Level 2 Diploma in Marine Electrical Engineering (Foundation) (2473-22)

February 2023 Version 1.1

Qualification Handbook

Qualification at a glance

Subject area	Marine
City & Guilds number	2473-22
Age group approved	16+
Entry requirements	None
Assessment	Multiple Choice; Centre Devised Practical; Short Answer Questions
Approvals	Qualification Approval
Support materials	Qualification handbook; Assessment pack; Centre-devised recording forms; Sample assessments
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds number	Accreditation number
Level 2 Diploma in Marine Electrical Engineering (Foundation)	2473-22	603/7332/5

Version and date	Change detail	Section
V1.0 April 2021	n/a	n/a
V1.1 Feb 2023	Clarified assessment approach for units 211 and 213	4 Assessment

Contents

1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	This qualification is aimed at learners aged 16 and above who would like to gain the basic knowledge and skills required during their initial training to become a Marine Electrical Engineer.
What does the qualification cover?	Learners will be introduced to the scope and opportunities offered within the marine industry. This qualification will cover marine electrical engineering processes and principles. Learners will gain an insight into the marine industry, including an understanding of the range of services offered, the terminology used and the health, safety and environmental rules and regulations. Learners will be introduced to the principles of marine electrical systems and learn how to install electrical wiring support systems. All the above will enable learners to progress into further training to become a Marine Electrical Engineer.
What opportunities for progression are there?	Upon completion of this qualification, learners will be equipped with the knowledge, skills and behaviours required for progression towards a Level 3 Marine Electrical Engineering qualification, with the goal of becoming a qualified marine electrician. On successful completion of the whole apprenticeship standard, learners will have been awarded BMET and MEI by British Marine and recognised by the Institute of Marine Engineering, Science and Technology (IMarEST) at 'Engineering Technician' level.
Who did we develop the qualification with?	This qualification has been developed in collaboration with the marine electrician employer group which is led by Berthon Boat Company (chair), Raymarine (UK), Pendennis Shipyard, RNLI, Osprey Technical Consulting, Princess Yachts, Sunseeker International, Cockwells, Volt Master Systems, Bournemouth and Poole College and British Marine.
Is it part of an apprenticeship standard or initiative?	No.

Level 2 Diploma in Marine Electrical Engineering (Foundation)		
City & Guilds unit number	**Unit title**	**GLH**
Mandatory		
201	Introduction to the Marine Industry	100
203	Business Improvement Techniques	50
211	Principles of Marine Electrical Systems	150
212	Marine Engineering and Electrical Processes and Principles	100
213	Installing Electrical Wiring Support Systems	100

Structure

To achieve the **Level 2 Diploma in Marine Electrical Engineering (Foundation)** learners must achieve all five mandatory units.

Centres should use the following certification units to claim for the achieved grade:

916 Pass

917 Merit

918 Distinction

Total Qualification Time

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to achieve and demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT is comprised of the following two elements:

1) The number of hours which an awarding organisation has assigned to a qualification for Guided Learning

2) An estimate of the number of hours a Learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by - but, unlike Guided Learning, not under the Immediate Guidance or Supervision of - a lecturer, supervisor, tutor or other, appropriate provider of education or training

Title and level	GLH	TQT
Level 2 Diploma in Marine Electrical Engineering (Foundation)	500	568

2 Centre requirements

Approval

To offer these qualifications, new centres will need to gain both centre and qualification approval. Please refer to the *City & Guilds Centre Manual* for further information.

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

Resource requirements

Resources

This qualification should be delivered in the workshops and classrooms of a centre with full facilities for marine electrical engineering activities, with all the equipment, machines, relevant tools and consumables for working safely with materials appropriate to each unit.

Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area[s] for which they are delivering training and/or have experience of providing training. This knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

See also page 11 for details from the assessment strategy on the role of supervisors and managers in the assessment process.

Centre staff may undertake more than one role, e.g., tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Assessors and Internal Quality Assurers

Registered centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre registration by City & Guilds and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance.

Standards and rigorous quality assurance are maintained by the use of:

- internal quality assurance
- City & Guilds external quality assurance.

In order to carry out the quality assurance role, Internal Quality Assurers must have appropriate teaching and vocational knowledge and expertise. Assessor/Verifier (A/V) units are valued as qualifications for centre, but they are not currently a requirement for the qualification.

Learner entry requirements

City & Guilds does not set entry requirements for these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualifications successfully.

Age restrictions

City & Guilds cannot accept any registrations for candidates under 16 as these qualifications are not approved for under 16s.

3 Delivering the qualification

Initial assessment and induction

An initial assessment of each candidate should be made before the start of their programme to identify:

- if the candidate has any specific training needs,
- support and guidance they may need when working towards their qualifications.
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications.
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification[s], their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

Support materials

The following resources are available for this qualification:

Description	How to access
Assessment pack	www.cityandguilds.com

Recording documents

Candidates and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, **Learning Assistant**, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at **www.cityandguilds.com/eportfolios**.

City & Guilds has developed a set of *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate. *Recording forms* are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre. Amendable (MS Word) versions of the forms are available on the City & Guilds website.

4 Assessment

Summary of assessment methods

Candidates must successfully complete:

- multiple-choice tests for units 201 and 212
- short-answer question assessment for unit 203
- centre-devised assignments with supporting centre-devised short-answer questions for units 211 and 213

Available assessments/assignments:

City & Guilds has written the following assessments to use with this qualification:

- multiple-choice tests to be delivered online for 201 and 212
- externally set, internally marked short-answer questions for unit 203.
- guidance for centre-devised assignments including example assignments and sample practice short-answer questions and model answers for units 211 and 213.
- sample assessments are available for each unit.

Centre set and marked assessments

City & Guilds has provided separate guidance for writers of centre-based assessments which should be read in conjunction with this document, entitled 'GM1 - Developing centre-devised assessments – guidance for centre-based assessment writers'.

A set of generic recording forms is also provided as follows:

- Assessment tasks (AD1)
- Assessment grading criteria (AD2)
- Assessment sign off form (AD3)
- Evidence recording form (GF1)
- Assessment unit front and mark sheet (GF2)
- Assessment task front sheet (GF3)
- Assessment unit mark sheet (GF4)
- Assessment feedback and action plan form (GF5)
- Qualification assessment tracking form (GF6)
- Group assessment tracking form (GF7)

A full explanation of the use of these forms can be found in the centre-devised assessment writing guidance. All of these materials are available to download from the City & Guilds website.

Approval process for centre set assignments

Centre set assignments must be approved by the external quality assurer before use. For each assignment, the Assessment sign off form (AD3) must be completed and be made available to the EQA for inspection.

Assessment Types			
Unit	**Title**	**Assessment method**	**Where to obtain assessment materials**
2473-201	Introduction to the Marine Industry	Multiple-choice online test 2473-201 The assessment covers all the outcomes in this unit	Evolve
2473-203	Business Improvement Techniques	Short-answer questions 2473-203	www.walled-garden.com
2473-211	Principles of Marine Electrical Systems	Centre-devised practical assignment and centre-devised short-answer questions 2473-211 These assessments cover all the outcomes in this unit	www.walled-garden.com
2473-212	Marine Engineering and Electrical Processes and Principles	Multiple-choice online test 2473-212 The assessment covers all the outcomes in this unit	Evolve
2473-213	Installing Electrical Wiring Support Systems	Centre-devised practical assignment and centre-devised short-answer questions 2473-213 These assessments cover all the outcomes in this unit	www.walled-garden.com

Time constraints

The following must be applied to the assessment of this qualification:

- All assessments must be completed within the candidate's period of registration.

Assessment strategy

Test specifications for the multiple choice online tests

The way the knowledge is covered by **each** test is laid out in the tables below:

Assessment title: Safe and effective working in the marine industry (marine electrical)
Assessment type: Multiple-choice online test
Assessment conditions: Invigilated examination conditions
Grading: X/P/M/D

Unit	Duration: 75 minutes		
201	**Learning Outcome**	**Number of questions**	**%**
	01: Understand the range of services available within the global marine industry	8	16
	02: Understand the terminology used to recognise boats and equipment	6	12
	03: Understand the environmental, Health and Safety rules and regulations applicable to the marine industry	17	34
	04: Understand employment roles and responsibilities	4	8
	05: Know how to contribute to self-development and create and maintain effective working relationships	7	14
	06: Know how to contribute to the effectiveness of boat production and support services	8	16
	Total	**50**	**100**

The grade boundaries for this test will be approximately:
Pass: 60%
Merit: 70%
Distinction: 80%

These boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the test be identified.

Assessment title: Safe and effective working in the marine industry (marine electrical)
Assessment type: Multiple-choice online test
Assessment conditions: Invigilated examination conditions
Grading: X/P/M/D

Unit	Duration: 75 minutes		
212	**Learning Outcome**	**Number of questions**	**%**
	01: Know how to identify marine engineering/electrical materials, their reaction to the environment and their properties	14	35
	02: Know how to interpret and use marine electrical specifications and installation requirements	7	17.5
	03: Know how to use tools and equipment safely in a marine electrical environment	7	17.5
	04: Understand marine electrical processes	12	30
	Total	**40**	**100**

The grade boundaries for this test will be approximately:
Pass: 60%
Merit: 70%
Distinction: 80%

These boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the test be identified.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

For this qualification, RPL is allowed and is not sector specific.

5 Grading

Grading of individual assessments

Individual assessments will be graded Pass/Merit/Distinction.

For the units to be achieved, candidates must achieve a minimum of Pass in each assessment, as per the marking scheme provided for each assessment.

Pass reflects the minimum requirements that are expressed in the unit, with Merit and Distinction showing progression in the depth and breadth of the learner's knowledge, as well as in the type of cognitive operations learners demonstrate.

Grading of qualification

The Marine Engineer Employer Group has taken the decision to grade this qualification Pass/Merit/Distinction, through the aggregation of the individual assessments graded Pass/Merit/Distinction.

All assessments must be achieved at a minimum of Pass for the qualification to be awarded. All assessments graded Pass/Merit/Distinction contribute equally to the overall qualification grade. For full details on how to grade the qualification, refer to the Assessment Pack available on the qualification page of **www.cityandguilds.com**.

Overall qualification grades must be entered using one of the following overall grading modules on the Walled Garden:

- 916 Pass
- 917 Merit
- 918 Distinction

6 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- Title
- Level
- Guided learning hours (GLH)
- Assessment type
- Learning outcomes, which are comprised of a number of assessment criteria

Centres must deliver the full breadth of the range. Specialist equipment or commodities may not be available to all centres, so centres should ensure that their delivery covers their use. This may be covered by a practical demonstration (eg video). For the practical assessments for this qualification, centres should ensure that there are sufficient resources to complete the task but are not required to use all the equipment or commodities in the range.

Unit 201 Introduction to the Marine Industry

Level:	2
GLH:	100
Aim:	This mandatory unit covers safety awareness and communication skills needed to work effectively in the marine industry. It covers health and safety, interaction with other employees and an understanding of the terminology and structure of the industry.
Assessment type	Multiple-choice test.

Learning outcome:

The learner will:

1. Understand the range of services available within the global marine industry

Assessment criteria

The learner can:

1.1 describe what boatyards, marinas and yacht basins are
1.2 list the facilities and services that are found in boatyards, marinas and yacht basins
1.3 describe the services of boatbuilding, refit and repair to the UK and global markets
1.4 describe the purpose of boatyards, marinas and yacht basins
1.5 describe methods for moving boats
1.6 identify personnel responsible for providing services
1.7 list ancillary marine services provided within the marine industry

Range

(AC 1.2)

Facilities:

- accommodation facilities:
  - laundry room (washing machines, spin driers)
  - showers
  - toilets
- crane services
- dry dock
- finishing (gel coat repair, polishing, burnishing, lacquering)
- fit out
- fuelling facilities
- launching and recovery
- locks
- machinery and equipment
- maintenance
- mast and spar storage arrangements

- materials storage facilities
- moorings
  - marina pontoons
  - on piles
  - swinging or fixed
- new build
- painting and varnishing
- pump-out facilities
- repair and lay-up facilities
- slipway services
- storage cabins or lock-ups
- storage facilities
- workshops

(AC 1.2)

Services:

- electrical hook-up
- fuel
- gas bottles
- material storage
- recycling
- waste and refuse disposal
- water points

(AC 1.3)

Services of boatbuilding, refit and repair to the UK and global markets:

- customer service and support
- fit out
- new build
- parts
- repair
- sales and after sales
- warranty

(AC 1.4)

Purpose of boatyards, marinas and yacht basins:

- berthing of boats
- boat covers and awnings
- boat lifting
- boat valeting
- building, repairing and fitting out of boats to include hull and deck construction in wood, metals and composites
- electrical and electronic diagnostic maintenance and installations
- electrics
- engine, propulsion and mechanical installation and maintenance
- fit out or refit operations for joinery and upholstery
- preparation, painting and finishing

- rigging
- sail making/ repair
- shower and laundry services
- storage ashore

(AC 1.5)

Methods for moving boats:

- afloat by:
  - engine power
  - rafting
  - rowing
  - sailing
  - towing
- ashore by:
  - coupled boat movers cradle
  - dry stack
  - forklift truck
  - mobile crane
  - mobile self-propelled boat movers
  - mobile self-propelled hoists
  - railed slipway
  - road transportation/ haulage
  - rollers
  - slippery ways
  - static crane
  - telehandler
  - tractor and cradle on wheels

(AC 1.6)

Personnel responsible for providing services:

- boat mover:
  - boat moving operations on water and ashore
  - forklift and tractor operations
  - lifting operations
  - pressure washing and blocking off
- boat valets
- chandler:
  - supply of yacht fittings and fastenings, including: glues, ropes, charts, books, paint, chain, shackles, anchors, yacht clothing, boots and navigation equipment
- composite technician:
  - FRP hull and deck mouldings
  - gel and FRP repairs
  - materials selection
  - post curing
  - vacuum bagging techniques
- finishers
  - burnishing operations
  - gel coat repair

    - lacquering
    - polishing operations
- interior and exterior boat cleaning
- laminators:
    - FRP hull and deck mouldings
    - gel and FRP repairs
- marine electricians and electronic engineers:
    - diagnostics and repair
    - electronic and electrical installations
- marine engineers and fitters:
    - engine and generator installations
    - fabricating and welding
    - fitters
    - hydraulics
    - machining
    - maintenance
    - mechanical system fitting and maintenance
    - propulsion systems
    - stern gear
    - winches
    - winterising and commissioning
- marina manager:
    - manages the marina, operations and dock masters
- marine plumbers and gas installers:
    - installation and maintenance of wash basins
    - showers, toilet and waste water systems and liquid petroleum gas (LPG) installations
- marine surveyor:
    - can be for sale or insurance purposes
    - inspects and examines boats and equipment on board to report on condition
- naval architect:
    - plans and designs all aspects of the boat
- painters and surface finishers:
    - antifouling
    - boat spraying
    - filling and fairing
    - interior and exterior varnishing
    - painting and finishing operations
    - preparation for boat painting
- project manager:
    - leads and manages a project from start to finish
    - liaises with owner
    - manages staff and subcontractors
    - oversees the build or refit of a vessel
- refrigeration engineer:
    - install and maintain AC and refrigeration units
- riggers:
    - dress and undress masts
    - install stays
    - lifeline/safety lines
    - manufacture and repair rigging

    - rope work
    - set/tune rig
    - splicing
    - step and unstep masts
- sail-makers:
    - make, repair and launder sails
- shipwrights, boat-builders, joiners and sawyers:
    - boat-building boat repair, joinery and refit operations
- upholsterers:
    - cabin décor
    - external covers and awnings
    - furnishings activities
- welders:
    - metal fabrication activities and welding
- yacht broker:
    - finds potential buyers
    - manages the sale
    - sells new and second-hand boats on behalf of the owner

(AC 1.7)

Ancillary marine services:

- boat haulage
- charities
- crew
- financial services
- harbour master
- insurance provision
- leisure operators
- material and product supply chain
- skippers
- water taxi

Learning outcome

The learner will:

2. Understand the terminology used to recognise boats and equipment

Assessment criteria

The learner can:

2.1 use basic terms to describe types of leisure and commercial craft
2.2 describe the terms used to identify boat locations and dimensions
2.3 identify common marine components and fittings
2.4 identify marine systems terminology

Range

(AC 2.1)

Terms:

- commercial craft:
  - dredgers
  - ferries
  - fishing vessels
  - lifeboats
  - lighters
  - military vessels
  - offshore support
  - passenger boats
  - pilot boats
  - regulatory vessels (police, border force, etc)
  - tankers
  - tugs and workboats
- leisure craft:
  - dinghies
  - motor cruisers
  - personal watercraft (PWC)
  - rigid inflatable boats (RIBS)
  - river and canal boats
  - super yachts
  - yachts

(AC 2.2)

Locations:

- accommodation areas on boats:
  - cabins
  - galley
  - heads
  - saloon
  - shower
- aft
- aloft
- below
- bilge
- bow
- chain locker
- coach roof
- cockpit
- engine room
- forepeak
- forward
- lazerette
- on deck
- port

- quarter
- starboard
- steering (helm) position
- stern
- tank space
- thwartships
- tiller flat
- transom
- upper steering position
- wheel house

Dimensions:

- beam
- draught (air and water)
- freeboard
- length overall (loa)
- length waterline (lwl)

(AC 2.3) **Marine components and fittings:**

- anchor
- anodes
- bollards
- brackets
- cleats
- davits
- fairleads
- furlers
- masts/spars, spreaders and booms
- navigation equipment
- P brackets
- propeller
- rope cutters
- rudder
- running rigging:
  - halyards
  - running backstays
  - sheets
- safety equipment:
  - guardwires
  - handrails
  - life belts
  - lifelines
  - life rafts
  - pulpit
  - pushpit
  - stanchions
- sails

- shaft
- shaft log
- skin fittings
- standing rigging:
  - shrouds
  - stays
- stern gear
- stern tube
- tiller
- tracks
- types of blocks
- through hull penetrations
- trim tabs
- wheel
- winch
- windlass

(AC 2.4)

Marine systems terminology:

- air conditioning
- black waste systems
- bow thrusters
- couplings and drives:
  - jet drive
  - outboard
  - outdrive
  - sail drive
  - V
  - Z
- fresh water systems
- grey waste systems
- heating
- instrument systems
- main engines
- navigation systems
- power supplies:
  - batteries
  - generators powered by engines
  - shore power hook up
  - solar panels
  - wind or water flow
- propulsion systems
- refrigeration
- reverse osmosis water makers (ROWM)
- steering systems:
  - hydraulic
  - electro-hydraulic
  - mechanical

- stern thrusters

Learning outcome

The learner will:

3. Understand the health, safety and environmental rules and regulations applicable to the marine industry.

Assessment criteria

The learner can:

3.1 identify the health, safety and environmental regulations in the marine industry
3.2 identify the range of personal protective equipment (PPE)
3.3 identify when PPE is used in the marine industry
3.4 identify safety signs in use within the marine industry
3.5 describe the role of qualified first aiders and the re-qualification period
3.6 explain evacuation procedures in the event of an emergency
3.7 identify common causes of fire
3.8 describe preventative measures to reduce risk of fire
3.9 identify types of fire extinguishers
3.10 explain the purpose of a risk assessment
3.11 identify potential hazards in the work environment
3.12 identify good housekeeping procedures

Range

(AC 3.1)

Health, safety, and environmental regulations:

- Biocidal Products and Chemicals (appointment of Authorities and Enforcement Regulations 2013)
- Carriage of Dangerous Goods and the Use of Transportable Pressure Equipment Regulations 2009
- Confined Spaces Regulations 1997 and the Approved Code of Practice (ACOP)
- Control of Major Accident Hazards Regulations 2015 (COMAH)
- Control of Substances Hazardous to Health Regulations 2002 (COSHH)
- CRC Energy Efficiency Scheme Order 2013
- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)
- Electricity at Work Regulations 1989
- Environmental Permitting (England and Wales) Regulations 2016
- Environmental Protection Act 1990
- Health, safety and environmental regulations:
  - Health and Safety at Work Act 1974 (HASAWA)
  - Lifting Operations Lifting Equipment Regulations 1998 (LOLER)

- Manual Handling Operations Regulations (MHOR) 1992
- Personal Protective Equipment (PPE) at Work Regulations
- Portable Appliance Testing Regulations (PAT)
- Provision and Use of Work Equipment Regulations 1998 (PUWER)
- REACH (the Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (EC)
- Recreational Craft Regulations 2004
- Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR) 2013
- Supply of Machinery (safety) Regulations 2008
- The Hazardous Waste (England and Wales) (Amendment) Regulations 2016
- The Hazardous Waste (Miscellaneous Amendments) Regulations 2015
- Waste Batteries and Accumulators Regulations 2009
- Waste Electronic, Electrical Equipment Regulations (WEEE) 2013
- Waste (England and Wales) Regulations 2011
- Work at Height Regulations (WAHR) 2005

(AC 3.2)

Personal Protective Equipment:

- boots
- buoyancy aids
- burning goggles
- ear plugs, attenuators and defenders
- gloves/gauntlets
- goggles/glasses/visors
- hard hats
- lifejacket
- overalls
- respiratory protection equipment (RPE):
  - masks
  - air fed hoods
- safety harness
- welding helmet/mask/air-fed
- wet weather gear

(AC 3.3)

When PPE is used in the marine industry:

- confined spaces
- explosive atmospheres, e.g. spraybooth
- fumes
- hot works
- lifting operations
- manual handling
- operating plant and machinery
- working at height
- working in noisy environments
- working on batteries
- working on board
- working on water

- working with electricity
- working with hazardous substances:
  - chemicals
  - paints
  - particulates

(AC 3.4)

Safety signs:

- COSHH signs
- general safety signs
- mandatory signs
- prohibition signs
- warning or cautionary signs

(AC 3.6)

Evacuation procedures:

- assembly points
- escape routes
- fire alarm
- fire drills

(AC 3.7)

Common causes of fire:

- electrical faults
- exotherming chemicals
- fuels
- hot works without a permit
- oils
- poor housekeeping (build-up of waste)
- solvents and paints

(AC 3.9)

Types of fire extinguisher:

- CO2 gas
- dry powder
- fire blankets
- fire suppression system
- foam
- water

(AC 3.11)

Potential hazards:

- air pressure systems
- chemicals
- confined spaces
- dust and fumes

- faulty, blunt or incorrectly set up of tools and equipment
- faulty electrical connections or damaged cables
- faulty material handling or transportation
- faulty or missing machine guards or interlocks
- moving loads
- moving machinery
- naked flames
- noise
- risk of explosion
- sharps
- slips, trips and falls
- spillages and slippery surfaces
- suspended loads
- untidy work habits
- vibration
- weather conditions
- working at heights
- working on water

(AC 3.12)

Good housekeeping procedures:

- 5S/6S technique of good housekeeping:
  - safety
  - set
  - shine
  - sort
  - standardize
  - sustain
- appropriate lighting and ventilation
- correct storage of tools, equipment and materials
- following instructions
- maintaining access and egress to:
  - emergency exits
  - fire doors
  - vessels
  - walkways
  - workstations
- safe removal of waste and methods of waste disposal:
  - burning
  - chemical breakdown
  - landfill
  - recycling
- the acceptable codes of behaviour and dress
- walking not running

Learning outcome

The learner will:

4. Understand employment roles and responsibilities

Assessment criteria

The learner can:

4.1 list the main aspects of a contract of employment
4.2 identify relevant legislation about conditions of employment
4.3 state sources of information on employment rights and responsibilities

Range

(AC 4.1)

Aspects of a contract of employment:

- disciplinary and grievance procedure
- Employment Rights Act
- holiday entitlement
- hours of work
- job description
- organisational structure
- policies and procedures
- rates of pay
- role and responsibilities
- terms of notice

(AC 4.2)

Relevant legislation:

- Employment Rights Act 1996
- Equality Act 2010
- Working Time Regulations

(AC 4.3)

Sources of information:

- ACAS
- Citizens Advice Bureau
- company policies and procedures
- employer/contract of employment
- gov.uk websites
- trade unions

Learning outcome

The learner will:

5. Know how to contribute to self-development and create and maintain effective working relationships

Assessment criteria

The learner can:

5.1 identify the methods of communication used to manage information within the organisation
5.2 explain how to maintain effective working relationships
5.3 explain the difficulties that can occur in working relationships
5.4 identify the relevant persons to contact when information is not clear or sufficient
5.5 state the importance of asking for help when required
5.6 identify appropriate listening, questioning, recording and presentation techniques

Range

(AC 5.1)

Methods of communication:

- diagrams
- drawings and sketches
- emails
- intranet
- job sheets
- manufacturers' instructions or guidance literature
- memos
- method statements
- mobile technology
- noticeboards
- pictures
- risk assessments
- safety datasheets
- short wave radios
- technical datasheets
- training
- videos
- written and verbal work instructions

(AC 5.2)

Effective working relationships:

- adhering to current regulations and legislation
- avoiding abusive or offensive behaviour

- being reliable and trustworthy
- good time keeping
- maintaining a positive attitude
- making sure that they understand what has been said by asking questions when unsure
- obeying company rules and regulations
- paying attention to work instructions
- personal hygiene
- the importance of listening skills
- treating people (workmates and customers) with courtesy and respect
- willing co-operation with all levels of organisation
- working safely

(AC 5.3)
Difficulties:

- direct and indirect discrimination
- disrespectful behavior
- harassment
- poor time keeping
- victimisation

(AC 5.4)
Relevant persons:

- charge hands
- experienced and reliable colleagues
- foreman
- managers
- mentors
- team leaders
- the company hierarchy

Learning outcome

The learner will:

6. Know how to contribute to the effectiveness of boat production and support services

Assessment criteria

The learner can:

6.1 identify the principles of costing, budgeting, pricing and hours
6.2 state the types of information to be used and recorded during a job
6.3 state sources of information for boat production and support services
6.4 state the importance of accuracy when completing records

6.5 state the importance of maintaining records for disposal of waste in an environmentally responsible way

Range

(AC 6.2)

Types of information:

- batch numbers
- calibration certificates
- description of the work
- location of work
- material certification or identification
- materials and quantities
- measurements:
  - humidity
  - ratio
  - size
  - temperature
  - timings
  - volume
  - weight
- permit to work (e.g. hot works)
- requisition sheets
- safety requirements
- special requirements (tools)
- sub-contracted work detail
- temperature and humidity
- test and quality information
- time sheets giving the labour hours

(AC 6.3)

Sources of information:

- external:
  - compliance organisations and regulations
  - designers' drawings and specifications
  - H&S regulations and information
  - manufacturer's specifications
  - Recreational Craft Directive (RCD)
  - regulation agencies
  - safety data sheets
  - technical data and information
- internal:
  - application records
  - boat files/manuals
  - calibration records
  - drawings and specifications
  - methods statements

- new build specifications
- past records
- requisition sheets
- risk assessments
- scantlings lists
- service records
- test records
- time sheets
- tool records

(AC 6.4)

Importance of accuracy:

- enable a true account of costs and time to be established
- prevent incorrect information being recorded
- prevent re-work and warranty claims
- provide a log of what was done when and by whom
- provide information for future planning, efficiency and potential customers

(AC 6.5)

Importance of maintaining records:

- company policy
- continuous improvement
- legal requirement
- safety
- social responsibility
- stock control
- warranty

Unit 203 Business Improvement Techniques

Level:	2
GLH:	50
Aim:	This mandatory unit aims to provide the learner with knowledge of lean business process and quality improvement in order to effectively monitor and make enhancements to production, manufacturing and maintenance processes.
Assessment type	Centre-devised short answer question test.

Learning outcome:

The learner will:

1. Know what is meant by continuous improvement

Assessment criteria

The learner can:

1.1 explain the meaning of continuous improvement
1.2 outline the benefits of applying continuous improvement techniques
1.3 define each stage of the Plan – Do – Check – Act (PDCA) improvement cycle
1.4 define the different categories of waste

Range

(AC 1.2)

Benefits:

- reduced cost (e.g. production)
- improved quality (e.g. reduced defects)
- improved safety (e.g. safe to use)
- improved working practices (e.g. reduced operator motion)
- improved delivery (e.g. reduced transportation time, reduced lead time)
- reduction of waste (e.g. over processing, excess inventory)
- resource utilisation (e.g. reduced waiting time)
- improved customer satisfaction (e.g. meeting customer requirements)

(AC 1.4)

Categories of waste:

- transport
- inventory
- motion

- waiting
- over-production
- over-processing
- defects
- skills/unrecognised people potential

Learning outcome:

The learner will:

2. Understand what is meant by workplace organisation

Assessment criteria

The learner can:

2.1 explain the meaning of workplace organisation
2.2 outline the benefits of having an organised working environment
2.3 describe the effect an unorganised work environment may have
2.4 explain the importance of Standard Operating Procedures (SOPs) within workplace organisation

---

Range

(AC2.3)

Effects:

- poor quality
- increased costs
- reduced efficiency
- poor delivery times
- poor morale/teamwork
- poor health and safety

Learning outcome:

The learner will:

3. Know what is meant by visual management

Assessment criteria

The learner can:

3.1 explain the meaning of visual management
3.2 describe the benefits of applying good visual management
3.3 describe different types of visual management

Range

(AC 3.2)

Good visual management:

- accurate and relevant
- eye-catching
- simple
- greater ownership

(AC 3.3)

Types of Visual management:

- shadow boards
- PDCA worksheets
- colour coding
- floor footprints
- storyboards
- gauges
- photographs/pictures
- labelling
- lights
- schedule boards
- Kanban (pull systems)
- graphs
- management boards
- other area specific types of visual management

Learning outcome:

The learner will:

4. Understand problem-solving techniques

Assessment criteria

The learner can:

4.1 explain what is meant by a problem within a work environment
4.2 describe the benefits of solving work related problems
4.3 outline different techniques used for identifying and analysing problems
4.4 explain the importance of applying the appropriate corrective action and eliminating the root cause of a problem

Range

(AC 4.3)

Techniques:

- tally charts
- flowcharts
- histogram/Pareto chart
- benchmarking
- process mapping
- correlation diagram
- run diagram
- Statistical Process Control
- control charts
- Gantt charts
- root cause paths
- value stream maps
- Ishikawa diagrams (cause and effect, fishbone)
- brainstorming
- mind mapping
- 5 Why analysis

Unit 211 Principles of Marine Electrical Systems

Level:	2
GLH:	150
Aim:	This mandatory unit covers the underlying principles that govern the electrical supply systems used on leisure and commercial small craft.
Assessment type	Centre-devised practical assignment and short-answer questions

Learning outcome:

The learner will:

1. Understand the functions of electrical distribution systems

Assessment criteria

The learner can:

1.1 identify the components used in electrical systems on board leisure/small commercial craft
1.2 describe the operation of shore power systems
1.3 describe the installation and operation of inverters and chargers
1.4 identify the components of propulsion engine driven generating systems
1.5 describe the safety considerations and operation of wind driven generating systems
1.6 describe the safety considerations and operation of solar generating systems
1.7 describe the safety considerations and operation of hydrogen cell generating systems
1.8 describe the safety considerations and operation of an engine driven generator
1.9 calculate power requirements for generating systems

Range

(AC 1.1)

Components:

- AC equipment (e.g. calorifiers, battery charger, outlets, air conditioning, etc.)
- circuit breakers (MCB)
- distribution units
- DC equipment (e.g. bow thruster, winches, luminaires etc)
- deck plugs and sockets
- ground fault circuit interrupters (GFCI)
- residual current devices (RCD)
- residual current breaker overload (RCBO)

- shore power cables
- switched mode power supplies
- transformers

(AC 1.2)

Shore power systems:

- 110V
- 230V
- 400V
- Single phase
- Three phase

(AC 1.3)

Inverters and chargers:

- charger-inverters
- chargers
- inverters
- kilowatt amps rating (KWA)
- manual neutral grounding or automatic neutral grounding
- modified sinewave
- pure sinewave
- three stage charging (bulk absorption float)
- uninterrupted power supply (UPS)

(AC 1.4)

Components of propulsion engine driven generating systems:

- changeover switches
- charge splitting diodes
- engine driven alternators
- isolators
- split charge relays
- supplementary high charge regulators

(AC 1.5)

Safe operation of wind driven generating systems:

- avoiding noise and vibration
- placing wind generators for safety
- power calculations
- regulating wind generators
- sizing wind generators for battery charging

(AC 1.6)

Safe operation of solar generating systems:

- avoiding shadows and excessive wear
- fixed solar generator systems
- optimum positioning for maximum power

- portable solar generators
- power calculations
- regulating solar panels
- sizing solar panel installations for battery charging

(AC 1.8)

Operation of separate engine driven generator:

- automatic operation systems
- battery demand operated plant
- constant running plant
- cooling
- frequency
- location of generator systems
- power calculations
- sound and vibration proofing
- special exhaust requirements
- voltage

(AC 1.9)

Generating systems:

- engine-driven
- hydrogen
- solar
- wind

Learning outcome:

The learner will:

2. Understand and install electrical supply systems (12/24v dc, 110/230/400v ac), circuit protection and grounding/earthing arrangements

Assessment criteria

The learner can:

2.1 describe the marine electrical supply systems as fitted on board leisure/small commercial craft

2.2 describe the relationships between battery capacity, current demand, and recharge arrangements for on board systems

2.3 identify the advantages and limitations of shore supplies

2.4 identify the safety implications of 110/230/400v ac systems at 50/60Hz frequencies on leisure/small commercial craft

2.5 identify the requirements for galvanic isolation on marine vessels

2.6 carry out calculations in accordance with regulatory requirements to select the correct cable sizes, determine load currents, volt drop and specify protective devices

2.7 select and use correct crimps and tools for termination of wiring loom

2.8 create wiring loom determining switching and protection requirements for circuits with all fixings and breakouts
2.9 install wiring into wiring support system including all terminations and coverings to suit environment
2.10 use correct overcurrent protection for dc supplies as required
2.11 identify requirements for circuits and sockets exposed on deck
2.12 identify the requirements for earthing and ground fault protection devices in 110/230/400v ac systems

---

Range

(AC 2.1)

Marine electrical systems:

- 12v, 24v, 110v, 230v, 400v
- ac/dc systems
- current capacity
- distribution
- overcurrent protection
- personal protection
- voltage requirements

(AC 2.4)

Safety implications:

- overcurrent protection
- personal protection
- safe isolation procedures
- safety from electric shock

(AC 2.5)

Requirements:

- anode selection
- bonding systems
- cathodic protection
- galvanic isolators
- isolation transformers

(AC 2.6)

Calculations:

- crimp sizing
- cross sectional area (CSA mm^2)
- current draw
- over current protection
- volt drop
- wire size - American wire gauge (AWG)
- wire strand diameter (WSD)

Regulatory requirements:

- British Marine Electrical and Electronics Association (BMEEA)
- International Standard Organisation (ISO)
- Recreational Craft Regulations (RCR)

(AC 2.11)

On deck:

- ingress protection (IP) rating requirements
- tri rated cable

(AC 2.12)

Earthing and ground fault protection devices:

- ground fault circuit interrupter (GFCI)
- residual current breaker overload (RCBO)
- residual current device (RCD)

Learning outcome:

The learner will:

3. Understand the types and uses of batteries, and methods of storing electricity on board, and carry out routine battery maintenance

Assessment criteria

The learner can:

3.1 describe the types and uses of batteries on board leisure/small commercial craft
3.2 describe how batteries should be stored on board leisure/small commercial craft
3.3 identify typical relationships between battery load, capacity and recharging requirements
3.4 calculate amp hour (Ah) requirements using Peukert's capacity and maximum discharge
3.5 identify appropriate battery sizes and arrangements for typical applications
3.6 explain the importance of separating batteries of different construction
3.7 explain the importance of insulating battery terminals
3.8 carry out the procedures for checking the condition of a battery
3.9 outline the procedures to maintain a battery in good condition
3.10 describe the safety precautions required in relation to battery charging and battery spaces
3.11 describe the effects of plate sulphation and how it can be minimised

---

Range

(AC 3.1)

Types and applications of battery:

- applications:

- cold cranking amps (CCA)
- cranking/engine starting
- emergency requirements
- leisure batteries/deep cycle
- on-board electric/electronic systems
- powering portable equipment

- types:
  - absorbed glass mat (AGM)
  - gel cell
  - lead-acid
  - li-ion

(AC 3.2)

Battery storage requirements:

- stable and secure installation
- watertight integrity
- well vented

(AC 3.3)

Recharging requirements:

- photovoltaic cell
- wind turbine
- alternator
  AC battery charger

(AC 3.5)

Calculations/requirements:

- cold cranking amps (CCA)
- cranking/engine starting
- emergency requirements
- leisure batteries/deep cycle
- on-board electrical and electronic systems loading
- powering portable equipment

(AC 3.8)

Procedures for checking the condition of a battery:

- battery test equipment
- hydrometer
- multimeter
- specific gravity test

(AC 3.9)

Procedures to maintain a battery in good condition:

- battery isolation when not in use
- cleaning and maintenance
- do not leave battery discharged

- maintaining internal battery levels
- keeping battery charged
- regular three-stage charging (bulk absorption float)
- regular use
- temperature management (e.g. install heater)
- terminal connection integrity

(AC 3.10)
Safety precautions:
- hydrogen generation
- safe isolation
- terminal insulation
- venting

Learning outcome:

The learner will:

4. Understand the requirements for installing instrumentation

Assessment criteria

The learner can:

4.1 identify the supply, installation, and interconnection requirements for on board instrumentation
4.2 identify the requirements for installing transducers
4.3 identify interface standards
4.4 explain the importance of routing ac/dc/data cabling separately
4.5 explain the importance of shielding data cables

Range

(AC 4.1)
Requirements:
- current requirements
- ethernet requirements
- NMEA 0183/2000/OneNet
- positioning weight/load requirements
- power supply
- safe isolation
- safe separation
- volt drop

(AC 4.3)
Interface standards:

- ethernet
- NMEA 0183
- NMEA 0183HS
- NMEA 2000
- NMEA OneNet

Unit 212 Marine Engineering and Electrical Processes and Principles

Level:	2
GLH:	100
Aim:	This mandatory unit covers the selection and use of materials, tools and equipment and their application in marine engineering operations.
Assessment type	Multiple-choice test.

Learning outcome:

The learner will:

1. Know how to identify marine engineering/electrical materials, their reaction to the environment and their properties

Assessment criteria

The learner can:

1.1 identify the common materials used in marine electrical engineering
1.2 list the properties that identify materials
1.3 identify the properties of materials
1.4 identify storage and disposal requirements of materials
1.5 describe the difference between oxidation, electrolytic and galvanic corrosion, cavitation and hydrolysis
1.6 identify types of bonding, fixing techniques and positioning used in marine electrical applications
1.7 identify types of protective coatings used in marine applications
1.8 state the factors influencing the choice of materials in marine electrical engineering applications

Range

(AC 1.1)

Materials:

Composites

Glass Reinforced Plastics, Fibre Reinforced Plastics, Carbon Fibre, Kevlar, Aramid

- metals
  - ferrous – iron
  - non-ferrous - aluminium, copper, lead, titanium, tungsten, gold, silver
  - alloys - brass, bronzes
- timbers

(AC 1.2)

Properties that identify materials:

- colour
- density
- magnetism
- texture

(AC 1.3)

Properties of materials:

- chemical resistance
- conductivity
- corrosion resistance
- ductility/malleability
- electrically active or passive
- environmental impact
- galvanic compatibility
- hardness
- insulation properties
- nobility,
- temperature tolerance
- tensile strength
- toughness/brittleness
- UV resistance
- soldering materials
    - corrosive properties
    - ease of use
    - fumes
    - melting point
    - toxicity

(AC 1.4)

Storage and disposal requirements of materials:

Storage:

- ancillary equipment - dry, ambient temperature, environment, security, weight, height
- cables – on racks, dry, ambient temperature, environment, security, weight,
- batteries – position, environment, security, weight, height, ventilation, insulation, charging, maintenance testing

Disposal:

- Hazardous waste
- non-hazardous waste
- recyclable
- Waste Electrical and Electronic Equipment (WEEE)

(AC 1.6)

Bonding, fixing techniques and positioning:

- AC/DC and data safe distance and compatibility
- antenna safe distance
- bolts
- circlips
- contact adhesive
- crimping
- electromagnetic interference (EMI)
- epoxy resins/adhesives
- fast mounts
- galvanic compatibility
- hot glue
- mastics
- nuts
- R clips
- rivets
- rivnuts
- screws
- split pins
- studs
- washers

(AC 1.7)

Protective coatings:

- corrosion inhibiters
- galvanic inhibitors
- insulation
- lagging
- metallic coatings (anodising, galvanising, sherardising)
- plastic sheathing – polystyrene, PVC

(AC 1.8)

Factors:

- availability
- conductivity
- corrosion resistance
- cost
- customer requirements
- ductility
- durability
- environmental impact
- galvanically compatible
- heat resistance
- ingress protection (IP) rating
    - water resistance
    - dust resistance

- impact resistance
- location
- lubrication
- performance requirements
- stability/longevity
- strength
- weight

Learning outcome:

The learner will:

2. Know how to interpret and use marine electrical specifications and installation requirements

Assessment criteria

The learner can:

2.1 identify drawing conventions to ISO8888 or BS8888 for lines, dimensions and setting out
2.2 identify types of drawings used in marine installations
2.3 identify marine electrical drawing conventions
2.4 identify common scales used for drawing
2.5 list the sources of marine electrical installation information

---

Range

(AC 2.1)

Lines, dimensions and setting out:

- aft perpendicular (AP)
- centre lines
- datum lines
- dimension lines
- forward perpendicular (FP)
- hidden detail
- scale
- station lines
- tolerance
- water line

(AC 2.2)

Types of drawings:

- block diagrams
- circuit diagrams
- construction plans

- detailed drawings
- exploded and sectional views
- first and third angle orthographic projections
- general arrangements
- general layout and assembly drawings
- layout diagrams
- lines plans and table of offsets
- oblique and isometric projections
- schematic diagrams
- wiring diagrams

(AC 2.3)

Electrical drawing conventions:

- ISO 8888
- components
- Institute for Electrical Engineers (IEE)
- Standard Index (SI)
- symbols
- terminations
- US/UK standards for conductors

(AC 2.5)

Sources:

- charts
- data sheets
- electronic sources
- graphs
- instruction manuals
- regulatory bodies
  - American Boat and Yachting Council (ABYC)
  - BMEEA code of practice
  - International Standards Organisation (ISO)
  - Lloyds
  - Maritime and Coastguard Agency
  - National Marine Electronics Association (NMEA)
  - Recreational Craft Regulations (RCR)
- tables
- technical books

Learning outcome:

The learner will:

3. Know how to use tools and equipment safely in a marine electrical environment

Assessment criteria

The learner can:

3.1 identify typical tools, fastening techniques and equipment used in marine electrical installations
3.2 identify the equipment for lifting loads
3.3 state the general rules for the maintenance of tools and equipment
3.4 describe the safety requirements for using power tools and machines

Range

(AC 3.1)

Hand tools, machine tools and equipment:

- air lines
- assembly and joining/fastening tools/techniques and equipment:
  - crimpers
  - fume extractor (local exhaust ventilation LEV)
  - heat gun
  - hexagon keys
  - impact wrench
  - pliers
  - screw drivers
  - security keys
  - socket sets
  - soft soldering iron
  - spanners
  - torque wrench/screwdriver
- cutting tools:
  - drills
  - pipe cutter
  - saws (cross-cut, panel, hacksaw, diamond tungsten tipped, oscillating, hole saw, horizontal band saw, band saw, circular saw, jig saw, air powered saws, retractable knives)
- electrical leads (test and extension)
- hammers:
  - ball pein
  - claw
  - cross pein
  - soft blow
- lead lights
- material removal tools:
  - abrasive wheel
  - de-burrers
  - emery cloth
  - files
  - flush cutters
  - grinder
  - rasps
  - reamer
  - sander
  - scrapers

    - side cutters
    - wire strippers
- measuring and marking out tools:
    - battery tester
    - calipers
    - capacitance tester
    - centre punch
    - clamp tester
    - dial test indicator (clock gauge)
    - hydrometer
    - laser measures and levels
    - levels (spirit/water)
    - insulation resistance tester
    - low ohm meter
    - micrometer (internal/external)
    - multimeter
    - polarity tester
    - portable appliance tester (PAT)
    - residual current device (RCD) tester
    - rules
    - scribes
    - signal wave ratio (SWR) tester
    - socket tester
    - squares
    - tapes
    - temperature sensing
    - templates
    - vernier
    - VHF beacon
- special tools:
    - cambus interfaces
    - engine manufacturers specialised tools (diagnostic)
    - jigs and templates
    - laptop
- work-holding devices:
    - adhesive tapes
    - grips
    - vices

(AC 3.1)

Fastening techniques:

- bolting
- cable ties
- crimping
- din rail terminals
- friction retention
- glue
- heat-shrink
- insulating tape
- insulation disrupting connector (IDC)

- multi-pin plug
- plugs
- riveting
- screw terminals
- screwing
- sockets
- soft soldering
- terminal strip

(AC 3.2)

Equipment for lifting:

- equipment:
  - boat mover
  - boat trailer
  - crane (static, telescopic)
  - engine hoist
  - forklift
  - negative lift forklift
  - overhead gantry
  - travel hoist

- lifting accessories:
  - blocks
  - bosuns chair
  - carabiners
  - chains
  - clutches and brakes
  - descenders
  - halyards
  - harness
  - hooks
  - lines
  - shackles
  - slings
  - strops
  - winches

(AC 3.3)

General rules:

- booking in/booking out
- calibration
- cleaning after use
- cleaning as you go
- inspection and testing
- inspection dates
- pre- and post-use checks

- reporting procedures
- routine maintenance
- safe storage
- safe working loads (SWL)
- shadow boards
- sharpening
- tag check
- thorough examinations

(AC 3.4)

Safety requirements:

- adherence to required legislation and regulation
- emergency stops on machines
- ensure use and correct settings for guides and guards
- equipment/machinery guards
- exposure action and limit values (EAV/ELV) for vibrating tools
- health surveillance (HAVS)
- local exhaust ventilation (LEVs)
- safe isolation procedure (lock out/tag out)
- portable appliance testing (PAT)
- PUWER in relation to pneumatic/electrical power tools
- use of correct PPE and RPE when using machinery/tools
- use of low voltage systems
- working at height procedures
- working on or near water procedures
- training

Learning outcome:

The learner will:

4. Understand marine electrical processes

Assessment criteria

The learner can:

4.1 state the units and derived units used to perform simple calculations
4.2 convert between units and derived units
4.3 identify the factors to be considered when measuring and marking out
4.4 list the factors affecting accuracy of measurement
4.5 describe the types of connection, joining and termination
4.6 describe the types of assembly and finishing
4.7 identify the sequence of operations which maximise efficiency when carrying out marine electrical activities
4.8 identify the electrical safety requirements in a marine environment

Range

(AC 4.1 & 4.2)

Units and derived units:

- area
- ampere-hours (Ah)
- capacitance (farads)
- current (amps)
- density
- energy (joules, coulomb)
- force
- frequency (Hz)
- imperial and metric
- inductance (henrys)
- kilovolt amps (kVa)
- kilowatt hours (kWh)
- length
- mass
- power (watts)
- pressure
- relative density
- resistance (ohms)
- temperature
- voltage (EMF)
- volume
- weight

(AC 4.3)

Factors:

- angle
- capacity
- datum
- flatness
- length
- levelling, declivity, and inclination
- parallelism
- profile
- relative position
- tolerance
- type of measuring equipment used
- units of measurement

(AC 4.4)

Factors affecting accuracy of measurement:

- calibration
- condition of equipment

- condition of mounting surface
- correct positioning
- dimensions
- humidity
- lighting
- temperature
- tolerances

(AC 4.5)

The types of connection, joining and termination:

- bolting
- cable ties
- crimping
- din rail terminals
- friction retention
- glue
- heat-shrink
- insulating tape
- insulation disrupting connector (IDC)
- multi-pin plug
- plugs
- riveting
- screw terminals
- screwing
- sockets
- soft soldering
- terminal strip

(AC 4.6)

Types of assembly and finishing:

- assembly
  - battery boxes
  - cable basket
  - conduit (rigid/flexible)
  - distribution units
  - general fixtures and fittings
  - glands/grommet
  - junction boxes (Ingress Protection rating)
  - separation/safe distance requirements (equipment, antenna, cabling)
  - tray
  - trunking

- finishing
  - appearance
  - cable protection/support (e.g. heatshrink, spiral wrap)
  - customer requirements
  - durability
  - functionality

- quality standards
- safety
- vessel use/end use requirement

(AC 4.7)

Sequence of operations:

- plan and set up marine electrical and electronic work operations following approved work methods and standard operating procedures.
- plan, organise and monitor wiring support systems (conduit, trays, trunking, bulkhead penetration and glands).
- install cable runs in boats correctly in accordance with relevant specifications and industry standards.
- install electrical and electronic systems on boats correctly in accordance with required specification, industry standards and to the customer's satisfaction.
- install Programmable Logic Controller (PLC) systems and networking and other relevant systems in accordance with required specification and industry standards.
- support the commission of electrical and electronic systems, tests and sea trials.
- maintain, fault find, and diagnose issues with electrical and electronic systems and equipment on boats.
- modify, add, and upgrade electrical and electronic circuits in boats.
- conduct routine marine electrical and electronic servicing.
- monitor marine batteries, charging and ancillary alternating current (ac) or direct current (dc) supply charging systems.
- seek opportunities to improve quality and efficiency of marine electrical and electronic work operations, where relevant.
- restore work area and return tools, and unused materials and equipment to a safe and reliable condition, to prescribed standards of cleanliness on completion of marine electrical and electronic work operations.
- complete documentation at the relevant stages of the marine electrical and electronic work operations in accordance with organisational policy, procedures and any other relevant information and guidance.

(AC 4.8)

Safety requirements:

- cabling safety
  - current rating
  - identification (colour/labelling)
  - insulation
  - protection
  - safe distance
  - shielding
  - shore power cable
  - support
  - termination
  - volt drop
- equipment safety
  - cleanliness (e.g. dust free)
  - circuit breaker/overcurrent protection (CB/fuse)
  - equipment location

  - mounting/insulation/isolation
  - reverse polarity (indication/protection)
  - test equipment (calibration and in date)
- personal safety
  - communication methods
  - earthing
  - ground fault circuit interrupter (GFCI)
  - isolation procedures (lock out/tag out)
  - PPE
  - residual current breaker overload (RCBO)
  - residual current device (RCD)
  - risk assessment
  - safe system of work
  - signage
- operational/vessel safety
  - awareness
  - commissioning and testing
  - cross-talk
  - dock side trials
  - documentation (e.g. manual, schematics)
  - earthing and bonding
  - fire suppression/protection
  - galvanic protection
  - sea trials (Intended Pleasure Vessel (IPV) code, Marine Guidance Note (MGN) 280)
  - shut down procedure
  - start up procedure
  - updates (e.g. charts, software)

Unit 213 Installing Electrical Wiring Support Systems

Level:	2
GLH:	100
Aim:	This mandatory unit covers preparing for and installing electrical wiring support systems. It includes identification of equipment, materials and components.
Assessment type	Centre-devised practical assignment and short-answer questions

Learning outcome:

The learner will:

1. Know how to prepare for the installation of electrical wiring support systems

Assessment criteria

The learner can:

1.1 describe drawings and technical information required for installation of wiring support systems
1.2 identify the information that should be contained in work plans
1.3 identify the existing services to be considered when installing wiring support systems
1.4 explain the importance of using appropriate techniques to pass cables through watertight bulkheads.

Range

(AC 1.1)

Drawings and technical information:

- installation drawings
- layout drawings to ISO standards
- symbology to BS 60617
- installation manuals
- manufacturer's literature
- relative code of practice

(AC 1.2)

Work plans:

- access
- estimate of time
- help required

- how
- materials and equipment required
- method statements
- order
- other trades
- risk assessments
- safety considerations
- technical information
- what you are going to do

(AC 1.3)

Existing services:

- Wiring
    - AC/DC conductors
    - communications cables
    - data cables

- Pipework and ducting
    - air conditioning
    - desalination
    - exhaust
    - fuel
    - gas
    - heating
    - hydraulics
    - navtex
    - ventilation
    - waste
    - water

(AC 1.4)

Bulkhead penetrations:

- cable separation (AC/DC)
- fire rated protection
- galvanic compatibility
- ingress protection (IP) rating
- minimum safe distance

Learning outcome:

The learner will:

2. Know how to identify equipment, materials and components for the installation of electrical wiring support systems

Assessment criteria

The learner can:

2.1 state the factors which affect the selection of appropriate conduit, ducting, trunking or traywork components for different marine applications and environments
2.2 state the components and connectors used in the installation of electrical wiring support systems
2.3 describe the equipment and tools used for installation operations
2.4 explain the importance and use of inspection fittings
2.5 state the ways in which wiring support systems are finished to prevent faults

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Range

(AC 2.1)

Factors:

- compliance with current regulations/legislations
- effects of ambient temperatures
- effect of proximity to existing systems
- size, weight and construction of materials
- specification/environment
- galvanic compatibility
- number, size and factor of cables
- trunking and conduit sizes and factors

(AC 2.2)

Components and connectors:

- bends
- fitting supports
- glued fittings
- inspection fittings
- power and control outlet boxes
- screwed fittings
- straight connectors
- tees

(AC 2.3)

Equipment and tools:

- battery and power tools
- files
- hammers
- hole punches and cutters
- hot air guns
- levels
- pipe bending equipment
- plumb bobs

- saws (hacksaw, junior hacksaw, mitre saw, hole saws)
- screwdrivers
- spanners
- stocks and dies
- vices

(AC 2.4)

Inspection fittings:

- bends
- boxes (round and square)
- elbows
- instrument panels and connectors
- junction boxes
- tees

Importance:

- ease of cable installation
- ease of cable removal
- ease of testing
- inspection
- removal of burrs and debris

(AC 2.5)

Faults:

- burrs
- containing internal foreign bodies
- contamination
- correct size for number and size of cables to be installed
- galvanic compatibility
- lack of corrosion inhibitor
- poor ingress protection
- proximity to heat source, fuel, and gas, exhaust
- sharp edges

Learning outcome:

The learner will:

3. Know how to install electrical wiring support systems

Assessment criteria

The learner can:

3.1 state the responsibilities under current electrical regulations

3.2 state the precautions to be taken when using cutting, bending and joining wiring support systems

3.3 explain wiring support selection, making allowances for safe positioning and installation
3.4 use methods of holding work pieces without damaging them
3.5 bend and fabricate electrical wiring support components to specification
3.6 use screw fittings, glued fittings, fabricated components, nuts and bolts as required to carry out installation of wiring support systems
3.7 list types of accessory fittings that are compatible with support systems
3.8 mark out and check alignment of components
3.9 use methods for securing system components to ensure correct position and spacing of supporting brackets and devices
3.10 use electrical bonding to ensure earth continuity of metallic support systems
3.11 carry out final checks to ensure that all finished components and installations are free from defects
3.12 explain the importance of following good working practices

Range

(AC 3.1)

Electrical regulations:

- Approved Codes of Practice (ACOPs)
- British Marine Electrical and Electronics Association (BMEEA)
- International Standards Organisation (ISO)
- National Marine Electronics Association NMEA
- Recreational Craft Regulations (RCR)

(AC 3.2)

Precautions:

- adequate space to carry out task
- COSHH requirements for adhesives
- personal protective equipment (PPE)
    - barrier creams
    - eye protection
    - gloves
    - overalls
    - safety shoes
- weight of equipment being installed

(AC 3.3)

Selection:

- flexible conduit
- PVC cable tray
- PVC conduit
- stainless steel cable tray
- steel conduit
- trunking
- wire basket

Safe positioning and installation:

- bending
- fabricating
- joining
- mounting
    - screwing
    - gluing
    - welding
    - bolting
    - clamping

(AC 3.5)

Bending methods:

- friction
- hot air guns
- jigs
- springs

(AC 3.7)

Accessory fittings:

- electrical/electronic hardware
- inspection fittings
- light fittings
- non-waterproof
- sockets
- specialist boxes for switchgear equipment
- switches
- terminals
- thermoplastic and metallic boxes with knockouts
- waterproof
- wire junctions

(AC 3.8)

Alignment of components:

- customer requirements
- levels
- plumb bobs
- positioning
- regulations
- visual check

(AC 3.9)

Methods of securing system components:

- adhesive
- cable ties
- drilling and using appropriate fixing devices
- joints
- screws

- use of saddles and supports

(AC 3.11)

Checks:

- checked against specification
- checked for level, plumb, squareness and aesthetics
- check system cleaned-through and construction markings removed
- position of bends or sets
- ripples/deformation around bends:
  - absence of burrs and sharp edges
  - angle of bends
  - foreign bodies
  - insufficient supports
  - loose connections
  - misalignment
  - overall dimensions
  - projections
  - swarf

Defects:

- basket
- burrs
- conduit
- correct tools are not available
- fittings do not fit together
- incorrect mounting and positioning
- incorrect sizing
- incorrect tools used
- loose fittings
- misalignment
- parts are damaged parts
- sharp edges
- shortages of fittings or fixings devices

(AC 3.12)

Good working practices:

- clean down work area
- compliance with specification
- dispose of waste appropriately
- ensure compliance with electrical regulations
- ensure compliance with safety regulations
- ensure neat and tidy appearance
- label and record finished work
- leave the work area free of unused consumables
- put tools and equipment into safe storage

Appendix 1 Relationships to other qualifications

Links to other qualifications

This qualification has connections to the:

- Level 2 Diploma in Marine Engineering (Foundation)
- Level 2 Diploma in Boatbuilding (Foundation)
- Level 3 Diploma in Marine Engineering (Advanced)
- Level 3 Diploma in Marine Electrical Engineering (Advanced)
- Level 3 Diploma in Marine Boatbuilding (Advanced)

Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on **www.cityandguilds.com**.

City & Guilds Centre Manual contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents such as:

- Regulatory Arrangements for the Qualifications and Credit Framework (2008)
- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre- and post-centre and qualification approval.

Access to Assessment & Qualifications provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **centre homepage** section of the City & Guilds website also contains useful information on such things as:

- **Walled Garden**: how to register and certificate candidates on line
- **Events**: dates and information on the latest Centre events
- **Online assessment**: how to register for e-assessments.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

Linking to this document from web pages

We regularly update the name of documents on our website, therefore in order to prevent broken links we recommend that you link to our web page that the document resides upon, rather than linking to the document itself.

Useful contacts

UK learners General qualification information	**E: learnersupport@cityandguilds.com**
International learners General qualification information	**E: intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	**E: centresupport@cityandguilds.com**
Single subject qualifications Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	**E: singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	**E: intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	**E: walledgarden@cityandguilds.com**
Employer Employer solutions including, Employer Recognition: Endorsement, Accreditation and Quality Mark, Consultancy, Mapping and Specialist Training Delivery	**E: business@cityandguilds.com**

If you have a complaint, or any suggestions for improvement about any of the services that we provide, email: **feedbackandcomplaints@cityandguilds.com**

About City & Guilds

As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

City & Guilds Group

Our vision is for a world in which everyone has the skills and opportunities to succeed. We support over 4 million people each year to develop skills that help them into a job, develop on that job and to prepare for their next job. As a charity, we're proud that everything we do is focused on achieving this purpose. Whether that's through delivering work-based learning programmes that build competency, providing flexible pathways that support lifelong employability or through the City & Guilds Foundation funding initiatives that help remove barriers to work and learning.

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