University College London Estates

UCL Seasonal Commissioning Employer’s Requirement

Contents

Introduction

The purpose of seasonal commissioning is to assess the operational performance of newly installed mechanical, electrical and renewable energy systems (typically those affected by changes in climate) throughout the various seasons to ensure these perform as they were designed to. Seasonal commissioning is a separate, but complementary process to the normal commissioning of building services. While normal commissioning of building services is completed ahead of practical completion, seasonal commissioning looks to assess operational performance of building services within the first year of substantial occupation under varying environmental conditions.

During seasonal commissioning, operational performance should be compared against design setpoints and systems should be fine-tuned or recommissioned where there are deviations. It also provides a good opportunity to see if setpoints and controls can be adjusted to better suit operational requirements and to reduce energy consumption, without compromising on comfort and performance. Seasonal commissioning shall be carried out across three seasons during the first year of occupation, including a session during the peak of summer, a session during the peak of winter, and a session during the off-peak seasons of spring or autumn.

For projects with minimal MEP installations, the number of seasonal commissioning sessions and the scope can be appropriately tailored following approval by the UCL Estates Mobilisation and Transition team. Where applicable, projects should comply with the seasonal commissioning BREEAM requirements that apply to the project – see Appendix 3: BREEAM 2018 Commissioning & Seasonal Commissioning Credits.

All capital projects with MEP installations must complete the following seasonal commissioning process within 12 months of substantial building occupation.

Outline of Activities and Responsibilities

Building Services Consultant and Commissioning Compliance Manager

During design development, the building services consultant shall specify which systems and data parameters are to be monitored and assessed as part of seasonal commissioning by completing the checklist in Appendix 1 of this document – see Appendix 1: Systems to be Assessed for Seasonal Commissioning. The consultant shall issue this completed checklist within their tender documentation to form part of the contractor's seasonal commissioning scope of works, together with this Employer's Requirement. The list of systems shall be agreed in advance with the UCL Estates Mobilisation and Transition team.

The consultant shall also specify details of the following:

- Duration of BMS trend monitoring required for seasonal commissioning.
- Frequency of data logging required for seasonal commissioning, and for general operation.

The building services consultant (and the client's commissioning compliance manager if one has been appointed) shall carry out the following activities during the seasonal commissioning process:

- Oversee the seasonal commissioning process.
- Review operational performance data (e.g. BMS data) at of each seasonal commissioning session, comparing operational performance against design set points and specifications. Identify any deviations and carry out the necessary investigations to understand the cause of deviations. If MEP systems are not connected to a BMS, then the consultant shall review live measurements taken on site by the contractor.
- Attend the on-site seasonal commissioning sessions at each season.
- Attend meetings to analyse operational performance data (e.g. BMS data) with the wider seasonal commissioning team - refer to attendee list later in this document.
- At each seasonal commissioning session, physically inspect all major plant, including main valves and meters for any visible faults or defects. Physically inspect all rooms within scope of works for any obvious problems such as overheating, overcooling, excess noise, draughts, condensation etc.
- Following each seasonal commissioning session, review the seasonal commissioning reports produced by the contractor.
- Specify the corrective and/or improvement works required to remedy any issues highlighted by seasonal commissioning and ensure these are closed out by the contractor.

Contractor

The contractor shall undertake seasonal commissioning of all systems identified by the building services consultant in their 'Checklist of Systems to be Assessed for Seasonal Commissioning' – refer to Appendix 1, by following the seasonal commissioning process outlined below.

During the construction phase, the contractor shall:

- Prepare a detailed seasonal commissioning plan in accordance with this employer's requirement and with the building services consultant's seasonal commissioning plan if applicable. The contractor's plan shall be issued to the commissioning compliance manager, the building services consultant and the UCL Estates Mobilisation and Transition team for approval ahead of practical completion.
- Establish the most suitable periods to undertake seasonal commissioning. For summer sessions, this should be the hottest and most occupied period of the year; for winter sessions this should be the coldest period of the year. Agree dates of seasonal commissioning sessions with the UCL Mobilisation and Transition Team ahead of practical completion.

At each seasonal commissioning session, the contractor shall:

- Arrange with the university project officer (UPO) and building operators the most suitable times to undertake seasonal commissioning activities, considering any operational impacts and how this could be avoided / minimised. For example, would seasonal commissioning works affect ventilation/temperatures in critical spaces? How can this be avoided?

- Gather feedback from building users through interviews or questionnaires to identify any problems with the effectiveness of systems (e.g. are there any areas that are too hot, too cold, too draughty, stuffy etc.). Compare feedback to BMS data log.
- Log the relevant BMS data across a minimum of two weeks ahead of each seasonal commissioning session. If the contractor has no access to the BMS head-end, the contractor shall request BMS trend logs and trend charts from UCL Estates / BMS maintenance contractor ahead of time. Once collected, this BMS data should be shared with all seasonal commissioning attendees ahead of the review sessions on site. Refer to Appendix 1: Systems to be Assessed for Seasonal Commissioning for a tailored list of the systems and BMS data points that shall be assessed as part of the scope of works.
- BMS trend charts should be reviewed for each system, focusing on parameters such as room temperatures, chilled water / low temperature hot water flow and return temperatures, set points, supply and extract temperatures.
- Analyse BMS data and compare actual performance of each system against design set points and specifications. Identify any deviations from design specifications and carry out the necessary investigations to understand cause of deviations.
- If the systems are not connected to a BMS, then live measurements should be carried out on site to ensure performance is in line with design specifications (e.g. measure room temperatures to ensure these remain within design set points; check time schedules of plant to ensure these are in line with hours of use etc.).
- Hold a meeting to analyse BMS data (or data from live measurements if there is no BMS installation) with wider seasonal commissioning team, including the mechanical building services consultant and commissioning compliance manager, if one has been appointed. User feedback to be investigated in conjunction with this.
- Physically inspect all major plant, including main valves and meters for any visible faults or defects. Physically inspect all rooms within scope of works for any obvious problems such as overheating, overcooling, excess noise, draughts, condensation etc.
- Undertake the necessary corrective works and recommissioning activities to bring set points and system performance in line with design specifications. Any changes to set points and flow rates must be approved by the mechanical building services consultant.
- Log the corrective works required in a tracker and ensure these are closed out in a timely manner. Liaise with UPO to programme any corrective works required.
- Produce a report at each seasonal commissioning session summarising the findings and the corrective works required to resolve any issues. The report shall include a tracker of all corrective works required and the status of these (open / closed). The report shall be issued to the independent commissioning manager and the building

services consultant for approval. Report shall also be issued to the UCL Estates Mobilisation and Transition team.

- Hold a review meeting at the end of the 12-month period with the UCL Estates Mobilisation and Transition team to summarise the findings from seasonal commissioning and to outline the corrective measures taken to resolve any issues. Recommendations for further works will be discussed during this review meeting.
- If applicable, issue a list of defects identified during seasonal commissioning to the Project Manager and University Project Officer prior to the end of the defects' liability period.

Following the completion of all seasonal commissioning sessions, the contractor shall update the Operation and Maintenance manuals (O&Ms), commissioning records and BMS Description of Operations to reflect any modifications made to MEP systems.

Attendees

A suggested list of attendees for the seasonal commissioning sessions is included below. The contractor shall appropriately tailor the list below to suit the scope of the project following approval from the UCL Estates Mobilisation and Transition team.

Attendee checklist to be tailored to suit scope of project:

Seasonal Commissioning Session Attendee List	**Required?**
Main Contractor	☐
Mechanical Contractor	☐
Electrical Contractor (Lighting Control Specialist)	☐
BMS Contractor	☐
Contractor Commissioning Manager (CxM)	☐
Commissioning Authority / Client Commissioning Compliance Manager (CxA)	☐
Mechanical Building Services Consultant	☐
Electrical Building Services Consultant	☐
Building FM Representative	☐
UCL incumbent BMS provider (Kendra)	☐
UCL Estates Mobilisation and Transition Team	☐
University Project Officer	☐

Referenced Standards

- BSRIA BG 44/2013
- LEED Enhanced Commissioning
- BREEAM Seasonal Commissioning
- SKA Rating System

Version Control

Date	Version	Change	Reason	Author	Authorised
15/07/2021	Draft 1	First Draft		Reshmi Govindankutty	
16/09/2021	Draft 2	Second Draft	Updates based on initial round of comments	Reshmi Govindankutty	
09/12/2021	Draft 3	Third Draft	Updates based on stakeholder comments	Reshmi Govindankutty	
10/02/2022	Draft 4	Fourth Draft	Updates	Reshmi Govindankutty	
25/02/2022	Version 1	Formal issue	First formal issue	Reshmi Govindankutty	

Author: Reshmi Govindankutty, Transition Engineer, UCL Estates

Peer Reviewed by: Kenichi Hamada (Buro Happold), Mark Dowson (Buro Happold), Ben Stubbs (UCL Estates), Stuart Carrick (UCL Estates), Neil Turvey (UCL Estates).

Appendix 1: Systems to be Assessed for Seasonal Commissioning

This appendix includes a checklist of all the systems and data points to be monitored across each season for seasonal commissioning. Ahead of tender, the building services consultant shall complete this checklist by identifying which systems, data parameters and activities are to be included within the scope of works, agreeing this in advance with the UCL Estates Mobilisation and Transition team. **The completed checklist shall form part of the seasonal commissioning scope of works for the contractor and shall be included within the tender package.**

All BMS data points listed below are to be monitored for a minimum of 2 weeks ahead of each seasonal commissioning session wherever possible.

The consultant may populate the editable Microsoft Excel version of this checklist (available for download on UCL website) and should append the checklist to this document ahead of tender.

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
Mechanical	
Air Handling Units	☐
Monitor the following parameters / trend logs to assess performance against design specifications:	
• Outdoor air, supply air, return air temperatures	☐
• Air flow rates via BMS	☐
• LTHW / CHW valve positions	☐
• Set points	☐
• Fan speed (% of max load)	☐
• Pressure readings	☐
• CO_2 levels (if applicable)	☐
• Other	☐
Additional checks:	
• Can supply air temperature be optimised to reduce the number of terminal units reheating cool supply air from the AHUs? And vice versa to reduce the number of terminal units cooling warm supply air? Any changes to set points must be approved by the mechanical building services consultant.	☐
For heat recovery unit operation:	
• Monitor outdoor air temperature, return temperature, supply temperature, exhaust air temperature to check heat recovery unit is operating well under correct temperature conditions	☐
• Pump speed for run around coils (% of max)	☐
Air Source / Ground Source Heat Pumps	☐
Monitor the following parameters / trend logs to assess performance against design specifications:	
• LTHW / CHW flow and return temperatures	☐
• LTHW / CHW flow rates	☐
• Set points	☐
• Run hours	☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
(continued from previous page)	
• Outdoor air temperature	☐
• Borehole side water temperatures	☐
• Pump speed (as % of max)	☐
• Other	☐
Additional checks:	
• Borehole side of ground source heat pump achieving a thermal energy balance across the year? Provide trend logs to evidence this.	☐
• Can set points be adjusted to improve performance and reduce energy consumption? Any changes to set points must be approved by the mechanical building services consultant.	☐
Boilers	☐
Monitor the following parameters / trend logs to assess performance against design specifications:	
• LTHW flow and return temperatures	☐
• LTHW flow rates	☐
• Set points	☐
• Run hours	☐
• Other	☐
Additional checks:	
• Can set points be adjusted to improve performance and reduce energy consumption? Any changes to set points must be approved by the mechanical building services consultant.	☐
Chillers	☐
Monitor the following parameters / trend logs to assess performance against design specifications:	
• CHW flow and return temperatures	☐
• CHW flow rates	☐
• Set points	☐
• Run hours	☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
(continued from previous page) • Outdoor air temperature • Other Additional checks: • Can set points be adjusted to improve performance and reduce energy consumption? Any changes to set points must be approved by the mechanical building services consultant.	 ☐ ☐ ☐
Condensers (for VRF and DX systems) • Run hours • Time schedules • Heating and cooling mode schedules	☐ ☐ ☐ ☐
Comms Room DX Splits Monitor the following parameters / trend logs to assess performance against design specifications: • Supply air temperature • Return air temperature • Room temperature • Set points • Run hours	☐ ☐ ☐ ☐ ☐ ☐
District heating connection / Heat exchanger connections Monitor the following parameters / trend logs to assess performance against design specifications: • Primary and Secondary LTHW / CHW temperatures • Primary and Secondary LTHW / CHW flow rates • Set points • Control valve positions • Heat meter readings (kWh) • Other	☐ ☐ ☐ ☐ ☐ ☐ ☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
Fans	☐
Monitor the following parameters / trend logs to assess performance against design specifications:	
• Run hours	☐
• Fan speed (is fan speed typically operating at efficient speeds according to their specific fan curves?)	☐
• Other	☐
Fan Coil Units / Chilled Beams / Radiators / Other water-based terminal heating or cooling units	☐
Monitor the following parameters / trend logs to assess performance against design specifications:	
• LTHW / CHW flow and return temperatures	☐
• Space temperatures - are we achieving set points in each space and we able to achieve these within a reasonable time frame?	☐
• CHW / LTHW control valve positions	☐
• Set points	☐
• Fan speed	☐
• Other	☐
Additional checks:	
• Are CHW and LTHW control valves opening simultaneously or within 15 minutes of each other?	☐
• Check the operation of systems to ensure there is no conflict of systems such as heating and cooling of spaces simultaneously, or any conflicts between newly installed systems and existing systems (e.g. conflict between newly installed FCUs with existing radiators)	☐
• Are set points in line with UCL heating and cooling policy?	☐
• If fresh air is ducted to the back of FCUs, are FCU fans running even when there is no demand for heating or cooling to ensure that fresh air is being supplied into the space? This should be compared against design specification.	☐
• Compare any issues highlighted by occupants against BMS log	☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
(continued from previous page) • Can set points be adjusted to improve performance and reduce energy consumption? Any changes to set points must be approved by the mechanical building services consultant.	☐
Humidifiers Monitor the following parameters / trend logs to assess performance against design specifications: • Relative humidity upstream of humidifier • Set points • Run hours	☐ ☐ ☐ ☐
Mechanical Ventilation Heat Recovery Units Monitor the following parameters / trend logs to assess performance against design specifications: • Supply air, outdoor air, return air, exhaust air temperatures • Set points • Bypass position • Run hours • LTHW valve position • CO_2 levels of room served • Other	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Natural Ventilation For naturally ventilated spaces, review the following parameters to assess performance against design specifications: • Review temperatures and thermal comfort of room, can take live measurements if no sensors in room • Review indoor air quality (e.g. CO2 levels) • Review occupant feedback • Review window contact sensor operation and whether this is working effectively with controls strategy • Other	☐ ☐ ☐ ☐ ☐ ☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
Pumps Monitor the following parameters / trend logs to assess performance against design specifications: • Run hours • Pump speed (are pump speeds typically operating at efficient speeds according to their specific pump curves?) • Other	☐ ☐ ☐ ☐
Solar Shading / Automatic control of blinds • Correct functionality of automatic controls? • Are shades being used as intended? (e.g. down in the summer, up in the winter, prevention of glare)	☐ ☐ ☐
VAVs / CAVs Monitor the following parameters / trend logs to assess performance against design specifications: • Supply air temperature • Space temperatures - are we achieving set points in each space and we able to achieve these within a reasonable time frame? • Air flow rates • LTHW control valve position • Indoor air quality (e.g. CO_2 levels) • Set points • Run hours • Other	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
VRF and Split Systems (indoor units) Monitor the following parameters / trend logs to assess performance against design specifications: • Supply air temperature • Return air temperature	☐ ☐ ☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
(continued from previous page) • Room temperature • Run hours • Time schedules • Heating and cooling mode schedules / Summer & Winter Modes	 ☐ ☐ ☐ ☐

Metering Systems
• Check that the following on-site meters and sub-meters are reading and logging data correctly, and are labelled correctly:
  o Main utility meters (electricity, gas, district heating network, water)
  o Renewable energy systems (e.g. solar PV)
  o Electrical sub-meters
  o Heat / DHW sub-meters
  o Others
• Check that the following remote energy management systems are reading and logging data correctly, and are labelled correctly:
  o EMON
  o Demand Logic
  o Fabriq
  o Solar Edge
  o Other
	☐
	
	☐
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	☐

Building Management System and Controls • Check time schedules of plant are still suitable for building use. Can these be optimised to reduce energy consumption whilst retaining high levels of comfort and system performance? • Optimise heating & cooling start up regimes / morning boost modes. Can the duration of these periods be reduced to minimise the duration of energy-intensive use whilst retaining high levels of comfort and system performance? • Are set points still in line with design specifications? Can any set points be adjusted to improve energy efficiency? (Deviations from design specifications must be approved by the mechanical building services consultant)	 ☐ ☐ ☐ ☐

Systems and activities to be included within scope of seasonal commissioning	**Within Scope of Project? *(Consultant to tick)***
(continued from previous page) • Can deadbands be optimised to improve performance and / or reduce energy consumption whilst retaining high levels of comfort? • Check whether sequencing of operation of components is suitable. • Optimise control loops where necessary • Monitor hand status on equipment to ensure plant is operating in auto and in line with design specifications • Check through log of faults / alarms. • Adjust location of sensors if necessary to ensure accuracy in readings • Other	☐ ☐ ☐ ☐ ☐ ☐
Electrical	
Daylight dimming • Is target lux level appropriate? Any changes to set points to be approved by Electrical building services consultant. • Are we achieving correct lux levels in space at different times of the day?	☐ ☐ ☐
Other	
Building Services consultant to list other parameters to be monitored as part of seasonal commissioning below: • [To be populated where necessary] • [To be populated where necessary] • [To be populated where necessary] • [To be populated where necessary]	☐ ☐ ☐ ☐ ☐

Appendix 2: Building User Questionnaire

The purpose of this questionnaire is to gather feedback from building users on the effectiveness of systems controlling environmental conditions. Feedback from building users can help identify any areas of concern that may need further investigating during seasonal commissioning.

An editable version of this questionnaire is downloadable from the UCL Website.

Questions:

1. Which areas of the building do you spend most of your time in and for how long?

   ………………………………………………………….

2. Does the air quality in your area of the building feel fresh enough? Does it feel stale?

   ………………………………………………………….

3. Is the overall indoor air temperature during the summer too warm, too cool or is it about right?

   ………………………………………………………….

4. Is the overall indoor air temperature during the winter too warm, too cool or is it about right?

   ………………………………………………………….

5. Are there any uncomfortable draughts in your area?

   ………………………………………………………….

6. Do you feel that you do not have enough control of temperatures in your area or is it fine?

   ………………………………………………………….

7. Do you know how to make changes to the heating / cooling / ventilation systems?

   ………………………………………………………….

8. Apart from the answers already given above, do you think there are any other issues with the environment you work in from a heating / ventilation / air conditioning point of view? Please provide as much detail as you can to enable us to investigate any issues.

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Appendix 3: BREEAM 2018 Commissioning & Seasonal Commissioning Credits

This appendix lists the BREEAM 2018 credits related to commissioning and seasonal commissioning. Refer to BREEAM website for full list of credits.

Man04 Commissioning and Handover

One Credit - Commissioning testing schedule and responsibilities

1 Prepare a schedule of commissioning and testing. The schedule identifies and includes a suitable timescale for commissioning and re-commissioning of all complex and non-complex building services and control systems and for testing and inspecting building fabric.

2 The schedule identifies the appropriate standards for all commissioning activities to be conducted, where applicable, in accordance with:

- 2.a: Current Building Regulations
- 2.b: BSRIA guidelines[1]
- 2.c: CIBSE guidelines[2]
- 2.d: Other appropriate standards (see Methodology).

Exclude from the assessment any process or manufacture-related equipment specified as part of the project. However, include such equipment in cases where they form an integral part of the building HVAC services, such as some heat recovery systems.

3 Where a building management system (BMS) is specified:

- 3.a: Carry out commissioning of air and water systems when all control devices are installed, wired and functional
- 3.b: Include physical measurements of room temperatures, off-coil temperatures, and other key parameters, as appropriate, in commissioning results
- 3.c: The BMS or controls installation should be running in auto with satisfactory internal conditions prior to handover
- 3.d: All BMS schematics and graphics (if BMS is present) are fully installed and functional to user interface prior to handover
- 3.e: Fully train the occupier or facilities team in the operation of the system.

4 Appoint an appropriate project team member to monitor and programme pre-commissioning, commissioning and testing. Where necessary include re-commissioning activities on behalf of the client.

5 The principal contractor accounts for the commissioning and testing programme, responsibilities and criteria within their budget and the main programme of works. Allow the required time to complete all commissioning and testing activities prior to handover.

One credit - Commissioning - design and preparation

6 Achieve criteria 1 to 5.

7 During the design stage, the client or the principal contractor appoints an appropriate project team member (see criterion 4), provided they are not involved in the general installation works for the building services systems, with responsibility for:

7.a: Undertaking design reviews and giving advice on suitability for ease of commissioning.

7.b: Providing commissioning management input to construction programming and during installation stages.

7.c: Management of commissioning, performance testing and handover or post-handover stages.

For buildings with complex building services and systems, this role needs to be carried out by a specialist commissioning manager (see Definitions).

Man05 Commissioning and Handover

One credit – Seasonal commissioning - implementation

3 Complete the following commissioning activities over a minimum 12-month period, once the building becomes substantially occupied:

3.a: Complex systems: The specialist commissioning manager will:

3.a.i Identify changes made by the owner or operator that might have caused impaired or improved performance.

3.a.ii Test all building services under full load conditions, i.e. heating equipment in mid-winter, cooling and ventilation equipment in mid-summer and under part load conditions (spring and autumn).

3.a.iii Where applicable, carry out testing during periods of extreme (high or low) occupancy.

3.a.iv Interview building occupants (where they are affected by the complex services) to identify problems or concerns regarding the effectiveness of the systems.

3.a.v Produce monthly reports comparing sub-metered energy performance to the predicted one (see Ene 01 Reduction of energy use and carbon emissions).

3.a.vi Identify inefficiencies and areas in need of improvement.

3.a.vii Re-commission systems (following any work needed to serve revised loads), and incorporate any revisions in operating procedures into the operations and maintenance (O&M) manuals.

3.b: Simple systems (naturally ventilated): The external consultant, aftercare team or facilities manager will:

3.b.i Review thermal comfort, ventilation, and lighting, at three, six and nine month intervals after initial occupation, either by measurement or occupant feedback.

3.b.ii Identify deficiencies and areas in need of improvement.

3.b.iii Re-commission systems and incorporate any relevant revisions in operating procedures into the O&M manuals.

Other appropriate standards

Appropriate standards for completion of Man04 criterion 2.d include the following:

Building fabric

1. BS EN 13187: 1999 Thermal performance of buildings. Qualitative detection of thermal irregularities in building envelopes. Infrared method[3].
2. BS EN ISO 9972: 2015 Thermal performance of buildings – Determination of air permeability of buildings – Fan pressurisation method[4].

Commercial refrigeration

1. Guide to Good Commercial Refrigeration Practice, Part 5 Commissioning[5].
2. GPG 347 Installation and Commissioning of refrigeration systems[6].

Fume cupboards and microbiological safety cabinets

Fume cupboards and microbiological safety cabinets shall be designed, installed, commissioned, and maintained in accordance with manufacturer's instructions, the current British, European or ISO standards for the devices.

Commissioning - Definitions

Complex systems

These include, but are not limited to, air-conditioning, comfort cooling, mechanical ventilation, displacement ventilation, complex passive ventilation, BMS, renewable energy sources, microbiological safety cabinets and fume cupboards, cold storage enclosures and refrigeration plant.

Specialist commissioning managers

The specialist commissioning manager is a specialist contractor rather than a general sub-contractor, able to independently verify the work carried out by the project team members installing the systems. The specialist commissioning manager can be appointed by the client or the contractor to perform the tasks described under the relevant criteria for buildings with complex building services and systems and defined in their contract. The specialist commissioning manager shall be a professional who, in the opinion of the assessor, has experience or qualifications that enable them to undertake the responsibilities described in this issue. As an example, membership to the Commissioning Specialists Association (CSA) is a relevant qualification.

Useful guidance

- Hawkins G. Commissioning Job Book - A framework for managing the commissioning process (BG 11/2010). BSRIA; 2010.
- Parsloe C. Commissioning Water Systems (BG 2/2010). BSRIA; 2010.
- Brown R, Parsloe C. Pre-Commission Cleaning of Pipework Systems (BG 29/2012). BSRIA; 2012.

- CIBSE. CCB Commissioning Code B: Boilers. CIBSE; 2002.
- CIBSE. CCC Commissioning Code C: Automatic Controls. CIBSE; 2001.
- CIBSE. CCL Commissioning Code L: Lighting. CIBSE; 2003.
- CIBSE. CCM Commissioning Code M: Commissioning Management. CIBSE; 2003.
- CIBSE. CCR Commissioning Code R: Refrigerating Systems. CIBSE; 2002.
- CIBSE. CCW Commissioning Code W: Water Distribution Systems. CIBSE; 2010.
- Parsloe C. Commissioning Air Systems (BG 49/2015). BSRIA; 2015.
- Measuring air permeability of building envelopes (non-dwellings), Technical standard Level 2 (TSL2). The Air Tightness Testing and Measurement Association (ATTMA). October 2010.