HEALTH TECHNICAL MEMORANDUM 2005

Building management systems
Operational management

1996

STATUS IN WALES

APPLIES

GIG CYMRU NHS WALES
Partneriaeth Cydwasanaethau
Gwasanaethau Cyfleusterau
Shared Services Partnership
Facilities Services

For queries on the status of this document contact
info@whe.wales.nhs.uk or telephone 029 2031 5512

Status Note amended March 2013

Building management systems

Operational management

Health Technical Memorandum 2005

London: HMSO

NHS Estates
An Executive Agency of the Department of Health

First published 1996

ISBN 0-11-322242-4

About this publication

Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

They are applicable to new and existing sites, and are of use at various stages during the inception, design, construction, refurbishment and maintenance of a building.

Health Technical Memorandum 2005

HTM 2005 focuses on the:

a. legal and mandatory requirements;

b. design;

c. testing and commissioning;

d. operation and maintenance of building management systems (BMS) in all types of healthcare premises.

It is published as four separate volumes, each addressing a specialist discipline:

- **Management policy** – outlines the overall responsibility of chief executives and managers of healthcare premises, and details their legal and mandatory obligations in installing and operating a reliable, efficient and economic BMS. It summarises the technical aspects and concludes with guidance on the management of systems;

- **Design considerations** – outlines BMS technology and details the requirements and considerations that should be applied to the design, tendering and installation stages of the project;

- **Validation and verification** – gives general advice for ensuring that the installed equipment has been formally tested and certified as to contract. The importance of commissioning the completed installation is emphasised. Handover procedure, including the provision of documentation and training, is also set out.

- this volume – **Operational management** – provides information for those responsible for overseeing and operating day-to-day running and maintenance procedures. Coverage includes routine tests, planned preventive maintenance and trouble-shooting;

Guidance in this Health Technical Memorandum is complemented by the library of National Health Service Model Engineering Specifications (MES) and, where applicable, the Scottish and Northern Ireland supplements. Users of the guidance are advised to refer to the relevant specifications on "Building Management Systems".

The contents of this Health Technical Memorandum in terms of management policy, operational policy and technical guidance are endorsed by:

a. the Welsh Office for NHS Wales;

b. the Health and Personal Social Services Management Executive in Northern Ireland;

c. the National Health Service in Scotland Estates Environment Forum.

References to legislation appearing in the main text of this guidance apply in England and Wales. Where references differ for Scotland and/or Northern Ireland, these are given as marginal notes.

Where appropriate, marginal notes are also used to amplify the text.

Executive summary

A building management system (BMS) is a computer-based centralised procedure that helps to manage, control and monitor certain engineering services within a building or a group of buildings. Such a system ensures efficiency and cost-effectiveness in terms of labour and energy costs and provides a safe and more comfortable environment for building occupants.

The BMS has evolved from being a simple supervisory control to a totally integrated computerised control and monitoring system.

Some of the advantages of a BMS are as follows:

- simple operation with routine and repetitive functions programmed for automatic response;
- reduced operator training time through on-screen instructions and supporting graphic display;
- faster and better response to occupant needs;
- reduced energy costs through centralised control and energy management programmes;
- better management of the facility through historical records, maintenance programmes and automatic alarm reporting;
- improved operation through software and hardware integration of multiple sub-systems, for example direct digital control, security and access and lighting controls.

This volume – 'Operational management' – provides information for those responsible for overseeing day-to-day operations and maintenance. Coverage includes routine tests, planned preventive maintenance and troubleshooting.

Management responsibilities in terms of compliance with statutory instruments are summarised in Chapter 2.

General operations criteria inclusive of procedures and training are included in Chapter 3.

Standards and monitoring of performance are outlined in Chapters 4 and 5.

Details of maintenance procedures as applied to individual items of the BMS are described in Chapter 6. This chapter also provides guidance on maintenance contractors.

Chapter 7 covers the recommended procedures in keeping records.

Chapters 8, 9 and 10 cover aspects of selected staff functions, definitions and references.

The document also includes appendices containing sample maintenance schedule record sheets.

Contents

1.0 Scope

1.1 Building management systems (BMS) are a management tool for the effective control of building engineering services, and can be applied equally to new and existing buildings.

Throughout this document, healthcare premises will include "social services premises" in Northern Ireland

1.2 BMS can be used to manage the environmental conditions of all types of building. In healthcare premises, a BMS is particularly valuable in maintaining suitable conditions in critical areas, for example operating departments, intensive care units, isolation suites, pharmacies and sterile supply departments. BMS provide alarm communication networks for the building services plant.

Other areas that can be monitored and targeted would include water consumption, sewage and waste disposal

1.3 A properly installed and maintained BMS operated by fully trained staff offers considerable opportunities for "energy management". A BMS can support separate software packages for energy monitoring and targeting.

1.4 A further use of the BMS is to help to establish the basis of the site's planned preventive maintenance operations.

When a BMS is specified, the NHS Model Engineering Specifications, with the appropriate supplements for Scotland and Northern Ireland, should be considered

1.5 A BMS should be specified with care and detail, focusing on the functionality and required performance of the systems under control. The specification should detail the commissioning and handover requirements. When a BMS is specified, especially if it is replacing existing controls, consideration should be given to the appropriate level of user control.

1.6 The commissioning of the BMS should be fully documented to ensure that all aspects of the system meet the specification. Adequate resources should be allocated to ensure satisfactory commissioning procedures are met.

1.7 To continue to meet specified environmental conditions and increase energy efficiency, a BMS should be regularly maintained and its performance tested.

1.8 It is important that BMS operators and maintenance staff receive adequate training.

1.9 The sophistication of building services in healthcare premises is increasing. Consequently, BMS controls should be designed, installed, operated and maintained to standards that will enable the controls to fulfil the desired functions reliably and safely.

2.0 Management responsibilities

2.1 It is incumbent on management to ensure that their BMS installations comply with all the statutory regulations applicable to BMS on their premises. Other functional guidance in terms of standards and codes of practice should also be noted.

Statutory requirements

2.2 Safety regulations are as laid down in the:

a. Health and Safety at Work etc Act 1974;

b. Electricity at Work Regulations 1989;

c. Building Act 1984 and the Building Regulations 1991 (including Approved Documents);

d. Management of Health and Safety at Work Regulations 1992;

e. Provision and Use of Work Equipment Regulations 1992;

f. Manual Handling Operations Regulations 1992;

g. Workplace (Health, Safety and Welfare) Regulations 1992;

h. Personal Protective Equipment at Work (PPE) Regulations 1992;

j. Health and Safety (Display Screen Equipment) Regulations 1992;

k. Construction (Design and Management) Regulations 1994;

m. Electromagnetic Compatibility Regulations 1992;

n. Electromagnetic Compatibility (Amendment) Regulations 1994.

Functional guidance

2.3 Guidance is as laid down in:

a. British Standards and Codes of Practice;

b. Health and Safety Executive Guidance;

c. NHS Model Engineering Specifications – NHS Estates;

d. Health Building Notes – NHS Estates;

e. Technical Standards (Scotland);

f. Health Technical Memoranda and Firecode – NHS Estates.

For further details please refer to Chapter 10 – "References".

a. Health and Safety at Work (Northern Ireland) Order 1978;
b. Electricity at Work Regulations (Northern Ireland) 1991;
c. Building Regulations (Northern Ireland) 1994 and Technical Booklets; Building Standards (Scotland) Regulations 1990;
d. Management of Health and Safety at Work Regulations (Northern Ireland) 1992, and Management of Health and Safety at Work (Amendment) Regulations (Northern Ireland) 1994;
e. Provision and Use of Work Equipment Regulations (Northern Ireland) 1993 and Provision and Use of Work Equipment (Amendment) Regulations (Northern Ireland) 1995;
f. Manual Handling Operations Regulations (Northern Ireland) 1992;
g. Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993;
h. Personal Protective Equipment at Work Regulations (Northern Ireland) 1993;
j. Health and Safety (Display Screen Equipment) Regulations (Northern Ireland) 1992;
k. Construction (Design and Management) Regulations (Northern Ireland) 1995

There are forthcoming CEN standards on BMS from CEN Technical Committee TC247

3.0 Criteria for operation

General

3.1 It is essential that those responsible for the operation should have a good working knowledge of the engineering installations controlled or monitored by the BMS. Initially they should decide what information they need for the effective operation of the installed plant and how it will be used. The operators should then use the BMS as a powerful tool to meet their needs.

3.2 Clear lines of managerial responsibility should be in place to identify the personnel responsible for the safe and effective operation and maintenance of the BMS. A periodic review of the management systems should take place in order to ensure that the agreed standards are being maintained.

3.3 It is a management responsibility to ensure that the standards applied during the design and installation of the BMS are not reduced during operation and maintenance of the equipment and that records of maintenance activities and routine inspections are kept.

3.4 Critical building service plant can be controlled by the BMS. This requires a high-quality BMS breakdown support service to be made available at all times. It is the responsibility of management to specify the required emergency and breakdown response.

3.5 Management is responsible for the appointment of suitably qualified contractors to provide a regular maintenance service and high-quality breakdown support. Contractors should be experienced and reliable and able to meet specified emergency response requirements.

3.6 A strict quality assurance procedure should be enforced to ensure that documentation and application software are continuously updated to record changes made to the BMS.

3.7 Management should provide adequate training for personnel responsible for the operation and maintenance of the BMS to enable them to undertake their designated tasks. Management should be aware that competent and enthusiastic BMS operators help to maximise the potential of a BMS operation. To prevent misuse of the system, access to the BMS should be limited to authorised users by means of a hierarchical password scheme.

Shared use allows more than one person or section to realise the benefits of the BMS

3.8 It is essential that the concept of ownership and shared use of the BMS is cultivated to enable the user to realise the full potential of the system.

3.9 It is a management responsibility to ensure that day-to-day operation, inspection, service and maintenance activities are carried out safely without hazard to staff, patients or members of the public.

Information

3.10 In order that the BMS can be properly operated and maintained, it is essential that the following is available:

a. BMS performance specification;

b. control strategy diagrams;

c. schematics;

d. points list;

e. plant diagrams showing locations of field devices;

f. software backup copies;

g. record drawings;

h. commissioning records;

j. operating and maintenance manuals;

k. any special tools and spare parts including backup software for all aspects of the system.

3.11 The operator will require a detailed description of the design intent of the scheme. This should include:

a. a "user" brief comprising a description of the BMS, plant under BMS control and the intended mode of operation;

b. precise design requirements with regard to physical parameters measured and controlled by the BMS;

c. commissioning manuals listing the results of commissioning tests as detailed in the 'Validation and verification' volume of this HTM.

Operational procedures

3.12 The following operational procedures should be implemented by the user. The procedures may need to be modified in the light of experience gained in the actual operation of the BMS:

a. user logging on, operation and logging off;

b. creation of record of system users;

c. password protection of all levels for different classes of user;

d. routine application-software backup;

e. operation of alarm log;

f. recovery of system from:

(i) power failure;

(ii) central station failure;

(iii) BMS communications failure;

g. integration of BMS with fire and security alarm systems – correct alarm override;

h. archiving of historical data;

j. record of alterations made to the BMS software;

k. record of observed defects (plant and BMS) and corrective action taken, together with dates;

m. systems which ensure that best use of the BMS information is made for maximum benefit.

3.13 Before making any changes in the BMS set-points or control strategies, operators should give careful consideration to the impact on both plant operation and the internal environment. To achieve this, the BMS operator needs to use his/her knowledge and understanding of the plant controlled by the BMS and to be mindful of the possible effects that changes will have at other times, for example in different seasons or under abnormal conditions.

3.14 The operators should be aware of the fail-safe modes in the BMS covering sensor and actuator failure etc.

Arrangements for dealing with alarms should be graded according to severity
The printer and monitor output can often be developed to facilitate this

3.15 The organisational arrangements need to be able to respond positively and promptly to alarm or deviations indicated by the BMS.

3.16 BMS output should be structured to allow convenient daily critical reviews.

Training

General

3.17 Those who use, operate and maintain the BMS will need to be instructed in its use. The instruction given should draw particular attention to the following topics:

a. the prime function of the BMS;

b. method of BMS operation;

c. problems and hazards that can arise from failing to follow the agreed operating, monitoring and maintenance procedures;

d. the permit-to-work in use;

e. the danger of making unauthorised modifications, alterations or additions to the BMS, as well as the possible legal consequences;

f. the procedure to be followed if it is suspected that the system is no longer operating correctly.

3.18 It is highly desirable that staff responsible for the daily operation or maintenance of the BMS should have had the opportunity to observe the commissioning results being demonstrated by the contractor. This will provide a greater in-depth understanding of the system.

Building occupiers

3.19 The BMS and its operation should be explained to the occupiers of areas where there is an interface with the BMS (for example manual override, adjustable set-point). Occupiers of areas where manual control has been replaced by BMS control should also have the control operation explained to them.

Service and maintenance staff

3.20 Training of all staff involved with the operation or maintenance of the BMS is essential to realise the benefits of the capital investment.

3.21 Maintenance staff should be trained in any special maintenance procedures. The depth of training will depend on the level of required maintenance, but it should at least draw attention to any hazards arising due to the maintenance activities.

Training on BMS strategy configuration may have to be undertaken off-site

3.22 Other personnel who monitor plant or the building via BMS terminals or who carry out routine plant maintenance should be trained in:

a. understanding the displays;

b. acknowledging and cancelling alarms;

c. taking required actions following alarm messages;

d. obtaining the best use of the system.

3.23 The training will need to be repeated periodically thereafter in order to cater for changes in staff.

3.24 Records of the training provided should be kept.

4.0 Standards

Reference should also be made to the NHS Model Engineering Specifications, Health Building Notes and associated activity data sheets

4.1 New BMS should be designed, installed, validated and handed over according to the standards set out in the 'Design considerations' and 'Validation and verification' volumes of this HTM.

4.2 Existing BMS may have been designed and installed to a different standard.

If this is not the case, changes should be implemented to ensure compliance

4.3 All BMS installed in healthcare premises should be surveyed to ensure that the minimum standards set out in the examples below are achieved (this list is not exhaustive):

a. a safe means of staff access should be provided to enable BMS service and maintenance operations to be carried out;

b. BMS panels should be secured to prevent unauthorised access;

c. the central station computer and outstations with terminals should be password-protected to prevent unauthorised access;

d. plantrooms containing BMS equipment should be well-illuminated and should permit safe access to all parts of the BMS requiring inspection, service and maintenance;

e. minimum standards for electrical safety are covered in BS 7671: 'Requirements for electrical installations' (IEE Wiring Regulations 16th edition), HTM 2007 and other documents detailed in Chapter 10, "References";

f. standards relating to electromagnetic interference (including HTM 2014) are detailed in Chapter 10, "References";

g. computer workstations, lighting etc should be suitable for purpose and comply with the Health and Safety (Display Screen Equipment) Regulations 1992.

5.0 Performance monitoring

General

5.1 Performance monitoring encompasses both the plant under control and the BMS.

5.2 The performance of a BMS and the plant it controls should be monitored regularly by the BMS operator via the central station. Feedback from building users should also be noted.

5.3 Those appointed to carry out performance monitoring should be competent and provided with the necessary facilities and training.

5.4 Any reduction in environmental standards notified by the occupiers should be investigated by the BMS operator.

5.5 The BMS operator should be able to recognise faults or abnormalities in order for these to be investigated. The operator should also know how to validate BMS information on sensors and actuators, and use trend logs.

5.6 General maintenance staff should be trained to observe any problems with the BMS during their normal course of work.

Monitoring

5.7 Performance monitoring can be described as regularly observing and checking the operation of the plant and controls via the BMS to ensure that standards are maintained.

5.8 For successful performance monitoring there should be criteria against which the performance can be checked. These criteria should be written and available for all to use.

5.9 One invaluable tool for performance monitoring is the trend log. Operators should be encouraged to initiate trend logs to monitor various aspects of the BMS.

Components

5.10 The values of BMS inputs and outputs (sensors and actuators) will normally lie within limited ranges. The experienced BMS operator should know what these ranges are, and recognise when an input or output is outside of the relevant range. Similarly for digital inputs and outputs, the operator should recognise the status of switches and inputs during specific conditions.

Systems

5.11 The performance of complete items of plant (for example boilers, chillers and air handling units) should be checked for system response, stable control, sequencing etc. This can be facilitated by using trend logs.

Buildings

5.12 The performance of the complete BMS can be checked in several different ways:

a. **environmental performance:** the thermal response and the humidity of the internal environment over time should be checked against the design specification.

b. **energy performance:** the energy consumption of the building or plant should be monitored and compared with predicted levels.

Automated performance monitoring

5.13 BMS have the ability to run self-checking routines which can be used to automate performance monitoring. A simple routine is to add high- and low-level limits to a sensor input, so that if a sensor fails, an alarm or service message is generated. Flow, temperature, pressure sensors or switches can be used to monitor the performance of pumps, fans, valves, dampers, filters, heating/cooling batteries etc. Where there is a known action in a plant operation, the BMS can be used to automatically check the response and initiate alarms.

Trouble-shooting

5.14 A trouble-shooting procedure should be developed to provide guidance for BMS operators and maintenance staff. The plant under control, BMS field devices and recent changes to the control strategy should be checked.

5.15 If necessary the latest authorised version of the configuration software and set-points should be examined to identify any changes in the current version.

Trend logs which have served their purpose should be removed

5.16 Trend logs should be initiated to provide data for analysis and to confirm performance.

5.17 If the performance of the plant under control is in question it should be tested in "hand" mode.

6.0 Maintenance

General

6.1 Management should make available to maintenance personnel commissioning data, manuals, and records of any changes implemented since commissioning.

6.2 Schedules of routine maintenance activities, suggested spares lists and operational information should be prepared.

6.3 Monitoring of data from the BMS enables faults to be rectified at an early date.

6.4 The actual frequency of any particular maintenance activity and the need for planned preventive maintenance of the BMS can only be finally determined after monitoring the BMS in operation. This is to avoid unnecessary routine maintenance.

6.5 The initial frequency of maintenance will depend on the manufacturer's recommendations and the type of application.

6.6 Record sheets should be completed for all maintenance actions (see Appendix 2 for sample record sheets).

Maintenance contractors

6.7 Management is responsible for the appointment of a specialist contractor to provide a maintenance service and emergency breakdown support should NHS staff not be suitably qualified. A quality contractor is essential because of the important nature of the building services controlled by the BMS.

6.8 Initial maintenance is particularly important. Responsibility for this can be focused effectively by including the initial 12 months' maintenance in the supply contract. If maintenance is to be provided by the supplier/ installer, it will be advantageous to detail the costs in the initial tenders.

a. This approach should reduce the potential for disputes during the contract defects liability period
b. Maintenance arrangements should commence at handover

6.9 The maintenance contractor may not be the BMS manufacturer or the installation contractor.

6.10 Management should be satisfied that the contractor responsible for the regular maintenance of the BMS employs BMS specialists who:

a. have had the necessary training;

b. have a knowledge of the installed system;

c. maintain a current awareness of the manufacturers' equipment, including computer hardware and software;

d. have access to modern diagnostic equipment;

e. have good technical support;

f. are supported by adequate stocks of spares;

g. have the back-up of a BMS organisation.

6.11 Service attendance dates (both scheduled and achieved) should be available to the BMS operator.

Fault reporting

6.12 A diary or service log should be maintained to record items observed by the BMS operator which require a follow-up service or attention. Maintenance action taken should be recorded against each entry, together with the dates of origin and clearance.

Maintenance de-briefing

6.13 Following any maintenance work, the BMS operator should be briefed on the work undertaken and any alterations made. A written service report should be provided on each occasion.

Sensors

6.14 A BMS relies upon the correct functioning of the sensors to provide accurate measurements of various parameters for good control. It is therefore necessary to ensure that maintenance procedures include the checking of sensors (a sample checklist is provided in Appendix 1):

a. clean the sensor head according to manufacturer's instructions;

b. check the position of the sensor is as originally installed;

c. check there is good surface contact, or good thermal conductivity in a pocket, as necessary;

d. check the sensor for damage;

e. check the sensor is securely mounted;

f. check that any wires or tubing are securely connected;

g. check the accuracy of the sensor against a calibrated instrument, where possible in situ;

h. check the operation of the sensor;

j. calibrate if necessary as per manufacturer's instruction.

6.15 Some BMS applications require sensors with high sensitivity/accuracy, for example humidity, chilled water, heat flux. These sensors will require more frequent checking and calibration.

Actuators

6.16 The control of plant is dependent upon accurate actuator performance. Actuators and their fail-safe operations (if applicable) should be checked and maintained as follows (a sample checklist is provided in Appendix 1):

a. check cables for signs of damage;

b. check the security of the mounting;

c. check the tightness of linkages;

d. check the span and speed of the actuator;

e. check the correct response of the actuator to normal control signals;

f. check actuator response on power failure;

g. check actuator response to fire/safety signals (six-monthly);

h. check the calibration and adjustment of any position feedback device.

Digital inputs

6.17 To fulfil its function, the BMS needs to know the status of plant and equipment items connected to it. This information is obtained from digital inputs which may comprise volt-free contacts or contactors, dampers, actuators etc, or from switches which change state at preset values (for example differential pressure switches, thermostats and level switches). The operation of these switches should be checked (a sample checklist is provided in Appendix 1):

a. check environment is not having an adverse effect on the operation of the switch;

b. check mounting of switch;

c. check cables for signs of damage;

d. calibrate/adjust switch if necessary.

Outstations

6.18 Outstations should be physically checked (a sample checklist is provided in Appendix 2):

a. check the condition of the cabinet and the local operating environment;

b. check the condition of the connectors, the door seals and cable entries;

c. check the operation of the standby battery;

d. check the automatic restart of the outstation after resumption of the power supply.

Configuration software

6.19 Some malfunctions may require the following software functions to be checked (a sample checklist is provided in Appendix 2):

a. check the accuracy of the time clock;

b. check the time schedules;

c. check that data logging is as required;

d. check alarms (faults and out-of-limits) for priority levels, associated messages and routing;

e. check existing management of BMS alarms;

f. review recently generated alarms;

g. check start-up and shut-down routines;

h. check optimum start and optimum stop routines;

j. check control loops for stability and accuracy;

k. check sequencing of multiple plant units;

m. check load cycling routines;

n. check load shedding routines;

p. check interlocks;

q. check interfaces with fire and security systems.

Communications

6.20 The fast and accurate flow of data in a BMS is vital for the successful operation. During normal operation any problems with data communications should be reported and investigated. The communications should be checked as follows (a sample checklist is provided in Appendix 3):

check the integrity of data flow in both directions between outstations; between central station and outstations; central station and remote terminals; and off-site communications via modems by ensuring that routine checks cover these various communications paths.

Central station

6.21 Housekeeping and maintenance of a central station should include the following (a sample checklist is provided in Appendix 3):

a. check all cables and connectors;

b. clean and service the computer, monitor and keyboard in accordance with the manufacturer's instructions;

c. make back-up disks of all site-specific operating data files;

d. verify the routine functions of the central station operating program;

e. check the operation of the password system and update as necessary;

f. verify the links, data transfer and operation of related software installed on the computer;

g. verify the routing of priority messages and alarms with integrated fire and security systems;

h. check the availability of the operating and maintenance manuals;

j. check the updating of records for configuration software, set-points etc;

k. clean and service the printer in accordance with manufacturer's instructions.

7.0 Records

Service and maintenance

7.1 A BMS maintenance record should be kept, covering all aspects of the system.

7.2 The following should be recorded:

a. routine inspections;

b. routine maintenance;

c. faults and unscheduled service and maintenance activities;

d. alterations to plant under BMS control;

e. changes in the control strategy;

f. changes in set-points;

g. results of any tests carried out on the system.

7.3 These records may take the form of maintenance checklists.

8.0 Designated staff functions

8.1 Only trained and competent persons should be appointed by management to operate and maintain the BMS.

8.2 Management: the owner, occupier, employer, general manager, chief executive or other person who is accountable for the premises and is responsible for issuing or implementing a general policy statement under the HSW Act 1974.

8.3 Employer: any person or body who:

a. employs one or more individuals under a contract of employment or apprenticeship;

Health and Safety (Training for Employment) Regulations (Northern Ireland) 1994

b. provides training under the schemes to which the Health and Safety (Training for Employment) Regulations 1988 (SI 1988/1222) apply.

8.4 Designated person (electrical): an individual who has overall authority and responsibility for the premises containing the electrical supply and distribution system and who has a duty under the HSW Act 1974 to prepare and issue a general policy statement on health and safety at work, including the organisation and arrangements for carrying out that policy. This person should not be the authorising engineer.

8.5 Duty holder: a person on whom the Electricity at Work Regulations 1989 impose a duty in connection with safety.

8.6 Authorising engineer (low voltage): a Chartered Engineer or Incorporated Electrical Engineer with appropriate experience and possessing the necessary degree of independence from local management who is appointed in writing by management to implement, administer and monitor the safety arrangements for the low voltage electrical supply and distribution systems of that organisation to ensure compliance with the Electricity at Work Regulations 1989, and to assess the suitability and appointment of candidates in writing to be authorised persons (see HTM 2020 – 'Electrical safety code for low voltage systems').

8.7 Authorised person (LV – electrical): an individual possessing adequate technical knowledge and having received appropriate training, appointed in writing by the authorising engineer (LV) to be responsible for the practical implementation and operation of the management's safety policy and procedures on defined electrical systems (see HTM 2020).

8.8 Competent person (LV – electrical): an individual who in the opinion of an authorised person has sufficient technical knowledge and experience to prevent danger while carrying out work on defined electrical systems (see HTM 2020).

8.9 Commissioning specialist (BMS): an individual or organisation authorised to carry out commissioning, validation and routine testing of BMS.

8.10 Maintenance person (BMS): a member of the maintenance staff, BMS manufacturer or maintenance organisation employed by management to carry out maintenance duties on BMS.

8.11 BMS operator: any authorised individual who operates a BMS.

9.0 Definitions

Actuator: an electromechanical device that positions control devices (such as valves or dampers) in relation to a supplied control signal.

Alarm: the annunciation of an event that the system operator needs to be aware of.

Analogue: pertaining to data that consists of continuously variable quantities.

BAS – building automation system: synonymous with BMS.

BEMS – building and energy management system: synonymous with BMS.

BMS – building management system: a system comprised of electronic equipment and software with the prime function to control and monitor the operation of building services within a building, including heating, air conditioning, lighting, and other energy using areas.

BMS contractor: the organisation responsible for the supply and/or installation of the BMS. The contractor may be either the manufacturer or a systems house. It is often the case that the BEMS contractor will commission the BMS.

Bus: a means of connecting a number of different devices, sensors, controllers, outstations etc to act as a means of data exchange.

Central station: the primary point of access to a BMS. The usual point from which all operations are supervised.

Client: the individual or group of individuals ultimately responsible for paying for and using the BMS.

Commissioning: the advancement of an installed system to working order to specified requirements.

Commissioning specialist: the individual responsible for the commissioning of the BMS. He may be employed by the BMS contractor or a specialist commissioning company.

Communications network: a system of linking together outstations and a central station to enable the exchange of data. Usually a dedicated cable system, but radio- or mains-borne signalling may be used.

Compensator: a control device whose control function is to either:

a. reduce heat supply with decreasing building heat load; or

b. reduce cooling energy supply with decreasing building cooling load, in response to outside and (sometimes) inside temperatures.

Completion: the state of being finished in its entirety, according to the specification, ready for use by the owner.

Configuration software: software (in the form of "building blocks") resident in an outstation which can be configured to create different control strategies.

Control function: a term used to describe a specific, discrete form of control eg. compensation, optimisation etc. These can be linked together in a control strategy.

Control loop: proportional, or proportional + integral, or proportional + integral + derivative control strategy where the output is related to a function of the input signal.

Control strategy: a description of the engineered scheme to control a particular item of plant or perform a series of control functions.

Data: a representation of information or instruction in a formalised manner suitable for communication, interpretation, or processing by humans or computer.

Derivative control: a control algorithm in which the control output signal is proportional to the rate of change of the controlled variable.

Direct digital control (DDC): a term used to define products that are based on microprocessor control.

Distributed intelligence: description of a system where data processing and control is carried out at outstations, and not at a central point.

Duty cycling: a control function that rotates the use of items of plant so that each item undergoes equal usage.

EMS – energy management system: synonymous with BMS.

Field device: the controls that are placed in the field level, that is, switches, sensors, actuators etc.

Gateway: software written to enable data to be exchanged between two different communications protocols.

Handover: the transfer of ownership of all or part of a building or system, usually to the client.

Integral control: a control algorithm in which the output signal is proportional to the integral of the error.

Load cycling: a control method where management of plant energy demand is achieved by means of fixed on/off periods of operation.

Load shedding: the function of switching off electrical equipment if the load exceeds a limit. This function therefore reduces the risk of maximum demand penalty charges.

Optimiser: a control device whose function is to vary the daily on and off times of heating, ventilation and air-conditioning (HVAC) plant in order to produce an acceptable environment with lowest energy usage.

Outstation: a device to which sensors and actuators are connected, capable of controlling and monitoring building services functions. It also has the facility to exchange information throughout the BMS network.

Performance tests: tests carried out to demonstrate that the system functions according to specification.

Point: a physical source or destination for data in the form of analogue or digital signals.

Pre-commissioning checks: systematic checking of a completed installation to establish its suitability for commissioning.

Proportional control: a control algorithm in which the output signal is proportional to the error in the controlled variable.

Proportional and integral control: a control algorithm in which the output signal is proportional to the error plus the integral of the error in the controlled variable.

Proportional and integral and derivative control: a control algorithm in which the output signal is proportional to the error plus the integral of the error and the rate of change of the controlled variable.

Protocol: a set of rules governing information flow in a communication system.

Sensor: a hardware device which measures, and provides to a control strategy, a value representing a physical quantity (for example temperature, pressure etc); or activates a switch to indicate that a preset value has been reached.

Stand-alone control: during normal operation, an item of equipment which can operate normally when isolated from the remainder of the system.

Testing: the evaluation of the performance of a commissioned installation tested against the specification.

Witnessing: the observation (by the client or his/her representative) of tests and checks of BMS hardware and operation prior to completion.

10.0 References

Acts and Regulations

The Building Act 1984. HMSO 1984.

Health and Safety at Work etc Act 1974. HMSO 1974.

SI 3140: 1994 The Construction (Design and Management) Regulations. HMSO 1994.

SR 209: 1995 Construction (Design and Management) Regulations (Northern Ireland). HMSO 1995.

SI 635: 1989 Electricity at Work Regulations. HMSO 1989.

SI 13: 1991 Electricity at Work (Northern Ireland) Regulations. HMSO 1991.

SI 2372: 1992 The Electromagnetic Compatibility Regulations. HMSO 1992.

SI 3080: 1994 The Electromagnetic Compatibility (Amendment) Regulations. HMSO 1994.

SI 2792: 1992 The Health and Safety (Display Screen Equipment) Regulations. HMSO 1992.

SR 513: 1992 The Health and Safety (Display Screen Equipment) Regulations (Northern Ireland). HMSO 1992.

SI 1039: 1978 (NI 9) Health and Safety at Work (Northern Ireland) Order. HMSO 1978.

SI 1380: 1990 Health and Safety (Training for Employment) Regulations. HMSO 1990.

SI 2051: 1992 The Management of Health and Safety at Work Regulations. HMSO 1992.

SI 459: 1992 The Management of Health and Safety at Work Regulations (Northern Ireland). HMSO 1992.

SI 2793: 1992 The Manual Handling Operations Regulations. HMSO 1992.

SR 535: 1992 The Manual Handling Operations Regulations (Northern Ireland). HMSO 1992.

SI 2966: 1992 The Personal Protective Equipment at Work Regulations. HMSO 1992.

SR 20: 1993 The Personal Protective Equipment at Work Regulations. HMSO 1993.

SI 2932: 1992 The Provision and Use of Work Equipment Regulations. HMSO 1992.

SR 19: 1993 The Provision and Use of Work Equipment Regulations (Northern Ireland). HMSO 1993.

SI 3004: 1992 The Workplace (Health, Safety and Welfare) Regulations. HMSO 1992.

SR 37: 1993 The Workplace (Health, Safety and Welfare) Regulations (Northern Ireland). HMSO 1993.

Building Regulations and related publications

SI 2768: 1991 The Building Regulations. HMSO 1991.

SI 1180: 1992 The Building Regulations (Amendment) Regulations. HMSO 1992.

SI 2179: 1990 (S 187) The Building Standards (Scotland) Regulations. HMSO 1990.

SR 243: 1994 The Building Regulations (Northern Ireland). HMSO 1994.

The Building Regulations 1991: approved documents A–N. Department of the Environment, HMSO 1992.

The Building Regulations 1991: approved document to support regulation 7. Department of the Environment, HMSO 1992.

The Building Regulations (Northern Ireland) 1990 – Technical booklets C–E, G1, H, P, R and V. Department of the Environment for Northern Ireland, HMSO 1994.

The Building Standards (Scotland) Regulations 1990: Technical standards. Scottish Office Building Directorate, HMSO 1990.

NHS Estates publications

National Health Service Model Engineering Specifications. NHS Estates, 1993. (2 vols mechanical; 2 vols electrical)

National Health Service Model Engineering Specifications updates. NHS Estates, 1995, 1996.

Health Technical Memoranda (HTMs)

2007 – Electrical services: supply and distribution. NHS Estates, HMSO 1993. (issued in 4 parts)

2011 – Emergency electrical services. NHS Estates, HMSO 1993. (issued in 4 parts)

2014 – Abatement of electrical interference. NHS Estates, HMSO 1993. (issued in 4 parts)

2015 – Bedhead services. NHS Estates, HMSO 1995. (issued in 3 parts)

2020 – Electrical safety code for low voltage systems (Escode – LV). NHS Estates, HMSO 1993, 1995. (issued in 2 parts)

2024 – Lifts. NHS Estates, HMSO 1995. (issued in 5 parts)

2025 – Ventilation of healthcare premises. NHS Estates, HMSO 1994. (issued in 4 parts)

2035 – Mains signalling. NHS Estates, HMSO, 1996. (issued in 4 parts)

2050 – Risk management in the NHS estate. NHS Estates, HMSO 1994. (issued in 4 parts)

2055 – Telecommunications (telephone exchanges). NHS Estates, HMSO 1994. (issued in 4 parts)

Firecode publications

Firecode: Directory of fire documents. Department of Health, HMSO 1987.

Firecode: Policy and principles. NHS Estates, HMSO 1994.

Firecode: Nucleus fire precautions recommendations. Department of Health, HMSO 1989. (new edition in preparation – January 1997)

Firecode Health Technical Memoranda (HTMs)

81 – Fire precautions in new hospitals. NHS Estates, HMSO 1996.

82 – Fire warning systems in hospitals. NHS Estates, HMSO (to be published in 1997)

83 – Fire safety in healthcare premises: general fire precautions. NHS Estates, HMSO 1994.

85 – Fire precautions in existing hospitals. NHS Estates, HMSO 1994.

86 – Fire risk assessment in hospitals. NHS Estates, HMSO 1994.

Scottish Office publications

National Health Services Model Engineering Specifications (supplement). Scottish Office, 1995.

Firecode in Scotland: Policy and principles. Scottish Office Home and Health Department, HMSO 1994.

Fire safety: New health buildings in Scotland. Scottish Home and Health Department, HMSO 1987.

Post-commissioning document for health buildings in Scotland (Scottish Hospital Technical Note 1). Scottish Office, HMSO 1993.

Scottish Hospital Planning Notes (SHPNs)

1. **Health service building in Scotland.** Scottish Office, HMSO 1991.
2. **Hospital briefing and operational policies.** Scottish Office, HMSO 1993.

Northern Ireland publications

Northern Ireland Firecode: Policy and principles. Management Executive, Health and Personal Social Services, HMSO 1994.

Northern Ieland Firecode: Fire safety in residential care premises. Management Executive, Health and Personal Social Services, HMSO 1995.

British Standards

BS 800: 1988 Specification for limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus. (AMD 6275, 6/90; AMD 6578, 6/91)

BS 4737 Intruder alarm systems.

BS 5445 Components of automatic fire detection systems.

BS 6238: 1982(1993) Code of practice for performance monitoring of computer-based systems.

BS 7671: 1992 Requirements for Electrical Installations. IEE Wiring Regulations. Sixteenth edition.

BS 7807: 1995 Code of practice for design, installation and servicing of integrated systems incorporating fire detection and alarm systems and/or other security systems for buildings.

BS EN 50065 Specification for signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz.

50065-1: 1992 General requirements, frequency bands and electromagnetic disturbances. (AMD 7950, 9/93)

BS EN 55011: 1991 Specification for limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

BS EN 55015: 1993 Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment. (AMD 7878, 7/93)

BS EN 60529: 1992 Specification for degrees of protection provided by enclosures (IP code). (AMD 7643, 7/93)

BS EN ISO 9000 Quality management and quality assurance standards.

The European Standards Committee CEN TS247 on Controls for mechanical building services is currently preparing a series of standards for heating, ventilation and air-conditioning:

Systems structure and definition of terms

Equipment functionality

Equipment characteristics, test and verifications

Communications

Implementation guidelines

Miscellaneous publications

CIBSE Commissioning codes

Series C: Automatic control systems. Chartered Institute of Building Services Engineers (CIBSE), 1973

CIBSE Guides:

Volume A: Design data. 5th edition, CIBSE, 1986.

Volume B: Installation and equipment data. 5th edition, CIBSE, 1986.

Volume C: Reference data. 5th edition, CIBSE, 1986.

Automatic controls and their implications for systems design (Application manual). CIBSE, 1985.

BSRIA publications

Applications handbook volume 1: Guide to BEMS centre standard specification. Building Services Research and Information Association (BSRIA), 1990.

Applications handbook volume 2: Standard specification for BEMS version 3.1. BSRIA, 1990.

Commissioning of BEMS: a code of practice (AH 2/92). BSRIA, 1992.

P.G. Pike **BEMS performance testing (AG 2/94).** BSRIA, 1994.

Standard maintenance specification for mechanical services in buildings. Volume III: Control, energy and building management systems. SMG 90c. Heating and Ventilating Contractors Association (HVCA), 1992.

Appendix 1

BMS outstation – field devices service and maintenance schedule

Building .....
Outstation ref no. .....

FIELD DEVICE TYPE	INSPECT, SERVICE & MAINTAIN	SATISFACTORY Yes / No
Sensor	Clean sensor head Check position Check surface contact/thermal pocket Check for damage Check sensor mounting Check wiring/tubing connections Measure sensor accuracy	
Actuator	Check for cable damage Check mounting security Check linkage tightness Measure actuator span and speed Check response to control signals Check response on power failure Check actuator response to fire/safety signals	
Digital inputs	Check location of switch Check switch mounting Clean switch Check switch operates at specified limits	
Signed ..... Date		

Appendix 2

Outstation service and maintenance schedule

Building .....
Outstation ref No. .....

OUTSTATION	INSPECT, SERVICE & MAINTAIN	SATISFACTORY Yes / No
Hardware	Check condition of cabinet Check local operating environment Check condition of connectors, door seals and cable entries Check operation of battery after mains power failure Check automatic restart after resumption of power supply Check analogue and digital inputs satisfactory Check analogue and digital outputs satisfactory	
Configuration software	Check accuracy of time clock Check time schedules Check data logging as required Check alarms for priority levels, messages, routing Check existing management of BMS alarms Review recently generated alarms Check start-up and shut-down routines Check optimum-start and optimum-stop routines Check control loops for stability and accuracy Check sequencing of multiple plant units Check load cycling routines Check load shedding routines Check interlocks Check interfaces with fire and security systems	
Signed ..... Date		

Appendix 3

Central station service and maintenance schedule

Building.....

FEATURE	INSPECT, SERVICE & MAINTAIN	SATISFACTORY Yes / No
Communications	Check integrity of data flow in both directions: - between outstations - between outstation and central station - between central station and remote terminals - off-site communications via modems	
Hardware	Check all cables and connectors Clean and service computer in accordance with manufacturer's instructions Clean and service printer in accordance with manufacturer's instructions	
Software	Make back-up disks of all site-specific operating data files Verify functions of operating program Check operation of password system and update as necessary Verify links, data transfer and operation of related software installed on computer Verify routing of priority messages and alarms with integrated fire and security systems Check updating of records for configuration software, set points etc	
Signed ..... Date.....		

Other publications in this series

(Given below are details of all Health Technical Memoranda available from HMSO. HTMs marked (*) are currently being revised, those marked (†) are out of print. Some HTMs in preparation at the time of publication of this HTM are also listed.)

1 Anti-static precautions: rubber, plastics and fabrics†
2 Anti-static precautions: flooring in anaesthetising areas (and data processing rooms), 1977.
3 –
4 –
6 Protection of condensate systems: filming amines†
2007 Electrical services: supply and distribution, 1993.
8 –
2009 Pneumatic air tube transport systems, 1995.
2010 Sterilizers, 1994, 1995, 1996.
2011 Emergency electrical services, 1993.
12 to 13 –
2014 Abatement of electrical interference, 1993.
2015 Bedhead services, 1994, 1995.
16 –
17 Health building engineering installations: commissioning and associated activities, 1978.
18 Facsimile telegraphy: possible applications in DGHs†
19 Facsimile telegraphy: the transmission of pathology reports within a hospital – a case study†
2020 Electrical safety code for low voltage systems, 1993.
2021 Electrical safety code for high voltage systems, 1993, 1994.
2022 Medical gas pipeline systems, 1994, 1996.
2023 Access and accommodation for engineering services, 1995.
2024 Lifts, 1995.
2025 Ventilation in healthcare premises, 1994.
26 Commissioning of oil, gas and dual fired boilers: with notes on design, operation and maintenance†
2027 Hot and cold water supply, storage and mains services, 1995.
28 to 29 –
2030 Washer-disinfectors, 1995.
2031 Steam supply for sterilization*
32 to 34 –
2035 Mains signalling, 1996.
36 to 39 –
2040 The control of legionellae in healthcare premises – a code of practice, 1993.
41 to 40 –
2045 Acoustics, 1996.
46 to 49 –
2050 Risk assessment in the NHS estate, 1994.
51 to 54 –
2055 Telecommunications (telephone exchanges), 1994.

Component Data Base (HTMs 54 to 80)

54.1 User manual, 1993.
55 Windows, 1989.
56 Partitions, 1989.
57 Internal glazing, 1995.
58 Internal doorsets, 1989.
59 Ironmongery†
60 Ceilings, 1989.
61 Flooring, 1995.
62 Demountable storage systems, 1989.
63 Fitted storage systems, 1989.
64 Sanitary assemblies, 1995.
65 Health signs*
66 Cubicle curtain track, 1989.
67 Laboratory fitting-out system, 1993.
68 Ducts and panel assemblies, 1993.
69 Protection, 1993.
70 Fixings, 1993.
71 Materials management modular system*
72 to 80 –

Firecode

81 Fire precautions in new hospitals, 1996.
82 Firecode: alarm and detection systems, 1989.
83 Fire safety in healthcare premises: general fire precautions, 1994.
85 Fire precautions in existing hospitals, 1994.
86 Fire risk assessment in hospitals, 1994.
87 Textiles and furniture, 1993.
88 Fire safety in health care premises: guide to fire precautions in NHS housing in the community for mentally handicapped/ill people, 1986.

Health Technical Memoranda published by HMSO can be purchased from HMSO bookshops in London (post orders to PO Box 276, SW8 5DT), Edinburgh, Belfast, Manchester, Cardiff, Birmingham and Bristol, or through good booksellers. HMSO provide a copy service for publications which are out of print; and a standing order service.

Enquiries about Health Technical Memoranda (but not orders) should be addressed to: NHS Estates, Department of Health, Publications Unit, 1 Trevelyan Square, Boar Lane, Leeds LS1 6AE.

About NHS Estates

NHS Estates is an Executive Agency of the Department of Health and is involved with all aspects of health estate management, development and maintenance. The Agency has a dynamic fund of knowledge which it has acquired during over 30 years of working in the field. Using this knowledge NHS Estates has developed products which are unique in range and depth. These are described below. NHS Estates also makes its experience available to the field through its consultancy services.

Enquiries about NHS Estates should be addressed to:
NHS Estates, Publications Unit, Department of Health,
1 Trevelyan Square, Boar Lane, Leeds LS1 6AE.
Telephone 0113 254 7000.
http://www.demon.co.uk/nhsestates/hpage.html/

Some NHS Estates products

Activity DataBase – a computerised briefing and design system for use in health buildings, applicable to both new build and refurbishment schemes. *NHS Estates*

Design Guides – complementary to Health Building Notes, Design Guides provide advice for planners and designers about subjects not appropriate to the Health Building Notes series. *HMSO*

Estatecode – user manual for managing a health estate. Includes a recommended methodology for property appraisal and provides a basis for integration of the estate into corporate business planning. *HMSO*

Concode – outlines proven methods of selecting contracts and commissioning consultants. Reflects official policy on contract procedures. *HMSO*

Works Information Management System – a computerised information system for estate management tasks, enabling tangible assets to be put into the context of servicing requirements. *NHS Estates*

Health Building Notes – advice for project teams procuring new buildings and adapting or extending existing buildings. *HMSO*

Health Guidance Notes – an occasional series of publications which respond to changes in Department of Health policy or reflect changing NHS operational management. Each deals with a specific topic and is complementary to a related HTM. *HMSO*

Health Technical Memoranda – guidance on the design, installation and running of specialised building service systems, and on specialised building components. *HMSO*

Health Facilities Notes – debate current and topical issues of concern across all areas of healthcare provision. *HMSO*

Encode – shows how to plan and implement a policy of energy efficiency in a building. *HMSO*

Firecode – for policy, technical guidance and specialist aspects of fire precautions. *HMSO*

Capital Investment Manual Database – software support for managing the capital programme. Compatible with Capital Investment Manual. *NHS Estates*

Model Engineering Specifications – comprehensive advice used in briefing consultants, contractors and suppliers of healthcare engineering services to meet Departmental policy and best practice guidance. *NHS Estates*

Quarterly Briefing – gives a regular overview on the construction industry and an outlook on how this may affect building projects in the health sector, in particular the impact on business prices. Also provides information on new and revised cost allowances for health buildings. Published four times a year; available on subscription direct from NHS Estates. *NHS Estates*

Items noted "HMSO" can be purchased from HMSO Bookshops in London (post orders to PO Box 276, SW8 5DT), Edinburgh, Belfast, Manchester, Birmingham and Bristol or through good booksellers.

NHS Estates consultancy service

Designed to meet a range of needs from advice on the oversight of estates management functions to a much fuller collaboration for particularly innovative or exemplary projects.

Enquiries should be addressed to: NHS Estates Consultancy Service (address as above).