Department for Education

Further Education Output Specification

Technical Annex 2I: Controls

November 2022

Document Control

Revision	Status	Date	Author	Amendment
C01	A	2021-11-09	ARA / ASP	First issue
P01	S2	2022-09-06	AWI	Amendments made at: 2.1.6 & 2.5.1
C02	A	2022-11-25	AWI	Gov.uk publication

Contents

Table of Figures

Summary

Technical Annex 2I provides the minimum requirements for controls for mechanical, electrical, fire and security systems. It is to be read in conjunction with the Generic Design Brief (GDB) and the College-specific Brief (CSB).

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 college 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 Further Education 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 Further Education Output Specification (FE-OS) Technical Annexes that forms part of the Generic Design Brief (GDB). [PM_10_20]

1.1.2. The definitions listed in the GDB shall apply to this Technical Annex and all other parts of the FE-OS. [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 College-specific Brief (CSB), including the College-specific Annexes. [PM_10_20]

1.1.4. This document sets out the required technical standards and performance criteria for controls. [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]

1.2. Refurbishment

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

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

a) Renewed controls shall be designed to satisfy the relevant outputs of the GDB as well as this Technical Annex (and by code in the ADS where relevant). [Ac_10_70_70]

b) Replaced controls shall satisfy the relevant outputs of the GDB as well as this Technical Annex (and by code in the ADS where relevant), as far as possible within the constraints of the location, the adjacent elements and the sub-structure. [Ac_10_70_70]

c) Repaired controls shall comply with the specifications in any project specific drawing issued as part of the CSB. The overall performance after repair shall be at least as good as that of the existing provision. [Ac_10_70_70]

d) Retained controls shall be left as existing, with minimal work required unless needed in order 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) Elements requiring ‘No Work’ shall be left as existing. [Ac_10_70_70]

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

1.2.4. The requirements in this Technical Annex apply to all parts of the Works except any controls that are designated Repaired, Retained or ‘No Work’ in the RSoW, or spaces designated ‘Untouched’ in Annex CS1. [PM_10_20_90]

2. General Philosophy and Strategy

2.1. General Requirements

2.1.1. The following section outlines the general philosophy and strategy for the controls and relevant associated systems. Project specific details shall be defined within the CSB. [PM_40_30_52]

2.1.2. The purpose and requirements of the control system are as follows:

a) Occupant comfort - to maintain the environmental internal conditions that are appropriate to the activity within the space. [PM_40_30_52]

b) Energy and carbon emissions - to reduce energy consumption and carbon emissions through efficient use of installed Building Services systems. [PM_40_30_52]

c) Space flexibility - the environmental conditions of the internal spaces shall be flexible where required. [PM_40_30_52]

d) Safe operation - The Building Services systems shall be safe to operate and maintain. [PM_40_30_52]

e) Information - to inform the end users about the environmental conditions that affect their thermal comfort. This also extends to informing the end users about energy consumption and carbon emissions. [PM_40_30_52]

2.1.3. Building Services control systems in education buildings shall be appropriate to the proposed application. [PM_40_30_52]

2.1.4. Building Services control systems shall be as simple as possible and complex inter-connected control systems are to be avoided. [PM_40_30_52]

2.1.5. The control of the Building Services systems shall be operable within the affected space and local to the end users. [PM_40_30_52]

2.1.6. The controls and monitoring arrangements shall meet the requirements listed in Table 1, which provides a summary of the expectations for education buildings. Partial education building projects shall be integrated with the controls, monitoring systems and site-wide controls and monitoring strategies e.g., BMS systems and alarm systems of an existing education building, as far as possible, and shall meet the relevant parts of the Table for any New and Refurbished Buildings. [PM_40_30_52]

SYSTEM	REQUIREMENT
Heating circuits – Weather compensation	• Centralised control from heat source/boiler control panel either optimiser or time clock control with automatic daylight-saving correction (BST/GMT changeover). • Boiler control should be weather compensated as well as based on spaces served e.g., if all AHUs or sensors/thermostats indicate no heat required then heating boiler and pumps should turn off. Provide demand led control strategies where appropriate to minimise the call on central mechanical plant during low building load demands.
Heating circuits – Zoning	• To allow operation of rooms out of normal core hours without heating the whole building. • As a minimum the zones listed in paragraph 2.4.2. • Any key rooms that are used outside normal core hours e.g., nursery, community facilities, lecture theatres, vocational and catering facilities or admin offices identified in the CSB and shall be zoned separately.
Heating, ventilation and domestic hot water – Central time and temperature control	Central time and temperature control to suit building occupation pattern • Control panel(s) located in the plant room(s) with BMS time schedule for out of hours/additional usage via BMS head end or local interface display panel. • Ensure centralised control of all Building Services to the level of master control i.e., on and off times which are capable of being set and overridden by a non-expert. Plant run time extension • Manual operation of plant extension via BMS head end or local BMS user interface display. • All alarms to be monitored during extension period.
Centralised ventilation system	• Trend logging and indication from a central point (BMS) of all supply temperatures, return temperatures, CO_2 hours run with monthly automatic data upload to iSERV. • Filter status indication. • Supply/extract fan status indication. • Control and monitoring of night purge ventilation and free cooling.

SYSTEM	REQUIREMENT
Local/ room based ventilation system	• Manually openable windows. • Teaching-controlled automatic window actuators, manual control or demand control based on CO_2 levels. • Local control with display of space temperature and CO_2 levels and trend logging where demand control is provided. • Monthly automatic data upload to iSERV. • Filter status indication. • Control and monitoring of night purge ventilation and free cooling. • All associated central plant (heat source/boiler, pumps etc.) enabled for core hours only from central control, depending on zoning. • Mechanical ventilation enabled centrally where more than 10 teaching spaces. • Dust and fume extract systems for: D&T equipment, 3D printers, laser cutters, photocopiers – local stand-alone control and interlocked with BMS where required for safe operation. • Kitchen ventilation and extract systems – local stand-alone control interlocked with gas supplies (where provided) and ventilation system(s) operating status monitored via the BMS, allowing variable speed control of the supply and extract system with marked position settings for ‘off, cold prep, hot prep and maximum’.
Temperature monitoring	• External air temperature. • Internal temperatures of each heating zone via the BMS and monthly automatic data upload to iSERV. • Domestic hot water flow and return via BMS. • Domestic hot water storage vessel temperatures • Heat pump flow and return via BMS • Thermal store high, mid and low level via BMS • Thermal store secondary flow and return via BMS • Boiler primary and secondary circuits heating flow and return via BMS. • Incoming mains water, main cold-water storage tank and any Cat 5 cold water break tanks via BMS.

SYSTEM	REQUIREMENT
	• Internal temperatures of each Classroom, Hall (Large Spaces) and Catering Facility via the BMS and automatic monthly data upload to iSERV.
Local control of temperature – classrooms, practical spaces	• Override of centrally set temperature by +/-2°C to provide local comfort adjustment through TRV or space sensor/thermostat. TRVs shall be lockable and set to allow occupant control up to 20°C or the normal maintained temperature for the space.
Boilers/heat source	• Minimum 2 boilers/heat source. • Fully modulating burners/control. • Automatic lead/lag sequence control/cascade. • Boiler/heat source fault. • Hard wired boiler/heat source plantroom safety circuit operated e.g., fire or refrigerant gas detection.
Heat pump systems	• Heat pump systems shall be supplied with a packaged control system with industry standard open protocol communications capability with the BMS. • Redundancy: Electric immersion heaters within direct storage vessel(s), replicating the heating supply from the heat pump system as a minimum. • Twin head pumps (with the exception of the single head pump included as part of the heat pump hydraulic system. • Two direct storage vessels. • Heat pump system heat meters to demonstrate BMS fault and system enable signal. • Indirect water heater control with HWS priority. • Anti-legionella programme. • Heat pump systems shall be enabled via a BMS time zone. • The BMS shall be capable of changing setpoints and control modes, monitor fault codes, alarm status and system information data feedback. • Hard wired interface to BEMS e.g., Enable, Fault, Run and Control Setpoint. • Open protocol communications to BMS e.g., compressor status, water pump status, pressure probe values etc. Final open protocol points shall be agreed with the client. • Monthly data upload to iSERV.

SYSTEM	REQUIREMENT
Emergency shut off	• Shut off at point of entry to Building for main incoming gas/water/electricity/oil supplies.
Pumps	• Duty and standby with auto changeover rotation for heating, sewage etc. • Each pump to have hand/auto/off local control for heating, HWS, boosted CWS, sewage etc. • Indication of pump failure at BMS/boiler panel/locally.
Pressurisation sets	• Pressurisation set fault. • System high/low pressure alarm. • Hard wired Interlock to heating plant and pumps.
Submetering	• Meters for: - gas to boilers - gas to kitchen - water supply – at building entry, at each cold-water storage tank or Cat 5 break tank - Heat meters - main electrical intake - kitchen general power - external lighting/power - HVAC control panel for centralised mechanical ventilation systems - server room general power - plant room general power - each floor general power - each floor lighting - any low or zero carbon energy sources except biomass. - EV charging points • Trend comparison between each day/week for all meters. • Local display on the submeter with centralised recording, monitoring and trend logging, with sampling at a minimum of every 15 minutes. • Automatic monthly data upload from all submeters to iSERV.

SYSTEM	REQUIREMENT
Fire strategy	• Fully addressable centralised alarm panel located in reception. • Interlocks as part of fire safety strategy: door hold-open devices/kitchen ventilation/gas solenoid valve/ventilation systems. • Break glass units or smoke or heat detectors. • Fire shutter activation. • Smoke clearance system. • Sprinkler system interlink. • Pressurised stairwells.
Emergency lighting	• Local testing facility/self-testing or centralised testing via lighting control system, not via BMS.
External lighting	• Local photocell or time clock.
Lighting	• Manual local switching to each room or presence/daylight control. See Technical Annex 2E.
BMS	• Provided for all education buildings with system heating loads. Graphics to be provided for each major plant item; menu driven for selection; monitoring and control of all major plant items; global and individual control and adjustment of operating times/temperatures for each operating zone; monitoring and reporting of fault/trip conditions and critical alarms. • Boilers/heating schematic; ventilation schematic; domestic hot and cold-water schematic; gas schematic; electrical schematic, sub-metering and energy graphic/dashboard. All graphics to show live values and allow historical review of energy usage for the previous 2-week period as a minimum. • Automatic uploading of sub-metering, Teaching space, Hall (Large Spaces), Lecture Theatre, Workshop and Catering Facilities temperatures and CO_2 data on a monthly basis to iSERV or similar approved system to allow data analysis with feedback to Teaching staff for monitoring and benchmarking purposes and to assist with the formal BPE reviews at 6 and 12-months following handover. • The system shall provide all the functions of the management system in the form of a web browser over the network. The web server shall be accessed simultaneously

SYSTEM	REQUIREMENT
	by different users in independent sessions on any personal computer on the network. • The system shall be able to support operation via Terminal Services (Web Browser). The remote clients shall use standard Microsoft Internet Explorer version 8 or greater to connect to a central server on which the BEMS software shall operate. • This configuration shall allow remote access to all BEMS functionality, according to the remote user's access profile as defined within the BEMS Management station. • Option to provide a BMS head end and access information via a user interface display on the plant room(s) control panel(s).
Lifts	• Stand-alone local control.
Automatic doors/gates	• Stand-alone local control unless a site-wide door access control system is specified as a result of the security risk assessment and included in the CSB.
Access controls	• Stand-alone local control unless a site-wide door access control system is specified as a result of the security risk assessment and included in the CSB.
Domestic hot water	• Local control point of use or centralised system with local TMVs. • Anti legionella programme.
Cooling	• Passive cooling except for server rooms. • Local control of DX/AC units, where fitted in server rooms etc and shall be provided with run/fault status via BMS.
Blinds	• Local manual or electric control.
Local emergency knock off of gas/electricity	• Local gas knock-off buttons at entrances/exits to kitchen. • Emergency gas/electricity knock-off in science, design and technology. See section 3.5 'Gas Services Controls' and section 3.6 'Electrical Services Controls'.
Local extract in toilets, chemical stores, workshops and LEV systems	• Single toilets to have local stand-alone control or via BMS time zone. Where twin fan toilet extract fan units are employed operate via a BMS time zone and monitor fan status. For chemical store fans via BMS for 24/7 operation and monitor fan failure status.
Security: intruder	• See Technical Annex 2G.

SYSTEM	REQUIREMENT
alarms, panic alarms	
Disabled toilet alarms	• Stand-alone system.

Table 1 Summary of Requirements for Control and Monitoring

2.2. Site-wide Strategy

2.2.1. The Site as a whole shall be considered when assessing the controls strategy. [PM_10_20]

2.2.2. A viable strategy shall be in place to fully support the BMS control system and associated peripheral devices for a period of 10 years after handover. This strategy shall ensure that the BEMS and associated peripheral devices can be upgraded and maintained without having to replace or re-commission main component parts including the main BMS servers, outstations and communications interfaces. [PM_10_20_82]

2.2.3. Details of the life cycle costs for the proposed BMS control system shall be provided including commercial and technical details about how the system should be maintained after the project completion/handover. This shall include indicative costs and recommended spares holding, client training, proposed planned and reactive maintenance plans including emergency call outs etc. [PM_10_20]

2.2.4. Simplicity and ease of use should prevail when designing the site-wide strategy. [PM_10_20]

2.2.5. The site-wide controls strategy shall take into account the occupied periods of the various zones and offer an energy efficient solution. [PM_40_30_52]

2.2.6. All control systems shall allow for optimum start up and shut off. [PM_40_30_52]

2.2.7. The control systems for relevant plant items shall be interlinked with the fire alarm interface in accordance with the fire strategy to shut down plant in the event of fire as required. [PM_35_30_30]

2.2.8. The following sections detail Building Services that may be controlled on/at a local level. There are some systems that are not appropriate for local control and shall be controlled and planned on a site-wide or building-wide scale to have a coordinated strategy. The following systems shall be controlled on a site-wide or building-wide scale:

a) Fire detection and alarms [Ss_75_50_28]

b) External lighting [Ss_70_80_25]

c) Security [Ss_75_40]

d) Access control: where there are existing site-wide access control systems on the Site, these shall integrate with the existing systems. Where this is not feasible the Contractor shall notify the Employer. [Ss_75_40_02]

2.3. Building Management Systems

2.3.1. A Building Management System (BMS) shall be provided for all education buildings. [Ss_75_70_54_10]

2.3.2. The BMS shall ensure the controlled plant shall operate safely, reliably and in an energy efficient manner. Control strategies shall be based on BSRIA 'AG7/98 Library of System Control Strategies'. The control system shall be complete with required outstation control panels, data network, all sensing devices, final control element devices (valves, dampers etc), actuators, control wiring and containment to form a complete working installation. [Ss_75_70_54_10]

2.3.3. Each BMS controller shall have at least 20% spare capacity for future expansion. The use of digital input multiplexers and/or relay modules to increase the overall controller point capacity, connected from either analogue or digital outputs of the main BMS controllers, SHALL NOT be accepted as a means of meeting the spare capacity requirement. [Ss_75_70_54_10]

2.3.4. Only main manufacturer I/O expansion modules shall be used in conjunction with the BMS controllers, the use of third-party manufacturers I/O expansion modules SHALL NOT be accepted. [Ss_75_70_54_10]

2.3.5. The BMS shall utilise the latest generation BACnet ‘open’ communication protocols as defined in ANSI/ASHRAE Standard 135-1995 to minimise the cost of providing integration and to allow interoperability between building systems and control vendors. [Ss_75_70_54_10]

2.3.6. The BMS shall employ EMC measures to meet the requirements of the EMC directive. [Ss_75_70_54_10]

2.3.7. Suitably rated Type 3 surge arresters complying with BS EN 62305-4 shall be connected to the main BMS control panel incoming power supply. [Pr_65_72_27]

2.3.8. A comprehensive graphics package shall be provided. Provision shall be made to display the current real-time status of every monitored point and every command output. This shall include all hard-wired physical points and all open protocol points associated with the BEMS interfaces to other control systems. The graphics package shall be developed

with the client. Floor plans and main plant systems may require more than one graphic to clearly display all control and monitoring data. [Ss_75_10_68_42]

2.3.9. Plant Graphics shall:

a) Update with live information within 5 seconds of being loaded. [Ss_75_10_68_42]

b) Show a schematic representation of the plant layout. [Ss_75_10_68_42]

c) Show the current value and status of all analogue, digital and open protocol points. [Ss_75_10_68_42]

d) Show the current value of all control set points e.g., temperature set points. [Ss_75_10_68_42]

e) Show the current operating status of the plant. This must be taken from the control software and must be used to inform the system users of the plant mode of operation i.e., normal operation, set back operation, frost protection etc. [Ss_75_10_68_42]

f) Provide the facility to manually adjust all set points. It shall be possible to manually alter all control setpoints via the graphics subject to password access levels. [Ss_75_10_68_42]

g) Provide the facility to override plant on/off, or valves open/close etc. It shall be possible to manually alter the status of every monitored point and every command output from the graphics subject to password access levels. [Ss_75_10_68_42]

h) Provide the facility to start and stop individual plant items via a single software override switch on the associated plant graphic. This shall allow the user to start and stop a ventilation system from a single software switch without having to open the dampers, start fans etc. A start/stop override switch shall be provided for each plant item. [Ss_75_10_68_42]

i) Provide graphic chaining or linking to allow the operators to logically navigate through the system, without having to constantly return to the main menu. [Ss_75_10_68_42]

2.3.10. The graphical displays shall use object-oriented icons, to provide a clear user display. The graphical icons shall be "intelligent" and capable of displaying a number of states per point, in a consistent format. It shall be possible to display a number of graphics pages simultaneously, with all open pages being dynamically updated. [Ss_75_10_68_42]

2.3.11. Graphics icons should conform to DIN and ASHRAE Standards and shall have a consistent "look and feel". [Ss_75_10_68_42]

2.3.12. Graphics pages shall support a number of file formats for background images e.g., AutoCAD, for the display of building floor plans. [Ss_75_10_68_42]

2.3.13. Measured values, set-points, operating modes and alarms shall be displayed in real-time and updated continuously. Changes shall be indicated either by the object symbol e.g., through animation, a change in the colour, shape or text of the affected values. [Ss_75_10_68_42]

2.3.14. Lighting controls and fire and security systems shall be independent of the BMS. [PM_10_20_82]

2.3.15. On smaller projects where BMS is not involved, controls shall be simple stand-alone controllers or Programmable Logic Controllers (PLC). Web based monitoring of systems is an alternative for BMS for local monitoring. [PM_10_20_82]

2.3.16. The use of BMS should only be used in preference to a simpler system in a small building where it can be demonstrated that the BMS shall provide greater benefit to outweigh the drawbacks of the BMS being a more complex system to operate and maintain. [Ss_75_70_54_10]

2.3.17. On very small installations, a domestic-type control system or the boiler manufacturer’s own controls may be sufficient, so long as the College is given the additional facility to select a holiday period with frost protection. [PM_10_20_82]

2.4. Zoning

2.4.1. The education building shall be zoned appropriately to ensure that:

a) spaces are flexible in use [PM_10_20_82]

b) spaces can be used in isolation out of hours where required [PM_10_20_82]

c) services shall be capable of being controlled to account for differing weather/solar gain characteristics. [PM_10_20_82]

2.4.2. As a minimum, the heating and cooling shall be zoned so that the following are provided with separate zones:

a) Sports facilities, including change areas and toilets. [PM_10_20_82]

b) Large Spaces (e.g., Lecture Theatres), catering facilities, and toilets and connecting corridors. [PM_10_20_82]

c) Other spaces as identified in the CSB [PM_10_20_90]

d) Each floor/level of the Building except in Buildings under 500m². [PM_10_20_82]

2.4.3. If centralised mechanical ventilation is used, the same zones shall be provided as that for heating or cooling. However, the zones for mechanical ventilation may not be provided through separate systems but can be met through dampers and other controls methods. [PM_10_20_82]

2.5. Submetering Requirements

2.5.1. Submeters shall include but not be limited to:

a) Gas to boilers [Pr_80_51_51_33]

b) Gas to kitchen [Pr_80_51_51_33]

c) Water supply (at building entry, at each cold-water storage tank or Category 5 break tank) [Pr_80_51_51_97]

d) Heat meters (primary/secondary) [Pr_80_51_51_37]

e) Main electrical intake [Pr_80_51_51_28]

f) Kitchen general power [Pr_80_51_51_28]

g) External lighting/power [Pr_80_51_51_28]

h) HVAC control panel for centralised mechanical ventilation systems [Pr_80_51_51_28]

i) Server room general power [Pr_80_51_51_28]

j) Plant room general power [Pr_80_51_51_28]

k) Each floor general power [Pr_80_51_51_28]

l) Each floor lighting [Pr_80_51_51_28]

m) Low or zero carbon energy sources except biomass. [Pr_80_51_51_28]

n) EV charging points [Pr_80_51_51_28]

2.5.2. All data collected from the submeters shall be logged, recorded and analysed in line with the requirements set out in Technical Annex 2H. [PM_10_20_90]

2.5.3. Automatic meters shall be installed complete with interface units for connection to the BMS to allow for automatic meter reading and data collection and automatic monthly uploading of data to iSERV or similar approved system. [Ac_05_50_54]

3. Mechanical Services Controls

3.1. Heating System Controls

3.1.1. The heating system(s) shall be adequately controllable to give good thermal comfort while maximising energy efficiency and minimising carbon emissions. [Ss_75_70_52_36]

3.1.2. The control options for switching on and off include manual override via BMS, time zone, optimisation routines and programmable controllers. A weather compensation routine, configured to regulate the operating temperature of a heating system in response to the outside air temperature, shall be used for variable temperature circuits. [Ss_75_70_52_36]

3.1.3. The following requirements shall be met:

a) Room sensors or thermostats are positioned appropriately, out of draughts and direct sunlight and at an appropriate height in the room and that the space is suitably zoned to be controlled by room sensors or thermostats. [Ss_75_70_52_36]

b) Weather compensated heating and centralised control from the boiler control panel is provided as either optimiser or time clock control with automatic daylight-saving correction (BST/GMT changeover). [Ss_75_70_52_36]

c) Control override is provided to enable out-of-hours use. [Ss_75_70_52_36]

d) The particular thermal comfort needs of students with complex disabilities or SEND are taken into consideration when designing the heating system. See Building Bulletin 101: ‘Guidelines on ventilation, thermal comfort and indoor air quality in schools’ (BB101) for further guidance. [PM_10_20_90]

e) Space heating control is provided using air and immersion sensors to operate principal items of plant, control valves and pump/fan motors or their drives. [Ss_75_70_52_36]

f) Weather compensation control, optimum start control, frost protection and condensation protection are provided. This shall require space temperature, outside air temperature, and flow and return temperature sensors. [Ss_75_70_52_36]

g) The heating system is responsive enough to changes in use in the spaces served. [Ss_75_70_52_36]

h) The operational hours of the different zones of the College are taken into account when designing the heating system and predicting energy use, since it

is likely that some or all areas may be used for after College activities. [Ss_75_70_52_36]

3.1.4. Table 2 details the heating control on a room level, it does not include building-wide control. The Contractor shall consider the heating controls on a building or site-wide scale for central plant. [Ss_75_70_52_36]

Heating Emitter	Automatic	Manual	Manual and Automatic	On / Off	Modulating	System Control	Control Options
Natural Convectors and Radiators	X	-	-	-	X	Variable Temperature	Wall mounted temperature detector measures the room air temperature and sends the signal to the control valves which reduce flow through the emitter/s. Thermostatic Radiator Valve(s) (TRVs) are used to reduce the flow to the emitter/radiator. TRVs shall be lockable and set to allow occupant control up to 20°C or the normal maintained temperature for the space.
Warm Air	X	-	-	-	X	Constant Temperature	Wall mounted temperature detector measures the room air temperature and sends the signal to the control valves which reduces flow through the emitter/coil in the terminal unit. Duct mounted or return air temperature detector measures the room air temperature and sends the signal to the control valves which reduces flow

Heating Emitter	Automatic	Manual	Manual and Automatic	On / Off	Modulating	System Control	Control Options
							through the emitter/coil in the terminal unit.
Radiant Heaters	X	-	-	X	-	Constant Temperature	Wall mounted temperature detector detects the room air temperature and sends the signal to turn the panel on/off.
Underfloor	X	-	-	-	X	Variable Temperature	Wall mounted temperature detector detects the room air temperature and sends the signal to turn the underfloor heating on/off.
Forced Convection - Fan Convector	X	-	-	-	X	Constant Temperature	Wall mounted thermostat detects the room air temperature and sends the signal to turn the fan convector on/off. Integral thermostat detects the room air temperature and sends the signal to turn the fan convector on/off.

Table 2 Summary of heating emitter controls at room level

3.2. Ventilation System Controls

3.2.1. Control, trend logging, indication and monitoring shall be provided for the following for the ventilation systems.

a) Supply temperatures and return temperatures. [Ss_75_70_52_94]

b) CO2 concentration. [Ss_75_70_52_94]

c) Filter status. [Ss_75_70_52_94]

d) Electrical energy consumed for centralised ventilation systems only. [Ss_75_70_52_94]

e) Night purge ventilation and free cooling (where applicable). [Ss_75_70_52_94]

f) Fault detection. [Ss_75_70_52_94]

3.2.2. Air quality detectors shall be provided (usually CO_2 sensors). Training shall be provided to ensure that staff understand the implications of the detected levels and the appropriate action to take. [PM_70_85_55]

3.2.3. Reference should be made to Technical Annex 2F for the specific ventilation control requirements for:

a) Catering kitchens. [Ss_75_70_52_94]

b) Food technology rooms. [Ss_75_70_52_94]

c) Science laboratories. [Ss_75_70_52_94]

d) Design and Technology (D&T) workshops and Practical Spaces, where dust and fume extract systems are provided for D&T equipment, 3D printers and laser cutters. [Ss_75_70_52_94]

e) Photocopiers, where an extract system is provided. [Ss_75_70_52_94]

3.2.4. In all cases below, local stand-alone control shall be provided, and where appropriate with BMS interface to allow for monitoring and improvements in efficiency. [Ss_75_70_52_94]

Ventilator	Automatic	Manual	Manual and Automatic	On/off	Modulating	System Type	Control Options
Natural ventilation	x	x	x	-	x	Natural Local	For actuated: a wall mounted air quality/CO_2 detector and thermostat senses a change and sends the signal to the actuators to open/close the window. Manual override to also be provided. For manual: a wall mounted air quality/CO_2 detector and thermostat senses a change and sends the signal to illuminate an LED to indicate to the occupant to open/close the window. For manual: where external noise ingress is an issue, natural ventilation through louvres with attenuators and dampers may be manually opened/closed. For manual: the window may be manually opened when the occupant feels it is required.

Ventilator	Automatic	Manual	Manual and Automatic	On/off	Modulating	System Type	Control Options
Fan assisted natural ventilation	x	-	x	-	x	Natural Local/ Central	A wall mounted air quality/CO_2 detector and thermostat senses the change and sends the signal to the fans to increase/decrease speed to change the air flow. Usually provided with a manual boost option.
Local stack and wind effect roof ventilation units	x	x	-	x	x	Natural Local	If fan assisted: a wall mounted air quality/CO_2 detector and thermostat senses the change and sends the signal to the fans to increase/decrease speed to change the air flow. Usually provided with a manual boost option. If manual: manually operated automatic damper control to open/close opening.
Anti-stratification fans	x	x	-	x	x	Mixing	A wall mounted sensor/thermostat (where on/off or temperature detector where modulating) senses the change and sends the signal to the fans to turn on/off or increase/decrease speed.

Ventilator	Automatic	Manual	Manual and Automatic	On/off	Modulating	System Type	Control Options
							If manual, then the occupant would turn the fan on/off when feels it is required.
Mechanical	x	-	-	x	-	Mechanical	No room level control, only building level, to provide a set amount of ventilation.
General local extract ventilation	x	x	-	x	-	Local/ Central Mechanical	Presence detector or manual switch for fan, usually connected to the electric lighting e.g., in WCs. Local only for WCs/changing rooms.
Specialist local extract ventilation	x	x	-	x	-	Local Mechanical	Occupant manually switches on fan when activity is commencing e.g., fume cupboards. Extract fan may be automatically linked to other systems or to a time schedule. Make-up air may need to be interlocked with extract system to avoid pressure issues.

Table 3 Summary of ventilation controls at room level

3.3. Mechanical cooling systems

3.3.1. Mechanical cooling shall not be necessary in the majority of colleges. [Ss_60_40_17]

3.3.2. The exception is in the server room for peak lopping in summertime conditions where a local controller shall be provided. [Ss_60_40_17]

3.3.3. If multi-room comfort cooling is provided each room shall be monitored via a central BMS only. [Ss_60_40_17]

3.4. Frost protection

3.4.1. The Contractor shall allow for 2-stage frost protection on all pumped systems as defined below.

3.4.2. Low temperature protection condition strategies shall be initiated at any time irrespective of whether the BMS is signalling any plant operation modes. [PM_35_10_60]

3.4.3. The low temperature protection modes shall be as follows:

a) Low outside air temperature. [PM_35_10_60]

b) Low primary heating return water temperature. [PM_35_10_60]

c) A low outside air temperature condition shall be activated when the outside air temperature falls below an adjustable setpoint (5°C). The signal shall remain active until the outside air temperature rises above the outside air temperature setpoint by 2°C. While the low outside air temperature condition is active the duty primary and secondary circuit pumps shall be enabled if not already running. [PM_35_10_60]

d) A low primary heating return water temperature condition shall be activated when the primary heating return water temperature falls below an adjustable setpoint. When active the primary and secondary heating pumps (if not already running due to a low outside air condition) and the lead boiler shall be enabled. The primary heating return water temperature condition shall remain active until the return water temperature rises above an adjustable setpoint of 55°C. [PM_35_10_60]

3.5. Gas Services Controls

3.5.1. When applying a flammable gas detection system, reference shall be made to IGEM UP/2, IGEM UP/11 and IGEM UP16. [PM_10_20_90]

3.5.2. Where a flammable gas detection system is installed within a boiler plant room, the system shall, in the event of a gas detected condition: automatically isolate the gas supply to the protected area, provide both an alarm locally (lamp and sounder) and hardwired digital status outputs to fire alarm panel and the BMS where installed. [Ss_75_50_33]

3.5.3. Emergency push buttons shall be provided on all exits of plant room(s) which when pressed shall close the gas valve. Closed Position Indication switches on the gas valve shall provide valve status to the BMS. [Ss_75_50_33]

3.5.4. In the event of a fire alarm, the incoming gas supply valve in the plant room shall close and following a routine fire alarm test the boilers shall automatically reset. [Ss_75_50_33]

3.5.5. Emergency push buttons shall be provided in any laboratories adjacent to the teacher's desk, in prep rooms and by the exit so that when pressed the gas valve shall close. [Ss_75_50_33]

3.5.6. Where gas is supplied to teaching areas such as science laboratories, science prep room, food technology classrooms and vocational training catering kitchen, a gas isolation/pressure proving system where required by IGEM UP/11 shall be fitted. [PM_10_20_90]

3.5.7. Gas safety interlocks in kitchens, science laboratories, food technology, Design and Technology areas shall be provided as required by IGEM UP11, IGEM UP19 and BB101. [PM_10_20_90]

3.5.8. All supplies to practical areas and to practical equipment shall be designed in accordance with BS4163 'Health and Safety for Design and Technology in educational and similar establishments, Code of Practice'. [PM_10_20_90]

3.6. Electrical Services Controls

3.6.1. The following requirements shall be met in all light and heavy practical spaces (as defined in Technical Annex 1A).

a) Electrical services shall be fitted with sufficient local master controls to control services in lessons and for cutting off supplies in an emergency. [PM_35_50]

b) All supplies to practical equipment shall be designed in accordance with BS4163 ‘Health and safety for Design and Technology in educational and similar establishments. Code of practice’. [PM_10_20_90]

3.6.2. Electrical equipment used by students shall be fitted with a local master electrical shut-off for the teacher to cut off supplies in an emergency. This shut off shall:

a) be easily accessible by the teacher [PM_35_50]

b) be provided with a key control, which can be used by the teacher to turn supplies back on (reset) as required [PM_35_50]

c) turn off power to all equipment in the room, including low voltage supplies [PM_35_50]

d) not control other services (such as heating, ventilation or lighting; the teacher’s PC or the projector; fridges/freezers, cleaners’ sockets) [PM_35_50]

e) not control critical circuits specifically installed to remove hazards (e.g., fume cupboards and fume extractor fans, alarm circuits). [PM_35_50]

3.6.3. As well as the shut-off for the teacher, there shall also be emergency electrical stop buttons positioned around the room local to any power supplies used for practical work. These shall be provided in each separate student work area and shall only control one work area. The stop buttons should be of mushroom-headed design and clearly identifiable. They shall be approximately 1.5m off the floor and in accessible positions. [PM_35_50]

3.6.4. In accordance with BS4163, emergency stop switches (which could be the normal ‘off’ switch) shall be provided at all fixed machines, where a risk assessment shows that it is required; these shall be easily actuated by the user. An emergency stop switch shall only control the power to the machine to which it is fixed, and not to other machines in the work area. [PM_35_50]

3.6.5. Emergency stops are also required in preparation areas which are for technician use only. These areas shall not be affected by the emergency system of any other area. [PM_35_50]

4. Handover Requirements

4.1. Overview

4.1.1. The detailed requirements for handover are set out in the DfE's EIR. [PM_10_20_28]

4.1.2. The following section outlines the handover requirements in relation to the control systems. [PM_70_85_35]

4.1.3. A 7-day period of 'soak testing' shall follow on from the successful commissioning and testing activities. [PM_70_15_82]

4.2. Soak Testing

4.2.1. A soak test of all the controls 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]

4.2.2. The soak test shall be programmed to occur after completion of all setting to work, commissioning, testing and witnessing of the mechanical and electrical services. This is to prove their reliability and correct calibrations over a continuous period of 7 days. [PM_70_85_35]

4.2.3. Practical Completion shall not be granted until a successful soak test as described here has been achieved and documented. [PM_70_15_82]

4.2.4. It is not necessary to install additional dummy loads into rooms to prove system performance at the maximum design. [PM_10_20_82]

4.2.5. All control systems shall be fully energised and placed in their normal/auto operation mode with all normal occupied time settings applying to:

a) Control systems [Ss_75_70]

b) Energy metering and monitoring systems [Ss_75_70_54]

4.2.6. 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 (plant operating times/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 the 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 Operation and Maintenance (O&M) Manuals and the Health and Safety File. [PM_70_15_82]

4.3. Documentation

4.3.1. On completion of system commissioning and witnessing a soft copy (in electronic editable format) and a hard copy of all operation and maintenance manuals shall be supplied within two weeks of handover. Preliminary copies shall be made available for review prior to commencement of system commissioning. All system documentation shall be in accordance with industry standard document templates. [PM_70_90]

4.3.2. The following documentation shall be supplied as a minimum and in line with the DfE's EIR:

a) Description of systems managed by each controller/outstation. [PM_70_90]

b) Control strategy drawings. [PM_70_90]

c) Description of the plant and how it is controlled. [PM_70_90]

d) Schedule of equipment. [PM_70_90]

e) ‘As Built’ drawings showing locations of sensors and control panels. [PM_70_90]

f) Control panel wiring diagrams. [PM_70_90]

g) Operation and Maintenance (O&M) Manual. [PM_70_90]

h) Health and Safety File (if appropriate). [PM_70_90]

i) Points list (list of all analogue, digital inputs/outputs and open protocol points). [PM_70_90]

j) Network schematic wiring diagram. [PM_70_90]

4.3.3. Operation Manuals shall comprise instructions on equipment safety checks, start-up and close down procedures, daily operation and full descriptions of operating features. These shall match and comply fully with the software supplied, provide examples of operation with supporting flow/strategy diagrams. Diagrams shall show the full diagrammatical (network structures, outstations and peripherals) and physical layout of the system and components. [PM_70_85]

4.3.4. Maintenance Manuals shall comprise full descriptive and maintenance details on each and every item of equipment supplied. Suppliers and spare parts references, contacts, telephone numbers, and addresses shall be supplied where relevant. Wiring schedules shall show the connection of each item of equipment to the field equipment. [PM_70_85]

4.3.5. Data sheets and maintenance instructions shall be provided for each item of equipment. [PM_70_85]

4.3.6. Diagrams showing the configuration of all control and monitoring schemes, identifying the modules used, their interconnections and setting parameters, copy printouts showing the individual outstation module configurations and sequences. [PM_70_90]

4.3.7. Detailed working drawings shall be prepared well in advance of any works taking place on site. [PM_40_40]

4.3.8. The detailed working drawings shall be adequate for the following purposes:

a) Clearly detail all the arrangements/aspects of the various sections of the works as actually installed and to identify and locate all component parts. [PM_10_20_82]

b) Make it possible to comprehend the extent and purpose of the works and the method of operation. [PM_10_20_82]

c) Set out clearly the extent to which maintenance and servicing is required and how, in detail, it should be executed. [PM_10_20_82]

d) Provide sufficient and readily accessible information properly to facilitate the ordering of spares and replacements. [PM_10_20_82]

4.3.9. Back-up copies of all system configuration files and master software strategy files shall be supplied. [PM_70_90]

4.3.10. All system configuration files and master software strategy files shall be current, 'As Installed and Commissioned' status at the handover date. [PM_70_90]

4.3.11. The following documentation shall be provided for review prior to implementation and again at project completion reflecting the final as installed status.

a) Software strategy electronic and hard (PDF) copy files. [PM_70_90]

b) Overall BMS architecture and BMS network schematic. [PM_70_90]

c) Details of the integration/interface with other control systems. [PM_70_90]

d) BMS operator station graphics. [PM_70_90]

e) Alarm handling strategy. [PM_70_90]

f) Monitoring and logging strategy and associated logging graphs. [PM_70_90]

g) BMS control panel drawings with highlighted hardwired controls interlocks. [PM_70_90]

h) Outstation/controller points lists. [PM_70_90]

i) Full equipment lists detailing all BMS field devices i.e., sensors, detectors, actuators, control valves etc. Provide manufacturer details, data sheets, installation instructions and operator manuals. [PM_70_90]

j) Controls wiring containment drawings and cable schedules. [PM_70_90]

k) Detailed functional design specification (FDS) for each HVAC system and each main plant item, detailing the control and monitoring routines, alarm handling and logging. [PM_70_90]

l) Factory, site and operational testing documentation fully signed off and dated. [PM_70_90]

4.3.12. The controls documentation shall include the optimum settings for all controls systems as well as product description, date of purchase, performance characteristics, application (suitability for use), method of operation and control, and cleaning and maintenance requirements. [PM_70_90]

4.3.13. ‘As Installed’ (record) drawings and information for the Operation and Maintenance (O&M) Manual and Building Log Book relating to the controls system shall be submitted which include all controls cabling, the cable origin, circuit designation, route, conductor material and insulation type and colour, number of cores per cable, number of cables in ducts, on tray or ladder and location of control panels, equipment and repeater panels. [PM_70_90]

4.3.14. A hard copy and an electronic copy of the cable schedules relating to the controls system shall be submitted with each copy of the Operation and Maintenance (O&M) Manual. [PM_70_90]

4.3.15. A Building User Guide shall be provided which includes a user friendly description of all controls and an overview of the controls philosophy. It shall include a short illustrated guide for each type of space e.g., classroom, Large Spaces, practical space, describing how to control the ventilation, lighting and heating for the user(s) of the space(s). [PM_70_85_25]

4.3.16. The Building User Guide shall be provided in hard copy and electronic format as detailed in the DfE’s EIR. [PM_10_20_28]

4.4. Commissioning and Building Performance Evaluation

4.4.1. All safety interlocks, overrides and fail safe conditions shall be operational prior to starting the plant for commissioning. [Ac_75_65_15]

4.4.2. Fault conditions for all alarms, safety devices and control interlocks shall be simulated and proved effective. [Ac_75_65_15]

4.4.3. The controls systems shall be fully commissioned throughout prior to handover. [Ac_75_65_15]

4.4.4. The building services systems shall be commissioned such that where control systems interact with each other they are commissioned at the same time in order to simulate this interaction as accurately as possible. [Ac_75_65_15]

4.4.5. The Building Services control systems shall be commissioned in accordance with CIBSE Commissioning Code C: Automatic controls (refer to Technical Annex 2F for details of seasonal commissioning required). [PM_10_20_90]

4.4.6. A commissioning programme shall be provided prior to construction. The programme shall capture a two week notice period prior to witness testing. [PM_60_30_13]

4.4.7. Inspection and testing shall be undertaken in line with BS 7671 ‘Requirements for electrical installations. IET Wiring Regulations’. [PM_10_20_90]

4.4.8. The controls system shall be commissioned in accordance with CIBSE Commissioning Code C: Automatic Controls. [PM_10_20_90]

4.4.9. BMS Sensors shall be checked to ascertain accuracy within limits, pressure switches checked for switch points and hysteresis. Humidity sensors shall be checked for accuracy using a wet/dry bulb thermometer. [PM_10_20_82]

4.4.10. All the necessary test equipment and materials used in commissioning shall be supplied. All test equipment shall have valid test certificates. [PM_10_20_82]

4.4.11. Trend graphs shall be provided to demonstrate the stable control of the plant. Simulated inputs shall be employed to check stability over the design environmental range. [PM_10_20_82]

4.4.12. The BMS specialist shall allow one additional full day for his commissioning engineer to revisit the system at a later date (after handover). They shall check and adjust operational parameters, and re-tune any control as maybe required by change in the control system load conditions or ‘bedding-in’ of the plant. [Ac_75_65_15]

4.4.13. Commissioning documentation and schedules shall be submitted showing each plant, point, interlock and control algorithms, and the stages of checks and commissioning required. [Ac_75_65_15]

4.4.14. A complete set of the commissioning documentation is to form part of the system documentation. Once any item of plant is commissioned and left running under the dictates of the BEMS, all commissioning data and documents shall be captured and issued within the building operations and maintenance manuals. [Ac_75_65_15]

4.4.15. All system documentation shall be in accordance with industry standard templates. [PM_10_20_82]

4.4.16. Building Performance Evaluation and Seasonal Commissioning shall be carried out in accordance with Section 8 of the GDB. [PM_40_60_62]

4.4.17. Performance testing/proving shall be carried out during the 12-month defects liability period. [PM_40_60_62]

4.4.18. Seasonal commissioning of the control systems shall be carried out during the 12 months after handover (during the defects liability period) to fine tune control settings. [PM_40_60_62]

4.4.19. The Contractor shall also run, monitor and maintain the systems for a minimum period of 1 week before handover. During this period, the required demonstration of the system and controls shall be undertaken in line with the requirements set out in the DfE's EIR. [PM_10_20_28]

4.5. Demonstration and Training

4.5.1. The detailed requirement for training and familiarisation is set out in the DfE's EIR. [PM_10_20_28]

4.5.2. The Contractor shall provide dedicated training to the Employer's and College's nominated representatives. [PM_70_85_55]

4.5.3. In the event that a facilities management team has not been appointed prior to Practical Completion, the Employer shall be responsible for selecting an appropriate representative for the training procedure. [PM_70_85_55]

4.5.4. The Employer shall then be responsible for ensuring that the training is passed on accordingly. [PM_70_85_55]

5. Demonstrating Compliance

5.1. Overview

5.1.1. 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 College Building(s) with photographic evidence and / or third-party accreditation. [PM_70_15]

6. Reference Standards

6.1.1. In addition to the guidance in the DfE's Building Bulletins, the requirements in the GDB, and the requirements that are set out within this document, the Contractor shall ensure that the design and installation of the controls and relevant associated systems within colleges shall be compliant with the following standards (or updated documents where relevant). [PM_10_20_90]

a) Approved Documents of the Building Regulations. [FI_70]

b) CIBSE Commissioning Code C: 'Automatic controls'. [FI_70_85]

c) CIBSE Guide H: 'Building Control Systems'. [FI_70_85]

d) All relevant CIBSE Guides. [FI_70]

e) BS 7671: 'Requirements for electrical installations. IET Wiring Regulations'. [FI_70_85]

f) BSRIA Application Guide: AG 7/98 'Library of System Control Strategies' [FI_70_85]

Department for Education

About this publication:
enquiries www.education.gov.uk/contactus
download www.gov.uk/government/publications