Unit 35: Ventilation and Air Conditioning in Building Services Engineering

NQF Level 3: **BTEC National**

Guided learning hours: 60

Unit abstract

For many centuries, ventilation has been recognised as being essential to the promotion of healthy and comfortable buildings for centuries. Today, ventilation is considered even more important, as buildings are more air-tight and legislation imposes a requirement for buildings to have a clean, wholesome, comfortable and fresh environment.

Many buildings have a tendency to over-heat in summer and often require methods of cooling them. Air conditioning, once seen as the benchmark for luxury, provides a method of doing this, but at a price that has to be justified and minimised in today's energy-conscious world.

A sound understanding of the principles, procedures and technologies of modern ventilation and air conditioning is therefore fundamental to the role of the building services engineer. This is particularly true for those involved in the Heating Ventilating and Air Conditioning (HVAC) sector, often referred to as the 'Mechanical Building Engineering Services'.

The unit explores the development of ventilation and air conditioning installations in a progressive manner. It begins with agreement of the client requirements for a system, through the design of layouts and the sizing, selection and specification of ductwork and equipment, and concluding with the commissioning of the system and its subsequent maintenance.

Learning outcomes

On completion of this unit a learner should:

1 Know how to establish ventilation and air conditioning requirements for buildings, recommend strategies, select design conditions and estimate cooling loads

2 Know how the operational features and characteristics of ventilation and air conditioning, equipment, plant and materials contribute to their application and usage

3 Be able to design ventilation and simple single zone air conditioning installations for specific applications

4 Understand how to size, select and specify ventilation and air conditioning systems, ductwork, plant and equipment.

Unit content

1 **Know how to establish ventilation and air conditioning requirements for buildings, recommend strategies, select design conditions and estimate cooling loads**

Requirements: purpose of ventilation; reasons for providing comfort and process ventilation; clients' needs; health and safety and other statutory requirements; identification of locations with specific ventilation requirements; types of contaminant; reasons for providing air conditioning in buildings; sources of heat gain to buildings; identification of locations requiring air conditioning; establishing performance requirements for proposed installations

Ventilation systems: operating principles; applications and key performance characteristics of natural ventilation; mechanical ventilation; comfort cooling/air conditioning and mixed mode ventilation systems; energy and environmental implications of ventilation and air conditioning installations; selecting ventilation and air conditioning strategies

Design conditions: methods of specifying ventilation rates; selection of ventilation rates for specific locations; occupational exposure limits (OEL) for single specific contaminants; selection of internal and external design conditions for air conditioned rooms; impact of room air velocity and temperature on comfort

Cooling loads: estimation of heat gains and cooling loads using tabulated data and established 'rules-of-thumb'

2 **Know how the operational features and characteristics of ventilation and air conditioning, equipment, plant and materials contribute to their application and usage**

Air terminal devices: characteristics; terminology; operational features; materials; installation requirements and application of supply and extract air terminal devices; control of quantity and direction of air discharge in supply and extract devices; operational features; installation requirements; materials and suction dynamics of booths, canopies, hoods and other extract devices used in commercial kitchens and industrial applications

Ductwork and jointing systems: ductwork shapes and materials used for HVAC systems; characteristics and features of jointing, assembly and installation procedures; relationship between physical properties of ductwork materials and their application; flexible and fire-rated ductwork; criteria for selection of materials and shape; published standards and specification for ductwork (eg DW144, DW171)

Ductwork ancillary components: requirement for; characteristics of; operational features and selection criteria of various types of ductwork items, eg volume control dampers, fire and smoke dampers, access doors, flexible connections, test points

Air handling plant: *fans* — types of fan; characteristics, operational features and application of fans; types of drive; installation requirements and ductwork connections; *heater/cooler batteries* — types; materials used; characteristics, operational features and application of heater batteries; chilled water and direct expansion cooling coils; installation requirements and ductwork connections; *heat recovery devices* — types of heat recovery device; characteristics, operational features and application of heat recovery devices; installation requirements and ductwork connections; *air cleaning devices* — terminology and definitions associated with filters and air cleaning devices; group and class of filter; filter testing methods; types, characteristics, operational features and application of filters and dust collection/removal devices for air-handling systems; installation requirements and ductwork connections; — *humidifiers*: types of humidifier; characteristics, operational features and application of humidifiers; installation requirements and ductwork connections; water supply; maintenance and health and safety implications of humidifiers; *refrigeration plant*: principles, components and application of vapour compression refrigeration systems; application of refrigeration in air conditioning systems; operation, features and application of heat pumps; — *air handling units*: configurations and features of simple composite air handling units (AHUs), local exhaust ventilation systems, dust collection and packaged air conditioning systems; control requirements and arrangements for ventilation and warm air heating installations

3 **Be able to design ventilation and simple single zone air conditioning installations for specific applications**

Design of HVAC installations: layout for supply air devices to achieve good room air distribution; location of extract devices for effective operation; relationship between supply and extract devices in balanced supply and extract systems; design of local exhaust ventilation and other simple industrial/commercial process ventilation; ductwork systems and arrangements for comfort/process ventilation; warm air heating and air conditioning installations; features of good ductwork design; prevention of noise problems; accommodation of ductwork within buildings; use of ductwork design and installation standards and codes; criteria and methods for zoning installations; prevention of spread of smoke and fire due to ductwork installations; provision for maintenance and testing ductwork

Design of HVAC plant space: space requirements and types of accommodation for air handling units; refrigeration/chiller plant and fans; location of air intake and discharge points; structural and builders' work requirements to accommodate air handling plant and ductwork

Provision for maintenance and commissioning: reasons for commissioning duct networks; location of flow regulation

Graphical detailing: production of appropriate drawings and sketches as required to communicate HVAC systems detailed designs; use of drawing symbols and annotation

4 **Understand how to size, select and specify ventilation and air conditioning systems, ductwork, plant and equipment**

Air flow rates and supply conditions: calculation of air flow rates for mechanical supply and extract ventilation systems; supply air conditions and mass and volumetric flow rates to maintain design room conditions for warm air heating and single zone air conditioning applications; plotting summer and winter psychrometric cycles for simple air conditioning applications; balance between fresh air and thermal requirements in warm air heating and air conditioning installations; determining re-circulation rates

Air terminal devices: selection of supply air terminal devices and booths, canopies, hoods and other extract devices using manufacturers' information; throw, resistance and noise characteristics; production of air terminal device specifications and schedules

Ductwork circuits: selection of ductwork design parameters; use of manual calculations and computer software to determine duct sizes (using constant pressure drop and/or constant velocity methods), total resistance of index circuits (in terms of total, static and velocity pressure); methods of producing balanced systems and absorbing excess pressure at branches; establishing commissioning data for ductwork distribution networks

Fans: application of margins; determining fan duty; selection of fans from manufacturers' data; fan and system characteristics; efficiency and operational features; production of fan schedules; establishing commissioning data

Air conditioning plant: use of psychrometric cycles to determine cooler coil, heater battery, frost coil and humidifier duties; selection of plant and components from manufacturers' data; production of plant specifications and schedules

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify the need for ventilation, warm air heating and air conditioning in buildings, select appropriate ventilation rates and estimate cooling loads for specific applications	M1 make comparisons between alternative strategies for providing ventilation and maintaining thermal comfort for given specific applications and make appropriate recommendations for the most suitable	D1 analyse and justify the design rationale used in the production of a ventilation and air conditioning design and demonstrate how the proposed design meets the needs of the client and their building
P2 describe the operating principles, characteristics, advantages and disadvantages of the different strategies commonly used for providing ventilation and maintaining thermal comfort in buildings via air based systems	M2 make comparisons between alternative items of ventilation and air conditioning plant for given specific applications and make valid and appropriate recommendations for the most suitable	D2 analyse and justify the design parameters and rationale used in the sizing and specification of duct networks, plant and components and demonstrate how the proposed selections satisfy the appropriate performance requirements.
P3 describe how the features and characteristics of air terminal devices, fans, heater/cooler batteries, heat recovery devices, humidifiers, air cleaning devices, ductwork and ancillary equipment contribute to their selection for specific applications	M3 produce comprehensive designs for air based heating, ventilation and air conditioning installations, plant arrangements and control strategies	

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Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P4 produce basic functional and workable designs for air based heating, ventilation and air conditioning installations appropriate for specific buildings requiring a variety of circuits	M4 produce clear and accurate answers to the calculations required to size duct networks and determine detailed commissioning data	
P5 determine air supply conditions, air flow rates ductwork sizes and resistances for heating, ventilation and air conditioning systems using recognised procedures	M5 analyse installation drawings, design calculations and manufacturers data to produce detailed and comprehensive specifications, schedules and commissioning data for air terminal devices, fans, heater and cooler batteries, humidifiers and other ancillary components.	
P6 plot summer and winter psychrometric cycles for single zone air conditioning applications, size and select appropriate models of air terminal device, fans, heater and cooler batteries, humidifiers and other ancillary equipment for given installations.		

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and the use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

The learning outcomes are strongly linked and form a logical and progressive structure. Teaching and learning strategies should reinforce this integrated learner-centred approach. Learners should appreciate that each aspect and topic forms a stage in the overall process of designing and specifying HVAC installations.

The method of delivery should, as far as possible, be activity-based where learning activities could include the use of case studies, site visits, product investigations, design exercises. The unit should not be seen by learners as an academic exercise, it should at all times be based on real-life applications and reflect industry best practice.

The delivery process should provide a balance between the calculations implicit within learning outcome 4, the knowledge and understanding required in learning outcomes 1 and 2 and the creativity and application required of learning outcome 3.

Reference should be made to appropriate regulations, standard building services guides and sources of reference wherever necessary. Learners should be encouraged to use these documents to make informed decisions in the design of HVAC installations and to understand the consequences of those decisions.

The use of manufacturers' current product information is also encouraged to help learners apply the principles and procedures learnt to real-life situations. This does not mean that mechanistic use of manufacturers' data, with little consequent need for understanding, is acceptable. The same logic applies to the use of specialist building services engineering design software and spreadsheets. Their use is encouraged, but only after an understanding of the underlying principles required for manual calculations have been established.

There is an assumption that, in addition to appropriate levels of mathematical, communication and IT skills, learners have a prior understanding (or are concurrently studying) the underlying principles of thermal comfort, heat transfer, material properties, sustainable development, processes that harm the natural environment, psychrometric properties of moist air, flow of fluids, operating characteristics of fans, and control principles and strategies for building engineering services.

Where learners do not have the prior understanding of these underlying principles it is strongly recommended that in order to avoid duplication this unit is delivered in parallel with the underpinning topics covered in other units.

The focus of this unit is on linking principles with practical applications and this in turn means that learners should have achieved a basic understanding of the relevant science and mathematics before starting this unit (for example flow of fluids, psychrometric properties of moist air, operating characteristics of fans and control principles).

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on page 19 of this specification.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used then suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

The unit has been written to allow all the assessment evidence for all learning outcomes to be produced from a single, well-designed project based around the design of ventilation, warm air heating and air conditioning installations for a real building.

The building(s) selected for the purpose of assessment should have a wide variety of uses, functions, activities and features. This will give learners the opportunity to consider options and make decisions. Any buildings selected should not be too complex and are capable of realistically incorporating standard comfort and process ventilation, warm air heating and single zone air conditioning installations.

Learners should be given a range of necessary architectural drawings to extract the required information. These should include plans, elevations, sections and/or details as appropriate. Where centres intend to use buildings of their own design, the buildings must meet current building design standards and should contain the same information as would be present in professionally produced architectural drawings.

Although this unit can stand-alone, it is strongly recommended that, where learners are concurrently studying other units, the assessment evidence is co-ordinated to avoid unnecessary duplication. In such cases, centres may want to consider integrative assignments. For example, assessments associated with thermal comfort, properties of materials, sustainable development, environmental impact,

psychrometric properties of air, flow of fluids, performance of fans, control applications, can be integrated within an assessment instrument designed to meet the grading criteria for this unit.

To achieve a pass grade learners must meet the six pass criteria listed in the grading grid.

For P1, learners must identify the need for ventilation, warm air heating and air conditioning in buildings, select appropriate ventilation rates and estimate cooling loads for specific applications. For those areas requiring ventilation learners are expected to select ventilation rates expressed in appropriate terms eg air change or volumetric flow rates. For any applications requiring single contaminant industrial process ventilation, learners should select appropriate occupational exposure limits. Learners are also expected to identify parts of a building for which may need warm air heating or air conditioning. For air conditioned areas, learners should select internal and external design conditions and estimate the cooling loads using established 'rules of thumb' eg 'BSRIA Rules of Thumb'. In all cases it is important that learners support their selections by indicating sources of reference used and indicate the factors used in their selection. To avoid the mechanistic use of tables, locations requiring a degree of judgement should be included. Evidence could take the form of a report supported by data, drawings and calculations as appropriate.

For P2, learners must describe the operating principles, characteristics, advantages and disadvantages of the different strategies commonly used for providing ventilation and maintaining thermal comfort in buildings via air based systems. These should include natural and mechanical ventilation, warm air heating, comfort cooling, single zone air conditioning and mixed mode systems, including the various sub-divisions within these. Learners are not required to recommend particular strategies for specific applications, but they are expected to contextualise their descriptions by indicating typical applications and criteria which might influence their selection. Examples of suitable evidence approaches could be as for P1.

For P3, learners must describe how the features and characteristics of air terminal devices, fans, heater/cooler batteries, heat recovery devices, humidifiers, air cleaning devices, ductwork and ancillary equipment contribute to their selection for specific applications. Examples of suitable evidence approaches could be as for P1.

For P4, learners must produce basic functional and workable designs for air based heating, ventilation and air conditioning installations appropriate for specific buildings requiring a variety of circuits. This should include ventilation (including simple process ventilation) warm air heating and air conditioning/comfort cooling installations. Designs should include the necessary major items of plant and indicate that the type of system, ductwork routing, air terminal placement, plant accommodation and appearance have been considered. Evidencing could be as for P1, supported by relevant drawings.

For P5, learners must determine air supply conditions, air flow rates ductwork sizes and resistances for heating, ventilation and air conditioning systems using recognised procedures. The size of the circuit should be representative of the circuit(s) used for P4. There should be evidence that learners understand the procedure used. Evidence approaches should rely on clear and accurate calculations.

For P6, learners must plot summer and winter psychrometric cycles for single zone air conditioning applications, size and select appropriate models of air terminal device, fans, heater and cooler batteries, humidifiers and other ancillary equipment for given installations. Learners are also expected to use data and manufacturers' information to select appropriate makes and models of air terminals, fans and heater/cooler batteries. There should be evidence that learners understand the procedure used. Evidence could take the form of a report with the cycles superimposed on standard psychrometric charts, supported by calculations as appropriate. Manufacturers' information on its own is not sufficient in terms of required evidence.

To achieve a merit grade learners must meet all of the pass grade criteria **and** the five merit grade criteria.

For M1, learners must make comparisons between alternative strategies for providing ventilation and maintaining thermal comfort for given specific applications and make appropriate recommendations for the most suitable. Learners should relate their decisions to the needs of particular client and the features, form and activities of the building. This could be a natural extension of the work carried out in P1 and P2.

For M2, learners must make comparisons between alternative items of ventilation and air conditioning plant for given specific applications and make valid and appropriate recommendations for the most suitable. Learners should relate their decisions to the needs of a particular building and the proposed systems and outline any constraints and considerations. This could be a natural extension of the work carried out for P2 and P3.

For M3, learners must produce comprehensive designs for air based heating, ventilation and air conditioning installations, plant arrangements and control strategies. The designs should include details of all items of plant and equipment (including controls) and their locations. There should be clear evidence that learners have carefully considered the proposed design. This includes features and constraints of the building, the space requirements for the accommodation of ductwork and air handling plant, the client's requirements and the need for maintenance and commissioning. Drawings and reports should be well produced, detailed and unambiguous and include layout and schematic drawings. This could be a natural qualitative extension of the work carried out for P4.

For M4, learners must produce clear and accurate answers to the calculations required to size duct networks and determine detailed commissioning data. This should include the flow rates for each section, duct sizes, index circuit resistance, procedures for absorbing excess pressure at branches to achieve balanced circuits. Learners are expected to extract and present the necessary commissioning data from these calculations. This could be a natural extension of the work carried out for P5.

For M5, learners must analyse installation drawings, design calculations and manufacturers data to produce detailed and comprehensive specifications, schedules and commissioning data for air terminal devices, fans, heater and cooler batteries, humidifiers and other ancillary components. Learners are expected to use this data with manufacturers' information to write specifications, select and produce schedules and commissioning information for appropriate makes and models of air

handling plant. This could include fans, air terminal devices, heater batteries, cooler batteries, humidifiers, air handling units, packaged air conditioning units, refrigeration plant and other ancillary equipment. This could be a natural extension of the work carried out for P6.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria **and** the two distinction grade criteria.

For D1, learners must analyse and justify the design rationale used in the production of a ventilation and air conditioning design and demonstrate how the proposed design meets the needs of the client and their building. In justifying the design, learners must clearly show how a proposed design meets the needs of the building, client and end users as well as the wider issues of environment impact. As part of the justification learner are expected to link the features of the design with appropriate underpinning principles. This could be a natural extension of the work carried out for P1, P2, P3, P4, M1, M2 and M3.

For D2, learners must analyse and justify the design parameters and rationale used in the sizing and specification of duct networks, plant and components and demonstrate how the proposed selections satisfy the appropriate performance requirements. In justifying the design parameters learners must clearly explain why they used particular parameters, what alternative parameters could be used and what the effect of using other parameters would be. For plant and components, learners' justification should establish appropriate performance standards (where applicable) and show whether selected items of plant and equipment selected meet these standards. As part of the justification learners are expected to make the link with appropriate underpinning principles. This could be a natural extension of the work carried out in P5, P6, M4 and M5.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes in this unit are closely linked with, for example, *Unit 2: Construction and the Environment, Unit 4: Science and Materials in Construction and the Built Environment, Unit 8: Graphical Detailing in Construction and the Built Environment, Unit 32: Building Services Control Systems, Unit 33: Building Services Science* and *Unit 36: Fluids Static and Dynamic in Building Services Engineering*, together with similar units at Higher National and degree level.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs.*

The content of this unit also covers some of the knowledge and understanding associated with SummitSkills National Occupational Standards, particularly Unit 008: Design RAC systems — small commercial refrigeration and air conditioning systems and Unit 015: Design heating and ventilating systems.

The content of this unit covers some of the knowledge and understanding associated with Summit Skills N-SVQ Level 3: Building Services Engineering Technology and Project Management, particularly Unit SST/NOS 3: Apply Design Principles to Building Services Engineering Projects and Unit SST/NOS 7: Provide Technical and Functional Information to Relevant People.

The contents of this unit will also provide a developmental stage in acquiring some of the knowledge and understanding associated with Summit Skills N-SVQ Level 4: Building Services Engineering Technology and Project Management, particularly SSTE/NOS 7: Prepare and Advise on Building Services Engineering Project Design Recommendations and SSTE/NOS 8: Prepare and Agree Detailed Building Services Engineering Project Designs.

This unit presents opportunities to demonstrate key skills in application of number, communication and problem solving. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annex F: Wider curriculum mapping*.

Essential resources

Centres should have access to a wide range of hard copy or online technical and manufacturer's literature some of which are listed below.

The availability of visual aids such as the range of ventilation plant and components indicated in the learning outcome 2 is considered to be highly advantageous. These can be either in the form of models and/or as part of live installations.

Centres should have access to sets of architectural drawings, heating system installation and schematic drawings to support the learning process and to facilitate assessments. Where these drawings are used as part of the assessment process it is recommended that repeated use of the same building is avoided to maintain the freshness of the assessment process.

It is useful for learners to become familiar with industry-recognised software able to size, select and specify ductwork, plant and equipment. If such software is used it is important that learners are assessed as being able to complete the calculations required using recognised manual procedures. The same principle applies to the graphical detailing required for learning outcome 3.

Indicative reading for learners

Textbooks

Chadderton D — *Air Conditioning: A Practical Introduction, 2nd Edition* (Spon Press, 1999) ISBN 0419226109

Chadderton D — *Building Services Engineering, 5th Edition* (Taylor & Francis, 2007) ISBN 0415413559

Chartered Institute of Building Services Engineer — *Energy Efficiency in Buildings* (CIBSE, 2004) ISBN 1903287340

Chartered Institute of Building Services Engineer — *Environmental Design, 7th Edition* (CIBSE, 2006) ISBN 1903287669

Chartered Institute of Building Services Engineer — *Hygienic Maintenance of Office Ventilation Ductwork* (CIBSE, 2000) ISBN 1903287111

Chartered Institute of Building Services Engineer — *Ventilation and Air Conditioning* (CIBSE, 2001) ISBN 1903287162

Health and Safety Executive — *Introduction to Local Exhaust Ventilation* (HSE, 1993) ISBN 0717610012

Jackman P — *Design Recommendations for Room Air Distribution Systems* (BSRIA, 1990) ISBN 0860222527

Martin P, Oughton D and Hodkinson S — *Faber and Kell's Heating and Air-conditioning of Buildings, 9th Edition* (Architectural Press, 2001) ISBN 075064642X

Mitchell S and Race G — *A Practical Guide to HVAC Building Services Calculations* (BSRIA, 2003) ISBN 0860226182

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• planning and obtaining data, extracting dimensions from drawings etc in order to determine air supply conditions, air flow rates ductwork sizes and resistances for ventilation and air-based thermal comfort systems • selecting appropriate formulae to solve problems in air supply rates, air supply conditions, fluid mechanics, flow measurement, plant duties etc • interpreting results from psychrometric cycles, air flow rates and ductwork design calculations to select and justify plant and equipment.	N3.1 Plan an activity and get relevant information from relevant sources. N3.2 Use your information to carry out multi-stage calculations to do with: a amounts or sizes b scales or proportion d using formulae. N3.3 Interpret the results of your calculations, present your findings and justify your methods.

Communication Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• identifying and describing the need for ventilation, warm air heating and air conditioning in buildings and selecting appropriate ventilation rates for specific applications • describing how the features and characteristics of air terminal devices, fans, heater/cooler batteries, heat recovery devices, humidifiers, air cleaning devices, ductwork and ancillary equipment contribute to their selection for specific applications • evaluating the feasibility of alternative strategies for providing ventilation and maintaining thermal comfort and making appropriate recommendations for specific applications • making comparisons between alternative items of air handling and distribution plant for given specific ventilation and air conditioning applications and making valid and appropriate recommendations for the most suitable • analysing and justifying the design rationale used in the production of ventilation and air conditioning design and demonstrating how the proposed design meets the needs of the client and their building.	C3.2 Read and synthesise information from at least **two** documents about the same subject. Each document must be a minimum of 1000 words long. C3.3 Write **two** different types of documents each one giving different information about complex subjects. One document must be at least 1000 words long.

Problem solving Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• producing basic functional and workable designs for ventilation and air conditioning installations appropriate for specific buildings requiring a variety of circuits • plotting summer and winter psychrometric cycles for single zone air conditioning applications and sizing and selecting appropriate models of air terminal device, fans, heater/cooler batteries, humidifiers and other ancillary equipment for given installations • making comparisons between alternative strategies for providing ventilation and maintaining thermal comfort for given specific applications and making appropriate recommendations for the most suitable • making comparisons between alternative items of ventilation and air conditioning plant and making valid and appropriate recommendations for the most suitable for specific applications • analysing and justifying the design rationale used in the production of ventilation and air conditioning design and demonstrating how the proposed design meets the needs of the client and their building.	PS3.1 Identify a problem and identify different ways of tackling it. PS3.2 Plan and implement at least one way of solving the problem. PS3.3 Check if the problem has been solved and review your approach to problem solving.