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Qualification

Specification

EAL Level 3 Technical Occupational Entry in

Metal Fabrication (Diploma)

Qualification Number: 610/3913/5

Version 1

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# About EAL

For over fifty years, EAL has been the specialist awarding organisation for engineering, manufacturing, building services and related sectors. Developed to the highest technical standards, our qualifications reflect ever-changing industry and regulatory needs. We support the providers of our qualifications with an unparalleled level of service to ensure that learners are well prepared to take the next step in their journeys, whether study, an apprenticeship or work.

Through industry partnerships with EAL Centres and training providers, decades of experience supporting our core sectors, and our role as part of the Enginuity Group, we have built unrivalled knowledge and understanding of employer skills needs. As a result, EAL’s skills solutions, including apprenticeship End-Point Assessment, External Quality Assurance and qualifications are respected and chosen by employers to deliver real lifelong career benefits for all our learners. That’s why in the last ten years, 1.2 million people across the UK have taken EAL qualifications.

## 1.1 Equal Opportunities and Diversity

EAL expects its Centres to enable learners to have equal access to training and assessment for qualifications in line with equalities legislation. Further details can be located in the EAL Equal Opportunities and Diversity Policy.

## 1.2 Customer Experience and Feedback

Customer Experience is a fundamental part of EAL’s commitment to you. EAL aims to ensure that all customers receive a high-quality efficient service. We are always interested in feedback and if you have any comments or feedback on our qualifications, products or services, please contact the Customer Experience team:

EAL Customer Experience

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

# Introduction to the Qualification

What is this qualification?

This qualification is for adults only (19+) and aligns to the knowledge, skills, and behaviours (KSBs) in the Metal Fabricator Apprenticeship Standard in England.

It **will not** make the learner industry competent in metal fabrication work but facilitates progression into the occupation by providing potential employers with reliable evidence of the learner’s attainment against the Metal Fabricator Apprenticeship Standard.

It is intended to form part of an engaging course of learning for adult learners and provides occupational entry, so that learners can progress with further learning and training, into employment and completion of the Apprenticeship Standard.

Who is this qualification for?

Adults (19+) who wish to pursue a career in the advanced manufacturing engineering and engineering construction sectors but have not yet secured employment or an apprenticeship.

What does this qualification cover?

This qualification comprises units, which reflect specific KSBs in the Metal Fabricator Apprenticeship Standard.

Please refer to Section 3 and Section 8 for more details about the units included in this qualification.

## 2.1 Support for this Qualification

This qualification:

* Is regulated at Level 3
* Is supported by employers from the engineering sector
* Forms part of recognised route to help adults into employment in the industry

## 2.2 Progression Opportunities

Learners who complete this qualification will be able to demonstrate to potential employers their commitment and achievement against the KSBs in the Metal Fabricator Apprenticeship Standard, thus enhancing employability prospects. This will also enable learners to progress to the recognised sector apprenticeship, and work toward becoming an industry recognised metal fabricator. Learners can further progress to undertake qualifications such as:

* EAL Level 3 Diploma in Advanced Manufacturing Engineering (Development Knowledge)

Further information can be obtained from the EAL Website or alternatively contact:

EAL Customer Experience

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

## 2.3 Qualification Support Materials

The following materials are available for these qualifications:

* **Assessor Pack**: which contain all relevant assessor guidance relating to the delivery and assessment and marking schemes for the holistically assessed practical assessment
* **Learner Assessment Pack:** which contain the holistically assessed practical assessment, assessment checklists and all associated guidance for learners
* **\*Practice Exam:** for the externally set and marked on-screen exam

**\***The practice exam is available to schedule online as per externally set and marked exams.

All materials can be accessed by EAL registered Centres from the EAL Website [www.eal.org.uk](http://www.eal.org.uk)

## 2.4 Achievement of the Qualification

This qualification is gained when all the necessary units have been achieved. The Centre will then be able to apply for the learner’s Certificate.

# Qualification Structure

## 3.1 Rule of Combination

This qualification will be obtained by the learner once they have successfully completed the **FOUR** mandatory core units and **FOUR** mandatory occupational specialism units.

This qualification has a minimum **545** GL(H) and **605** Total Qualification Time.

**Mandatory core units: ALL must** be achieved.

|  |  |  |  |
| --- | --- | --- | --- |
|  EAL Code | Unit Title | GL(Hrs) | Ofqual Code |
| TOEC3/001 | Engineering and environmental health and safety in the workplace | 75 | M/651/0911 |
| TOEC3/002 | Engineering organisational efficiency and improvement | 75 | R/651/0912 |
| TOEC3/003 | Essential mathematics and science for engineering and manufacturing | 60 | T/651/0913 |
| TOEC3/004 | The structure, properties and characteristics of common materials | 60 | Y/651/0914 |

**Mandatory occupational specialism units: ALL must** be achieved.

|  |  |  |  |
| --- | --- | --- | --- |
| EAL Code | Unit Title | GL(Hrs) | Ofqual Code |
| TOEMF3/001 | Fabrication and welding principles | 60 | L/651/0948 |
| TOEMF3/002 | Pattern development | 60 | M/651/0949 |
| TOEMF3/003 | Produce metal fabrications | 80 | Y/651/0950 |
| TOEMF3/004 | Joining techniques  | 75 | A/651/0951 |

# Centre and Qualification Approval

Centres wishing to run the qualifications will need to comply with the Qualification Specification and EAL’s Centre recognition criteria for these qualifications upon accreditation and launch. Centres must also put in place the appropriate physical and human resources and administration systems to effectively run the qualification. Please refer to Section 5 for the requirements of Centre staff involved in the delivery of the qualification.

**For existing EAL Centres to put the qualification on your Centre remit:**

* To add this qualification to your Centre qualification remit, create and complete a Qualification Approval Application Form in Smarter Touch and submit to EAL

**For non EAL Centres to gain Centre approval to run the qualification:**

* Please contact the EAL Customer Experience Department, who will be delighted to hear from you:

EAL Customer Experience

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

# Profiles and Requirements

## 5.1 Staff Responsible for Registering and Certification of Learners

Centres are required to appoint a suitable member of staff who can take responsibility for registering learners onto qualifications, submitting entries for assessments to EAL and taking receipt of external assessment procedures (if appropriate). They may also be responsible for applying to EAL for learner certificates. The role may be undertaken by the same person who undertakes quality assurance.

5.2 Teaching Staff

Tutors / trainers involved with the delivery of the units must demonstrate an understanding of the topics / technical content in this qualification. As a minimum they must have achieved a relevant technical qualification to at least Level 3 which covers the key topics in this qualification.

Teaching staff **must** have knowledge and understanding of:

* The qualification structure and content
* The learning outcomes and assessment criteria they are delivering

It is a **recommendation** that teaching staff will:

* Have a minimum of two years’ experience in teaching / training

 **or**

* Be working towards an appropriate teaching / training qualification

 **or**

* Hold an appropriate teaching / training qualification (e.g., Cert Ed or Learning and Development trainer units)

5.3 Learners

There are no formal academic entry requirements for the qualification; however, Centres should ensure that learners have the potential to achieve the qualification. Learners must have the minimum levels of literacy and numeracy to complete the learning outcomes and assessments.

Centres should make learners with particular requirements aware of the content of the qualification and they should be given every opportunity to successfully complete the qualification. EAL will consider any reasonable suggestions for, and from, those with disabilities that would help them to achieve the learning outcomes without compromising the standards required.

Age Restrictions

Learners **must** be at least 19 years old.

## 5.4 Assessors

The Centre MUST provide EAL with the names of any teachers, trainers or other individuals who will undertake internal assessment, so that these can be approved prior to them carrying out an assessment role.

Internal assessors **must:**

* Have knowledge and understanding of the assessment criteria they are assessing
* Have knowledge and understanding of the qualification structure, content and assessment components
* Understand the assessment process

It is a **recommendation** that assessor’s will**:**

* Have a minumum of two years’ experience in assessment (e.g. within an N/SVQ or teaching / training environment)

  **or**

* Be working towards an appropriate assessment qualification, such as the ‘Level 3 Award in Assessing Vocationally Related Achievement’

 **or**

* Hold an appropriate assessment qualification (as above)

Assessor continuing professional development

It is the responsibility of each assessor to identify and make use of opportunities for Continuing Professional Development (CPD), such as industry conferences, access to trade journals, and Professional Body / Trade Association events, at least on an annual basis to enhance and upgrade their professional development and technical knowledge.

It is imperative that records are kept of all such CPD opportunities / occasions and that they provide evidence of cascading such technical knowledge and industry intelligence to all relevant colleagues.

5.5 Markers: Technically Competent

Where Centre-based assessments are marked by a person who does not come into the assessor category, the marker must have auditable technical competence in the subject. As an example, for a scientific based assessment the person may have auditable competency in that subject area.

5.6 Internal Quality Assurers

This relates to staff undertaking internal verification / moderation of assessment. The Centre MUST provide EAL with the names of any teachers, trainers or other individuals who will undertake internal quality assurance, so that these can be approved prior to them carrying out this role.

The main focus of internal quality assurance for these qualifications are:

* The quality assurance of assessment procedures, including standardisation of assessment practice across different assessors within the Centre
* Internal standardisation of marking and moderation of learner marks awarded

Internal quality assurance staff **must**:

* Be familiar with the occupation(s) covered by the qualification
* Have knowledge and understanding of the qualification structure and content
* Understand the assessment process and the role of quality assurance

It is a **recommendation** that the quality assurance staff will:

* Have experience in quality management / internal verification

 **or**

* Hold an appropriate qualification, such as the ‘Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practice, or the ‘Level 4 Certificate in Leading the Internal Quality Assurance of Assessment Processes and Practice’

Continuing professional development of internal quality assurance staff

It is the responsibility of each internal quality assurance staff member to identify and make use of opportunities for CPD, such as industry conferences, access to trade journals, and SSC and Professional Body / Trade Association events, at least on an annual basis to enhance and upgrade their professional development and technical knowledge. It is imperative that records are kept of all such CPD opportunities / occasions and that they provide evidence of cascading such technical knowledge and industry intelligence to all relevant colleagues.

5.7 Staff Invigilating On-Screen Exams

Members of staff with responsibility for invigilating on-screen exams must know, understand, and comply with the Procedures for Conducting the Exam Component within EAL Qualifications’ (EAF 1), which are published by EAL. These members of staff must also:

* Have experience in conducting and controlling exam sessions

 **or**

* Be supervised by an individual experienced in conducting and controlling exam sessions

Note: A tutor / trainer who has prepared the learners for the subject of the exam must not be the sole supervisor at any time during an exam for that subject(s).

# Assessment

The following table indicates the assessment components that are included in the qualification and for each component:

* Who is responsible for setting and marking the component
* How the component is quality assured

|  |  |  |  |
| --- | --- | --- | --- |
| **Assessment component** | **Set by** | **Marked by** | **Method of quality assurance** |
| **Internal** | **External** |
| On-screen exam1 | EAL | EAL | Exam invigilation | Verification and continuous monitoring via EQA visits |
| Centre-marked holistic assessments2 | EAL | Centre | On-going standardisation within the Centre(Including moderation) | Verification and continuous monitoring via EQA visits |

1 Refer to Section 6.1 External Assessments (On-Screen Exams).

2 Refer to Section 6.2 Internal Holistic Assessments (EAL Set and Centre Marked).

The learner must pass ALL assessments to achieve the qualification.

A breakdown showing the assessment requirements for each unit is shown below:

|  |  |  |  |
| --- | --- | --- | --- |
| **EAL Code** | **Unit Title** | **On-Screen Exam** | **Centre Marked Holistic Assessment** |
| TOEC3/001 | Engineering and environmental health and safety in the workplace | Core Knowledge Exam 1 | No |
| TOEC3/002 | Engineering organisational efficiency and improvement |
| TOEC3/003 | Essential mathematics and science for engineering and manufacturing | Core Knowledge Exam 2 | No |
| TOEC3/004 | The structure, properties and characteristics of common materials |
| TOEMF3/001 | Fabrication and welding principles | No | Holistic practical assessmentQuestioning component |
| TOEMF3/002 | Pattern development |
| TOEMF3/003 | Produce metal fabrications |
| TOEMF3/004 | Joining techniques  |

## 6.1 External Assessments (On-Screen Exams)

A specification for the exam, indicating the number of questions to be set for each learning outcome is provided in Appendix 1.

Key Points

* Arrangements must be made for learners to complete the external assessment between the 01st and the 30th of April
* The exam must be undertaken by the learner under controlled exam conditions, in accordance with EAL’s Procedures for Conducting the Exam Component within EAL Qualifications’ (EAF 1)
* The EAL co-ordinator within the Centre will assume responsibility for liaison and correspondence regarding the external assessment component
* Centres will be sampled, and spot checks will be carried out by EAL to ensure exams are delivered in accordance with EAL published procedures
* EAL will release exam results at the end of the third week in May

Assessment objectives are used to set the level of thinking skills being assessed within the level 3 context, including knowledge, understanding and application of knowledge and understanding. Our approach to assessment objectives is designed to complement the purpose of the qualification and align with the occupational levels’ guidance provided by the regulator.

Each unit within the setting specification (Appendix 1) has a set number of questions. Across the questions, there is a question writing requirement to meet a defined coverage of each assessment objective so that the following assessment objective profile is met across the full range of assessment questions, as shown in the table below:

|  |  |
| --- | --- |
| **Assessment Objective**  | **MCQ Coverage**  |
| AO1 Knowledge of the principles, processes and procedures | 25%  |
| AO 2 Understanding of the principles, processes and procedures | 50%  |
| AO3 Application of understanding of the principles, processes and procedures | 25% |

Resitting external assessments (on-screen exams)

Learners who fail to achieve a pass will be permitted to resit this exam after feedback and appropriate tuition has taken place.

The learner will be allowed a maximum of two resit opportunities (three attempts in total). Learners who fail to achieve after three attempts will be required to re-register on the qualification.

The resits for externally set and marked exams will be subject to the current published charges.

Resit scheduling

Learners will be permitted to resit within the following arrangements:

Resit 1:

* EAL will open the window for the first resit scheduling opportunity during the last week of May
* Arrangements must be made for learners to complete the external assessment between 1st and the 14th of June.

Resit 2:

* EAL will open the window for the second resit scheduling opportunity during the last week of June
* Arrangements must be made for learners to complete the external assessment between 1st and the 14th of July.

Practice exam

In January of academic year 1 (following the launch of the qualification), EAL will make available an onscreen practice exam. This can be accessed via EAL’s Surpass Exam System. The practice exam is not part of the formal assessment arrangements and will therefore NOT count towards the qualification.

6.2 Internal Holistic Assessments (EAL Set and Centre Marked)

Internal holistic assessment, both knowledge and practical, are a form of controlled internal assessment marked by the Centre. General information regarding conducting controlled internal assessment can be found in the document ‘EAL Guidance for Controlled Internal Assessment marked by the Centre’ with specific guidance referenced from or contained within this qualification specification.

Internal holistic assessment includes practical and /or knowledge assessments. These assessments are set by EAL and marked by members of the delivery team at the Centre (see profiles of markers in Section 5). All assessment decisions are then subject to internal standardisation and external quality assurance.

Holistic assessments involve collecting and evaluating evidence that demonstrates achievement of the learning outcome / criteria. They are accompanied by marking criteria and other materials to ensure that the markers are consistent in their approach to assessment across learners.

Centres are responsible for ensuring that Centre marked holistic assessments are suitably controlled to ensure that assessment decisions are valid and reliable, and that work submitted for assessment by learners is prepared and produced by them independently, without assistance from others, and free of plagiarism.

Specific Guidance - Controlled internal assessment marked by the Centre

Assessor packs

Assessor packs contain relevant information for Centre staff to use as reference/guidance. These documents must not be shared with the learner as they may contain confidential information for Centre staff only.

Learner assessment packs

Learner assessment packs contain instructions relating to the practical assessment. Learners will require access to this document when they are ready to be assessed. Assessors should issue the learner assessment packs to the learner, together with any Centre devised practical assessment task or tasks which have been developed based on the assessment specification provided by EAL. These documents must be controlled by the assessor and provided to the learner as and when required but not retained by the learner. All assessment documentation must be retained by the assessor and/ or internal quality assurer within the controlled environment, unless where otherwise specified.

Centres must ensure that the assessment criteria information is only made available to a learner during the active part of the assessment.

Learners must be appropriately supervised when undertaking the practical assessment. The level of supervision must be sufficient to safeguard the learners’ health and safety, and ensure the evidence generated is attributable to the learner.

Electronic systems and records

Interactive word-based versions of the learner assessment pack and knowledge assessments are available through on-line publications. Where an electronic system is used to administer the electronic versions of the learner assessment pack and /or knowledge assessment, the system used **must** operate with the necessary controls in the same manner as that described under ‘Learner assessment packs and knowledge assessment’ i.e., no assessment documentation should be left with the learners to have uncontrolled access, etc. Any electronic system that is used **must** prevent the unauthorised sharing of assessment documentation by learners i.e., via email etc. Where electronic systems with the necessary controls are used, evidence such as learner reports and completed knowledge assessment answers may be uploaded or embedded within the system.

E-portfolio systems are generally NOT considered appropriate for delivering/administering internal assessments electronically. E-portfolio systems may be used to track learner attainment, record assessment outcomes and feedback. The following elements from the assessor and learner assessment packs may be replicated/uploaded to an e-portfolio system:

* Assessor pack: learning outcomes, assessment criteria, assessment specification to include the assessment criteria.
* Learner assessment pack: assessment checklist for the practical assessment and assessment feedback.

It is the responsibility of the internal quality assurer (IQA) for the qualification in advance to verifier the electronic system’s functionality and to agree the systems capabilities with regards to the control of qualification documentation before first use and to quality assure what has been uploaded/embedded is accurate and fit for purpose.

In relation to this qualification, evidence should generally not be uploaded to an e-portfolio system without the necessary controls but may reference to what the evidence is, and where this is located. Where electronic or e-portfolio systems are used, the system must be capable of capturing auditable electronic declarations of authenticity, learner and assessor sign off or the electronic equivalent.

About the holistic assessment

Learners are required to complete a holistic assessment for this qualification between the 01st of April and the 30th of June.

The holistic assessment will be set by EAL and comprises of a work-related scenario.

The holistic assessment will be designed to cover a range of assessment criteria from several units that are relevant to the scenario and related tasks.

The holistic assessment will ensure that all relevant learning outcomes within the qualification have been appropriately covered.

The instructions provided with the holistic assessment will specify the time allowed to complete the tasks, the type of evidence that is expected, and other requirements, as appropriate.

A detailed Assessment Checklist will be provided by EAL, which must be held securely in accordance with EAL procedures, and adhered to by all assessors who are involved in assessing the holistic assessment.

Delivery of the holistic assessment will be subject to rigorous internal standardisation (including moderation).

Planning and conducting the holistic assessment

Scheduling the holistic assessment

Arrangements must be made for learners to complete the holistic assessment between the 01st of April and the 30th of June. Centres may determine the precise timing of the holistic assessment to suit local needs.

Time allowed

The time (number of hours) in which the holistic assessment must be completed will be specified in the instructions that accompany it from EAL. The ‘actual’ number of hours spent on the holistic assessment, and the period over which it is completed, must be logged by the learner and verified by Centre staff.

Setting a deadline for completing the holistic assessment

The Centre must specify a due date when learners must complete the holistic assessment. The due date must fall within the designated period (see above) and be communicated clearly to learners. In setting the due date, consideration should be given to ensuring that:

* Learners have a realistic period of time in which to complete the holistic assessment, taking into consideration the specified number of hours and any possible limitations on access to equipment, materials, etc
* Sufficient time will be available for grading, moderation and external verification after the due date has passed
* Contingency arrangements need to be made in the event of learner absence and in extreme cases centres are advised to make a request for special consideration and/or reasonable adjustment.

Resources

Access to resources should be limited to those that are appropriate to the tasks to be completed as part of the holistic assessment, taking account of any requirement for learners to select appropriate tools and materials, if this is specified in the assessment criteria.

The nature of the holistic practical assessment is “open book”. This dictates that access to the internet may be a requirement but will be appropriately restricted in order for learners to access (e.g.) programming manuals, maintenance manuals, relevant formulas, etc. Centres will need to ensure access to unauthorised electronic or wi-fi enabled devices, such as laptops, mobile phones, mobile watches, etc. is restricted. This is to ensure confidentiality of all assessments. EAL recommends that all learner’s unauthorised electronic devices and wi-fi enabled devices, such as mobile phones/watches, are collected by the supervisor at the start of each session.

Learners should be provided with the flexibility to be able to move in the allocated workshop space from one station to another.

Supervision

Learners are not required to be directly supervised under high control conditions with invigilators and high-profile codes of conduct rules on display for learners to adhere to. However, there needs to be sufficient levels of supervision to enable the learner's work to be authenticated (e.g. by delivery staff). This measure will ensure that the progress of the response, at each stage of the development, to the assessment task the learner submits is their own.

The assessor will ensure that interactions between learners are kept to a minimum and are solely for the purpose of accessing the required facilities. At no time should learners be discussing information directly or indirectly related to the assessment.

Learner collaboration

Learners must complete and evidence their work individually. Collaboration between learners undertaking any aspect of the holistic assessment should only be allowed where tasks explicitly state that this is acceptable.

**Advice and Feedback from Assessors**

Assessors may review learners’ work and provide oral and/or written advice at a general level and, subsequently, allow learners to progress with their task. General advice of this nature does not need to be recorded or considered when the work is being assessed.

Assessors should not give any assistance which goes beyond general advice, for example:

* provide detailed specific advice on how to deliver any aspect of what is being assessed in the assessment criteria
* give detailed feedback on production mistakes which limits learners’ opportunities to show initiative themselves
* intervene personally to improve the product outcome

Assessors must not provisionally assess work (e.g. conduct a formative assessment) and then allow the learner to revise it. Failure of centre staff to adhere to this may constitute malpractice.

Completion and submission

Any material evidence and other supporting information submitted by learners for the holistic assessment will be detailed in the Learner Assessment Pack.

Late submission

Learners must complete their holistic assessment and hand in all relevant materials to the Centre by the due date. Any request to extend the submission date must be considered in accordance with EAL’s policy for Special Consideration.

Assessment decisions and annotation

Assessors are responsible for making assessment decisions of work, in accordance with the assessment criteria detailed in the relevant specification and guidance documents. Assessor annotation should be used to provide evidence to indicate how and why assessment decisions have been awarded. This will facilitate the standardisation of assessment decisions within the centre and enable the moderator to check that assessment decisions are in line with the assessment criteria.

Grading the holistic assessment

Centre assessors should allocate a grade for the holistic assessment for each learner using the Assessment Checklist provided. No other sources of information should be used to make judgements about the quality and sufficiency of the evidence.

All materials should be retained securely and confidentially by the Centre, in accordance with EAL policy.

Re-taking internal holistic assessments

Learners who fail to achieve a pass in any specific area of the holistic assessment/s will be permitted a re-take opportunity after feedback and appropriate tuition have taken place.

The learner will be allowed a maximum of two re-take opportunities (three attempts in total) for each section within the Assessment Checklist. Learners who fail to achieve after three attempts, will be required to re-register on the qualification.

All assessment documents that pass or refer must be recorded and retained by the Centre and made available on request.

Standardisation of holistic assessment

Members of the internal quality assurance team at the Centre should work with tutors / assessors to ensure that the correct procedures relating to the delivery of the holistic assessment are followed and ensure assessment decisions taken by different assessors are consistent, fair and reliable. Key activities will include:

* Meeting with tutor / assessors (individually and collectively) throughout the course to discuss quality assurance and standardisation issues and provide support and guidance where needed
* Observing tutor / assessors and giving them feedback to help improve their assessment technique
* Sampling learner evidence across different learner cohorts to ensure that appropriate standards have been met
* Arranging cross-marking of learner work to compare results and agree benchmarks

In addition, once all learners have undertaken and completed the holistic assessment and grading has been carried out, internal moderation should be undertaken by a nominated member of the quality assurance team. This will involve checking a sample of learner’s work to:

* Ensure that assessors have been consistent in their use of the Assessment Checklist
* Ensure that grades have been allocated fairly and consistently for all learners
* Check the authenticity of learner evidence
* If appropriate, agree changes to grades where anomalies have been detected

Centres/Organisations must have a moderation process in place to ensure that the assessing of internal assessments is both valid and reliable, through which adjustments to results are made and recorded accordingly. This ensures that the assessment process remains current and standards are consistently applied.

Internal moderation should be based on a sample of at least 25% of learners who have completed the holistic assessment and cover all assessors who have been involved in grading decisions. The sample should include any borderline cases that have been identified for review by assessors. If there are fewer than five learners who have completed the holistic assessment, then all learners’ work should be moderated.

Where inconsistencies or other discrepancies are identified, or where there is a disagreement on the grades allocated for particular learners, the level of sampling should be increased. All supporting records should include the comparison of assessment decisions from a representative sample of assessments including purposely highlighting where adjustments were necessary.

The outcomes from internal moderation of holistic assessment, including any proposed changes to allocated grades, should be recorded and made available to the External Quality Assurer.

Centres must maintain an assessment and feedback record for each learner, which details the evidence evaluated against the outcomes and the feedback given to the learner. The record will form part of the Learner Assessment Pack. These records must be available to the External Quality Assurer.

Centres/Organisations can utilise EAL’s IQA documents to support their moderation activities, which can be obtained through Smarter Touch

Further guidance on holistic assessment is provided within the Assessor Pack.

Questioning component

At appropriate opportunities throughout the duration of the practical holistic assessment, the assessor will ask 10 open questions to assess any underpinning technical knowledge that did not naturally occur during the observation. The assessor may ask open questions to enable to learner to underpin the skills demonstrated too. The assessor may also ask follow-up questions where clarification is required. Examples of open question types have been provided in Section 3 of the Assessor Pack. Questioning must be completed within the total time allowed for the practical holistic assessment. All questions, together with the learner’s responses must be recorded and attached to the assessment recording document in the Learner Assessment Pack. The questioning component must be conducted on a one-to-one basis, under controlled conditions free from influence. A quiet room, free from distraction, should be made available to the learner if they wish to use it. However, due to the nature of the questions, the learner may choose to demonstrate part, or all, of their understanding whilst within the working area (e.g., by providing a narrative response during a walk through if appropriate).

The assessor should:

* Use open questions to provide opportunities for all learners to demonstrate attainment
* Use follow-up questions, giving the learner the opportunity to explore the discussion point fully. The questions should be thoughtful, relevant and pitched at the appropriate level
* Discuss the learner’s activities with them, looking for evidence of specific knowledge, procedures and processes, and decision making, together with their skills. Questioning should provide a gradual ‘handing over’ to the learner. You would expect the learner to be taking the lead in the discussion after the initial opening questions / brief

What to avoid:

* Using one question type throughout
* Answering the question yourself instead of expanding on it to get a response
* Overloading the learner with too many questions, allowing them no time to think or to answer fully
* Disregarding answers
* Spending too long on one area of discussion, reducing the time available for other areas
* Asking complex questions too early in the discussion
* Asking closed questions unless a ‘yes’ or ‘no’ answer is specifically required

# Quality Control of Assessments

There are two major activities in which EAL interacts with the Centre in relation to the External Quality Control of Assessment for this qualification. These are:

* Recognition: when a Centre decides to offer the qualification, the EAL External Quality Assurer (EQA) ensures that the Centre is suitably equipped and prepared for delivery and assessment
* Engagement: throughout the ongoing delivery of the qualification EAL, through monitoring and other mechanisms will review the quality and consistency of assessment and internal quality assurance and recommend actions to address issues of concern

Recognition

In granting approval, EAL, normally through its EQAs, will ensure that the prospective Centre:

* Meets any procedural requirements specified by EAL
* Has sufficient and appropriate physical and staff resources
* Meets relevant health and safety and / or equality and access requirements
* Has a robust plan for the delivery, assessment, and QA for the qualifications (including, where appropriate, scope for involving employers)

EAL may decide to visit the Centre to view the evidence provided.

Engagement

EAL, through EQA Engagement and other mechanisms will ensure that:

* A strategy is developed and deployed for the ongoing monitoring of the Centre – this will be based on an active risk assessment of the Centre, and will include details of the learner, assessor and internal quality assurer’s sampling strategy and the rationale behind this
* The Centre’s internal quality assurance processes are effective in learner assessment
* Outcomes of internal assessment are verified, through sampling, to ensure standards are being maintained
* Sanctions are applied to a Centre where necessary and that corrective actions are taken by the Centre and monitored by the EQA
* Reviews of EAL’s external auditing arrangements are undertaken

8.0 Unit Content

## Unit: TOEC3-001 Engineering and environmental health and safety in the workplace

### GLH: 75

### Unit description

### This unit focuses on the essential knowledge required to ensure a comprehensive understanding of key aspects of both health and safety practices and environmental management.

### Summary of learning outcomes

1. Understand health and safety roles and responsibilities
2. Understand the application of health and safety in the engineering environment
3. Understand environmental management

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 3.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand health and safety roles and responsibilities
 | 1.1 | Recognise the roles of key people involved in workplace health and safety | Cover:* HSE inspectors
* Safety officers
* Safety representatives
* Environmental health officers

Look at the powers and roles of these key people in ensuring a safe working environment for all. |
| 1.2 | Recognise the roles of organisations involved in workplace health and safety | Cover:* Health and Safety Executive (HSE)
* Local authorities
* Trading standards
* Environmental health

Look at the powers and penalties at the disposal of these organisations and how they work with engineering companies. |
| 1.3 | State the key duties of the employee in conforming with health and safety requirements | Cover:Duties of employees under sections 7 and 8 of the HASAWA to include the implications of not complying with regulations and procedures.The correct procedures and responsibilities for reporting accidents and injuries in the workplace as given in The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR):* Recording and reporting: accidents, near misses or reportable occurrences
* Principles: incidents, accidents, minor or serious
 |
| 1.4 | State the key duties of the employer in the management of health and safety | Cover:Duties of employers under both the HASAWA section 2 and the Management of Health and Safety at Work (MHSW) Regulations |
| 1.5 | Recognise the content and application of key health and safety legislation | Cover:The content of a typical Health and Safety Policy Statement, to include:* Responsibilities
* Risks
* Consultation with employees
* Safe plant and equipment
* Safe handling and use of substances
* Information, instruction and supervision
* Induction training
* Accident, first aid monitoring
* Emergency, and fire procedures
* Key areas of risk
* Lone working

The content, application and responsibilities within Key Health and Safety Legislation to include current issues of:* The Health and Safety at Work etc. Act 1974
* Control of Substances Hazardous to Health (COSHH) Regulations
* The Health and Safety (Safety Signs and Signals) Regulations
* The Provision and Use of Work Equipment Regulations
* The Health and Safety (Display Screen Equipment) Regulations
* The Personal Protective Equipment at Work (PPE) Regulations
* The Management of Health and Safety at Work Regulations
* The Workplace (Health, Safety and Welfare) Regulations
* The Manual Handling Operations Regulations
* First Aid at Work Regulations
 |
| 1. Understand the application of health and safety in the engineering environment
 | 2.1 | Recognise the procedures in performing a risk assessment activity | Cover:How the procedures apply to the learner:* What is risk assessment?
* What are risks / hazards?
* What are the 5 steps to risk assessment?
* Recording risk assessments
* When to perform a risk assessment
* Relationship with other safety regulations
 |
| 2.2 | State how to safely perform manual handling tasks | Cover:* Correct manual handling procedures and risk assessment
* The content of The Manual Handling Operations Regulations:
	+ duties of employer
	+ duties of employee
	+ assessing loads and risk
* The use of mechanical aids to assist manual handling
* The correct handling / lifting technique
* The maximum recommended manual handling load weights at specified heights
* Distance from the body
 |
| 2.3 | State how to safely move loads |
| 2.4 | Recognise how to correctly store gases, oil, acids, adhesives and engineering materials | Cover:* The requirements of COSHH regulations
* The structure of storage buildings, stillages and shelving
* Control of ventilation, extraction and temperature
* Good housekeeping and stock management
* The storage of flammable liquids / compressed gases
* The storage of oil, acids and adhesives
 |
| 2.5 | Recognise the procedures for working in dangerous circumstances | Cover:* Confined spaces
* Trenches
* At height
* With chemicals / toxic substances
* Dust enriched atmospheres
* Damp/wet atmospheres
 |
| 2.6 | Recognise fire and emergency evacuation procedures | Cover:* The causes of fire and the fire triangle
* Types of extinguishers and the classes of fire
* Evacuation and fire procedures notices
* Escape route identification
* The role of fire marshals
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand environmental management
 | 3.1 | Recognise the relevant legislation and EU directives with regard to environmental management | Cover:The basic content and application of current environmental legislation and EU directives, to include:* ISO 14001
* Environmental Protection Act
* Pollution Prevention and Control Act
* Clean Air Act
* Radioactive Substances Act
* Controlled Waste Regulations
* Dangerous Substances and Preparations and Chemical Regulations
* Hazardous waste regulations.
* Waste Electric and Electronic Equipment (WEEE) Regulations
 |
| 3.2 | Identify what other sources of energy are available other than fossil fuels | Cover:How are they harnessed and converted into usable energy, to include:* Solar
* Heat pump
* Hydroelectric (reservoirs)
* Tidal
* Wind power (wind farms)
* Waste end energy-producing incineration
 |
| 3.3 | Identify the types and likely causes of industrial emissions | Cover:* Air / pollution
* Noise
* Water
* Vibration
* Light
 |
| 3.4 | Recognise the requirements for the safe disposal of waste | Cover:* Labelling of waste materials
* Oils; cutting oil, sump oil, etc
* Contaminated PPE
* Radioactive waste
* Chemicals, dangerous substances, acids and adhesives
* Refrigeration gases
* Workshop waste; oily rags, swarf, etc
* The action required in the event of accidental spillage/release of substances
 |
| 3.5 | Identify ways in which industry may manage, reduce or control their emissions and meet carbon reduction targets  | Cover:* Designing products to be more sustainable
	+ Using less energy to manufacture products
	+ Using less material and packaging within products
	+ Increasing the services life of products; making products easier to repair and spare parts available
	+ Manufacture products from recyclable material and / or manufacture products from materials that can be recycled at the end of their life
* Recycling waste materials from the manufacturing process and / or services to recycle products at the end of their life
* Climate change agreements and impact on industry
* Mandatory carbon emissions reduction scheme for energy-intensive organisations in the public and private sectors; Carbon Reduction Commitments (CRC)
* Energy monitoring: Data logging to optimise energy performance
 |

Unit: TOEC3-002 Engineering organisational efficiency and improvement

GLH: 75

Unit description

This unit focuses on the essential knowledge required to ensure a comprehensive understanding of key aspects of modern production methods, quality control, business improvement and the rights and responsibilities of those employed within an engineering organisation.

Summary of learning outcomes

1. Understand production activities
2. Understand the application of quality control and quality assurance
3. Understand organisational improvement techniques and competitiveness
4. Understand personal rights and responsibilities within an organisation

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 4.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand production activities
 | 1.1 | Explain the different types and methods of production | Cover:* Mass
* Flow
* Automated
* Batch
* One-off
 |
| 1.2 | Recognise the considerations that need to be made when selecting a production type or method | Cover:* Market requirements
* Design of product
* Plant and equipment availability
* Plant and equipment layout
* Personnel
* Production control
* Quality control
* Cost
* Reverse engineering

~~Describe~~ The methods and application of Cellular and Just in Time (JIT) production techniques to modern production needs. Explain and give examples of how Push andPull types of production are applied to meeting company and customer needs and expectations.~~Describe~~ The cost factors to be considered with the different production methods, to include both direct and indirect costs. |
| 1.3 | Identify the different stages of production planning | Cover:* Scheduling
* Loading
* Dispatching (co-ordination of pre-production activities)

The requirements necessary to produce a work schedule, to include:* Engineering drawings
* Technical data
* Personnel
* Machinery/tools
* Components
* Materials
* Consumables
* Time management
 |
| 1.4 | Explain how to apply typical process charts | Cover:* Flow charts / diagrams, to include Gantt charts
* The symbols used in flow charts
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the application of quality control and quality assurance
 | 2.1 | Explain the meaning of the terms ‘Quality Control’ and ‘Quality Assurance’ | Cover:The meaning of the term ‘quality’ as fitness for purpose or meeting customer expectations.The meaning of the terms ‘quality control’ and ‘quality assurance’:* Quality control as carrying out the procedures identified in quality assurance
* Quality assurance as the writing and implementing the procedures that ensure
* Quality control takes place

When to apply quality control:* Design
* Purchasing
* Production planning
* Manufacture (process control)
* Final inspection and dispatch
 |
| 2.2 | Describe the role and stages of inspection activities | Cover: Inspection as the tool by which quality control is applied and the role of the Inspector as checking compliance with the quality standard and procedures.Statistical process control (SPC) as a means of measuring quality/performance is within agreed limits.Document control as an integral part of quality assurance that provides:* Evidence about the existence of a system
* A record of the correct operation

Quarantine as a clearly marked area that is controlled by the quality department that is used to store any defective work, whilst a decision is made if the work will be:* Scrapped
* Reworked
* Adjusted

Types and the purpose of sampling, to include:* Spot check and random sampling
* Process sampling and batch sampling

What is meant by mean time between failures (MTBF), in the context of sample size and frequency. |
| 2.3 | Explain the application and content of the BS EN ISO 9000 series of standards | Cover:BS EN ISO 9001, as an internationally recognised quality assurance standard, which is designed to bring together all the activities that may already exist in a company that support quality advantages, including:* Involvement of all levels within a company
* Rationalised systems and procedures
* Improved costs
* Improved efficiency
* Consistent quality of product or service
* Customer confidence

The role of the Quality Manual, the Process/Procedures Manual and internal/external audits in compliance with BS EN ISO 9001. |
| 2.4 | Explain the role and responsibilities of the Quality Manager | Cover:The role of the quality manager / team as a functional role in terms of relationship with other managers / departments within the company. |
| 2.5 | List the elements of quality planning | Cover: The considerations to be made when developing a quality plan, to include:* Establishing quality requirements (customer expectations)
* Allocation of responsibilities (at all levels)
* Agree production times to ensure quality can be met
* Agree budgets to support quality activities
* The setting up of systems to measure quality and report progress
* Identification and calibration of quality equipment
* Ability to take corrective actions if non-conformity is found
 |
| 2.6 | Describe the principles of Total Quality Management (TQM) | Cover:The principles of Total Quality Management (TQM), as a way of thinking about goals, organisations, processes and people to ensure that the right things are done right first time. This thought process can change attitudes, behaviour and hence results for the better.The advantages of adopting TQM, to include:* Making an organisation more competitive
* Establishing a new culture which will enable growth and longevity
* Providing a working environment in which everyone can succeed
* Reducing stress, waste and friction
* Building teams, partnerships and co-operation
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand organisational improvement techniques and competitiveness
 | 3.1 | Explain the meaning of the terms Lean Manufacture, Kaizen, Just in Time and Kanban and their overall advantages | Cover:Examples for the terms meanings:* Lean manufacture e.g., removal of waste of all kinds (time, motion, inventory, poor cost of quality etc.), stimulate productivity and quality and use value-added processes. (Low Quality = High Waste; High Quality = Low waste and Higher Values)
* Kaizen e.g., a philosophy that encompasses continuous improvement, ‘can we make it faster with less waste and fewer mistakes and also make it easier’
* Just in time (stockless production or lean production) e.g., manufacturing to order not to stock
* Kanban is an aspect of manufacturing that manages the overall supply chain efficiently and effectively

Examples of overall advantages:* Better quality products
* Making quality a responsibility of every worker, not just for quality control inspectors
* Reduced scrap and rework
* Reduced cycle times
* Lower setup times
* Smoother production flow
* Less inventory of raw materials, work-in-progress and finished goods
* Cost savings
* Higher productivity
* Higher worker participation
* More skilled workforce, able and wiling to switch roles e.g., multi skilling and flexible workforce
* Reduced space requirements
* Improved relationships with supplier
* Improved safety
 |
| 3.2 | Recognise the importance of improving productivity | Cover:The meaning of the term ‘production’, using historical and present day examples of practice to compare how it has developed in recent years.How improved productivity benefits the company, the region, the GDP of a country and also the individual employee in terms of:* Earnings
* Pension security
* Safety
* Working hours / conditions

How improved productivity means by definition less waste (show how this has an effect on the environment).How the national and global marketplaces are driven by competitiveness, therefore the importance for companies to improve productivity:* Multinationals, nationals and regional
* SMEs and sole traders
 |
| 3.3 | Recognise the need for continuous improvement to ensure organisational competitiveness | Cover:* What is ‘continuous improvement’?
* What benefits are gained as a result of continuous improvement?
* Who within an organisation is involved with continuous improvement and in which roles?
* What are the basic four stages of a continuous improvement cycle (plan, do, check, and action)?
* What are the underlying principles that support continuous improvement?
* How ‘flexible working’ and ‘multi-skilling’ apply to continuous improvement?

Why continuous improvement is important in the national and global marketplaces, toallow a company to keep its competitive edge:* Multinationals, nationals and regional
* SMEs and sole traders
 |
| 3.4 | Recognise how to manage the production process | Cover:* What is the importance of the layout of the production area?
* What are: batch production, synchronisation and lead-time?
* How can lead time be improved?
 |
| 3.5 | Recognise the importance of teamwork and the individual’s contribution to effective teamwork | Cover:Teamwork and individuals’ contribution; the meaning of the term ‘team’:T - together E - everyone A - achieves M – more.What are the stages of the development of a team?* What are the roles within a team (e.g., leaders, doers, thinkers and carers)?
* Why is it important to have balance in a team?
* What can individuals bring to a team?
* How can team building be used to bring a team together into and effective group?
* How effective communication within the team is important

What skills are important for effective teamworking? * Good communication, influencing, listening, problem-solving, planning and organising, decision making, conflict resolution, reliability.
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand personal rights

and responsibilities within anorganisation | 4.1 | Identify the relevant organisational documentation and employment legislation in relation to personal rights and responsibilities | Cover:What is contained in each of the relevant organisational documentation and employment legislation listed below:* Contracts of Employment
* Employment Rights Act
* Staff Handbook
* Working Time Regulations
* Health and Safety at Work etc Act
* Data Protection Act
* Personnel Records
* Equal Opportunities Policies
* Human Rights Act
* Equalities Act
* Grievance Procedures
* Appraisals
* Discipline Procedures
 |
| 4.2 | Identify the personal opportunities for development and progression | Cover:The various development and progression opportunities listed below and what is required to achieve them (e.g., the necessary career path):* Company training programme
* Apprenticeships
* Organisational training opportunities
* Promotion
* Transfer
* Higher education
* Professional qualifications
 |

Unit: TOEC3-003 Essential mathematics and science for engineering and manufacturing

GLH: 60

Unit description

This unit enables the learner to develop knowledge and understanding of fundamental numeracy and science applied to engineering and manufacturing practice.

Summary of learning outcomes

1. Understand fundamental numeracy applied to engineering and manufacturing
2. Understand fundamental science applied engineering and manufacturing

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 2.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**Calculations should, wherever possible, be related to the engineering activities the learners are involved in. |
| --- | --- | --- |
| 1. Understand fundamental numeracy applied to engineering and manufacturing
 | 1.1 | Identify the metric and imperial systems and the preferred standard form | Cover:* Converting metres to centimetres and millimetres
* Converting feet to metres and centimetres
* Expressing large, small, and decimal numbers in preferred standard form
* Converting square millimetre (mm²) to square metres (m²)
 |
| 1.2 | Identify the techniques used for calculating approximation | Cover:* Calculating approximate material requirements
* Calculating approximate cost
* Calculating approximation to complete a task
 |
| 1.3 | Add, subtract, multiply and divide: whole numbers, fractions and decimals | Cover:* Add, subtract, multiply and divide: whole numbers
* Add, subtract, multiply and divide: fractions
* Add, subtract, multiply and divide: decimals (to 2 decimal places)
 |
| 1.4 | Convert fractions to decimals and decimals to fractions | Cover:* Converting fractions to decimals (to 2 decimal places)
* Converting decimals (to 2 decimal places) to fractions
 |
| 1.5 | Calculate mean, median and mode | Cover:* Calculating the mean of specific engineering data
* Calculating the median of specific engineering data
* Calculating the mode of specific engineering data
 |
| 1.6 | Calculate ratio, proportion and percentages | Cover:* Calculating ratio in an engineering context
* Calculating proportion in an engineering context
* Calculating percentages in an engineering context
 |
| 1.7 | Calculate area, surface area, mass, volume, capacity | Cover:* Calculating area (rectangles, squares, circles, triangles)
* Calculating surface area (cylinders and spheres)
* Calculating mass (solid objects and liquid substances)
* Calculating volume (rectangular prisms and cubes, cylinders and pyramids)
* Calculating capacity (spherical objects and cone-shaped objects)
 |
| 1.8 | Calculate probability | Cover:* Calculating single event probability
* Calculating two independent events probability
* Calculating dependant events probability
 |
| 1.9 | Calculate the square and square root of a number | Cover:* Square of whole numbers
* Square root of a number
* Definition and formula for obtaining the square of a number
* Definition and formula for obtaining the square root of a number
 |
| 1.10 | Transpose simple formulae | Cover:* Transposing formula, such as:
	+ Ohms law (V = IR)
	+ Area of a circle (A= πr²)
	+ Newton’s second law of motion (F = m x a)
* Methods of transposition such as: adding, subtracting, dividing or multiplying the same quantity both sides
* Methods of transposition by using the opposite sign method
 |
| 1.11 | Calculate spindle speeds  | Cover: * Calculating spindle speeds for twist drills of various diameters

Formula (Metric)Spindle Speed [Revolutions Per Minute (RPM)] = S x 1000 / π x DS (m/min) = Surface speed or cutting speed constant provided by the manufacturer for a given material D = Diameter of the twist drill |
| 1.12 | Solve problems using Pythagoras’ theorem for right-angle triangles  | Cover:* Finding the length of c of a right-angle triangle:

c2 = a2 + b2* Finding the length of b of a right-angle triangle:

b2 = c2 - a2* Finding the length of a of a right-angle triangle:

a2 = c2 - b2Using practical engineering examples, where appropriate. |
| 1.13 | Solve problems using trigonometry for right-angle triangles  | Cover:* Finding the length of the hypotenuse in a right-angle triangle: sin x = opposite / hypotenuse
* Finding the length of the adjacent side of the hypotenuse in a right-angle triangle: cos x = adjacent / hypotenuse
* Finding the length of the opposite side in a right-angle triangle: tan x = opposite / adjacent
* Calculating the size of an angle in a right-angle triangle using three primary trigonometric ratios for a right-angled triangle: sine (sin), cosine (cos), and tangent (tan)
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand fundamental science applied to engineering and manufacturing
 | 2.1 | Recognise common SI units | Cover:* Length
* Area
* Volume
* Time
* Heat
* Temperature
* Mass
* Force
 |
| 2.2 | Identify the types of forces used in engineering | Cover:* Tension
* Compression
* Bending
* Torsion
* Shear
 |
| 2.3 | Identify the modes of heat transfer | Cover:* Conduction
* Convection
* Radiation
 |
| 2.4 | Identify how and why materials are selected with low frictional values | Cover:* Inhibit mechanical damage
* Reduce noise
* Reduce heat
 |
| 2.5 | Identify structures and states of matter | Cover:* Atoms
* Molecules
* Elements
* Mixtures
* Compounds
 |
| 2.6 | Identify lines of flux within magnetic fields | Cover:* Lines of flux for like poles
* Lines of flux for unlike poles
* Current passing along a straight wire
* Solenoids
* Transformer induction
 |
| 2.7 | Identify the causes of friction | Cover:* Surface roughness
* Surface contamination
* Inter-surface adhesion
 |
| 2.8 | Recognise the main principles of the basic theory of electricity | Cover:* Electron flow
* Conventional current flow
* Structure of an atom
* Charged particles
* Coulomb
* Ampere
 |
| 2.9 | Recognise the relationship between conductors, current, magnetic fields and relative movement | Cover:* Production of alternating current
* Production of direct current
* Generator principle (Fleming’s Right Hand Rule)
* Motor principle (Fleming’s Left Hand Rule)
 |
| 2.10 | Calculate moments and levers | Cover:* Calculating moments (m = force x perpendicular distance)
* Classes of levers
* Mechanical advantage (MA = Fo )

 Fi |
| 2.11 | Calculate heat input and change in length | Cover:* Calculating heat input (Amps x Volts) / Travel speed
* Calculating thermal expansion (ΔL = αLΔT)
 |
| 2.12 | Calculate resistors in series and parallel circuits | Cover:* Calculate resistors in series circuits
* Calculate resistors in parallel circuits
* Calculate resistors in equivalent circuits
 |
| 2.13 | Perform simple calculations using thebasics of electricity | Cover:* Simple circuits
* Power (W) = Voltage (V) x Current (A)
* Resistance
* Ohms law
 |

Unit: TOEC3-004 The structure, properties and characteristics of common materials

GLH: 60

Unit description

This unit enables the learner to develop knowledge and understanding of the structure, properties and characteristics of common materials.

Summary of learning outcomes

1. Understand how to select engineering materials
2. Understand material properties and heat treatment processes

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 2.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**To support the learning from this learning outcome, learners should be encouraged to consider how materials are applied to engineering applications and why. |
| --- | --- | --- |
| 1. Understand how to select engineering materials
 | 1.1 | Identify the factors that make materials suitable for engineering applications | Cover:* Available forms of supply
* Cost
* Properties of material
* Application of product
* Manufacturing capability
* How a material reacts in different environments
 |
| 1.2 | Identify the classification, range and application of materials used in engineering | Cover:Material classification:* Metallic (pure metals and alloys)
* Non-metallic materials
* Composites
* Natural materials
* Thermoplastics
* Thermosetting plastics
* Ceramics

Range of materials:* Cast iron
* Carbon and alloy steels
* Stainless steel
* Aluminium
* Aluminium alloys
* Copper
* Brass
* Bronze
* Lead
* Nylon
* PVC
* Perspex
* Rubber
* Wood
* Glass
* Glass fibre
* Epoxy resins
* Carbon fibre
 |
| 1.3 | Identify the forms of supply of engineering materials | Cover:* Sheet
* Plate
* Bar
* Wire
* Section
* Extrusions
* Castings
* Wrought
* Forgings
* Pipe and tube
* Hot and cold rolled
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth** If possible, learners should be shown materials at different stages/states of heat treatment (e.g., before and after annealing work hardened) showing how properties can be altered to suit further reworking. |
| --- | --- | --- |
| 1. Understand material properties and heat treatment processes
 | 2.1 | Identify the properties associated with basic engineering materials | Cover:* Ductility
* Malleability
* Hardness
* Toughness
* Strength
* Brittleness
* Plasticity
* Elasticity
* Conductivity
* Dielectric strength
 |
| 2.2 | Identify the basic heat treatment process as applied to changing the properties of materials | Cover:* Hardening
* Tempering
* Annealing
* Normalising
 |
| 2.3 | Identify how the properties are affected by the application of heat | Cover:* Thermal expansion
* Structural alterations
* Magnetism
* Electrical resistance
 |
| 2.4 | Identify why the different properties make materials suitable for different applications | Cover:* Heat resistance
* Thermal and electrical conductivity
* Thermal and electrical insulation
* Wear resistance
* Corrosion resistance
* Load bearing capacity
* Shear strength
* Weight
* Cost
* Tensile strength
* Ability to withstand low temperatures
* Factors why engineering materials can fail.
 |

Unit: TOEMF3-001 Fabrication and welding principles

GLH: 60

Unit description

This unit enables the learner to develop the knowledge essential and common to all aspects of fabrication and welding engineering. It covers materials and their treatment and applies maths to fabrication and welding engineering.

Summary of learning outcomes

1. Understand materials technology relating to fabrication and welding
2. Understand the principles of metallic corrosion and methods of surface protection
3. Understand materials testing procedures relevant to fabrication & welding
4. Be able to apply maths to metal fabrications

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 4.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand materials technology relating to fabrication and welding
 | 1.1 | Identify the types and applications of ferrous and non-ferrous metals and their alloys | Cover:Ferrous – such as:* Alloy steel, carbon steel

Non-ferrous – such as:* Pure non-ferrous metals –copper, tin, lead, zinc, aluminium etc
* Non-ferrous alloys – copper, aluminium, magnesium and nickel alloys
 |
| 1.2 | Describe the effect of heat on metal structures | Cover:* Crystal structures of welded joints – the weld as a heat source, parent metal and HAZ
* Heat treatment:
	+ Heat treatment of different materials (ferrous and non-ferrous)
	+ Influence of carbon/alloying content
	+ The effect of the rate of cooling (relationship with equilibrium diagrams)
	+ Effects of overheating; Grain size; Pre and post heating
* Hot and cold working – influence on grain structure, work hardening, residual stress and grain growth
 |
| 1.3 | Describe typical causes of material failure | Cover:* Brittle and ductile fractures
* Fatigue failure
* Yielding due to overloading of remaining cross section
* Instability (buckling)
* Creep failure

Learners must be able to identify changes to crystal and crystalline structures of metals caused through heat treatment and welding procedures in relation to common materials used in fabrication and welding; recognise the effects of heat as well as environmental issues relating to the selection of materials in fabricated work / structures. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the principles of metallic corrosion and methods of surface protection
 | 2.1 | Describe the types of corrosion affecting different metals | Cover:* Dry chemical corrosion (oxidation)
* Electrolytic corrosion
* Galvanic series
 |
| 2.2 | State the factors affecting the rate of surface corrosion | Cover:* Structural design
* Applied and internal stresses
* Environmental
* Metal composition
* Electrolyte concentration
* Temperature
 |
| 2.3 | State the need for corrosion prevention | Cover:* Cost implications of corrosion
* Avoidance of material / component malfunction
* Techniques and reagents used for removing corroded parts
 |
| 2.4 | Describe commonly used methods of surface protection | Cover:* Hot dipping
* Galvanising
* Tin plating
* Terne plating
* Electroplating
* Cladding
* Metal/ceramic spraying
* Sheradising

Surface protection by electro-chemical means:* Anodising
* Chromating
* Phosphating
* Cathodic protection
* Anodic protection (sacrificial protection)
* Inhibitors e.g., paints, varnishes, lacquers, oils

Learners must be able to identify methods of surface protection and corrosion prevention relating to common materials used in fabrication and welding as well as environmental issues relating to the selection of materials in fabricated work / structures. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand materials testing procedures relevant to fabrication & welding
 | 3.1 | Describe the types of non-destructive testing techniques used within fabrication & welding | Cover:Non-destructive testing techniques (NDT)Visual inspection techniques:* Surface defects
* Casting distortion
* Welded joints
* Use of visual exam aids (torch, magnifying glass, probes and welding gauges)
* Volumetric Testing (size, length and profile)

Dye-penetrant testing:* Health and safety when handling, using and storing penetrant fluids
* Principles of dye penetrant testing
* Principles of capillary action
* Suitability for surface and surface breaking defects
* Types of fluids used; fluorescent dye, non-fluorescent dye, cleaner, developer
* Procedures for use; application, soak times, removal, developer, interpretation of results
* Use of ultra violet light with fluorescent dye
* Applications and limitations of penetrant testing

Magnetic particle testing:* Health and safety when handling, using and storing magnetic particle materials
* Principles of magnetic particle testing procedures
* Suitability for ferro-magnetic materials
* Types of magnetic field and the effect of discontinuities on the field
* Suitability for surface and immediate sub surface defects
* Detection media; powders, inks, fluorescent inks
* Types of magnets; permanent and electro
* Procedures for use; materials preparation, selection and application of detection media
* Interpretation of results
* Applications and limitations of magnetic particle testing

Radiographic testing:* Health and safety when handling, using and storing radioactive materials
* Principles of radiographic testing procedures
* Types of radiation (Gamma and X-ray)
* Sources and generation of suitable radiation
* Suitability for sub surface defects
* Use of image quality indicators
* Procedures for using equipment
* Development of x ray films and interpretation of results
* Applications and limitations of radiography

Ultrasonic testing:* Principles of ultrasonic testing procedures
* Method of operation of equipment
* Testing of welded joints
* Types and use of couplants
* Calibration of equipment
* Interpretation of results
* Applications and limitations of ultrasonic testing
 |
| 3.2 | Describe the types of destructive testing techniques used within fabrication & welding | Cover:Destructive Testing TechniquesTensile testing* Principles of tensile testing procedures
* Typical applications and use of tensile testing
* Types of tensile testing equipment used
* Standardisation of test specimen dimensions
* Interpreting stress-strain curves for low carbon steel, cast iron and aluminium
* Yield points

Fracture toughness (impact) testing:* Principles of testing resistance to impact
* Types of impact testing equipment
* Difference in Charpy and Izod tests
* Principles of Crack Opening Displacement testing (COD)
* Comparison of impact values for common materials
* Visual exam of fracture faces
* Typical applications and uses of testing
* Examples of brittle fracture

Hardness testing procedures:* Principles of testing resistance to indentation / scratching
* Operation of portable testing equipment (hand-held scratch test; Shore Scleroscope)
* Procedures for using testing equipment
* Brinell, Vickers and Rockwell testing procedures
* Interpretation of indentation results

Fatigue testing:* Principles of fatigue testing procedures
* Interpretation of S-N curves for LCS & non-ferrous alloys
* Factors affecting fatigue failure
* Examples of typical fatigue failures

Creep testing:* Principles of creep testing procedures
* Examples of creep in materials/component
* Interpretation of creep test results
* Applications of creep testing
 |
| 1. Be able to apply maths to metal fabrications
 | 4.1 | Calculate values for sides of a right-angle triangle using Pythagoras’ theorem | The application of the assessment criteria must be related to the holistic practical assessment the learners are involved in. |
| 4.2 | Use trigonometry to calculate the sides and angles of 900 triangles: sine; cosine; tangent |
| 4.3 | Calculate bend allowance using mean and neutral lines |

Unit: TOEMF3-002 Pattern development

GLH: 60

Unit description

This unit enables the learner to develop skills and knowledge about the methods of using pattern development for developing the geometric shapes used in the fabrication environment.

Summary of learning outcomes

1. Understand the principles of parallel line, radial line and triangulation development
2. Understand the principles of cutting planes and common central spheres to determine joint lines
3. Be able to develop pattern and produce template for fabrication activity

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 3.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the principles of parallel line, radial line and triangulation development
 | 1.1 | Describe how to apply the methods and principles of pattern development for parallel line and / or radial line developments | Cover:The application of the methods and principles of manual pattern development for parallel line and / or radial line developments:* Application of standard and machine manufacturer’s bend and bend reduction allowances to patterns based on material type and thickness
* Application of bend relief and notches to pattern corners and joints

Parallel line development:Learners should be shown by demonstration the parallel line development of the different shapes relating to equal diameter and square and rectangular tubes / pipes / cylinders. This should be followed by practice activities in the classroom to underpin the knowledge and understanding prior to undertaking the learning outcome assessment.Radial line development:Learners should be shown by demonstration the development of the different shapes relating to right cones and right pyramids. This should be followed by practice activities in the classroom to underpin the knowledge and understanding prior to undertaking the learning outcome assessment.Triangulation development:Learners should be shown by demonstration the development of the different shapes relating to hoppers and transformers having edges between parallel planes and those that do not have edges between parallel planes. This should be followed by practice activities in the classroom to underpin the knowledge and understanding prior to undertaking the learning outcome assessment. |
| 1.2 | Describe how to apply the methods and principles of pattern development triangulated developments  | Cover:The application of the methods and principles of manual pattern development for triangulated developments:* Application of standard and machine manufacturer’s bend and bend reduction allowances to patterns based on material type and thickness
* Application of bend relief and notches to pattern corners and joints

Learners should be shown by demonstration the development of the different shapes relating to hoppers and transformers having edges between parallel planes and those that do not have edges between parallel planes. This should be followed by practice activities in the classroom to underpin the knowledge and understanding prior to undertaking the learning outcome assessment. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the principles of cutting planes and common central spheres to determine joint lines
 | 2.1 | Describe how to construct the joint lines between two or more components using cutting planes and common central spheres | Learners should be shown by demonstration the construction of the joint lines associated with bringing cylindrical, conical and spherical components together. This should be followed by practice activities in the classroom to underpin the knowledge and understanding prior to undertaking the learning outcome assessment. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to develop pattern and produce template for fabrication activity
 | 3.1 | Develop pattern / templates for fabrication activity | Learners will need to develop pattern / templates to be used on the practical fabrication activity. |
| 3.2 | Verify pattern / template accuracy before and throughout the development of the fabrication activity. | Learners will need to verify pattern / template accuracy before and throughout the development of the fabrication activity. |

Unit: TOEMF3-003 Produce metal fabrications

GLH: 80

Unit description

This unit enables the learner to acquire both the knowledge and skills necessary to use the techniques and equipment required in the production of metal fabrications. They will develop the knowledge of tools, equipment and techniques and apply this knowledge in a practical task.

Summary of learning outcomes

1. Be able to apply safe working practices to metal fabrications
2. Be able to plan and prepare the metal fabrication activities
3. Be able to produce the metal fabrication
4. Be able to carry out the required checks on the metal fabrication
5. Be able to restore the work area on completion of the metal fabrication activity

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 5.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to apply safe working practices to metal fabrications
 | 1.1 | Comply with health and safety legislation and regulations relevant to producing the metal fabrication  | Learners will need to comply with health and safety legislation and regulations relevant to the practical metal fabrication activity.The learner will need to select, and use, appropriate PPE throughout the duration of the practical assessment. This aligns with the knowledge contained within Unit: TOEC3-001 Engineering and environmental health and safety in the workplace. |
| 1.2 | Comply with environmental legislation and regulations relevant to producing the metal fabrication | Learners will need to comply with environmental legislation and regulations relevant to the practical metal fabrication activity.This aligns with the knowledge contained within Unit: TOEC3-001 Engineering and environmental health and safety in the workplace. |
| 1.3 | Assess risk and hazards associated with producing the metal fabrication | Learners will need to assess the risks and hazards associated with the practical metal fabrication activity and produce an appropriate risk assessment. |
| 1.4 | Apply the correct methods for moving and handling materials | Learners will need to apply the correct methods for moving and handling materials, such as:* Correct manual handling procedures and risk assessment
* The correct handling/lifting technique
* The maximum recommended manual handling load weights at specified heights
* Distance from the body
* The use of mechanical aids to assist manual handling
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to plan and prepare the metal fabrication activities
 | 2.1 | Identify, obtain, and check the appropriate instructions, specifications, drawings and other relevant documentation | Cover:Appropriate instructions, specifications, drawings and other relevant documentation, such as:* First angle, third angle and isometric projection
* Interpretation of drawings and standards
* Weld symbols
* Welding standards
* Material surface finish
* CAD Files
* Specifications or instructions
* Interpretation of production information

The learner can utilise a range of documentation to analyse practical assessment requirements.The learner can interpret representations, symbols, annotations, and conventions used, as outlined in BS 8888 and BS EN ISO 2553. |
| 2.2 | Select and set up appropriate cutting equipment and tools | Cover:The selection of mechanical cutting processes and machines, such as:* Shears and guillotines
* Punches and nibblers
* Universal metalworking machines
* Saws
* Drills

The selection of thermal cutting process for sheet metal products, such as:* Oxy-fuel gas
* Plasma
* Lazer
 |
| 2.3 | Select and set up appropriate forming equipment and tools | Cover:The selection of forming and shaping equipment, such as:* Press
* Panel bending
* Roll forming
* Hammers
 |
| 2.4 | Prepare the materials to be marked out, cut, shaped and assembled using appropriate tools and techniques | Cover:The materials to be marked out, cut, shaped and assembled, such as:* Allowance for material thickness when bending/folding (mean and neutral line)
* Tolerances
* Accurately transfer measurements and profiles to sheet metal and sections from plans/drawings using marking out equipment
* Arrange shapes and forms to make the most economic use of available material (Nesting) and reduce scrap material
* Methods to avoid mirror image and cumulative error
 |
| 2.5 | Mark out using appropriate tools and techniques | Cover:Marking out using appropriate tools and techniques that ensure dimensional accuracy. Accurately using tools and marking equipment, such as:* Engineer’s rule
* Dividers
* Scribe
* Templates
* Set squares
* Protractors
* Compasses
* Combination square
* Punches (Centre and dot)
* Slip gauges
* Surface table and plates
* Angle plates
* Vee blocks
* Clamps

. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to produce the metal fabrication
 | 3.1 | Follow correct metal fabrication instructions, specifications, drawings and other relevant documents | The learner can demonstrate their ability to follow correct metal fabrication instructions, specifications, drawings and other relevant documents throughout the duration of the practical assessment. |
| 3.2 | Use appropriate cutting equipment and tools to produce the metal fabrication | The learner can safely and effectively use cutting equipment and tools to produce the metal fabrication to the required specification.The learner can cut metal parts accurately, and in accordance with the specification, during the production of the metal fabrication. |
| 3.3 | Use appropriate forming equipment and tools to produce the metal fabrication | The learner can safely and effectively use forming equipment and tools to produce the metal fabrication to the required specification.The learner can form metal parts accurately, and in accordance with the specification, during the production of the metal fabrication. |
| 3.4 | Use correct processes and procedures to assemble metal fabrication to shape and dimensional accuracy | Cover:The correct processes and procedures for pre-assembly preparation, such as:* The importance of checking level and clean surfaces
* Checking sub / part assemblies are correct and to tolerance
* Checking availability of all necessary parts / materials
* Checking suitable surface protection is in place

The correct processes and procedures for assembling metal components, such as:* Logical sequence
* Economy of material and labour
* Use of datums and tolerances
* Control of distortion
* Quality of finish
* Simplicity of construction
* Importance of close contact between surfaces
* Maintaining shape (freedom from twist and buckle)
* The use of assembly aids
* Ensuring dimensional accuracy
 |
| 3.5 | Produce and assemble metal fabrication to required specification and quality requirements | The learner can demonstrate their ability to produce and assemble metal fabrication to required specification and quality requirements. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to carry out the required checks on the metal fabrication
 | 4.1 | Carry out the required checks using the correct procedures, processes and / or equipment | The learner can carry out the required checks using a range of inspection equipment available to ensure fabrication conforms toSpecification, such as:* Measuring/checking equipment
* Levelling equipment
* Bolt tensioning equipment
* Weld gauge equipment

The learner can conduct quality monitoring and assurance checks as part of the production of the metal fabrication. |
| 4.2 | Deal promptly and effectively with problems within the limits of their responsibility using approved diagnostic methods and techniques and report those which cannot be resolved to the appropriate personnel | The learner can demonstrate that they can:* Identify potential risks, issues and problems with the immediate task to inform processes and agreed outcomes and timeframes
* Monitor practical fabrication activity
* Deal promptly with problems within limits of their responsibility using approved diagnostic methods and techniques
* Follow reporting procedures for raising any issues
* Identify areas for improvement
 |
| 4.3 | Inspect the metal fabrication to ensure that it meets the required specification and quality requirements | The learner can inspect the metal fabrication to ensure that it meets the required specification and quality requirements, such as: * Accuracy
* Alignment
* Form and shape
* Squareness
* Freedom from distortion
* Surface damage

Methods of inspection, such as:* First-off
* In process
* Final
 |
| 4.4 | Complete any required documentation using the defined recording systems  | The learner can complete any required documentation using the defined recording systems. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to restore the work area on completion of the metal fabrication activity
 | 5.1 | Restore the work area on completion of the metal fabrication activity | Correct procedures must be followed when disposing of various materials and wastes in accordance with organisational policies, regulations and legislation.Disposal of wastes, such as:* General waste
* Recycling
* Re-use
* Hazardous waste
* Non-hazardous waste
 |
| 5.2 | Return any resources and consumables to the appropriate location | The learner can sort, maintain and store resources and consumables, such as:* Store correctly
* Protect and evaluated for future use
* Maintain resources (replace any perished items, re-grind tooling, complete basic maintenance)
 |

Unit: TOEMF3-004 Joining techniques

GLH: 75

Unit description

This unit enables the learner to acquire both the knowledge and skills necessary to use equipment, consumables and techniques required to produce welding joints.

Summary of learning outcomes

1. Understand the principles of the joining process
2. Understand metallurgy associated with the joining process
3. Understand health and safety associated with the joining process
4. Be able to use equipment associated with the joining process
5. Be able to use consumables associated with the joining process
6. Be able to produce welding joints in accordance with welding procedure
7. Be able to test welding joints in accordance with welding procedure

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 7.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the principles of the joining process
 | 1.1 | Demonstrate an understanding of specific principles applicable to one of the following:* Manual metal-arc (MMA) welding
* Metal inert gas (MIG), Metal active gas (MAG) welding
* Tungsten inert gas (TIG) welding
* Mechanised welding
 | Cover:Specific principles applicable to MMA welding:* Electric circuit
* Open circuit and arc voltage
* Welding current
* Metal transfer with ac and dc

Specific principles applicable to MIG/MAG & TIG welding:* Electric circuit
* Open circuit and arc voltage
* Welding current
* Modes of metal transfer, to include:
	+ dip
	+ globular
	+ spray
	+ pulse

Specific principles applicable to mechanised welding - Understanding of the terms:* Manual welding
* Machine welding
* Mechanised welding
* Automatic welding
* Semi-automatic welding
* Automation
* Robotic welding
* Adaptive control
* Joint recognition
 |
| 1.2 | Identify types of welds and joints | Cover:Identify types of welds and joints:* ISO 17659 – Welding
* Multilingual terms for welded joints with illustrations
* Butt, tee, lap, corner joint

Fillet weld characteristics:* Leg length
* Throat thickness
* Penetration
* Number of runs
* Surface finish
* Weld toes and weld profile

Butt weld characteristics:* Types of preparation
* Number of runs
* Excess weld metal
* Penetration
* Surface finish
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand metallurgy associated with the joining process
 | 2.1 | Recognise the effects of heating and cooling metals | Cover:* Heating metals and cooling slowly and rapidly
* Mechanical properties
* Grain size and structure
 |
| 2.2 | Recognise the effects of welding on metals | Cover:* Microstructures of welded joints (parent metal, weld metal and HAZ)
* Concept of weldability
* Effect of composition, thickness, heat input and temperature
* Carbon equivalent
 |
| 2.3 | Recognise how cracking occurs in welds | Cover:* Cold cracking
* Hydrogen: sources of hydrogen and control of hydrogen in the deposited weld metal
* Stress - nature and avoidance of stress

Lamellar tearing:* Causes: through thickness properties and inclusions
* Avoidance: joint design, welding sequence and buttering techniques

Hot cracking:* Causes - manganese/sulphur ratio, copper content, oxygen content and depth to width ratio of the weld
* Avoidance - joint design and selection of consumables

Reheat cracking:* Types of steels sensitive to reheat cracking
* Reheat cracking due to heat treatment
* Reheat cracking due to multi-pass welding
 |
| 2.4 | Recognise residual stress | Cover:* Thermal cycle in welding
* Development of residual stress, effect of heat
* Use of heat to relieve stress
* Relationship between heat input and shrinkage
* Residual stress and distortion
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand health and safety associated with the joining process
 | 3.1 | Describe the safe working practices observed when carrying out the welding process | Cover:Health and safety legislation and current regulations applicable to the welding process:* Health & safety at work act
* Personal protective equipment regulations
* Control of substances hazardous to health regulations
* Management of health and safety at work regulations
* Reporting of injuries, diseases and dangerous occurrences regulations
* Provision and use of work equipment regulations
* Noise at work regulations
* Safe working practices when welding on site
* Wiring Regulations
* Manual Handling
* COSHH essentials for welding, cutting and allied tasks (HSE guidance notes)

Personal protective equipment (PPE) worn and the reasons for need:* Protection of others from hazards
* Hot materials
* Sparks
* Falling objects
* Heat
* Burns

Safe start-up and shutdown procedures.Gas cylinder safety:* Storage
* Identification
* Handling
* Use

Arc radiation:* Visible light
* Infra-red
* Ultra-violet
* Effects on health

Hazards from fume produced during welding and safe working procedures adopted:* Types of fume
	+ Particulate
	+ Gaseous
* Effects on health

Hazards from fume produced during welding and safe working procedures adopted:* Methods of control
	+ Extraction
	+ Local
	+ General
	+ Air-fed head shield
	+ Respirator
	+ Breathing apparatus

Working in confined spaces:* Definition of a confined space
* Asphyxiation hazard
* Risk of explosion
* Risks from oxygen enrichment
* Hazards to health from pollutants

Hazards from fire and safe working procedures adopted:* Flammable materials
* Suitable types of extinguishers
* Identification of fire exit and evacuation procedures

Health and safety issues associated with welding related activities, such as:* Grinding and material removal
* Safe disposal of waste
* Workshop layout
* Obstacles
* Noise
* Hot metal
* Positioning of cables
 |
| 3.2 | Summarise the electrical hazards associated with welding plant and safe working procedures adopted | Cover:Electrical hazards associated with welding plant and safe working procedures adopted, such as:* Fire
* Electric shock
* Emergency procedures in the event of an electric shock
* Use of fuses
* Electrical insulation
* Use of earthing
* Workpiece (welding)
* Plant
* Use of circuit breakers (including earth leakage circuit breakers - ELCB)
* Use of no-load low voltage protection devices
 |
| 3.3 | Perform safe working practices throughout the joining process | The learner can demonstrate that they can perform safe working practices throughout the joining process. |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to use equipment associated with the joining process
 | 4.1 | Summarise the equipment requirements for the welding process | Cover:The learner can summarise the equipment requirements for the welding process applicable to **one** of the following:The equipment requirements for the **MMA welding** **process.**Types of power sources and their application:* Transformers
* Transformer/rectifiers
* Inverters
* Generators

Power source characteristics:* Power source duty cycle
* Drooping characteristic (constant current)
* Welding current
* Open circuit voltage
* Arc voltage

Principles of different current control methods:* Stepped reactor
* Moving core
* Moving coil
* Moving shunt
* Variable resistance
* Satiable reactor
* Instrumentation (e.g., ammeter, voltmeter)
* Calibration of equipment
* Output monitoring

The equipment requirements for the **MIG/MAG welding process.*** Types of power sources and their application:
* Transformers
* Transformer/rectifiers
* Inverters
* Generators

Power source characteristics:* Power source duty cycle
* Flat characteristic (constant voltage)
* Welding current
* Open circuit voltage
* Welding voltage
* DC electrode polarity
* Pulse parameters
* Synergic pulse

Power source control:* Principles of different current control methods
* Control of wire feed rate
* Variable resistance
* Satiable reactor
* Inductance control
* Instrumentation (e.g., ammeter, voltmeter)
* Calibration of equipment
* Output monitoring

The equipment requirements for the **TIG welding process.**Types of power sources and their application:* Transformers
* Transformer/rectifiers
* Inverters
* Generators

Power source characteristics:* Power source duty cycle
* Drooping characteristic (constant current)
* Welding current/voltage
* Open circuit voltage
* DC electrode polarity
* Pulse parameters
* Synergic pulse
* Slope-in/out controls
* AC square wave
* DC pulse

Power source control:* Principles of different current control methods
* Control of wire feed rate
* Stepped reactor
* Moving core
* Moving coil
* Moving shunt
* Variable resistance
* Satiable reactor
* Instrumentation (e.g., ammeter, voltmeter)
* Calibration of equipment
* Output monitoring

The equipment requirements for the **mechanised welding process**:Power source characteristics:* Power source duty cycle
* Flat characteristic (constant voltage)
* Welding current
* Open circuit voltage
* Welding voltage
* Electrode polarity
* Pulse parameters
* Synergic pulse

Power source control:* Principles of different current control methods
* Control of wire feed rate
* Variable resistance
* Satiable reactor
* Inductance control
* Instrumentation (e.g., ammeter, voltmeter)
* Calibration of equipment
* Output monitoring

Mechanisation methods:* Tractor drives
* Application of tractor driven systems
* Fixed welding stations
* Turntables
* Positioning equipment
* Turning rolls
* Tilting / rotating turntables
* Column and boom
* Headstock-tailstock
* Process specific features

Mechanised welding processes:Submerged arc:* Applications
* Advantages and disadvantages of process
* Equipment set-up
* Wire feed method
* Types of flux
	+ Fused
	+ Agglomerated
	+ Mixed

Electroslag:* Applications
* Equipment set-up
* Wire feed method
* Function of flux
* Benefits
* Limitations
* Consumable guide variation of process
* Multiple wire method
* Advantages and disadvantages of process

Mechanised MIG:* Applications
* Advantages and disadvantages of process
* Equipment set-up
* Wire feed method
* Gases / gas mixtures
	+ Argon
	+ Helium
	+ Argon / helium mixtures
	+ Carbon dioxide
	+ Argon / carbon dioxide mixtures
	+ Argon / oxygen / carbon dioxide mixtures
	+ Argon / oxygen mixtures
	+ Helium / argon / oxygen / carbon dioxide mixtures
* Flux cored welding

Mechanised TIG:* Applications
* Advantages and disadvantages of process
* Equipment set-up
* Wire feed method / autogenus
* Hot wire setup
* Gases / gas mixtures
	+ Argon
	+ Helium
	+ Argon / helium mixtures
	+ Helium / argon mixtures
	+ Argon / hydrogen mixtures
	+ Nitrogen
	+ Argon / nitrogen mixtures

Mechanised plasma arc:* Applications
* Advantages and disadvantages of process
* Equipment set-up
* Wire feed method / autogenus
* Identify plasma and shielding gases / gas mixtures
	+ Argon
	+ Helium
	+ Argon / helium mixtures
	+ Helium / argon mixtures
	+ Argon / hydrogen mixtures
 |
| 4.2 | Perform checks to prepare and reinstate the work area and equipment for the welding operation | The learner can perform all the required checks to prepare and reinstate the work area and equipment for the welding operation. |
| 4.3 | Set up, check, adjust and use joining and related equipment correctly | The learners can set-up, check, adjust and use the welding equipment safely and correctly for the efficient welding of joints. |
| 4.4 | Maintain equipment in a reliable and safe condition | Cover:The need for care and maintenance:* Cleanliness
* Identify equipment faults
* Clearing a burn-back
* Gas supply and control
* Insulation
* Contact faces and connections
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to use consumables associated with the joining process
 | 5.1 | Summarise the consumable requirements for the welding process. | Cover:The learner can summarise the consumable requirements for their chosen welding process.**One** from the following:**MMA welding process**The classification of electrodes for carbon steels (check specification is current):* BS EN 499 (1995)
* ISO 2560 2009
* American classification – AWS A5.1-91

Electrode types, sizes and selection:* Rutile
* Basic
* Cellulosic
* Iron powder
* Electrode sizes (SWG and metric)
* Principles of electrode selection

**MIG/MAG** **welding process**The consumables requirements for the MIG/MAG welding process (check specification is current):* BS EN 440:1995 – Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels. Classification
* BS EN 12072:2000 – Welding consumables. Wire electrodes, wires and rods for arc welding of stainless and heat-resisting steels. Classification
* BS 2901-4:1990 – Filler rods and wires for gas-shielded arc welding. Specification for aluminium and aluminium alloys and magnesium alloy
* BS EN 758:1997 – Welding consumables. Tubular cored electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels. Classification
* EN 439:1994 – Welding consumables. Shielding gases for arc welding and cutting)

Electrode wire composition and sizes:* Types of cored wire electrodes
* Flux cored
* Self / Gas shielded

**TIG** **welding process**Electrode wire composition and sizes (check specification is current), to include reference to:* BS EN 1668:1997 – Welding consumables. Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine grain steels. Classification
* BS EN 12072:2000 – Welding consumables. Wire electrodes, wires and rods for arc welding of stainless and heat-resisting steels. Classification
* BS 2901-4:1990 – Filler rods and wires for gas-shielded arc welding. Specification for aluminium and aluminium alloys and magnesium alloy

The type of tungsten electrodes:* Electrode types and sizes (BS EN 26848:1991 – Specification for tungsten electrodes for inert gas shielded arc welding and for plasma cutting and welding)
* Thoriated, Zirconiated, Lanthaniated and Ceriated
* Electrode selection and preparation

**Mechanised welding process**Electrode wire composition and sizes, to include reference to:* BS EN ISO 14341:2008 – Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels. Classification
* BS EN ISO 14343:2007 – Welding consumables. Wire electrodes, wires and rods for arc welding of stainless and heat-resisting steels. Classification
* BS EN ISO 18273:2004 – Filler rods and wires for gas-shielded arc welding. Specification for aluminium and aluminium alloys and magnesium alloy
* BS EN ISO 17632:2008– Welding consumables. Tubular cored electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels. Classification

Electrode wire composition and sizes, to include reference to:* Types of cored wire electrodes:
* Flux cored
* Iron cored
* Self-shielded
* Gas shielded
 |
| 5.2 | Select and use the correct welding consumables for the joints to be welded | The learner can select and use the correct welding consumables relevant to their chosen joining process (MMA, MIG/MAG, TIG or mechanised welding) and for the joints to be welded. |
| 5.3 | Store and handle welding consumables correctly | Cover:The learner can store and handle welding consumables correctly for **one** of the following:**MMA** **welding process**Electrode storage, handling and defects:* Storage conditions
* Heating times and temperatures
* Baking of basic electrodes
* Holding of basic electrodes
* Damaged flux
* Corroded core wire
* Protect from damp conditions or extreme temperature changes
* Core wire not concentric with covering

**MIG / MAG** **welding process**Storage, handling and defects:* Storage conditions
* Use of de-oxidants and function of copper coating on steel wire
* Protection of bare wires
* Protect from damp conditions or extreme temperature changes

**TIG** **welding process**Storage, handling and defects:* Use of de-oxidants and function of copper coating on steel wire
* Protection from atmospheric contamination
* Protection of bare wires
* Wire storage and handling
* Extraction of dust during sharpening of tungsten electrode

**Mechanised welding process*** Storage, handling and defects:
* Use of de-oxidants and function of copper coating on steel wire
* Protection of bare wires
* Electrode/wire storage and handling
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to produce welding joints in accordance with welding procedure
 | 6.1 | Summarise the procedural requirements for the welding process | Cover:* Objectives
* Role of manufacturer and examining body
* Standards EN 287 (ISO 6947) and ASME IX Quality assurance:
* Role of the welding inspector
* Key role of welders
* Introduction to ISO 3834 – Quality requirements for welding
* Introduction to ISO 14731 – Welding coordination
* Interpretation of welding symbols – EN 22553
* Features of a welded joint
* Welding positions in accordance with both EN 287 (ISO 6947) and ASME IX
 |
| 6.2 | Interpret welding symbols | Cover:EN 22553* Significance of the arrow
* Symbols for butt and fillet welds
* Weld sizes
* Intermittent welds
 |
| 6.3 | Interpret welding procedure specification | Cover:EN ISO 15609-1:Welder qualification testing:* Quality levels
* Process
* Material / thickness
* Welding positions
* Range of approval
* Testing requirements
* Mechanical testing requirements
* Location of test
* Witnessing
* Certification
* Prolongation
* Non-destructive testing requirements
 |
| 6.4 | Demonstrate an understanding of pre and post welding operations | Cover:Pre and post welding operations in terms of:* Cutting and preparation processes
	+ Manual
	+ Machine
* Surface finish / flaws
* Joint cleanliness
* Pre-welding alignment and accuracy checks
* Methods of distortion control
* Application of pre-heat
* Arc and gas gouging
* Post-weld cleaning
 |
| 6.5 | Weld joints in accordance with approved welding procedure and quality requirements | Cover:Welded joints – **Two** from: * Butt
* Corner
* T-fillet
* Lap
* Edge

Welding positions – **Two** from: * Flat (PA)
* Horizontal (PC)
* Vertical Up (PF)
* Overhead butt (PE)
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to test welding joints in accordance with welding procedure
 | 7.1 | Demonstrate an understanding of welding defects as per current standard | Cover:Types of weld defects:* Cracks
* Cavities
* Solid inclusions
* Lack of fusion and penetration
* Imperfect shape
* Miscellaneous defects

BS EN ISO 5817 provides guidelines on quality levels of imperfections in fusion-welded joints (except for beam welding) in all types of steel, nickel, titanium, and their alloys. |
| 7.2 | Test welding joints as per current standards | Cover:The methods of weld inspection and testing, such as:* Visual inspection:
* Prior to welding
* During welding
* After welding
* Measuring equipment
* Optical aids

Destructive testing, such as:* Face
* Side
* Root
* Macroscopic
* Nick-break
* Tensile

Non-destructive testing, such as:* Dye penetrant
* Magnetic particle
* Ultrasonic
* Radiography
 |
| 7.3 | Complete any required documentation using the defined recording systems at the appropriate stages of the work activity | The learner can complete relevant documentation before commencing their practical activity, during their practical activity and on completion of their practical activity.  |
| 7.4 | Restore the work area on completion of the activity and return any resources and consumables to the appropriate location | Cover:Correct procedures must be followed when disposing of various materials and wastes in accordance with organisational policies, regulations and legislation.Disposal of wastes, such as:* General waste
* Recycling
* Re-use
* Hazardous waste
* Non-hazardous waste

The learner can sort, maintain and store resources and consumables, such as:* Store correctly
* Protect and evaluated for future use
* Maintain resources (replace any perished items, re-grind tooling, complete basic maintenance)
 |

# Appendix 1: Centre Exam Specifications

**Core knowledge exam 1**

|  |
| --- |
| **Units:** TOEC3/001 - Engineering and Environmental Health and Safety in the Workplace TOEC3/002 - Engineering Organisational Efficiency and Improvement  |
| Assessment type: Multiple ChoiceNumber of questions: 35Time allowed: 70 minutesClosed bookThe exam will cover the knowledge learning outcomes of the units, as follows: |
| **No** | **Learning outcome title** | **No of questions** |
| 1.1 | Understand health and safety roles and responsibilities | 7 |
| 1.2 | Understand the application of health and safety in the engineering environment | 6 |
| 1.3 | Understand environmental management | 5 |
| 2.1 | Understand production activities | 4 |
| 2.2 | Understand application of quality control and quality assurance | 6 |
| 2.3 | Understand organisational improvement techniques and competitiveness | 5 |
| 2.4 | Understand personal rights and responsibilities within an organisation | 2 |
| **Total:** | **35** |
| **NOTE:** The pass mark for the exam is 60%.  |

**Core knowledge exam 2**

|  |
| --- |
| **Units:** TOEC3/003 -Essential Mathematics and Science for Engineering and Manufacturing TOEC3/004 - The Structure, Properties and Characteristics of Common Materials |
| Assessment type: Multiple ChoiceNumber of questions: 35Time allowed: 70 minutesClosed book, non-programmable calculator permittedThe exam will cover the knowledge learning outcomes of the units, as follows: |
| **No** | **Learning outcome title** | **No of questions** |
| 3.1 | Understand fundamental numeracy applied to engineering and manufacturing | 13 |
| 3.2 | Understand fundamental science applied engineering and manufacturing | 13 |
| 4.1 | Understand how to select engineering materials | 4 |
| 4.2 | Understand material properties and heat treatment processes | 5 |
| **Total:** | **35** |
| **NOTE:** The pass mark for the exam is 60%.  |

# Appendix 2: Learner Registration and Certification

Learners must be registered with EAL on a code which relates to the qualification - this must be completed prior to assessment. Both learner registration and certification can be completed online at the EAL Website www.eal.org.uk. For paper-based registration and certification use the appropriate forms. These are located on the EAL Website, for guidance on registration and certification please refer to the Registration and Certification User Guide.

To register the learner on the chosen qualification/pathway code:

|  |  |
| --- | --- |
| **Qualification Title:** | **Code:** |
| EAL Level 3 Technical Occupation Entry in Metal Fabrication (Diploma) | 610/3913/5 |

For further information, please contact EAL Customer Experience:

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

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