NHS National Services Scotland

Scottish Health Technical Memorandum 08-05:

Specialist services
Building management systems
Part D
Operational management

Health Facilities Scotland
Engineering and Environment

April 2012

Contents

Acknowledgements

This new SHTM 08-05 Part D – Operational Management has been developed, updated and expanded from SHTM 2005 which it replaces. SHTM 2005 was originally published in June 2001 by NHSScotland Property and Environment Forum Executive. The contributions from the National Ventilation Advisory Group and Stuart Robertson of Enterprise Control Engineers Ltd. are gratefully acknowledged.

Preface

About Scottish Health Technical Memoranda

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

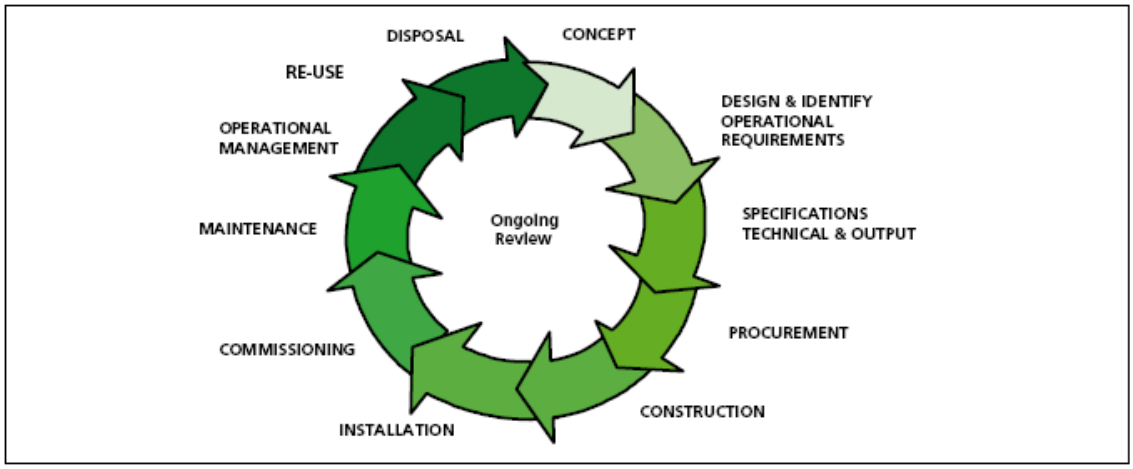
The focus of SHTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle. Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

It is not the intention within this suite of documents to repeat unnecessarily international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of eight subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.



Healthcare building life-cycle

Structure of the Scottish Health Technical Memorandum suite

The series of engineering-specific guidance contains a suite of eight core subjects:

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Scottish Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

Some subject areas have been further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A represents: Electrical safety guidance for low voltage systems

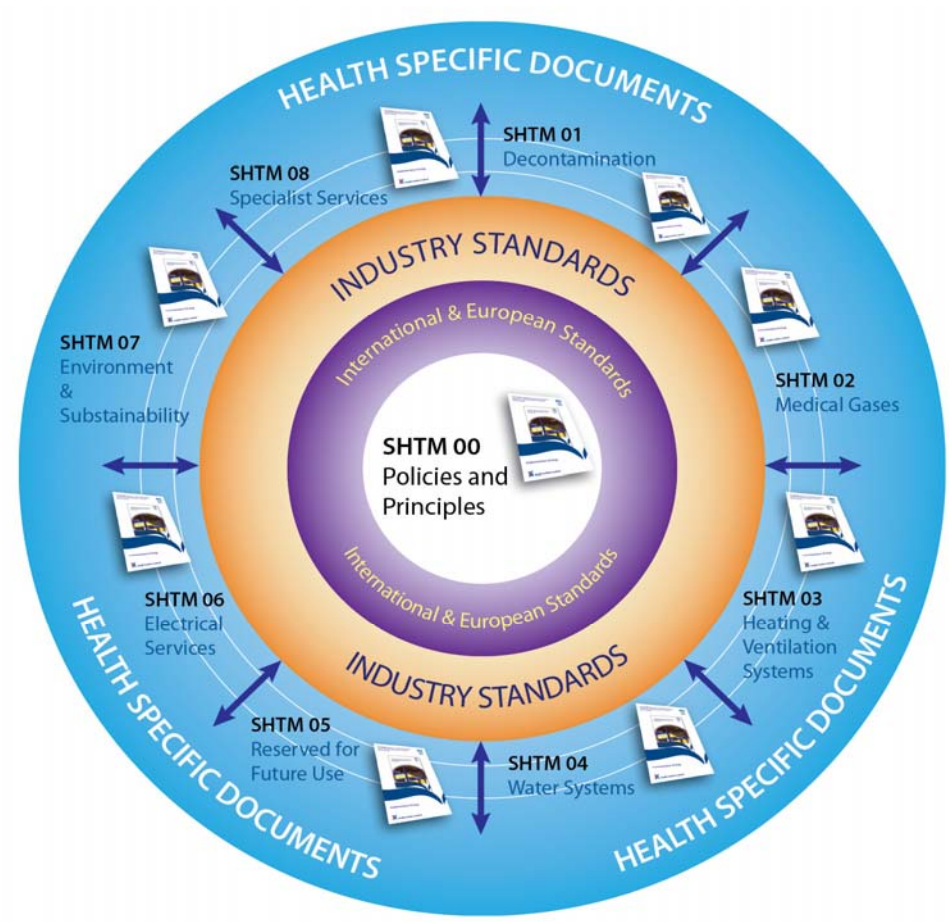
In a similar way Scottish Health Technical Memorandum 07-02 simply represents: Environment and Sustainability – EnCO_2de.

All Scottish Health Technical Memoranda are supported by the initial document Scottish Health Technical Memorandum 00 which embraces the management

and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

Health Facilities Scotland wishes to acknowledge the contribution made by professional bodies, engineering consultants, healthcare specialists and NHS staff who have contributed to the review.



Engineering guidance

Executive summary

A building management system (BMS) or Building and Energy Management System (BEMS) 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 carbon usage and 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 part, '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 Section 2.

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

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

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

Section 7 covers the recommended procedures in keeping records.

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

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

1. Scope

1.1 A Building Management System (BMS) or Building and Energy Management System (BEMS) is a management tool for the effective control of building engineering services, and can be applied equally to new and existing buildings.

1.2 A BMS can be used to manage the environmental conditions of all types of building. In healthcare premises, increasing energy efficiency, reducing CO_2 emissions and saving costs are a mandatory daily task. A BMS is particularly valuable in maintaining climate control and 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 and equipment.

1.3 A properly installed and maintained BMS operated by fully trained staff offers considerable opportunities for 'energy and carbon management'. A BMS can support separate software packages for energy monitoring and targeting and also data evaluation and reporting. Consideration should also be given to web-based energy performance monitoring, reporting and analysis tools.

Note: Other areas that can be monitored and targeted include water consumption, sewage and waste disposal. As energy management is an important tool, installations are often described as 'Building and energy management systems' (BEMS). However, the abbreviation 'BMS' is used throughout this document. Section 9: 'Definitions' also refers.

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

1.5 A BMS should be specified with care and detail, focusing on the functionality and required performance of the systems under control, optimising the workflows and service processes to be more efficient. 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.

Note: When a BMS is specified, the NHS Model Engineering Specifications, with the appropriate supplements for Scotland should be considered.

1.6 The commissioning of a 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 as technical malfunctions have to be detected on time and reported so that appropriate measures can be immediately carried out.

1.9 The sophistication of building services in healthcare premises is increasing, with the task of combining energy efficiency and carbon usage reduction with comfort and secure energy supply. The BMS controls should be designed, installed, operated and maintained to standards that will enable the controls to fulfil the desired functions reliably, safely, economically and efficiently.

1.10 BMS controls should be designed to standards for the full spectrum of today's building services applications in keeping up with new energy-efficient technologies, with system functions such as alarm management, time scheduling, and trend logging, combined with sophisticated control functions, Intelligent networking of information and communication technology as well as web technology and open communications making a financially wise investment for the future.

1.11 The design of the BMS controls should be consistent in its support of open communications, making it easy to connect a wide variety of building services equipment on the basis of standard open data interfaces;

- BACnet;
- LONWORKS®;
- Konnex (KNX);
- M-bus;
- Modbus;
- OPC;
- TCP/IP network protocol.

2. 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:

- Health and Safety at Work etc (HSW) Act 1974;
- Electricity at Work Regulations 1989;
- The Building (Scotland) Regulations 2004;
- Management of Health and Safety at Work Regulations 1999;
- Provision and Use of Work Equipment Regulations 1998;
- Manual Handling Operations Regulations 1992;
- Workplace (Health, Safety and Welfare) Regulations 1992;
- Personal Protective Equipment at Work (PPE) Regulations 1992;
- Health and Safety (Display Screen Equipment) Regulations 1992;
- Construction (Design and Management) Regulations 2007;
- Electromagnetic Compatibility Regulations 2005.

Functional guidance

2.3 Guidance is as laid down in:

- British Standards and Codes of Practice;
- Health and Safety Executive Guidance;
- NHS Model Engineering Specifications;
- Scottish Health Technical Memoranda (SHTM);
- Scottish Hospital Planning Notes (SHPN);
- Scottish Hospital Technical Notes (SHTN);
- NHS in Scotland – Firecode;
- Health Building Notes still applicable in Scotland;

For further details please refer to the 'References' section at the end of this document.

3. Criteria for operation

General

3.1 Those responsible for operation and building technology in healthcare premises have a great responsibility for patients, staff and visitors every day. It is essential they 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 energy saving 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. A contractor should be preferably be an approved partner to a BMS organisation, 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 appropriate 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.

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.

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

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:

- BMS performance specification;
- control strategy diagrams;
- schematics;
- points list;
- provision for adding to system and updating without major disruption;
- plant diagrams showing locations of field devices;
- software backup copies;
- record drawings;
- commissioning records;
- operating and maintenance manuals;
- 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 ‘user’ brief comprising a description of the BMS, plant under BMS control and the intended mode of operation;
- precise design requirements with regard to physical parameters measured and controlled by the BMS;
- commissioning manuals listing the results of commissioning tests as detailed in the ‘Validation and verification’ (Part ‘C’) of this SHTM.

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:

- user logging on, operation and logging off;
- creation of record of system users;
- password protection of all levels for different classes of user;
- routine application-software backup;
- operation of alarm log;

- relaying of critical alarms via email, sms or autodial;
- recovery of system from:
  - power failure;
  - central station failure;
  - BMS communications failure;
- integration of BMS with fire and security alarm systems – correct alarm override;
- archiving of historical data;
- record of alterations made to the BMS software;
- record of observed defects (plant and BMS) and corrective action taken, together with dates;
- 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.

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

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

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:

- the prime function of the BMS;
- method of BMS operation;
- problems and hazards that can arise from failing to follow the agreed operating, monitoring and maintenance procedures;
- the permit-to-work in use;

- the danger of making unauthorised modifications, alterations or additions to the BMS, as well as the possible legal consequences;
- 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. The BMS installer shall provide training in accordance with the specification for the staff starting at the end of the contract period.

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 together with the conscientious use of energy.

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 being undertaken.

Note: 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:

- understanding the displays;
- acknowledging and cancelling alarms;
- taking required actions following alarm messages;
- 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. Standards

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' parts of this SHTM.

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

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

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):

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

- a safe means of staff access should be provided to enable BMS service and maintenance operations to be carried out;
- control enclosures housing BMS outstations should be secured to prevent unauthorised access;
- BMS outstations should have the power source backed up with a battery backup system to prevent loss of trend logs and historical data in the event of power failure. The length of battery autonomy will vary from 2-3 minutes to 1 hour and will be project-specific;
- the central station computer and outstations with terminals should be password-protected to prevent unauthorised access;
- plantrooms containing BMS equipment should be well-illuminated and should permit safe access to all parts of the BMS requiring inspection, service and maintenance;
- minimum standards for electrical safety are covered in BS7671: 2008 Requirements for electrical installations (IEE Wiring Regulations 17th edition), SHTM 06-01 and other documents detailed in the 'References' section at the end of this document;
- standards relating to electromagnetic interference (including SHTM 06-01) are detailed in the 'References' section;
- computer workstations, lighting etc. should be suitable for purpose and comply with the Health and Safety (Display Screen Equipment) Regulations 1992.

5. 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 or remotely via web browsing facility. 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 appropriate 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 filter alarms to recognise faults speedily, together with recurring 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. The BMS should offer options for monitoring the plant. Information should be able to be monitored locally, centrally and remotely via the internet. Access to the system should be password protected and users should login to gain access to functionality, defined by their access level.

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 data logging facility. Operators should be encouraged to initiate trend logs to monitor various aspects of the BMS and should include critical environmental parameters such as temperature, humidity, pressure, etc. Trend logging data should be stored within the outstations and automatically uploaded to hard disk storage when archival is required. Uploads should occur based upon manual command, or when the logging buffers become full.

Components

5.10 The values of BMS inputs and outputs (sensors and actuators) will 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 BMS should offer the facility to inspect the performance of complete items of plant (for example boilers, chillers and air handling units) for system response, stable control, sequencing, etc. Operation should be configured to be automatic, manual or a combination of these. This mode should also be used for calibration of sensors and alterations of standard control functionality, e.g. PID loops, etc.

Buildings

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

- **environmental performance**: the thermal response and the humidity of the internal environment over time should be checked against the design specification;
- **energy performance**: the energy consumption of the building or plant should be monitored and compared with predicted levels.

These methods may be combined and, in both cases, the system should provide the facility to create reports for individual rooms/areas/zones.

Automated performance monitoring

5.13 The BMS should 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 check the response and initiate alarms automatically.

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.

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

Note: Trend logs which have served their purpose should be removed.

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

6. Maintenance

General

6.1 Management should prepare a maintenance plan describing the best means to maximise equipment operational availability, while minimising equipment downtime. Once developed, the maintenance plan should identify task descriptions and schedules, troubleshooting, corrective maintenance task descriptions, and spare parts identification. This information should be incorporated in the manuals.

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

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

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 manufacturers' 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 and therefore should preferably be an approved partner to a BMS organisation.

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.

Note: 1. This approach should reduce the potential for disputes during the contract defects liability period.

2. Maintenance arrangements should commence at handover.

6.9 The maintenance contractor may not be the BMS manufacturer or the installation contractor but should preferably be an approved partner to the BMS manufacturer of the system installed.

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

- are an approved partner to a BMS organisation;
- have had the necessary training;
- have a knowledge of the installed system;
- maintain a current awareness of the manufacturers' equipment, including computer hardware and software;
- have access to modern diagnostic equipment;
- have good technical support;
- are supported by adequate stocks of spares.

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):

- clean the sensor head according to manufacturer's instructions;
- check the position of the sensor is as originally installed;
- check there is good surface contact, or good thermal conductivity in a pocket, as necessary;
- check the sensor for damage;
- check the sensor is securely mounted;
- check that any wires or tubing are securely connected;
- check the accuracy of the sensor against a calibrated instrument, where possible in situ;

- check the operation of the sensor.

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):

- check cables for signs of damage;
- check the security of the mounting;
- check the tightness of linkages;
- check the span and speed of the actuator;
- check the correct response of the actuator to normal control signals;
- check actuator response on power failure;
- check actuator response to fire/safety signals (six-monthly);
- 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 on contactors, relays, dampers, actuators etc., or from switches which change state at pre-set 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):

- check environment is not having an adverse effect on the operation of the switch;
- check mounting of switch;
- check cables for signs of damage;
- calibrate/adjust switch if necessary.

Outstations

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

- check the condition of the cabinet and the local operating environment;
- check the condition of the connectors, the door seals and cable entries;
- check the operation of the battery back-up system.

Configuration software

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

- check the accuracy of the time clock;
- check the time schedules;
- check that data logging is as required;
- check alarms (faults and out-of-limits) for priority levels, associated messages and 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.

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 integrity of data flow in both directions should be confirmed by carrying out routine checks on the following communication paths (a sample checklist is provided in Appendix 3):

- between outstations;
- between outstations and modules;
- between central station and outstations;
- between central station and remote terminals;
- via modems to off-site installations;
- via internet to off-site installations;
- via intranet to on-site installations;

Central station

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

- check all cables and connectors;
- clean and service the computer, monitor and keyboard in accordance with the manufacturer's instructions;
- make back-up copies of all site-specific operating data files;
- verify the routine functions of the central station operating program;
- check the operation of the password system and update as necessary;
- verify the links, data transfer and operation of related software installed on the computer;
- verify the routing of priority messages and alarms with integrated fire and security systems;
- check the availability of the operating and maintenance manuals;
- check the updating of records for configuration software, set-points etc.;
- clean and service the printer in accordance with manufacturer's instructions.

7. 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:

- routine inspections;
- routine maintenance;
- faults and unscheduled service and maintenance activities;
- alterations to plant under BMS control;
- changes in the control strategy;
- changes in set-points;
- results of any tests carried out on the system.

7.3 These records may take the form of maintenance checklists.

8. 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:

- employs one or more individuals under a contract of employment or apprenticeship;
- provides training under the schemes to which the Health and Safety (Training for Employment) Regulations 1990 (SI 1990/1380) 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 SHTM 06-02, 2011: *Electrical safety guidance 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 SHTM 06-02).

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 SHTM 06-02).

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. 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.

BACnet: BACnet is a communication protocol for building automation and control networks, suited for the management and automation levels, especially for HVAC, lighting control, life safety, security and fire alarm systems.

BAS – building automation system: synonymous with BMS.

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

BMS – building management system: a system comprising electronic equipment and software with the prime function of controlling and monitoring 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 BMS 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/she 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:

- reduce heat supply with decreasing building heat load; or

- 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, for example 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: a description of a system where data processing and control is carried out at outstations, 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.

LonWorks: Collective term for LON technology as a whole.

M-Bus - (Meter-Bus): Standardised field bus system (conforming to EN 1434) for the transmission of energy consumption data.

Modbus: Open standard protocol for industrial use.

OPC: Software interface defined in process automation.

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.

Soft point: a point that can be referenced as if it were a monitoring or control point in a BMS, although it has no associated physical location. It may have a set value or be the result of a given calculation or algorithm.

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

TCP/IP: Transmission Control Protocol/Internet Protocol

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

Web: Standardised communication system for worldwide data exchange via script languages.

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

Appendix 1

BMS outstation – field devices service and maintenance schedule

Building .....

Outstation ref no. .....

Field device type	Inspect, service and maintain	Satisfactory Yes/no
Sensor	Clean sensor head Check position Check surface contact/thermal pockets 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 and 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 are satisfactory Check analogue and digital outputs are 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 and 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 …….		

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Note: Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.

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