tool can be used to estimate A_{eff}. It is necessary to use these tools with care and to consider clear opening dimensions rather than structural openings taking into account reductions in opening dimensions due to frames, mullions, cills, reveals and adjacent windows. [PM_40_30_20]

11.3.9 For turbulent flow through a PPO as normally occurs in natural ventilation openings in buildings the airflow is governed by the following equation: [PM_40_30_20]

$$Q = A\_eff \sqrt{(2\Delta P/\rho)}$$

Q = turbulent uni-directional Airflow rate (m^3/s)

A_{eff} = effective area of PPO (m^2)

ΔP = pressure drop across the opening (P_a)

ρ = density of the air (kg/m^3)

11.3.10 This equation applies where flow is fully turbulent, and the coefficient of discharge (C_d) does not depend on the airflow velocity. Where this is not the case as in the case of a single PPO comprised of many small openings in parallel e.g., an insect mesh, then caution is required, and measurements are needed to establish the relationship between airflow rate and pressure difference. [PM_40_30_20]

11.3.11 For fully turbulent flow the effective area of a PPO, A_{eff} is defined as the product of its discharge coefficient and its free area: [PM_40_30_20]

$$A_{eff} = A_f \, x \, C_d$$

A_f = Free area of the PPO (m^2), this is simply the physical size of the aperture (the ventilator) and does not reflect the airflow performance of the ventilator.

C_d = Coefficient of discharge of the PPO. Note that for windows this value changes dependent upon the opening angle and shape.

11.3.12 Some dynamic thermal modelling software uses equivalent area, this term simply compares the PPO opening of effective area (A_{eff}) in question with an opening, which is circular and sharp-edged: [PM_40_30_20]

$$A_{eq} = \frac{A_{eff}}{C_{do}}$$

A_{eq} = Equivalent area m^2

C_{do} = Discharge coefficient of a sharp-edged circular orifice. Designers should check their software documentation for values of C_{do} used, as these can vary between 0.60 and 0.65.

11.3.13 The Contractor shall take into consideration that, the more complicated and/or contorted the airflow passages in a ventilator, the less air shall flow through it. [PM_10]

11.3.14 If airflow occurs both into and out of a space through a single opening on one side of a building (bidirectional flow), the PPO coefficient of discharge shall be reduced to around 40% of the value for unidirectional flow, in part because only half of the ventilation opening is available for airflow into the Building. This shall impact on the effective area of the

PPO. This is explained on pages 45 and 46 of CIBSE AM10 ‘Natural Ventilation in Non-domestic Buildings’, 2005 where it states that in the buoyancy flow equation 4.12 the value of is reduced typically from 0.6 to 0.25. Some software programmes e.g., IES, already allow for this reduction in flow. [PM_40_30_20]

11.3.15 Obstructions to the flow of air (e.g., deep external sills and recesses) shall be taken into account, as these reduce the airflow through the opening. [PM_35_70_94]

11.3.16 Examples of obstructions include cills, recesses and blinds. They can be seen as another airflow obstruction coefficient, and their presence means their impact on the PPO free area should be accounted for to achieve the required effective area. [PM_35_70_94]

11.4. Mechanical Ventilation

11.4.1 Where hybrid ventilation is being proposed, the mechanical ventilation element needs to be modelled correctly. [PM_35_70_94]

11.4.2 If it is supply and extract ventilation, then a fixed or demand-controlled ventilation rate of outside air shall be incorporated in the model. [PM_35_70_94]

11.4.3 If the system is extract only with openable windows, the model shall be set up with a zone exhaust and not an exchange rate to outside. [PM_35_70_94]

11.4.4 Note: For thermal modelling and overheating assessment purposes, mechanical ventilation is classified as ‘free- running’ in the absence of mechanical cooling and tight temperature control. [PM_35_70_94]

11.5. Thermal Comfort Calculations

11.5.1. Weather Files for Overheating Risk Assessment

11.5.1.1 In New Buildings, an Overheating Risk Assessment shall be carried out against a 2°C and 4°C global warming scenario. The following weather files shall be used within the ORA.

a) The 2°C global warming scenario weather file, represented by CIBSE DSY1, 50th Percentile Low Emission 2080, most appropriate to the location of the School building shall be used for the summertime thermal comfort assessment. This does not necessarily mean the nearest location and the file shall reflect the most compatible climatic conditions [PM_35_10_13]

b) Design shall demonstrate that they are able to adapt to overcome overheating when assessed against a 4°C global warming scenario weather file, represented by CIBSE

DSY1, 50th Percentile High Emission 2080, without needing changes to the superstructure and in line with the cooling hierarchy in Section 8.1. [PM_35_10_13]

11.5.1.2 The requirements of this clause shall take precedence over BB101 where there is a conflict. [PM_10_20_90]

11.5.1.3 Intervention in an Existing Building should be relative to the extent of the Works described within the Project Brief. [PM_10_20_82]

11.5.1.4 All Existing Buildings on site shall also be future proofed to avoid the risk of overheating by testing the Building design with the standard defined within Building Bulletin 101 2018. The following weather files should be used within ORA assessments:

a) Existing Buildings shall demonstrate compliance with the current Overheating Risk Assessment (ORA) as established in BB101, using a 2020 DSY weather file most appropriate for that location. [PM_35_10_13]

b) Designs shall also demonstrate that they are able to adapt to overcome overheating when assessed against a 2°C global warming scenario weather file, represented by CIBSE DSY1 50th Percentile Low emission 2080. [PM_35_10_13]

11.5.1.5 CIBSE/Met Office hourly weather data Test Reference Years (TRYs) and Design Summer Years (DSYs) are available for 14 locations across the UK. [PM_10]

11.5.1.6 Proposed adaptation measures shall form part of the Strategic Brief and shall be considered in conjunction with the Project Brief. Adaptation measures should not involve significant changes to the structural configuration of the Building and shall follow the energy hierarchy in the GDB and the cooling hierarchy in Section 8.1 of this Technical Annex. [PM_10_20_90]

11.5.2. Internal Gains for Overheating Risk Assessment

11.5.2.1 Occupancy rates vary depending on the activity present in the room. [PM_10]

11.5.2.2 For a typical Mainstream classroom, 32 occupants shall be allowed with each having a sensible heat gain of 70W and a latent heat gain of 55W (in Primary School settings, a lower sensible heat gain of 60W/pupil may be allowed). [PM_35_10_13]

11.5.2.3 Lighting gains shall be calculated to include all heat gains such as parasitic loads from dimmers and ballasts. [PM_35_10_13]

11.5.2.4 If daylighting is being used to lower the lighting gain, then this shall be justified as being within the software's capability and that it has been properly implemented. If the blinds are included in the window transmission values, then the lights should be assumed to be on. [PM_35_10_13]

11.5.2.5 ICT usage is dependent on the room type being investigated. Typically, a classroom shall have a maximum ICT gain of 10W/m^2, with dedicated ICT rooms and practical rooms with more powerful computers having up to 25W/m^2. [PM_35_10_13]

11.5.2.6 In some rooms, lower or higher equipment gains may be applicable. [PM_35_10_13]

11.5.2.7 The DfE ICT equipment heat gain calculator, available from the tools section of the gov.uk BB101 webpages, can be used to estimate the heat gain from ICT equipment in teaching spaces. Alternatively, the default values in Section 11.5.2.5 can be used. [PM_10_20_90]

11.5.2.8 The calculator allows for the diversity of use and loads. [PM_10]

11.5.2.9 For the purposes of modelling summertime overheating to determine the required size of summertime natural ventilation openings to prevent summertime overheating, the maximum average air speed through the vent should be assumed to be less than 0.8m/s. [PM_35_10_13]

11.5.2.10 Food rooms should be modelled with the same internal heat loads as a standard classroom. The additional load associated with cookers should be assumed to be removed by extract hoods where they are fitted and in use. [PM_35_10_13]

11.5.2.11 Opening windows shall be provided to provide cross ventilation to Practical Spaces to maximise airflow in summer peak conditions. [PM_35_10_13]

11.6. Reference Standards

11.6.1 Design calculations for ventilation and thermal comfort shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) See GVA/15 CIBSE Guide A: 'Environmental Design 2015' Section 4.2 'Ventilation air quality' including equations 4.1 and 4.2. [FI_70]

b) *A review of ventilation opening area terminology,* BM Jones, MJ Crook, SD Fitzgerald, CR Iddon, Energy and Buildings 118 (2016) 249-258 [FI_70]

c) See the Discharge Coefficient Calculator available on www.gov.uk [FI_70]

d) CIBSE Technical Briefing and Testing report on the new weather files. [FI_70] http://www.cibse.org/getmedia/ce7a77e8-3f98-4b97-9dbc-7baf0062f6c6/WeatherData_TechnicalBriefingandTesting_Final.pdf.aspx

12. Public Health Engineering Services

12.1. Overview

12.1.1 Public health engineering includes above and below ground drainage and domestic hot and cold water services. [PM_10]

12.1.2 Any new or extended system shall be fully integrated with existing systems even if outside of project scope. [PM_10_20_82]

12.2. Drainage Systems

12.2.1. Foul Drainage Above-ground

12.2.1.1 The design, supply, installation, testing and commissioning of all necessary above ground soil and waste drainage systems required to drain all of the Building's sanitary fittings and waste shall be carried out. [PM_10_20_82]

12.2.1.2 Wherever possible new draining runs should be connected to the nearest foul drainage outfall from the Site to give a 60-year system design life. [PM_35_10_25]

12.2.1.3 Where it is not possible to connect into the outfall from the Site any existing drain into which a new drainage system is connected shall be:

a) in a suitable state of repair [Ss_50_30]

b) of the correct size to allow for the increased capacity [Ss_50_30]

c) of the correct fall to take account of the lower flow rates from modern sanitaryware to avoid blockages [Ss_50_30]

12.2.1.4 The condition of existing drains shall be assessed via CCTV up to the main utility connection point. [Ss_50_30]

12.2.1.5 Any repairs required to existing drains shall be inspected and validated by a drainage test upon completion to ensure compliance with Building Control requirements. [PM_10_20_82]

12.2.1.6 Pumped drainage shall not be connected into existing gravity fed drainage systems. [PM_10_20_82]

12.2.2. System Description

12.2.2.1 The following requirements shall be met:

a) A soil and waste system shall be provided to collect the soil and waste from WCs, sinks, showers and wash hand basins throughout the Buildings to convey this to the below ground foul water drainage system. [Ss_50_30_04]

b) A soil and waste system shall be provided, based on the single stack principle, with anti-siphon pipework used only where necessary to prevent both induced and self-siphonage occurring thereby reducing the likelihood of trap seal loss. [Ss_50_30_04]

c) Throughout the system, access points shall be provided on all vertical soil stacks at each floor level and in horizontal runs at changes of direction to assist in the maintenance of the system and to aid in the clearing of blockages. [Ss_50_30_04_97]

d) All stub stacks shall incorporate an access cap. [Ss_50_30_04_97]

e) All soil stacks shall rise to roof level where they safely discharge to atmosphere with a durable and secure domical cage which is resistant to bird nesting and movement by vermin. [Ss_50_30_04_97]

f) Automatic Air Vents (AAVs) shall only be used by agreement where there is no practicable way to provide a roof stack (AAVs are only permitted for isolated rooms). Heads of drains in kitchens shall be taken to air wherever possible. [Pr_65_54_93_05]

g) Air admittance valves are permitted for isolated rooms where providing a roof stack is not possible. [Pr_65_54_24_02]

h) Ventilation stacks shall not terminate less than 900mm above the top of any openable window or natural ventilation opening and shall be within a horizontal distance of 3m and shall terminate at least 450mm above the roof level. [Ss_50_30_04_97]

i) Where drainage and discharge stacks pass through occupied spaces, they are acoustically insulated to prevent noise breakout into the space. [Ss_50_30_04_97]

j) The stacks serving laboratory sinks are HDPE or cast iron incorporating chemical resistant EPDM couplings. [Ss_50_30_04_97]

k) Either all laboratory pipework is polypropylene, and a dilution trap fitted before the below-ground drainage connection, or a polypropylene dilution trap is fitted to each laboratory sink. [Ss_50_30_04]

l) No other waste is connected into the above ground drainage runs in a science laboratory. [PM_10_20_82]

m) For kitchens, a suitable method of dealing with fats, oils and grease (FOG) discharge with the system adequately ventilated and meeting the requirements of the Local

Water Authority. Grease interception and/or dispersion may be required. Any grease traps provided are fitted externally to the catering spaces, suitably ventilated to roof level if required, and in an accessible position. Any floor gullies and floor traps shall be easy to maintain. [Ss_50_70_05_22]

n) Waste storage areas have an impervious floor and have the provision for washing down and draining the floor into a system suitable for receiving polluted effluent. Areas outside the waste enclosure drain away from the enclosure. [Ss_50_35_08_30]

12.2.3. Performance Criteria

12.2.3.1 Appliances shall drain quickly, quietly and completely at all times without nuisance or risk to health. [PM_10_20_82]

12.2.3.2 Discharge shall be conveyed without crossflow, backfall, leakage or blockage. [PM_10_20_82]

12.2.3.3 Air from drainage systems shall not enter the Building. [PM_10_20_82]

12.2.3.4 Pressure fluctuations in pipework shall not vary by more than plus or minus 38mm water gauge and traps retain a water seal of not less than 25mm. [PM_10_20_82]

12.2.3.5 Systems shall be adequately tested, cleaned, and maintained. [PM_10_20_82]

12.2.4. Routes

12.2.4.1 Pipe routes shall be of the shortest that are practicable, with the number of bends being kept to the absolute minimum and no bends in wet portions of soil stacks. [PM_10_20_82]

12.2.5. Access Points

12.2.5.1 Rodding and access points shall be provided at all changes of direction to enable the whole system to be maintained. [PM_80_10_50]

12.2.5.2 Access points shall be provided at the foot of all soil and ventilation pipes, local access points and horizontal anti-siphon pipes above fitment flood level. [PM_10_20_82]

12.2.5.3 Access/rodding points shall be located externally or in unoccupied spaces such as cleaners’ stores. [PM_10_20_82]

12.2.6. Rainwater Drainage

12.2.6.1 The following requirements shall be met:

a) All necessary above ground rainwater drainage systems required to drain all the Building's roofs, terrace balconies and paved areas receiving rainfall shall be designed, supplied, installed, tested and commissioned. [Ss_50_30_02]

b) Roof outlets shall be selected to suit the particular roof construction arrangement or system, as the construction of the roof can greatly affect the outlet type used. [Ss_50_30_02]

c) Gutters and downpipes shall be sized according to the design rainwater volumes for the particular location. Consideration shall be given to the area of the roof, the number of outlets or downpipes, the rainfall intensity, the strength and direction of wind and any runoff from adjacent walls. [Ss_50_30_02]

12.2.7. Design Parameters

12.2.7.1 The roof drainage system shall be designed to provide a level of protection against flooding equal to a Category of storm for the particular building with a return period calculated on the advised building life and protection category, in accordance with BS EN 12056-3:2000. [PM_10_20_90]

12.2.7.2 The Design Rainfall Intensity for Road and Paved Areas shall be 50mm/hour. [PM_10_20]

12.2.8. System Description

12.2.8.1 Rainwater pipework shall be robust and durable. [Ss_50_30_02]

12.2.8.2 Internal rainwater pipework shall be avoided to avoid leakage. If internal pipes are selected, they shall be routed to avoid noise sensitive areas and drop to connect to an underground surface water drainage system. [Ss_50_30_02_40]

12.2.8.3 Access points and rodding eyes shall be incorporated into the system to allow full access for maintenance. Access points shall be provided for maintaining all drainage systems including siphonic drainage. [PM_80_10_50]

12.2.8.4 External rainwater pipework shall be located and sized to suit the Building form. [Ss_50_30_02_28]

12.2.9. Drainage Below Ground

12.2.9.1 All necessary below-ground foul and surface drainage systems required to drain all the Buildings' soil vent pipes, stub stacks and rainwater pipes shall be designed, supplied, installed, tested and commissioned. [Ss_50_35_08]

12.2.9.2 Manholes shall not be located in areas likely to be used as pitches. [PM_10_20_82]

12.2.9.3 A trapped roddable floor drain with stainless steel cover shall be provided in the following areas, in addition to those required by specialist plant and equipment including kitchen and refrigeration appliances.

a) General kitchen areas for cleaning and washing down. [Pr_65_52_24]

b) Serving all showers (where these are grouped there can be continuous drainage which serves several cubicles, but water should not have to pass from one cubicle to another for the purposes of accessing a drain). [Pr_65_52_24]

c) Hygiene rooms. [Pr_65_52_24]

d) Where there are clusters of showers, outside the shower area for the purpose of drainage and washing down the floor. [Pr_65_52_24]

e) External lobby areas to changing rooms where the floors cannot be washed as part of the changing room area. [Pr_65_52_24]

f) Specialist DT spaces, especially where these are used for horticulture and clay (where these serve areas that could be used for clay the drain should be trapped to limit the effects of clay on the remaining system). [Pr_65_52_24]

12.2.10. Foul Water System

12.2.10.1 Foul water drainage shall comprise a network of manholes which discharge into the nearest available utility sewers directly by gravity wherever possible, and avoiding the use of sewage ejectors, pumps and holding tanks. [Ss_50_35_06]

12.2.10.2 Each foul water drain point shall connect directly to the external foul water drainage system. Where this cannot be accommodated, particularly in congested areas, internal manhole locations are discussed and agreed with the Employer and shall be suitably located to receive the drains. [Ss_50_35_06]

12.2.10.3 Each internal manhole shall incorporate fully recessed double seal cover with a stainless-steel edge strip and incorporates the final floor finishes within the cover. [Ss_50_35_06]

12.2.10.4 Manholes shall be located externally or in unoccupied spaces. [Ss_50_35_06]

12.2.10.5 Where drains pass through structural faces such as beams a rocker pipe shall be installed to facilitate ground movement. [Ss_50_35_08_30]

12.2.10.6 Rocker pipes shall be installed on all drain entries into manholes. [Ss_50_35_06]

12.2.11. Surface Water System

12.2.11.1 Surface water drainage systems shall collect rainwater from the rainwater pipes and discharge to the surface water drainage system then into either soakaways or the nearest utility sewer network systems. [Ss_50_35_08_85]

12.2.11.2 Each surface water drain point shall connect directly to the external surface water drainage system. Where this cannot be accommodated, particularly in congested areas, internal manhole locations shall be discussed and agreed with the Employer and are suitably located to receive the drains. [Ss_50_35_06]

12.2.11.3 Each internal manhole shall incorporate a fully recessed double seal cover with a stainless-steel edge strip and incorporate the final floor finishes within the cover. [Ss_50_35_06]

12.2.11.4 Manholes shall be located externally or in unoccupied spaces. [Ss_50_35_06]

12.2.11.5 Manholes shall not be located in areas that are likely to be used as pitches. [PM_10_20_82]

12.2.11.6 Where drains pass through structural faces such as beams a rocker pipe is installed to facilitate ground movement. [Ss_50_35_08_30]

12.2.11.7 Rocker pipes shall be installed on all drain entries into manholes. [Ss_50_35_06]

12.3. Domestic Water Services

12.3.1. Cold Water Services

12.3.1.1 A potable/non-potable cold water service system shall be designed, supplied, installed, tested and commissioned, such that it is capable of providing an adequate supply of potable and/or non-potable water to draw off points throughout the Building. [Ss_55_70_38_15]

12.3.1.2 The system shall be designed to a maximum velocity of water in pipework of 2m/sec. [Ss_55_70_38_15]

12.3.1.3 The system shall be designed to a maximum water temperature in accordance with HSE L8 (Legionnaires' disease. The control of legionella bacteria in water systems - Approved Code of Practice and guidance). [PM_10_20_90]

12.3.2. System Description

12.3.2.1 Cold water mains shall be sized to serve the diversified water demand of the School. [Ss_55_70_38_15]

12.3.2.2 The cold water main shall be connected to a sectional GRP twin compartment insulated tank; allow for tank maintenance whilst maintaining the water supply to the Building. This tank is sized to provide storage of 3 l/occupant for nursery and Primary Schools and 5 l/occupant for Secondary Schools. [Ss_55_15_65]

12.3.2.3 Where it is known that the School's pupil intake is phased, the tank capacity shall be variable and be such that the School can easily make adjustments to the stored volume. [Ss_55_15_65]

12.3.2.4 The tank shall be located in a separate plant room from heat producing equipment. [Ss_55_15_65]

12.3.2.5 The incoming cold water main shall be sub-metered at entry to the Building and at the tank inlet to allow monitoring from the Building Management System (BMS). [Ac_05_50_54]

12.3.2.6 The BMS shall be able to show the daily, weekly, monthly and total consumptions for all the water sub-meters as separate items. [Ac_05_50_54]

12.3.2.7 The temperature of incoming mains water and tank storage water shall be recorded on the BMS as live values with trend logging recorded for a period of 10 days on a rolling basis. [Ac_05_50_54]

12.3.2.8 Where a pressurised hot and cold water supply system is provided, see Section 3.8.2. This shall be provided by a booster pump set adjacent to the cold water tank. The set shall be configured to run as duty standby operation. Each pump shall be fitted with anti-surge protection and connected to the low-level probe to the tank to ensure the pumps do not run dry. [Ss_55_70_38]

12.3.2.9 A booster set shall consist of:

a) Inverter driven booster pumps [Pr_65_53_86_66]

b) Expansion vessel [Pr_60_50_20_28]

c) Pressure vessel [Pr_60_50_67]

d) Safety valves [Pr_65_54_95_75]

e) Speed control [Pr_75_51_52_94]

12.3.2.10 Where refurbishment or block replacement projects are being undertaken an assessment of water resilience elsewhere in the School shall determine whether cold water storage is required. Where access for pupils to toilets supplied from tanked supplies exist in other blocks then no additional cold water storage needs to be installed. Where cold water storage is required, it shall be sized based on the maximum occupancy for the block forming part of the Works. [Ss_55_15_65]

12.3.2.11 Pressure regulating valves shall be provided to balance and equalise the pressures throughout the system. [Pr_65_54_95_64]

12.3.2.12 The mains or boosted potable cold water service shall be distributed throughout the Building via ceiling level voids and dedicated service risers to serve sanitary appliances and equipment. They shall not run adjacent to any other piped services carrying hot water. They shall run in a manner that promotes good turnover of water with high use outlets at the ends of the runs. [Ss_55_70_38_15]

12.3.2.13 Where good water turnover within the pipework cannot be guaranteed, a device shall be included for scheduled water changeover within the system using an end of line programmable (adjustable for time and temperature) automatic flushing and recording device, such as Kemper KHS. Monitoring/programming of this device shall be possible from the BMS head end. The volume of stored water within the pipework system shall not exceed 5% of the cold water tank storage volume. [Ss_55_70_38_15]

12.3.2.14 The cold water service shall serve the following fittings:

a) Wash hand basins, sinks and showers [Pr_40_20]

b) WCs [Pr_40_20]

c) Category 5 break tanks, where required to serve fittings with a Category 5 fluid rating (Category 5 break tanks shall be fitted with a sub-meter on their incoming supply and include tank temperature monitoring from the BMS) alongside the device for scheduled water changeover. See clause 12.3.4. [Ss_55_15_65]

d) Mechanical quick fill, plant and equipment. [Ss_55_15_65]

12.3.2.15 The complete installation shall be thermally insulated for frost protection and for anti-condensation purposes. [PM_35_70_92]

12.3.2.16 The taps to wash hand basins shall incorporate a timed flow control in line with Technical Annex 2A. [PM_10_20_90]

12.3.2.17 All sanitary fitting supplies (except WCs) shall incorporate flow regulators ensuring the system is balanced and minimises water consumption. [Pr_65_54_95_31]

12.3.2.18 The taps to sinks shall be non-percussive and appropriate to their intended use. They shall be WRAS or Kiwa KUKreg4 approved and to relevant British Standards. [Pr_40_20_87]

12.3.2.19 An electro-magnetic water conditioner shall be installed within the cold water storage tank room on the boosted cold water supply to prevent scale/calcium build up within the system where the calcium carbonate content of the incoming mains water supply is greater than 200mg/l or 14 on the Clark scale. [Pr_60_55_97_50]

12.3.2.20 The total number of external taps shall be limited to reduce water usage. External taps shall only be provided where a clear use is specified e.g., Green Roofs. A WRAS or Kiwa KUKreg4 approved device shall be fitted. [Pr_40_20_87]

12.3.3. Drinking Water Outlets, Fountains and Bottle Fillers

12.3.3.1 Drinking water outlets and fountains shall be served from a potable water tank or be mains fed. [Ss_40_15_75_25]

12.3.3.2 Drinking water outlets and fountains shall be clearly and correctly marked as drinking water. [Ss_40_15_75_25]

12.3.3.3 Water supplies fed from storage tanks not designed for potable water provision shall be clearly labelled as “not drinking water.” [Ss_55_70_38_15]

12.3.3.4 Drinking water fountains and bottle fillers shall be designed to permit users to recharge water bottles using spigots and the supply system should incorporate a push button or ‘dead’ handle system to minimise spillages and prevent the water supply being left on. [Ss_40_15_75_25]

12.3.3.5 Drinking fountains shall be plumbed in and floor mounted. All plumbing and drainage shall be concealed. Drinking fountains shall be stainless steel with built-in bottle filler, fastened back to the wall. [Ss_40_15_75_25]

12.3.3.6 Bottle fillers shall be suitable for bottle sizes up to 1 litre. [Ss_40_15_75_25]

12.3.4. Science Laboratories and Refuse Areas

12.3.4.1 Water supplies in new science accommodation serving sinks and dishwashers used for science equipment shall be designed to cater for fluid Category 5 back pressure and back siphonage. [Ss_55_70]

12.3.4.2 External bib taps with an adequately protected water supply (Category 5 with a stored volume designed to a minimum i.e.,100 litres) shall be provided, where applicable, for:

a) Refuse areas with washdown facilities for bin stores [Pr_40_20_87_93]

b) Early Years external areas [Pr_40_20_87_93]

c) Outdoor classrooms [Pr_40_20_87_93]

d) Green roof areas to provide irrigation for planting. [Pr_40_20_87_93]

12.3.4.3 The tank and pump shall be accessible for ease of maintenance. [PM_80_10_50]

12.3.4.4 When refurbishing or remodelling science accommodation, the fluid category and the protection against back-siphonage and pressure shall be agreed with the local

Water Company; a fluid Category 4 type installation may be acceptable. Adapters fitted to taps to provide an air gap are not acceptable in science as they prevent many experiments from being carried out. [PM_10_20_82]

12.3.4.5 Water supplies in each science lab shall be provided with central isolation located at the teaching wall. [Pr_65_54_40_44]

12.3.4.6 Water supplies from the Category 5 break tank serving all science accommodation shall include a device for scheduled water changeover within the system using an end of line programmable (adjustable for time and temperature) automatic flushing and recording device (mains powered and hard wired), such as Kemper KHS or similar. Monitoring/programming of this device shall be possible from the BMS head end. This is to prevent water stagnation and to assist the School in managing water quality for this low water use area of the Building. [Ss_55_70_38_15]

12.3.4.7 Refuse areas shall be provided with washdown facilities from an adequately protected water supply (Category 5). The stored volume shall be designed to a minimum i.e., 100 litres. [Ss_55_70_94]

12.3.4.8 Refer to Section 2: Common Requirements for full requirements for cold water services pipework, pumps, and fittings. [PM_10_20_90]

12.3.5. Hot Water Services

12.3.5.1 The Contractor shall design, supply, install, test and commission systems to provide hot water to meet maximum demand at all draw-off points within the Building. [Ss_55_70_38]

12.3.5.2 Hot water system design and installation shall prioritise the use of local non-storage (or low storage) ‘point of use’ electric hot water heaters. This is to reduce standing losses from centralised systems and to prevent pipework heat loss increasing the risk of overheating. [Ss_55_70_38_45]

12.3.5.3 Centralised hot water generator systems shall only be used where:

a) site specific electrical infrastructure limitations are present [Ss_55_70_38]

b) where it is not economically viable or sufficient to support electric hot water heating loads [Ss_55_70_38]

c) a low and zero carbon system is acting as the lead heat source for heating and/or hot water generation and requires to act as the baseload for improved system utilisation (e.g., ASHP, GSHP, solar HWS, CHP or biomass heat sources) [Ss_55_70_38]

d) a large single ‘point of use’ of hot water exists, such as a main cooking kitchen facility and the gas-fired DHWS generator can be located immediately adjacent to it. [Ss_55_70_38]

12.3.5.4 School changing rooms are not typically considered as large single ‘point of use’; ‘point of use’ electric showers shall be provided unless the demand for it can be demonstrated. [PM_10_20_82]

12.3.5.5 Where the usage pattern allows a centralised gas-fired hot water generator system to be provided, it must use a fully condensing burner system, be demonstrated that all system and standing losses are minimised and that the optimum overall energy solution for generating domestic hot water has been provided. [Ss_55_70_38]

12.3.5.6 The following requirements shall be met:

a) Domestic hot and cold water are provided to toilets, changing rooms and showers, kitchens, art and food rooms and cleaners’ stores which have sinks. [Ss_55_70_38]

b) The hot water generating system shall be operated independently of the space-heating system to prevent heat loss increasing the risk of overheating. [Ss_55_70_38]

c) Any other DHW outlet requirement is agreed on a case-by-case basis (e.g., General Teaching Spaces may not require one). [Ss_55_70_38]

d) The Contractor determines the use profile of each outlet. Where there is a low use profile these are to be served by local ‘point of use’ systems. Kitchens and high use areas are to be served using a centralised system. [Ss_55_70_38]

e) Stagnant water in the domestic water services systems is minimised by ensuring that only high water usage areas are on index runs and that areas such as disabled WCs or DWS to classrooms are not on index runs. [Ss_55_70_38]

f) Hot water distribution return service water temperatures are maintained at a minimum temperature of 55ºC. [Ss_55_70_38]

12.3.5.7 To minimise the risk of scalding, all wash basins in Primary Schools, Special Schools and Designated Units shall be provided with fail-safe thermostatic mixing valves to limit the outlet temperature to 43ºC. [Pr_65_54_95_48]

12.3.5.8 All showers shall be provided with thermostatic mixing valves set at 43ºC. [Pr_65_54_95_48]

12.3.5.9 Taps to kitchen sinks and cleaners’ sinks shall receive the water at the full stored water temperature. [PM_10_20_82]

12.3.5.10 The system shall be designed to the following parameters:

a) Maximum velocity of water in pipework: 2m/sec [Ss_55_70_38]

b) Maximum storage water temperature: 65°C. [Ss_55_70_38]

12.3.5.11 Refer to Section 2: Common Requirements for full details for hot water services pipework, pumps and fittings. [PM_10_20_90]

12.3.6. Reference Standards

12.3.6.1 The Contractor shall ensure that the design and installation of the public health engineering systems shall comply with the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) The Water Supply (Water Fittings) Regulations [FI_70_72]

b) The Building Regulations AD H and AD G [FI_70]

c) BS 8558 – 'Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages' [FI_70]

d) BS EN 806 – 'Specifications for installations inside buildings conveying water for human consumption' [FI_70_85]

e) BS EN 752 – 'Drain and sewer systems outside buildings' [FI_70_85]

f) BS EN 1610 – 'Construction and testing of drains and sewers' [FI_70_85]

g) BS EN 12056 – 'Gravity Drainage systems inside buildings' [FI_70_85]

h) BS EN 12056-1 – 'Gravity Drainage systems inside buildings. (General and performance requirements)' [FI_70_85]

i) BS EN 12056-3 – 'Roof Drainage, Layout and Calculation' [FI_70_85]

j) BS EN 12056-2 – 'Gravity Drainage systems inside buildings. (Sanitary pipework, layout, and calculation). Calculations to be based on System III Single Discharge Stack with Full Bore Discharge Pipes' [FI_70_85]

k) BS EN 12056-5 – 'Gravity Drainage systems inside buildings. (Installation and testing)' [FI_70_85]

l) BS 8000-13 – 'Workmanship on Building Sites. Code of Practice for Above Ground' [FI_70]

m) BS EN 12354-1 – 'Building Acoustics. Estimation of acoustic performance in buildings from the performance of elements' [FI_70_85]

n) HSE L8 – 'Legionnaires' disease. The control of legionella bacteria in water systems Approved Code of Practice and guidance' [FI_70]

13. Handover Requirements

13.1. Overview

13.1.1 The detailed requirements for handover are set out in the Handover Completion Checklist. [PM_10_20_82]

13.1.2 The following section outlines the handover requirements in relation to mechanical services. [PM_70_85_35]

13.1.3 A 7-day period of ‘soak testing’ shall follow on from the successful commissioning and testing activities. [PM_70_15_82]

13.2. Soak Testing

13.2.1 A soak test of all the mechanical services in their normal/auto operation mode shall be carried out, prior to Completion, as if the Building were occupied and in use. [PM_70_15_82]

13.2.2 The soak test shall be programmed to occur after completion of all setting to work, commissioning and testing of the mechanical services and is to prove their reliability and correct calibrations over a continuous period of 7 days. [PM_70_85_35]

13.2.3 Practical completion shall not be granted until a successful soak test as described here has been achieved. [PM_70_15_82]

13.2.4 It is not necessary to install additional dummy heat or cooling loads into rooms to prove system performance at the maximum design. [PM_10_20_82]

13.2.5 During the 'soak test' all mechanical systems shall be fully energised and placed in their normal/auto operation mode with all normal occupied time settings applying to:

a) Heating system [Ss_60_40_37]

b) Domestic hot and cold water [Ss_55_70_38]

c) Drinking water services [Ss_55_70_38]

d) Gas services [Ss_55_20_34]

e) Ventilation systems [Ss_65_40]

f) Control systems [Ss_75_70]

g) Energy metering and monitoring systems [Ss_75_70_54]

h) Cooling systems. [Ss_60_40_17]

13.2.6 The soak test shall meet the following requirements.

a) The test shall be included in the programme for the Works and shall continue until seven continuous days of plant operation have occurred without fault or failure of any component/function. [PM_70_15_82]

b) Monitor all functions (pressures/temperatures/CO_2 levels/starts per hour/energy and water use) which shall be trend logged using the microprocessor controls equipment where installed. [Ac_05_50_54]

c) Each type of space served by the plant and equipment shall be monitored using data loggers (supplied by the Mechanical or Electrical Contractor) or the BMS system to verify performance. [Ac_05_50_54]

d) Specified noise performance surveys shall be carried out during this period. [Ac_15_55_04]

e) All data and monitoring results shall be provided to the Employer in Excel spreadsheet format (electronic and hard copy) along with details of any faults arising and corrective action taken. [Ac_05_50_54]

f) Should the soak test fail for any reason, then the results shall be null and void and the test period shall re-commence upon rectification of the problem/failure. [PM_70_15_82]

g) All costs associated with the soak test, such as test equipment, attendance and supervision shall be at the Contractor's expense. [PM_70_15_82]

h) Costs incurred as a result of or a consequence of having to restart the soak test shall be at the Contractor's expense. [PM_70_15_82]

i) The soak test results shall be included in the Health and Safety File. [PM_70_15_82]

13.3. Documentation

13.3.1 A user-friendly Building User Guide including details of all user controls shall be provided in hard copy and electronic format as detailed in the DfE's EIR. [PM_10_20_28]

13.4. Commissioning and Building Performance Evaluation

13.4.1 The Building Services engineering systems shall be fully tested and commissioned in line with all relevant current regulations, Standards and guidance documents including those detailed in the Reference Standards, Section 13.6. [PM_10_20_90]

13.4.2 The Building Services systems shall be commissioned such that where systems interact with each other they are commissioned at the same time in order to simulate this interaction. [Ac_75_65_15]

13.4.3 Seasonal commissioning and performance testing/proving shall be undertaken during the 12 months defects liability period in order to fine tune the systems for optimum performance and energy consumption in accordance with BSRIA BG 44/2013. [PM_10_20_90]

13.4.4 Pre-commissioning, commissioning and seasonal commissioning on all aspects of the heating system and main plant shall be conducted in line with BSRIA BG 2/2010, BSRIA BG 44/2013 and the CIBSE commissioning code. [PM_10_20_90]

13.4.5 A notice period of 1 week shall be provided to the Employer's engineering representative for witnessing. [PM_10_20_82]

13.4.6 The results of the commissioning and performance testing shall be recorded in line with BSRIA Building Applications Guide BG2/2010 and provided as part of the Operation and Maintenance (O&M) Manual documentation. [PM_10_20_90]

13.4.7 The Building Performance Evaluation (BPE) shall be carried out in accordance with Section 8 of the GDB. [PM_40_60_62]

13.5. Demonstration and Training

13.5.1 The Employer shall appoint and/or nominate an appropriate candidate(s) to receive training by the Contractor on the Building Services engineering systems. [PM_70_85_55]

13.5.2 All Building Services engineering systems, controls adjustment procedures, optimum settings and maintenance procedures shall be demonstrated to the Employer's appointed representative/s. [PM_70_85_55]

13.5.3 The functioning/calibration of the installed energy sub-metering shall be demonstrated along with the automatic uploading of data using the iSERV methodology to the national benchmarking database. See Technical Annex 2H. [PM_10_20_90]

13.5.4 Training shall be provided for the appointed representative to receive training and demonstration on the energy monitoring system. [PM_70_85_55]

13.5.5 The Operation and Maintenance (O&M) Manuals shall be available during the training and demonstration to ensure that the appropriate and correct documentation has been included. [PM_70_85_55]

13.6. Reference Standards

13.6.1 The handover, documentation and commissioning of the Building Services engineering installation and design shall comply with all relevant regulations as well as the relevant parts of the standards as listed below, and any updated versions of these standards. [PM_10_20_90]

a) CIBSE Commissioning Codes. [FI_70]

b) BSRIA BG 2/2010 – ‘Commissioning Water Systems’. [FI_70]

c) BSRIA BG 44/2013 – ‘Seasonal Commissioning’. [FI_70]

d) CIBSE KS09 – ‘Commissioning variable flow pipework systems’. [FI_70]

e) BSRIA BG49/2015 – ‘Commissioning Air Systems’. [FI_70]

14. Demonstrating Compliance

14.1. Overview

14.1.1 The Contractor shall demonstrate compliance with the Employer's Requirements by use of protocols detailed in the Contractor's Quality Assurance procedures capturing evidence of both coordinated design and its implementation into the construction of the School Building(s) with photographic evidence and / or third-party accreditation. [PM_70_15]

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