

Level 4 Higher Professional Diploma in Building Services Engineering (4467)

Qualification handbook

500/2240/4

Electrotechnical

Mechanical Engineering Services



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1 About this document

This document contains the information that centres need to offer the following qualification:

Level 4 Higher Professional Diploma in Building Services Engineering

City & Guilds qualification number	4467
QCA accreditation number	500/2240/4
Total guided learning hours	480

QCA unit accreditation numbers

QCA unit number	City & Guilds unit number	Unit title	Guided Learning Hours per unit
R/501/0809	Unit 1	Health and safety legislation	40
L/501/0811	Unit 2	Applying CAD and ICT in Building Services Engineering Projects	40
R/501/0812	Unit 3	Electrotechnical engineering project design and management	80 (Double unit)
Y/501/0813	Unit 4	Electrotechnical engineering principles	40
D/501/0814	Unit 5	Mechanical engineering services project design and management	80 (Double unit)
H/501/0815	Unit 6	Mechanical engineering principles	40
K/501/0816	Unit 7	Science for electrical installation	40
L/501/0923	Unit 8	Electrical installation technology	40
R/501/0924	Unit 9	Electrotechnical services, installation and systems	40
Y/501/0925	Unit 10	Electrical supply and distribution	40
D/501/0926	Unit 11	Space heating technology and design	40
H/501/0927	Unit 12	Hot water systems technology and design	40
K/501/0928	Unit 13	Cold water systems technology and design	40
M/501/0929	Unit 14	Sanitation and drainage systems technology and design	40
H/501/0930	Unit 15	Air conditioning and ventilation technology and design	40
K/501/0931	Unit 16	Heating and ventilating systems technology and design	40
M/501/0932	Unit 17	Mathematics for building services engineers	40
T/501/0933	Unit 18	Planning work methods, workforce and resource requirements for building service engineering projects	40
A/501/0934	Unit 19	Contract procedures and requirements for building services engineering projects	40

F/501/0935	Unit 20	Estimating and tendering for building service engineering projects	40
J/501/0936	Unit 21	Financial management of building services engineering projects	40
L/501/0937	Unit 22	Managing resources for building services engineering projects	40
R/501/0938	Unit 23	Planning building engineering services projects	40
Y/501/0939	Unit 24	Using materials technology in building services engineering	40
	Unit 25	Electrotechnical sustainability	40

This document includes details and guidance on:

- centre resource requirements
- candidate entry requirements
- information about links with, and progression to, other qualifications
- qualification standards and specifications
- assessment requirements

2 About the qualification

2.1 Background to the Higher Level qualifications

The City & Guilds Higher Level Qualifications have been developed in response to:

- government initiatives to increase the numbers participating in higher level education and training and Lifelong learning
- the emergence of QCA design principles for the submission of higher level vocational qualifications (excluding NVQs and degrees) into the National Qualifications Framework
- a need from existing City & Guilds customers for higher level qualifications which offer a progression route from traditional level 3 qualifications
- a City & Guilds initiative to offer its customers the full range of vocational qualifications from the basic to the highest levels.

These qualifications have been designed to:

- combine the development of knowledge, understanding and skills in a variety of vocational areas
- equip the individual with a flexible programme of study which will provide the relevant level of knowledge and skills that are needed in the world of work
- meet the needs of industry and commerce and reflect the knowledge areas expressed in the relevant National Occupational Standards and/or professional standards

The design of the Level 4 City & Guilds Higher Professional Diplomas (HPDs) reflects an Outcomes-based model that meets the requirements for Certificate Level (Level 1 HE) Outcomes under the Framework for Higher Education Qualifications. This articulation facilitates the use of the HPD as the first year of a two year Foundation Degree. Please see the City & Guilds publication: *Further Education and Higher Education Working together to deliver Foundation Degrees*.

It is anticipated that potential candidates for these qualifications will currently be in work or have access to work placement but require a mechanism for the acquisition of relevant knowledge. In the first instance it is expected that many of these individuals will undertake the City & Guilds Higher Level Qualifications on a part-time basis, i.e. half day and evening, evenings only or as block release. However, there is also potential for these qualifications to be delivered as full-time programmes.

It is likely that these qualifications will be delivered in

- colleges
- training organisations
- higher education institutions
- armed forces

Whilst some of the content covered in the units can contribute to the underpinning knowledge of S/NVQs, the Higher Professional Diploma should be considered an alternative to S/NVQs. Effective delivery mechanisms could connect the delivery of units from both qualifications in a coherent, linked fashion.

2 About the qualification

2.2 Aims of the qualification

The qualification

The **Higher Professional Diploma in Building Services Engineering**:

- is offered at Level 4 of the National Qualifications Framework
- is designed to meet the needs of the high achieving, work-based City & Guilds candidates and take account of the patterns of work in the sector
- comprises units which can be accredited separately and have the potential to be packaged into mini-awards tailored to the needs of the individual
- provides the opportunity for skills/craft acquisition, supervision and underpinning knowledge
- reflects the knowledge areas expressed in the National Occupational Standards to ensure industry and QCA acceptability
- provides pathways for candidates to specialise in either Electrotechnical or Mechanical Engineering Services
- contains units which cover the transferable skills and knowledge needed by employers such as developing self, individuals and the team, finance, resource management, managing change
- is assessed by means of centre-devised work-related assignments and case studies
- is externally moderated by City & Guilds.

2 About the qualification

2.3 The structure of the qualification

In order to achieve the full Higher Professional Diploma in Building Services Engineering, candidates must successfully complete all designated units, as indicated in the award structure below. It has been designed as a 480 guided learning hours programme deliverable most probably part-time, but possibly as a full-time programme. An example mode of study could be two years part time (6.5 hours per week). The recommended total of notional learning hours for this award (including guided learning hours) is 1200 hours (120 credits).

The award has been designed to provide a set of units which will form the basis of a coherent and targeted course of study.

The table below shows the award requirements in terms of mandatory and optional unit combinations.

The two specialist pathways are as follows:

Level 4 Higher Professional Diploma in Building Services Engineering (Electrotechnical)

Units 1, 2, 3*, 4, 7, 8, 9, 10 and 25, and two units from 17 - 24

Level 4 Higher Professional Diploma in Building Services Engineering (Mechanical Engineering Services)

Units 1, 2, 5*, 6, four units from 11 – 16, and three units from 17 - 25

* denotes double unit

Mandatory units for both pathways

Unit 1: Health and safety legislation

Unit 2: Applying CAD and ICT in building services engineering projects

Mandatory units for Electrotechnical pathway

Unit 3: Electrotechnical project design and management (Double unit)

Unit 4: Electrotechnical principles

Unit 7: Science for electrical installation

Unit 8: Electrical installation technology

Unit 9: Electrotechnical services, installation and systems

Unit 10: Electrical supply and distribution

Unit 25: Electrotechnical sustainability

Mandatory units for Mechanical Engineering Services

Unit 5: Mechanical engineering services project design and management (Double unit)

Unit 6: Mechanical engineering principles

Optional units for Mechanical Engineering Services

Unit 11: Space heating technology and design

Unit 12: Hot water technology and design

Unit 13: Cold water technology and design

Unit 14: Sanitation and drainage technology and design

Unit 15: Air conditioning and ventilation technology and design

Unit 16: Heating and ventilating systems technology and design

Unit 25: Electrotechnical sustainability

Optional units for both pathways

Unit 17: Mathematics for building services engineers

Unit 18: Planning work methods, workforce and resource requirements for building service engineering projects

Unit 19: Contract procedures and requirements for building services engineering projects

Unit 20: Estimating and tendering for building service engineering projects

Unit 21: Financial management of building services engineering projects

Unit 22: Managing resources for building services engineering projects

Unit 23: Planning building engineering services projects

Unit 24: Using Materials technology in building services engineering

Certificates of unit credit

Certificates of unit credit (CUC) will be issued to candidates for each successfully completed unit, even if the full qualification is not attempted.

Candidates who do complete a full qualification will receive, in addition to their full certificate/diploma, a CUC for each unit achieved.

2 About the qualification

2.4 Sources of information

Other essential City & Guilds documents

There are other City & Guilds documents which contain general information on City & Guilds qualifications:

- ***Providing City & Guilds qualifications – a guide to centre and qualification approval*** contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification.
- ***Ensuring quality*** contains updates on City & Guilds assessment and policy issues.
- ***Centre toolkit*** contains additional information on *Providing City & Guilds qualifications*, in a CD-ROM, which links to the internet for access to the latest documents, reference materials and templates. The *Centre Toolkit* is sent to centres when they receive approved centre status. It is also available from to order at an additional cost.
- ***Online catalogue*** contains details of general regulations, registration and certification procedures and fees. This information is also available online.

For the latest updates on our publications and details of how to obtain them and other City & Guilds resources, please refer to the City & Guilds website.

City & Guilds websites

Website	Address	Purpose and content
City & Guilds main website	www.cityandguilds.com	This is the main website for finding out about the City & Guilds group, accessing qualification information and publications. For access to the Higher Professional Diploma in Building Services Engineering web page, type into the web browser the following 'URL' www.cityandguilds.com/uk/centres/constructionandbuilding then click on and follow the 'Electrical installation' or 'Plumbing' link.
Walled Garden	www.walled-garden.com	The Walled Garden is a qualification administration portal for approved centres, enabling them to register candidates and claim certification online.

Contacting City & Guilds by e-mail

The following e-mail addresses give direct access to our Customer Relations team.

e-mail	Query types
<hr/> learnersupport@cityandguilds.com	all learner enquiries, including <ul style="list-style-type: none">• requesting a replacement certificate• information about our qualification• finding a centre. <hr/>
<hr/> centresupport@cityandguilds.com	all centre enquiries
<hr/> walledgarden@cityandguilds.com	all enquiries relating to the Walled Garden, including <ul style="list-style-type: none">• setting up an account• resetting passwords.

3 Candidate entry and progression

Candidate entry requirements

City & Guilds Higher Level Qualifications have been designed primarily for those in work, or with access to work experience as the specifications are vocationally relevant to the needs of the sector. In addition, given the high level of understanding and skills required of the qualification, it is likely that in order for prospective candidates to cope with the demands of the programme and achieve their full potential, they will have acquired one of the following:

- City & Guilds Progression Award in the Building Services Engineering sector at Level 3
- Other Level 3 vocational qualification in the area of Building Services engineering
- a level of expertise commensurate with Level 3 in the National Qualifications Framework which has been acquired through work experience and can be demonstrated through the City & Guilds APL procedure and/or appropriate certification.

Please note that for funding purposes, candidates should not be entered for a qualification of the same type, content and level as that of a qualification they already hold. (Information on Funding, is provided in the Appendices.)

Age restrictions and legal considerations

This qualification is not approved for use by candidates under the age of 19, and City & Guilds cannot accept any registrations for candidates in this age group.

Progression

The qualification provides knowledge and practical skills related to the Higher Level Summit Skills Occupational Standards.

The qualification provides a strong foundation for career progression to Senior Technician status within the Building Services Engineering sector. It could also form the first part (120 credits) of a related Foundation Degree programme and, as such, provides a possible first year exit or second year entry point qualification.

On completion of this qualification candidates may progress into employment or to the following City & Guilds qualifications:

- Level 5 Certificate in Engineering (Engineering Council)
- Level 6 Graduate Diploma in Engineering (Engineering Council)
- Level 7 Post-Graduate Diploma in Engineering (Engineering Council)

Further Progression with City & Guilds and the Institute of Leadership and Management

In addition, achieving a City & Guilds Higher Level Qualification provides the opportunity to also gain a Senior Award from City & Guilds and/or a grade of membership from the Institute of Leadership & Management.

Senior Awards are available at three levels and are offered under City & Guilds Royal Charter. They recognise a combination of academic achievement and vocational skills

The Institute of Leadership & Management (ILM) is part of the City & Guilds Group. It is a professional body dedicated to raising leadership and management capability through qualifications, learning support, publishing and membership services across all sectors and at all levels.

Higher Level Qualification	Senior Award	ILM Membership grade
Master Professional Diploma + 10 yrs management experience	Membership (MCGI) in Management (Masters Degree level)	ILM Fellow (FInstLM)
Master Professional Diploma + 5 yrs management experience	Graduateship (GCGI) in Management (Honours Degree level)	ILM Fellow (FInstLM) or ILM Member (MInstLM)
Higher Professional Diploma + 5 yrs vocational experience	Licentiatehip (LCGI) in Management (Foundation Degree level)	ILM Member (MInstLM)

In order to gain the relevant Senior Award you will need to submit a copy of your Higher Level Qualification certificate, full CV and an endorsement of your vocational experience from a senior manager. All Senior Award holders receive a diploma, post nominal letters, and the opportunity to attend the yearly graduation ceremony.

If you would like more details please contact Senior Awards on 0207 294 8220, email senior@cityandguilds.com, or write to us at City & Guilds, 1 Giltspur Street, London, EC1A 9DD.

For more information about gaining ILM membership or any other ILM services please contact the membership team on 01523 251346 or email membership@i-l-m.com

4 Centre requirements

4.1 Obtaining centre and qualification approval

Centres not yet approved by City & Guilds

To offer this qualification, new centres will need to gain both **centre and qualification approval**. Please refer to Appendix 3 for further information.

Existing City & Guilds centres

To offer this qualification, centres already approved to deliver City & Guilds qualifications will need to gain **qualification approval**. Please refer to Appendix 3 for further information.

4 Centre requirements

4.2 Staff requirements

Staff delivering the qualifications

To meet the quality assurance criteria for this qualification, the centre must ensure that the following internal roles are undertaken:

- quality assurance co-ordinator
- tutor
- assessor.

It is important that centre staff involved in delivery, assessment, and internal moderation have appropriate knowledge and skills to ensure effective provision of Higher Level Qualifications. It is a requirement that centre staff have one or more of the following:

- Level 4/5/6/7 qualification eg Degree/HNC/HND/HPD or MPD/NVQ in an appropriate subject with 3 years relevant sector experience

or

- Level 3 qualification in an appropriate subject with 5 years relevant sector experience at senior/managerial level

or

- 7 years proven experience in the sector at a managerial/senior level which could include recognised professional practice at a high level eg running a sector-related business or consultancy. (In certain circumstances this may be negotiable on discussion with the external moderator).

and

- A Cert Ed/equivalent teaching qualification and/or 2 years teaching/training experience

While the Assessor/Verifier (A/V) units are valued as qualifications for centre staff, they are not currently a requirement for the qualification.

Please note: Centre staff may undertake more than one role eg tutor and assessor but must never internally moderate their own assessments.

If additional experts (eg workplace practitioners) involved in the delivery of the programme do not have the necessary teaching qualifications or experience, it is necessary for any assessment they undertake to be second-marked by a qualified member of staff and form part of the internal moderation process.

Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge of the occupational area and of best practice in delivery, mentoring, training, assessment and moderation remains current, and takes account of any national or legislative developments.

4 Centre requirements

4.3 City & Guilds registration and certification

Administration

Full details of City & Guilds' administrative procedures for this qualification are provided in the *Online Catalogue*. This information includes details on:

- registration procedures
- enrolment numbers
- fees
- claiming certification.

Centres should be aware of time constraints regarding the registration and certification periods for the qualification, as specified in the City & Guilds *Online Catalogue*.

Centres should follow all administrative guidance carefully, particularly noting that fees, registration and certification end dates for the qualification are subject to change.

Please note that the centre should ensure that candidates are registered for this qualification with City & Guilds **within 12 weeks** of enrolling at the centre. The external moderator will be unable to check any evidence from a candidate that has not been registered with City & Guilds for the qualification.

Please also note that final results for the qualification should not be submitted until they have been agreed by the external moderator.

Retaining assessment records

Centres must retain copies of candidate assessment records for at least three years after certification.

Notification of results

After completion of assessment, candidates will receive, via their centre, a 'notification of candidate results', giving details of how they performed. It is not a certificate of achievement.

Certificate of unit credit (CUC)

A certificate of unit credit records the successful completion of a unit. Centres can apply for CUCs on behalf of a candidate at any time after they have achieved the unit. They do not need to wait until the full programme of study has been completed.

Full certificates

Full certificates are only issued to candidates who have met the full requirements of the qualifications, as described in section 2.3 'The structure of the qualification'.

4 Centre requirements

4.4 Quality assurance

This information is a summary of quality assurance requirements.

Providing City & Guilds qualifications and in the *Centre toolkit* provide full details and guidance on:

- internal quality assurance
- external quality assurance
- roles and responsibilities of quality assurance staff.

Internal quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of Higher Level Qualifications.

Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance, and City & Guilds is responsible for external quality assurance.

It is expected that the centre will appoint a Qualification Co-ordinator/Internal Moderator who will ensure that assessment is subject to a suitable and agreed system of internal moderation. The following roles are key to successful implementation and assessment of these qualifications.

The role of the Qualification Co-ordinator/Internal Moderator is to:

- liaise with City & Guilds (including completion of Form APU - Approval Update - to notify City & Guilds of any change in details previously provided)
- ensure that all staff are appropriately qualified to deliver and assess the qualification (see section 4.2 'Staff requirements')
- plan and manage the implementation of the qualification
- ensure there are adequate resources – both staff and materials
- keep staff members who are involved in the delivery of the qualification informed of any changes to the qualification documentation made by City & Guilds
- establish and monitor candidate support systems
- ensure all staff carrying out assessment are familiar with and understand the specifications and assessment requirements
- discuss and ensure the implementation of any action agreed with the external moderator as a result of the outcomes of the approval or any subsequent visits
- ensure that assignments and candidate evidence are available and clearly organised and accessible for the external moderator
- ensure that all City & Guilds documentation is completed when required
- manage the internal moderation process within the centre
- ensure that there is consistent interpretation of the requirements through standardisation procedures and meetings
- ensure that policies for equal opportunities, complaints and appeals are effectively operated
- provide feedback or relevant documentation relating to standardisation procedures to the external moderator.

The **internal moderation** process should provide a sampled check of all aspects of the assessment process and should take account of:

- all candidates for each student group
- all tutors
- all assignments
- all forms of assessed work
- all grades of performance.

In addition, confidence in the validity, reliability, sufficiency and authenticity of the centre's assessment practice must be established by these internal checks. Consequently, they must show that work assessed as satisfactory or better is:

- the candidate's own work
- sufficient and appropriate to meet the requirements of the specification
- at the correct level
- free from assessor bias.

One of the strategies to be included in internal moderation is double marking of a representative sample of candidates for each assignment.

The role of the Tutor is to:

- ensure that each candidate is fully briefed on the characteristics of this qualification (eg approach to assignments, delivery, grading etc)
- design assignments according to City & Guilds requirements which provide opportunities for the assessment requirements and, where applicable, the grading criteria to be met
- assess the extent to which the candidate's work contains evidence demonstrating that the assessment requirements have been met
- exercise judgement on claims for Accreditation of Prior Learning (APL), as appropriate
- provide each candidate with prompt, accurate and constructive written feedback
- keep accurate and legible records
- assist in the centre's internal moderation by carrying out double marking, as required
- meet with the qualification co-ordinator and other tutors to monitor, agree and maintain standards.

External quality assurance

External quality assurance for the qualification will be provided by City & Guilds external moderation process.

City & Guilds appoints a subject-specific External Moderator to approve centres to run the qualification, to monitor the assessment and internal quality assurance carried out by centres, and provide advice and guidance. External moderation is carried out to ensure that assessment is valid and reliable, that there is good assessment practice in centres, and confirm results, as appropriate.

To carry out their quality assurance role, external moderators must have appropriate occupational and verifying/moderating knowledge and expertise. City & Guilds external moderators attend training and development designed to keep them up-to-date, facilitate standardisation between moderators and share good practice.

When carrying out monitoring visits and external moderation visits, the External Moderator will carry out checks to ensure the following:

- continued compliance with centre approval criteria
- effective qualification co-ordination
- effective internal quality assurance systems by sampling assessment activities, methods and records
- consistent interpretation of the specified standards
- appropriate and accurate grading of the completing candidates
- centre documentation meets the specified requirements
- effective appeals, complaints and equal opportunities provision.

The role of the External Moderator in relation to assessment is to ensure that:

- the assignments set by the centre are relevant, meet the specifications and are at the correct level
- centres interpret assessment standards fairly, consistently and accurately
- centres are following the assessment specifications published by City & Guilds
- centre documentation meets the requirements of City & Guilds
- judgements on APL are fair, consistent and appropriate
- centres carry out internal moderation of candidate work .

The External Moderator will:

- independently assess a piece of work from every candidate, against the specifications, and provide feedback
- sample and confirm grading decisions

and will require to see:

- a record of all units completed by candidates
- the assignments (including any candidate guidance and marking criteria) and internally assessed work by all candidates for whom the centre intends to seek certification
- a record of tutors showing their teaching/assessment responsibilities for the units
- evidence of internal moderation and standardisation procedures.

5 Course design and delivery

Initial assessment and induction

Centres will need to make an initial assessment of each candidate prior to the start of their programme to ensure they are entered for an appropriate type and level of qualification.

During the initial assessment, tutors/lecturers are likely to consider what, if any

- previous educational qualifications the candidates have, what training they have had and in particular what experience they have had in relevant vocational programmes and Key Skills
- previous and current practical work experience the candidate has which is relevant to the aims of the qualification and from which relevant skills and knowledge may have been informally acquired.

The initial assessment should also identify any specific training needs the candidate has, and the support and guidance they may require when working towards their qualification.

City & Guilds recommends that centres provide an induction programme to ensure the candidate fully understands the requirements of the qualification they will work towards, their responsibilities as a candidate, and the responsibilities of the centre. It may be helpful to record the information on a learning contract.

Effective communication between the tutor and candidate is a key component of successful delivery. It is important that candidates know for each assignment or activity, its purpose, the knowledge and skills required and the criteria for success. In addition, candidates should receive regular constructive feedback on their progress and achievement and also be provided with the opportunity to provide comments on their progress and course from their own personal perspective.

Some centres use a 'self-directed study' or 'negotiated approach' in terms of assignment design to enable candidates to tailor their response to a particular work opportunity or scenario. Tutors meet with candidates individually to discuss the learning outcomes of the unit and negotiate assignments which will allow the achievement of the criteria and relate to the candidate's work context or experience. Centres have the flexibility to work with candidates in terms of the context of the assignment or the presentation format of the assessment, as long as the specified requirements are met.

Consideration should be given regarding **candidate access to certification for the Higher Level Qualification**. In cases where the HLQ is the first part of a Foundation (or Honours) Degree, the candidate must be made aware of and enabled to gain City & Guilds certification for the HLQ part of the award.

Recommended delivery strategies

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

As long as the assessment requirements of units within the Higher Level Qualifications are met tutors/lecturers can design courses of study to meet the needs of their candidates as individuals.

Learning and support resources

The qualification specification includes suggested resources for each unit. Please see the Guidance section of each unit for a detailed list.

Academic integrity and plagiarism

On undertaking the Higher Professional Diploma, candidates will be developing professional skills and values which are sought by employers. In order to develop the skills which are essential in the longer term for personal and academic growth, academic integrity must be maintained.

Academic integrity involves candidates conducting all aspects of their learning in a professional manner, including:

- taking responsibility for their own work
- respecting the rights of other scholars
- fully acknowledging the work of others wherever it has contributed to their own (thereby avoiding plagiarism)
- ensuring that their own work is reported honestly
- maintaining the standards of conduct which are appropriate to a skilled practitioner in a professionally-recognised vocational programme
- avoiding actions which seek to give them an unfair advantage over others.

Plagiarism (copying others work without acknowledgement) is a prime example of a candidate failing to act with academic integrity.

Centres delivering the Higher Professional Diploma in Building Services Engineering need to ensure that their quality assurance procedures incorporate a plagiarism policy. Centres should maintain a record system which flags up suspected breaches of academic integrity for an individual. This will assist the centre in improving its staff training for recognising and dealing with breaches of academic integrity.

Legislative changes

Please note that while legislative details referred to within this qualification were correct at the time of going to print, centres should check for and incorporate any subsequent changes to legislation when delivering units.

Health and safety

The requirement to follow safe working practices is an integral part of all City & Guilds qualifications and assessments, and it is the responsibility of centres to ensure that all relevant health and safety requirements are in place before candidates start the programme.

Should a candidate fail to follow health and safety practice and procedures relating to the learning and assessment of the programme, the candidate should be alerted to and advised on this. In case of any doubt, guidance should be sought from the external moderator.

Data protection and confidentiality

Data protection and confidentiality must not be overlooked when planning the delivery of this qualification.

Centres offering this qualification may need to provide City & Guilds with personal data for staff and candidates. Guidance on data protection and the obligations of City & Guilds and centres are explained in *Providing City & Guilds qualifications*.

Equal opportunities

It is a requirement of centre approval that centres have an equal opportunities policy (see *Providing City & Guilds qualifications*).

The regulatory authorities require City & Guilds to monitor centres to ensure that equal opportunity policies are being followed.

The City & Guilds equal opportunities policy is set out on the City & Guilds website, in *Providing City & Guilds qualifications*, in the *Directory of qualifications*, and is also available from the City & Guilds Customer Relations department.

Access to qualifications on the National Qualifications Framework is open to all, irrespective of gender, race, creed, age or special needs. The centre co-ordinator should ensure that no candidate is subject to unfair discrimination on any ground in relation to access to assessment and the fairness of the assessment.

Access to assessment

City & Guilds' *Access to assessment and qualifications guidance and regulations* document is available on the City & Guilds website. It provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

Appeals

Centres must have their own, auditable, appeals procedure that must be explained to candidates during their induction. Appeals must be fully documented by the quality assurance co-ordinator and made available to the external moderator or City & Guilds.

Further information on appeals is given in *Providing City & Guilds qualifications*. There is also information on appeals for centres and learners on the City & Guilds website or available from the Customer Relations department.

6 Relationship to other qualifications and the wider curriculum

Links to National Occupational Standards and N/SVQs

City & Guilds has identified the connections to linked N/SVQs and National Occupational Standards. This mapping is provided as guidance and suggests areas of overlap and commonality between the qualifications. It does not imply that candidates completing units in one qualification are automatically covering all of the content of the qualifications listed in the mapping.

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications. For example, a qualification may provide knowledge towards an N/SVQ, but centres are responsible for ensuring that the candidate has met all of the knowledge requirements specified in the N/SVQ standards.

This qualification has connections to the

- The Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Links with the relevant NOS can be found in the Guidance section of each unit, and mapped in detail in Appendix 4.

Key skills (England, Wales and Northern Ireland)

This qualification includes opportunities to develop and practise many of the underlying skills and techniques described in Part A of the standard for each key skills qualification. Where candidates are working towards any key skills alongside this qualification they will need to be registered with City & Guilds for the key skills qualifications.

It should not be assumed that candidates will necessarily be competent in, or able to produce evidence for, the key skills at the same level as this [these] qualification[s].

- Key Skills signposting can be found in the Guidance section of each unit

The wider curriculum

City & Guilds recommends centres address the wider curriculum, where appropriate, when designing and delivering the course.

7 Assessment

7.1 Summary of assessment requirements

Assessment is by means of assignments which provide the opportunity for the assessment requirements of the unit to be achieved. Centres must ensure that assignments relate to the assessment requirements and learning outcomes set out in the unit. To guide centres, the assessment section of each unit suggests how the outcomes could be assessed. For further guidance on assignment design, please refer to section 6.2 'Guidance on assignment design'.

Assessment must reflect the achievement of the candidate in fulfilling the assessment requirements which are related to a consistent national standard. The assessment must therefore be carried out by competent and impartial tutors/assessors and by methods which enable them to assess a student fairly against the set requirements. This process will be monitored by the appointment to each centre of a City & Guilds external moderator who will be responsible for upholding the subject standards to a national level.

Assignment design should take account of opportunities for the Merit and Distinction criteria to be met for those candidates with the potential to achieve a higher grade. For instance, the grading descriptors (please refer to section 6.3 'Grading and marking') reflect the need for candidates to carry out research with increasing degrees of independence and also to take more responsibility for the learning process.

It is important for centres to use an **integrated approach** (ie content which links effectively across two or more units) in relation to at least one assignment. Please see section 6.2 'Guidance on assignment design' for further guidance on integrated assignments.

Assignments (including any candidate guidance and marking criteria) together with candidate evidence must be available for checking by the Higher Level Qualifications external moderator.

Centres must design a selection of assignments **prior to the start of the course**, so that there is an opportunity to obtain some feedback on their suitability from the Higher Level Qualifications external moderator.

In all cases the assessment tools proposed by the centres should take account not only of the intended outcomes of the unit but also of the particular needs, interests and commercial concerns of the candidates themselves and their supporting organisations.

7 Assessment

7.2 Guidance on assignment design

Designing assignments

The purpose of an assignment is to provide candidates with the opportunity to produce work which demonstrates that they have gained the knowledge and skills detailed in the learning outcomes.

Assignments may focus on either a single unit or more than one unit where there are common themes across some of the units.

It is important for centres to use an **integrated approach** (ie content which links across two or more units) in relation to at least one assignment.

There are many opportunities within the HPD in Building Services Engineering to carry out integrated assessments. For example, the optional units for both pathways can be integrated into the core technical units. The mandatory units, Unit 1: Health and safety legislation and Unit 2: Applying CAD and ICT in building services engineering, can also be integrated with the technical units. Both the Electrotechnical and Mechanical Engineering Services Project Design and Management units can be linked with all other units for an integrated assessment.

Where it is not possible or practical to cover all of the assessment requirements for each unit linked to the integrated assignment, it will be necessary for candidates to complete additional 'mini' assignments or 'top-up' activities to ensure that all the requirements have been met.

The approach to marking/assessing integrated assignments should enable an individual grade to be allocated to each unit covered, for the purposes of grading calculations.

Regardless of whether the assignment is based on an individual unit or an integrated selection of units, complete familiarity with the specification requirements will allow both tutors and candidates to identify relevant opportunities, content, and topics which can facilitate the development of work-related and challenging assignments. Specifically, the assessment and guidance section of the specifications should be used to generate ideas about possible approaches to assignment design.

In most units the assessment section is quite detailed and provides a strong basis for an assignment. In these cases, the main focus is likely to be on providing further background or a scenario to place the assignment into a meaningful context with a clear vocationally-related purpose. In addition, it is probable that centres will wish to present the assignment in a user-friendly manner for candidates, eg addressing the candidate in the second person, using a different font-size. Other units in the specifications have a less detailed assessment section which provides more scope for centres and candidates to tailor assignments to their specific work roles and experience, bearing in mind the need for the unit outcomes to be met. Although a particular form of assessment may be identified in the assessment section of the unit eg a report, it is possible to select an alternative approach such as a case-study or presentation, as long as candidates produce evidence of comparable quantity and quality and meet the same outcomes.

To aid manageability and clarity, the assignment may be broken down into activities or tasks which relate to each other so that the overall assignment is coherent. In addition, assignments should be vocationally-relevant, realistic and motivating. It is important that each assignment brief provides the following information:

- the purpose of the brief or rationale for the assignment
- intended context
- knowledge and skills to be demonstrated
- the criteria for success.

Assignment design should take account of those candidates who have the potential to achieve a higher grade to meet the Merit and Distinction criteria. For instance, the grading descriptors reflect the need for candidates to carry out research with increasing degrees of independence, apply work-related skills, knowledge and understanding effectively and analyse and reflect on ideas and actions. There should therefore be opportunities for candidates to respond to their assignments in this way.

Assignments can be completed in any order. However, centres will be expected to sequence assignments logically according to the requirements of the candidates, the course, and resources within the centre.

Opportunities for repeating assignments

At this level candidates should be encouraged to take a proactive role in their own self assessment and be encouraged to match their work to the unit requirements. This should be supplemented with tutor feedback on performance. As part of this process, if candidates have not been successful in the assignment, there should be discussion and illustration of why they were not successful. If a candidate is then able to attempt the assignment again and meet the criteria independently, a pass can be achieved.

Safe working

The importance of safe working practices must always be stressed. Candidates have responsibilities for the safety of others as well as themselves. A candidate cannot be allowed to continue working on an assignment if they have contravened health and safety requirements. To complete the unit, the candidate will be allowed to recommence on a different occasion and tutors will closely monitor the achievement of the safety aspects.

Permission & confidentiality

Candidates may need to maintain confidentiality in the use of business data by 'anonymising' sensitive information.

Marking and grading of assignments

To confirm that an outcome is achieved, it is useful to identify the key points or key assignment indicators which one would expect to see in a candidate's response. Reference should be made to the unit content of each outcome as well as the requirements of the brief/task to select the key points.

The content of the assignments and feedback to candidates should take into consideration the importance of

- a formative approach
- candidates being encouraged to reflect on building their achievements throughout the provision of the qualification, rather than only on the final outcome
- indicating clearly and supportively to candidates on a regular basis any gaps there might be in the sufficiency and level of achieving the outcomes.

In order for candidates to achieve a Pass, it is necessary for them to complete all parts of the assignment and produce evidence which clearly shows that the outcomes have been met. The overall quality of the work must be of a satisfactory and reliable standard.

The assignments should be graded: Pass, Merit or Distinction. Candidates who show greater degrees of autonomy in the ways in which they carry out research, approach and evaluate their work, or demonstrate originality and imagination will gain higher grades than those who work completely from tutor prepared material. Please refer to the 'The grading criteria', under section 6.3 'Grading and marking', for full grading descriptors.

Internal and external moderation of assignments

Please refer to the section 4.4 'Quality assurance' for information on how assignments are moderated.

7 Assessment

7.3 Grading and marking

Each unit will be graded with a Pass, Merit or Distinction. In order for candidates to achieve a **Pass**, it is necessary for them to produce evidence which clearly shows that all the assessment requirements (and therefore all the outcomes) have been met. In addition, the overall quality of the work should be of a satisfactory and reliable standard.

To gain a **Merit** grade, candidates will, in addition to meeting the Pass requirements, need to produce work which meets all of the criteria detailed in the Merit section below. To gain a **Distinction** grade, candidates will need to meet both the Pass and Merit requirements and produce a high standard of work as reflected in the Distinction section below.

The criteria for Merit and Distinction focus on the quality of the work, and the way in which candidates have approached it. The criteria have been written to specify the requirements in terms of 'better' (not 'more') work.

The Grading Criteria

Unit grades

Each unit within the qualification should be graded on the following basis:

Pass: Candidates must meet the assessment requirements and outcomes in the unit specifications

Merit: Candidates must achieve a Pass and in addition achieve at least 14 marks from the Merit descriptors in the table below

Undertake research with minimum guidance from tutors/assessors (1) select and use a wide range of appropriate research resources (1) , record and analyse data/information accurately (1) to draw valid conclusions (1)	4 marks
Present and analyse information and ideas accurately and clearly (2) , using a well-structured format and appropriate technical language (2)	4 marks
Demonstrate effective and consistent application and development of work-related skills (2) knowledge and understanding (2)	4 marks
Demonstrate management of time, resources and learning (2) and an ability to analyse and reflect upon own ideas and actions (2)	4 marks

Distinction: Candidates must achieve a Merit and in addition achieve 16 marks from the Distinction descriptors in the table below

Define the focus and scope of research (1) , carry out research independently (1) , evaluate the suitability of research sources and methods used (1) , analyse and verify data/information (1) to develop an appropriate work strategy (1)	5 marks
Consolidate and present complex information and concepts fluently and persuasively (2) with evidence of an original and imaginative approach (2)	4 marks
Evaluate and synthesise relevant work-related skills, knowledge and understanding (2) and use these to justify conclusions and recommendations (2)	4 marks
Demonstrate consistently good management of time, resources and learning (2) and an ability to identify areas for development and improvement by critically reflecting upon own ideas and actions (2) , employ appropriate methods to resolve unpredictable problems (1)	5 marks

Calculating an overall grade for the qualification

Each unit grade achieved by the candidate should firstly be converted into points as follows:

Pass = 1 Merit = 2 Distinction = 3

The unit grade allocated to a double unit should be converted into point(s), as above, and then doubled.

The *points* should then be aggregated into an overall score and corresponding grade for the whole qualification as follows:

Pass = 12-17

Merit = 18-27

Distinction = 28-36

NB Achievement of **all** the designated units is necessary for the full award. It is therefore necessary for candidates to achieve a minimum of 1 point for each of the single units and 2 points for each of the double units.

8 Units

8.1 About the units

Availability of units

The units in this qualification may also be obtained from the Higher Professional Diploma in Building Services Engineering web page on the City & Guilds website.

Structure of units

As far as possible the units have been expressed in a standard format which fits with QCA Design Principles for Higher Level Vocational Qualifications.

Each unit comprises:

- Unit title
- Unit summary
- Aims
- Learning outcomes – statements of what the candidate is expected to achieve
- Unit content – specifies all the learning the candidates need to apply and draw upon in order to be able to produce evidence indicated in the assessment section which addresses outcomes. In addition, it provides guidance to tutors in the design of their programmes and can be used as a diagnostic tool to identify areas of weakness when candidates have not been able to achieve outcomes
- Suggested assessment approach– suggests how candidates could be assessed to show that they have met the outcomes. A form of evidence, eg a report, is indicated in this section, but different forms of evidence such as a case-study, presentation or a piece of practical work accompanied by appropriate research and information gathering activity are valid as long as they provide the opportunity for candidates to produce evidence of comparable quantity and quality and to meet the same outcomes
- Guidance – on delivery, links with other units/qualifications, resources. Guidance also on Key Skills signposting – suggestions on where evidence could contribute to the Key Skills of Communication, Application of Number, Information Technology, Improving own Learning and Performance, Working with Others, and Problem-Solving at Level 4.

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8 Units

8.2 The units

- Unit 1: Health and safety legislation
- Unit 2: Applying CAD and ICT in building services engineering projects
- Unit 3: Electrotechnical project design and management (Double unit)
- Unit 4: Electrotechnical principles
- Unit 5: Mechanical engineering services project design and management (Double unit)
- Unit 6: Mechanical engineering principles
- Unit 7: Science for electrical installation
- Unit 8: Electrical installation technology
- Unit 9: Electrotechnical services, installation and systems
- Unit 10: Electrical supply and distribution
- Unit 11: Space heating technology and design
- Unit 12: Hot water technology and design
- Unit 13: Cold water technology and design
- Unit 14: Sanitation and drainage technology and design
- Unit 15: Air conditioning and ventilation technology and design
- Unit 16: Heating and ventilating systems technology and design
- Unit 17: Mathematics for building services engineers
- Unit 18: Planning work methods, workforce and resource requirements for building service engineering projects
- Unit 19: Contract procedures and requirements for building services engineering projects
- Unit 20: Estimating and tendering for building service engineering projects
- Unit 21: Financial management of building services engineering projects
- Unit 22: Managing resources for building services engineering projects
- Unit 23: Planning building engineering services projects
- Unit 24: Using materials technology in building services engineering
- Unit 25: Electrotechnical sustainability

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Unit 1 Health and safety legislation

Overview

Unit summary

This unit is about health and safety, welfare and risk assessment as they are defined by the relevant Health, Safety and Welfare legislation. It also includes the requirements set down in the various construction regulations as they apply to the candidate's work. As managers, candidates will need this knowledge to enable them to plan and execute site work in a safe manner which complies with all relevant legislation.

The unit is an opportunity for the candidate to consolidate and fully understand the health and safety requirements and their implementation on site. The requirement for the key skill of communication in implementing the unit needs should also be noted. The unit relies on the candidate's ability and commitment to undertake research of the Regulations and to carry out the relevant report writing in addition to the formal hours allocated.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and learning outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- appreciate the importance of health and safety in the construction process
- be aware of legislation and the regulations which govern the approach to the health, safety and welfare of people who may be affected by the work
- reduce the construction and other risks to health, safety and welfare which occur on sites
- be aware of some of the principal Acts of Parliament which cover health, safety and welfare in the construction industry
- understand the requirements of relevant construction regulations, particularly the Construction Design and Management (CDM) Regulations (2007) and the Construction (Health, Safety and Welfare) Regulations 1996
- ensure that the construction work is arranged properly and maintained at all times in a manner which complies with the law and the regulations
- monitor the work to ensure health and safety is being properly considered
- use feedback from the monitoring process to improve the level of health, safety and welfare on the construction site.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Ensure that the work complies with the relevant construction regulations
2. Put in place health, safety and welfare arrangements which are consistent with all requirements and ensure that people are aware of these arrangements
3. Use appropriate risk assessment procedures to minimise risk on site and apply the results and demonstrate an awareness of the risk assessment process
4. Ensure that statutory and hazard warning notices are displayed as necessary and health and safety information is fully available
5. Confirm that the regulations concerning first aid provision are fully and correctly implemented
6. Ensure that plant, equipment, systems of work and other resources available on site comply fully with health and safety legislation
7. Verify that all systems are monitored regularly as required by the statutory legislation and areas of failure are noted and then rectified.

Unit 1 Health and safety legislation

Unit content

Outcome 1: Ensure that the work complies with the relevant construction regulations

The candidate knows how to:

- apply the construction regulations relevant to the work he/she undertakes
- refer items of the work to relevant legislation
 - Construction Design and Management (CDM) Regulations (2007)
 - Construction (Health, Safety and Welfare) Regulations 1996
- ensure that work procedures comply with the relevant construction regulations
 - Approved Code of Practice (ACoP) Managing Health and Safety in Construction,

Outcome 2: Put in place health, safety and welfare arrangements which are consistent with all requirements and ensure that people are aware of these arrangements

The candidate knows how to:

- assess the requirements for health, safety and welfare which are consistent with requirements of the organisation, the contract, and legislation
 - Management of Health and Safety at Work Regulations 1999
- prepare a simple Safety Plan for the on site phase of the work
- delegate responsibility for health and safety as necessary
 - role of health and safety advisor
 - role of health and safety officer
 - role of health and safety representative
- ensure that everyone whose health and safety is affected by the work is fully aware of the situation. This includes the general public and others not directly concerned with the work (visitors, for example).

Outcome 3: Use appropriate risk assessment procedures to minimise risk on site

The candidate knows how to carry out the risk assessment process, including:

- identifying hazards which exist on a site. These may be detailed in the pre-tender health and safety plan or established by practical experience of the work process
- preparing risk assessments on the hazards
 - Management of Health and Safety at Work Regulations 1999
 - Control Of Substances Hazardous to Health (COSHH) Regulations 2002
- eliminating or reducing hazards where appropriate
- alerting those concerned to any remaining hazard.

Outcome 4: Ensure that statutory and hazard warning notices are displayed as necessary and health and safety information is fully available

The candidate knows how to:

- prepare requirements for the display of statutory notices
 - Health and Safety – what you should know
 - Employer liability insurance certificate
- display relevant hazard warnings
- provide the health and safety information to all who may be affected

Outcome 5: Confirm that the regulations concerning first aid provision are fully and correctly implemented

The candidate knows how to

- apply the provisions of the Regulations in:
 - First aid at work. The Health and Safety (First-Aid) Regulations 1981
 - training of first aiders and the requirements for them
 - providing suitable first aid equipment
 - providing the requirement for standby first aiders
 - informing employees and others of what first aid arrangements are in place.

Outcome 6: Ensure that plant, equipment, systems of work and other resources available on site comply fully with health and safety legislation.

The candidate knows how to:

- ensure that plant and equipment provided is adequate for the job it is used for
- ensure that materials are properly stored and used in accordance with the manufacturers or suppliers instructions
- ensure that all staff are properly trained and competent to do the work expected of them
- provide induction and ongoing training
- meet the requirements of Provision and Use of Work Equipment Regulations (PUWER) 1988

Outcome 7: Verify that all systems are monitored regularly as required by the statutory legislation and areas of failure are noted and then rectified.

The candidate knows how to:

- ensure effective monitoring for health, safety and welfare
- report on the results of the monitoring procedures
- action any breaches of the health, safety and welfare arrangements
- meet the requirements of Safety Representatives and Safety Committees Regulations 1977

Unit 1 Health and safety legislation

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- a word processed report containing about 2000 words. The report will show the candidate's knowledge and understanding of health, safety and welfare matters as they apply to the work they carry out. The candidate should describe arrangements made on one contract referring specifically to the required outcomes of the unit.

Candidates should include evidence with the report which comes directly from a project.

Details from the regulations and data from the candidate's work experience are required. This may include organisational data in notes which refer to specific items in the Regulations.

Unit 1 Health and safety legislation

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Assessment must relate to current regulations which apply within the sector and should be practical and relate directly to the candidate's experience.

Candidates should be encouraged to demonstrate as wide a level of ability as they can and to show some detailed knowledge which is taken directly from the various regulations.

Where appropriate the relevant Acts of Parliament, codes of practice or other regulations should be quoted. Safe working methods and the safety precautions which were implemented should be stated.

The project chosen for the report, and the outlines of items to be included, should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and carry out their reports independently.

Suggested resources list

Griffith A. and Howarth T. *Construction health and safety management*. Longman. 2001

Health and Safety Executive. *Managing health and safety in construction: approved code of practice and guidance: Construction (Design and Management) Regulations 1994*. HSE Books. 2001

Websites:

www.citb.org.uk

www.ciob.org.uk

www.hse.gov.uk

www.hse.gov.uk/publications/conindex.htm

This last web site offers an excellent range of leaflets and information on construction health and safety.

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Unit 2

Applying Computer Aided Design (CAD) and ICT in building services engineering projects

Overview

Unit summary

The advance in the scope and use of information technology has led, among many other things, to an increase in computer aided design (CAD). It is important that designers are able to use the relevant CAD system. To do this effectively designers need to know the capabilities of the system, what it can and cannot do. Designers also need specialist training to use the system effectively and must have the capability of carrying out the design process independently.

This unit gives an opportunity for candidates to improve their understanding of the CAD process (how it works, what it can do and what it cannot do).

The unit relies on the candidate's ability and commitment to undertake an element of design and report writing in addition to the formal hours allocated to the unit.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and learning outcomes, and producing work of a satisfactory and reliable standard.

Aims

This unit aims to enable the candidate to know:

- how CAD works
- what CAD can do
- what CAD cannot do
- the advantages of CAD
- the disadvantages of CAD

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Appreciate the dangers and disadvantages of the CAD system
2. Appreciate the advantages of the CAD system
3. Use a CAD system effectively

Unit 2

Applying Computer Aided Design (CAD) and ICT in building services engineering projects

Unit content

Outcome 1: Appreciate the dangers and disadvantages of the CAD system

The candidate knows:

- the CAD system only assists design. (It cannot carry out the design process itself).
- the accuracy of the CAD information output is only as accurate as the information inputted.
- CAD is not always appropriate at the initial design stage. It is more appropriate at the later stage when a full CAD compatible grid is available.
- specialised training in CAD use is required.
- CAD gives an illusion of greater operator accuracy than might be warranted (the quality of the output **looks** excellent).
- health and safety issues can arise with excessive CAD use (back strains and eyesight problems for example).
- drawings can be produced without a full appreciation by the design of the implications. (Designers must be able to design).
- CAD leads to greater specialisation in the designer team. (topographical surveys are usually carried out by experts for example)

Outcome 2: Appreciate the advantages of the CAD system

The candidate knows:

- neat, accurate and speedy drafting of drawings.
- the transfer of information between drawings. (CAD drawings can be e-mailed for example).
- putting all drawings of an area onto a common base. (This reduces the likelihood of inconsistencies between architect's and engineer's drawings for example).
- the ease of incorporating different construction trades onto the different drawings (service requirements onto an architect's detail for example).
- the ability to plot survey information automatically and in a manner suitable for forming the base for subsequent drawings.
- the carrying out of geometric calculations. (The co-ordinates of any point and the distance between points for example).

Outcome 3: Use a CAD system effectively

The candidate knows:

- draft accurately, neatly and quickly.
- transfer information accurately between drawings.
- put all relevant drawings onto a common base.
- plot survey information automatically.
- carry out geometric calculations.
- produce tidy drawings which are suitable for presentation.

Unit 2 Applying Computer Aided Design (CAD) and ICT in building services engineering projects

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A computer aided design of a project or an element of a project and which includes:
 - the relevant drawings
 - supporting notes prepared by the candidate
 - relevant calculations

and

- A word-processed report, of approximately 1500 words, which details how the CAD system used by the candidate works. The report should include the good and the bad points of CAD used and candidates must indicate a good grasp of the relevant knowledge.

Unit 2

Applying Computer Aided Design (CAD) and ICT in building services engineering projects

Guidance

Delivery advice

Assessment should be practical and relate directly to the candidate's experience. It should be based on the step-by-step actions which are taken in the CAD process. Candidates must show a proper knowledge of each step in the process.

The design chosen, and the outline of the items to be included in the accompanying report, should be agreed by appropriate staff prior to commencement.

All evidence should be the candidate's own work and candidates are expected to plan and prepare their reports independently.

Suggested resources list

The relevant design theory

The appropriate manufacturers' instructions for the computer hard and software

Unit 3 Electrotechnical project design and management

Overview

Unit summary

This unit enables a candidate to prepare a project brief and execute a building services engineering or building services engineering management project, adequate in scope and design content. The candidate will also be able to compile a report according to a recommended procedure consisting of title, contents, index, section headings, introduction, design, results conclusions, appendices, references, and bibliography. The use of Information and Communication Technology should be apparent in the presentation of the report in the form of spreadsheets, databases graphs etc where appropriate.

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements and Outcomes of the unit, and the production of work to a satisfactory standard.

This is a double unit and therefore equates to two units.

Aims

This unit aims to enable the candidate to:

- effectively apply knowledge gained to the investigation and solution of an engineering problem that requires some implementation of engineering design and solution evaluation
- compile a report to a required format.

Learning outcomes

On successful completion of this unit the candidate will be able to:

1. Select an building services engineering project of appropriate scope and content
2. Prepare a project brief
3. Execute a procedure for the solution of an engineering problem
4. Evaluate the outcomes of the building services engineering project
5. Produce a project report.

Unit 3 Electrotechnical project design and management

Unit content

Outcome 1: Select a building services engineering project of appropriate scope and content

The candidate knows how to:

- identify an appropriate engineering problem that will involve an element of design
- limit the scale of the problem to a realistic size in terms of time and quantity
- negotiate the proposed project with his or her tutor.

Outcome 2: Prepare a project brief

The candidate knows how to:

- compile a written proposal to a recommended format that includes a title for the project, table of contents, summary, appendices, references and bibliography as appropriate
- define the engineering problem
- state the objectives of the project
- examine options for the solution of the building services engineering problem
- explain the reasons for the proposed solution to the problem
- outline the techniques or method of realising the proposed solution
- state the expected time scales of implementation or project completion
- outline any potential improvements in efficiency arising from the implementation of the solution
- outline prospective costs of implementation of the project
- outline implications on safety.

Outcome 3: Execute a procedure for the solution of a building services engineering problem

The candidate knows how to:

- state the objective(s) to be achieved through the solution to the project problem
- utilise the appropriate design expertise to solve the project problem
- utilise data, calculations, graphs, simulations, charts, etc. where appropriate to produce and present project problem solutions
- communicate when necessary with the project supervisor for advice and Guidance.

Outcome 4: evaluate the outcomes of the building services engineering project

The candidate knows how to:

- critically appraise the project against the original objectives
- estimate design and possible implementation costs of the project
- state and estimate any safety improvements or efficiency savings resulting from the solution of the project problem.

Outcome 5: Prepare a project report

The candidate knows how to:

- compile a written project report to a recommended format that includes a title for the project, table of contents, index, section headings, summary, results, conclusions, appendices, list of references and bibliography.
- use Information and Communication Technology to word-process the report and incorporate the use spreadsheets and databases to present data as appropriate
- outline the scope and objectives of the project in the form of an introduction
- describe any design procedures with specimen calculations, charts, graphs or other data display forms
- state any recommendations and the degree to which the solution(s) arrived at meet or do not meet the original scope and objectives
- state any actual or estimated cost implications arising from the implementation of the project recommendations
- state any actual or expected cost savings or expenditure arising from implementation of the project solution(s)
- state any safety ramifications arising from the project solution(s)
- list any appendices, manufacturers' data, standards, etc. according to a recognised format
- list references and or bibliography as appropriate
- paginate and appropriately section the compiled document.

Unit 3 Electrotechnical project design and management

Suggested assessment approach

Assessment for this unit should be carried out in the context appropriate to the Electrotechnical pathway being undertaken by the candidate.

The following suggests how the outcomes of the unit could be assessed:

- A report of a minimum of 5000 words which incorporates:
 - a standard report format
 - use of appropriate IT skills
 - analysis and design
 - measurement, testing and data correlation as appropriate
 - costing, efficiency and safety appraisals.

Unit 3 Electrotechnical project design and management

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Communication

- C4.1 Develop a strategy for using communication skills over an extended period of time.
- C4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving at least one group discussion about a complex subject and one document of 1,000 words or more about a complex subject.
- C4.3 Evaluate your overall strategy and present the outcomes from your work, using at least one formal oral presentation. Include a variety of verbal, visual and other techniques to illustrate your points.

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Improving own Learning and Performance

- LP4.1 Develop a strategy for improving your own learning and performance.
- LP4.2 Monitor progress and adapt your strategy to improve your performance.
- LP4.3 Evaluate your strategy and present the outcomes of your learning.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Working with Others

- WO4.1 Develop a strategy for working with others.
- WO4.2 Monitor progress and adapt your strategy to achieve agreed objectives.
- WO4.3 Evaluate your strategy and present the outcomes from your work with others.

Links with other units/qualifications

The project should reflect the synthesis of knowledge gained and applied from the other units in the Level 4 Higher Professional Diploma in Building Services Engineering.

This unit also has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Where appropriate, reference should be made to relevant legislation, standards and industrial codes of practice.

The candidate should be encouraged to draw on personal occupational experience related to current industry practice where appropriate when completing this unit. Close contact should be maintained between candidate and project supervisor and it is preferable that a series of project progress reports are submitted at strategic intervals. The candidate should be encouraged to formulate a schedule of completion agreed with the project supervisor.

Candidates should have full access to a range of Information and Communication Technology, learning and reference resources. These include:

- Appropriate national standards
- Manufacturers' data sheets
- Suitably specified Personal Computer equipped with appropriate software packages
- Reference textbooks.

This unit would usually only be attempted in the latter half of the programme subsequent to the completion of the relevant technological units.

Suggested resources list

An extensive range of resource materials is available for students that would assist in the successful completion of this unit, examples of which include:

Engineering Project Guide, COLU, 2001

How to write reports in plain English, Plain English Campaign, 2000

Technical Report Writing, NASA, <http://ltdid.grc.nasa.gov/Publishing>, 2000

Report Writing, S Allender, Bracie, 1991.

Unit 4

Electrotechnical engineering principles

Overview

Unit summary

This unit is about providing the candidate with a sound knowledge of the electrotechnical principles required at a higher level for building services engineering technicians. The topics include the analysis of composite magnetic circuits, network theorems, complex notation and the analysis of a.c. circuits, first-order transients, two-port networks and an introduction to three-phase systems. The unit also provides a foundation for further study in more specialised areas of electrotechnical engineering.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and Outcomes and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to develop an underpinning knowledge and theory of electrotechnical principles that might be required in the study of electro-technology units of the Level 4 Building Services Engineering Programme.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Analyse series, parallel and series-parallel composite electromagnetic circuits
2. Apply Thévenin's and Norton's theorems to the solution of d.c. network problems
3. Apply complex notation to the analysis of single-phase series, parallel and series-parallel a.c. circuits
4. Analyse series, parallel and series-parallel RLC circuits
5. Analyse electrical systems when modelled as two-port networks
6. Analyse three-phase circuits
7. Investigate the transient response of first-order circuits

Unit 4 Electrotechnical engineering principles

Unit content

Outcome 1: Analyse series, parallel and series-parallel composite electromagnetic circuits

The candidate knows how to:

- explain the occurrence of coercivity, remanance and saturation in relation to the behaviour of a magnetic material undergoing cyclic magnetisation
- relate the shapes of the hysteresis loops of magnetically soft and hard materials to their application in magnetic and electromagnetic circuits
- calculate the reluctance of series and parallel magnetic circuits involving composite materials
- estimate the inductance of a magnetic circuit given the applied m.m.f., circuit dimensions and permeability
- solve problems relating to typical electromagnetic circuits.

Outcome 2: Apply Thévenin's and Norton's theorems to the solution of d.c. network problems

The candidate knows how to:

- solve problems involving d.c. networks by the application of Kirchhoff's current and voltage laws
- solve problems involving d.c. networks by the application of Thévenin's theorem
- solve problems involving d.c. networks by the application of Norton's theorem.

Outcome 3: Apply complex notation to the analysis of single-phase series, parallel and series-parallel a.c. circuits

The candidate knows how to:

- manipulate complex variables in addition, subtraction, multiplication and division using the method of complex conjugates
- convert between polar form and rectangular form
- represent series R, L and C circuits by complex impedance
- represent parallel R, L and C circuits by complex admittance
- calculate real and apparent power using the relationships $P = \text{Re}[VI^*]$; $Q = \text{Im}[VI^*]$.

Outcome 4: Analyse series, parallel and series-parallel RLC circuits

The candidate knows how to:

- represent series, parallel and series-parallel R, L and C circuits by phasor diagrams
- derive the condition for resonance of a series RLC circuit
- derive the condition for resonance of a parallel RL-C circuit (i.e. with a non-ideal inductor)
- plot the frequency responses of series and parallel tuned circuits
- solve problems of resonance involving Q-factor and dynamic impedance
- solve problems involving series, parallel and series-parallel R, L and C circuits
- solve problems relating to power-factor improvement.

Outcome 5: Analyse electrical systems when modelled as two-port networks

The candidate knows how to:

- define the parameters used in Z, Y and h-parameter models
- derive the input and output equations for the Z, Y and h-parameter models
- convert from one set of parameters to another
- solve problems involving low frequency, mid-band and high frequency gain of a two-port model capacitively coupled to a parallel RC load.

Outcome 6: Analyse three-phase circuits

The candidate knows how to:

- represent a three-phase system by phasor diagram
- solve problems involving line and phase values, power and power-factor improvement in balanced three-phase loads
- analyse and describe methods of three-phase power measurement for balanced and unbalanced systems

Outcome 7: Investigate the transient response of first-order circuits

The candidate knows how to:

- produce graphs of the growth and decay of transient voltages and currents in RL and RC circuits
solve problems relating to the time constant, rise-time, fall-time and steady state values of RL and RC circuits

Unit 4 Electrotechnical engineering principles

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of electrical engineering. The case studies should cover the following areas:
 - magnetic circuits
 - circuit theorems
 - complex notation, circuit analysis and series and parallel resonance
 - three phase circuits
 - two port networks
 - transient response of RC and RL circuits.

The above pieces of work should total approximately 2500 words.

Unit 4 Electrotechnical engineering principles

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Links with other units/qualifications

This unit is mandatory within the Electrotechnical pathway and as such provides the underpinning knowledge and theory of electrical principles that is required in many of the technology units of this programme. It will in particular be a prerequisite for the following units:

- Unit 5: Electrotechnical project design and management
- Unit 7: Science for electrical installation
- Unit 8: Electrical installation technology
- Unit 9: Electrotechnical services, installation and systems
- Unit 10: Electrical supply and distribution

Delivery advice

An integrative approach should be adopted using problems modelled on typical applications. The links between theory and engineering practice should be established wherever possible.

Candidates should be encouraged to give numerical answers to an appropriate accuracy for the application and also encouraged to develop a sound engineering judgement, enabling them to justify the use of approximations and assumptions in solving electrical engineering problems.

If possible the results of calculations and graphs should be confirmed by the use of an appropriate software package.

Access to circuit emulation and mathematics' software application packages is recommended.

Suggested resources list

An extensive range of textbooks and resource materials is available for students undertaking research in electrical engineering principles. These include:

Books:

Edward Hughes -*Electrical Technology*- (Longmans)

Robert L Boylestead - *Introductory Circuit Analysis* – (Merrill 1991)

Noel M Morris – *Electrical Principles 111*- (Macmillian)

Open Learning Text:

Electrical Engineering Principles - (COLU - 2001)

Websites:

www.ee.surrey.ac.uk/Workshop/advice/coils/

<http://users.cyberelectric.net.au/~rjandusimports/>

www.teleport.com/~jughead/electronics_school.htm

www.tpub.com/neets/index.htm

Unit 5 Mechanical engineering project design and management

Overview

Unit summary

This unit enables a candidate to prepare a project brief and execute a building services engineering or building services engineering management project, adequate in scope and design content. The candidate will also be able to compile a report according to a recommended procedure consisting of title, contents, index, section headings, introduction, design, results conclusions, appendices, references, and bibliography. The use of Information and Communication Technology should be apparent in the presentation of the report in the form of spreadsheets, databases graphs etc where appropriate.

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements and Outcomes of the unit, and the production of work to a satisfactory standard.

This is a double unit and therefore equates to two unit credits.

Aims

The unit aims to enable the candidate to:

- effectively apply knowledge gained to the investigation and solution of a building services engineering problem that requires some implementation of building services engineering design and solution evaluation
- compile a report to a required format.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Select an building services engineering project of appropriate scope and content
2. Prepare a project brief
3. Execute a procedure for the solution of a building services engineering problem
4. Evaluate the outcomes of the building services engineering project
5. Produce a project report

Unit 5 Mechanical engineering project design and management

Unit content

Outcome 1: Select a building services engineering project of appropriate scope and content

The candidate knows how to:

- identify an appropriate engineering problem that will involve an element of design
- limit the scale of the problem to a realistic size in terms of time and quantity
- negotiate the proposed project with his or her tutor

Outcome 2: Prepare a project brief

The candidate knows how to:

- compile a written proposal to a recommended format that includes a title for the project, table of contents, summary, appendices, references and bibliography as appropriate
- define the engineering problem
- state the objectives of the project
- examine options for the solution of the building services engineering problem
- explain the reasons for the proposed solution to the problem
- outline the techniques or method of realising the proposed solution
- state the expected time scales of implementation or project completion
- outline any potential improvements in efficiency arising from the implementation of the solution
- outline prospective costs of implementation of the project
- outline implications on safety

Outcome 3: Execute a procedure for the solution of a building services engineering problem

The candidate knows how to:

- state the objective(s) to be achieved through the solution to the project problem
- utilise the appropriate design expertise to solve the project problem
- utilise data, calculations, graphs, simulations, charts, etc where appropriate to produce and present project problem solutions
- communicate when necessary with the project supervisor for advice and guidance

Outcome 4: Evaluate the outcomes of the building services engineering project

The candidate knows how to:

- critically appraise the project against the original objectives
- estimate design and possible implementation costs of the project
- state and estimate any safety improvements or efficiency savings resulting from the solution of the project problem

Outcome 5: Produce a project report

The candidate knows how to:

- compile a written project report to a recommended format that includes a title for the project, table of contents, index, section headings, summary, results, conclusions, appendices, list of references and bibliography
- use Information and Communication Technology to word-process the report and incorporate the use spreadsheets and databases to present data as appropriate
- outline the scope and objectives of the project in the form of an introduction
- describe any design procedures with specimen calculations, charts, graphs or other data display forms
- state any recommendations and the degree to which the solution(s) arrived at meet or do not meet the original scope and objectives
- state any actual or estimated cost implications arising from the implementation of the project recommendations
- state any actual or expected cost savings or expenditure arising from implementation of the project solution(s)
- state any safety ramifications arising from the project solution(s)
- list any appendices, manufacturers' data, standards, etc. according to a recognised format
- list references and or bibliography as appropriate
- paginate and appropriately section the compiled document.

Unit 5 Mechanical engineering project design and management

Suggested assessment approach

Assessment for this unit should be carried out in the context appropriate to the Mechanical Engineering Services pathway being undertaken by the candidate.

The following suggests how the outcomes of the unit could be assessed:

- A report of a minimum of 5000 words, which incorporates:
 - a standard report format
 - use of appropriate IT skills
 - analysis and design
 - measurement, testing and data correlation as appropriate
 - costing, efficiency and safety appraisals.

Unit 5 Mechanical engineering project design and management

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Communication

- C4.1 Develop a strategy for using communication skills over an extended period of time.
- C4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving at least one group discussion about a complex subject and one document of 1,000 words or more about a complex subject.
- C4.3 Evaluate your overall strategy and present the outcomes from your work, using at least one formal oral presentation. Include a variety of verbal, visual and other techniques to illustrate your points.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Improving own Learning and Performance

- LP4.1 Develop a strategy for improving your own learning and performance.
- LP4.2 Monitor progress and adapt your strategy to improve your performance.
- LP4.3 Evaluate your strategy and present the outcomes of your learning.

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Working with Others

- WO4.1 Develop a strategy for working with others.
- WO4.2 Monitor progress and adapt your strategy to achieve agreed objectives.
- WO4.3 Evaluate your strategy and present the outcomes from your work with others.

Links with other units/qualifications

The project should reflect the synthesis of knowledge gained and applied from the other units within the Level 4 Higher Professional Diploma in Building Services Engineering.

This unit also has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Where appropriate, reference should be made to relevant legislation, standards and industrial codes of practice.

The candidate should be encouraged to draw on personal occupational experience related to current industry practice where appropriate when completing this unit. Close contact should be maintained between candidate and project supervisor and it is preferable that a series of project progress reports are submitted at strategic intervals. The candidate should be encouraged to formulate a schedule of completion agreed with the project supervisor.

This unit would usually only be attempted in the latter half of the programme subsequent to the completion of the relevant technological units.

Whilst not essential to the completion of the unit, access to the Internet and the use of a mathematics application package (such as Mathcad) could enhance candidates' understanding of the Unit content and the presentation of Assessment material.

Candidates must have access to tables of properties of saturated water and steam and superheated steam (commonly referred to as 'steam tables').

Suggested resources list

J.Hannah and M.J.Hillier, *Applied Mechanics*, Longman Higher Education (1995)

J.Hannah and M.J.Hillier, *Mechanical Engineering Science*, Longman Higher Education (1999)

W.Bolton, *Engineering Science*, Newnes (1998)

W.Bolton, *Higher Engineering Science*, Newnes (1999)

E.W.Nelson et al, *Schaum's Outline of Engineering Mechanics*, Schaum (1997)

G.F.C.Rogers, Y.R.Mayhew, *Thermodynamic and Transport Properties of Fluids*, Blackwell

Open Learning Text:

Mechanical Engineering Principles (COLU - 2001)

Unit 6

Mechanical engineering principles

Overview

Unit summary

This unit is about fundamental mechanical engineering principles and how to apply such principles in the description of building services engineering situations and to the solution of problems in statics, dynamics, work and power, thermodynamics and fluid dynamics.

Successful achievement of this unit is dependent upon the candidate meeting the assessment requirements relating to the outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

This unit aims to enable the candidate to:

- recognise mechanical engineering principles which are appropriate to a given situation
- select, combine and use building services engineering principles in the description of a given situation
- use appropriate building services engineering principles to solve problems
- interpret the significance of solutions to problems in terms of building services engineering principles.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Solve problems involving loaded beams
2. Solve problems involving thermal stresses
3. Solve problems involving power transmission
4. Apply dynamic principles to problems of rotation
5. Apply thermodynamic principles to simple fluid processes
6. Solve problems involving fluid dynamics.

Unit 6 Mechanical engineering principles

Unit content

Outcome 1: Solve problems involving loaded beams

The candidate knows how to:

- evaluate forces to maintain equilibrium
- calculate shear forces, bending moments and thrusts and draw shear force, bending moment and thrust diagrams for simply supported and cantilever beams carrying combined transverse point and uniformly distributed loads and for hinged beams carrying combined distributed and angular loads
- apply the bending formula in given situations
- use beam data to select a beam for a given loading.

Outcome 2: Solve problems involving thermal stresses

The candidate knows how to:

- calculate changes in length due to temperature changes
- calculate the magnitude and nature of stresses due to temperature changes.

Outcome 3: Solve problems involving power transmission

The candidate knows how to:

- use the torsion formula, $\frac{T}{J} = \frac{\theta}{r} = \frac{G}{l}$ to solve problems related to drive shafts
- use the formulae, $T = (F_1 - F_2)r$, $P = T \omega$, $P = (F_1 - F_2)v$ and $F_1/F_2 = \exp(\sin \alpha)$, to solve problems relating to power transmission by vee belt drives.

Outcome 4: Apply dynamic principles to problems of rotation

The candidate knows how to:

- solve problems relating to torque and kinetic energy of rotating masses
- solve problems involving the kinetic energy of rotation and translation
- solve problems using the conservation of linear and angular momentum
- solve problems of horizontal circular motion.

Outcome 5: Apply thermodynamic principles to simple fluid processes

The candidate knows how to:

- use tables of properties to determine values of internal energy, enthalpy and volume of steam
- determine the dryness fraction of wet steam
- use tables of properties to solve problems relating to changes in the properties of steam
- use the general energy equation to obtain values of energy and property changes when a fluid undergoes a process.

Outcome 6: Solve problems involving fluid dynamics

The candidate knows how to:

- use the continuity equation and Bernoulli's equation to solve problems of flow in pipes
- use the continuity equation, Newton's second law of motion and the conservation of momentum to solve problems of fluid flow in pipe bends and against perpendicular and oblique plates and curved vanes.

Unit 6 Mechanical engineering principles

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of electrical engineering. The case studies should cover the following areas:
 - the use of analytical and diagrammatic techniques in the solution of realistic beam problems and involving the selection of beam data from standard references
 - the effects of temperature on stress
 - the analysis of problems involving rotating machinery and belt drives
 - the application of the general energy equation and the use of steam tables in the investigation of energy and property changes involves in an industrially related process
 - the solution to practical problems encountered in the flow of fluids around pipe bends and against vanes.

The above pieces of work should total approximately 2500 words.

Unit 6 Mechanical engineering principles

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Problem Solving

- PS4.1 Develop a strategy for problem solving.

Links with other units/qualifications

This unit has links with the following unit within the Level 4 Higher Professional Diploma in Building Services Engineering:

Unit 5: Mechanical engineering project design and management

Delivery advice

Candidates should be reassured of the relevance of this unit by relating it to building services engineering practice wherever the opportunity occurs. This may be done by referring to other units within the building services engineering programme and, if possible, to the candidates' experience.

The use of computer spreadsheets, databases and mathematics software packages for processing data and presenting results should be encouraged.

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Unit 7

Science for electrical installation

Overview

Unit summary

This unit is about the science relating to electrical installations in terms of theory and its application in practice. It covers electromagnetic theory and applications, a.c. and d.c. machines, motors, generators, transformers, measuring instruments, utilisation of power, tariffs and electronic applications in electrical installation.

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements relating to the Outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aims to provide the candidate with an understanding of the theoretical background behind electrical installations, as well as practical use of measuring instruments and a knowledge of the electronic applications in electrical installation.

Learning outcomes

On successful completion of the unit the candidate will know how to:

1. Demonstrate a working knowledge of electromagnetic-based equipment
2. Apply measurement instruments to a range of uses
3. Utilise electric power
4. Demonstrate a working knowledge of electronic applications in electrical installation

Unit 7 Science for electrical installation

Unit content

Outcome 1 Demonstrate a working knowledge of electromagnetic-based equipment

The candidate knows how to:

- explain electromagnetic theory
 - relation to applications
 - machines
 - contractors
 - relays
 - transformers
 - flux/ampere-turns
 - physical properties
 - magnetic circuit
 - effect of air gaps
- explain electromagnetic induction
 - rate of change of current
 - effects of frequency
 - effects of flux density
 - growth and decay of an inductive circuit
 - B/H curves
 - Hysteresis
 - stored energy
 - discharge resistors
 - eddy current losses
 - precautions to be observed when using single core cables
 - knowledge of inductive effect of one circuit upon another
 - radio frequency interference and its suppression
 - L/R growth and decay curves
 - voltage dependent resistors and “flywheel” diodes
- explain electrostatic theory
 - capacitors in series and parallel
 - energy stored
 - need for discharge of capacitors and cables
 - charge as voltage x capacitance
 - graphically develop C-R growth and decay curves
 - charge and discharge curves of a capacitor
 - voltage and current changes in capacitance-resistance circuits
 - capacitance of cables
 - industrial uses of capacitors
 - static electricity
 - causes
 - method of control
 - dielectric strength
 - voltage limits

- describe d.c. machines
 - simple motor theory
 - simple generator theory
 - armature reaction
 - commutation
 - methods of achieving
 - brush position
 - efficiency
 - applications of motors and generators
 - shunt
 - series
 - compound
 - procedures for carrying out commissioning tests
- describe types of transformers in common use
 - construction
 - double-wound
 - auto-transformers
 - copper and iron losses
 - cooling
 - short circuit currents resulting from an installation fault
 - standard terminal marking
 - permissible parallel arrangements
 - calculate regulation
 - approximate methods
 - graphical methods
 - calculate installation fault currents
 - calculate percentage dependence
 - calculate transformer efficiency
 - determine voltage drop
- describe a.c. distribution
 - single and three-phase systems up to 11 kV
 - 2-, 3- and 4-wire circuits
 - need for balance of three-phase loads
 - correct distribution of single phase loads on a three-phase circuit
 - applications of overcurrent and earth leakage protective devices
 - discrimination and grading of protective devices

- describe a.c. machines
 - production of a rotating field by 3 phase supply
 - effect of supply frequency on speed of rotating field
 - description of rotating field with the aid of simple diagrams of winding arrangements of stator and rotor
 - effects of connecting stator windings in star or delta and of phase reversal in one winding
 - three-phase cage induction motor
 - double cage and pole changing motors
 - three-phase wound rotor slip ring induction motor
 - production of simulated 'rotating field' in single-phase motors
 - capacitor start cage induction motor
 - split-phase cage induction motor
 - shaded pole cage induction motor
 - 'universal' commutator motor
 - compare and explain speed/torque/current characteristics of cage and wound rotor induction motors with varying field arrangements
 - effect of double cage rotor on starting torque and current
 - concept of frequency variation to achieve speed control
 - effect of overloading or stalling on currents in windings
 - slip frequency
 - effect on iron losses
 - copper and iron losses in relation to efficiency
 - distinguish between total torque developed and shaft torque
 - compare types of single-phase motors in general use
 - starting characteristics of capacitor start
 - capacitor start and run
 - split phase
 - shaded pole
- describe the basic constructional feature of the synchronous motor and alternator
 - effect of varying excitation and mechanical input to an alternator
 - methods of synchronising three-phase alternators
 - modification necessary to make synchronous motors self-starting
 - power factor improvement
- describe motor starting and control systems
 - starting currents
 - torques due to different methods of starting
 - effect on the supply system of the above
 - face plate
 - contactor
 - field and armature regulators
 - components of the basic Ward Leonard system
 - operations of the circuit
 - intermittent rating of starters and continuous rating of field rheostats

Outcome 2 Apply measurement instruments to a range of uses

The candidate knows how to:

- describe principles of measurement instruments
 - voltage
 - current
 - power
 - resistance including bridge type instruments
 - speed
 - temperature
 - frequency
 - power factor
 - analogue
 - digital
- describe applications for measurement instruments
 - uses
 - sketches
 - permanently installed
 - associated external circuits
 - associated external equipment
 - portable
 - multi range
 - clip-on ammeters
 - continuity testers
 - insulation testers
 - earth loop impedance testers
 - resistance of earth electrodes testers
 - testers for the operation of residual current and voltage operated protective devices
 - pyrometers
 - tachometers
 - use of voltage transformers
 - use of current transformers, including selector switches

Outcome 3 Utilise electric power

The candidate knows how to:

- determine electrical and mechanical power requirements to carry out mechanical tasks
 - hoists
 - lifts
 - pumps
- determine electrical power requirements for heating loads
 - for water heating
 - selection and siting of the most suitable forms of electrical heating and their associated controls
 - calculation of steady state heat loss from a heated building using recommended design criteria

- state and apply terms used in illumination
 - light sources
 - filament lamps
 - discharge lamps
 - other associated luminaires
 - principles of lighting design
 - calculate illumination
 - inverse square law
 - cosine law
 - luminous flux method
 - state the cause and effect of glare (not using glare index)
- explain tariffs and load demand curves
 - advantages and limitations of tariffs
 - flat rate
 - block two-part
 - maximum demand
 - off-peak
- calculate costs using typical Electricity Board tariffs
- describe the importance and effect of power factor in the rating of electrical machines and equipment
 - rating of electrical machines and equipment
 - effect of loads with low power factor
 - advantages of power factor improvement
 - economics of power factor improvement
 - power factor improvement calculations
 - equate the merits of individual and group improvement methods

Outcome 4 Demonstrate a working knowledge of electronic applications in electrical installation

The candidate knows how to:

- describe uses and applications of the cathode-ray oscilloscope
 - Determine from trace readings
 - time
 - amplitude
 - frequency
- describe operational function of transducers
 - light dependent resistors
 - photodiodes
 - phototransistors
 - strain gauge
 - piezoelectric pressure transducers
 - thermocouples
 - thermistors
 - variable capacitors
 - resistors

- describe operational function of other electronic components
 - diodes
 - transistors
 - zener diodes
 - diacs
 - triacs
 - thyristors
- state voltage, current and temperature limits for transducers and other electronic components listed above
- describe the effects or transients and thermal runaway for transducers and other electronic components listed above
- describe briefly the packaging used for active components integrated circuits and printed circuit boards
 - factors to be observed when replacing components on printed circuit boards
- draw circuit diagrams and describe the operation of d.c power supplies
 - half-wave
 - full-wave
 - bridge circuits
 - smoothing circuits
 - simple zener diode voltage stabilising
- describe the operational function of amplifiers
 - treated as a black box
 - relationship between input output and gain
- describe the use of signal and pulse generators
 - signal sources as a tool for circuit investigation
 - markspace ratio in simple terms
- describe logic gates and circuits
 - logic gates
 - AND
 - OR
 - NAND
 - NOR
 - NOT
 - use truth tables to illustrate function
 - logic circuits
 - restricted to two inputs per gate
 - restricted to up to four gates
 - demonstrate knowledge of methods of gating thyristors and triacs
 - control circuits
 - amplitude
 - phase angle
 - pulse firing
 - burst firing
 - methods of isolating gates
 - ❖ three-phase control
 - remote control devices
 - infrared beams
 - sonic beams

- describe testing of electronic and semiconductor devices
 - types of test instruments and their uses
 - effects of test instruments when applied to circuits
 - simple go/no go tests on electronic components
 - relate sensitivity, polarity and voltage limitations to the use of multimeters for testing electronic components

Unit 7 Science for electrical installation

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of laboratory-based exercises and, where appropriate, simulated or real work studies that demonstrate the candidate's understanding of the theory behind the underpinning scientific principles that relates to electrical installations. The exercises/studies should be supported by all relevant reports, findings and other data sheets needed to support the conclusions made by the candidate.

Unit 7

Science for electrical installation

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Candidates should be reassured of the relevance of this unit by relating it to building services engineering practice wherever the opportunity occurs. This may be done by referring to other units within the building services engineering programme and, if possible, to the candidates' experience.

The use of computer spreadsheets, databases and mathematics software packages for processing data and presenting results should be encouraged.

Unit 8

Electrical installation technology

Overview

Unit summary

This unit is about taking the information required relating to electrical installations and making decisions about materials, methods and techniques to be used. It covers the safety regulations governing the industry, special installations, equipment, plant, building services and electrical distribution.

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements relating to the Outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to gain sufficient knowledge to make decisions about electrical installations in terms of the regulations that apply, and the requirements for various types of installations in different environments. It also covers electrical distribution and the requirements associated.

Learning outcomes

On successful completion of the unit the candidate will know how to:

1. Apply regulations to electrical installations
2. Specify the requirements for special electrical installations
3. Demonstrate a working knowledge of electrical distribution
4. Specify the requirements for electrical installation of equipment, plant and building services
5. Determine estimating, planning and site supervision requirements

Unit 8 Electrical installation technology

Unit content

Outcome 1 Apply regulations to electrical installations

The candidate knows how to:

- demonstrate knowledge of the practical applications to electrical installation work of the current edition of the Regulations for Electrical Installations and the ability to use this knowledge in electrical installation work
- demonstrate knowledge of the electricity at work regulations, 1989
 - persons on whom duties are imposed by these regulations
 - systems, work activities and protective equipment
 - strength and capability of electrical equipment
 - adverse or hazardous environments
 - insulation, protection and placing of conductors
 - earthing or other suitable precautions
 - integrity of referenced conductors
 - connections
 - means for protecting from excess of current
 - means for cutting off the supply and for isolation
 - precautions for work on equipment made dead
 - work on or near live conductors
 - working space, access and lighting
 - persons to be competent to prevent danger and injury
- demonstrate knowledge of the Electricity Supply Regulations in so far as they deal with consumer installations under Regulations 2229 and 32, and of any regulations concerning consumer installation which may be issued by the Electricity Commissioners in addition to or in substitution for those mentioned above
 - supplier's works on consumer's premises
 - interconnected supplies
 - general conditions as to consumers
 - discontinuance of supply in certain circumstances
 - notices and determination of differences
 - declaration of phases, frequency and voltage at supply terminals
 - information to be provided on request
 - electricity boards to provide constant supply
- state the need for reference to the appropriate British Standards and Codes of Practice when planning and carrying out installation work: BS 7671:2008 (The IEE Wiring Regulations 17th Edition)

Outcome 2 Specify the requirements for special electrical installations

The candidate knows how to:

- recognise areas exposed to the risk of fire and explosion and the selection of suitable installation techniques
 - categories of areas of risk
 - types of wiring and apparatus for specific areas of risk
 - need for special protection against overcurrent
 - need for special protection against earth leakage currents
 - supplies to portable and transportable apparatus
 - handlamps
 - consideration of monitored earth leakage protection
 - techniques to be adopted when installing lighting and power
 - steel conduit
 - mineral insulated cables
 - armoured cables
 - need for special techniques when inspecting and testing installations
 - intrinsically safe circuits and apparatus
 - segregation ventilation and pressurisation methods of avoiding
 - ignition
 - flameproof installations
 - identify risks attendant in the installation of petrol and diesel retailing pumps
 - recognise the need to conform to local licensing authorities and statutory regulations
 - select means of satisfying safety requirements regarding supply wiring to pump, control of supplies to pump lighting and motors
 - draw and explain circuit diagrams for pressurised and pipe ventilated system
 - Identify the dangers due to the presence of dust in areas not normally considered to be explosive areas
- describe the special precautions to be observed in installation and maintenance procedures
- recognise dangers due to static electricity discharges and simple means of minimising danger
 - outline the risks attendant in hospital operating theatres due to static electricity
 - state simple ways of minimising danger
- recognise hazardous installation areas due to the presence of harmful conditions
 - mines and quarries
 - heavy plant maintenance depots
 - water and sewage plant
 - lighting of public areas
 - outdoor lighting and power
 - steelworks and foundries
 - building and construction sites

- recognise the potential hazards to persons property and animals from the use of electricity due to the abnormal conditions prevalent in agricultural and horticultural establishments
 - damp and humid atmosphere
 - mechanical and animal damage
 - chemical corrosion and erosion
 - rough usage
 - rodent and vermin attack
 - electric fences
 - provision of reduced voltage supplies
 - monitored earth leakage protection
 - installation of overhead distribution cables
 - installation of underground distribution cables

- describe areas requiring special consideration due to high operating temperature conditions
 - cables and terminations
 - effects of high temperature on rotating plant and control gear performance
 - use of special enclosures
 - siting of equipment to avoid defects and premature failure
 - effects of high temperatures on luminaires
 - use of special enclosures

- describe areas requiring special installations consideration due to abnormally low operating temperature conditions
 - cables and terminations for use in low temperature areas
 - effects of low temperature on rotating plant and control gear performance
 - use of special enclosures
 - effects of low temperature conditions on discharge luminaires
 - selection of tubes/lamps and luminaries

- describe areas requiring special consideration due to the presence of corrosive atmosphere
 - corrosive media
 - liquids
 - fumes
 - chemical attack
 - electrolytic action
 - outdoor installations
 - atmospheric conditions
 - selection of installation cables
 - selection of installation equipment
 - selection of installation techniques
 - application of protective surfaces
 - surface finishes
 - paints
 - tapes
 - gaskets
 - sheaths
 - need for preventative maintenance

- demonstrate knowledge of cathodic protection
 - galvanic current
 - impressed current
 - sacrificial anode materials
 - zinc
 - magnesium
 - aluminium
 - effects of corrosive waters on immersion heaters and appropriate preventive measures

- describe systems of electrically operated fire alarm systems
 - simple open circuit
 - monitored open circuit
 - closed circuit
 - monitored closed circuit
 - types of call point
 - manual break glass
 - smoke detectors
 - temperature rise detectors
 - rate of temperature rise detectors
 - flame detectors
 - factors affecting the siting of call points to afford maximum protection to persons and property
 - types of warning devices used for fire alarm systems
 - bells
 - horns
 - sirens
 - warblers
 - visual
 - factors affecting the siting of warning devices to afford maximum coverage of premises
 - types of supervisory devices
 - zone indicators
 - supervisory sounders and diversion relays
 - use of telephone links to fire services and police
 - restricted warning arrangements for hospitals, and public entertainment premises
 - servicing arrangements for fire alarm systems
 - read and interpret circuit diagrams for fire alarm systems
 - describe types of cables, wiring and power supplies for use with fire alarm systems and method of installation
 - need for reliability of supply
 - exclusive main circuit
 - emergency standby supplies
 - ❖ dual supplies
 - ❖ battery systems: charging and maintenance requirement for cells
 - ❖ standby generators

Outcome 3 Demonstrate a working knowledge of electrical distribution

The candidate knows how to:

- describe methods of distribution to load centres
- describe multi-substation systems on sites and in buildings (single and multi-storey)
- explain the importance of security of supply
 - use of ring mains
 - radial feeders
 - duplicate busbars
 - means of isolation
 - balancing of loads
 - need for discrimination between protective devices
- describe provision for future extension
- describe and show methods of distribution in industrial, commercial and domestic premises
 - cables
 - busbar
 - trunking
- demonstrate knowledge of load centres and application of diversity to sub-mains
 - factors governing the choice of system
- describe the construction and use of cables for distribution systems up to 11 kV
 - PILCSTA
 - PIAS
 - Consac
 - Waveconal
 - spilt concentric
 - cables
- describe labour-saving benefits derived from the use of contemporary techniques in cable installation
- describe the construction and installation of distribution busbar systems
 - connection of take-off points
- describe a substation layout
- describe methods of cooling transformers
- demonstrate concept knowledge of the forces released on interrupting heavy fault current
- explain how arc control is achieved
 - semi-enclosed fuses
 - HBC fuses
 - moulded case circuit breakers
 - air circuit breakers
 - oil circuit breakers – plain and assisted
 - vacuum circuit breakers
- demonstrate knowledge of air-blast circuit breakers

- state applications for current and voltage transformers
 - overcurrent
 - earth leakage protection
- state applications of induction overcurrent relays and earth leakage relays in the tripping circuit of circuit breakers
- explain fault energy levels and the effect of power factor on these
- describe metering arrangements for domestic tariffs
 - normal
 - off-peak
- describe the use of commercial whole current metering
 - maximum demand indicators
- describe industrial CT metering requirements for consumers installations to enable the connection of the various types of metering
- describe installation and connection of meters
 - voltmeters
 - ammeters
 - wattmeters
 - use of instrument transformers
 - CTs
 - VTs
- describe the reasons for earthing
 - hazards associated with earth leakage currents
 - shock
 - fire
- describe the methods for earthing
 - earth fault loop impedance
 - earth fault loop circuit in relation to methods of earthing
 - terminal provided by supply authority connected via a metallic path to system earth
 - use of earth electrodes
 - PME terminal provided by supply authority
- describe the installation and testing of earth electrodes
 - voltage gradients and step potential of electrodes
 - earth leakage protection and requirements for the consumers' installation
 - state the effects of fortuitous earth paths
- describe the earth circuit
 - bonding
 - overcurrent protective devices
 - residual current devices
 - monitored earthing systems

- describe methods to protect buildings against lightning stikes
 - determine the number of air terminations
 - electrodes and down conductors
 - use of building structures in lieu of down conductors
 - bonding of extraneous and testing
 - metalwork to protection system and bonding to main earthing system
 - need for periodic inspection and recording of results
 - testing the resistance to earth of protection electrodes and measurement of soil resistivity

Outcome 4 Specify the requirements for electrical installation of equipment, plant and building services

The candidate knows how to:

- describe the application and installation of motors
 - types of motors
 - induction
 - synchronous
 - a.c.
 - d.c.
 - starting methods
 - operation of control devices
 - use and operation of protective devices
 - determination of cable sizes
 - effects of environment
 - use of motor enclosures
- describe the application and installation of d.c. power supplies
 - types of supply
 - motor generators
 - rectifiers
 - control circuits for standby generators
 - use of time delay
 - installation requirements for rectifiers and generators including mobile units
- describe the application and installation of electrical plant
 - fixing requirements
 - transformers
 - switchgear
 - motors
 - problems in siting of plant
 - vibration
 - noise levels
 - leakage of oil
 - correct methods for lifting and moving equipment
 - use of direct drives and belt drives
 - alignment of pulleys
 - maximum and minimum spacing of pulleys
 - belt speed
 - pulley speed
 - select type and number of belts

- use of gear and chain drives
 - methods of achieving change of speed
 - advantages and limitations of each type in respect of the environment
- maintenance requirements
 - switchgear
 - transformers
 - rotating machines
- planned maintenance routines
 - use of inspection lists
 - manufacturers recommendations
- describe the installation of lighting systems
 - discharge lamps
 - signs
 - associated control gear
 - select and describe suitable luminaires for various situations
 - office blocks
 - computer workspaces
 - hospitals
 - road lighting
 - stock yards
 - car parks
 - select light source related to the advantages and disadvantages
 - incandescent
 - fluorescent
 - halogen
 - mercury vapour
 - sodium vapour
 - stroboscopic effect
 - high voltage discharge signs
 - requirements
 - identify problems associated with their use
 - solve problems associated with their use
 - effects of harmonics on installations and equipment
 - cause and effect

- describe the installation of heating systems
 - electric space heating systems
 - direct
 - ❖ radiant
 - ❖ convection
 - thermal storage
 - ❖ storage radiators
 - ❖ underfloor
 - water heating and steam raising by electrical methods
 - electric control circuits for heating systems using other fuel
 - methods of wiring
 - methods of control
 - methods of protection
 - comparison of different schemes
 - advantages and disadvantages
 - off-peak tariff arrangements
 - heat recovery from lighting systems
 - comparison of domestic and commercial water heaters
 - types, ratings
 - installation problems
 - temperature control
 - electrode water heater
 - installation methods
 - temperature control methods
 - interconnection of control components (external circuitry only)

- describe electrical installation cable
 - for use on systems up to and including 11 kV
 - determination of conductor cross-sectional area
 - consideration of load
 - consideration of length
 - consideration of ambient temperature
 - grouping
 - class of protection
 - installation techniques
 - cable termination techniques
 - problems associated with careless installation techniques
 - methods of handling
 - problems associated with mishandling

- describe methods of visual inspection and electrical testing of installations relating to fault finding and periodic inspection and testing
 - inspection, testing and reports on electrical installations
 - commissioning of new installations
 - faults diagnosis and location
 - use of Murray and Varley loops

- describe procedures for dealing with common faults likely to be encountered in electrical installation work
 - a.c. motors
 - d.c. motors
 - generators
 - transformers
 - contactors
 - protective devices
- state routine testing and reporting procedures
- describe tests and procedures in the recommissioning of machines and equipment

Outcome 5 Determine estimating, planning and site supervision requirements

The candidate knows how to:

- consider for estimating purposes problems associated with installations in various types and phases of building construction
 - assess labour requirements
 - materials and plant based upon information from drawings
 - specifications or measurements taken on site
 - identify the problems concerned with access for delivery of materials
 - special handling plant for offloading and siting of items of equipment
 - transformers
 - switch and control panels
- appreciate what is involved in programming an installation and the resources needed to carry it out
 - preparation and use of bar charts
 - reading of networks
 - utilisation of resources
 - co-ordination of electrical contractors and other trades
 - economical use of available labour and plant resources through planned utilisation
 - need to plan phased deliveries of materials to suit site conditions and contract progress
- describe and use site records and procedures
 - importance of detailed records of all site instructions, deliveries and occurrences
 - variations from tendering
 - constructional drawings
 - electrical symbols

Unit 8 Electrical installation technology

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies that demonstrate the candidate's understanding of the requirements for electrical installations. The case studies should be supported by all relevant drawings, specifications, and other data sheets needed to support the decisions made by the candidate relating to the installation materials, methods and techniques selected for specified types of installation and environment.

The above pieces of work should total approximately 2500 words.

Unit 8

Electrical installation technology

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Candidates should be reassured of the relevance of this unit by relating it to building services engineering practice wherever the opportunity occurs. This may be done by referring to other units within the building services engineering programme and, if possible, to the candidates' experience.

The use of computer spreadsheets, databases and mathematics software packages for processing data and presenting results should be encouraged.

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Unit 9 Electrotechnical services, installations and systems

Overview

Unit summary

This unit is about the design of domestic, commercial and industrial electrical installations in accordance with the 16th Edition of the Institution of Electrical Engineers Wiring Regulations (BS 7671), Electricity Supply Regulations, the Electricity at Work Regulations (EAWR) the Health and Safety at Work etc Act 1974 and other international codes and regulations. The unit also covers Interior, exterior and emergency lighting design according to the Chartered Institution of Building and Services Engineers (CIBSE). Fire alarm system requirements according the relevant British Standards are included and electrical installation inspection and testing requirements are covered together with portable equipment testing. A section is also devoted to hazardous area classification and equipment requirements for use in such environments.

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements relating to the Outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aim is to enable candidates to obtain an extensive knowledge of the electrical installation industry and the related regulations and standards governing the many areas of building services engineering expertise that they as Electrical or Incorporated Engineers will encounter in their everyday involvement in industrial or commercial projects.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Demonstrate an understanding of the concepts embodied in the UK, European and International regulations governing design and the safety of personnel and equipment in domestic, commercial and industrial electrical installations
2. Evaluate materials used in electrical service installations
3. Design aspects of low voltage electrical service installations
4. Analyse earthing systems and circuits
5. Evaluate the requirements of equipment appropriate to electrical service installations
6. Demonstrate an understanding of the inspection and testing techniques associated with electrical service installations
7. Evaluate the requirements of electrical equipment for protection against non-electrical hazards.

Unit 9 Electrotechnical services, installations and systems

Unit content

Outcome 1: Demonstrate an understanding of the concepts embodied in the UK, European and International regulations governing design and the safety of personnel and equipment in domestic, commercial and industrial electrical installations

The candidate knows how to:

- appropriately apply international, European and national regulations for safe electrical installation practice
- interpret and assign correct International Code of Protection ratings for electrical equipment
- appropriately apply the international standards and codes of practice governing the use of electrical equipment for use in hazardous areas
- interpret national and international standards covering electrical equipment.

Outcome 2: Evaluate materials used in electrical service installations

The candidate knows how to:

- classify types of cable by construction, voltage rating, material of construction, size and compatibility for installation location
- evaluate and select types of circuit equipment and accessories according to installation method and location
- evaluate electrical switchgear in terms of voltage, short circuit capacity, load rating and operating time
- evaluate and select circuit protective devices according to type of fault protection required
- analyse the performance of electric motor starting equipment
- analyse the operation of motor control circuitry
- analyse and interpret a commercial specification for an industrial motor control centre.

Outcome 3: Design aspects of low voltage electrical service installations

The candidate knows how to:

- describe the factors influencing the design of an electrical installation in the initial stages and the factors influencing the choice of supply
- calculate cable sizes and cable characteristics and protective device ratings using techniques and data in the Wiring Regulations
- calculate circuit parameters using tabulated data in order to determine circuit protective devices
- analyse data on cable grouping, temperature, and insulation correction factors as defined in the Wiring Regulations to determine suitably sized cables and circuit protective devices
- calculate from given data, input power, line and phase load currents, earth loop impedance, percentage voltage drop and touch voltage levels
- calculate diversity and load factors for electrical installations from given data
- calculate fault levels in an electrical supply system

- design internal, external and emergency lighting installations according to current regulations
- analyse Zener diode barrier circuits
- evaluate types of fire system installations
- calculate detector spacings from given data.

Outcome 4: Analyse earthing systems and circuits

The candidate knows how to:

- evaluate types of permitted earthing systems
- analyse electrical circuits to determine earth loop impedance, external loop impedance, fault current, and conductor size
- analyse the operation of a residual current devices (RCDs)
- analyse earth electrode resistance and soil resistivity using appropriate techniques
- analyse earth electrode resistance and soil resistivity using appropriate techniques
- evaluate earthing installation testing methods according to the Wiring Regulations
- analyse and interpret an industrial electrical installation test certificates.

Outcome 5: Evaluate the requirements of equipment appropriate to electrical service installations

The candidate knows how to:

- evaluate and select appropriate electrical equipment for use in temporary supplies to construction sites
- apply equipment installation techniques and regulations to electrical installations according to current safe installation practice
- apply installation techniques and regulations to special locations according to current safe installation practice.

Outcome 6: Demonstrate an understanding of the inspection and testing techniques associated with electrical service installations

The candidate knows how to:

- describe accurately and interpret, testing requirements for fixed and portable installed electrical equipment
- evaluate inspection techniques and procedures appropriate to an electrical service installation and according to the relevant regulations
- evaluate the testing requirements of an electrical installation according to international and national codes and regulations
- evaluate appropriate test equipment required for different testing procedures as required by the regulations in the testing of electrical installations
- analyse and interpret a completed regulation test certificate for a commercial or industrial electrical installation
- determine the correct certification requirements of electrical equipment and installations.

Outcome 7: Evaluate the requirements of electrical equipment for the protection against non-electrical hazards

The candidate knows how to:

- evaluate hazards associated with static charge
- evaluate methods of minimising hazards associated with high resistivity hydrocarbons and other inflammable substances
- evaluate, according to international and national regulations, appropriate electrical equipment for use in hazardous areas
- evaluate current international and national standards and regulations to establish equivalent national classifications and equipment classes
- select correct types of hazardous area electrical equipment appropriate to various industrial and commercial locations .
- analyse and interpret certification authority requirements for electrical equipment for use in hazardous areas.

Unit 9 Electrotechnical services, installations and systems

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of electrical supply and installations. The case studies should cover the following areas:
 - Electrical installation requirements and design according to the 16th Edition of the IEE Wiring Regulations (British Standard 7671)
 - Hazardous Area Equipment and Certification to BS British Standard 5345 and British Standard 5501 (European Standard 50 014 – 039)
 - Lighting Design according to the recommendations of the Chartered Institution of Building Services Engineers (CIBSE).

The above pieces of work should total approximately 2500 words.

Unit 9 Electrotechnical services, installations and systems

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Links with other units/qualifications

This unit has links with the following unit within the Level 4 Higher Professional Diploma in Building Services Engineering:

- Unit 5: Mechanical engineering project design and management
- Unit 6: Electrical engineering principles

Delivery advice

The approach to this unit should be from a fundamental point of view in so far as emphasis should be placed on the unifying concept of an 'electrical installation'. This notion is the link between all the items of electrical circuit equipment to be found in the domestic, commercial and industrial spheres of low voltage electrical supply systems (as defined by the IEE Wiring Regulations). Candidates should be made aware that not only requirements for installations are contained within the IEE Wiring Regulations but also several techniques to facilitate installation design.

Assessments should be practically orientated where possible and relate to current Building services engineering standards and codes of practice. Reference should be made to the wide variety of manufacturer's equipment and specifications where appropriate as in for example.

Candidates should be encouraged to utilise experiences from their own building services engineering environment to demonstrate competence in meeting the appropriate aspects of the unit Outcomes. They should also be encouraged to use all potential sources of up-to-date information. These may be in the form of amendments to British Standards and reports in technical journals.

Where appropriate, reference should be made to health and safety legislation.

Suggested resources list

T. Davies - *The protection of industrial power systems* – (Newnes)

Edward Hughes - *Electrical Technology* - (Longmans)

J.Shepherd, A.H.Morton, L.F.Spence - *Higher Electrical Engineering* – (Pitman)

British Standard 7671 '*Requirements for Electrical Installations*' - IEE Wiring Regulations

British Standard 4363 '*Specification for Distribution Units for use on Construction Sites*'

British Standard 7375 '*Code of Practice for Distribution of Electricity on Construction and Building Sites*'

British Standard 5345 '*Code of Practice for selection, installation, and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture)*'

British Standard 5501 (European Standard 50 014 – 039) '*Electrical apparatus for potentially explosive atmospheres*'

British Standard 5839 Part 1 '*Fire detection and alarm systems for buildings*'

British Standard 5266 Part 1 '*Emergency Lighting*'

Institution of Electrical Engineers '*Recommendations for the Electrical and Electronic Equipment of Mobile and Fixed Offshore Installations*'

British Standard BS EN 60529 '*Degrees of protection provided by enclosures*' (IP Code)

Open Learning Text:

Electrical Services and Installation - (COLU - 2001)

Supplementary reading material in the form of trade magazines, Institution publications and manufacturer's data are useful for unit background information if able to be accessed by the candidate.

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Unit 10

Overview

Electrical supply and distribution

Unit summary

This unit is about providing the candidate with a sound knowledge of electrical system transmission and distribution. The topics covered are transmission and distribution circuits and components, system economics, load sharing, load voltage levels, generator performance and capability charts, short transmission line characteristics and voltage control, system fault level calculations, line and unit overcurrent protection and voltage transients.

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements relating to the Outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to develop an underpinning knowledge and theory of electrical supply transmission and distribution that will enable him or her to provide a useful input as an engineer in an electrical system transmission and distribution environment.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Describe the basic components and economic factors of an electrical transmission and distribution system
2. Relate the operating characteristics of three-phase power transformers to their suitability for parallel operation and analyse their sharing of load
3. Analyse feeder configurations to determine load distribution and phase voltage regulation
4. Describe and analyse the operating characteristics of three-phase generators on infinite busbars
5. Determine the fault levels at points on various electrical supply system configurations
6. Describe and analyse protection systems for electrical supply systems.

Unit 10 Electrical supply and distribution

Unit content

Outcome 1: Describe the basic components and economic factors of an electrical transmission

The candidate knows how to:

- describe and state the functions of isolating switches, contactors, fuses, circuit breakers, current transformers and protective relays used in an electrical supply system
- describe overcurrent protection equipment on contactors and circuit breakers
- describe radial, parallel and ring network systems and state their relative advantages and disadvantages
- relate position of faults to circuit breaker operation
- compare relative advantages of using IDMT and Directional Overcurrent Relays
- state and evaluate the relationship of energy to power
- list and distinguish between fixed and variable costs involved with an electricity supply system
- define types of industrial tariffs and perform tariff calculations involving load, demand, maximum demand, diversity factor, load factor and power factor.

Outcome 2: Relate the operating characteristics of three-phase power transformers to their suitability for parallel operation and analyse their sharing of load

The candidate knows how to:

- draw representations and interpret phasor groupings of three phase power transformers
- use impedances to schematically represent transformers operating in parallel to supply a common load
- determine the kVA load of a transformer operating in a parallel mode, in terms of the product of total load being shared and the ratio of transformer impedances
- state the necessary conditions for transformers to successfully and safely operate in parallel
- represent transformer impedances referred to the primary or secondary windings
- describe methods of voltage control of transmission lines by the use of tap changing transformers
- solve problems involving transformers connected in parallel and with different complex impedances supplying different loads over short transmission lines and connected in various configurations in order to determine load distribution, current circulation and phase voltage regulation.

Outcome 3: Analyse feeder configurations to determine load distribution and phase voltage regulation

The candidate knows how to:

- construct equivalent circuits of a supply system consisting of generators, transformers, motors lines and loads
- construct a schematic diagram and analyse radial supply, parallel and ring systems using complex reactances
- construct a phasor diagram of a series equivalent circuit representing a transmission line, using load current as the reference
- construct a phasor diagram of a series equivalent circuit representing a transmission line, using receiving end voltage as the reference
- state the line voltage equations
- construct a short line receiving end line chart for different power factors
- develop and interpret a receiving end line performance chart from given data
- use performance charts to control the real and reactive power by transmission angle and sending end voltage
- construct a performance chart to show the effects of variation in real power and power factor on the sending end voltage
- determine using complex notation, the sending end voltage, line voltage drop, load angle and other quantities from given line parameters and data.

Outcome 4: Describe and analyse the operating characteristics of three-phase generators on infinite busbars

The candidate knows how to:

- construct an equivalent circuit for a synchronous machine
- state the relationship between the stator phase voltage, stator phase current, generated voltage and synchronous reactance and impedance
- construct a phasor diagram showing the stator phase voltage, stator phase current, generated voltage, load angle, stator voltage drop, power factor constant power and constant VAR loci
- state the short circuit ratio (SCR) of a generator
- construct and interpret a generator load diagram from calculations on given data for stator phase voltage, stator phase current, synchronous impedance, short circuit ratio, power, reactive power, load angle and power factor
- calculate, construct and indicate the prime mover limit (MW or turbine power limit), theoretical and practical stability limits, excitation and stator heat limits on a generator load diagram
- describe the generator performance limitations with respect to real power output, reactive power output, the p.u. excitation, operating power factor and apparent power output.

Outcome 5: Determine the fault levels at points on various electrical supply system configurations

The candidate knows how to:

- define fault level and per unit impedance as applied to an electrical supply system
- construct a one-line diagram of supply system units represented as p.u. impedances
- calculate the magnitude of a fault level at various points in an electrical supply system using the circuit p.u. impedance, base VA and impedance circuit reduction
- describe techniques for reducing fault levels to specified values
- define grid in-feed or source fault VA
- solve supply system fault level problems involving star/delta circuit transformation
- describe and analyse system switching transients
- draw a circuit breaker equivalent circuit
- describe the principles of arc suppression, control and interruption, used in high voltage circuit breakers
- sketch the construction and describe the operation of Plain Break Oil Circuit Breakers, Air Blast Circuit Breakers, Vacuum Interrupters and Sulphur Hexafluoride Circuit Breakers, HRC Liquid and HRC Expulsion and High Voltage Fuses.

Outcome 6: Describe and analyse protection systems for electrical supply systems

The candidate knows how to:

- describe the elements used in electrical supply system overcurrent protection schemes
- describe the operation of an inverse definite minimum time (IDMT) relay used in overcurrent protection schemes
- calculate time setting multipliers and plug setting multipliers for IDMT relays with reference to B.S 142 IDMT characteristic curve where appropriate
- calculate the time setting multipliers and plug setting multipliers for IDMT relays to give the required discrimination in radial feeder circuits with various load take off points
- describe supply system unit protection schemes such as circulating current differential protection to protect a large generator and circulating current differential protection to protect a delta/star transformer
- describe over-voltage protection methods using overhead earth wires on EHV lines, surge diverters and non-linear surge diverters.

Unit 10 Electrical supply and distribution

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of electrical supply and distribution. The case studies should cover the following areas:
 - electrical transmission and distribution equipment
 - industrial tariffs
 - load distribution and voltage regulation for various feeder configurations
 - characteristics of three – phase generators on infinite busbars
 - short transmission line performance charts
 - electrical supply system fault level and protection calculations
 - electrical supply system switching transients.

The above work should total approximately 2500 words.

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Links with other units/qualifications

This unit has links with the following unit within the Level 4 Higher Professional Diploma in Building Services Engineering:

Unit 6: Electrical engineering principles

Unit 9: Electrical services, installations and systems

Delivery advice

The approach to this unit should be from the point of view of studying the diverse aspects of electrical energy supply and protection but integrating all elements to form a broad Electricity Supply Industry knowledge base.

Assessments should be practically orientated where possible and relate to current Building services engineering standards and codes of practice. Reference should be made to different manufacturer's equipment and specifications. This is especially relevant with the progress being made in solid state relays and circuit breaker technology

Candidates should be encouraged to utilise experiences from their own industrial environment to demonstrate a knowledge of the unit content. They should also be encouraged to use all potential sources of up-to-date information. These may include works reports and reports in technical journals.

Where appropriate, reference should be made to health and safety legislation.

Suggested resources list

T. Davies - *The protection of industrial power systems* – (Newnes)

Edward Hughes - *Electrical Technology* - (Longmans)

J.Shepherd, A.H.Morton, L.F.Spence -*Higher Electrical Engineering* – (Pitman)

Cotton H, Barber H - *The Transmission & Distribution of Electrical Energy*(Hodder and Stoughton, 1985)

Bosela T – *Introduction to Electrical Power System Technology*(Prentice Hall, 1997)

Open Learning Text:

Electrical Supply and Distribution - (COLU - 2001)

Supplementary reading material in the form of trade magazines, Institution publications and manufacturer's data are useful sources of background information.

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Unit summary

This unit is about the practical aspects of space heating and fuel technology, from an overview of the fundamentals to the specifics of system design. It includes the most current areas of interest, such as solar and heat pump technology, underfloor heating and energy conservation. It provides an introduction to all types of systems — industrial, commercial and residential.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- Enhance and develop existing skills
- Manage and maintain boiler house plant and equipment
- Promote energy efficiency in central heating design
- Have an understanding of central heating technology and design techniques
- Use appropriate measuring and monitoring equipment
- Understand the critical factors necessary to achieve recommended thermal comfort conditions
- Select plant for specific applications
- Understand recent legislation and be aware of the relevant standards and guidance documents
- Interpret schematic diagrams of central heating systems and components.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Set out and draw a properly designed heating system using the correct graphical symbols for pipework and ancillary equipment.
2. Understand proper combustion and fuel characteristics.
3. Select the correct boiler for specific application.
4. Understand the importance of alternative heat sources and energy efficient design.
5. Calculate heating loads using outdoor design conditions and indoor design criteria.
6. Understand the principles of good system design.
7. Understand the advantages and disadvantages of the different central heating systems.
8. Accurately pipesize a central heating system for a commercial/industrial building and select a suitable pump.
9. Show a knowledge of the relevant building regulations and standards required for central heating.
10. Understand the need for controls and control methods such as Building Management systems.

Unit 11 Space heating technology and design

Unit content

Outcome 1 Set out and draw a properly designed heating system using the correct graphical symbols for pipework and ancillary equipment

The candidate knows how to:

- Set out the relevant drawings
- Interpret schematic diagrams of central heating systems
- Draw a basic isometric diagram of heating systems
- Scale up and down from a drawing
- Understand graphical symbols for pipework
- Demonstrate knowledge of the abbreviations noted on drawings.

Outcome 2 Understand proper combustion and fuel characteristics

The candidate knows how to:

- Understand the difference between primary and delivered energy when considering running costs
- Understand the terms Calorific input and output values, viscosity, ignition temp, density etc.
- Understand air supply requirements
- Understand the advantages and disadvantages of the different fuels — gas, oil, solid fuel, electricity
- Consider environmental protection
- Understand the different oil supply systems
- Minimise carbon emissions
- Select the correct materials for flues
- Select between open and balanced flues
- Understand the factors which affect flue performance
- Understand how to avoid condensation in flues
- Find regulations regarding flues ie. fire regulations and safety procedures

Outcome 3 Select the correct boiler for specific application

The candidate knows how to:

- Establish the clients requirements ie. Fuel choice, heating requirements, ventilation, type of boiler, flue location, type and position of heat emitters, controls, pipework layout, energy efficiency
- Understand the working principles and advantages of a condensing boiler
- Understand correct flue temperatures
- Recognise the different types of boilers — condensing, combination etc.
- Understand the operation of modular boiler / boilers and close load matching
- Recognise the factors affecting choice of boiler
- Recognise compact efficient design
- Prepare a specification for installation work

Outcome 4 Understand the importance of alternative heat sources and energy efficient design

The candidate knows how to:

- Have a professional responsibility to promote benefits of a clean and energy efficient system
- Recognise the factors affecting thermal comfort conditions
- Understand the benefits of insulation
- Understand U-values of different building fabrics eg. E, K glass etc.
- Identify and know the principle of operation of a heat pump
- Know the principle of operation of a combined heat power unit
- Design a basic solar heating system
- Avoid solar overheating
- Be aware of the effect on the environment of burning fossil fuels such as gas, oil and coal
- Understand the term heat energy rating

Outcome 5 Calculate heating loads using outdoor design conditions and indoor design criteria

The candidate knows how to:

- Carry out a heating load calculation using mathematical exercise, Meyers calculator and computer software package.
- Understand recommended room temperatures, external design temperatures, recommended design air change rates, building exposure, high ceilings, adjoining properties, intermittent heating and ventilation rates
- Select correct heat emitter from available charts
- Understand the terms mean water temperature, maximum density of water, sensible heat, latent heat, exposed pipework emissions
- Calculate the required boiler power for building
- Understand heat transfer theory
- Understand the importance of insulation of heating system pipework
- Survey existing building for insulation etc.
- Recognise heat recovery methods

Outcome 6 Understand the principles of good system design

The candidate knows how to:

- Layout the pipework in the most efficient manner
- Understand how to avoid reverse circulation
- Understand the three-tee rule
- Recognise By-Pass arrangements
- Install pump in correct position
- Diagnose system design faults including boiler and system noise
- Understand the effects of ferric oxide and ferrous oxide in the heating system
- Properly commission a central heating system

Outcome 7 Understand the advantages and disadvantages of the different central heating systems

The candidate knows how to:

- Design a proper open vented heating system including position of open safety vent, pump, cold feed, feed and expansion cistern, close coupled F+E
- Design a sealed heating system, understanding the advantages and disadvantages, safety aspects, safety components, static pressure, working pressure, position of vessel, position of pump, filling point, safety devices, top up units, pressure gauge, sealed system boilers
- Size expansion vessel
- Consider safety features and regulations
- Properly carry out filling and commissioning of systems and plant
- Design an underfloor system, covering coil layouts etc.
- Understand the working of a mixing valve
- Recognise one-pipe and two-pipe systems ie. one-pipe ring, two-pipe reverse return

Outcome 8 Accurately pipesize a central heating system for a commercial/industrial building and select a suitable pump

The candidate knows how to:

- Carry out a pipe sizing exercise
- Calculate mass flow rates, velocity, specific heat capacity, pressure loss
- Understand how to calculate and find the index circuit
- Select correct pump for system or circuit
- Understand and follow the CIBSE Guide
- Understand frictional resistances and K-factors
- Carry out a pipe sizing exercise on a gravity circuit

Outcome 9 Show a knowledge of the relevant building regulations and standards required for central heating

The candidate knows how to:

- Find the correct documentation
- Find the correct information
- Understand the standards and guidance documents
- Understand the importance of handover to the client and the need for future service
- Understand the importance of pre-commissioning plant and equipment

Outcome 10 Understand the need for controls and control methods such as Building Management systems

The candidate knows how to:

- Recognise the fundamentals of automatic control ie. temperature, pressure, valves etc.
- Identify control devices ie. low pressure, high pressure, high temperature controls, oil level controls, flow switches etc.
- Select the appropriate control package
- Understand wire less controls
- Apply energy conservation techniques
- Understand time / thermostatic control
- Importance of frost stats — outside weather compensators
- Understand enhanced control functions, compensating controls
- Understand the need for safety features
- Identify major plant items and associated services
- Recognise computer software packages in use in mechanical services industry, ie. building energy management systems, AutoCAD etc.

Unit 11 Space heating technology and design

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A project comprising the detailing of an energy efficient central heating system for a commercial/industrial building.

The following criteria should be covered in the assessment:

- Recording and presenting of information
- Managing time and meeting targets
- Decision making
- Applying self learning
- Applying independent critical thinking
- Evidence of research

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as demonstrating a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken should comply with current safety legislation and any regulations and standards should be noted.

The outline of the items to be included in the project should be agreed with appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Chartered Institute of Building Service Engineers Guides (A,B,C), CIBSE (London).

Faber and Kells, *Heating and Air Conditioning of Buildings*, Architectural Press. 1995.

Hall, *Building Services and Equipment (Vols 1,2,3)*, Longmans, 1994.

McQuiston, F.C., Parker, D.J., *Heating, Ventilation and Air Conditioning — Analysis and Design*, John Wiley and Sons, 1994.

Domestic Heating Design Guide, Institute of Plumbing, 2001.

Plumbing Engineering Services Design Guide, Institute of Plumbing, 2002.

F.Hall, *Heating Technology (Second Edition)*, Longmans, 1986.

Hall and Greeno, *Building Services Handbook*, Butterworth, Heinemann, 2001.

Websites:

Centre for Education in the Built Environment
www.cebe.cf.ac.uk

EEVL — Edinburgh Engineering Virtual Library
www.eevl.ac.uk

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Unit 12 Hot water systems technology and design

Overview

Unit summary

This unit deals with the technology and background design associated with hot water services. Candidates will be made aware of the best practices pertaining to hot water design currently used within the industry.

A significant portion of the unit will deal with new technologies water and energy conservation. The role of the modern day craftsman will also be dealt with and in particular how to deal with health and safety issues relating to plumbing installations.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and learning outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit is designed to enable students to develop their skills in relation to hot water technology and design, in terms of

- Legionella
- Hot water generation
- Safe water Temperatures
- Centralised and local systems
- Disinfection of Plumbing Systems
- Storage Requirements
- Pipe Sizing for Hot Water Systems
- Unvented Hot Water Supply Systems
- Calculate Heat recovery periods
- Water Conservation
- Solar Energy

Learning outcomes

On successful completion of the unit, the candidate will be able to:

1. Understand and promote the best practices for water conservation
2. Understand the latest technologies and best practices in the prevention of Legionnaire's disease
3. Mix quantities of hot and cold water to safe temperatures
4. Disinfect hot water systems
5. Determine the pipe size hot water distribution pipework, secondary returns and heat recovery periods
6. Ensure quality and conformity of water systems
7. Understand the need for water conservation
8. Understand the function of solar energy in energy conservation

Unit 12 Hot water systems technology and design

Unit content

Outcome 1 Understand and promote the best practices for water conservation

The candidate knows how to:

- Understand the Code for Sustainable Homes 2006 and the role of Ofwat (economic regulator) for the management and conservation of drinking water
- Interpret drawings and symbols relevant to plumbing systems
- Understand the specifications relating to backflow prevention arrangements and devices
- Differentiate between wholesome, suspicious and dangerous water supplies

Outcome 2 Understand the latest technologies and best practices in the prevention of Legionnaire's disease

The candidate knows how to:

- Have an understanding of Legionnaires disease and how it affects people
- Be aware of the duties of maintenance engineers regarding Legionella control
 - The control of legionella bacteria in water systems – Approved Code of Practice and guidance 2000
- Understand the procedures to be taken should an outbreak of Legionnaires disease be suspected
- Understand the best practices relating to the storage of hot and cold water and the recommended temperature ranges
- Recognise the problems associated with stagnant water/dead legs and associated pipework and fittings
- Identify the various components of cooling towers and humidifiers and the dangers associated with these items regarding Legionnaires disease
- Understand the need for disinfection of water systems
- Know how to differentiate between the different disinfection methods available
- Demonstrate knowledge of the correct procedures to be followed when disinfection is taking place
- Show an understanding of the frequency of disinfection for water systems

Outcome 3 Mix quantities of hot and cold water to safe temperatures

The candidate knows how to:

- Understand the advantages and disadvantages between storage and instantaneous hot water supply
- Recognise and know the functions of multi-point, single point, gas-fired, Oil-fired and electric systems
- Recognise and know the functions of storage types:
 - vented
 - unvented
- Recognise and know the functions of plate exchangers
- Differentiate between centralised and localised supply
- Interpret schematic diagrams of plumbing systems
- Be aware of the problems associated with dead legs
- Show an understanding of the need for secondary circulation relating to hot water supply
- Recognise and know the functions of insulation and frost protection associated with hot water systems
- Calculate storage requirements for hot water plumbing systems
- Describe the various types of materials used for storage
 - cylinders
 - calorifiers
- Identify the various connections taken from storage cisterns and demonstrate knowledge of best practice currently used

Outcome 4 Disinfect hot water plumbing systems

The candidate knows how to:

- Understand the TMV 3 Scheme
- Understand the importance of Temperature control of hot water distribution
- Understand the principles of Thermostatic Mixing Valves
- Understand the requirements to Blend and Mix Quantities
- Recognise the Safe Bathing Temperatures
- Understand the importance of Boiling water for Beverage Provision

Outcome 5 Determine the pipe size hot water distribution pipework, secondary returns and heat recovery periods

The candidate knows how to:

- Calculate pipe sizes using Loading Units or Litres per Second methods.
- Understand the use of 'Equivalent Pipe Lengths' for fittings and valves.
- Appreciate the 'Loss of Head' through stop valves and at point of delivery.
- Calculate pipe sizes and pumping for secondary circuits
- Complete relevant exercises in pipe sizing.
- Calculate Heat recovery periods
- Calculate pipe sizes for secondary returns

Outcome 6 Ensure quality and conformity of water systems

The candidate knows how to:

- Understand the advantages and disadvantages of unvented hot water supply systems
- Correctly interpret the relevant Local Authority Byelaws as pertaining to unvented hot water supply installations
- Recognise the various types of safety equipment, which must be provided when unvented systems are installed
- Understand the need for regular servicing of unvented hot water systems
- Be aware of the dangers of overheating and corrosion, which can be associated with unvented systems

Outcome 7 Understand the need for water conservation

The candidate knows how to:

- Be aware of the impact of climatic changes on water availability
- Understand the need for incorporating water conservation in the planning and design of new and refurbished buildings
- Understand the need for leak detection in preventing water wastage and water damage

Outcome 8 Understand the function of solar energy in energy conservation

The candidate knows how to:

- Be aware of the efficiency of solar collector panels
- State the benefits of solar energy
- Understand the design and installation procedures associated with solar panels
- Calculate the size of collectors for domestic hot water requirements

Unit 12 Hot water systems technology and design

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A project utilising the skills and knowledge gained from this part of the course. The project must incorporate drawings and specifications to an outline plan and also include all calculations for the hot water services. Relevant BS and EN standards must be referred to.

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Unit 12

Guidance

Hot water systems technology and design

Links with other units/qualifications

This unit has links with the following unit within the Level 4 Higher Professional Diploma in Building Services Engineering:

Unit 13: Cold water systems technology and design

This unit also links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as demonstrating a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken must comply with current safety legislation and any regulations and standards applicable at the time should be noted.

The outline of the items to be included in the project should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Plumbing Engineering Services Design Guide, Institute of Plumbing and Heating Engineering (2002)

Domestic Heating Design Guide, Institute of Plumbing and Heating Engineering (2001)

Chartered Institute of Building Services Engineers Guide, CIBSE. (London)

Building Regulations Technical Guidance Documents, Department of Environment (1991)

Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages, British Standards Institution BS 6700:1997.

Hot and cold Water supply – An illustrated guide, British Standards Institution (1993)

Guidance on Legionella, Institute of Plumbing and Heating Engineering

Unit summary

This unit is about the practical aspects of cold water systems, outlining the fundamentals, to the specifics of system design. It includes current areas, such as: Water Regulations, cold water services, storage requirements, Legionella, disinfection, pipe sizing, residential sprinkler systems, water conservation management.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- Enhance and develop existing skills
- Manage and maintain cold water services and equipment
- Promote water conservation in the plumbing industry
- Have a knowledge of Water Regulations
- Use measuring and monitoring equipment
- Understand the critical factors necessary for water conservation
- Select materials of an approved quality, suitable for specific applications
- Understand current legislation and be aware of the relevant standards and guidance documents
- Interpret diagrams and drawing specifications of water supply and fittings

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Understand and apply water regulations to cold water systems design
2. Be aware of the latest technologies and best practices in the prevention of Legionnaire's disease
3. Demonstrate knowledge of disinfection techniques used in plumbing systems
4. Demonstrate knowledge of installation of cold water services
5. Calculate the storage requirements for cold water supplies
6. Determine pipe sizes for mains water and cold water systems
7. Understand the advantages and disadvantages of different fittings and appliances
8. Demonstrate knowledge of fire fighting and residential sprinkler systems
9. Understand the critical factors necessary for water conservation

Unit 13 Cold water systems technology and design

Unit content

Outcome 1: Understand and apply water regulations to cold water systems design

The candidate knows how to:

- Understand the Water Regulations as applicable to Britain
 - The Water Supply (Water Fittings) Regulations 1999, (Byelaws 2000 in Scotland)
- Interpret drawings and symbols relevant to plumbing systems
- Understand the specifications relating to backflow prevention arrangements and devices
- Differentiate between wholesome, suspicious and dangerous water supplies
- Maintain water quality

Outcome 2: Be aware of the latest technologies and best practices in the prevention of Legionnaire's disease

The candidate knows how to:

- Have an understanding of Legionnaires' disease and how it affects people
- Be aware of the duties of maintenance engineers regarding Legionella control.
 - The control of legionella bacteria in water systems – Approved Code of Practice and guidance 2000
- Understand the procedures to be taken should an outbreak of Legionnaires disease be suspected
- Understand the best practices relating to the storage of cold water and the recommended temperature ranges
- Recognise the problems associated with stagnant water and associated pipe work and fittings
- Identify the various components of cooling towers and humidifiers and the dangers associated with these items regarding Legionnaires disease
- Demonstrate a knowledge relating to materials, which are approved for use in potable water installations

Outcome 3: Demonstrate knowledge of disinfection techniques used in plumbing systems

The candidate knows how to:

- Understand the need for disinfection of plumbing systems
- Differentiate between the different disinfection methods available
- Demonstrate a knowledge of the correct procedures to be followed when disinfection is taking place
- Understand the frequency of disinfection for plumbing systems

Outcome 4: Demonstrate knowledge of installation of cold water services

The candidate knows how to:

- Understand the advantages and disadvantages between storage and mains fed cold water systems
- Interpret schematic diagrams of cold water plumbing systems
- Be aware of the problems associated with dead legs and water hammer
- Understand the need for insulation and frost protection associated with mains and cold water systems

Outcome 5: Calculate the storage requirements for cold water supplies

The candidate knows how to:

- Accurately calculate storage requirements for cold water systems
- Describe the various types of materials used for storage cisterns
- Understand the principles of cold water cisterns connected in series and parallel
- Identify the various connections taken from storage cisterns
- Demonstrate a knowledge of the best practice currently used
- Identify and select the various types of float operated valves used to control the supply of water to storage cisterns, i.e. equilibrium and delayed action valves
- Be aware of the requirements regarding tank rooms in the prevention of contamination, freezing and overheating

Outcome 6: Determine pipe sizes for mains water and cold water systems

The candidate knows how to:

- Calculate pipe sizes using loading units or litres per second method
- Understand the principles of equivalent pipe lengths for fittings and valves
- Appreciate the term "loss of head" through float operated valves, stop valves and at a terminal fitting
- Complete relevant exercises in pipe sizing

Outcome 7: Understand the advantages and disadvantages of different fittings and appliances

The candidate knows how to:

- Understand sanitary appliances and the various materials used in their manufacture
- Be aware of the many specialist appliances available and where they might be used
- Be aware of fittings to reduce undue consumption of water
- Understand the need to provide sanitary facilities for people with disabilities and the space considerations, which must be taken into account

Outcome 8: Demonstrate knowledge of fire fighting and residential sprinkler systems

The candidate knows how to:

- Understand the process of combustion
- Be aware of the different classifications of fire risk
- Identify the different types of fire extinguishers and where they should be used
- Specify fire blankets
- Understand the various types of first aid fire hose reels and where they should be positioned
- Identify the different components associated with residential/domestic sprinkler systems
- Understand the procedures for commissioning, documentation and maintenance of residential/domestic sprinkler systems

Outcome 9: Understand the critical factors necessary for water conservation

The candidate knows how to:

- Be aware of the impact of climatic changes on water availability
- Understand the need for incorporating water conservation in the planning and design of new and refurbished buildings
- Recognise knowledge of the benefits of grey water and rainwater use
- Identify the different types of public lavatory controls available
- Understand the need for leak detection in preventing water wastage and water damage

Unit 13 Cold water systems technology and design

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A project comprising the detailing of an efficient and economical hot and cold water system of supply for a commercial/industrial building.

The following criteria should be covered in the assessment:

- Recording and presenting of information
- Managing time and meeting targets
- Decision making
- Applying self learning
- Applying independent critical thinking
- Evidence of research

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Unit 13 Guidance

Cold water systems technology and design

Links with other units/qualifications

This unit has links with the following unit within the Level 4 Higher Professional Diploma in Building Services Engineering:

Unit 13: Hot water systems technology and design

Delivery advice

As well as acquiring a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken must comply with current safety legislation and any regulations and standards applicable at the time should be noted.

The outline of the items to be included in the project should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Plumbing Engineering Services Design Guide, Institute of Plumbing and Heating Engineering (2002)

Department of the Environment (1991) Building Regulations Technical Guidance Document.

Chartered Institute of Building Services Engineers Guide (A, B, C) CIBSE. (London)

Water Regulations Guide, Water Regulations Advisory Scheme (2000)

Guidance on Legionella, Institute of Plumbing and Heating Engineering

Hot and cold Water supply – An illustrated guide, British Standards Institution (1993)

Unit 14 Sanitation and drainage systems technology and design

Overview

Unit summary

This unit is about the practical aspects of sanitation and drainage systems, outlining the fundamentals, to the specifics of system design. It includes current areas, such as: Regulations, drainage design and building regulations.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit is designed to enable the student to:

- Enhance and develop existing skills
- Further develop the students' knowledge and understanding of scientific principles and the practical applications of these principles in buildings and their environment
- Know typical sanitation & drainage system operating conditions
- Understand sanitation & drainage system design
- Identify the maintenance required for sanitation & drainage systems
- Have a general knowledge of building regulations

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Demonstrate a knowledge of relevant standards and regulations
2. Understand the methods used regarding access, ventilation and the design of inspection chambers and ramps
3. Calculate pipe sizes, velocities and inclines
4. Demonstrate knowledge of best management practice with regard to drainage design
5. Access special design requirements
6. Understand the function of drains and drain testing
7. Interpret building regulations with regard to systems and accommodation
8. Select between sanitation systems and appliances for both single and ranges of appliances
9. Understand the need for protection and support for pipes and their proximity to buildings
10. Interpret schematic diagrams with regard to siphonic drainage of grey water systems and the control of radon gas in buildings
11. Determine the sizes of discharge and ventilating pipes

Unit 14 Sanitation and drainage systems technology and design

Unit content

Outcome 1 Demonstrate a knowledge of relevant standards and regulations

The candidate knows how to:

- Understand definitions and terms; drain, private sewer, public sewer
- Demonstrate a good knowledge of systems used
 - separate
 - combined
 - partially separate
- State the advantages and disadvantages of each system
- Understand and comply with British standards, regulations and codes of practice
 - Building regulations – Drainage and waste disposal
- Illustrate knowledge of the principles of good design

Outcome 2 Understand the methods used regarding access, ventilation and the design of inspection chambers and ramps

The candidate knows how to:

- Design for means of access to drains and sewers, rodding eyes, inspection chambers
- Calculate inspection chamber sizes
- Understand the methods used for inspection chambers within buildings
- Design backdrop chambers and ramps
- Make allowances for ventilation of drains and sewers

Outcome 3 Calculate pipe sizes, velocities and inclines

The candidate knows how to:

- Determine inclination and velocity in circular pipes and channels
- Use "Maguire's" rule effectively
- Calculate pipe sizes for drains and sewers
- Be able to understand
 - self cleansing velocity
 - self cleansing gradient
- Estimate flow loads in pipes

Outcome 4 Demonstrate knowledge of best management practice with regard to drainage design

The candidate knows how to:

- Design storm drains, source control options, swales, infiltration basins, French drains and retention ponds systems for
 - car parks
 - playgrounds
- Demonstrate a knowledge of management practice for the design of drainage systems for
 - garages
 - kitchen layouts
 - petrol interceptors
 - biological control of fat, oil, and grease

Outcome 5 Access special design requirements

The candidate knows how to:

- Design for methods of sewage disposal
- Design for the construction
 - cesspools
 - soakaways
- Demonstrate an understanding bio-cycle systems
- Demonstrate the correct use of definitions

Outcome 6 Understand the function of drains and drain testing

The candidate knows how to:

- Know the methods of inspection and testing of drains
- Know the methods of testing
 - water
 - air
 - smoke
- Know the test pressures and equipment
- Understand the need for bedding and supporting of drains
- Understand the need for inspection and maintenance

Outcome 7 Interpret building regulations with regard to systems and accommodation

The candidate knows how to:

- Apply knowledge of statutes, and building regulations applicable to sanitation installations
 - Building regulations – Drainage and waste disposal
- Design for provision of sanitary accommodation for all types of buildings
- Provide for access and ventilation requirements for sanitary accommodation and bathrooms

Outcome 8 Select between sanitation systems and appliances for both single and ranges of appliances

The candidate knows how to:

- Choose between appliances for all applications
 - soil
 - waste
- Understand sanitation systems
 - ventilated stack
 - single stack
 - modified single
 - stub stacks
- Understand terms used
 - discharge stack
 - ventilating stack
 - branch discharge pipes for single and ranges of appliances
 - branch ventilating pipes
- Understand the loss of seal in traps
- Understand the effects of branches and bends at base of stack
- Understand the effects of offsets in discharge stacks
- Demonstrate the prevention of cross flow in stacks
- Understand the termination and access to discharge stacks

Outcome 9 Understand the need for protection and support for pipes and their proximity to buildings

The candidate knows how to:

- Understand the methods used to support and fix pipes
- Demonstrate knowledge of protection during building construction
- Understand the need for fire stops and seals
- Understand the need for inspection and testing systems for soundness and performance

Outcome 10 Interpret schematic diagrams with regard to siphonic drainage of grey water systems and the control of radon gas in buildings

The candidate knows how to:

- Differentiate between different types of drainage systems
- Compare advantages and disadvantages of vacuum drainage to gravity systems
- Understand the operation of the vacuum drainage system
- Consider the factors necessary in design and equipment used
- Demonstrate a knowledge and understanding of grey water systems
- Understand how radon gas enters buildings
- Demonstrate a knowledge of how to exclude radon gas
 - passive
 - active protection measures
- Demonstrate a knowledge of installation procedures and best practice measures

Outcome 11 Determine the sizes of discharge and ventilating pipes

The candidate knows how to:

- Determine the size discharge and ventilating pipes for all types of sanitary systems
- Apply discharge unit methods for pipe sizing
- Estimate flow loads using probable simultaneous discharge
- Use probability graphs for design for sanitary pipework systems

Unit 14 Sanitation and drainage systems technology and design

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A project which details plans and sketches of systems and back-up information with regard to design and calculation procedures

The following criteria should be covered in the assessment:

- Recording and presenting of information
- Managing time and meeting targets
- Decision making
- Applying self learning
- Applying independent critical thinking
- Evidence of research

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Unit 14

Sanitation and drainage systems technology and design

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as acquiring a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken must comply with current safety legislation and any regulations and standards applicable at the time should be noted.

The outline of the items to be included in the project should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Fred Hall & Roger Greene, *Building Services Hand book*, (2001)

Kevin Stead, *Plumbing revision and self-assessment*, (2000)

Leslie Woolley, *Sanitation Details*

Leslie Woolley, *Drainage Details*

Institute of Plumbing, *Plumbing Engineering Services Design Guide*, (2002)

BS.5572 Code of practice for sanitary Pipework

BS.6367 Drainage of roofs and paved areas

BS. 8301 Building Drainage

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Unit 15

Air conditioning and refrigeration systems technology and design

Overview

Unit summary

This unit is about the practical aspects of air-conditioning and refrigeration, from an overview of the fundamentals, to the specifics of system design. It includes the most current areas of interest, such as computer-aided design, desiccant air conditioning, and energy conservation. It provides an introduction to all types of systems — industrial, commercial, and residential.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- Enhance and develop existing skills
- Provide a sound understanding of ventilation and air-conditioning technology and techniques
- Know typical ventilation and air-conditioning system operating conditions
- Use appropriate measuring and monitoring equipment
- Understand ventilation and air-conditioning system design
- Select plant for specific applications
- Manage and maintain ventilation and air-conditioning plant

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Illustrate and analyse the change in properties and the thermal characteristics of the air conditioning process and cycles, using psychometrics
2. Select between central systems, air handling units and packaged units for specific applications
3. Interpret schematic diagrams of ventilation and air-conditioning duct systems and components
4. Understand the heat pump principle as applied to a vapour compression cycle
5. Differentiate between the vapour compression refrigeration systems and absorption refrigeration systems and name appropriate refrigerants for specific applications
6. Calculate design space loads using outdoor design conditions and indoor design criteria
7. Safe use of instruments and equipment to record air movement, humidity temperature and pressure
8. Accurately assess refrigeration components and evaporative coolers
9. Understand and calculate air system basics
10. Understand the need for control, control methods and system basics

Unit 15 Air conditioning and refrigeration systems technology and design

Unit content

Outcome 1 Illustrate and analyse the change in properties and the thermal characteristics of the air conditioning process and cycles, using psychometrics

The candidate knows how to:

- understand the terms: moist air, humidity, specific enthalpy, specific volume, density, specific heat, dry bulb, wet bulb and dew point temperature, moisture content, open and closed cycles, latent heat changes, room sensible heat ratio
- plot air properties using psychometric charts
- determine air conditioning processes using psychometric charts, i.e. sensible heating and cooling, isothermal humidification
- calculate air properties using psychometric charts, including mixing of two air streams
- determine operating characteristics of an air-conditioning cycle

Outcome 2 Select between ventilation, central systems, air handling units and packaged units for specific applications

The candidate knows how to:

- understand the terms: natural ventilation, mechanical ventilation, central system, air handling unit, packaged unit, split system, chilled water system, VAV system, all-air, air-water, terminal reheat, jewel of duct, induction and fan-coil
- understand outside air requirements and air change rates
- recognise the different types of water system
- identify the piping materials of various water systems
- know the different piping arrangements
- understand various types of heating system
- understand the classifications of refrigeration system

Outcome 3 Interpret schematic diagrams of ventilation and air-conditioning duct systems and components

The candidate knows how to:

- identify the layout of duct systems
- understand automatic control in ducts
- understand types and operation of fire dampers and smoke detectors
- identify typical air filters, humidifiers, dehumidifiers and coils
- determine the factors used to evaluate filters
- desiccant air conditioning
- identify transmission of noise and vibration
- recognise the different types of diffuser and other terminal devices

Outcome 4 Understand the heat pump principle as applied to a vapour compression cycle

The candidate knows how to:

- understand the terms: low grade heat source, split, packages, bivalent and monovalent indoor and outdoor units
- understand the characteristics of direct expansion systems and heat pumps
- identify pipework and components, i.e. four-way valve, NRV, bi-flow 1EV, scroll compressors
- recognise heat recovery methods, e.g. heat pipe, thermal wheel, water to water heat exchangers, run around coils

Outcome 5 Differentiate between the vapour compression refrigeration systems and absorption refrigeration systems and name appropriate refrigerants for specific applications

The candidate knows how to:

- understand the terms: refrigeration cycle, refrigerants, cooling mediums, subcooling, superheating, coefficient of performance
- differentiate between principles of a vapour compression and absorption chiller system
- recognise refrigerants by their operating characteristics
- identify desirable properties of a refrigerant
- recognise secondary refrigerants
- plot thermodynamic properties of refrigerants using pressure enthalpy charts
- determine coefficient of performance of refrigeration cycles
- determine system operating characteristics using different refrigerants
- calculate the compression ratio of refrigeration systems
- understand the characteristics of multi-stage vapour compression systems and cascade systems

Outcome 6 Calculate design space loads using outdoor design conditions and indoor design criteria

The candidate knows how to:

- understand the terms: outdoor design conditions, indoor design criteria, thermal comfort, indoor temperature, relative humidity, air velocity, indoor air quality, outdoor ventilation air requirements, clean rooms, space pressure differential, sound levels, comfort indices
- understand methods used by the human body to emit heat
- recognise indoor air contaminants
- identify typical HTVAC design conditions
- understand cooling loads, conduction and internal heat gains
- identify the interaction of the building fabric and the ventilation/air conditioning system in controlling the indoor climate
- calculate cooling coil and heating loads and infiltration volume flow rate

Outcome 7 Safe use of instruments and equipment to record air movement, humidity temperature and pressure

The candidate knows how to:

- understand the terms: globe thermometer, sling psychrometer, vane anemometer, hot wire anemometer, pitot tube
- connect a pressure manifold gauge set to a refrigerating system
- leak test a vapour compression refrigerating system
- measure the relative humidity of air
- measure the temperature of air and refrigerant at various locations in a system
- measure and record the velocity of air using a pitot tube and a vane anemometer
- measure and record the running current of electrical motors and compare with motor FLA
- calculate volume flow rate using recorded air velocities for various shaped ducts

Outcome 8 Accurately assess refrigeration components and evaporative coolers

The candidate knows how to:

- understand the terms: refrigeration compressors, refrigeration condensers, fouling factor, evaporators, refrigerant flow control device, evaporative coolers, centrifugal chillers, screw chillers
- identify various refrigeration components and describe their function
- identify various refrigeration systems
- differentiate between air-cooled, water cooled, evaporative condensers and cooling towers
- understand the problems and remedies in recirculated water systems
- recognise refrigerant behaviour which lubricating oils

Outcome 9 Understand and calculate air system basics

The candidate knows how to:

- understand the terms: flow resistance, fan duct system, system operating point, constant volume systems, variable air volume systems, fan characteristic curves
- identify the four types of minimum outdoor ventilation air control
- recognise different fan types, i.e. centrifugal, axial-flow and tangential
- plot fan characteristic curves
- determine appropriate motor size
- calculate air conditioning system conditions using the fan laws
- understand types of modulation of volume flow rate of VAV air systems
- recognise sick building syndrome (SBS) characteristics and contributors
- differentiate SBS with building related illness

Outcome 10 Understand the need for control, control methods and system basics

The candidate knows how to:

- understand the terms: automatic control, two-position, floating, proportional control, PID control, open- and closed-loop control, actuators
- recognise the fundamentals of control, i.e. temperature, humidity, pressure sensors, dampers, valves, variable speed drives
- identify controlled devices, i.e. low-pressure, high-pressure, high-temperature controls, pressure regulators, oil-level controls, flow switches, overload protection, capacity control
- understand direct digital control
- recognise computer software packages in use in the mechanical services industry, i.e. building energy management systems (BEMS), Hevacomp, Cymap, Apache Building Simulation Package, Auto CAD
- apply energy conservation techniques

Unit 15 Air conditioning and refrigeration systems technology and design

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- **A project comprising of the detailing of an air conditioning and refrigeration system.**

The following criteria should be covered in the assessment:

- Recording and presenting of information
- Managing time and meeting targets
- Decision making
- Applying self learning
- Applying independent critical thinking
- Evidence of research

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Unit 15

Air conditioning and refrigeration systems technology and design

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as demonstrating a detailed understanding of system design, plan selection, management, employment and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken must comply with current safety legislation and any regulations and standards applicable at the time should be noted.

The outline of the items to be included in the project should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Banhan, R., *The Architecture of the Well Tempered Environment*, Architectural Press (1994).

Burberry, *Environment and Services*, Batford (1992).

Chartered Institute of Building Service Engineers Guides (A, B, C), CIBSE (London).

Clifford, G., *Modern Heating, Ventilating and Air Conditioning*, Prentice Hall, (1990).

Dossat, R. J., *Principles of Refrigeration*, Prentice Hall, (1996).

Faber & Kell's, *Heating and Air Conditioning of Buildings*, Architectural Press, (1995).

Gosling, C. T., *Applied Air Conditioning and Refrigeration*, Applied Science, (1980).

Hall, *Building Services and Equipment (f/ok. 1, 2, 3)*, Longmans, (1994).

Jennings, *The Thermal Environment*, Harper and Row, (1978).

Jones, W. P., *Air Conditioning Engineering*, Arnold, (1994).

Legg, R. C., *Air Conditioning - Design, Commissioning and Maintenance*, Batford, (1991).

McQuiston, F. C., Parker, D. J., *Heating, Ventilating and Air Conditioning - Analysis and Design*, John Wiley & Sons, (1994).

Sauer, H. J., Jr., Howell, R. H., *Principles of Heating Ventilating and Air Conditioning*, ASHRAE, (1992).

Sherrat, A. F., *Air Conditioning - Impact on the Built Environment*, Wiley, (1987).

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Unit 16 Heating and ventilating systems technology and design

Overview

Unit summary

This unit will provide the student with in-depth and adequately referenced information along with practical experience regarding the many avenues available to them, which will help them to improve the environmental performance of buildings.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes, and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- Enhance and develop existing skills
- Promote the use of alternative heat sources
- Understand what good thermal comfort conditions are
- Understand the term – Heat Energy Rating
- Understand the effects on the environment of burning fossil fuels
- Realise the benefits of building a passive solar house
- Design and install solar hot water and photovoltaic systems
- Identify the savings made when installing a micro combined heat power unit
- Know the principle of operation of the different types of heat pumps
- Select the advantages and disadvantages of using wood burning stoves
- Select quality insulating materials for specific applications
- Interpret diagrams and drawing specifications of relevant systems
- Select materials of an approved quality suitable for a specific application

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Understand the need for alternative technologies in the design of sustainable buildings
2. Realise the benefits of implementing the “heat energy rating” on buildings
3. Understand the benefits of a passive house
4. Design and install a solar hot water system
5. Understand the principle of photovoltaic systems
6. Know the principle of operation of a micro combined heat power unit
7. State the benefits of using heat pumps in modern buildings
8. Select an energy efficient wood burning stove
9. Identify new technologies in sewage disposal, rain and waste water treatment
10. State the current trends in heating the houses of the future

Unit 16 Heating and ventilating systems technology and design

Unit content

Outcome 1: Understand the need for alternative technologies in the design of sustainable buildings

The candidate knows how to:

- Be aware of the consequences of climate change
- Know the importance of good thermal comfort
- Recognise the benefits of installing good insulating materials
- Recognise the opportunities available in alternative energy
- Describe the greenhouse gas effect on the environment
- Realise the problems associated with burning fossil fuels
- Understand the importance of reducing the heating load in buildings
- Understand what solar energy is
- Briefly explain the difference between passive and active solar energy

Outcome 2: Realise the benefits of implementing the “heat energy rating” on buildings

The candidate knows how to:

- Play an active part in reducing future energy consumption
- Know how to calculate and actively reduce CO² emissions
- Know the role of the assessors in calculating the HER of a dwelling
- Know the time scale for the implementation of the HER process
- Understand the term energy labelling
- Know the energy efficient measures being put in place to ensure efficiency in energy use

Outcome 3: Understand the benefits of a passive house

The candidate knows how to:

- Understand site orientation, layout and design of a passive house
- Know the quality of insulation required in the design of a passive house
- Understand the workings of a heat recovery unit in a passive house
- List the maximum permissible “U” values allowed in the design of a passive house
- Understand the advantages and disadvantages of building passive houses
- Know the ventilation requirements of a passive house
- Understand the importance of air tightness in a passive house

Outcome 4: Design and install a solar hot water system

The candidate knows how to:

- Have an understanding of the quality of solar radiation in Britain
- List the different types of solar collectors used in solar design
- Design and install a solar hot water system
- Know the principle requirements on components and materials
- Calculate the cost of a standard solar hot water system for a two storey dwelling
- Know how to commission a solar hot water system
- Know how to control the temperature of a solar installation
- Have an understanding of the function and requirements of heat exchangers
- State the safety considerations of a solar installation
- Understand the advantages and disadvantages of a solar installation
- Calculate the size of collectors for domestic hot water requirements

Outcome 5: Understand the principle of photovoltaic systems

The candidate knows how to:

- Know the different types of solar cells available
- Design a basic PV system
- Understand the different types of PV systems
- List the components of a PV system
- Know how to measure solar energy
- Understand efficiency and impacts of solar electricity
- Have a knowledge of how PV cells are made
- Know how electricity is stored
- Know how much electricity can be generated using PV cells
- Understand how the battery inverter works

Outcome 6: Know the principle of operation of a micro combined heat power unit

The candidate knows how to:

- Know how a micro combined heat power unit operates
- State the advantages and disadvantages of a micro CHP unit
- Know the principle requirements on components and materials
- Understand how efficiency is achieved with micro CHP units
- Describe how surplus electricity is stored

Outcome 7: State the benefits of using heat pumps in modern buildings

The candidate knows how to:

- State the advantages and disadvantages of installing heat pumps
- State the efficiencies of the different types of heat pumps
- Describe the alternative uses of Geo-thermal water
- Know the factors affecting the cost when designing a system
- Have a knowledge of the maintenance requirements of heat pumps
- Understand the term co-efficient of performance
- Identify the various types of soil/rock suitable for use with heat pumps
- Appreciate the success of heat pumps in other European countries
- Demonstrate a knowledge of the mechanics of the heat pump process
- Describe the heat sources available for heat pumps
- Have the ability to select the correct heat pump
- Describe the difference between the open and closed loop system

Outcome 8: Select an energy efficient wood burning stove

The candidate knows how to:

- Understand the potential and utilisation of wood fuels in Britain
- Know the properties of wood as a fuel
- Identify the sources of wood fuels
- Have an understanding of wood fuels in heat production techniques
- Know how to heat residential buildings using wood pellet boilers
- Understand the environmental aspects of wood burning
- Be aware of the different types of burners and feeders
- Know the high efficiencies achievable with the use of pellet boilers

Outcome 9: Identify new technologies in sewage disposal, rain and waste water treatment

The candidate knows how to:

- Know how to design grey waste systems
- Design a basic rainwater harvesting system
- Understand the cost implications relating to these systems
- State the advantages and disadvantages of the different systems
- Understand the sustainable urban drainage systems
- Understand the reed bed sewage treatment system

Outcome 10: State the current trends in heating the houses of the future

The candidate knows how to:

- Have a list of the sources of information required for sustainable technologies
- Know the advisory bodies, groups and trade associations linked to sustainable technologies
- Have a basic understanding of biomass, bio-fuels, hydrogen cells, and wind generation

Unit 16 Heating and ventilating systems technology and design

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A project comprising of the detailing of an energy efficient heating or hot water system using an alternative heat source for a residential building.

The following criteria should be covered in the assessment:

- Recording and presenting of information
- Managing time and meeting targets
- Decision making
- Applying self learning
- Applying independent critical thinking
- Evidence of research

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Unit 16

Heating and ventilating systems technology and design

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as demonstrating a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; Independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken must comply with current safety legislation and any regulations and standards applicable at the time should be noted.

The outline of the items to be included in the project should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Plumbing Engineering Services Design Guide, The Institute of Plumbing (2002)

Domestic Heating Design Guide, The Institute of Plumbing (2001)

Building Regulations Technical Guidance Documents, Department of the Environment (1991)

Hall K, *The Green Building Bible*. Green Building Press, (2005).

Felix A, Remmers K, Schnauss M., *Solar Thermal Systems*, (2002).

Unit 17

Overview

Mathematics for building services engineers

Unit summary

This unit is about the application of a range of mathematical techniques to the solution of building services engineering problems.

Successful achievement of this unit is dependent upon the candidate meeting the assessment requirements relating to the outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

This unit aims to enable the candidate to:

- acquire mathematical techniques
- recognise situations in which mathematical techniques may be applied to solve problems
- apply a variety of mathematical methods in the solution of building services engineering problems
- demonstrate the generality of mathematics with respect to the analysis of different building services engineering situations.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Solve building services engineering problems that involve the use of trigonometric identities
2. Use methods of differential calculus to solve building services engineering problems
3. Use methods of integral calculus to solve building services engineering problems
4. Apply complex numbers to the solution of building services engineering problems.

Unit 17 Mathematics for building services engineers

Unit content

Outcome 1: Solve building services engineering problems that involve the use of trigonometric identities

The candidate knows how to:

- identify trigonometric identities appropriate to the solution of problems. The identities may include the compound and double angle formulae for sine and cosine, and the sums to products formulae and products to sums formulae
- apply trigonometric identities to the solution of problems involving maximum and minimum values, addition of waves and trigonometric equations.

Outcome 2 Use methods of differential calculus to solve building services engineering problems

The candidate knows how to:

- obtain the first derivatives of the following functions: ax^n , $(ax \pm b)^n$, $\sin(ax \pm b)$, $\cos(ax \pm b)$, $e^{(ax \pm b)}$, $\ln(ax \pm b)$ and linear combinations of these functions
- obtain the derivatives of products, quotients and functions of the functions given above
- determine the nature and position of stationary values
- use differentiation methods to sketch graphs and solve problems involving maximum and minimum values.

Outcome 3 Use methods of integral calculus to solve building services engineering problems

The candidate knows how to:

- obtain indefinite integrals of the following functions: ax^n , $(ax \pm b)^n$, $\sin(ax \pm b)$, $\cos(ax \pm b)$, $e^{(ax \pm b)}$ and $1/(ax \pm b)$
- obtain definite integrals of the functions given above
- describe the significance of and calculate mean values of the functions given above and root mean square values of trigonometric functions.

Outcome 4 Apply complex numbers to the solution of building services engineering problems

The candidate knows how to:

- add, subtract, multiply and divide complex numbers in rectangular form
- multiply and divide complex numbers in polar form
- convert complex numbers to and from rectangular and polar forms
- solve problems involving two complex parallel impedances.

Unit 17 Mathematics for building services engineers

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of building services engineering mathematics. The case studies should cover the following areas:
 - application of trigonometric identities in the solution of building services engineering problems
 - application of integral and differential calculus in the solution of building services engineering problems
 - application of complex algebra in the solution of building services engineering problems.

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Improving own Learning and Performance

- LP4.1 Develop a strategy for improving your own learning and performance.
- LP4.2 Monitor progress and adapt your strategy to improve your performance.
- LP4.3 Evaluate your strategy and present the outcomes of your learning.

Links with other units/qualifications

This unit is a mandatory unit for all Level 4 Building Services Engineering programmes. It provides underpinning knowledge for all technology units and develops strategies to enable candidates to research within technology units, and also to integrate and consolidate knowledge across different units.

This unit also has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Candidates should be reassured of the relevance of this unit by relating it to building services engineering principles wherever the opportunity occurs. This may be done by referring to other units within the building services engineering programme and, if possible, to work experience.

The use of computer spreadsheets, databases and mathematics software packages for processing data and presenting results should be encouraged.

Whilst not essential to the completion of the unit, access to the Internet and the use of a mathematics application package (such as Mathcad) would enhance candidates' understanding of the Unit content and the presentation of Assessment material.

Suggested resources list

K.A.Stroud, *Engineering Mathematics*, Palgrave, (1995)

A.Greer and G.W.Taylor, *BTEC National NII: Mathematics for Technicians*, Nelson Thornes, (1994)

A.Greer and G.W.Taylor. *BTEC National NIII: Mathematics for Technicians*, Nelson Thornes, 1989.

Open Learning Text:

Mathematics for Engineers, COLU, (2001)

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Unit 18

Planning work methods, workforce and resource requirements for building service engineering projects

Overview

Unit summary

This unit is about demonstrating the competence in assessing project data, calculating resource requirements, optimising the use of resources, identifying reliable and quality individuals and organisations to form a project team and plotting the critical path and the consequences of variations to the project.

Successful achievement of this unit is dependent upon the candidate meeting the assessment requirements relating to the outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

This unit aims to enable the candidate to:

- Prepare method statements
- Evaluate, analyse and quantify method statements adopted
- Develop a system for monitoring and evaluating project outcomes
- Identify the resources required for the project team to operate
- Negotiate project team contracts
- Produce a specification for individual and organisational responsibilities

Learning outcomes

1. Evaluate work methods
2. Select work methods
3. Plan work activities and resources
4. Select and form a project work team
5. Establish and maintain project organisation and communication systems

Unit 18 Planning work methods, workforce and resource requirements for building service engineering projects

Unit content

Outcome 1: Evaluate work methods

The candidate knows how to:

- access project data
- obtain information from alternative sources in cases where the available project data is insufficient
- assess the available project data accurately
- summarise project data to enable decisions on work activities to be made
- evaluate the methods against relevant technical and project data
- select the one which method meets the criteria

Outcome 2: Select work methods

The candidate knows how to:

- identify work methods that best utilise resources and which meet approved procedures and practices
- recommend the selected method to decision makers and encourage them to adopt it
- analyse the method which has been selected for its activity content and quantify it accurately
- prepare a method statement which is accurate, clear, concise and acceptable to all individuals and organisations involved

Outcome 3: Plan work activities and resources

The candidate knows how to:

- identify work activities and calculate the resources needed from the information available obtaining clarification and advice where the resources needed are not available
- analyse the work activities against project data and the requirements of significant external factors
- calculate how long each activity will take, identify work activities which influence each other and sequence them logically and realistically so that they make the best use of the resources available
- produce detailed plans for work activities which are consistent with approved procedures and practices
- identify alterations to work activities which will meet changed circumstances or offer cost and time benefits, calculating the savings accurately and justifying them to decision makers
- develop a system for monitoring the work activities implementing it and using the results to improve future production and planning

Outcome 4: Select and form a project work team

The candidate knows how to:

- identify the individuals and organisations that are needed and where they can be obtained, and select those that meet agreed timescales and budget limits
- identify any significant factors which will affect the number, type and availability of individuals and organisations
- evaluate the quality and potential reliability of individuals and organisations and resources and circulate the results to decision makers
- negotiate and agree proposals for team membership which are likely to produce effective working relationships
- follow approved procedures and practices for obtaining individuals and organisations
- produce appropriate contractual arrangements and terms of appointment for the individuals and organisations and confirm in writing with stakeholders
- negotiate contracts and agreements in a way which preserves goodwill and trust

Outcome 5: Establish and maintain project organisation and communication systems

The candidate knows how to:

- identify what project organisational and communication needs are
- develop and introduce systems which are compatible with approved procedures and practices and which enable clear and effective management, and administrative and operational controls
- produce accurate and unambiguous information about people's roles and responsibilities and the organisational structure, and circulate the information to individuals and organisations who have an interest
- introduce methods of communicating, reporting, recording and retrieving information which are appropriate to the needs of the project and comply with approved procedures and practices and monitor the methods regularly for effectiveness
- identify and investigate breakdowns in communication, and take action to restore effective communication
- set up systems for recording and providing feedback on the ways in which resources are allocated and used

Unit 18 Planning work methods, workforce and resource requirements for building service engineering projects

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies/projects to demonstrate the candidate's understanding of the underpinning theory/principles and its application when planning work methods, workforce and resource requirements for building service engineering projects

The above pieces of work should total approximately 2500 words.

Unit 18

Planning work methods, workforce and resource requirements for building service engineering projects

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Communication

- C4.1 Develop a strategy for using communication skills over an extended period of time.
- C4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving at least one group discussion about a complex subject and one document of 1,000 words or more about a complex subject.
- C4.3 Evaluate your overall strategy and present the outcomes from your work, using at least one formal oral presentation. Include a variety of verbal, visual and other techniques to illustrate your points.

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Working with Others

- WO4.1 Develop a strategy for working with others.

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as demonstrating a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken should comply with current safety legislation and any regulations and standards should be noted.

The outline of the items to be included in the project should be agreed with appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

W. Bolton, *Production Planning and Control*, Longman (1994)

Knox *Engineering Project Planning*

D. Lock, *Essentials of Project Planning*, Gower

Open Learning Text:

Project Planning , COLU (2001)

Unit 19

Contract procedures and requirements for building services engineering projects

Overview

Unit summary

This unit is about the contract documents that are required in connection with a building project. Similar documents are required for works of civil engineering construction although the context and contents are different. The requirements must consider the following:

- contractual conditions under which the work will be carried out
- work to be performed that usually requires some form of drawn information
- quality of the work required
- cost of the finished work
- construction programme

Managers need an ability to examine the various documents provided, and to make their own investigations as necessary. They need to identify exactly what is required by the client and what actions need to be taken to ensure project success, against the various criteria.

Successful achievement of this unit is dependent upon the candidate meeting the assessment requirements relating to the outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- Understand the employer's requirements and contractor's obligations under a building contract - a standard form of contract, of which there are many, will usually be required
- Identify the different requirements in respect of drawn information and schedules
- Assess the requirements for quality which is frequently described in a specification of bills of quantities
- Understand how costs are calculated, and often predetermined, through the use of bills of quantities, schedules of rates, measured work packages or other forms analysis
- Familiarise themselves with the master programme
- Make a site visit to note how the conditions on the site may affect the works

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Understand key clauses and concepts from one of the standard forms of building contract
2. Identify the different types of drawn information, their purposes and use
3. Identify schedules of information and relate these to the other documents
4. Understand the requirements of a specification of the works
5. Examine a bill of quantities or schedule of rates and understand its contents
6. Read a master programme and relate this to the progress of the works
7. Identify the important points to note on a pre-visit to a site

Unit 19 Contract procedures and requirements for building services engineering projects

Unit content

Outcome 1: Understand key clauses and concepts from one of the standard forms of building contract

The candidate knows how to:

- use the different forms of building contract
- identify the arrangement and the contents of a major form of building contract
- use the articles of agreement and appendix and their purpose
- identify the key clauses in respect of time, cost and quality

Outcome 2: Identify the different types of drawn information, their purposes and use

The candidate knows how to:

- read production drawings relevant to the work
- understand the implications of the details shown on the drawings including their buildability
- decide the work sequence and methods of work by examination of the drawings
- understand how the drawings are used to inform the construction works on site

Outcome 3: Identify schedules of information and relate these to the other documents

The candidate knows how to:

- identify where and how schedules are used
- interpret data provided on schedules and other similar information
- relate the schedules to the other contract documentation
- compare and contrast the information included on the schedules with the drawings and bills of quantities

Outcome 4: Understand the requirements of a specification of the works

The candidate knows how to:

- use a specification when this is required as a contract document
- interpret the information contained in a specification
- consider the implications of the specification information and how it affects the work
- interpret the specification in the way construction work is carried out

Outcome 5: Examine a bill of quantities or schedules of rates and understand its contents

The candidate knows how to:

- identify the purpose of bills of quantities or schedule of rates
- prepare a bills of quantities or schedules of rates
- assess the significance of the quantities in a bill
- use the bills of quantities of work to help define the work programme
- interpret the rules of a method of measurement

Outcome 6: Read a master programme and relate this to the progress of the works

The candidate knows how to:

- understand the contents and inter-relationship of a master programme
- know how it relates to the conditions of contract
- identify reasons why the project may fall behind its programme
- make suggestions of how the programme might be brought back on schedule

Outcome 7: Identify the important points to note on a pre-visit to a site

The candidate knows how to:

- make a visit to a proposed site and list the factors which will affect the work
- list the provisions needed on a site to support the project
- inspect the site and note any special requirements for temporary works and access
- assess how the nature of the site might affect the costs of construction

Unit 19 Contract procedures and requirements for building services engineering projects

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A word processed report of about 1500 words based on one contract with which the candidate is familiar and which details:
 - the nature of the building site, identifying its salient features
 - the type of work and what it involved
 - the nature of the client
 - the contract documents used
 - the inter-relationship of these documents
 - conflicts arising from the use of the documents and how these were resolved

The inclusion of relevant sketches, drawings or other data to assist the presentation of the report should be included as an appendix.

Unit 19

Contract procedures and requirements for building services engineering projects

Guidance

Links with other units/qualifications

This unit links with:

- Building Site Management NVQ 4
- Civil Engineering Site Management NVQ 4
- Building Maintenance & Estates Services NVQ4

This unit also has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Data from the candidate's organisation, and guidance from colleagues in other departments (estimating, for example), will be required.

Assessment must relate directly to the candidate's experience and involve good work practice.

The unit relies on the candidate's ability to write a report detailing how to decide the scope of the construction work and to note the factors which can affect the work. Candidates must be able to demonstrate a clear understanding of the technical requirements of the work. An element of preparation and report writing, in addition to the formal hours allocated, is likely to be necessary in order for the candidate to fully understand the requirements of the work which he/she is involved in.

Observance of relevant regulations should be noted in the report where relevant.

Examples of good and poor practices from site experiences should be identified and how these impacted on the progress of the works should be noted.

The contract chosen, and the outline of the items to be included in the report, should be agreed by appropriate staff prior to commencement. Permission to use any information from a firm should be obtained where necessary.

All evidence should be the candidate's own work and candidates are expected to plan and produce their reports independently.

Suggested resources list

Aqua Group, *Pre-Contract Practice and Contract Administration for the Building Team*, Blackwell Publishing (2003)

Ashworth A., *Contractual Procedures in the Construction Industry*, Longman (2001)

Latham M., *Constructing the Team*, HMSO (1994)

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Overview

Unit summary

This unit is about calculating the contractor's costs involved during the preparation of estimates and then using this information to complete the tender. Building Services managers need a detailed understanding of how the estimates of cost have been calculated. Building Services managers are then able to use and identify the resources contained within the contractor's tender to plan and execute the work on site.

Successful achievement of this unit is dependent upon the candidate meeting the assessment requirements relating to the outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to calculate construction costs using basic cost data, other information and labour outputs that have been retrieved from the feedback of previous projects.

This unit gives candidates an opportunity to improve their understanding of:

- The use of resource costing in the tendering process
- How tenders are prepared and what is included in them.
- The use of the tender and its contents in planning construction work

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Understand the need to be fully appraised of the contract documents including the need for a site visit
2. Calculate the costs of resources
3. Calculate the costs of measured items of work
4. Identify the contractor's costs associated with nominated subcontractors
5. Consider the conditions of contract and their implication on the contractor's costs
6. Assess site on-costs and head office overheads charges and profit

Unit 20 Estimating and tendering for building services engineering projects

Unit content

Outcome 1: Understand the need to be fully appraised of the contract documents including the need for a site visit

The candidate knows how to:

- identify the individual nature of each proposed construction site and note any factors which will affect the work
- examine the drawings to gain an understanding of the project requirements
- study the bills of quantities, specification or schedule of rates to understand the various requirements of time, quantity and quality
- review the conditions of contract and especially the contents of the appendix

Outcome 2: Calculate the costs of resources

The candidate knows how to:

- build up the costs of employing operative and craft
- interpret the provisions of the Working Rule Agreement inasmuch as they affect costs
- calculate the costs involved of owning or operating plant and equipment
- allocate costs to materials in respect of delivery, unloading, hoisting, fixing in position, wastage, shrinkage, consolidation or increase in bulk, storage and workshop charges
- prepare and send out enquiries for material prices and subcontractor quotations

Outcome 3: Calculate the costs of measured items of work

The candidate knows how to:

- calculate the costs of a range of typical measured items from bills of quantities
- use site feedback to update labour outputs and material wastage factors
- reconcile a range of invoices for common building materials with the quantities in the final account
- consider the particular aspects of a project when analysing rates for measured works
- discuss the various price analysis with the estimator

Outcome 4: Identify the contractor's costs associated with nominated subcontractors

The candidate knows how to:

- understand what is meant by prime cost and provisional sums and is aware of how these items are included in the overall price.
- understand why profit is added to the various lump sums for prime costs sums
- calculate the proportion of costs allocated to general attendance items
- calculate the proportion of costs allocated to other or special attendance items

Outcome 5: Consider the conditions of contract and their implication on the contractor's costs

The candidate knows how to:

- consider whether a particular form of contract has an affect on the contractors method of working or risks involved
- identify which contract clauses may have a particular effect on the contractor's costs
- understand the difference between fixed price and fluctuating price contracts
- discuss these issues with the estimator

Outcome 6: Assess site on-costs and head office overheads charges and profit

The candidate knows how to:

- differentiate between estimating and tendering
- identify the items from the preliminaries section of bill of quantities that attract a monetary value
- build up prices for preliminary items using method related charges
- identify the head office overhead costs
- recognise the cost implications in respect of safety, health and welfare
- assess the factors that govern the amount to be added for the contractor's profit
- understand the purpose and need for contingencies

Unit 20 Estimating and tendering for building services engineering projects

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A range of bills of quantities items that have been priced from first principles and using an analysis of the resources required. The candidate needs to demonstrate:
 - a knowledge of the process involved
 - an awareness of the resources used and the various allowances made to different resource prices
 - an understanding how the nature of the project, the conditions of contract and the conditions under which the work will be carried out affect a contractor's costs.

The above pieces of work should total approximately 2500 words.

Unit 20

Estimating and tendering for building services engineering projects

Guidance

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Assessment should be practical and realistic and relate to current sector practice. It should relate directly to the candidate's experience and must demonstrate the candidate's knowledge and good estimating practice.

Published cost databases can be used in conjunction with the assessment, but it is essential that candidates are able to demonstrate the calculation of rates from first principles.

Candidates should be encouraged to give examples of bad practice (guessing prices or using incorrect logic) to calculate costs. The effect this had on the work should be noted, and the actions which should be taken to overcome such practices.

The data to be used, and the priced estimate of contract work intended to be submitted, should be discussed with and agreed by appropriate staff prior to commencement.

All evidence should be the candidate's own work and candidates are expected to plan and produce their submissions independently.

Suggested resources list

Ashworth A., *Pre-contract Studies: Development Economics, Tendering and Estimating*, Blackwell Publishing (2002)

Brook M., *Estimating and Tendering for Construction Work*, Butterworth Heinemann (2004)

Buchan R. D., Fleming F. W. and Grant F. E. K., *Estimating for Builders and Surveyors*, Butterworth Heinemann (2003)

CIOB, *Code of Estimating Practice*, Longman (1997)

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Overview

Unit summary

This unit is concerned with the monitoring and control of the financial resources of building services engineering organisations. In a competitive environment the organisation which can operate effectively, efficiently and economically will be pro-active in their evaluation of the impacts of change or new opportunities. The unit focuses on the practical application of various accounting techniques, which will allow the manager to make an accurate evaluation of the impact of a variety of decisions on the financial capabilities of the building services engineering organisation.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes and producing work of a satisfactory and reliable standard.

Aims

This unit aims to enable the candidate to:

- Acquire practical skills and techniques
- Apply those techniques to the evaluation, monitoring and control of the organisations financial resources
- Understand the role of financial management in the achievement of the organisation's objectives and in the wider business environment

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Describe the accounting function of an engineering organisation and the requirements of a regulatory framework
2. Demonstrate an understanding of the content of financial statements for a variety of building services engineering related organisations
3. Interpret and analyse a variety of financial statements for organisations both inside and outside the building services engineering sector
4. Analyse the nature of costs and methods of overhead recovery related to pricing strategies appropriate to the building services engineering industry
5. Apply the appropriate techniques to the evaluation of capital investment projects
6. Demonstrate an understanding of the nature of the strategic objectives of a building services engineering related organisation and determine an annual planning cycle

Unit 21 Financial management for building services engineering projects

Unit content

Outcome 1: Describe the accounting function of a building services engineering organisation and the requirements of a regulatory framework

The candidate knows how to:

- distinguish between various types of business organisation in both the public and private sector
- explain the primary and secondary objectives of business
- demonstrate an understanding of the need for accounting records and of the process of recording financial information
- explain the legal and professional regulations which apply to this area of management
- explain the difference between financial and management accounting

Outcome 2: Demonstrate an understanding of the content of financial statements for a variety of building services engineering related organisations

The candidate knows how to:

- define the purpose, structure and layout of a profit and loss account
- define the purpose, structure and layout of a balance sheet
- explain the concept of adjustments to financial statements e.g. depreciation
- demonstrate an appreciation of the need for a cash flow statement and the relationship between this statement and the main areas of business activity
- evaluate the links between the financial statements and their part in enabling owners and managers to monitor performance
- demonstrate an understanding of the differing requirements for the published accounts of limited companies

Outcome 3: Interpret and analyse a variety of financial statements for organisations both inside and outside the building services engineering sector

The candidate knows how to:

- explain the importance of the accurate interpretation of financial statements
- illustrate use of the main tools of financial analysis
 - ratios
 - vertical analysis
 - horizontal analysis
 - trend analysis
- comment on any trends shown by an analysis
- report on the overall financial situation of the organisation
- evaluate the limitations of these types of analysis in decision making

Outcome 4: Analyse the nature of costs and methods of overhead recovery related to pricing strategies appropriate to the building services engineering industry

The candidate knows how to:

- explain the role of costing in assessing performance and in decision making
- discuss the concepts of cost units, cost centres and the classification of costs
- illustrate the difference between direct and indirect costs
- evaluate the main costing systems and their use in the engineering industry
- demonstrate an understanding of the need to recover overheads through the units of output
- explain the concept of the break-even point
- explain the importance of marginal costing techniques in relation to management decision making
- demonstrate an understanding of relevant costs when making pricing decisions
- consider the factors to consider when determining price and the main pricing strategies

Outcome 5: Apply the appropriate techniques to the evaluation of capital investment projects

The candidate knows how to:

- define a capital investment project and explain the factors to be taken into consideration prior to decision making
- demonstrate an understanding of the main financial techniques of capital investment appraisal
- evaluate the advantages and disadvantage of each technique when used within the engineering industry
- discuss the use of cost benefit analysis as an investment appraisal technique
- calculate internal rates of return and its application as a method of capital investment appraisal (Discounted cash flow)
- use computer software programs to obtain information from data bases and spreadsheets

Outcome 6: Demonstrate an understanding of the nature of the strategic objectives of a building services engineering related organisation and determine an annual planning cycle

The candidate knows how to:

- explain that planning is the process of using available information to set objectives and deciding how those objectives might be achieved within resource constraints
- define the nature of the organisations strategic objectives and explain how those would be supported by an annual planning cycle
- demonstrate an understanding of the nature, benefits and limitations of budgets
- discuss the steps involved in budgetary planning and the purpose of budgetary control
- demonstrate a understanding of the differences between fixed and flexible budgets
- recognise environmental influences and internal resource constraints
- define the purpose, format and uses of the cash and master budgets
- evaluate the role of a budgetary control report as an aid to investigating variances
- recognise the human behavioural implications inherent in preparing, negotiating, implementing and controlling the budgetary cycle

Unit 21 Financial management for building services engineering projects

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A word processed report, of approximately 2000 words, assessing the financial performance of a building services engineering related organisation. The four main methods of analysis should be used to evaluate performance in the areas of profitability, solvency, asset utilisation and investment performance. The report should include comparative analyses of at least two years of company performance or alternatively comparison with another company in the same industrial sector over a one year period.

and

- A 15 minute presentation, using appropriate visual aids, which makes an assessment of a recently completed capital investment project. The candidate should research and critically examine the investment appraisal techniques used by the organisation, report on how those techniques were used for the particular project and discuss any non- financial aspects of the project which were considered. Evaluation should also be made of how close the actual results of the project were to the original estimates and the reasons for any variances. On completion of the presentation, the candidate should be prepared to answer questions and should submit a 500 word précis of the presentation content

Unit 21

Financial management for building services engineering projects

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Communication

- C4.1 Develop a strategy for using communication skills over an extended period of time.
- C4.3 Evaluate your overall strategy and present the outcomes from your work, using at least one formal oral presentation. Include a variety of verbal, visual and other techniques to illustrate your points.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.

Working with Others

- WO4.1 Develop a strategy for working with others.
- WO4.2 Monitor progress and adapt your strategy to achieve agreed objectives.
- WO4.3 Evaluate your strategy and present the outcomes from your work with others.

Improving own Learning and Performance

- LP4.1 Develop a strategy for improving your own learning and performance.

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Lecture and seminar hours should be used for the delivery of theory and for the practical evaluation of case studies where appropriate. Candidates should be given opportunities to investigate and evaluate the ways in which particular areas of financial management are dealt with in their organisation. It will be necessary at all times to consider the confidential and sensitive nature of this type of information when requiring the student to use workplace related data. Candidates should be encouraged to investigate and critically review current trends and innovative practice and use a range of resources to gather data.

There is a need for the candidate to have:

- a resourced learning centre/library with a stock of relevant materials for reference texts in the area of Financial Management
- a facility with IT provision needs to be available on a flexible basis to allow the candidate to collect and produce the evidence required for Assessment.
- access to information within the candidate's own or support organisation would be necessary in order to draw evidence of activity relevant to the Unit content.
- data from the candidate's engineering experience
- case study materials

Valuable information can be obtained through visits to organisations and from presentations given by guest speakers.

Where possible the assessment should be related to the candidates' work places, i.e. practical, realistic and relate to current sector practice. Where this is not appropriate, case studies may need to be provided for assessment purposes. Appropriate centre staff should agree the title and outline of the report to be presented for assessment prior to commencement.

Evidence presented must be the candidates' own work and candidates are expected to plan and carry out their assessments independently.

Suggested resources list

Cox D. & Fardon M., *Management of Finance*, Osborne Books (1997)

Atkinson A. et al, *Management Accounting*, Prentice Hall International (1996)

Knott G., *Financial Management*, Macmillan Press Ltd (1998)

Atrill P. & McLaney E., *Management Accounting for Non-Specialists*, Prentice Hall (1998)

Unit 22

Managing resources for building services engineering projects

Overview

Unit summary

This unit is about the management skills and knowledge required when purchasing items and monitoring the use of supplies. As a senior member of staff, it may well be necessary to co-ordinate, prioritise and manage resources (bearing in mind budgetary constraints) to ensure effectiveness of production and customer satisfaction in order to support the overall operation of the business.

In this unit there is opportunity to consider health and safety issues, as well as how moral, social and ethical issues affect the management of resources in the engineering industry.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- acquire the appropriate skills needed to manage resources
- use manual and computer data to monitor and review the use of supplies and keep records
- plan and implement the organisation's business policy.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Evaluate the systems used to record, monitor, review and control resources
2. Demonstrate effective resource management skills and techniques
3. Understand and deal with problems that can occur when managing resources
4. Develop a business policy for resource management
5. Implement quality control systems for resources
6. Ensure compliance with legal and statutory requirements

Unit 22 Managing resources for building services engineering projects

Unit content

Outcome 1: Evaluate the systems used to record, monitor, review and control resources

The candidate knows how to:

- compare varying practices used to record, monitor, review and control resources
 - staffing structures including security
 - purchasing specifications
 - purchase recording systems (electronic and manual methods)
 - Pareto analysis of stock/value levels
- compare different stock monitoring systems
 - electronic and manual
 - minimum and maximum stock levels and the possible effects on costs
 - automatic and 'just-in-time' ordering methods
- review ordering systems
 - identifying requirements
 - evaluation of goods purchased
- control resource systems by
 - stock taking
 - requisition procedures and authorisations
 - bar codes and inventories
- check the availability of items to be purchased
 - follow specified procedures to identify the items required for different departments
 - determine availability of required items through discussion with colleagues and suppliers
 - identifying problems that may arise from non-availability
 - specify procedures for purchasing exceptional items that may be required
 - check that any problems which arise are dealt with efficiently and effectively
 - that the appropriate people are informed of any action taken
- control the use of materials and equipment
 - ensure that 'goods in' are checked prior to use
 - monitor the efficient use of supplies
 - identify any opportunities for improved use of supplies and report findings to the appropriate people
- ensure that records of supplies used are accessible, complete and accurate
- compare the purchasing and supply methods and procedures currently used in the industry to include make or buy, hire or lease, direct or contract purchasing, taking into account capital investment considerations
- review current purchasing methods to evaluate the extent to which they
 - reflect market conditions
 - take advantage of the various ways in which supplies might be obtained
- assess the format and use of current purchasing contracts for legal compliance, value for money, and the relationship with suppliers
- check that current tendering procedures are cost effective and comply legal requirements

Outcome 2: Demonstrate effective resource management skills and techniques

The candidate knows how to:

- manage teams
 - be positive and delegate
 - roster staff and set targets
 - plan and implement work procedures
 - direct and control daily business to ensure effective performance of personnel
 - identify and implement appropriate leadership styles
 - motivate personnel in order to achieve organisational goals
 - ensure individuals understand their responsibilities within the organisation
- control communication and recording procedures
 - establish clear lines of communication with senior managers, peers and subordinates
 - meet targets, Outcomes and schedules
 - analyse the information gained from company recording and monitoring procedures
 - identify any corrective action that needs to be taken in response to any identified deviations from the company plan
 - assess the existing record keeping procedures for effectiveness, identifying any faults, in order to suggest improvements to the system
 - state the importance of respect for confidentiality regarding the obtaining and use of resources, and the need to make required information available to colleagues at the correct time
 - use the information gained from the review of existing procedures to predict future trends and advise company decision making in the future

Outcome 3: Understand and deal with problems that can occur when managing resources

The candidate knows how to:

- recognise the problems that can occur with engineering plant and machinery, equipment and materials
 - accidents
 - equipment breakdown
 - unexpected or emergency requirements
 - changes in production schedules to meet targets
- ensure that planned objectives concerning purchasing and supply have been met in relation to
 - shortage of stock
 - late or non-delivery
 - incorrect or faulty items delivered
 - breakages and spoilage
 - reviewing different sources
 - not exceeding budgetary estimates
- negotiate when dealing with disputes
 - the function of trade unions and arbitration tribunals
 - salary and bonus negotiations
 - effects on company image

Outcome 4: Develop a business policy for resource management

The candidate knows how to:

- evaluate the effect of the business policy on the area of operation
 - develop business policies regarding resources
 - identify organisational goals to be achieved by the team
 - evaluate business targets and identify the action to be taken by the team in order to meet them
- relate the role of manager with senior levels of management in relation to
 - production
 - maintenance
 - sales and marketing
 - personnel
 - accounting
- ensure individuals understand their responsibility within the whole process
 - need to consult and co-operate
 - select the appropriate sources of information concerning the conditions of purchase
- evaluate different methods of purchasing resources by
 - consortiums and co-operatives
 - fixed contracts
 - speculation (price change possibilities)
- identify the factors to be included in the preparation of purchase specifications for a variety of products
 - plant and machinery
 - tools and equipment
 - consumable materials,
- check methods used for monitoring and assuring appropriate standards of quality, performance and optimal ordering of quantities to include
 - lead times
 - usage rates
 - units and costs
 - contingency planning
- calculate economic ordering, quantities and stock levels for regular and fluctuating situations
- identify the information needed to make decisions regarding 'in house' manufacture or the use of sub-contractors
- consider the methods used to determine the economic time periods for replacement or upgrading of production resources
 - discounted cash flow
 - bath tub curves
 - break-even points
- review the use of the documentation related to various purchase and stock control procedures in order to
 - identify possible faults
 - ensure efficiency of recording procedures
 - make a contribution to future planning procedures

Outcome 5: Implement quality control systems for resources

The candidate knows how to:

- set up a procedure for directing and controlling quality
 - demonstrate the principles of planning
 - state the need for clearly defined standards, objectives and measurement in respect of control and quality issues
 - outline the need for control and feedback relating to changes in procedures
- evaluate the role of the manager in maintaining standards of work
 - modify systems if indicators show change is appropriate
 - describe the importance and methods of correcting poorly performing systems
 - review the organisation's list of supplies and suppliers in order to establish the quality of their products and identify any changes that need to be made
- review agreements with suppliers to ensure that legal and ethical considerations are met
- check that the methods used to negotiate with suppliers in that they
 - conform with legal requirements
 - help to maintain continuing good relationships
- evaluate monitoring procedures in order to identify
 - action which may need to be taken to address any potential shortcomings in the supply of goods
 - that the method used to record the supply and use of goods supports current practice
 - that the system allows for any failures to be identified and dealt with in accordance with company procedures

Outcome 6: Ensure compliance with legal and statutory requirements

The candidate knows how to:

- determine the legal aspects associated with the management of resources
- evaluate the implications of related statutory regulations
- implement and control correct procedures in respect of
 - health & safety
 - employment law
 - equal opportunities and discrimination (sex and race)
 - working hours and conditions
 - control of hazardous substances
 - environmental requirements
- carry out the basic processes of risk Assessment with regard to
 - lifting and handling
 - storage
 - third parties
- implement the requirements of laws and regulations affecting the purchasing, storing, maintaining and monitoring of resources.

Unit 22 Managing resources for building services engineering projects

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A word-processed report of a minimum of 2000 words which includes:
 - a review of the systems used to control resources in a building services engineering organisation
 - a business policy describing a suitable strategy for resource management
 - records which show the candidate has:
 - applied effective resource management skills and dealt with problems
 - complied with quality assurance and legal & statutory requirements
 - subjective and objective conclusions about resource management practices in relation to the outcomes of this unit.

Unit 22

Managing resources for building services engineering projects

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Communication

- C4.1 Develop a strategy for using communication skills over an extended period of time.
- C4.3 Evaluate your overall strategy and present the outcomes from your work, using at least one formal oral presentation. Include a variety of verbal, visual and other techniques to illustrate your points.

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Working with Others

- WO4.1 Develop a strategy for working with others.
- WO4.2 Monitor progress and adapt your strategy to achieve agreed objectives.
- WO4.3 Evaluate your strategy and present the outcomes from your work with others.

Improving own Learning and Performance

- LP4.1 Develop a strategy for improving your own learning and performance.

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Assessments should be practical and realistic and relate to current sector practice. If candidates are currently working in the sector, there will be opportunities for them to draw evidence from activities carried out in the workplace as agreed by their employer.

There is a need for the candidate to have access to:

- a resourced learning centre/library with a stock of relevant materials for reference purposes.
- a facility with IT provision on a flexible basis to allow the candidate to obtain information and produce the evidence required for Assessment.
- data relating to their engineering experience

Candidates should be given opportunities to investigate and evaluate the ways in which particular areas of resource assessment and acquisition are dealt with in their organisation and critically review current trends and innovative practice. They should give examples of system failures and note the actions that were taken to rectify matters.

It will be necessary at all times to consider the confidential and sensitive nature of this type of information when requiring the student to use workplace related data.

Where appropriate, reference should be made to relevant legislation, British Standards and industrial codes of practice. In addition, safe working methods and health and safety precautions should be considered at every stage of the activity.

Suggested resources list

An extended range of textbooks and materials are available to students undertaking research studies in Managing Resources and include:

Page Productions – *Manage Resources*

Management Charter Initiative – *Manage Resources – Key Role B*

Unit 23

Planning building services engineering projects

Overview

Unit summary

This unit is about providing the candidate with a sound knowledge of commercial and industrial project planning and management. The topics covered are Company organisation, particularly the technical and engineering departments concerned with engineering project management, team organisation, project objectives, project planning, project network analysis, Gantt (Bar) charts, Project Evaluation and Review Technique (PERT) charts (logic diagrams) resource tables and lists. At the end of the unit, the candidate will be able to plan a small engineering project using computer software for presentation

Successful achievement of this unit is dependent upon the candidate meeting the Assessment requirements relating to the Outcomes of the unit and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to develop an underpinning knowledge and theory of commercial and industrial engineering project planning that will enable him/her to contribute in the initiation, planning and execution of a commercial or industrial engineering project.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Describe typical organisational structures prevalent in industry
2. Describe the objectives, processes and procedures involved in project planning
3. Describe various means of data presentation used in project planning analysis
4. Plan a project using project planning software.

Unit 23 Planning building services engineering projects

Unit content

Outcome 1: Describe typical organisational structures prevalent in industry

The candidate knows how to:

- construct a typical management structure block diagram
- describe the responsibilities of departmental heads and/or managers
- detail the specific functions of the Technical Department
- describe the responsibilities of the Engineering Department.

Outcome 2: Describe the objectives, processes and procedures involved in project planning

The candidate knows how to:

- describe three objectives to be achieved in the successful execution of an engineering project
- describe the procedure for establishing the scope of a project
- describe the main processes and procedures required when executing a project.

Outcome 3: Describe various means of data presentation used in project planning analysis

The candidate knows how to:

- describe the use of Gantt charts, bar charts, logic diagrams (PERT charts), cost tables, and resources lists
- construct an arrow diagram
- construct a precedence diagram.

Outcome 4: Plan a project using project planning software

The candidate knows how to:

- enter a project start date
- enter a project title
- set a work schedule
- enter tasks and durations
- structure tasks into a logical sequence
- start and finish tasks on specific dates
- create a resource list (labour and materials)
- assign pay rates to resources
- set fixed costs
- display Gantt and PERT Charts, Task Usage and Resource Usage Tables, Resource Graphs, Resource Sheets and Calendar.

Unit 23 **Planning building services engineering projects**

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of project planning. The case studies must should the following areas:
 - organisational structures in industry
 - objectives of project planning
 - methods of data presentation
 - use of a software package to produce an engineering project plan.

The above pieces of work should total approximately 2500 words.

Unit 23 Planning building services engineering projects

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Information and Communication Technology

- ICT4.1 Develop a strategy for using ICT skills over an extended period of time.
- ICT4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving the use of ICT for two different, complex purposes.
- ICT4.3 Evaluate your overall strategy and present the outcomes from your work using at least one presentation, showing integration of text, images and number.

Links with other units/qualifications

This unit has links with Unit 5: Mechanical engineering project design and management within the Level 4 Higher Professional Diploma in Building Services Engineering:

This unit also has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

Assessments should be orientated and relate to current building services engineering standards and codes of practice whether domestic, commercial or industrial. Reference should be made to different manufactures systems and specifications where appropriate.

There is a need for the candidate to have access to:

- a resourced learning centre/library with a stock of relevant materials for reference purposes.
- a facility with IT provision on a flexible basis to allow the candidate to obtain information and produce the evidence required for Assessment.

Candidates should be encouraged to use examples from their own experience and industrial environment to demonstrate a knowledge of the unit content. They should be encouraged to use all potential sources of up-to-date information. These may include works reports and reports in technical journals.

Where appropriate, reference should be made to appropriate health and safety legislation.

Candidates should be encouraged to draw on supplementary material in the form of trade magazines, institution publications and manufacturer's data for useful unit background information.

Suggested resources list

Bolton W., *Production Planning and Control*, Longman (1994)

Knox, *Engineering Project Planning*

Lock D., *Essentials of Project Planning*, Gower

Open Learning Text:

Project Planning, COLU (2001)

Unit 24

Using materials technology in building services engineering

Overview

Unit summary

This unit is about the classification, structure, properties and applications of materials used in building services engineering. The analysis of metals and their alloys, polymers and ceramics is rigorous and the unit will be of value to candidates studying all branches of building services engineering.

The unit will give candidates greater confidence in selecting and using materials for given applications. The unit also forms a sound basis for further more specialised study.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to

- Become conversant with the terminology of building services engineering materials
- Relate the structure of materials to their physical properties
- Critically appraise materials in relation to function
- Perform calculations to determine values of physical properties of building services engineering materials.

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. Demonstrate an understanding of the crystalline structure of metals
2. Investigate the physical properties of metals, methods of testing these properties and distinguish between different modes of metal fracture
3. Predict the microstructure and properties of simple binary alloys
4. Investigate the manufacture of ceramic components for building services engineering applications
5. Investigate the physical properties and manufacture of polymeric materials.

Unit 24 Using materials technology in building services engineering

Unit content

Outcome 1: Demonstrate an understanding of the crystalline structure of metals

The candidate knows how to:

- draw the Bravais, or space, lattices of crystalline structures common to metals
- describe and illustrate point, line and plane defects in crystalline structure
- describe some consequences of defects on the properties of metals
- distinguish between substitutional and interstitial solid solutions in alloys.

Outcome 2: Investigate the physical properties of metals, methods of testing these properties and distinguish between different modes of metal fracture

The candidate knows how to:

- determine ultimate tensile strength, Young's modulus and proof stress for a metal sample
- describe tests for hardness and impact resistance of metals
- describe and distinguish between ductile fracture, brittle fracture, fatigue and creep in metals
- use Griffith's theory of brittle fracture to calculate fracture stress
- calculate stress amplitude or cycles to failure using the Basquin equation, $S = A N^B$

Outcome 3: Predict the microstructure and properties of simple binary alloys

The candidate knows how to:

- calculate liquid/solid proportions of alloys using the lever rule
- sketch common equilibrium diagrams and describe the phases illustrated
- sketch and describe the microstructure of alloys in relation to equilibrium diagrams
- relate the properties of alloys to their microstructure
- describe how heat treatments affect the microstructure of steel.

Outcome 4: Investigate the manufacture of ceramic components for building services engineering applications

The candidate knows how to:

- justify the selection of a material for a particular application in terms of its mechanical and electrical properties
- identify the influences of powder particle size, shape and distribution on the forming and quality of ceramic components
- choose shaping processes for a range of materials and components.

Outcome 5: Investigate the physical properties and manufacture of polymeric materials

The candidate knows how to:

- classify polymeric materials in terms of polymer structures, physical form, and design and marketing requirements
- relate the mechanical, electrical and thermal properties of polymers to molecular structure and chemical bonding
- select additives to improve the properties, processing and range of application of polymers.

Unit 24 Using materials technology in building services engineering

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A series of work-related case studies to demonstrate the candidate's understanding of the underpinning theory and principles of materials commonly used in building services engineering. The case studies should cover the following areas:
 - metallurgy, including the crystalline structure of metals and alloys, properties, testing and modes of failure
 - the use of equilibrium diagrams to predict the microstructure and properties of binary alloys and the use of heat treatment to modify microstructure
 - an investigation into the use ceramics as a building services engineering material
 - an investigation into the use of polymers as a building services engineering material.

Unit 24

Using materials technology in building services engineering

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Improving own Learning and Performance

- LP4.1 Develop a strategy for improving your own learning and performance.
- LP4.2 Monitor progress and adapt your strategy to improve your performance.
- LP4.3 Evaluate your strategy and present the outcomes of your learning.

Delivery advice

This unit may be delivered by formal teaching or by open learning or by a mixture of the two. It is fundamentally a theoretical unit with practical applications in a wide variety of manufacturing areas and where candidates can obtain some practical experience or observation, they should be encouraged at all times to relate theory to practice.

Whilst the unit will prove of value to all building services engineering students, some candidates from 'non-mechanical' disciplines, such as Electrical Engineering, may well require supplementary teaching support and revision on basic building services engineering science.

Links with other units/qualifications

This unit has links with the following unit within the Level 4 Higher Professional Diploma in Building Services Engineering:

Unit 5: Mechanical engineering project design and management

Suggested resources list

Lawrence H. Van Vlack, *Elements of Materials Science and Engineering*, (1989)

Milton Ohring, *Engineering Materials Science*, (1995)

James F. Shackelford, *Introduction to Materials Science for Engineers*, (1995)

Michael F. Ashby & David R. H. Jones, *Engineering Materials 1: An Introduction to Their Properties and Applications*, (1996)

William D. Callister Jr., *Materials Science and Engineering: An Introduction*, (1996)

William D. Callister Jr., *Solid-State Physics: An Introduction to Principles of Materials Science*, (2nd ed., 1995)

Vernon John, *Introduction to Engineering Materials*, (3rd ed., 1992)

Open learning text:

Materials, University of Sunderland and COLU, (2001)

Unit summary

The purpose of this unit is to provide a programme of study relating to changing energy needs in relation to forms of supply, newer alternatives, energy efficiency and the more energy conscious design of buildings. The unit focuses on the implications and impact of decisions made when specifying building services equipment and systems with a view on the full supply system from generator to end user.

Successful achievement of this unit is dependent upon candidates meeting the assessment requirements and outcomes and producing work of a satisfactory and reliable standard.

Aims

The unit aims to enable the candidate to:

- Select appropriate sources of energy
- Describe the environmental impact of energy sources
- Research alternative sources of energy
- Apply Heat Energy Rating
- Realise the benefits of building a passive solar building
- Design and specify solar hot water and photovoltaic systems
- Explain the principle of operation of the different types of heat pumps
- State the new sources of energy used in buildings

Learning outcomes

On successful completion of the unit the candidate will be able to:

1. State the sources of energy and environmental impact
2. Describe energy conservation methods
3. Describe passive buildings
4. Describe photovoltaics systems
5. Determine the requirements of embedded micro generation systems
6. State the uses, benefits and limitations of new sources of energy in buildings

Unit 25 Electrotechnical sustainability

Unit content

Outcome 1: State the sources of energy and environmental impact

The candidate knows how to:

- demonstrate an awareness of traditional sources of energy supply, in terms of power stations: fossil fuels (coal, oil, gas) nuclear (magnox, AGR, PWR), hydro-electric
- demonstrate an awareness of newer sources of energy: photovoltaic, tidal wave, wind, geothermal, biomass
- demonstrate an awareness of potential new energy sources, eg: artificial photosynthesis, organic solar PV technologies, clean-coal, new nuclear build, etc.
- demonstrate an awareness of the benefits and limitation of energy sources identified
- explain the benefits of energy reduction
- recognise the impact upon the environment from energy sources identified
- explain the need for efficient energy production
- recognise the need to develop sources of energy that have the minimal amount of environmental impact
- list sources of information required for sustainable technologies
- state the advisory bodies, groups and trade associations linked to sustainable technologies

Outcome 2: Describe energy conservation methods

The candidate knows how to:

- state the impact of climate change and future predictions
- describe the greenhouse gas effect on the environment
- determine CO₂ emissions and CO₂ reduction
- state the implications for the Kyoto protocol in terms of CO₂ levels and energy production
- state the implications of 2006 Energy Review in terms of bridging the UK's energy gap
- state the implications of Climate Change and Sustainable Energy Act 2006
- state the implications of the UK government's zero carbon ambition for new homes
- explain the importance of reducing the energy consumption
- state how building regulations have an impact on domestic energy
- recognise the benefits of installing good insulating materials
- recognise the opportunities available for alternative energy sources in buildings
- apply the system of energy labelling
- explain the nature of solar energy
- explain the difference between passive and active solar energy
- explain how new and alternative methods of producing energy contribute to energy conservation
- state the types of building management control and their application in reducing the energy consumption of building services
- explain the importance of fully functioning energy management systems and the role facilities management contributes to the reduction of energy consumption in buildings

Outcome 3: Describe passive buildings

The candidate knows how to:

- define what is meant by 'passive building'
- describe site orientation, layout and design of a passive building
- explain the need to insulate to reduce energy demand
- explain the function of a heat recovery unit in a passive building
- list the maximum permissible 'U' values allowed in the design of a passive building
- state the advantages and disadvantages of building passive buildings
- state the ventilation requirements of a passive building
- explain the importance of air tightness in a building
- state the energy sources that can be incorporated into the design of a building, eg: solar panels for photovoltaic energy production, wind turbines
- identify how energy sources that can be incorporated into the design of a building contribute to energy efficiency
- state the purpose of the BERR Low Carbon Buildings Programme

Outcome 4: Describe photovoltaics systems

The candidate knows how to:

- state the different types of PV systems
- state the function of a PV cell
- state the different types of solar cells available
- design a basic PV system
- list the components of a PV system
- explain how to measure solar energy
- explain efficiency and impacts of solar electricity
- explain how electricity is distributed from PV arrays
- explain how much electricity can be generated using PV cells
- explain how the battery inverter works
- explain how to control the temperature of a PV installation
- describe the installation requirements and commissioning of a PV system
- state the safety considerations for a PV installation

Outcome 5: Determine the requirements of embedded micro generation systems

The candidate knows how to:

- Define micro-hydro in terms of output
- State the applications and future trends for micro-hydro
- State the benefits of using micro-hydro
- Determine the feasibility of types of site for the development of micro-hydro
- Determine the power available from micro-hydro systems
- Describe the installation and commissioning requirements for micro-hydro systems
- Describe the control systems requirements for micro-hydro systems
- State the safety considerations for a micro-hydro installation
- Define micro-wind in terms of output
- State the applications and future trends for micro-wind
- State the benefits of using micro-wind
- Determine the feasibility of types of site for the development of micro-wind
- Determine the power available from micro-wind systems

- Describe the installation and commissioning requirements for micro-wind systems
- State the safety considerations for a micro-wind installation
- Describe the control systems requirements for micro-wind systems

Outcome 6: State the uses, benefits and limitations of new sources of energy in buildings

The candidate knows how to:

- describe the use of solar heating
- state the benefits to be gained from and limitations of solar heating
- list the different types of solar collectors used in solar design
- state the principle requirements on components and materials
- describe the installation and commissioning requirements for a solar heating system
- describe how to control the temperature of a solar installation
- explain the use of heat pumps in the use of solar-thermal energy to air, water and ground
- explain the function and requirements of heat exchangers
- state the safety considerations of a solar installation

Unit 25 Electrotechnical sustainability

Suggested assessment approach

The following suggests how the outcomes of the unit could be assessed:

- A project comprising of the detailing of an energy efficient system using an alternative heat/energy source in a new or existing building for heat, light or general power. The use of appropriate system controls and energy reduction methods need to be included in the project with an assessment of the reduction in energy and CO2 emissions the system offers.

The following criteria should be covered in the assessment:

- Recording and presenting of information
- Managing time and meeting targets
- Decision making
- Applying self learning
- Applying independent critical thinking
- Evidence of research

It may be appropriate for the candidate to be interviewed by the assessor after submitting the project, to establish the degree of learning attained from the project and that the work submitted is the candidate's own work.

Unit 25 Electrotechnical sustainability

Guidance

Key Skills signposting

As candidates are working towards the outcomes of this unit, there are opportunities for Key Skills development in the following Level 4 Key Skills units:

Application of Number

- N4.1 Develop a strategy for using application of number skills over an extended period of time.
- N4.2 Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving deductive and inferential reasoning and algebraic modelling (excluding algebra)
- N4.3 Evaluate your overall strategy and present the outcomes from your work, including the use of charts, graphs and diagrams to illustrate complex data.

Problem Solving

- PS4.1 Develop a strategy for problem solving.
- PS4.2 Monitor progress and adapt your strategy for solving the problem.
- PS4.3 Evaluate your strategy and present the outcomes of your problem solving skills.

Links with other units/qualifications

This unit has links with the Summit Skills Level 4 N/SVQ in Building Services Engineering Technology and Project Management. Detailed mapping can be found in Appendix 4.

Delivery advice

As well as demonstrating a detailed understanding of system design, plan selection, management and communication techniques, candidates should be encouraged to develop and apply skills, such as, self directed learning; time management and planning; independent critical thinking; and information gathering and assimilation.

Practical examples should be used to demonstrate each point. Where appropriate the actions taken must comply with current safety legislation and any regulations and standards applicable at the time should be noted.

The outline of the items to be included in the project should be agreed by appropriate staff prior to commencement. All evidence should be the candidate's own work and candidates are expected to plan and produce their projects independently.

Suggested resources list

Department of the Environment, Building Regulations Technical Guidance documents, (1991)

Hall K., *The Green Building Bible*, Green Building Press (2005)

Felix A., Remmers K., & Schnauss M., *Solar Thermal Systems*, (2002)

Kreith F., *Energy Management and Conservation Handbook*, (2006)

Appendix 1 Accreditation, national frameworks and qualification level descriptors

Please visit the following websites to find information on accreditation, national frameworks and qualification level descriptors in each country.

Nation	Who to contact	Website
England	The Qualifications and Curriculum Authority	www.qca.org.uk
Scotland	The Scottish Qualifications Authority	www.sqa.org.uk
Wales	The Department for Education, Lifelong Learning and Skills Wales	www.new.wales.gov.uk
Northern Ireland	The Council for Curriculum, Examinations and Assessment	www.ccea.org.uk

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Appendix 2 Funding

City & Guilds does not provide details on funding as this may vary between regions.

Centres should contact the appropriate funding body to check eligibility for funding and any regional/national arrangements which may apply to the centre or candidates.

For funding regulatory purposes, candidates should not be entered for a qualification of the same type, level and content as that of a qualification they already hold.

Please see the table below for where to find out more about the funding arrangements.

Nation	Who to contact	For higher level qualifications
England	<p>The Learning and Skills Council (LSC) is responsible for funding and planning education and training for over 16-year-olds. Each year the LSC publishes guidance on funding methodology and rates. There is separate guidance for further education and work-based learning.</p> <p>Further information on funding is available on the Learning and Skills Council website at www.lsc.gov.uk and, for funding for a specific qualification, on the Learning Aims Database http://providers.lsc.gov.uk/lad.</p>	<p>Contact the Higher Education Funding Council for England at www.hefce.ac.uk.</p>
Scotland	<p>Colleges should contact the Scottish Further Education Funding Council, at www.sfc.co.uk.</p> <p>Training providers should contact Scottish Enterprise at www.scottish-enterprise.com or one of the Local Enterprise Companies.</p>	<p>Contact the Scottish Higher Education Funding Council at www.shefc.ac.uk.</p>
Wales	<p>Centres should contact the Welsh Assembly Government www.learning.wales.gov.uk</p> <p>0845 010 3300 – bilingual greeting, or 0845 010 4400 – Welsh language greeting</p>	<p>Centres should contact the Welsh Assembly Government www.learning.wales.gov.uk</p> <p>0845 010 3300 – bilingual greeting, or 0845 010 4400 – Welsh language greeting</p>
Northern Ireland	<p>Please contact the Department for Employment and Learning at www.delni.gov.uk.</p>	<p>Please contact the Department for Employment and Learning at www.delni.gov.uk.</p>

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Appendix 3 Obtaining centre and qualification approval

Only approved organisations can offer City & Guilds qualifications. Organisations approved by City & Guilds are referred to as **centres**.

Centres must meet a set of quality criteria including:

- provision of adequate physical and human resources
- clear management information systems
- effective assessment and quality assurance procedures including candidate support and reliable recording systems.

An organisation that has not previously offered City & Guilds qualifications must apply for approval to become a centre. This is known as the **centre approval process (CAP)**. Centres also need approval to offer a specific qualification. This is known as the **qualification approval process (QAP)**, (previously known as scheme approval). In order to offer this qualification, organisations which are not already City & Guilds centres must apply for centre and qualification approval at the same time. Existing City & Guilds centres will only need to apply for qualification approval for the particular qualification.

Full details of the procedures and forms for applying for centre and qualification approval are given in *Providing City & Guilds qualifications - a guide to centre and qualification approval*, which is also available on the City & Guilds centre toolkit, or downloadable from the City & Guilds website.

Approval applications for this qualification should be sent to the **HLQ Department at City & Guilds, 1 Giltspur Street, London EC1A 9DD**. The HLQ Department will support new centres and appoint an External Moderator to guide the centre through the approval process. They will also provide details of the fees applicable for approvals.

Assessments must not be undertaken until qualification approval has been obtained.

City & Guilds reserves the right to withdraw qualification or centre approval for reasons of debt, malpractice or non-compliance with City & Guilds' policies, regulations, requirements, procedures and guidelines, or for any reason that may be detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds. Further details of the reasons for suspension and withdrawal of approval, procedures and timescales, are contained in *Providing City & Guilds qualifications*.

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Appendix 4 Mapping links between the City & Guilds HPD in Building Services Engineering and the Summit Skills National Occupational Standards for Building Services Engineering Technology and Project Management

Unit 1: Health and safety legislation	Summit Skills National Occupational Standard
<p>Outcome 1: ensure that the work complies with the relevant construction regulations</p> <ul style="list-style-type: none"> • apply the construction regulations relevant to the work he/she undertakes • refer items of the work to relevant legislation • ensure that work procedures comply with the relevant construction regulations 	<p>UNIT SST/NOS 1 All Performance objectives and knowledge requirements</p> <p>UNIT SSTE/NOS 1 All Performance objectives and knowledge requirements</p>
<p>Outcome 2: put in place health, safety and welfare arrangements which are consistent with all requirements and ensure that people are aware of these arrangements</p> <ul style="list-style-type: none"> • assess the requirements for health, safety and welfare which are consistent with requirements of the organisation, the contract, and legislation • prepare a simple Safety Plan for the on site phase of the work • delegate responsibility for health and safety as necessary • ensure that everyone whose health and safety is affected by the work is fully aware of the situation. This includes the general public and others not directly concerned with the work (visitors, for example) 	<p>UNIT SST/NOS 1 All Performance objectives and knowledge requirements</p> <p>UNIT SSTE/NOS 1 All Performance objectives and knowledge requirements</p>
<p>Outcome 3: use appropriate risk assessment procedures to minimise risk on site and apply the results and demonstrate an awareness of the risk assessment process</p> <ul style="list-style-type: none"> • identify the hazards which exist on a site. These may be detailed in the pre-tender health and safety plan or established by practical experience of the work process • prepare risk assessments on the hazards • eliminate hazards where possible • where elimination is not possible, reduce the hazard • alert those concerned to any remaining hazard 	<p>UNIT SST/NOS 1 <i>Performance objective</i></p> <p>a. identify all relevant aspects of the risk assessment and method statement prepared for the workplace where building services engineering operations⁽²⁾ are taking place</p> <p><i>Knowledge requirements</i></p> <p>1. all relevant aspects of the risk assessment and method statement which will affect you and all those operatives for whom you are responsible [P.O. (a)]</p>

UNIT SSTE/NOS 1

Performance objectives

- p. when work conditions change, carry out a review in accordance with organisational procedures
- q. seek appropriate sources of information and advice to assist the review
- r. ensure the identification process covers all relevant areas of potential risk including site procedures and evacuation procedures
- s. ensure that your review includes new and previously identified risks and is conducted in line with accepted best practice and agreed procedures
- t. ensure that adjustments and improvements are implemented against any shortcomings found in the review
- u. pass on relevant information relating to the review at site meetings and communicate any changes that might impact for health and safety to those for whom you are responsible
- v. maintain relevant records for use in contributing to future decisions with regard to amendments to risk assessments
- w. resolve health and safety issues relating to your operatives when conflicts arise regarding the risk assessment and communicate your decision to your operatives and the relevant person(s)

Knowledge requirements

- 12. having conducted a risk assessment, how to consider levels of risk and to further consider whether it is reasonably practicable to implement measures to reduce or eliminate such risks
[P.O. (o), (p)]
- 13. the principles of risk acceptability from levels of risk (eg high vs low risk)
[P.O. (k), (p)]
- 14. how to assess single risks from the work of your operatives and the combination of risks from the work of other trades
[P.O. (k), (p), (r), (s)]
- 15. methods of collecting and evaluating information
[P.O. (q)]
- 16. how to use information sources such as internal and external sources, legislation, organisational and industry recommended systems and procedures
[P.O. (q), (r), (s)]
- 17. the implications of relevant legislation and approved codes of practice
[P.O. (t), (u)]

18. review techniques
[P.O. (q), (r), (s), (t), (u), (v)]
19. communication techniques and communications with management and site supervised personnel
[P.O. (u), (w)]

Outcome 4: ensure that statutory and hazard warning notices are displayed as necessary and health and safety information is fully available

- prepare requirements for the display of statutory notices
- display relevant hazard warnings
- provide the health and safety information to all who may be affected

Outcome 5 : confirm that the regulations concerning first aid provision are fully and correctly implemented

- train of first aiders and the requirements for them
- provide suitable first aid equipment
- provide the requirement for stand-by first aiders
- inform employees and others of what first aid arrangements are in place.

Outcome 6: ensure that plant, equipment, systems of work and other resources available on site comply fully with health and safety legislation

- ensure that plant and equipment provided is adequate for the job it is used for
- ensure that materials are properly stored and used in accordance with the manufacturers or suppliers instructions
- ensure that all staff are properly trained and competent to do the work expected of them
- provide induction and ongoing training

UNIT SSTE/NOS 1

Performance objective

- e. ensure that statutory notices appropriate to the hazards⁽⁴⁾ and risks are displayed where they will be seen clearly and to best effect

Knowledge requirements

4. how to access information regarding health and safety legislation
[P.O. (d), (e), (f)]

UNIT SSTE/NOS 1

Performance objective

- c. appoint qualified first-aiders and ensure that personnel for whom you are responsible are provided with clear and accurate information about first aid provisions within the context of the work environment

Knowledge requirements

2. the importance of appointing first aiders and checking they are qualified
[P.O. (c)]
3. the purpose and importance of setting up a safe system of work in accordance with risk assessments and method statements
[P.O. (a), (b), (c)]

UNIT SST/NOS 1

Performance objective

- d. ensure that plant and equipment relevant to the building services engineering operations⁽²⁾ is safe to use

Knowledge requirements

4. how to ensure that plant and equipment is safe to use
[P.O. (d)]

Outcome 7: verify that all systems are monitored regularly as required by the statutory legislation and areas of failure are noted and then rectified

- ensure effective monitoring for health, safety and welfare
- report on the results of the monitoring procedures
- action any breaches of the health, safety and welfare arrangements

UNIT SST/NOS 1

Performance objectives

- h. *monitor and implement⁽⁶⁾ procedures that help ensure the workplace remains safe for building services engineering work to continue*
- i. *monitor that building services engineering operatives⁽¹⁾ for whom you are responsible are ensuring their actions minimise risks as identified in the risk⁽⁸⁾ assessment*
- j. *identify hazards⁽⁴⁾ which could cause harm to yourself or others occurring as a result of changes to the building services engineering operations⁽²⁾*
- k. *control hazards⁽⁴⁾ within your capability and job responsibility, others you cannot eliminate are reported to the responsible person⁽⁷⁾*
- l. *ensure you and all building services engineering operatives⁽¹⁾ for whom you are responsible take appropriate action where risks are identified*

Knowledge requirements

10. how to monitor whether building services engineering operatives are following health and safety procedures correctly
[P.O. (h)]
11. how to identify hazards which might cause harm as a result of changes and how to control those hazards within your capability and job responsibility relevant to building services engineering operations
[P.O. (i, j)]
12. the importance of remaining alert to the presence of hazards in the workplace and when to report them
[P.O. (k)]
13. what action you and the building services engineering operatives should take when risks are identified
[P.O. (k)]
14. the importance of using and storing tools, equipment and plant safely and securely
[P.O. (l)]
15. the importance of using and storing materials safely
[P.O. (l)]

UNIT SSTE/NOS 1

Performance objectives

- j. *verify that the scope and responsibilities for the work activity are clearly defined*
- k. *identify potential hazards⁽⁴⁾ from the work activity and ensure that risk assessments are carried out to minimise the risk*

- l. ensure that access equipment is installed and used in accordance with instructions and regulations
- m. ensure that special site conditions⁽⁶⁾ and instances of non-compliance⁽⁵⁾ are identified and recorded accurately
- n. ensure that safe and appropriate action is taken promptly for every occasion where a non-compliance⁽⁵⁾ is identified
- o. monitor the work of the operatives to ensure they are carrying out their work safely

Knowledge requirements

- 7. the importance of keeping operatives fully informed about what to do and when in the context of health and safety and their responsibilities with regard to their work
[P.O. (b), (c), (i), (j), (w)]
- 8. how to identify and record site conditions and instances of non – compliance
[P.O. (m)]
- 9. disciplinary procedures and other sanctions in relation to non-compliance of health and safety procedures
[P.O. (n)]
- 10. the principles and methods of hazard identification and classification methods
[P.O. (k)]
- 11. qualitative and quantitative risk assessment techniques
[P.O. (k)]
- 12. having conducted a risk assessment, how to consider levels of risk and to further consider whether it is reasonably practicable to implement measures to reduce or eliminate such risks
[P.O. (o), (p)]

Unit 2:	Applying CAD and ICT in building services engineering projects	Summit Skills Equivalent
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There is no Summit Skills equivalent content to this unit

Unit 3: Electrotechnical project design and management	Summit Skills Equivalent
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Outcome 1: select an engineering project of appropriate scope and content

- identify an appropriate engineering problem that will involve an element of design
- limit the scale of the problem to a realistic size in terms of time and quantity
- negotiate the proposed project with his or her tutor.

Outcome 2: prepare a project brief

- compile a written proposal to a recommended format that includes a title for the project, table of contents, summary, appendices, references and bibliography as appropriate
- define the engineering problem
- state the objectives of the project
- examine options for the solution of the engineering problem
- explain the reasons for the proposed solution to the problem
- outline the techniques or method of realising the proposed solution
- state the expected time scales of implementation or project completion
- outline any potential improvements in efficiency arising from the implementation of the solution
- outline prospective costs of implementation of the project
- outline implications on safety.

Unit SSTE/NOS 4

Manage Building Services Engineering Projects In The Work Location

Knowledge Requirements

1. The scope, purpose and requirements of the project which is being managed
2. The importance of planning the project in a sequence to ensure an effective project completion
3. The importance of ensuring that pre-site planning takes place and includes the requirements for health and safety
4. The purpose and importance of risk assessments and method statements and their implications for safe working as well as keeping them updated in view of variations
5. How to plan a project effectively and to include identifying resource quantities that will be required and when
6. The importance of identifying risks and planning workable and acceptable contingencies
10. The importance of ensuring the sequence and delivery of resources matches the project budget and specification
11. Organisational quality assurance standards appropriate to the project
12. The importance of regularly monitoring progress and the implications of poor time-management
13. The importance of dealing with problems promptly and seeking agreement on variations and recording the agreements
14. How to prepare and complete final documentation relevant to the project and who it should be given to

Outcome 3: execute a procedure for the solution of an engineering problem

- state the objective(s) to be achieved through the solution to the project problem
- utilise the appropriate design expertise to solve the project problem
- utilise data, calculations, graphs, simulations, charts, etc. where appropriate to produce and present project problem solutions
- communicate when necessary with the project supervisor for advice and guidance.

Outcome 4: evaluate the outcomes of the engineering project

- critically appraise the project against the original objectives
- estimate design and possible implementation costs of the project
- state and estimate any safety improvements or efficiency savings resulting from the solution of the project problem.

Outcome 5: prepare a project report

- compile a written project report to a recommended format that includes a title for the project, table of contents, index, section headings, summary, results, conclusions, appendices, list of references and bibliography
- use information technology to word-process the report and incorporate the use spreadsheets and databases to present data as appropriate
- outline the scope and objectives of the project in the form of an introduction
- describe any design procedures with specimen calculations, charts, graphs or other data display forms
- state any recommendations and the degree to which the solution(s) arrived at meet or do not meet the original scope and objectives
- state any actual or estimated cost implications arising from the implementation of the project recommendations
- state any actual or expected cost savings or expenditure arising from implementation of the project solution(s)

Unit SSTE/NOS 9

Plan Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

Knowledge Requirements

1. How to summarise and assess the available project data
4. How to obtain more information from alternative sources in cases where the available project data is insufficient
8. How to calculate the resources needed from the information available
11. How to obtain clarification and advice where the resources needed are not available
16. How to calculate how long each activity will take and sequence activities
29. How to identify the organisational and communication needs for the project
33. How to monitor the methods of communicating, reporting, recording and retrieving information
34. How to introduce methods of communicating, reporting, recording and retrieving information which are appropriate to the needs of the project

- state any safety ramifications arising from the project solution(s)
- list any appendices, manufacturers' data, standards, etc. according to a recognised format
- list references and or bibliography as appropriate
- paginate and appropriately section the compiled document.

Unit 4: Electrotechnical engineering principles

Summit Skills Equivalent

No direct match to unit content

Unit 5: Mechanical engineering project design and management

Summit Skills Equivalent

Outcome 1: select an engineering project of appropriate scope and content

Unit SSTE/NOS 4

Manage Building Services Engineering Projects In The Work Location

- identify an appropriate engineering problem that will involve an element of design
- limit the scale of the problem to a realistic size in terms of time and quantity
- negotiate the proposed project with his or her tutor.

Knowledge Requirements

Outcome 2: prepare a project brief

- compile a written proposal to a recommended format that includes a title for the project, table of contents, summary, appendices, references and bibliography as appropriate
- define the engineering problem
- state the objectives of the project
- examine options for the solution of the engineering problem
- explain the reasons for the proposed solution to the problem
- outline the techniques or method of realising the proposed solution
- state the expected time scales of implementation or project completion
- outline any potential improvements in efficiency arising from the implementation of the solution
- outline prospective costs of implementation of the project
- outline implications on safety.

1. The scope, purpose and requirements of the project which is being managed
2. The importance of planning the project in a sequence to ensure an effective project completion
3. The importance of ensuring that pre-site planning takes place and includes the requirements for health and safety
4. The purpose and importance of risk assessments and method statements and their implications for safe working as well as keeping them updated in view of variations
5. How to plan a project effectively and to include identifying resource quantities that will be required and when
6. The importance of identifying risks and planning workable and acceptable contingencies
15. The importance of ensuring the sequence and delivery of resources matches the project budget and specification
16. Organisational quality assurance standards appropriate to the project
17. The importance of regularly monitoring progress and the implications of poor time-management
18. The importance of dealing with problems promptly and seeking agreement on variations and recording the agreements
19. How to prepare and complete final documentation relevant to the project and who it should be given to

Outcome 3: execute a procedure for the solution of an engineering problem

- state the objective(s) to be achieved through the solution to the project problem
- utilise the appropriate design expertise to solve the project problem
- utilise data, calculations, graphs, simulations, charts, etc. where appropriate to produce and present project problem solutions
- communicate when necessary with the project supervisor for advice and guidance.

Outcome 4: evaluate the outcomes of the engineering project

- critically appraise the project against the original objectives
- estimate design and possible implementation costs of the project
- state and estimate any safety improvements or efficiency savings resulting from the solution of the project problem.

Outcome 5: prepare a project report

- compile a written project report to a recommended format that includes a title for the project, table of contents, index, section headings, summary, results, conclusions, appendices, list of references and bibliography
- use information technology to word-process the report and incorporate the use spreadsheets and databases to present data as appropriate
- outline the scope and objectives of the project in the form of an introduction
- describe any design procedures with specimen calculations, charts, graphs or other data display forms
- state any recommendations and the degree to which the solution(s) arrived at meet or do not meet the original scope and objectives
- state any actual or estimated cost implications arising from the implementation of the project recommendations
- state any actual or expected cost savings or expenditure arising from implementation of the project solution(s)

Unit SSTE/NOS 9

Plan Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

Knowledge Requirements

1. How to summarise and assess the available project data
4. How to obtain more information from alternative sources in cases where the available project data is insufficient
8. How to calculate the resources needed from the information available
11. How to obtain clarification and advice where the resources needed are not available
16. How to calculate how long each activity will take and sequence activities
29. How to identify the organisational and communication needs for the project
33. How to monitor the methods of communicating, reporting, recording and retrieving information
35. How to introduce methods of communicating, reporting, recording and retrieving information which are appropriate to the needs of the project

- state any safety ramifications arising from the project solution(s)
- list any appendices, manufacturers' data, standards, etc. according to a recognised format
- list references and or bibliography as appropriate
- paginate and appropriately section the compiled document.

Unit 6: Mechanical Engineering Principles	Summit Skills Equivalent
	No direct match to unit content
Unit 7: Science for Electrical Installation	Summit Skills Equivalent
Outcome 3 Utilise electric power	UNIT SST/NOS 3
<ul style="list-style-type: none"> • determine electrical and mechanical power requirements to carry out mechanical tasks • determine electrical power requirements for heating loads • state and apply terms used in illumination • explain tariffs and load demand curves • calculate costs using typical Electricity Board tariffs • describe the importance and effect of power factor in the rating of electrical machines and equipment 	<p>Performance objective</p> <p>j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾</p>
	<p>Knowledge requirements</p> <p>12. How to calculate the relative effectiveness of different design solutions [P.O. (j)]</p>
	<p>UNIT SSTE/NOS 8</p> <p>Performance objective</p> <p>p. Calculate the relative effectiveness of different design solutions</p>
	<p>Knowledge requirements</p> <p>21. How to calculate the relative effectiveness of different design solutions [P.O. (p)]</p>
Unit 8: Electrical installation technology	Summit Skills Equivalent
Outcome 1: Apply regulations to electrical installations	UNIT SSTE/NOS 1
<ul style="list-style-type: none"> • demonstrate knowledge of the practical applications to electrical installation work of the current edition of the Regulations for Electrical Installations and the ability to use this knowledge in electrical installation work • demonstrate knowledge of the electricity at work regulations, 1989 	<p>Performance objectives</p> <p>a. check that your health, safety and welfare responsibilities are consistent with:</p> <ul style="list-style-type: none"> • contract, legislation⁽¹⁾, organisational policy • project specific requirements • site procedures <p>b. communicate your health, safety and welfare responsibilities to relevant project personnel</p>

- demonstrate knowledge of the Electricity Supply Regulations in so far as they deal with consumer installations under Regulations 2229 and 32, and of any regulations concerning consumer installation which may be issued by the Electricity Commissioners in addition to or in substitution for those mentioned above
 - state the need for reference to the appropriate British Standards and Codes of Practice when planning and carrying out installation work
- d. ensure there is a safe system of work in place which:
 - meets health and safety legislation
 - is in accordance with organisational requirements
 - complies with the method statement and risk assessments
 - e. ensure that statutory notices appropriate to the hazards and risks are displayed where they will be seen clearly and to best effect
 - f. ensure that personal protective equipment, safety equipment and resources:
 - comply with health and safety legislation⁽¹⁾
 - are available in sufficient quantities
 - are immediately accessible to those who may need them
 - g. ensure that you have appropriate systems which meet statutory requirements for the identification and rectification of hazards and ensure that the reporting of accidents and emergencies are developed and implemented
 - i. ensure you fully inform all relevant personnel, for whom you are responsible, about:
 - the importance of co-ordinating with other trade operatives
 - where safety equipment is kept and when to use it
 - all evacuation procedures
 - j. verify that the scope and responsibilities for the work activity are clearly defined
 - k. identify potential hazards from the work activity and ensure that risk assessments are carried out to minimise the risk
 - l. ensure that access equipment is installed and used in accordance with instructions and regulations

Knowledge requirements

20. what your health, safety, welfare and employment responsibilities and liabilities are and the importance of ensuring that other people are kept informed
[P.O. (a)]
3. the purpose and importance of setting up a safe system of work in accordance with risk assessments and method statements
[P.O. (a), (b), (c)]
4. how to access information regarding health and safety legislation
[P.O. (d), (e), (f)]

5. organisational procedures and requirements relevant to:
 - the safe system of work
 - carrying out a review of health and safety
 - ensuring sufficient quantities and availability of personal protective equipment, safety and access equipment and resources
 - welfare facilities
 - reporting an accident
[P.O. (d), (g), (h), (i), (l)]
6. the importance of having statutory notices and hazard warnings and where to place them for best effect and for having systems to assist with the identification and rectification of hazards
[P.O. (e)]
7. the importance of keeping operatives fully informed about what to do and when in the context of health and safety and their responsibilities with regard to their work
[P.O. (b), (c), (i), (j), (w)]

UNIT SSTE/NOS 1

Performance objectives

- a. identify all relevant aspects of the risk assessment and method statement prepared for the workplace where building services engineering operations are taking place
- b. confirm before work starts which building services engineering operatives are eligible and competent to operate plant and equipment and undertake those duties allocated to them
- c. ensure that all health and safety documentation is in accordance with the building services engineering operations and organisational requirements and is legible, accurate and timely
- d. ensure that plant and equipment relevant to the building services engineering operations is safe to use

Knowledge requirements

1. all relevant aspects of the risk assessment and method statement which will affect you and all those operatives for whom you are responsible
[P.O. (a)]
2. how to identify which building services engineering operatives have received the correct training, are eligible and competent to operate plant and equipment
[P.O. (b)]

3. organisational requirements for completing the necessary documentation and how to ensure clarity, accuracy and completion within schedule
[P.O. (c)]
4. how to ensure that plant and equipment is safe to use
[P.O. (d)]

Outcome 5: Determine estimating, planning and site supervision requirements

- consider for estimating purposes problems associated with installations in various types and phases of building construction
- appreciate what is involved in programming an installation and the resources needed to carry it out
- Describe and use site records and procedures

UNIT SST/NOS 4

Performance objectives

- a. Contribute to work undertaken in preparation of the tender⁽⁶⁾ and collate all necessary information prior to commencement
- b. Use the client information to help identify the sequence of work and the types of plant, labour and materials required for the project
- c. Assess the potential cost of plant, labour and material requirements and their availability against the requirements of the project
- d. Through liaison with relevant person(s)⁽³⁾, apply the organisation's estimating systems to estimate the quantities of plant, labour and materials in relation to the requirements of the project
- e. Incorporate the requirements for a method statement and risk assessments into the tender
- f. Seek clarification from the relevant person(s) where there are potential problems with the tender⁽⁶⁾ information provided
- g. Confirm that the information contained within the completed estimate is accurate and represents your organisation in a professional manner
- h. Distribute promptly the completed estimate to the relevant person(s) for authorisation, adjudication and submission as a tender bid in accordance with organisational procedures
- i. Record and store all relevant information used in the tender preparation
- j. Monitor the progress of the tender and check with relevant person(s) if further information is required

Knowledge requirements

1. The resources, including information technology software that are available to your organisation for the purposes of tendering
[P.O. (a, b)]
2. The organisation's schedule of work and its implications for the tender
[P.O. (b)]

3. What information will need to be included within the tender
[P.O. (a, b)]
4. How to prepare a schedule of work
[P.O. (b)]
5. How to assess plant, labour and materials required in accordance with the following factors:
 - types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender[P.O. (c, d, e)]
6. Delivery times of plant, labour and materials
[P.O. (c)]
7. Who can clarify potential problems arising from the tender information provided
[P.O. (f)]
8. How to incorporate the requirements of method statements and risk assessments into the organisation's schedule of work to meet the project requirements
[P.O. (e)]
9. Who needs to authorise the tender bid and submission of the tender bid
[P.O. (g, h)]
10. Organisational procedures for recording and storing information used in tender preparation
[P.O. (i)]
11. How to monitor the progress of the tender and check if further information is required
[P.O. (j)]

UNIT SST/NOS 8

Performance objectives

- a. Identify work methods which will make the best use of resources and which meet approved procedures and practices
- b. Evaluate the methods against relevant technical and project data⁴ and select the one which best meets the criteria
- c. Prepare a method statement which is accurate, clear, concise and acceptable to all individuals and organisations involved
- d. Identify work activities and calculate the resources needed from the information available obtaining clarification and advice where the resources needed are not available

- e. Calculate how long each activity will take, identify work activities which influence each other and sequence them logically and realistically so that they make the best use of the resources available
- f. Produce detailed plans for work activities which are consistent with approved procedures and practices
- g. Identify the individuals and organisations that are needed and where they can be obtained, and select those that meet agreed timescales and budget limits
- h. Identify what the organisational and communication needs are for the project

Knowledge requirements

1. How to prepare a method statement
[P.O. (c)]
2. How to identify work methods which will make the best use of resources and which meet approved procedures and practices
[P.O. (a)]
3. How to evaluate the methods against relevant technical and project criteria and select the method which best meets the criteria
[P.O. (b)]
4. How to calculate the resources needed from the information available
[P.O. (d)]
5. The activities that influence each other
[P.O. (e)]
6. How to obtain clarification and advice where the resources needed are not available
[P.O. (d)]
7. How to prepare a draft work programme
[P.O. (f)]
8. How to calculate how long each activity will take and sequence activities
[P.O. (e)]
9. How to produce detailed programmes and schedules of planned activities
[P.O. (f)]
10. How to select individuals and organisations that meet agreed timescales and budget limits
[P.O. (g)]
11. How to identify the individuals and organisations that are needed and where they can be obtained
[P.O. (g)]
12. How to identify the organisational and communication needs for the project
[P.O. (h)]

UNIT SST/NOS 8

Performance objectives

- i. Ensure that sufficient organisational resources are available to meet the tender deadline in accordance with the project
- j. Plan the preparation of the tender and collate all necessary information prior to commencement
- d. Use the client information to identify the sequence of work and the types of plant, labour and materials required for the project
- e. Assess the potential cost of plant, labour and material requirements and their availability against the requirements of the project
- f. Apply the organisation's estimating systems to estimate the quantities of plant, labour and materials in relation to the requirements of the project
- g. Establish the costs of plant, labour and materials derived from potential sources in accordance with the requirements of the project
- h. Establish the estimated cost for each activity in accordance with the requirements of the project
- i. Incorporate the requirements for a method statement and risk assessments into the tender
- j. Seek clarification from the relevant person(s) where there are potential problems with the tender information provided
- k. Finalise total estimated costs in accordance with the procedures of your organisation

Knowledge requirements

1. The deadline for submission of the tender
[P.O. (a)]
2. The resources, including information technology software that are available to your organisation for the purposes of tendering
[P.O. (a), (b)]
3. How to evaluate whether these resources will be sufficient
[P.O. (a), (b)]
4. The organisation's schedule of work and its implications for the tender
[P.O. (d)]
5. What information will need to be included within the tender
[P.O. (All)]
6. How to prepare a schedule of work
[P.O. (d)]

7. How to assess plant, labour and materials required in accordance with the following factors:
 - types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender
 [P.O. (d), (e), (f), (g)]
8. How to obtain competitive costings of plant, labour and materials derived from potential sources in accordance with the requirements of the project
[P.O. (g)]
9. Delivery times of plant, labour and materials
[P.O. (e)]
10. The implications of long and lead times, extended delivery dates and required completion times
[P.O. (e)]
11. Who can clarify potential problems arising from the tender information provided
[P.O. (j)]
12. How to incorporate the requirements of method statements and risk assessments into the organisation's schedule of work to meet the project requirements
[P.O. (i)]
13. The implications of the requirement of method statements and risk assessments within the tender specification
[P.O. (i)]

UNIT SSTE/NOS 4

Performance objectives

- a. Identify other individuals and organisations who will be at the work location and plan the coordination of the project's requirements with theirs
- b. Confirm the quantities of resources required and check that they meet with the project specification
- c. Identify any areas of skilled work within the project where other experts or specialists are required
- d. Identify whether specialists are available within your own team or whether it is necessary to outsource work
- e. Identify a programme of work activities and communicate instructions⁽⁵⁾ to individuals and organisations
- f. Order resources ahead of time to ensure their arrival in accordance with scheduling

- g. Confirm with individuals and organisations that risk assessments and method statements are carried out in accordance with the project specification⁽³⁾ and approved procedures and practices
- h. Ensure that pre-site planning is agreed and is in accordance with the project specification⁽³⁾ and approved procedures and practices

Knowledge requirements

1. The scope, purpose and requirements of the project which is being managed
[P.O. (All)]
2. The importance of planning the project in a sequence to ensure an effective project completion
[P.O. (I)]
3. The importance of ensuring that pre-site planning takes place and includes the requirements for health and safety
[P.O. (a)]
4. The purpose and importance of risk assessments and method statements and their implications for safe working as well as keeping them updated in view of variations
[P.O. (g)]
5. How to plan a project effectively and to include identifying resource quantities that will be required and when
[P.O. (b), (f)]
7. The size of workforce necessary to undertake the project requirements and comply with the project schedule
[P.O. (d), (i), (j)]

Unit 9: Electrotechnical Services, Installation And Systems

No direct match with Summit Skills Standards

Unit 10: Electrical supply and distribution

No direct match with Summit Skills Standards

Outcome 1: Set out and draw a properly designed heating system using the correct graphical symbols for pipework and ancillary equipment

No direct match with Summit Skills Standards, as the standards do not cover drafting

Outcome 2: Understand proper combustion and fuel characteristics

- Understand the difference between primary and delivered energy when considering running costs
- Understand the terms Calorific input and output values, viscosity, ignition temp, density etc.
- Understand air supply requirements
- Understand the advantages and disadvantages of the different fuels — gas, oil, solid fuel, electricity
- Consider environmental protection
- Understand the different oil supply systems
- Minimise carbon emissions
- Select the correct materials for flues
- Select between open and balanced flues
- Understand the factors which affect flue performance
- Understand how to avoid condensation in flues
- Find regulations regarding flues ie. fire regulations and safety procedures

UNIT SST/NOS 3

Performance objectives

- a. identify which parts of the overall project⁽¹⁾ require detailed design
- b. choose techniques⁽²⁾ which are suitable for investigating, calculating, testing, developing and specifying detailed design solutions
- c. choose techniques⁽²⁾ for developing detailed designs and associated information which are consistent with best industry practice and which conform to relevant codes of practice
- d. identify and decide on the relative importance of building services engineering project requirements⁽³⁾ which are contained in the design brief
- e. analyse the building services engineering project criteria⁽⁴⁾ which are significant to the overall design, both individually and in combination with other project consideration
- f. analyse the factors⁽⁷⁾ which will influence the detailed design, deciding which are the most important for the design solution and resolving any conflicts between the different factors

Knowledge requirements

1. How to identify parts of the overall project that require detailed design
[P.O. (a)]
2. How to choose techniques for investigating, calculating, testing, developing and specifying detailed design solutions
[P.O. (b)]
3. How to choose techniques for developing detailed designs and associated information
[P.O. (c)]

Outcome 3: Select the correct boiler for specific application

- Establish the clients requirements ie. Fuel choice, heating requirements, ventilation, type of boiler, flue location, type and position of heat emitters, controls, pipework layout, energy efficiency
- Understand the working principles and advantages of a condensing boiler
- Understand correct flue temperatures
- Recognise the different types of boilers — condensing, combination etc.
- Understand the operation of modular boiler / boilers and close load matching
- Recognise the factors affecting choice of boiler
- Recognise compact efficient design
- Prepare a specification for installation work

Outcome 4: Understand the importance of alternative heat sources and energy efficient design

No direct match with Summit Skills Standards, as the standards do not cover alternative heat sources and energy efficient design

Outcome 5: Calculate heating loads using outdoor design conditions and indoor design criteria

- Carry out a heating load calculation using mathematical exercise, Meyers calculator and computer software package.
- Understand recommended room temperatures, external design temperatures, recommended design air change rates, building exposure, high ceilings, adjoining properties, intermittent heating and ventilation rates
- Select correct heat emitter from available charts
- Understand the terms mean water temperature, maximum density of water, sensible heat, latent heat, exposed pipework emissions
- Calculate the required boiler power for building
- Understand heat transfer theory
- Understand the importance of insulation of heating system pipework
- Survey existing building for insulation etc.
- Recognise heat recovery methods

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

Outcome 6: Understand the principles of good system design

- Layout the pipework in the most efficient manner
- Understand how to avoid reverse circulation
- Understand the three-tee rule
- Recognise By-Pass arrangements
- Install pump in correct position
- Diagnose system design faults including boiler and system noise
- Understand the effects of ferric oxide and ferrous oxide in the heating system
- Properly commission a central heating system

UNIT SSTE/NOS 11

Performance objectives

- i. Specify the methods and procedures for commissioning ⁽⁵⁾ the building services products ⁽¹⁾
- j. Plan the most appropriate way to commission ⁽⁵⁾ the building services products ⁽¹⁾
- k. Confirm that conditions ⁽⁶⁾ are suitable to implement the commissioning ⁽⁵⁾ procedures
- l. Determine and obtain the resources ⁽²⁾ required to undertake the commissioning ⁽⁵⁾ procedures
- m. Ensure that the commissioning ⁽⁵⁾ is implemented correctly
- n. Identify any problems with the commissioning ⁽⁵⁾ and effectively resolve them
- o. Assess the results of the commissioning ⁽⁵⁾ to identify the outputs of the building services products ⁽¹⁾
- p. Confirm that the building services products ⁽¹⁾ meet specifications and comply with all relevant approved procedures and practices ⁽³⁾
- q. Ensure that the results of the commissioning ⁽⁵⁾ are recorded in the appropriate information systems ⁽⁴⁾ and passed to stakeholders

Knowledge requirements

11. How to confirm that the building services products meet specifications and comply with all relevant approved procedures and practices
[P.O. (p)]
12. How to plan the most appropriate way to commission the building services products
[P.O. (j)]
13. How to specify the methods and procedures for commissioning building services products
[P.O. (i)]
14. How to identify and resolve problems with commissioning
[P.O. (n)]
15. How to determine and obtain the resources required to undertake commissioning
[P.O. (l)]
16. How to ensure that commissioning is implemented correctly
[P.O. (m)]

Outcome 7: Understand the advantages and disadvantages of the different central heating systems

- Design a proper open vented heating system including position of open safety vent, pump, cold feed, feed and expansion cistern, close coupled F+E
- Design a sealed heating system, understanding the advantages and disadvantages, safety aspects, safety components, static pressure, working pressure, position of vessel, position of pump, filling point, safety devices, top up units, pressure gauge, sealed system boilers
- Size expansion vessel
- Consider safety features and regulations
- Properly carry out filling and commissioning of systems and plant
- Design an underfloor system, covering coil layouts etc.
- Understand the working of a mixing valve
- Recognise one-pipe and two-pipe systems ie. one-pipe ring, two-pipe reverse return

Outcome 8: Accurately pipe size a central heating system for a commercial/industrial building and select a suitable pump for same

- Carry out a pipe sizing exercise
- Calculate mass flow rates, velocity, specific heat capacity, pressure loss
- Understand how to calculate and find the index circuit
- Select correct pump for system or circuit
- Understand and follow the CIBSE Guide
- Understand frictional resistances and K-factors
- Carry out a pipe sizing exercise on a gravity circuit

Outcome 9: Show a knowledge of the relevant building regulations and standards required for central heating

- Find the correct documentation
- Find the correct information
- Understand the standards and guidance documents
- Understand the importance of handover to the client and the need for future service

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

UNIT SSTE/NOS 11

Performance objectives

- r. Ensure that the building services products⁽¹⁾ are ready for transfer and comply with all relevant approved procedures and practices⁽³⁾
- s. Provide clear and accurate information to the relevant people on the building services products⁽¹⁾

- Understand the importance of pre-commissioning plant and equipment

Outcome 10: Understand the need for controls and control methods ie. Building Management systems

- Recognise the fundamentals of automatic control ie. temperature, pressure, valves etc.
- Identify control devices ie. low pressure, high pressure, high temperature controls, oil level controls, flow switches etc.
- Select the appropriate control package
- Understand wire less controls
- Apply energy conservation techniques
- Understand time / thermostatic control
- Importance of frost stats — outside weather compensators
- Understand enhanced control functions, compensating controls
- Understand the need for safety features
- Identify major plant items and associated services
- Recognise computer software packages in use in mechanical services industry, ie. building energy management systems, AutoCAD etc.

- t. Identify and explain any aspects of the building services products ⁽¹⁾ that vary from the agreed specifications and requirements
- u. Obtain acceptance of the building services products ⁽¹⁾ according to the agreed transfer procedures
- v. Ensure that all relevant documentation is correctly completed and recorded in the appropriate information systems ⁽⁴⁾ in accordance with approved procedures and practices ⁽³⁾

Knowledge requirements

20. How to confirm the procedures for transferring control of the building services products
[P.O. (r), (u)]
21. How to provide clear and accurate information to the relevant people on building services products
[P.O. (s)]
22. How to obtain acceptance of the building services products according to the agreed transfer procedures
[P.O. (u)]
23. How to identify any aspects of the building services products that vary from the agreed specifications and requirements
[P.O. (t)]
24. How to ensure that the building services products are ready for transfer and comply with all relevant approved procedures and practices
[P.O. (r)]
25. How to ensure that all relevant documentation is correctly completed and recorded in the appropriate information system
[P.O. (v)]

No direct match with Summit Skills Standards, as the standards do not cover controls and control methods

Unit 12: Hot water technology and design	Summit Skills Equivalent
<p>Outcome 1: Understand and interpret Water By-Laws and promote the best practices for water conservation</p>	<p>No direct match with Summit Skills Standards, as the standards do not cover Water By-Laws and promote the best practices for water conservation</p>
<p>Outcome 2: Be aware of the latest technologies and best practices in the prevention of Legionnaire's disease</p>	<p>No direct match with Summit Skills Standards, as the standards do not cover the latest technologies and best practices in the prevention of Legionnaire's disease</p>
<p>Outcome 3: Mix quantities of hot and cold water to safe temperatures</p> <ul style="list-style-type: none"> • Understand the advantages and disadvantages between storage and instantaneous hot water supply. • Recognise and know the functions of multi-point, single point, gas-fired, Oil-fired and electric systems • Recognise and know the functions of storage types: <ul style="list-style-type: none"> • vented • unvented • Recognise and know the functions of plate exchangers • Differentiate between centralised and localised supply. • Interpret schematic diagrams of plumbing systems. • Be aware of the problems associated with dead legs. • Show an understanding of the need for secondary circulation relating to hot water supply. • Recognise and know the functions of insulation and frost protection associated with hot water systems. • Calculate storage requirements for hot water plumbing systems. • Describe the various types of materials used for storage <ul style="list-style-type: none"> • cylinders • calorifiers • Identify the various connections taken from storage cisterns and demonstrate knowledge of best practice currently used. 	<p>UNIT SST/NOS 3</p> <p><i>Performance objective</i></p> <p>j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾</p> <p><i>Knowledge requirements</i></p> <p>12. How to calculate the relative effectiveness of different design solutions [P.O. (j)]</p> <p>UNIT SSTE/NOS 8</p> <p><i>Performance objective</i></p> <p>p. Calculate the relative effectiveness of different design solutions</p> <p><i>Knowledge requirements</i></p> <p>21. How to calculate the relative effectiveness of different design solutions [P.O. (p)]</p>

Outcome 4: Know how to disinfect hot water systems	No direct match with Summit Skills Standards, as the standards do not cover how to disinfect hot water systems
Outcome 5: Determine the pipe size hot water distribution pipework, secondary returns and heat recovery periods	No direct match with Summit Skills Standards
Outcome 6: Ensure quality and conformity of water systems	No direct match with Summit Skills Standards, as the standards do not cover the quality and conformity of water systems
Outcome 7: Understand the need for water conservation	No direct match with Summit Skills Standards, as the standards do not cover the need for water conservation
Outcome 8: Understand the function of solar energy in energy conservation	No direct match with Summit Skills Standards

Unit 13: Cold water technology and design

No direct match with Summit Skills Standards

Unit 14: Sanitation and drainage technology and design

Summit Skills Equivalent

Outcome 1: Demonstrate a knowledge of relevant standards and regulations

UNIT SST/NOS 3

- Understand definitions and terms; drain, private sewer, public sewer
- Have a good knowledge of systems used
 - separate
 - combined
 - partially separate
- State the advantages and disadvantages of each system
- Have an understanding of British/Irish standards, regulations and codes of practice
- Illustrate knowledge of the principles of good design

All Performance objectives and knowledge requirements

UNIT SSTE/NOS 6

All Performance objectives and knowledge requirements

Outcome 2: Design for means of access to drains and sewers, rodding eyes, inspection chambers

- Calculate inspection chamber sizes
- Understand the methods used for inspection chambers within buildings
- Design backdrop chambers and ramps
- Make allowances for ventilation of drains and sewers

Outcome 3: Calculate pipe sizes, velocities and inclines

- Determine inclination and velocity in circular pipes and channels
- Use "Maguire's" rule effectively
- Calculate pipe sizes for drains and sewers
- Be able to understand
 - self cleansing velocity
 - self cleansing gradient
- Estimate flow loads in pipes

Outcome 4: Demonstrate knowledge of best management practice with regard to drainage design

- Design storm drains, source control options, swales, infiltration basins, French drains and retention ponds systems for
 - car parks
 - playgrounds
- Demonstrate a knowledge of management practice for the design of drainage systems for
 - garages
 - kitchen layouts
 - petrol interceptors
 - biological control of fat, oil, and grease

UNIT SST/NOS 3

All Performance objectives and knowledge requirements

UNIT SSTE/NOS 6

All Performance objectives and knowledge requirements

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

Outcome 5: Access special design requirements

- Design for methods of sewage disposal
- Design for the construction
 - cesspools
 - soakaways
- Demonstrate an understanding of bio-cycle systems
- Demonstrate the correct use of definitions

Outcome 6: Understand the function of drains and drain testing

Outcome 7: Interpret By-Laws and building regulations with regard to systems and accommodation

Outcome 8: Select between sanitation systems and appliances for both single and ranges of appliances

Outcome 9: Understand the need for protection and support for pipes and their proximity to buildings

Outcome 10: Interpret schematic diagrams with regard to siphonic drainage of grey water systems and the control of radon gas in buildings

Outcome 11: Determine the sizes of discharge and ventilating pipes

- Determine the size discharge and ventilating pipes for all types of sanitary systems
- Apply discharge unit methods for pipe sizing
- Estimate flow loads using probable simultaneous discharge
- Use probability graphs for design for sanitary pipework systems

UNIT SST/NOS 8

All performance objectives and knowledge requirements

No direct match with Summit Skills Standards, as the standards do not cover the function of drains and drain testing

No direct match with Summit Skills Standards, as the standards do not cover By-Laws and building regulations with regard to systems and accommodation

No direct match with Summit Skills Standards, as the standards do not cover sanitation systems and appliances for both single and ranges of appliances

No direct match with Summit Skills Standards, as the standards do not cover the need for protection and support for pipes and their proximity to buildings

No direct match with Summit Skills Standards, as the standards do not cover schematic diagrams or siphonic drainage of grey water systems and the control of radon gas in buildings

UNIT SST/NOS 3

Performance objective

- p. Calculate the relative effectiveness of different design solutions⁽¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

Unit 15: Air-conditioning and ventilation technology and design**Outcome 1: Illustrate and analyse the change in properties and the thermal characteristics of the air conditioning process and cycles, using psychometrics**

- understand the terms: moist air, humidity, specific enthalpy, specific volume, density, specific heat, dry bulb, wet bulb and dew point temperature, moisture content, open and closed cycles, latent heat changes, room sensible heat ratio
- plot air properties using psychometric charts
- determine air conditioning processes using psychometric charts, i.e. sensible heating and cooling, isothermal humidification
- calculate air properties using psychometric charts, including mixing of two air streams
- determine operating characteristics of an air-conditioning cycle

Summit Skills Equivalent**UNIT SST/NOS 3*****Performance objective***

- j. Calculate the relative effectiveness of different design solutions⁽¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8***Performance objective***

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

UNIT SSTE/NOS 6***Performance objectives***

- a. Obtain information, options and design parameters which are relevant to the development of the design brief
- b. Analyse the findings of investigations and identify approved procedures and practices⁽¹⁾ which may influence work activities⁽²⁾
- c. Format and collate data and conclusions from all areas of specialist research and design evaluation, and circulate the documents to project team members
- d. Analyse the information available with the project team, and produce realistic design parameters which recognise significant implications and constraints⁽³⁾
- e. Assess the design parameters and circulate the assessment to the people responsible for project design, planning and scheduling
- f. Advise the client on the most appropriate courses of action
- g. Select design concepts for further development by the project team which appear to meet the requirements of the design brief and which resolve a significant number of implications and constraints⁽³⁾ on development

Knowledge requirements

1. How to obtain information, options and design parameters which are relevant to the development of the design brief
[P.O. (a)]
2. How to format and collate data and conclusions and circulate documents containing data and conclusions to project team members
[P.O. (c)]
3. How to analyse the findings of investigations
[P.O. (b)]
4. How to identify significant factors which may influence existing and anticipated development
[P.O. (b)]
5. How to assess the design parameters
[P.O. (e)]
6. How to circulate the assessment of the design parameters to people who are responsible for project design, planning and scheduling
[P.O. (e)]
7. How to produce realistic design parameters which recognise significant opportunities and constraints
[P.O. (d)]
8. How to analyse the information available
[P.O. (d)]
9. How to advise the client on the most appropriate courses of action
[P.O. (f)]
10. How to select design concepts for further development by the project team
[P.O. (g)]

Outcome 2: Select between central systems, air handling units and packaged units for specific applications

No direct match with Summit Skills Standards, as the standards do not cover central systems, air handling units and packaged units for specific applications

Outcome 3: Interpret schematic diagrams of ventilation and air-conditioning duct systems and components

No direct match with Summit Skills Standards, as the standards do not cover drafting

Outcome 4: Understand the heat pump principle as applied to a vapour compression cycle

No direct match with Summit Skills Standards, as the standards do not cover the heat pump principle as applied to a vapour compression cycle

Outcome 5: Differentiate between the vapour compression refrigeration systems and absorption refrigeration systems and name appropriate refrigerants for specific applications

- understand the terms: refrigeration cycle, refrigerants, cooling mediums, subcooling, superheating, coefficient of performance
- differentiate between principles of a vapour compression and absorption chiller system
- recognise refrigerants by their operating characteristics
- identify desirable properties of a refrigerant
- recognise secondary refrigerants
- plot thermodynamic properties of refrigerants using pressure enthalpy charts
- determine coefficient of performance of refrigeration cycles
- determine system operating characteristics using different refrigerants
- calculate the compression ratio of refrigeration systems
- understand the characteristics of multi-stage vapour compression systems and cascade systems

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

UNIT SSTE/NOS 6

Performance objectives

- a. Obtain information, options and design parameters which are relevant to the development of the design brief
- b. Analyse the findings of investigations and identify approved procedures and practices⁽¹⁾ which may influence work activities⁽²⁾
- c. Format and collate data and conclusions from all areas of specialist research and design evaluation, and circulate the documents to project team members
- d. Analyse the information available with the project team, and produce realistic design parameters which recognise significant implications and constraints⁽³⁾
- e. Assess the design parameters and circulate the assessment to the people responsible for project design, planning and scheduling
- f. Advise the client on the most appropriate courses of action
- g. Select design concepts for further development by the project team which appear to meet the requirements of the design brief and which resolve a significant number of implications and constraints⁽³⁾ on development

Knowledge requirements

1. How to obtain information, options and design parameters which are relevant to the development of the design brief
[P.O. (a)]

2. How to format and collate data and conclusions and circulate documents containing data and conclusions to project team members
[P.O. (c)]
3. How to analyse the findings of investigations
[P.O. (b)]
4. How to identify significant factors which may influence existing and anticipated development
[P.O. (b)]
5. How to assess the design parameters
[P.O. (e)]
6. How to circulate the assessment of the design parameters to people who are responsible for project design, planning and scheduling
[P.O. (e)]
7. How to produce realistic design parameters which recognise significant opportunities and constraints
[P.O. (d)]
8. How to analyse the information available
[P.O. (d)]
9. How to advise the client on the most appropriate courses of action
[P.O. (f)]
10. How to select design concepts for further development by the project team
[P.O. (g)]

Outcome 6: Calculate design space loads using outdoor design conditions and indoor design criteria

- understand the terms: outdoor design conditions, indoor design criteria, thermal comfort, indoor temperature, relative humidity, air velocity, indoor air quality, outdoor ventilation air requirements, clean rooms, space pressure differential, sound levels, comfort indices
- understand methods used by the human body to emit heat
- recognise indoor air contaminants
- identify typical HTVAC design conditions
- understand cooling loads, conduction and internal heat gains
- identify the interaction of the building fabric and the ventilation/air conditioning system in controlling the indoor climate
- calculate cooling coil and heating loads and infiltration volume flow rate

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

Outcome 7: Safe use of instruments and equipment to record air movement, humidity temperature and pressure

- understand the terms: globe thermometer, sling psychrometer, vane anemometer, hot wire anemometer, pitot tube
- connect a pressure manifold gauge set to a refrigerating system
- leak test a vapour compression refrigerating system
- measure the relative humidity of air
- measure the temperature of air and refrigerant at various locations in a system
- measure and record the velocity of air using a pitot tube and a vane anemometer
- measure and record the running current of electrical motors and compare with motor FLA
- calculate volume flow rate using recorded air velocities for various shaped ducts

UNIT SSTE/NOS 8

Performance objectives

- a. Identify relevant resources ⁽⁷⁾ and implications and constraints ⁽⁶⁾ which are likely to influence the detailed design solution, assessing their significance and prioritising them
- b. Analyse and weight the resources ⁽⁷⁾ which will influence the detailed design, deciding which are the most important for the design solution and resolve any conflicts between the different factors
- c. Calculate the relative effectiveness of different design solutions
- d. Analyse and test ⁽⁸⁾ the detailed design solutions against all relevant resources ⁽⁷⁾
- e. Conduct and commission investigations ⁽³⁾ which are capable of confirming the performance of the detailed design solutions which have been selected
- f. Record the data from calculations, investigations ⁽³⁾ and analyses and pass them on for checking
- g. Select the preferred designs and present them to individuals and organisations ⁽¹⁾
- h. Identify and record detailed design solutions which have not been selected but which might be useful in other projects

Knowledge requirements

1. How to agree with individuals and organisations the purposes which will be served by detailed design information
[P.O. (a)]
2. How to choose a format for presenting the detailed design information which meets the requirements of individuals and organisations
[P.O. (b)]
3. How to identify which parts of the overall project require detailed design and which interact with each other
[P.O. (c)]
4. How to set up procedures which will maintain coherence and consistency and how to agree suitable ways to maintain coherence and consistency between all aspects of the detailed design
[P.O. (d), (e)]
5. How to choose techniques for investigating, calculating, testing, developing and specifying detailed design solutions
[P.O. (f)]
6. How to choose techniques for developing detailed designs and associated information
[P.O. (g)]

Outcome 8: Accurately assess refrigeration components and evaporative coolers

Outcome 9: Understand and calculate air system basics

- understand the terms: flow resistance, fan duct system, system operating point, constant volume systems, variable air volume systems, fan characteristic curves
- identify the four types of minimum outdoor ventilation air control
- recognise different fan types, i.e. centrifugal, axial-flow and tangential
- plot fan characteristic curves
- determine appropriate motor size
- calculate air conditioning system conditions using the fan laws
- understand types of modulation of volume flow rate of VAV air systems
- recognise sick building syndrome (SBS) characteristics and contributors
- differentiate SBS with building related illness

7. How to explain the relative importance of work activities contained within the design brief and the potential implications and constraints
[P.O. (h)]

No direct match with Summit Skills Standards, as the standards do not cover refrigeration components and evaporative coolers

UNIT SST/NOS 3

Performance objective

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

Knowledge requirements

12. How to calculate the relative effectiveness of different design solutions
[P.O. (j)]

UNIT SSTE/NOS 8

Performance objective

- p. Calculate the relative effectiveness of different design solutions

Knowledge requirements

21. How to calculate the relative effectiveness of different design solutions
[P.O. (p)]

UNIT SSTE/NOS 6

Performance objectives

- a. Obtain information, options and design parameters which are relevant to the development of the design brief
- b. Analyse the findings of investigations and identify approved procedures and practices⁽¹⁾ which may influence work activities⁽²⁾
- c. Format and collate data and conclusions from all areas of specialist research and design evaluation, and circulate the documents to project team members
- d. Analyse the information available with the project team, and produce realistic design parameters which recognise significant implications and constraints⁽³⁾
- e. Assess the design parameters and circulate the assessment to the people responsible for project design, planning and scheduling
- f. Advise the client on the most appropriate courses of action

- g. Select design concepts for further development by the project team which appear to meet the requirements of the design brief and which resolve a significant number of implications and constraints⁽³⁾ on development

Knowledge requirements

1. How to obtain information, options and design parameters which are relevant to the development of the design brief
[P.O. (a)]
2. How to format and collate data and conclusions and circulate documents containing data and conclusions to project team members
[P.O. (c)]
3. How to analyse the findings of investigations
[P.O. (b)]
4. How to identify significant factors which may influence existing and anticipated development
[P.O. (b)]
5. How to assess the design parameters
[P.O. (e)]
6. How to circulate the assessment of the design parameters to people who are responsible for project design, planning and scheduling
[P.O. (e)]
7. How to produce realistic design parameters which recognise significant opportunities and constraints
[P.O. (d)]
8. How to analyse the information available
[P.O. (d)]
9. How to advise the client on the most appropriate courses of action
[P.O. (f)]
10. How to select design concepts for further development by the project team
[P.O. (g)]

Outcome 10: Understand the need for control, control methods and system basics

No direct match with Summit Skills Standards, as the standards do not cover the need for control, control methods and system basics

Unit16: Heating and ventilating systems technology and design

Summit Skills Equivalent

Outcome 1: Understand the need for alternative technologies in the design of sustainable buildings

No direct match with Summit Skills Standards, as the standards do not cover alternative technologies in the design of sustainable buildings

Outcome 2: Realise the benefits of implementing the “heat energy rating” on buildings

- Play an active part in reducing future energy consumption
- Know how to calculate and actively reduce CO₂ emissions
- Know the role of the assessors in calculating the HER of a dwelling
- Know the time scale for the implementation of the HER process
- Understand the term energy labelling
- Know the energy efficient measures being put in place to ensure efficiency in energy use

UNIT SST/NOS 3**Performance objective**

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

UNIT SSTE/NOS 8**Performance objective**

- p. Calculate the relative effectiveness of different design solutions

Outcome 3: Understand the benefits of a passive house

No direct match with Summit Skills Standards, as the standards do not cover the benefits of a passive house

Outcome 4: Design and install a solar hot water system

- Have an understanding of the quality of solar radiation in Ireland
- List the different types of solar collectors used in solar design
- Design and install a solar hot water system
- Know the principle requirements on components and materials
- Calculate the cost of a standard solar hot water system for a two storey dwelling
- Know how to commission a solar hot water system
- Know how to control the temperature of a solar installation
- Have an understanding of the function and requirements of heat exchangers
- State the safety considerations of a solar installation
- Understand the advantages and disadvantages of a solar installation
- Calculate the size of collectors for domestic hot water requirements

UNIT SST/NOS 3**Performance objective**

- j. Calculate the relative effectiveness of different design solutions⁽¹¹⁾

UNIT SSTE/NOS 8**Performance objective**

- p. Calculate the relative effectiveness of different design solutions

UNIT SSTE/NOS 11**Performance objectives**

- i. Specify the methods and procedures for commissioning⁽⁵⁾ the building services products⁽¹⁾
- j. Plan the most appropriate way to commission⁽⁵⁾ the building services products⁽¹⁾
- k. Confirm that conditions⁽⁶⁾ are suitable to implement the commissioning⁽⁵⁾ procedures
- l. Determine and obtain the resources⁽²⁾ required to undertake the commissioning⁽⁵⁾ procedures
- m. Ensure that the commissioning⁽⁵⁾ is implemented correctly
- n. Identify any problems with the commissioning⁽⁵⁾ and effectively resolve them

- o. Assess the results of the commissioning⁽⁵⁾ to identify the outputs of the building services products⁽¹⁾
- p. Confirm that the building services products⁽¹⁾ meet specifications and comply with all relevant approved procedures and practices⁽³⁾
- q. Ensure that the results of the commissioning⁽⁵⁾ are recorded in the appropriate information systems⁽⁴⁾ and passed to stakeholders

Outcome 5: Understand the principle of photovoltaic systems

No direct match with Summit Skills Standards, as the standards do not cover the principle of photovoltaic systems

Outcome 6: Know the principle of operation of a micro combined heat power unit

No direct match with Summit Skills Standards, as the standards do not cover the principle of operation of a micro combined heat power unit

Outcome 7: State the benefits of using heat pumps in modern buildings

No direct match with Summit Skills Standards, as the standards do not cover the benefits of using heat pumps in modern buildings

Outcome 8: Select an energy efficient wood burning stove

No direct match with Summit Skills Standards, as the standards do not cover wood burning stoves

Outcome 9: Identify new technologies in sewage disposal, rain and waste water treatment

No direct match with Summit Skills Standards, as the standards do not cover new technologies in sewage disposal, rain and waste water treatment

Outcome 10: State what the current trends are in heating the houses of the future

No direct match with Summit Skills Standards, as the standards do not cover the current trends are in heating the houses of the future

Unit 17: Mathematics for Building Services Engineers

Summit Skills Equivalent

Application of the unit content to possible design problems: eg:

- use of trigonometric identities appropriate to the solution of problems
- use differentiation methods to sketch graphs and solve problems involving maximum and minimum values.
- solve problems involving two complex parallel impedances

UNIT SST/NOS 3

Performance objective

- k. Calculate the relative effectiveness of different design solutions⁽¹⁾

UNIT SSTE/NOS 8

Performance objective

Calculate the relative effectiveness of different design solutions

Outcome 1: Evaluate work methods

- access project data
- obtain information from alternative sources in cases where the available project data is insufficient
- assess the available project data accurately
- summarise project data to enable decisions on work activities to be made
- evaluate the methods against relevant technical and project data
- select the one which method meets the criteria

Outcome 2: Select work methods

- identify work methods that best utilise resources and which meet approved procedures and practices
- recommend the selected method to decision makers and encourage them to adopt it
- analyse the method which has been selected for its activity content and quantify it accurately
- prepare a method statement which is accurate, clear, concise and acceptable to all individuals and organisations involved

Outcome 3: Plan work activities and resources

- identify work activities and calculate the resources needed from the information available obtaining clarification and advice where the resources needed are not available
- analyse the work activities against project data and the requirements of significant external factors
- calculate how long each activity will take, identify work activities which influence each other and sequence them logically and realistically so that they make the best use of the resources available
- produce detailed plans for work activities which are consistent with approved procedures and practices

Unit SST/NOS 8

Contribute To Planning Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

- a. identify work methods which will make the best use of resources and which meet approved procedures and practices
- b. evaluate the methods against relevant technical and project data and select the one which best meets the criteria
- c. prepare a method statement which is accurate, clear, concise and acceptable to all individuals and organisations involved
- d. identify work activities and calculate the resources needed from the information available obtaining clarification and advice where the resources needed are not available
- e. calculate how long each activity will take, identify work activities which influence each other and sequence them logically and realistically so that they make the best use of the resources available
- f. produce detailed plans for work activities which are consistent with approved procedures and practices
- g. identify the individuals and organisations that are needed and where they can be obtained, and select those that meet agreed timescales and budget limits
- h. identify what the organisational and communication needs are for the project all knowledge requirements

Unit SSTE/NOS 9

Plan Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

- evaluate work methods
- select work methods
- plan work activities and resources
- select and form a project work team
- establish and maintain project organisation and communications
- all knowledge requirements

-
- identify alterations to work activities which will meet changed circumstances or offer cost and time benefits, calculating the savings accurately and justifying them to decision makers
 - develop a system for monitoring the work activities implementing it and using the results to improve future production and planning

Outcome 4: Select and form a project work team

- identify the individuals and organisations that are needed and where they can be obtained, and select those that meet agreed timescales and budget limits
- identify any significant factors which will affect the number, type and availability of individuals and organisations
- evaluate the quality and potential reliability of individuals and organisations and resources and circulate the results to decision makers
- negotiate and agree proposals for team membership which are likely to produce effective working relationships
- follow approved procedures and practices for obtaining individuals and organisations
- produce appropriate contractual arrangements and terms of appointment for the individuals and organisations and confirm in writing with stakeholders
- negotiate contracts and agreements in a way which preserves goodwill and trust

Outcome 5: Establish and maintain project organisation and communication systems

- identify what project organisational and communication needs are
- develop and introduce systems which are compatible with approved procedures and practices and which enable clear and effective management, and administrative and operational controls
- produce accurate and unambiguous information about people's roles and responsibilities and the organisational structure, and circulate the information to individuals and organisations who have an interest

- introduce methods of communicating, reporting, recording and retrieving information which are appropriate to the needs of the project and comply with approved procedures and practices and monitor the methods regularly for effectiveness
- identify and investigate breakdowns in communication, and take action to restore effective communication
- set up systems for recording and providing feedback on the ways in which resources are allocated and used

Unit 19: Contract procedures and requirements for building services engineering projects

Outcome 1: Understand key clauses and concepts from one of the standard forms of building contract

The candidate knows how to:

use the different forms of building contract
 identify the arrangement and the contents of a major form of building contract
 use the articles of agreement and appendix and their purpose
 identify the key clauses in respect of time, cost and quality

Outcome 2: Identify the different types of drawn information, their purposes and use

The candidate can, for work with which he/she is familiar demonstrate an ability to:
 read production drawings relevant to the work
 understand the implications of the details shown on the drawings including their buildability
 decide the work sequence and methods of work by examination of the drawings
 understand how the drawings are used to inform the construction works on site

Outcome 3: Identify schedules of information and relate these to the other documents

The candidate can, for work with which he/she is familiar demonstrate an ability to:
 identify where and how schedules are used
 interpret data provided on schedules and other similar information
 relate the schedules to the other contract documentation
 compare and contrast the information included on the schedules with the drawings and bills of quantities

Summit Skills Equivalent

Unit SST/NOS 6

Apply Contract Conditions For Building Services Engineering Projects

- i. Identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender
- c. Regularly review progress information and liaise with your site base regularly to ensure that your organisation is adhering to their contractual obligations with the client relating to the following:
 - time constraints
 - progress on site
 - achieving deadlines
 - variations
- d. Investigate and evaluate the contractual implications of variations, their likely effect on programme activities, timings and sequences
- e. Promptly identify problems in complying with the terms of your organisations contractual obligations in terms of:
 - timescales
 and ensure that they are reported promptly to the relevant person(s)

Knowledge requirements

1. How to identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender
 [P.O. (a)]

Outcome 4: Understand the requirements of a specification of the works

The candidate knows how to:

use a specification when this is required as a contract document

interpret the information contained in a specification

consider the implications of the specification information and how it affects the work

interpret the specification in the way construction work is carried out

Outcome 5: Examine a bill of quantities or schedules of rates and understand its contents

The candidate knows how to:

identify the purpose of bills of quantities or schedule of rates

prepare a bills of quantities or schedules of rates

assess the significance of the quantities in a bill

use the bills of quantities of work to help define the work programme

interpret the rules of a method of measurement

Outcome 6: Read a master programme and relate this to the progress of the works

The candidate can, for work with which he/she is familiar demonstrate an ability to:

understand the contents and inter-relationship of a master programme

know how it relates to the conditions of contract

identify reasons why the project may fall behind its programme

make suggestions of how the programme might be brought back on schedule

Outcome 7: identify the important points to note on a pre-visit to a site

The candidate can, for work with which he/she is familiar demonstrate an ability to:

make a visit to a proposed site and list the factors which will affect the work

list the provisions needed on a site to support the project

inspect the site and note any special requirements for temporary works and access

assess how the nature of the site might affect the costs of construction

3. With whom you should liaise to monitor progress and check contractual compliance
[P.O. (c)]

4. How to identify problems in complying with the terms of your organisation's contractual obligations
[P.O. (e)]

8. Various forms of contract, contract terms and conditions
[P.O. (All)]

Unit SSTE/NOS 5

Manage Contract Procedures For Building Services Engineering Projects

a. Identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender

c. Enter into contractual agreements with external suppliers of materials, plant and labour

d. Monitor external suppliers to ensure that they are complying with the terms of the contractual agreement

e. Resolve differences and seek suitable solutions with external suppliers in the context of the contract

f. Regularly review progress information and liaise with your site bas regularly to ensure that your organisation is adhering to their contractual obligations with the client relating to the following:

- time constraints
- progress on site
- achieving deadlines
- variations

h. Investigate and evaluate the contractual implications of variations, their likely effect on programme activities, timings and sequences

i. Promptly identify problems in complying with the terms of your organisations contractual obligations in terms of:

- timescales

and ensure that they are reported promptly to the relevant person(s)

j. Resolve difficulties and seek suitable solutions with the client in the context of the contract

Knowledge requirements

1. How to identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender
[P.O. (a)]
3. The contractual obligations between:
 - your organisation and the client
 - your organisation and external contractors[P.O. (c)]
4. How to monitor:
 - the client
 - external contractors
 - sub contractorsto ensure that they adhere to their contractual obligations with your organisation
[P.O. (d)]
5. With whom you should liaise to monitor progress and check contractual compliance
[P.O. (d), (j)]
6. Suitable solutions that are available in the event that the client, external contractors or your workforce are not adhering to the terms of their contract
[P.O. (e)]
7. How to identify problems in complying with the terms of your organisation's contractual obligations
[P.O. (i)]
8. To whom you should report such problems
[P.O. (i)]
9. How to investigate the contractual implications of anticipated, proposed and actual variances and evaluate their likely effect on programme activities, timings and sequences
[P.O. (h)]

Unit 20: Estimating and tendering for building services engineering projects

Summit Skills Equivalent

Outcome 1: Understand the need to be fully appraised of the contract documents including the need for a site visit

- identify the individual nature of each proposed construction site and note any factors which will affect the work
- examine the drawings to gain an understanding of the project requirements
- study the bills of quantities, specification or schedule of rates to understand the various requirements of time, quantity and quality
- review the conditions of contract and especially the contents of the appendix

Outcome 2: Calculate the costs of resources

- build up the costs of employing operative and craft
- interpret the provisions of the Working Rule Agreement inasmuch as they affect costs
- calculate the costs involved of owning or operating plant and equipment
- allocate costs to materials in respect of delivery, unloading, hoisting, fixing in position, wastage, shrinkage, consolidation or increase in bulk, storage and workshop charges
- prepare and send out enquiries for material prices and subcontractor quotations

UNIT SST/NOS 4***Performance objectives***

- a. Contribute to work undertaken in preparation of the tender⁽⁶⁾ and collate all necessary information prior to commencement
- b. Use the client information⁽¹⁾ to help identify the sequence of work and the types of plant, labour and materials required for the project⁽²⁾

Knowledge requirements

12. The resources, including information technology software that are available to your organisation for the purposes of tendering
[P.O. (a, b)]
13. The organisation's schedule of work and its implications for the tender
[P.O. (b)]
14. What information will need to be included within the tender
[P.O. (a, b)]
15. How to prepare a schedule of work
[P.O. (b)]

UNIT SST/NOS 4***Performance objectives***

- c. Assess the potential cost of plant, labour and material requirements and their availability against the requirements of the project⁽²⁾
- d. Through liaison with relevant person(s)⁽³⁾, apply the organisation's estimating systems to estimate⁽⁵⁾ the quantities of plant, labour and materials in relation to the requirements of the project⁽²⁾

Knowledge requirements

16. How to assess plant, labour and materials required in accordance with the following factors:
 - types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender[P.O. (c, d, e)]
17. Delivery times of plant, labour and materials
[P.O. (c)]

UNIT SSTE/NOS 3

Performance objectives

- d. Use the client information⁽¹⁾ to identify the sequence of work and the types of plant, labour and materials required for the project⁽³⁾
- e. Assess the potential cost of plant, labour and material requirements and their availability against the requirements of the project⁽³⁾
- f. Apply the organisation's estimating systems to estimate⁽⁷⁾ the quantities of plant, labour and materials in relation to the requirements of the project⁽³⁾
- g. Establish the costs of plant, labour and materials derived from potential sources⁽²⁾ in accordance with the requirements of the project⁽³⁾

Knowledge requirements

5. How to decide the relative importance of building services engineering project requirements?
[P.O. (d)]
6. How do you analyse the building services engineering project criteria which are significant to the overall design
[P.O. (e)]
7. How to select products which meet the identified building services engineering project criteria and standards and which balance cost and quality
[P.O. (g)]

Outcome 3: Calculate the costs measured items of work

- calculate the costs of a range of typical measured items from bills of quantities
- use site feedback to update labour outputs and material wastage factors
- reconcile a range of invoices for common building materials with the quantities in the final account
- consider the particular aspects of a project when analysing rates for measured works
- discuss the various price analysis with the estimator

UNIT SST/NOS 4

Performance objectives

- f. Seek clarification from the relevant person(s)⁽⁴⁾ where there are potential problems with the tender⁽⁶⁾ information provided
- g. Confirm that the information contained within the completed estimate⁽⁵⁾ is accurate and represents your organisation in a professional manner

Knowledge requirements

18. Who can clarify potential problems arising from the tender information provided
[P.O. (f)]
9. Who needs to authorise the tender bid and submission of the tender bid
[P.O. (g, h)]

Outcome 4: Identify the contractor's costs associated with nominated subcontractors

Outcome 5: Consider the conditions of contract and their implication on the contractor's costs

- consider whether a particular form of contract has an affect on the contractors method of working or risks involved
- identify which contract clauses may have a particular effect on the contractor's costs
- understand the difference between fixed price and fluctuating price contracts
- discuss these issues with the estimator

Outcome 6: assess site on-costs and head office overheads charges and profit

- differentiate between estimating and tendering
- identify the items from the preliminaries section of bill of quantities that attract a monetary value
- build up prices for preliminary items using method related charges

UNIT SSTE/NOS 3

Performance objective

- j. Seek clarification from the relevant person(s)⁽⁴⁾ where there are potential problems with the tender⁽⁶⁾ information provided

Knowledge requirements

12. Who can clarify potential problems arising from the tender information provided
[P.O. (j)]

No direct match with Summit Skills Standards, as the standards do not cover subcontracting

UNIT SST/NOS 4

Performance objective

- e. Incorporate the requirements for a method statement and risk assessments into the tender⁽⁶⁾

Knowledge requirements

5. How to assess plant, labour and materials required in accordance with the following factors:
- types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender
- [P.O. (c, d, e)]

UNIT SSTE/NOS 3

Performance objective

- k. Incorporate the requirements for a method statement and risk assessments into the tender⁽⁸⁾

Knowledge requirements

10. Organisational procedures for recording and storing information used in tender preparation
[P.O. (i)]

UNIT SST/NOS 4

Performance objective

- e. Incorporate the requirements for a method statement and risk assessments into the tender⁽⁶⁾

- identify the head office overhead costs
- recognise the cost implications in respect of safety, health and welfare
- assess the factors that govern the amount to be added for the contractor's profit
- understand the purpose and need for contingencies

Knowledge requirements

5. How to assess plant, labour and materials required in accordance with the following factors:
 - types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender
 [P.O. (c, d, e)]

Unit 21: Financial management for building services engineering projects

Summit Skills Equivalent

Outcome 4: Analyse the nature of costs and methods of overhead recovery related to pricing strategies appropriate to the engineering industry

- explain the role of costing in assessing performance and in decision making
- discuss the concepts of cost units, cost centres and the classification of costs
- illustrate the difference between direct and indirect costs
- evaluate the main costing systems and their use in the engineering industry
- demonstrate an understanding of the need to recover overheads through the units of output
- explain the concept of the break-even point
- explain the importance of marginal costing techniques in relation to management decision making
- demonstrate an understanding of relevant costs when making pricing decisions
- consider the factors to consider when determining price and the main pricing strategies

Outcome 6: Demonstrate an understanding of the nature of the strategic objectives of an engineering related organisation and determine an annual planning cycle

- explain that planning is the process of using available information to set objectives and deciding how those objectives might be achieved within resource constraints

Unit SSTE/NOS 5

Manage Contract Procedures For Building Services Engineering Projects

1. Identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender

Knowledge Requirements

1. How to identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender

Unit SST/NOS 4

Contribute To Estimating And Tendering Processes For Building Services Engineering Projects

- c. Assess the potential cost of plant, labour and material requirements and their availability against the requirements of the project

Knowledge Requirements

19. How to assess plant, labour and materials required in accordance with the following factors:
 - types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender

- define the nature of the organisations strategic objectives and explain how those would be supported by an annual planning cycle
- demonstrate an understanding of the nature, benefits and limitations of budgets
- discuss the steps involved in budgetary planning and the purpose of budgetary control
- demonstrate a understanding of the differences between fixed and flexible budgets
- recognise environmental influences and internal resource constraints
- define the purpose, format and uses of the cash and master budgets
- evaluate the role of a budgetary control report as an aid to investigating variances
- recognise the human behavioural implications inherent in preparing, negotiating, implementing and controlling the budgetary cycle

Unit SST/NOS 6

Apply Contract Conditions For Building Services Engineering Projects

- a. Identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender

Knowledge Requirements

1. How to identify client priorities, project requirements and financial constraints in accordance with the requirements of the tender

Unit SSTE/NOS 3

Develop Estimates And Tenders For Building Services Engineering Projects

- c. If appropriate, assess the status and financial viability of the potential client and suppliers in accordance with the practices of your organisation
- e. Assess the potential cost of plant, labour and material requirements and their availability against the requirements of the project
- g. Establish the costs of plant, labour and materials derived from potential sources in accordance with the requirements of the project
- h. Establish the estimated cost for each activity in accordance with the requirements of the project

Finalise total estimated costs in accordance with the procedures of your organisation

Knowledge Requirements

20. If appropriate, how to assess the status and financial viability of the potential client and suppliers in accordance with the practices of your organisation
8. How to assess plant, labour and materials required in accordance with the following factors:
 - types required
 - availability
 - cost
 - quantity
 - your organisation's estimating systems
 - the requirements of the tender
9. How to obtain competitive costings of plant, labour and materials derived from potential sources in accordance with the requirements of the project

Unit SSTE/NOS 12

Control Building Services Engineering Project
Income And Expenditure

- allocate organisational budgets for projects
- recover and record income due
- update budget and cash flow against variances and contingencies

Knowledge Requirements

1. How to identify as appropriate methods for presenting financial information to responsible personnel
2. How to issue information about expenditure and changes to budgets to those responsible
3. How to authorise expenditure and changes to budgets and why this may be required
4. Responsibilities for budgetary control and allocations under the budget headings of financial plans
5. Appropriate method of maintaining overall control of the budget
6. How to produce guidance documents and circulate the information to those responsible
7. How to issue allocations under budget headings, cash flow calculations and reporting requirements to those with financial responsibilities
8. Appropriate methods and timescales for reporting contingencies and variances
9. How to resolve queries and discrepancies over allocated budgets
10. How to specify and agree how payments for contracts will be made
11. How to develop project costing methods for recording and verifying expenditure
12. How to record information about payments due and calculate the total income due under the contract
13. How to collate and store records and receipts which support payments due
14. How to produce accounts for payments at agreed stages
15. How to keep records of accounts, payments received and due, and receipts issued
16. What to identify as outstanding payments
17. How to take action to recover outstanding debts and retentions
18. How to calculate fluctuations in financial performance

19. How to take appropriate corrective action promptly and inform staff about the changes that are required to allocated budgets
20. How to update allocated budgets and reissue them to people who have financial responsibilities
21. How to monitor and audit allocated budgets
22. How to inform stakeholders about actions which will require major restructuring of allocated budgets and cash flow projections
23. How to estimate cash flow projections against actual income and expenditure
24. How to assess actions which are recommended by staff
25. How to compare actions which are recommended by staff with relevant sources of information about allocated budgets and cash flow projections
26. How to investigate the reasons for variances and contingencies
27. How to take action to prevent variances and contingencies happening again
28. How to recommend ways of dealing with variances and contingencies

Unit 22: Managing resources for building services engineering projects

Summit Skills Equivalent

Outcome 1: evaluate the systems used to record, monitor, review and control resources

Unit SSTE/NOS 5

Manage Contract Procedures For Building Services Engineering Projects

Outcome 2: demonstrate effective resource management skills and techniques

All unit content and knowledge requirements

Outcome 3: understand and deal with problems that can occur when managing resources

Unit SSTE/NOS 4

Manage Building Services Engineering Projects In The Work Location

Outcome 4: develop a business policy for resource management

- planning
- prior to commencement of the project
- during the project
- at the end of the project
- all knowledge requirements

Outcome 5: implement quality control systems for resources

Outcome 6: ensure compliance with legal and statutory requirements

Unit SSTE/NOS 9

Plan Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

- evaluate work methods
- select work methods
- plan work activities and resources
- select and form a project work team
- establish and maintain project organisation and communication systems
- all knowledge requirements

Unit SSTE/NOS 2

Manage The Effectiveness Of The Project Workforce In The Building Services Engineering Work Location

- prior to commencement of the project
- during the project
- all knowledge requirements

Unit SST/NOS8

Contribute To Planning Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

All unit content and knowledge requirements

Unit 23: Planning building engineering services projects

Outcome 1: Describe typical organisational structures prevalent in industry

- construct a typical management structure block diagram
- describe the responsibilities of departmental heads and/or managers
- detail the specific functions of the Technical Department
- describe the responsibilities of the Engineering Department.

Outcome 2: Describe the objectives, processes and procedures involved in project planning

- describe three objectives to be achieved in the successful execution of an engineering project
- describe the procedure for establishing the scope of a project
- describe the main processes and procedures required when executing a project.

Summit Skills Equivalent

Unit SSTE/NOS 9

Plan Work Methods, Resources And Systems To Meet Building Services Engineering Project Work Requirements

- evaluate work methods
- select work methods
- plan work activities and resources
- select and form a project work team
- establish and maintain project organisation and communications
- all knowledge requirements

Unit SST/NOS 7

Provide Technical And Functional Information To Relevant People

- j. Identify the relevant people that need to be supplied with technical information and functional information
- k. Discuss, with the relevant people, their technical information and functional information requirements

Outcome 3: Describe various means of data presentation used in project planning

- describe the use of Gantt charts, bar charts, logic diagrams (PERT charts), cost tables, and resources lists
- construct an arrow diagram
- construct a precedence diagram.

Outcome 4: Plan a project using project planning software

- enter a project start date
- enter a project title
- set a work schedule
- enter tasks and durations
- structure tasks into a logical sequence
- start and finish tasks on specific dates
- create a resource list (labour and materials)
- assign pay rates to resources
- set fixed costs
- display Gantt and PERT Charts, Task Usage and Resource Usage Tables, Resource Graphs, Resource Sheets and Calendar.

- l. Obtain current and relevant information from appropriate sources
- m. Assess the nature and extent of information required by the relevant people in order for the installation, or equipment, to be operated safely and effectively
- n. Pass on the information in a timely, courteous and professional manner and in accordance with organisational procedures
- o. Provide written technical information and functional information to the relevant people in accordance with organisational procedures
- p. Confirm that the relevant people receive the necessary health and safety information and advice in the approved manner

Knowledge Requirements

1. Which situations warrant written technical and functional information
2. Methods of checking the relevant person's understanding of the technical and non-technical information provided
3. Sources of technical and functional information including the manufacturer, supplier or own organisation
4. Ways of checking the relevant people understand those aspects of the information which have a bearing on health and safety
5. Responsibilities and limitations in your job role with respect to supplying technical and functional information
6. Organisational practice on the amount of information and detail that individual members of the relevant person's organisation are entitled to receive
7. The importance of providing information clearly, courteously and professionally
8. The safety implications and functional consequences of supplying inaccurate or incomplete information to the relevant person

Unit 24: Using Materials Technology in building services engineering

No direct match to unit content

Unit 25: Electrotechnical sustainability	Summit Skills Equivalent
Outcome 1: State the sources of energy and environmental impact	No direct match with Summit Skills Standards, as the standards do not cover sources of energy and environmental impact
Outcome 2: Describe energy conservation methods <ul style="list-style-type: none"> • Be aware of the consequences of climate change • Describe the greenhouse gas effect on the environment • Know how to calculate CO₂ emissions and CO₂ reduction • Know the role of the assessors in calculating the HER (Heat Energy Rating) of a dwelling • Understand the system of energy labelling • Recognise the benefits of installing good insulating materials • Understand the importance of reducing the heating load in buildings • Recognise the opportunities available for alternative energy sources in buildings • Understand the nature of solar energy • Understand the difference between passive and active solar energy 	UNIT SST/NOS 3 Performance objective k. Calculate the relative effectiveness of different design solutions ⁽¹¹⁾ UNIT SSTE/NOS 8 Performance objective q. Calculate the relative effectiveness of different design solutions
Outcome 3: Describe passive buildings	No direct match with Summit Skills Standards, as the standards do not cover the benefits of a passive building
Outcome 4: Describe photovoltaics systems	No direct match with Summit Skills Standards, as the standards do not cover the principle of photovoltaic systems
Outcome 5: Determine the requirements of embedded micro generation systems <ul style="list-style-type: none"> • Understand the use of solar water heating • Understand the benefits to be gained from and limitations of solar water heating • List the different types of solar collectors used in solar design • Design and install a solar hot water system • Know the principle requirements on components and materials • Calculate the cost of a standard solar hot water system for a two storey dwelling • Know how to commission a solar hot water system • Know how to control the temperature of a solar installation • Have an understanding of the function and requirements of heat exchangers • State the safety considerations of a solar installation 	UNIT SST/NOS 3 Performance objective k. Calculate the relative effectiveness of different design solutions ⁽¹¹⁾ UNIT SSTE/NOS 8 Performance objective q. Calculate the relative effectiveness of different design solutions UNIT SSTE/NOS 11 Performance objectives r. Specify the methods and procedures for commissioning ⁽⁵⁾ the building services products ⁽¹⁾ s. Plan the most appropriate way to commission ⁽⁵⁾ the building services products ⁽¹⁾ t. Confirm that conditions ⁽⁶⁾ are suitable to implement the commissioning ⁽⁵⁾ procedures

- Calculate the size of collectors for domestic hot water requirements
- u. Determine and obtain the resources ⁽²⁾ required to undertake the commissioning ⁽⁵⁾ procedures
- v. Ensure that the commissioning ⁽⁵⁾ is implemented correctly
- w. Identify any problems with the commissioning ⁽⁵⁾ and effectively resolve them
- x. Assess the results of the commissioning ⁽⁵⁾ to identify the outputs of the building services products ⁽¹⁾
- y. Confirm that the building services products ⁽¹⁾ meet specifications and comply with all relevant approved procedures and practices ⁽³⁾
- z. Ensure that the results of the commissioning ⁽⁵⁾ are recorded in the appropriate information systems ⁽⁴⁾ and passed to stakeholders

Outcome 6: State the uses, benefits and limitations of new sources of energy in buildings

No direct match with Summit Skills Standards, as the standards do not cover the benefits of using heat pumps in modern buildings

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