Applying HVAC building services calculations

Model Demonstration Project

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BSRIA Guide BG 1/2006
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APPENDICES

1 INTRODUCTION TO THE BUILDING PROCESS

Overview of the building process

The building process covers the complete project from inception to successful handover, either to the developer for later fit-out or to the end-user for occupation. This encompasses a number of stages and can vary with the type of project. There are many models of the building process, and it is outside the scope of this project to review all of them. The *Royal Institute of British Architects Plan of Work* stages (RIBA, 1999), shown in Table 1, are used as the model for this report. The *Plan of Work* breaks projects down into a series of work stages (A to M).

The 2002 edition of the Association of Consulting Engineers *Agreement B2 (2002 Conditions of Engagement for Mechanical and Electrical Services Engineering* uses the same work stages to define a project. These are also shown in Table 1.

Table 1: RIBA Plan of Work stages.

RIBA Plan of Work		ACE Conditions (2002)	
Work stage	**Title**	**Stage**	
A	Appraisal stage	C1	Pre–design
B	Strategic brief	C2	
C	Outline proposals	C3	Design
D	Detailed proposals	C4	
E	Final proposals	C5	
F	Production information	C6	
G	Tender documentation	C7	Construction
H	Tender action		
J	Mobilisation/project planning	C8	
K	Construction		
L	After practical completion		

Note that the RIBA *Plan of Work* is being revised and is likely to be issued in 2007.

Mechanical and electrical designers may be appointed, either to provide a full design and calculation service, or to produce a performance specification for development by an m&e contractor. This is covered in more detail on page 3. In all cases there should be clear lines of accountability within the project team. In a building project this is traditionally determined by the architect.

Project management is a core requirement to make sure that:

- The completed building provides the functional requirements stipulated in the brief
- the cost budget is met
- the programme is met
- quality levels are achieved
- the building can be safely maintained, operated and decommissioned.

There are three critical success factors for projects to remain under good control and to increase the likelihood of providing excellent value for money. These are:

- Cost estimates are calculated from a properly defined specification of what the completed building must provide – this is usually called a functional specification or a performance specification
- contracts for design work, building work and supply of materials and components are awarded according to the best value rather than lowest price
- decisions regarding variations to the project are made according to whether they provide functions necessary for the building to perform in the way the client requires.

Project management techniques particular to building services are explained in the BSRIA's *Project Management Handbook for Building Services*, AG 11/98.

Project inception

The need for a project is determined by business or policy requirements that are identified and justified well in advance of design or construction work. This is done through the business case. One option always open to the client is to do nothing.

The purpose of the project is to satisfy the requirements defined by the client according to the business (or policy) needs. This covers both commercial clients, such as developers and public sector clients, such as National Health Service trusts or local authorities. These needs will define:

- What the completed project is for
- the deadline by which it must be delivered
- the maximum amount it can cost
- the quality threshold it must reach.

If the business or policy needs are achieved then the client will receive value for money and the project will be considered a success. Business or policy needs must not be confused with achievement of technical specifications (for example, providing a specified internal temperature in an office space) which are a means to achieving business needs, not ends in themselves.

Analysis of claims and litigation in respect of building services has shown that 45% of successful claims are due to errors in design concepts and parameters (Griffiths & Armour, 1999). The importance of fully and correctly understanding a client's business needs cannot be overstated.

Initial understanding of client needs can be changed by interpretations made by others (for example the architect or the surveyor), particularly if the building services engineer becomes isolated from the client and end-user. It is therefore important that a client can express its needs directly to the full design team, including the building services engineer.

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Assembling the project team

The selection of the project team is based on many factors beyond the scope of this publication. Project team selection has been adequately covered in many other publications (for example in Chapter 17 of the *Handbook of Project Management*, Gower, 2000).

The selection and internal and external management of the project team (and the contractual conditions under which that management must operate) is vital to the success of a project. Specifically, the early appointment of the building services engineer can add real value to a project, particularly the orientation of the building on its site, the layout of the building and the space planning, and their effects on the operating efficiency and energy use of the building.

In very general terms, conditions of engagement attempt to limit exposure to litigation by imposing boundaries of responsibility rather than fostering a spirit of co-operation that is essential for a successful project. Great care must be taken by the client and the client's advisors to ensure that the responsibilities defined for different members of the team do not leave areas unaddressed or create areas of overlapping responsibilities.

Before accepting any terms of engagement it is essential that the client and the specialist and professional team members fully understand and agree the contents, limitations and respective responsibilities of all participants. The latest BSRIA publication, BG 6/2006: *A Design Framework for Building Services – Design Activities and Drawing Definitions*, provides project teams with a set of comprehensive pro-formas, completion of which will determine which member of the project team is taking the lead on particular aspects of design.

More detail of the appointment of the building services engineer is discussed on page 3.

Briefing

Briefing can be defined as:

- The process by which a client informs others of needs, aspirations and desires, either formally or informally
- the process by which a client's requirements are investigated, developed and communicated to the construction industry.

Briefing is an essential and important part of the project process. It sets the cost and value parameters for the project and defines a client's requirements and needs. Good briefing is essential for good design. It will ensure the project team delivers a product that meets the needs of the client and end user, and delivers a building that will benefit the client's business interests.

In many projects, the client (who appoints the building team) will not be the same as the end-user of the completed building. For example, a university that is building a new teaching block may delegate the role of client to its internal facility managers, although the end-users will be the lecturers and students.

In situations like this, the building's success will be determined by the degree to which it meets the needs of the end-users.

The project team, including the services engineer, should find out as much as they can about the end-users' needs. As users can change, so can the requirements. It is better to have a consolidated brief from the main client that states the end users' requirements.

Buildings are a major financial expenditure for most clients. Some poorly performing buildings have been reported in the post-occupancy evaluation project, PROBE (Post-occupancy Review Of Buildings and their Engineering). These studies showed that buildings with poorly performing architecture and engineering services could create unsatisfactory working environments. This can have serious consequences for a client's business.

Briefing, in the context of the building process, is thought of as solely referring to a client brief. In practice, the briefing process extends throughout the design stages of a building project. It is an iterative process involving regular feedback from clients, advisers, the design team and end users. The brief ideally should provide everything the design team need to know about the building the client requires, the site being used and its links to the local environment.

Good briefing is essential to ensure that the client's needs are met and that best value for money is obtained. The brief usually starts as a statement of needs from the client and then evolves into a consolidated brief for the project.

The statement of needs will usually contain the following data:

- The client's business function
- the client's business objectives
- the structure of the client organisation
- the client's perceived need for the project
- any relevant historical background
- the triggers that have necessitated change
- the perceived consequences of failure/risk analysis
- the nature of advice needed to progress the project.

The statement of needs is entirely in the hands of the client and has a profound effect throughout the project. It is important that all consultants and contractors involved in the project have seen the statement of needs and understand it.

The consolidated brief would include all of the basic information contained in the client brief and strategic brief, as listed above. It would also include specific details of the project team and proposed building design solutions (in so far as these have been decided), client requirements regarding issues such as the attitude to be adopted towards health and safety, the procurement method to be adopted, and the quality criteria to be applied throughout the project.

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Typical contents include:

- Details of the project team
- project description
- description of the proposed building functions
- site location and access details
- details of constraints arising from legislation or other factors
- total floor areas of proposed buildings
- building layouts
- proposed number of occupants
- details of any special equipment or processes to be housed in buildings
- space requirements for people and equipment
- internal and external environmental design conditions
- design solutions to be adopted
- the required life span of the proposed building and of individual components
- the agreed construction procurement strategy
- cost budgets
- design and construction programmes.

The consolidated brief develops alongside the proposals from the project team, including contractors and specialists.

Appointment and duties of the building services engineer

Appointment

An enquiry for design services might come to the building services engineer from the client, the architect, the main contractor or the m&e subcontractor, depending on the nature of the project and the procurement route. However, the approach to selection is likely to be based on one of the following methods.

Appointment on merit, whereby appointment is based purely on the client's previous experience of working with the building services engineer. Fees may be calculated according to a partnering arrangement between the client and the engineer, or by negotiation.

Competitive interview, whereby some form of specified presentation must be given. This might be appropriate where the client has an outline project description and wishes to hear the designer's views before making an appointment. The scope of services and fee would be negotiated afterwards with the preferred firm.

Design ideas competition, whereby a designer is chosen based on design ideas. The design fee is stated in the competition conditions.

Design submission, whereby a designer is chosen based on a design submission and the quoted fee. The client would usually pay for the design submission.

Fee tender, whereby a designer is selected based solely on the fee quoted for a given project brief and description of service required.

Fee tender and qualifications, whereby a designer is selected based on an assessment of proven technical qualifications and ability, as well as the quoted fee.

One to one negotiation, whereby appointment is based on one or more interviews. This is a useful method for getting a designer on board at a very early stage in order to help the client consider, develop and define requirements.

Qualifications-based selection, whereby a designer is selected on quality, such as technical qualifications, previous relevant experience, and general suitability. Having short-listed, typically, three companies on this basis, the finalists are interviewed and a selection made. The scope of services and fee is negotiated afterwards.

Design duties

Most m&e designers are appointed using *Agreement B2*, published by the Association of Consulting Engineers. The duties within *Agreement B2* can be aligned with the RIBA work stages, as shown in the example in Table 2.

The duties of the building services engineer also reflect the fact that building services are dynamic systems. The selection of components, their installation and their commissioning all influence the system performance. More so than other design disciplines, building services design is an iterative process, where initial assumptions about materials and construction methods may be shown to be incapable of achieving the functional specification. In these cases, changes to the materials or components may mean a re-design.

One of the major causes of conflict between building services engineers and other members of the project team is a lack of clear understanding regarding the division of responsibilities, particularly at the interfaces of work done by designer and installer. One example of this is responsibility for preparation of the co-ordination drawings. Other areas of conflict include the degree of detail provided on drawings.

This can cover:

- Precise services routes
- responsibility for design re-evaluation due to alternative plant selection and the implication of changes
- responsibility for the specification of requirements for systems commissioning
- the preparation of handover material.

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Table 2: RIBA work stages and detailed design duties from ACE agreement B2, Normal Services.

RIBA work stage	ACE Agreement B2 Detailed design service*	ACE	
A - Appraisal stage	Obtain and inform the client's brief Discuss roles and responsibilities of the project team Discuss the likely requirement for site staff, such as Clerk of Works, Facilities manager	C1	Pre-design
B - Strategic brief	Obtain information regarding utility services to the site Comment on any physical site restrictions Make initial recommendations regarding technical viability of the works	C2	
C - Outline proposals	Visit the site as necessary and gather relevant data and information Advise the client of the need for any surveys or special investigations, such as occupancy survey or drainage survey Consult with utilities and the relevant authorities Consider alternative outline solutions Prepare outline reports and sketches in order to develop the brief Provide an approximate cost plan and advice based on unit area rates	C3	Design
D - Detailed proposals	Develop the design of the detailed proposals in collaboration with other consultants Prepare sketch drawings showing spatial/structural requirements for plant rooms, major items of plant, major ducts and service routes Assess preliminary loads for power, heating and cooling Assess the thermal performance of the building envelope and examine details of solar control. Prepare initial sizing of heating/cooling plant Negotiate with utility authorities regarding incoming services	C4	
E - Final proposals	Develop the design and prepare sufficient schematic drawings, schedules and specifications to allow consultants to finalise their proposals Assist the lead consultant in co-ordinating the m&e services into the overall design Prepare a revised cost plan based on unit area rates	C5	
F - Production information	Prepare detailed design drawings Prepare specifications	C6	
G & H - Tender documentation and tender action	Assemble documents for tender Comment on tender returns	C7	Construction
J, K & L - Mobilisation/ project planning, construction, practical completion	Advise the client on the need for the appointment of site staff Comment on installation drawings and builders' work drawings submitted by the contractor Attend relevant site meetings and make other periodic visits to site Provide technical advice regarding payment to contractors Examine testing and commissioning procedures Examine records of commissioning results Comment on record drawings and operation and maintenance manuals prepared by the contractor Inspect the works on completion and record any defects	C8	
Part M - Feedback	Activities not defined by ACE, but important to performance Fine tuning User education		Handover

* Summarised by Fulcrum Consulting

The new BSRIA guide BG 6/2006: *A Design Framework for Building Services* provides detailed proformas for clients, design teams and contractors to agree an allocation of design activities and deliverables among themselves. In this way the potential for conflict arising from duplication or omission of design activities can be minimised.

There are potential areas of conflict between members of a project team that are particularly relevant to building services engineers.

Conflicts can arise when building services designs are based on superseded versions of the architect's layout drawings. This can occur when the architect continues a design right up to issue of tender information. If significant changes are made to the architectural drawings, the building services engineer will have to modify design during or after the tender process. This gives the potential for delays and additional cost.

Tender returns from building services contractors may exceed the client's budget. This usually requires some re-design by the building services engineers. Responsibility for paying for this re-design will need to be established.

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The design process

Overview

Design is a complex process which involves the activity of translating ideas, proposals and statements of needs and requirements into precise descriptions of a specific product. Design problems are often ill-defined, and their solutions are often not obvious. There is also rarely one correct answer to a design problem. Different designers will arrive at different but possibly equally satisfactory solutions.

Two major features characterise the design process. First, design tends to evolve through a series of stages at which the solution is increasingly refined to greater levels of detail, moving from broad outline through to fine detail. Second, design tends to contain iterative cycles of activities during which designs and design components are tested, evaluated and refined. Feedback loops are therefore an essential component of design. Most models of the design process involve many feedback and iteration loops.

There are many instances where the expertise of the building services engineer can influence the form of a building, including:

- Suggesting thermal mass for use in passive heating and cooling systems
- optimising fenestration and roof lights to maximise daylight without compromising thermal performance
- suggesting a narrow footprint to allow natural ventilation
- modification to floor heights to accommodate sufficient underfloor or ceiling voids for services distribution
- suggested orientation of the building to optimise solar gain – either to minimise to prevent overheating in summer or to maximise to encourage thermal gain in winter
- suggested orientation to use prevailing winds to enhance natural ventilation
- suggested layout of spaces within the building to simplify services distribution
- contributing to structural design options to accommodate services distribution.

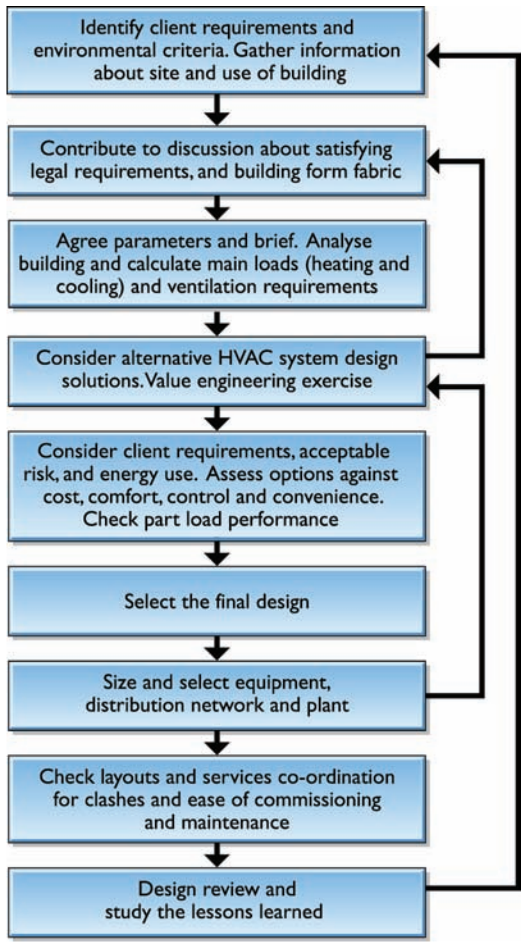
The building services design process

Figure 1 shows an example of the building services design process, based on the model developed by BSRIA and published in AG 1/2002: *Design Checks for HVAC*. This gives a simple design sequence from a statement of need, through problem analysis, synthesis, and evaluation to a final solution. Only some of the feedback loops are shown, but in practice there are often feedback loops between all tasks and even within specific tasks.

This sequence of design tasks has been developed into a design map showing the breadth of design choices and considerations for building services design, (Figure 2). This provides an overview of the design process to both inform the designer and to enable design elements to be seen in context. However, the real design process usually involves a number of iterations with overlap from one design stage to another. It may be necessary to revise calculations or modify assumptions at almost any stage.

In turn, this may lead to a series of subsequent revisions. Such revisions will have cost implications, which should also be considered as the overall process is managed and controlled. The calculations used in this document are taken from the BSRIA guide BG 30/2003: *Practical Guide to HVAC Building Services Calculations*. The use of standard calculations helps designers to document their design process, which then makes it easier to make revisions at a later date.

Figure 1: Simple example of a building services design process.



Based on the model developed in the *Design Checks HVAC – A Quality Control Framework for Building Services Engineers*, AG 1/2002.

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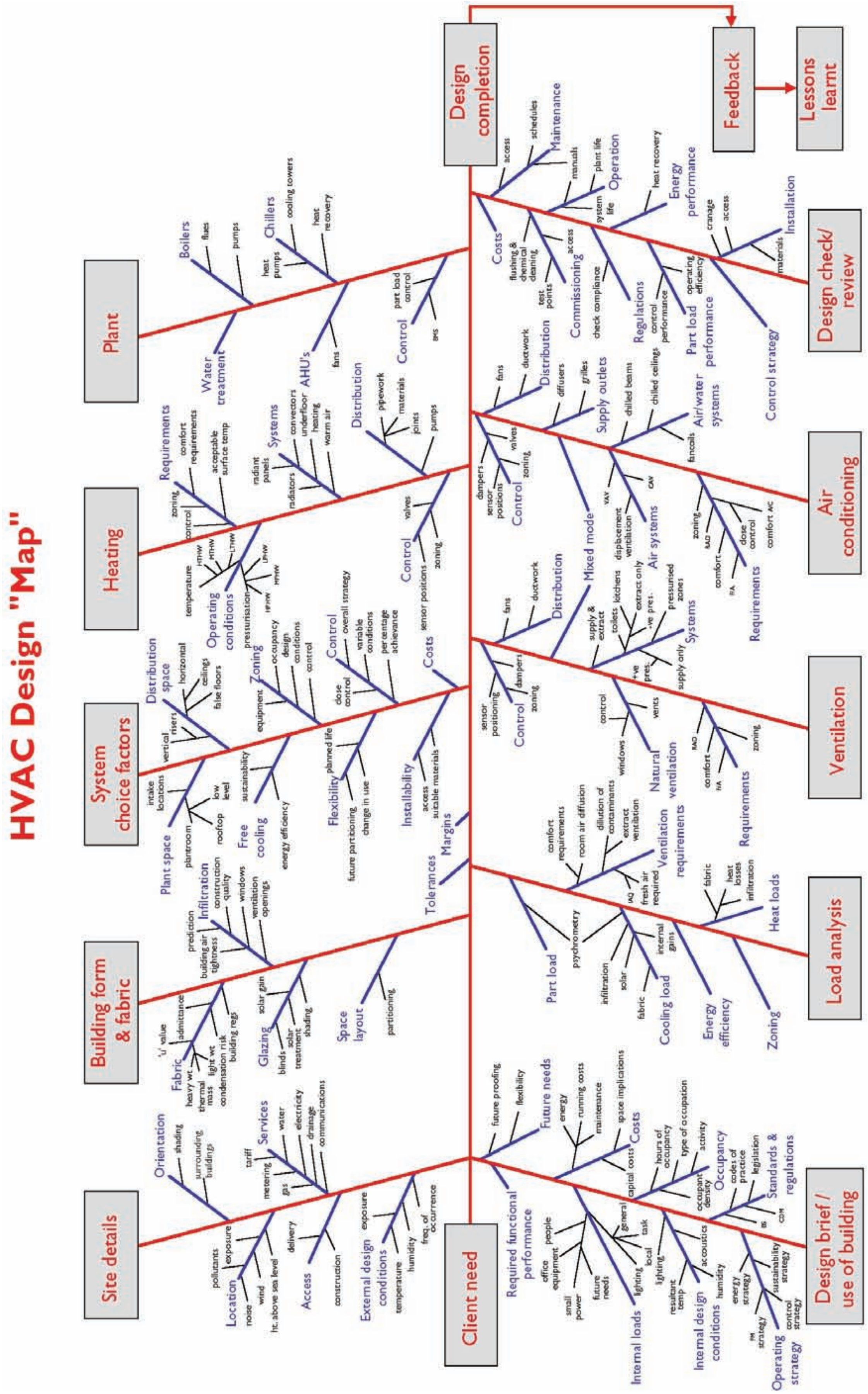
Figure 2: HVAC design map.



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Introduction

The remainder of this report demonstrates the application of the calculations published in BSRIA's Guide BG 30/2003: *A Practical Guide to HVAC Building Services Calculations*, as a construction project progresses through the two principal stages of HVAC design: outline and detailed proposals, followed by final proposals and production information.

The demonstration project has been based on a real building to make the calculation process as realistic as possible.

The project starts with a building specification, which is summarised in the rest of this section. Section 3 then presents the calculations made during outline and detailed proposals stages (ACE Stages C3 and C4). Section 4 presents the calculations made during final proposals stage (ACE Stages C5).

The specification details given below are of the type usually provided by an experienced client. In many cases, the initial brief may contain much less detail. In these situations the building services engineer should meet with the client and other members of the design team to understand the client's needs for the building and to discuss how the different design disciplines can work together to produce the optimum design.

It is assumed that the appointment of the consulting engineer is as detailed in ACE *Agreement B2 Schedule I – Detailed Design Normal Duties*.

The building

The development is on an existing estate, purpose-built for business use, and is located in a previously undeveloped part of the estate. The original estate was developed in the 1940s and has changed ownership three times with various tenants on short term and long-term leases. The estate is five miles from the M3 in southern England, and is surrounded by controlled forestry land.

The development consists of three main areas, shown in drawing 70206/01 in Appendix A:

- Two blocks of offices (each including an internal atrium): 10 220 m^2 (110 000 ft^2)
- laboratories and workshops at the rear of the building: 3345 m^2 (36 000 ft^2)
- reception area and internal two-storey circulation space that links the office blocks and the laboratories.

The client will occupy one of the two office blocks, plus the laboratory and workshops. The remaining office block will be let to a local business. The client has provided the following details of what it wants and what it needs according to its business requirements. Where appropriate, comments and references explain the criteria.

Client's functional requirements

Office layout

The office space of the building should generally be open-plan with the facility to incorporate 3 m-wide by 6 m-deep cellular offices around the perimeter, as and when required. The planning grid is 1500 mm, within a 7·5 m structural grid. The planning grid will affect how building services components can be modularised for easiest fit and the spacings to be used between components. Both structural and planning grids are shown on the arrangement drawings in Appendix A.

Lighting

The client is keen to optimise the amount of natural daylight in the office space, but appreciates that the size of the office and the likelihood of partitions being installed for separate perimeter offices will reduce daylight effectiveness.

Design occupancy

The client requires an occupancy density of 1 person per 15 m^2 of offices. This is within the current guidance of 12 m^2 to 17 m^2 per person published by the British Council for Offices (BCO). This allows for approximately 255 occupants for the client and the same for the tenant.

Source of equipment

Systems and components are to be obtained from reliable sources able to provide matching spares and replacements.

Duty and standby provision

The term duty/standby describes a plant arrangement whereby duplicate or standby plant is provided to maintain continuity of service in the event of failure of the main plant or duty plant items.

This should not be confused with spare capacity, which is an additional plant capacity over and above the design value. Spare capacity is typically used to provide a boost in power at start-up of the system, or to lessen the effects of losing an item of duty plant.

There are no business-critical activities planned for the office building (such as data centres, or dealing rooms), so standby plant is not required. However, as office work would be compromised by failure of cooling in summer or heating in winter, the systems should be easily accessible for maintenance and repair.

Security systems

The building is to incorporate a closed-circuit television system around the perimeter of the building and at entrances and exits of the building. A door access system is required for all entrances and exists to the building.

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Design criteria for building services

Specific design criteria are generated in two ways.

First the client may specify the criteria based on previous experience of construction. This requires the client to have a detailed knowledge of the design and construction processes and will typically arise if the client is a property developer or frequently involved in procuring buildings.

Second the design team, usually led by an architect or a design and build contractor, will meet with the client to ascertain the building's requirements and translate these into technical design criteria. Depending on the timing of design team appointments, these meetings may not always include building services engineers.

However the criteria are generated, the building services engineer will need to check that these comply with the appropriate regulations.

Using the information provided, the architect can design a suitable building and the building services engineer can start the preliminary calculations to design the services.

For the demonstration project, many of the criteria specified by or agreed with the client are based on recommendations from CIBSE or the British Council for Offices (BCO). For brevity, the criteria included here focus on the office building that is the subject of the design process in later sections of this guide.

Occupancy heat load (office)

At 22°C (Winter)

- Sensible: 90 W/person.
- Latent: 50 W/person.

Based on *CIBSE Guide A – 1999 table 6.1*

At 24°C (Summer)

- Sensible: 80 W/person.
- Latent: 60 W/person.

Based on *CIBSE Guide A – 1999 table 6.1*

Small power loads (office)

20 W/m² of net office area. The BCO 's recommended range is 15 to 25 W/m² which allows for future expansion. A higher figure may be appropriate if the client's business requires lots of office equipment.

Lighting loads (office)

12 W/m² of net office area. This is at the lower end of the BCO's recommended range of 10 to 25 W/m².

Fresh air allowance (office)

12 l/s per person based on 1 person/15 m². This is in line with the BCO's recommended range of 8 l/s to 12 l/s.

Infiltration rate

The specification is for the building to achieve the good practice guidelines for air tightness, with an air permeability index of 5 m³/(h.m²)

Indoor design conditions

Winter

Offices: 22°C±2°C (This is the BCO's recommendation).

Summer

Offices: 24°C±2°C (This is the BCO's recommendation).

Indoor design conditions should reflect the average condition in the space and not the temperature at the thermostat. The figures for this demonstration project were selected by the client in the knowledge that these will require mechanical refrigeration. A different client who wishes to use natural ventilation or thermal mass to regulate summer temperatures will need to agree different criteria.

Outdoor design conditions

Winter design

-4°C db; saturated.

Summer design

29°C db; 20°C wb.

The chillers must operate in conditions up to 40°C in order to provide cooling capacity in the event of ambient conditions above design.

Humidity

The client has not provided any specific criteria for humidity control in this case, but 50% has been used for the purposes of these calculations as a typical figure for office environments.

Acoustics

The standard for the open plan office spaces is NR38, as recommended by *BCO Guide* (2000). In the perimeter zone where cellular offices may be installed at a later date, cross-talk must be limited to maintain privacy between adjacent offices. The BCO recommended noise level standard for these cellular offices is NR35.

Relevant building construction details

Building grid and floor capacity

- Primary grid (generally): 7·5 m²
- floor slab loading capacity: 3·50 kN/m²
- additional capacity for light partitions 1·0 kN/m².

(Allowance of 10% of floor area to withstand 7·5 kN/m² in a location defined by the developer.)

Roof drainage

The roofs of the offices, and the circulation space are to incorporate uPVC rainwater outlets, connecting to rainwater drainage collection system, to down pipes within service risers. Roof drainage design to incorporate overflow system to provide a safety warning.

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External wall elevations

External solid wall

- Outer brick skin: 105 mm
- insulation: 75 mm
- air gap: 50 mm
- lightweight block: 100 mm
- plaster: 13 mm.

Glazed elevations

- Polyester powder coated aluminium thermally broken curtain wall system.
- full height (slab to soffit) glazing–outer pane: 6 mm clear
- air gap:12 mm
- toughened inner pane: 6 mm.

(Clear high performance thermal coating to the outside surface of the inner pane.)

Internal partitions

General internal solid partitions comprise: plasterboard, an air gap and plasterboard.

A glazed wall to the atrium at the centre of each office block comprises floor to ceiling double-glazed units.

A glazed wall between the offices and the two-storey circulation space comprises floor to ceiling double-glazed units as per the external façade.

Ground floor and roof construction

- Carpet tiles
- raised flooring system (150 mm void)
- concrete slab 100 mm.
- Insulation: 25 mm
- oversite/blinding: 250 mm
- felt/bitumen: 5 mm
- insulation: 100 mm
- cast concrete: 210 mm.

Ceilings (offices)

The perimeter margin is formed with a British Gypsum mineral-fibre ceiling, to a 1500 mm planning grid, incorporating 500 × 500 mm white perforated Tegular-metal tiles in an exposed fineline grid. The ceiling provides a minimum of 25 dB(A) sound reduction.

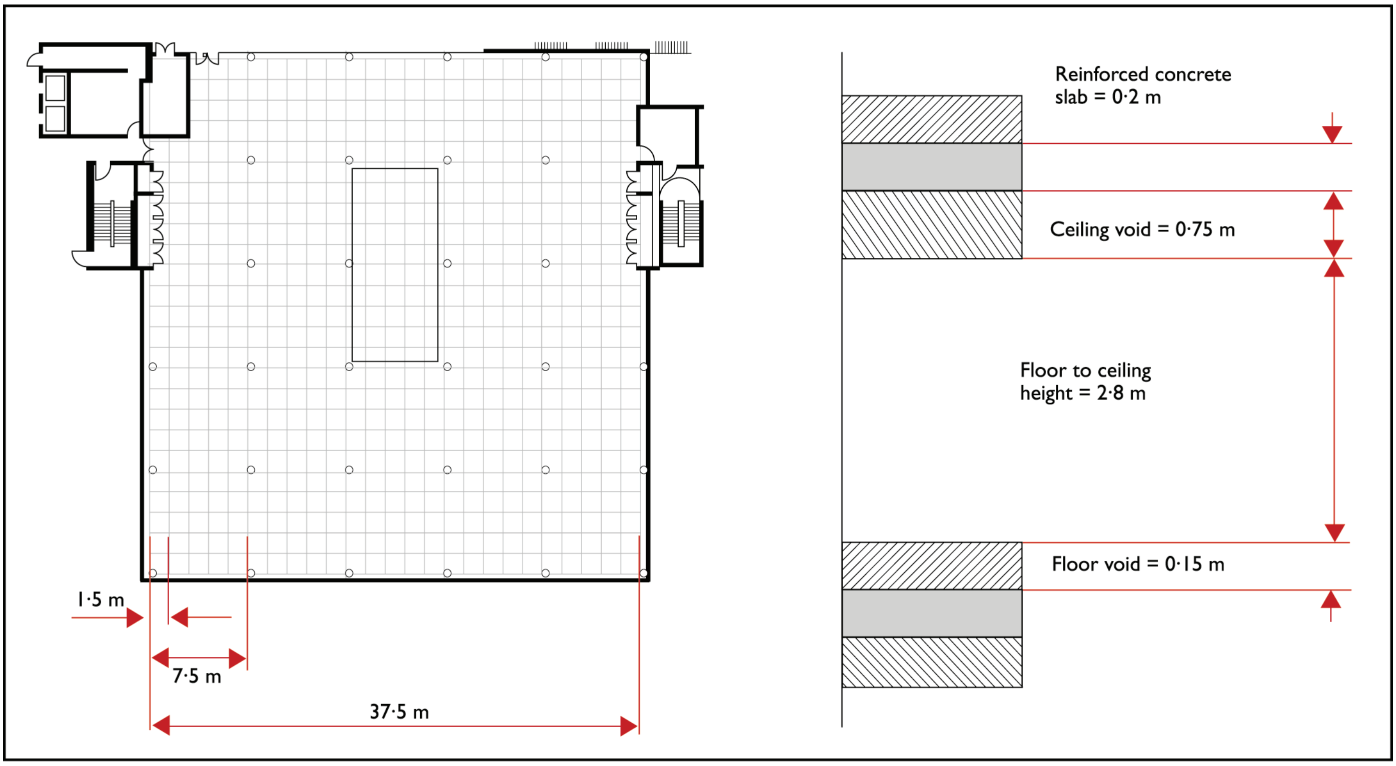
Building dimensions

The dimensions for a building are normally taken from the approved drawings by the architect. The main dimensions concerning the office space in this hypothetical project are given below and shown in Figure 3.

- Internal office height: 2·8 m
- raised floor zone (depth): 0·15 m
- ceiling void (height): 0·75 m nominal height, but allow 0·2 m beam depth below slab soffit on grid lines, therefore 0·55
- distance between columns: 7·5 m
- maximum internal distance between walls: 37·5 m
- reinforced concrete floor thickness: 0·2 m
- planning grid: 1·5 m.

For calculating heat gain and loss through the external walls, designers should use the slab to soffit dimension not the internal office height, as heat will also be transmitted to and from the floor and ceiling voids.

Figure 3: General office layout and vertical section.



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Calculation topics

The calculation topics covered by in BSRIA Guide BG 30/2003: *Practical Guide to HVAC Building Services Calculations* and this model demonstration project are listed in Table 3, below. The references (for example H1) are to the calculation sheets in BG 30/2003. Table 3 also indicates which topics are covered in which of the two stages of the design process that are demonstrated in this report.

Table 3: Schedule of calculation topics.

Calculation topic	Outline and detailed proposals (section 3)	Final proposals and production information (section 4)
Stack effect (H1)		
Infiltration (H2)	✓	
U values (H3)	✓	
Condensation risk (H4)	✓	
Heat loss (H5)	✓	
Plant heating load (H6)	✓	
Radiator sizing (H7)		
Boiler sizing (H8)	✓	
Flue sizing (H9)	✓	
Pipe sizing – general (W1)	✓	
Pipe sizing – straight lengths (W2)		✓
Pipe sizing – pressure drop across fittings (W3)		✓
System resistance for pipework – index run (W4)		✓
Pump sizing (W5)		✓
Water system pressurisation (W6)		
Internal heat gains (C1)	✓	
External gains (C2)	✓	
Cooling plant loads (C3)	✓	
Ventilation – fresh air requirements (C4)	✓	
Supply air quantity and condition (C5)		✓
Heating/cooling coil sizing (C6)		✓
Humidifier sizing (C7)		
Duct sizing – general (A1)	✓	
Duct sizing – selecting a circular duct size (A2)	✓	✓
Duct sizing – circular to rectangular ducts (A3)	✓	
Ductwork - pressure loss through fittings (A4)		✓
Duct sizing – index run (A5)		✓
Fan sizing (A6)		✓
Grille and diffuser sizing (A7)		✓
Air density correction (A8)		
Pressurisation of spaces (A9)		
Acoustics for building services (new)		
Dehumidification (new)		
Control valve selection/sizing (new)		✓
Effect of return air temperature on coil duty (new)		
Heating plant configuration and load matching (new)		

The calculations marked new will be included in a revision of the *Practical Guide to calculations*.