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Design Checks for HVAC

A quality control framework (Second edition)

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PREFACE

This publication provides practical, easy to follow HVAC design guidance. It is presented in a format that can be readily incorporated into company Quality Assurance (QA) systems and become part of the daily routine of design. It can be used to demonstrate compliance with the relevant requirements of *ISO 9001* and *BS 7000 Part 4*.

There are two major elements of the guidance. The design guidance sheets provide information and guidance on design inputs, outputs and practical watchpoints for 62 key building services design topics, to aid the design process and reduce errors. The design check sheets provide checks that can be used as part of the project quality assurance process to record and demonstrate control of design inputs and outputs.

The guidance and check sheets are detailed and relevant to many design applications, although they cannot be fully comprehensive or exclusive or cover every possible design scenario. Every design project is different and has differing needs. It is the responsibility of the design engineer to consider fully all design requirements. In particular, the design watchpoints are not an exhaustive list of all factors to be considered, so designers should exercise professional judgement to decide which factors are relevant. Diagrams are included for illustrative purposes only and do not necessarily include all required components.

Designers must be aware of their contractual obligations and ensure that these are met. Adherence to this guidance does not preclude or imply compliance with those obligations. Similarly, it is the duty of the designer to ensure compliance with all relevant legislation and regulations. This publication is also relevant to those responsible for the installation, commissioning, operation and maintenance of building services.

This second edition of *Design Checks for HVAC* is up to date with the requirements of the latest building legislation, standards and codes of practice current in January 2007. The guide also contains new design checks for whole life costing and health and safety. Where possible, design topics have been cross-referenced to the relevant Common Arrangement of Work Sections (CAWS).

It is hoped that design practices and individual designers will be encouraged to further share knowledge and experience by extending and adding to the design watchpoints and disseminating this within their organisations. BSRIA would be pleased to receive any such contributions for incorporation into any future revisions of this publication.

OVERVIEW OF DESIGN CHECK TOPICS AND ADDITIONAL CONTENTS

Design considerations

Design data

Calculations

Systems and equipment

Additional contents

INTRODUCTION

Aim

The aim of *Design Checks for HVAC* is to improve the quality control and performance of the technical design process within the building services industry by identifying best practice. This should reduce the risk of design errors and omissions, improve the overall efficiency of the design process, and provide HVAC services that better meet the needs of the client.

A comprehensive review of current building services design practice and procedures was carried out in consultation with the industry to identify best practice and current problems and explore relevant design tools. The result includes:

- A map of the HVAC building services design process
- Design guidance sheets giving information and guidance on design inputs, outputs and practical watchpoints for 62 key design topics, to aid the design process and reduce errors
- Design check sheets that can be included in project quality assurance procedures.

These provide a formal framework to record and review design inputs and encourage designers to consider the requirements for installation, commissioning, operation and control and subsequent maintenance of their selected systems at the design stage.

This should lead to improvements in both the design process and in the subsequent implementation of that design, and reduce the risk of problems occurring during installation, commissioning or system operation.

This practical easy to follow guidance can be incorporated into company quality assurance systems to become part of the daily routine of design and can be used to demonstrate compliance with the relevant requirements of *ISO 9001:2000*[1] and *BS 7000 Part 4:1996*[2].

The guidance incorporates practical design watchpoints based on feedback from many practising engineers and others experienced in design. These vary from avoidance of possible errors or misunderstandings that could be made by inexperienced, junior engineers to very practical tips based on experience of installation, commissioning, maintenance and facilities management over many years. Use of the design checks will allow these lessons to be passed on to other engineers, particularly junior engineers, and future projects. This can help improve design quality, reduce risk and increase client confidence.

Intended users

This guidance is intended for practising HVAC design engineers. Clients, PII providers and others involved in the design process and its outcomes are also potential users as they may request compliance with this guidance or ask to see evidence that reasonable design quality assurance procedures are being followed. The guidance complements the CIBSE *Guide B, Heating, Ventilating, Air-conditioning and Refrigeration*, and the CIBSE *Concise Guide*.

The check sheets and design inputs and outputs guidance are intended for use by all design engineers, whether to gather information and complete the sheets or to check or sign off as completed. While the more detailed guidance in the design watchpoints is obviously directly useful for junior engineers, experienced engineers will also find it useful when designing a less-familiar system.

Companies may also use the guidance to support formal design quality assurance procedures while the check sheets may be photocopied, they are also available, for purchase in electronic format, thus enabling them to be customised for particular projects and kept on specific project files. For further information visit www.bsria.co.uk/bookshop.

Note that the design of HVAC systems involves working in a design team with other disciplines. This involves interactive efforts, co-ordination and project programming.

DESIGN CONSIDERATIONS

1 DESIGN MARGINS

Project title.................................... **Project No**.................... **Design stage**....................

Engineer.................................... **Revision No**.................... **Date**....................

Checked by.................................... **Approved by**.................... **Date**....................

Design outputs	✓	Notes / Design file cross-reference
• Overall design margin strategy, including QA procedures, and design reviews	❑	
• Clear identification in the design file of any margins used within design calculations, together with a written justification for their use	❑	
• Clear statement of operating limits of the design for client	❑	

Key design checks	✓	Notes / Design file cross-reference
• Agree margins policy with client as part of a value engineering strategy	❑	
• At the end of a calculation procedure review all margins used to avoid possible double counting and remove excess margins	❑	
• At design review stage review again the appropriateness of any design margins used	❑	
• Assess system part load performance and review the impact of the use of any margins on the system design	❑	

Project specific checks and notes	✓	Notes / Design file cross-reference
	❑	
	❑	
	❑	

1 DESIGN MARGINS

Why consider this?

Consideration of design margins at design stage is essential for:

- Avoidance of unnecessary oversizing of plant and systems
- Good part load performance of plant and systems
- Client future need requirements
- Equipment and system selection
- Plant space allowance
- Avoidance of re-design and extension of programme

Design information

- Client brief including future needs requirements and any specific requirements for system or plant duplication or critical systems
- Details of building and space use to determine the level of system reliability required
- Building construction details such as heavyweight or lightweight

See also: Future needs

Design outputs

- Overall design margin strategy, including QA procedures and design reviews
- Clear identification in the design file of any margins used within design calculations, together with a written justification for their use
- Clear statement of operating limits of the design for client

Key design checks

- Agree margins policy with client as part of a value engineering strategy
- At the end of a calculation procedure review all margins used to avoid possible double counting and remove excess margins
- At design review stage review again the appropriateness of any design margins used
- Assess system part load performance and review the impact of the use of any margins on the system design

DESIGN WATCHPOINTS

General watchpoints

1. Clearly identify and justify the use of all margins added during the design process in the design file.
2. Reduce the need for margins where possible. Provide the client with a clear statement of operating limits of the design to ensure client is aware of, and satisfied with, the anticipated real performance of the system. Make explicit any risk of under-performance and get client agreement. Some clients are now accepting designs where design conditions are exceeded by an agreed amount, such as 1-2°C for short periods of time.
3. Clarify with the client the level of system reliability required. Critical systems and services will require a different level of safety provided by redundancy, or installed plant margins, to non-critical ones.
4. At the end of a calculation procedure review all margins used to avoid possible double counting and remove excess margins.
5. At design review stage review again the appropriateness of any design margins used.
6. Design margins can be added for legitimate operational reasons and these should be clearly identified, for example in heating systems, a pre-heat margin may be required to provide rapid heat-up in the mornings to avoid the plant having to run all night.
7. Margins are sometimes added to allow for design or installation uncertainties and missing design information. Uncertainties or assumptions should be clearly flagged and reviewed when correct information is available. Reduce uncertainties in design as much as possible by clarifying the brief, agreeing acceptable airtightness standards, and having equipment performance tested.
8. Avoid unnecessary use of margins. Excessive use can result in system oversizing and inefficient plant operation with plant running at a fraction of rated load for much of the time. This may result in hunting and cycling under low load conditions, reduced efficiency, excessive wear through continual stop/start operation and increased risk of failure.
9. Assess the impact of the use of margins on system design and system part load performance.

Installation, operation and control

10. For good part load operation consider using boilers with fully modulating burners, not just on/off or two stage firing as the output can be more accurately controlled to the system load at any time, giving good operating efficiency at part load.
11. To optimise part load performance consider installing two or three smaller boilers instead of one larger boiler. Each will then run at full load more frequently, increasing efficiency. This must be balanced against the increased costs.
12. Margins added to pipework and ductwork distribution systems to account for future needs can result in low initial operating fluid velocities. For air systems this can affect the performance of grilles and diffusers and make commissioning and system control difficult.
13. Where grilles and diffusers are selected on a greater air volume to allow for future needs, they are likely to underperform, resulting in poor room air distribution and possible occupant discomfort. The lower air volume gives reduced face velocity and reduced throw.
14. Check that suitable controls have been provided to cope with the margins applied. In ductwork systems low air velocities due to oversizing may make air sensing and subsequent control difficult.
15. Do not assume that control systems can make an oversized design operate efficiently and effectively to meet building and occupant needs. Controls cannot cure bad design. Part load performance should always be assessed.
16. Avoid oversizing chillers as this can cause cycling and excessive starts. Consider selection of chillers with more stages, the addition of extra system capacity or widening the control band to increase the switching differential.

Economics

17. Agree margins policy with client as part of a value engineering strategy.
18. Sizing systems and equipment initially for anticipated future expansion can result in lower operating efficiencies and increased running costs. Allow space for future plant items or, where additional capacity is required, select systems to maximise energy efficiency and optimise part load performance, for example by the use of modular or multiple plant systems.
19. Where a known margin is to be applied to a system to cater for future expansion, consider selecting plant and equipment that can provide a variable supply, such as variable speed pumps and fans. This will allow optimum efficiency in both cases, and the increased capital cost should be recovered through increased energy efficiency.
20. Applying margins to a system can lead to increased installation costs as well as increased capital costs.
21. Consider the life cycle cost implications imposed by enhanced controls, and plant selection.

DESIGN DATA

18 INTERNAL DESIGN CRITERIA

Project title .... **Project No.** .... **Design stage** ....

Engineer .... **Revision No** .... **Date** ....

Checked by .... **Approved by** .... **Date** ....

Design inputs

✓ Notes / Design file cross-reference

- Occupancy details: ❑
  - Usage of each space/zone within the building
  - Occupancy patterns - hours of occupancy
  - Number and composition - % male/female and disabled
  - Whether there are any vulnerable occupants, such as the elderly, children, or those with special needs
- Details of any equipment or items that require special conditions ❑

Design outputs

✓ Notes / Design file cross-reference

- Design internal temperature and humidity (winter) for each space/zone ❑
- Design internal temperature and humidity (summer) for each space/zone ❑
- Schedule of acceptable criteria for each space/zone - noise levels, lighting level, air quality, and air velocity ❑

Key design checks

✓ Notes / Design file cross-reference

- Obtain client approval of design criteria ❑
- Check whether smoking will be allowed in any spaces ❑
- Determine whether there are any localised sources of odours/pollutants ❑
- Consider client requirements for flexibility ❑

Project specific checks and notes

✓ Notes / Design file cross-reference

❑

❑

❑

18 INTERNAL DESIGN CRITERIA

Design inputs

- Occupancy details:
  - Usage of each space/zone within the building
  - Occupancy patterns – hours of occupancy
  - Number and composition – % male/female and disabled
  - Whether there are any vulnerable occupants, such as the elderly, children, or those with special needs
- Details of any equipment or items that require special conditions

Design information

- Client brief
- Preliminary information on system types
- The nature of the internal surfaces/furniture
- Equipment types and loads
- Lighting loads
- Spacing of luminaires and diffusers
- False floor and ceiling heights
- Slab to slab heights

See also: Future needs, Zoning, Sensor locations, Occupancy, Internal gains

Design outputs

- Design internal temperature and humidity (winter) for each space/zone
- Design internal temperature and humidity (summer) for each space/zone
- Schedule of acceptable criteria for each space/zone – noise levels, lighting level, air quality, and air velocity

Key design checks

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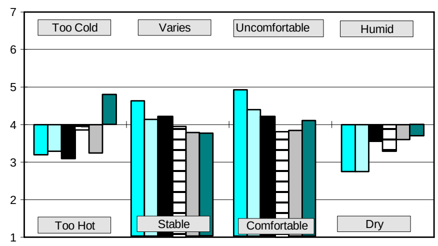


DESIGN WATCHPOINTS

General watchpoints

1. Obtain client approval of final design criteria.
   Note that *CIBSE Guide A – Environmental Design* provide internal design criteria for a range of specific applications.
2. Liaise with architects and other design team members as appropriate to provide information on any criteria that may affect their designs, such as daylighting and noise levels.
3. Agree whether any relaxation of conditions is acceptable, for example a specified length of time - this can allow for more efficient system design and operation. The risks of under-performance should be clearly explained to the client and agreed.
4. Tolerance limits on control of internal temperature should be specified, to allow for variations within the space, and agreed with the client. For occupancy, commonly specified with a tolerance of ± 1or 2°C on resultant temperature, depending on the application.
5. Vertical and horizontal temperature gradients will occur within the space depending on space height, position of heat sources and system type. Consideration may be needed to check these are not excessive.
6. Check that the internal design temperature is clearly specified, for example as either resultant temperature or air temperature. It can make a substantial difference to load calculations whether air temperature or resultant temperature is used for internal design values.
7. Most control sensors only sense air temperature. Consider whether other temperature sensors may be required.
8. Check the occupancy hours of all spaces within the building, for example 24-hour use or office hours. Clarify usage with client if necessary. Check whether longer hours will be worked at certain times of year, such as for year-end or stock takes. Check whether any spaces have longer usage hours, for example for security, cleaning or maintenance.
9. Determine occupancy details - activity, clothing levels, type of occupants, and degree of acclimatisation. Establish whether any areas have transient occupants as well as permanent users, such as visitors/shoppers who are more likely to be wearing outdoor clothing.
10. Check what constitutes the occupied zone for occupied spaces, for example whether occupants are predominantly seated or standing.
11. Consider developing a clear documented ventilation design strategy at an early design stage.
12. Establish whether smoking will be allowed in any spaces. This makes a substantial difference to the ventilation requirements.
13. Determine whether there are any localised sources of odours/pollutants, such as coffee machines/microwaves in offices which can generate considerable steam and odours.
14. Consider acceptable air quality criteria for each space/zone - CO_2, pollutants, and degree of filtration required.
15. Consider room air diffusion carefully and where necessary analyse patterns for system choices or options to check that velocity levels will not exceed comfort criteria.
16. Consider the impact of localised heat sources on room air diffusion.
17. Consider acceptable noise levels for each space/zone considering building location and space usage.
18. Check for any localised zones of discomfort, such as near local radiation sources, entrance doors, or air supply terminals.
19. Consider the effect of localised radiation, such as solar gain or other radiant sources, on comfort. Wide differences between air and radiant temperature can cause discomfort.
20. Consider client requirements for flexibility, for example whether internal partitions will be erected or re-positioned frequently.
21. Consider future required flexibility of services equipment within ceiling and/or floor voids at an early stage, for example will free space be needed in the ceiling void to enable luminaires to be moved around (normally 150 mm).
22. Consider small power loads carefully to ensure a realistic figure is used. (See Internal gains, page 55.) Check that any changes to lighting and equipment levels are reflected in the design.
23. Agree permissible tolerance and 'alarm' conditions.
24. Review design criteria carefully after system selection to check that conditions can be met, for example so that air velocities in the occupied zone will not be excessive.

Economics

25. Consider discussing relaxation of internal conditions, such as the temperature with the client, specifying an acceptable maximum temperature and time limit, as varying conditions can reduce energy use. (See point 3.)

CALCULATIONS

26 HEAT LOSS

Project title .... **Project No.** .... **Design stage** ....

Engineer .... **Revision No** .... **Date** ....

Checked by .... **Approved by** .... **Date** ....

Design inputs

	✓	Notes / Design file cross-reference
• External design temperature	❑	
• Internal design temperatures for all spaces	❑	
• Infiltration rates for each zone	❑	
• Room dimensions for all heated spaces	❑	
• Thermal transmittance data - U-values for all fabric elements – walls, roof, and glazing	❑	
• Heating system type	❑	

Design outputs

	✓	Notes / Design file cross-reference
• Schedule of rooms/zones giving heat loss for each space including fabric loads, infiltration load and internal design conditions.	❑	

Key design checks

	✓	Notes / Design file cross-reference
• Check overall load totals in terms of W/m^2 and W/m^3 against reasonable benchmarks	❑	
• Check relative proportions of fabric loss and infiltration loss	❑	
• Check whether internal design temperatures are given as air or dry resultant	❑	
• Review external design data and correlate to site location and exposure selected	❑	
• Record any assumptions made because input information not available and mark to redo/check when information received	❑	
• Review any margins added at any of the calculation stages – justify or remove	❑	

Project specific checks and notes

	✓	Notes / Design file cross-reference
	❑	
	❑	
	❑	
	❑	

26 HEAT LOSS

Design inputs

- External design temperature
- Internal design temperatures for all spaces
- Infiltration rates or specified airtightness for each zone
- Room dimensions for all heated spaces
- Thermal transmittance data - U-values for all fabric elements – walls, roof, and glazing
- Heating emitter type

Design information

- Site location details – to determine degree of exposure
- Thermal inertia of fabric
- Heating system operating times

See also: External design criteria, Internal design criteria, Infiltration, Fabric, Glazing, Computer calculations

Design outputs

- Schedule of rooms/zones giving heat loss for each space including fabric loads, infiltration load and internal design conditions

Key design checks

- Check overall load totals in terms of W/m^2 and W/m^3 against reasonable benchmarks
- Check relative proportions of fabric loss and infiltration loss
- Check whether internal design temperatures are given as air or dry resultant
- Review external design data and correlate to site location and exposure selected
- Record any assumptions made because input information not available and mark to redo/check when information received
- Review any margins added at any of the calculation stages – justify (record in design file) or remove

DESIGN WATCHPOINTS

General watchpoints

1. Check the calculated heat losses on a W/m^2 and W/m^3 basis against reasonable benchmarks or rules of thumb.
2. Check relative proportions of fabric loss and infiltration loss. This can identify possible errors and scope for energy saving.
3. Check that external design conditions selected reflect site location taking into account degree of exposure and impact of surrounding buildings, if any. (See External design criteria, page 49.)
4. Check the percentage exceedence of design conditions, for example the % of year for which external temperature drops below design temperature is known and accepted by the client. Typical basis for design is 1%. Some clients may specify or accept other values.
5. Review any margins added at any of the calculation stages – and check whether these are justified. Reasons for use should be recorded in the design file. If used because required input data not available, record and revisit when data is available. (See Design margins, page 13.)
6. Check whether internal design temperatures are given as air or dry resultant temperature. These can be used to derive environmental temperature for fabric loss calculations once the type of heating system has been selected.
7. Calculate heat losses at the agreed internal design conditions. When design temperatures are specified with control tolerances, do not use the control tolerances to adjust the design temperature used in calculations.
8. Internal air temperatures are used as the basis for calculating heat losses due to air infiltration.
9. Check air infiltration rates have been properly determined. (See Infiltration, page 57.)
10. For room load and emitter sizing the maximum infiltration rate for the space should be used. For heating load and boiler sizing the maximum infiltration rate for the building should be used.
11. Check construction detailing for achievable airtightness performance.
12. Consider whether client/architect should be advised to have the building pressure tested, if not already mandatory, to establish leakage rate to ensure design basis is met in construction. (See Infiltration, page 57.)
13. Room dimensions should be as accurate as possible. If using architects' drawings use the dimensions shown on the drawings wherever possible rather than scaling as the drawing can become distorted when copied. Check dimensions with the originator if in doubt.
14. Clarify all construction details.
15. Check that construction meets *Part L2 of the Building Regulations*. Note that the responsibility for the performance of the building skin normally rests with the architect, not with the building services engineer. Building services engineers do not usually design the building and its fabric or have the responsibility to select materials, method of construction or quality of workmanship. (See Fabric, page 59, point 1.) Always provide the architect with full information on any construction details used in calculations highlighting any assumptions.
16. Check that adequate information is available on roof and wall structure.
17. Check that adequate information is available on ground floor construction and any basement floors.
18. Check the location of insulation in roof plant rooms.
19. Wherever possible, base the calculations on the U-values of the actual materials or products to be used.
20. Heat loss design packages often require details of the heating system selected in terms of relative proportion of radiant and convective output.
21. Apply relevant height factor for system type and room height.
22. Make suitable allowance for intermittent heating, taking into account thermal mass of building, and check that the effect on system operation has been assessed.
23. Take account of heat loss through whole building envelope, such as loss through void above a false ceiling.
24. The need for a pre-heat margin should be assessed and added, where necessary, to boiler and terminal unit loads.
25. Check the effects of internal heat gains have been assessed. Although often ignored, known fixed heat gains may have an impact on the heat requirement.
26. Check that suitable heating zones have been established, such as south-facing areas with large solar gains may be separately zoned. (See Zoning, page 21.)
27. There may be a heat gain to the room if an adjacent space is warmer than the room being calculated.

Economics

28. Enhanced insulation can offer energy cost savings. Check payback if appropriate. (Also check heat gain performance to ensure any summer overheating is not worsened.)

SYSTEMS AND EQUIPMENT

35 OVERHEAD FAN COILS

Project title .... **Project No.** .... **Design stage** ....

Engineer .... **Revision No** .... **Date** ....

Checked by .... **Approved by** .... **Date** ....

Design inputs	✓	Notes / Design file cross-reference
• Zone heating and cooling loads	❑	
• Internal design conditions	❑	
• Fresh air requirements	❑	
• Fresh air supply condition	❑	
• Noise rating for each zone	❑	

Design outputs	✓	Notes / Design file cross-reference
• Schedule of fan coils giving sufficient data for manufacturer selection	❑	
• Schedule of supply air diffusers giving sufficient data for manufacturer selection	❑	
• Fan coil electrical and control requirements	❑	
• Statement of commissioning strategy	❑	
• Relevant specification clauses	❑	
• Condensate flow rates for drainage sizing	❑	

Key design checks	✓	Notes / Design file cross-reference
• Check noise level from diffusers and fan coils	❑	
• Airside or waterside control	❑	
• Fall in condensate pipe work (if applicable)	❑	
• Check throw from diffuser	❑	

Project specific checks and notes	✓	Notes / Design file cross-reference
	❑	
	❑	
	❑	

35 OVERHEAD FAN COILS

Design inputs

- Zone heating and cooling loads
- Internal design conditions
- Fresh air requirements
- Fresh air supply condition
- Noise rating for each zone

Design information

- Architectural drawings for all zones including space plan and layout, floor to ceiling heights, position of partitions, doors, glazing and shading details
- Details of structural frame
- Occupancy details
- Space usage
- Ceiling type and grid size
- Lighting system and position of luminaires
- Position of drainage pipes that can be used for condensate run off
- Client control criteria

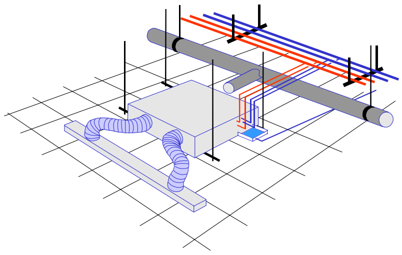
See also: Future needs, Ventilation requirements, Sensor locations, Pipework, Ductwork, Diffusers, HVAC control systems

Design outputs

- Schedule of fan coils giving sufficient data for manufacturer selection
- Schedule of supply air diffusers giving sufficient data for manufacturer selection
- Fan coil electrical and control requirements
- Statement of commissioning strategy
- Relevant specification clauses
- Condensate flow rates for drainage sizing

Key design checks

- Check noise level from diffusers and fan coils
- Airside or waterside control
- Fall in condensate pipe work (if applicable)
- Check throw from diffuser



DESIGN WATCHPOINTS

Sizing and selection

1. Check that manufacturer's thermal and acoustic data is applicable to the conditions at which the fan coils will be operating and apply any relevant corrections for space temperature, and flow and return temperatures. Note manufacturer's outputs are based on chilled water and space temperatures, and room dimensions which may differ substantially from the required operating conditions.
2. Check performance is acceptable for both sensible and latent cooling requirements. The proportion of latent and sensible cooling will vary with chilled water temperature. (See point 1.) Fan coil output is usually selected on sensible duty and chilled water pipework sized on total duty.
3. Changes in fan speed make a significant difference to cooling output and noise. Manufacturers often state cooling/ heating performance at highest fan speed setting. (See point 5.)
4. Check manufacturer's stated outputs for both thermal and acoustic performance are verified by certified independent laboratory tests.
5. Check noise level is acceptable for the usage of the space. High fan speed settings can create noise problems and wherever possible fan coil units should be sized using a low to medium fan speed setting.
6. Check supply air temperature off fan coil under both cooling and heating. Too low a temperature gives dumping and draughts, too high a temperature gives stratification and discomfort at foot level.
7. Check that throw from diffusers is satisfactory under both heating and cooling and whether the throw of any two diffusers cross each other as this can cause cold air to dump.
8. Check the index run has been correctly selected for the duct work as secondary ductwork can be of significant length.
9. Check that the pressure drop across the secondary ductwork and diffuser is within the capability of the fan coil.
10. Consider return air path, for example via air handling light fittings, dedicated grilles, and shadow ceiling gaps.
11. Check whether the ceiling is sealed.
12. Check whether fresh air is supplied direct to FCU or to plenum.
13. Consider balance between size of plenum and size of fan coil.
14. Consider any known future needs or flexibility requirements when positioning fan coils so they are away from potential partition lines and will supply all planned spaces.
15. Check that selected flexible hose are appropriate. Consider the guidance provided in the BSRIA publication BG 4/2004: *Flexible Hoses Standard.*

Installation, operation and control

16. Check for downdraughts at windows if no other heating source and arrange perimeter diffusers to compensate.
17. Check that control positions are compatible with any partitioning. If sensing return air check that air sensed is from area served.
18. Check whether airside or waterside control will be used, with return air sensor or remote wall-mounted sensor.
19. Check that control valves can operate correctly against system pressure as they may not close against high system pressures.
20. Consider control criteria such as individual control, control in groups of two of three, or group from single BMS outstation.
21. Fire barriers which are breached by, for example condensate pipes which should be adequately sealed.
22. Check whether fresh air makeup is humidified by direct steam injection. This can lead to limescale build up which needs removal.
23. The low air pressure developed by fan coil units necessitates relatively short secondary ductwork, especially when flexible ductwork is used. A guideline is a max. 1m for flexible duct. If a longer length is needed check the effect on pressure drop.
24. Where possible, select all supply diffusers served by fan coil units with low pressure drop and maintain same pressure drop at all diffusers for ease of commissioning.
25. Gravity fed condensate drainage systems require sufficient fall in the pipework for adequate run off. Shallow ceiling voids may not permit long drainage pipe runs and a pumped condensate system may be required. (Note that pumps can be unreliable.)
26. Check that flexible hoses will be installed in accordance with the BSRIA publication COP 11/2002: *Flexible Hoses. A Code of Practice for Service Installers.*

Access and maintenance

27. Provide air vents for each unit and local drain points. Check units can be isolated and by-passed during flushing and chemical cleaning.
28. Allow adequate access to fan coil units for cleaning, filter replacement, and general maintenance. If possible, also allow for removal of complete unit for bench maintenance or replacement.

Economics

29. Consider whole life cost of fan coil system against other choices.