QUALIFICATION HANDBOOK

Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (2463-03)

August 2017 Version 4.2

City & Guilds

Qualification at a glance

Subject area	**Marine Construction, Systems Engineering and Maintenance**
City & Guilds number	2463
Age group approved	All
Assessment	Online test Centre devised assignments
Support materials	Centre handbook Assessment pack
Registration/ certification dates	Consult the Walled Garden/Online Catalogue for last dates

Title and level	GLH	TQT	City & Guilds number	Accreditation number
Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (Boatbuilding)	450	490	2463-03	600/2306/5
Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (Marine Engineering)	450	490	2463-03	600/2306/5
Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (Painting and Finishing)	450	490	2463-03	600/2306/5

Version and date	Change detail	Section
1.1 Oct 2011	Unit 311 title and QAN amended in ROC and unit	Structure, unit content
2.0 May 2012	Unit 312 UAN updated in ROC, changes to unit 312	Structure (page 5) Unit 312 (pages 67 - 68)
2.1 August 2016	Information on grading added	Assessment
3.0 November 2016	Age restrictions amended	Age restrictions
4.0 March 2017	The sub section 'centre set assignment' of the Assessment section was amended	Assessment
4.1 August 2017	'Centre set and marked assessments' - Information on where to find materials added	Assessment
4.2 August 2017	Added TQT details Deleted QCF	**Qualification at a glance, Structure** **Throughout**

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Contents

1 Introduction

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

Area	Description
Who are the qualifications for?	They are for candidates who work or want to work in the marine engineering and boatbuilding sector
What do the qualifications cover?	They allow candidates to learn, develop and practise the skills required for employment and/or career progression in the Marine engineering or boatbuilding sector.
What opportunities for progression are there?	They allow candidates to progress into employment or to the following City & Guilds qualifications: • 2463 Level 3

Structure

To achieve the **Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (Boatbuilding)**, learners must achieve **27** credits from the mandatory units and a minimum of **28** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory			
L/503/2274	301	Safe and effective working in the marine industry	11
R/503/2275	302	Principles of boat construction	16
Optional			
R/503/2390	304	Construction and repair of hulls and boat structures	14
D/503/2392	305	Producing and fitting structural boat components	14
H/503/2393	306	Establishing reinstatement requirements when servicing, repairing and maintaining boats	14
T/503/2396	307	Fibre reinforced plastics technology for marine construction	14
F/503/2398	308	Installation and repair of vessel services	14

To achieve the **Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (Marine Engineering)**, learners must achieve **27** credits from the mandatory units and a minimum of **28** credits from the optional units available.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory			
L/503/2274	301	Safe and effective working in the marine industry	11
Y/503/2276	303	Principles of marine construction and components	16
Optional			
H/503/2393	306	Establishing reinstatement requirements when servicing, repairing and maintaining boats	14
T/503/2396	307	Fibre reinforced plastics technology for marine construction	14
F/503/2398	308	Installation and repair of vessel services	14
J/503/2399	309	Installation and repair of marine engines	14
T/503/2401	310	Installation and repair of marine propulsion systems	14
H/503/6024	311	Maintaining electrical marine engineering equipment and systems	14
J/503/9840	312	Principles of marine electrical systems	14
K/503/2413	313	Principles of integrated marine electronic systems	14

To achieve the **Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance (Painting and Finishing)**, learners must achieve **49** credits from the mandatory units.

Unit accreditation number	City & Guilds unit	Unit title	Credit value
Mandatory			
L/503/2274	301	Safe and effective working in the marine industry	11
R/503/2275	302	Principles of boat construction	16
D/503/2277	314	Prepare surfaces and marine coatings	11
H/503/2278	315	Apply marine coatings	11

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

Title and level	GLH	TQT
Level 3 Diploma in Marine Construction, Systems Engineering and Maintenance	450	490

2 Centre requirements

Approval

If your centre is approved to offer the Level 3 Certificates in Boat Building, Maintenance and Support (2451) you will be automatically approved for the Level 3 Marine construction, systems engineering and maintenance diplomas (2463).

To offer these qualifications, new centres will need to gain both centre and qualification approval. Please refer to the *Centre Manual - Supporting Customer Excellence* for further information.

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

Resource requirements

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 areas 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.

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

Assessors and internal verifiers

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

Continuing professional development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Candidate 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

This qualification is accredited for candidates aged 16 -18 years and 19+.

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 qualifications, their responsibilities as a candidate, and the responsibilities of the centre. This information can be recorded on a learning contract.

4 Assessment

This qualification is assessed by a combination of online multiple choice tests and centre and marked assignments covering practical skills and underpinning knowledge. The table below provides details on the assessment methods for each unit.

City & Guilds unit	Unit title	Assessment method
301	Safe and effective working in the marine industry	e-assessment
302	Principles of boat construction	e-assessment
303	Principles of marine construction and components	e-assessment
304	Construction and repair of hulls and boat structures	Centre set assignment
305	Producing and fitting structural boat components	Centre set assignment
306	Establishing reinstatement requirements when servicing, repairing and maintaining boats	Centre set assignment
307	Fibre reinforced plastics technology for marine construction	Centre set assignment
308	Installation and repair of vessel services	Centre set assignment
309	Installation and repair of marine engines	Centre set assignment
310	Installation and repair of marine propulsion systems	Centre set assignment
311	Maintaining electrical marine engineering equipment and systems	Centre set assignment
312	Principles of marine electrical systems	Centre set assignment
313	Principles of integrated marine electronic systems	Centre set assignment
314	Prepare surfaces and marine coatings	Centre set assignment
315	Apply marine coatings	Centre set assignment

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 this material is available to download from the City & Guilds website *at* ***http://www.cityandguilds.com/delivering-our-qualifications/centre-development/quality-assurance/quality-assurance-documents***.

Approval process for centre set assignments

Centre set assignments must be approved by the external verifier before use. For each assignment, the *assignment sign off sheet* (AD3) must be completed and be made available to the EV for inspection.

Grading

Centre set assignments are graded Pass, Merit and Distinction. Please see generic grading criteria on www.cityandguilds.com

Test specifications

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

Test 1: Unit 301
Duration: 1 hour 20 mins

Unit	Outcome	Number of questions	%
301	1. Understand the importance of compliance with statutory regulations and organisational requirements in the marine industry	13	33
	2. Understand safe working practices and procedures	11	27
	3. Know how to plan, organise and monitor work needed to carry out marine industry activities	11	27
	4. Understand safe and effective production systems used in the marine industry	5	13
	Total	**40**	**100**

Test 2: Unit 302
Duration: 1 hour 20 mins

Unit	Outcome	Number of questions	%
302	1. Understand materials used in boat construction	13	33
	2. Understand the use of drawings and specifications used in boat construction	11	28
	3. Understand boat construction techniques	5	12
	4. Know the ancillary equipment and systems used on a boat	5	12
	5. Know the fittings and components used in boat construction	6	15
	Total	**40**	**100**

Test 3: Unit 303
Duration: 1 hour 20 mins

Unit	Outcome	Number of questions	%
303	1. Understand materials used in boat construction	13	33
	2. Understand the use of drawings and specifications used in marine engineering	11	28
	3. Understand marine construction techniques	5	12
	4. Know the ancillary equipment and systems used on a boat	5	12
	5. Know the fittings and components used in marine construction	6	15
	Total	**40**	**100**

NB – All percentages have been rounded to whole numbers.

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. RPL is allowed and is also sector specific.

5 Units

Availability of units

Below is a list of the learning outcomes for all the units.

Structure of units

These units each have the following:

- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- unit aim
- relationship to NVQ
- endorsement by a sector or other appropriate body
- learning outcomes which are comprised of a number of assessment criteria

Unit 301 Safe and effective working in the marine industry

UAN:	**L/503/2274**
Level:	Level 3
Credit value:	11
GLH:	100
Relationship to NVQ:	This unit is linked to the following NVQ units: 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236 and 237
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This mandatory unit is concerned with 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.

Learning outcome	**The learner will:**
1. Understand the importance of compliance with statutory regulations and organisational requirements in the marine industry	
Assessment criteria	
The learner can: 1.1 describe **safety regulations** applicable to the marine industry 1.2 state **employers' responsibilities** to maintain safety 1.3 state **employees' responsibilities** to maintain safety 1.4 describe how the Management of Health and Safety Regulations **should be implemented** 1.5 explain the **roles, responsibilities and powers** of people in health and safety positions 1.6 describe where to **access Health & Safety information** and advice. 1.7 describe the **conditions** leading to accidents 1.8 describe **methods of accident prevention** in the workplace 1.9 describe the **requirements of the Recreational Craft Directive** 1.10 state the organisational **procedures for reporting accidents**. 1.11 state how to carry out a risk assessment 1.12 identify **potential health hazards** 1.13 describe **environmental legislation** relevant to the marine industry.	

1.14 state the **qualifications required** for craft operating in harbours and inland waterways

Range

Safety regulations Health and Safety at Work Act, Control of Substances Hazardous to Health Regulations (COSHH), Provision and use of Work Equipment Regulations, Portable Appliance Testing Regulations. (P.A.T), Control of Major Accident and Hazards Regulations, Noise and Statutory Nuisance Act, Noise Act, Reportable Diseases and Dangerous Occurrences Regulations (RIDDOR)

Employer's responsibilities Safe place of work, safe plant and equipment, a safe system of work, safe working environment, safe methods of handling, storing and transporting goods and materials, reporting of accidents, information, instruction, training and supervision of employees, A safety policy.

Employee's responsibilities Wearing the appropriate Personal Protective Equipment (PPE), wearing the appropriate Respiratory Protective Equipment (RPE), maintaining secure area's free from danger to self or others, working so that your actions do not cause damage to the environment in terms of air water or ground pollution, safe working practices (be alert, maintain personal hygiene, protect yourself and other people, know emergency procedures, report all hazards)

Should be implemented Establish and specify a health and safety policy in accordance with the act, nominate a Health and safety officer, set up a safety committee with cross company membership, Carry out regular risk assessments, provide regular Health and Safety training and updating, keep up-to-date with Health and Safety matters by all means available, Internet etc, establish safe working practices and procedures, encourage good safety practice.

Roles, responsibilities and powers

The Safety officer - in a company is responsible for ensuring that Health and Safety in the company is up to date on regular training and updating is implemented.

A safety representative - is generally a member of the workforce who sits on a Safety Committee convened by the Safety officer who brings to attention safety matters within the company.

Health and Safety Inspectors - are employed by the Health and Safety Executive and have the power to inspect the premises if Health and Safety is below requirements and they have the power to close down companies or parts of a company who are at fault.

Environmental Health Officers - are employed to investigate and provide information on such matters as: fume, noise, waste or liquid pollution or other environmental issues such as the contamination of rivers and the sea and the presence of vermin

Access Health & Safety information Company Safety officer, Workshop notice boards, HMSO, the Health and Safety Executive, Commercial safety organisations and companies selling safety equipment, the internet.

Conditions Carelessness, improper behaviour and dress, lack of training, supervision and experience, fatigue, drug-taking and drinking, unguarded or faulty machinery or tools, inadequate ventilation; untidy, dirty, overcrowded, badly lit workplaces.

Methods of accident prevention Eliminate the hazard, replace the hazard with something less dangerous, guard the hazard, personal protection, safety training and publicity

Requirements of the Recreational Craft Directive Craft identification, builder's plate, protection from falling overboard, visibility from main steering position

Procedures for reporting accidents Summary of what happened, name of victim, summary of events prior to accident, details of witnesses, information on injury or loss sustained, conclusions, recommendations, date & signature of person(s) responsible for reporting. supporting material (photographs, video, diagrams)

Potential health hazards Slippery or uneven surfaces, spillages, scrap or waste material, flammable materials, faulty or missing machine guards, or incorrect setting, faulty electrical connections or damaged cables, material ejection, pressure and stored energy, unshielded processes, volatile and toxic materials, dust and fumes, contaminants and irritants, materials handling and transportation, working at heights, working afloat

Environmental legislation Environmental Protection Act, Pollution Prevention and Control Act, Clean Air Act, Controlled Waste Regulations, Dangerous Substances (COSHH), Preparations and Chemicals Regulations

Qualifications required Legal boatman's license (MCA), Royal Yachting association (RYA), STCW 95 compliance

Learning outcome	**The learner will:**
2. Understand safe working practices and procedures	
Assessment criteria	
The learner can:	
2.1	state the range of to the **Personal Protective Equipment (PPE)** appropriate to task or operation being undertaken
2.2	state when Respiratory Protective Equipment (RPE) **should be used**.
2.3	describe the **safety rules** for the use of mechanical lifting equipment.
2.4	list **accessories** for lifting equipment
2.5	describe **how lifting equipment accessories are used**
2.6	state the various **knots** used in ropes and slings and their application.
2.7	describe the **current Manual Handling Operations Regulations** that relate to boat building repair and servicing.
2.8	state why it is necessary to have a **permit to work**
2.9	identify **who hazards should be reported to**
2.10	state **situations** in which it is unsafe to work in isolation

Range
Personal Protective Equipment (PPE) Safety boots when moving heavy materials, ear defenders for working in a noisy workshop, safety goggles or glasses when grinding etc, gloves when working with resins and chemicals etc, overalls for working in dirty conditions.
Should be used When working with - chemicals and solvents, fumes, dust or harmful particulates, heat
Safety rules Loads over 20kg need powered lifting gear, never exceed the maximum safe working load (SWL) indicated, avoid shock loading the lifting equipment, swinging and twisting, estimate the centre of gravity,

position the lifting hook above the centre of gravity of the load, avoid pushing or pulling the load to adjust the balance, do not transport loads over the heads of people or walk under a load, do not leave a load hanging unattended, always lower the load gently into position; make sure it will not move once the lifting equipment is removed, check date of equipment tests.

Accessories Hooks: swivel & safety hooks, slings; chain & ropes of wire, natural and man-made fibers, eyebolts, shackles, chains, rings, special-to-purpose equipment; oil drum lifting and cap opening levers, spreaders

How lifting equipment accessories are used Always observe the SWL and its date of test, check colour of slings for correct load, never bend slings around sharp corners and edges and avoid over-bending, use protective covers on corners of loads with slings and chains, never twist or kink the sling or chain, never use a worn or damaged slings or chains, the importance of the angle at the top, forces in the legs proportional to the angle at the top (LOLER)

Knots Reef knot – joining ropes of equal thickness, clove hitch – joining ropes to a pole or bar, single or double loop – preventing a sling from slipping off a crane hook, two half-hitches – connecting a rope to a sling, bowline – preventing a load from tightening a loop.

Current Manual Handling Operations Regulations Carrying out a risk assessment on the types of manual handling in operation in a boatyard or marina, methods employed in transporting or supporting boats in a yard or marina, methods used for lifting boats and equipment both manual and mechanical, correct posture and technique for manual lifting and carrying, the use of suitable clothing, footwear or other personal effects, providing adequate or appropriate knowledge and training to the workforce.

Permit to work

For safety, to ensure no unauthorised people have access to a potentially dangerous workshop;

For security, preventing theft, malicious damage; For reasons of Industrial secrecy.

Who hazards should be reported to Supervisors, safety officers or representatives, fire officers, works rescue team.

Situations At heights (up the mast, on stage planks), In trenches, In close proximity to machinery, When a fire risk exists, with toxic or corrosive substances, confined spaces, where danger of falling overboard or in the water is possible

Learning outcome	**The learner will:**
3. Know how to plan, organise and monitor work needed to carry out marine industry activities	
Assessment criteria	
The learner can:	
3.1 state how to maximise the **efficiency and effectiveness** of the resources	
3.2 state the types of **records** that need to be maintained	
3.3 state who is responsible for production records	
3.4 state **problems** that may occur if records are not maintained and completed accurately.	
3.5 state the **key roles** in a marine industry environment	
3.6 state the **technical skills, tools and materials** needed to deliver	

the work outcome

3.7 list the **information sources** that detail what is required to deliver work outcomes

3.8 state the **action to be taken** when required resources are unavailable

3.9 state the **regulatory bodies and regulations** that cover marine industry activities

3.10 state the **checks** used to ensure marine industry activities meet quality & design specifications.

3.11 explain the **considerations** when planning boat construction schedules

Range

Efficiency and effectiveness Labour (by employing the right skills, training), effective time management, correct quality and quantity of tools, equipment and materials, effective use of working area and facilities

Records Work schedule sheets, time sheets, requisitions sheets, critical path analysis charts, or other progress charts, quality assurance certificate, recreational craft directive logs and files, trials and equipments test records, stock control records.

Problems Work may be done more than once, work that should be done may be missed or not completed, work may be done incorrectly or not up to the standard required or expected, the true cost of the work may not be recovered, the customer may be charged too much or too little, the reputation of the company may be put at risk.

Key roles Manager, foreman, charge-hand, store keeper, buyer, qa manager, designer, team leader, sales manager, production manager, administrative support, skilled workers

Technical skills, tools and materials Working methods and level of skill, specialist tools and equipment, materials and components

Information sources Design drawings, specifications, scantlings lists (which gives sizes & types of material and fastenings required for construction), job instructions, customer requirements, Lloyds rules, RCD requirements, manufactures' and suppliers' catalogues & data sheets, specialist magazines and the internet.

Action to be taken Notify relevant personnel, re-schedule work, contingency plans

Regulatory bodies and regulations Classification societies (Lloyds), Recreational Craft Directive, BSI/ISO standards, Environmental Protection Act 1990, British Waterways Board, Boat Safety Scheme, Marine Coastguard Agency, American Bureau of shipping (ABS), British Marine Federation (BMF), Royal Yachting Association (RYA)

Checks

Measurement, checking – alignment, geometric shape

Testing with specialised equipment - Barcol hardness tester, moisture content meter, thickness gauge

Destructive testing - the ash test, tensile testing, Impact testing

Visual inspections – Appearance, blemish free, matching grain, even colour.

Mechanical testing by checking correct operation of: winches & windlass, sliding hatches, sky-lights, portholes doors, drawers and cupboards, Locks catches, cabin hooks etc.

Sea trials - Steering and manoeuvrability functions, engine start & function, navigation lights & equipment **Considerations** Size of craft, end use, materials, construction method, location of construction, cost

Learning outcome	**The learner will:**
4. Understand safe and effective production systems used in the marine industry	
Assessment criteria	
The learner can: 4.1 state the basic **components of a typical production system** 4.2 describe **factors that affect productivity** 4.3 state the **effect of industrial changes** on productivity 4.4 describe the **influence** of industrial changes on working patterns and training needs. 4.5 state **factors that affect marine business trading** 4.6 state the **factors that affect good customer relations**	

Range
Components of a typical production system Energy, labour (person/hours), machinery and equipment, materials, land and buildings, overheads **Factors that affect productivity** Value of materials, person hour, machine hour, use of energy The effect on costs of - lateness and absenteeism, machinery and equipment, breakdown/ failure, down time, need to rework, scrap **Effect of industrial change** Reduced demand, increased scale of competition, lack of competitiveness in terms of:- marketing, productivity & quality, introduction of new technology **Influence** Broad-based skill requirement, transferable skill requirement, increased technological content of job, changeable and flexible working, demand for increased organisational cohesiveness, need for continual retraining and updating, expectation of more frequent job change, development of new career patterns, for continued trading and maintaining good customer relations providing employment for local people, supporting local shops and companies, having friendly and well informed staff who give sound and practical advice **Factors that affect marine business trading** Producing good quality work, clean and well maintained premises, ensuring the product service, repairs and builds are fit for purpose, the cost is within the quoted price including any agreed extras, agreed delivery dates and the implications of penalty clauses, the method of payment, the legal standing of the designer's specification, the signatures of all parties in the contract. **Factors that affect good customer relations** Producing good quality work, meeting customer expectations, ensuring the product service is fit for purpose; the cost is within the quoted price including any agreed extras, the product (boat) is finished by the agreed delivery date, the product is of the required quality and reliability, after sales service and rectification of faults

Unit 302 Principles of boat construction

UAN:	**R/503/2275**
Level:	Level 3
Credit value:	16
GLH:	150
Relationship to NVQ:	This unit is linked to the following NVQ units: 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236 and 237.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This mandatory unit is concerned with the selection and use of materials, tools and equipment and their application in boat building maintenance and support operations.

Learning outcome	**The learner will:**
1. Understand materials used in boat construction	
Assessment criteria	
The learner can: 1.1 describe **materials** used in boat construction 1.2 explain the **properties of materials** used in boat construction 1.3 describe common **defects in materials** 1.4 state methods of **protection and application methods** for wood, metal and composites used in boat construction and repair activities 1.5 state the common **methods in which timber is converted/seasoned** 1.6 identify calculations used to determine size of **materials and components** 1.7 state **types of reinforcement and stiffening materials** 1.8 explain the selection and use of **fastenings** for structural and decorative purposes 1.9 evaluate the **classification** and comparative holding power of **adhesives** 1.10 distinguish **primary and secondary bonds** when fixing FRP structures 1.11 describe applications of **sealing and bedding compounds** used in boat construction and repair	

Range
Materials Wood – hardwoods, softwoods, manufactured boards. Metals – ferrous, non-ferrous. Composites – GRP/FRP. Plastics. **Properties of materials** Strength, resistance to degradation/corrosion, toughness, hardness, elasticity, density/weight, sustainability (renewable sources), cost **Defects in materials** Wood – infestation, decay, knots, splits, distortion. Metals – corrosion, oxidation, galvanic and electrolytic action, fatigue Plastics- crazing, fibre pattern, resin starvation, resin rich laminates, air entrapment, under-cure etc **Protection and application methods** Wood – Brushing and rollering (varnishing - UV protection, painting), pressure treatment, steeping, hot and cold tank dipping, spraying Metal - Brushing and rollering (painting), spraying, anodising, galvanising (including Swedish/Chinese), electro plating Composites - anti-fouling, polishing **Methods in which timber is converted/seasoned** Conversion methods: Through & through, quarter sawn, tangential/radial sawing etc. Seasoning methods: air seasoning, kiln seasoning & types, reason for battens 'stickers' between boards when stacking, ways of reducing end splits by painting or strapping. **Materials and components** Timber, fibre reinforced plastics, water & fuel tank capacities **Types of reinforcement and stiffening materials** Carbon fiber, aramid, pre-impregnated cloths, polyurethane foam, pvc foam, wood (end grain Balsa). **Fastenings** Screws, nails, tacks and pins, bolts **Classifications** Interior, exterior, moisture resistant or weather and boil proof **Adhesives** Urea formaldehyde, resorcinol, epoxy, polyurethane, casein **Primary and secondary bonds** Primary bonds made between plies of resin & reinforcement laid and cured at the same time; secondary bonds made between plies of resin and reinforcement laid after previous layers have cured. **Sealing and bedding compounds** Silicones, polysulphides, polyurethanes, oil based (putties and bedding compounds), acrylic and jointing tapes.

Learning outcome	The learner will:
2. Understand the use of drawings and specifications used in boat construction	
Assessment criteria	
The learner can: 2.1 state the **specification authorities and regulating bodies** for boat construction and repair activities	

2.2	explain how to use scales
2.3	identify **boat terms** from drawings and specifications
2.4	explain how to extract information from lines plans, construction and general arrangement drawings
2.5	state the **reasons for drawing up a 'setting-out rod'** taking information from the relevant drawings
2.6	explain **how to draw up a 'setting-out rod'** taking information from the relevant drawings
2.7	explain the **method of lofting** a simple hull shape
2.8	state the **methods** used to find points, shapes and true shapes of figures & components from plans and drawings
2.9	explain the types of **calculations** relating to drawings and specifications in boatbuilding technology.

Range

Specification authorities and regulating bodies Recreational Craft Directive (RCD)., BSI/EN., ISO., Lloyds., Inland Waterways (Boat Safety Scheme)., Marine Safety Agency., Bureau veritax, B.I.S. Department of Business Innovation and Skills., British marine federation (BM), British marine electronics association (BMEA)

Boat terms Port, starboard, forward, aft, amidships, bow, stern, outboard, inboard, length, breadth, depth, draught, freeboard, displacement, deadweight, bulkhead, camber, bilge, superstructure, frame, floor, bridge, cockpit, deckhouse, decks, hatches, vents, saloon, cabins, deck equipment, winch, fairleads, bollards, bow rollers, davits, anchor

Reasons for drawing up a 'setting-out rod' To determine appropriate sizes and proportions for components and joints, Enable a cutting list to be drawn up, Identify possible problems, Use to check component sizes when cut before assembly.

How to draw up a 'setting-out rod' Prepare rod material (hardboard, mdf, plywood), Extract dimensions from drawings, Set out dimensions full size on rod material, Establish profile and sectional views.

Method of lofting

Tools and equipment - loft nails or pins, chalk line, straight edges, squares, trammels, fairing battens profile curves, bevel board.

Setting out operations and terms - perpendiculars, forward and after (frd.aft) and station, lines, level lines& waterlines, buttock lines, diagonal lines.

The use of a table of offsets to establish sheer plan or profile view, body plan, half breadth view.

Methods Setting out beam cambers, conic sections of ellipse parabola, hyperbola, flat and curved transom expansion, determining the Centre of effort of sail plans.

Calculations

These may include the use of 'Simpsons rule' to determine such things as: areas of boat components: bulkheads, rudders, decks, volumes: hull forms, tanks, ballast keel.

Calculations related to: levers, beam reactions, centres of gravity, simple machines (mechanical advantage, velocity ratio, efficiency).

Learning outcome	The learner will:
3. Understand boat construction techniques	
Assessment criteria	
The learner can: 3.1 explain the **types of propulsion** 3.2 explain **boat building techniques** 3.3 explain the use of **tools** and **equipment** in boat construction 3.4 describe **techniques** for building plugs for frp moulding 3.5 describe **considerations** when building plugs for frp moulding	

Range
Type of propulsion Sails, oars, paddles & paddle wheels, Inboard & outboard marine engines driving propellers with direct, Z or V drives, Jet, hydraulic, electric drives, Air driven (hover craft), poles (punts), hybrid engines
Boat building techniques Modern wood/epoxy (strip plank, cold moulding, clinker ply, stitch and tape), glass reinforced plastics GRP/fibre reinforced plastics FRP (mass produced and one-off), Metals (steel, aluminium), fabrics, plug construction techniques
Equipment Jigs, templates, framing, stocks
Tools Portable power tools shipwrights maul for driving in keel, bolts adze, draw knife, spar gauge, caulking mallets and caulking irons, rove punch, clenching (clinching/riveting)
Techniques Strip planking, cold moulding, plaster of paris, modelling with CNC routers, flat panel construction
Considerations Integrity of structure (made from stable material), quality of surface finish required, work schedules, release angles, minimum radii, split moulds

Learning outcome	The learner will:
4. Understand the ancillary equipment and systems used on a boat	
Assessment criteria	
The learner can: 4.1 explain **communication systems** used on a boat 4.2 explain **environmental systems** installed on boats 4.3 describe **personal safety equipment** found on boats 4.4 describe **general safety equipment** found on boats 4.5 describe **ancillary systems** installed on boats	

Range
Communication systems Radio, navigation lights, flags, satellite support systems, rockets and flares, mobile phones
Environmental systems Heating, water, fresh and waste, ventilation and air-conditioning
Personal safety equipment Buoyancy equipment, lifejackets, safety harness
General safety equipment Flares, first aid box, fire fighting equipment, emergency locker

Ancillary systems Hydraulic (steering system. backstay tensioning etc), pneumatic(liquefied petroleum gas systems), electrical (batteries, distribution systems, lighting d.c. generators etc), water systems and calorifiers

Learning outcome	**The learner will:**
5. Know the fittings and components used in boat construction	
Assessment criteria	
The learner can: 5.1 explain the importance of **location and purpose** of fittings and components installed on boats 5.2 explain the functions of **exterior fitting and components** 5.3 explain the importance of providing additional stiffening and support in way of fittings and components 5.4 explain the use of different **types of fastening devices** for particular applications 5.5 explain the reason for the use of bedding and sealing compounds in way of fittings and dissimilar metals 5.6 explain the **problems that can affect the work** when installing equipment, fittings and components to boats.	

Range
Location and purpose Function satisfactorily, do not present a hazard in use, allow easy access and operation, meet operational requirements
Exterior fitting and components
Hull and superstructure fittings: bilge keels, rolling chocks, rudders, rudder stops , rudder gland, skeg fittings, pintles and gudgeons, skin fittings, hawse pipes, portlights and windows, stern tubes and stern glands, 'A' and 'P' brackets, bow thrusters, hatches and skylights, depth sounders, logs and anodes.
Deck fittings: masts and spars, grab rails , pulpit and pushpit, guard rails, chain plates, forestay and backstay fittings, bow rollers, winches and windlasses, cleats, bollards, sampson post and fairleads, mainsheet and headsail tracks, tabernacle, anchor stowage, stanchions, davits, life-buoy and life-raft stowage.
Types of fastening devices
Use of bolts, rather than screws for fittings subject to tensile loads
Specialist bolt heads: 'galley' bolts in narrow rudders sections, barrel bolts in wooden engine beds
Use of locking devices to prevent fastenings becoming loose or undone.
Problems that can affect the work Working practices and standard of workmanship (poor training), access to working areas, incorrect reading of drawings and not understanding the work instructions, location of existing installations

Unit 303 Principles of marine construction and components

UAN:	**Y/503/2276**
Level:	Level 3
Credit value:	16
GLH:	150
Relationship to NVQ:	This unit is linked to the following NVQ units: 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236 and 237.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This mandatory unit is concerned with the selection and use of materials, tools and equipment and their application in marine engineering operations.

Learning outcome	**The learner will:**
1. Understand materials used in marine construction	
Assessment criteria	
The learner can: 1.1 identify **materials** used in marine construction 1.2 evaluate the **properties of materials** used in marine construction 1.3 describe common **defects in materials** 1.4 state **protection and application methods** for wood, metal and composites used in marine construction 1.5 identify calculations used to determine size of **materials and components** 1.6 state **types of reinforcement** materials used in marine construction 1.7 explain the selection and use of **fastenings** for structural purposes 1.8 evaluate the **classification** and comparative holding power of **adhesives** 1.9 distinguish **primary and secondary bonds** when fixing FRP structures 1.10 describe applications of **sealing and bedding compounds** used in marine construction	

Range
Materials Wood – hardwoods, softwoods, manufactured boards. Metals – ferrous, non-ferrous. Composites – GRP/FRP. Plastics – thermosetting, thermoplastics **Properties of materials** Strength, resistance to degradation/corrosion, toughness, hardness, elasticity, density/weight, sustainability (renewable sources), cost **Defects in materials** Wood – infestation, decay, knots, splits, distortion. Metals – corrosion, oxidation, galvanic and electrolytic action, cavitation, fatigue Plastics- crazing, fibre pattern, resin starvation, resin rich laminates, air entrapment, under-cure etc **Protection and application methods** Wood – Brushing and rollering (varnishing - UV protection, painting), pressure treatment, steeping, hot and cold tank dipping, spraying Metal - Brushing and rollering (painting), spraying, anodising, galvanising (including Swedish/Chinese), electro plating Composites - anti-fouling, polishing **Materials and components** Timber, fibre reinforced plastics, water & fuel tank capacities **Types of reinforcement** Carbon fiber, aramid, pre-impregnated cloths, polyurethane foam, pvc foam, wood (end grain Balsa). **Fastenings** Screws, nails, bolts **Classifications** Interior, exterior, moisture resistant or weather and boil proof **Adhesives** urea formaldehyde, resorcinol, epoxy, polyurethane, casein **Primary bonds and secondary bonds** Primary bonds made between plies of resin & reinforcement laid and cured at the same time; secondary bonds made between plies of resin and reinforcement laid after previous layers have cured. **Sealing and bedding compounds** Silicones, polysulphides, polyurethanes, oil based (putties and bedding compounds), acrylic and jointing tapes.

Learning outcome	The learner will:
2. Understand the use of drawings and specifications used in marine engineering	
Assessment criteria	
The learner can: 2.1 state the **specification authorities and regulating bodies** for marine construction activities 2.2 explain how to use scales 2.3 identify **boat terms** from drawings and specifications 2.4 explain how to extract information from lines plans, construction and general arrangement drawings 2.5 explain the **method of lofting** 2.6 state the **methods** used to find points, shapes and true shapes of	

	figures and components from plans and drawings
2.7	explain the types of **calculations** relating to drawings and specifications in marine technology.

Range
Specification authorities and regulating bodies Recreational Craft Directive (RCD)., BSI/EN., ISO., Lloyds., Inland Waterways (Boat Safety Scheme)., Marine Safety Agency., Bureau veritax, B.I.S. Department of Business Innovation and Skills., British marine federation (BM), British marine electronics association (BMEA)
Boat terms Port, starboard, forward, aft, amidships, bow, stern, outboard, inboard, length, breadth, depth, draught, freeboard, displacement, deadweight, bulkhead, camber, bilge, superstructure, frame, floor, bridge, cockpit, deckhouse, decks, hatches, vents, saloon, cabins, deck equipment, winch, fairleads, bollards, bow rollers, davits, anchor
Method of lofting
Setting out operations and terms - perpendiculars, forward and after (frd.aft) and station, lines, level lines& waterlines, buttock lines, diagonal lines.
The use of a table of offsets to establish sheer plan or profile view, body plan, half breadth view.
Methods Conic sections of ellipse parabola, hyperbolas, cross sections, orthographic projections, isometric projections
Calculations
'Simpsons rule' to determine such things as: areas of boat components: rudders, volumes - hull forms, tanks, ballast keel.
Calculations related to: levers, beam reactions, centres of gravity, simple machines (mechanical advantage, velocity ratio, efficiency).

Learning outcome	**The learner will:**
3. Understand marine construction techniques	
Assessment criteria	
The learner can:	
3.1	explain the **types of propulsion**
3.2	explain **marine construction techniques**
3.3	explain the use of **tools** and **equipment** in marine construction
3.4	describe **techniques** for building plugs for frp moulding
3.5	describe **considerations** when building plugs for frp moulding

Range
Type of propulsion Sails, oars, paddles & paddle wheels, Inboard & outboard marine engines driving propellers with direct, Z or V drives, Jet, hydraulic, electric drives, air driven (hover craft), poles (punts), hybrid engines
Marine construction techniques Modern wood/epoxy (strip plank, cold moulding, clinker ply, stitch and tape), glass reinforced plastics GRP/fibre reinforced plastics FRP (mass produced and one-off), metals (steel, aluminium), fabrics, plug construction techniques, ferro cement
Tools Shipwrights maul, bolts, spanner, sockets, screwdriver, wrench, pliers, mole grips, vernier gauge, dial gauge, welding equipment (mig, tig)

Equipment Jigs, templates **Techniques** Strip planking, cold moulding, plaster of paris, modelling with CNC routers, flat panel construction **Considerations** Integrity of structure (made from stable material), quality of surface finish required, work schedules, release angles, minimum radii, split moulds

Learning outcome	**The learner will:**
4. Understand the ancillary equipment and systems used on a boat	
Assessment criteria	
The learner can: 4.1 explain **communication systems** used on a boat 4.2 explain **environmental systems** installed on boats 4.3 describe **personal safety equipment** found on boats 4.4 describe **general safety equipment** found on boats 4.5 describe **ancillary systems** installed on boats	

Range
Communication systems Radio, navigation lights, flags, satellite support systems, rockets and flares, mobile phones **Environmental systems** Heating, water, fresh and waste, ventilation and air-conditioning **Personal safety equipment** Buoyancy equipment, lifejackets, safety harness **General safety equipment** Flares, first aid box, fire fighting equipment, emergency locker **Ancillary systems** Hydraulic (steering system. backstay tensioning etc), pneumatic (liquefied petroleum gas systems), electrical (batteries, distribution systems, lighting d.c. generators etc), water systems and calorifiers

Learning outcome	**The learner will:**
5. Understand the fittings and components used in marine construction	
Assessment criteria	
The learner can: 5.1 explain the importance of **location and purpose** of fittings and components installed on boats 5.2 explain the functions of **exterior fitting and components** 5.3 explain the importance of providing additional stiffening and support in way of fittings and components 5.4 explain the use of different **types of fastening devices** for particular applications 5.5 explain the reason for the use of bedding and sealing compounds in way of fittings and dissimilar metals 5.6 explain the **problems that can affect the work** when installing equipment, fittings and components to boats	

Range
Location and purpose Function satisfactorily, do not present a hazard in use, allow easy access and operation, meet operational requirements
Exterior fitting and components
Hull and superstructure fittings: bilge keels, rolling chocks, rudders, rudder stops , rudder gland, skeg fittings, pintles and gudgeons, skin fittings, hawse pipes, portlights and windows, stern tubes and stern glands, 'A' and 'P' brackets, bow thrusters, hatches and skylights, depth sounders, logs and anodes.
Deck fittings: masts and spars, grab rails , pulpit and pushpit, guard rails, chain plates, forestay and backstay fittings, bow rollers, winches and windlasses, cleats, bollards, sampson post and fairleads, mainsheet and headsail tracks, tabernacle, anchor stowage, stanchions, davits, life-buoy and life-raft stowage.
Types of fastening devices
Use of bolts, rather than screws for fittings subject to tensile loads
Specialist bolt heads: 'galley' bolts in narrow rudders sections, barrel bolts in wooden engine beds
Use of locking devices to prevent fastenings becoming loose or undone.
Problems that can affect the work Working practices and standard of workmanship (poor training), access to working areas, incorrect reading of drawings and not understanding the work instructions, location of existing installations

Unit 304 Construction and repair of hulls and boat structures

UAN:	**R/503/2390**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 216, 217, 227, 228, 229, 230 and 231.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. This unit covers the underlying technology and skills requirements for the successful construction of boats. It includes the interpretation of drawings and specifications, the terminology and techniques needed to obtain the shape of moulds and templates and the skills required to mark, cut-out, assemble and finish the items which make up a boat.

Learning outcome	**The learner will:**
1. Be able to produce templates, moulds and jigs for the construction and repair of boats	
Assessment criteria	
The learner can: 1.1 read and interpret information from lines plans, working drawings, specifications or computer generated data 1.2 prepare working drawings and materials lists 1.3 set out and cut materials for template and jigs 1.4 complete and check finished templates and jigs 1.5 complete and store records and data 1.6 obtain **sources of technical information** 1.7 extract **template and jig information** 1.8 select suitable **tools and equipment** for developing, marking and cutting out templates and jigs 1.9 identify **materials** for producing templates and jigs 1.10 state the **methods** of transferring lines and data onto moulds, templates or jigs 1.11 describe **techniques** for retaining the shapes of hulls and decks before a repair operation 1.12 describe the correct sequence of operations for carrying out repairs to hulls and decks	

1.13 identify **safe working practices** in the workplace 1.14 state the **causes** of defects in materials 1.15 state the **factors** which influence the finish and quality of work

Range
Sources of technical information Manufacturers'/supplier's data sheets, technical journals, Lloyds rules, Recreational Craft Directive, designers' drawings **Template and jig information** Computer generated data, lines plan, working drawings, specifications, scantlings lists **Tools and equipment** Lofting equipment, battens, hammer and loft nails, trammels, bevel board, chalk line, curves (ships, French, rams horn, tick sticks or transfer battens) Hand tools: saws, compass plane, smoothing, jack and try planes, spoke shaves Power tools: jig saw, drill, screw driver, small band saw **Materials** Softwood, hardwood, manufactured boards, template card/paper, metal **Methods** Direct measurement, tracing/transfer, spiling/scribing, nail head impressions **Techniques** Shores and temporary jigs, bracings, ties, deck and hull support, jacks, wedges **Safe working practices** Personal protective equipment, dust and fume extraction, adequate lighting, noise control, safe lifting and handling regulations, LOLER 1998, handling and removal of waste materials, COSHH regulations and BS/EN 4001, safe use of fixed and portable woodworking machinery **Causes** Poor setting out, poor cutting, poor shaping, template distortion timber defects natural: knots, shakes, sap and timber decay seasoning: warping and twisting, splitting metals: corrosion, buckling and casting voids FRP layups: voids, dry areas, blisters **Factors** Standard of workmanship, material selection, time constraints, methods of visual and dimensional inspection, temperature, humidity

Learning outcome	**The learner will:**
2. Be able to cut and shape materials to form the structural components of boats	
Assessment criteria	
The learner can: 2.1 select and mark out **materials** 2.2 cut materials to form structural components 2.3 shape materials to meet required configuration of hulls and decks	

2.4 finish and inspect structural components
2.5 read and interpret drawings, scantlings lists, specifications, moulds and patterns
2.6 state the importance of following work instructions and job sheets
2.7 describe the **criteria** for the selection of materials
2.8 identify materials used in boat construction and their characteristics
2.9 describe the **main structural components** which make up hulls and decks
2.10 describe **marking out methods** for making components to hulls and deck
2.11 describe the **tools** and **techniques** used to manufacture structural members of hulls and decks
2.12 describe the **steps** to be taken when installing engine beds/plates and associated features
2.13 describe how to use materials **economically and minimise waste**
2.14 describe the **joints** used to connect structural components
2.15 identify **problems and faults** when cutting and shaping materials

Range

Materials

Hardwoods, softwoods, manufactured boards, composite boards

Metals, iron, steel, aluminium, copper, lead, alloys

Plastics, thermoplastics and thermosetting plastics

Criteria

Free from natural and seasoning defects, grain direction, working properties, durability, stability, strength requirements, weight considerations

Main structural components

Backbone structures - keels, stems, sternpost, apron, deadwood, knees, horn timber, transom, ballast keel and mast step, floors (grown, laminated, composites, metal plate, angle)

Frames/timbers - steam bent timbers, grown, laminated

Skin construction - carvel, clinker, double diagonal, cold moulded, strip, plate metal, chine construction and composite, plywood

Beams - carlins, stringers, gunwales, beam shelf, mast clamp, sole bearers, thwarts, deck and decking arrangements, deck pads, bulkheads

Knees - breast hooks, quarter knees, thwart knees, hanging and lodging knees, reinforcement for chain plates

Marking out methods

Direct measurement, tracing transfer, spiling/scribing, nail head impressions, use of templates

Tools

Adze, draw knife, compass planes, hollow and moulding planes, rove punch, dolly, clippers, ballpein hammer, claw hammer, chisels, planes, mallet, spoke shaves (flat, round), marking gauges, rule

Techniques

Establishing 'sided and moulded' sizes

Marking and working bearding and rabbet lines

Setting out beam cambers

Methods used to form laminated members such as frames, floors, beams, stems

Methods used to form 'grown' members such as frames, floors, beams, stems

Techniques of 'steam or heat bending'

Steps

Setting up shaft line, cut, fit and fix engine beds, cut out and align stern tube opening and fit stern tube, align and fix propeller brackets in accordance with RCD and classification societies

Economically and minimise waste

Using templates, nesting, utilising appropriate off-cuts, computer numerically controlled (CNC) cutting, ISO14001

Joints

Scarphs (plain, lipped and hooked), tabling, skew/beam dovetails, chine logs/corner posts, butt straps, halvings, loose tennons

Problems and faults

Setting out, selection of material, workmanship, reading of drawings specifications data sheets or work instructions, lack of or insufficient seasoning, poor storage

Learning outcome	**The learner will:**
3. Be able to assemble and finish hull and boat structures	

Assessment criteria

The learner can:

3.1 position and fix structural components of hulls and decks
3.2 check the alignment of structural components
3.3 carry out finishing operations to hulls and decks
3.4 inspect completed hulls and decks for quality
3.5 describe how to **prepare the work area** for the assembly of hull and deck components
3.6 identify **manual and mechanical lifting equipment**
3.7 state the **procedure** for positioning and bracing structural and moulds components during assembly operations
3.8 identify **tools and equipment** used in assembly operations
3.9 identify the fixing methods used to join hull and deck assemblies
3.10 describe how the fixing methods can affect the integrity and strength of the assembled structure
3.11 identify **problems** that can occur during alignment of hulls and decks
3.12 identify **methods** of making hulls and decks watertight
3.13 define a range of **covering and sheathing systems**
3.14 identify **methods of comparing the cost effectiveness** of building FRP hulls and decks

Range

Prepare the work area

Free from obstructions and contamination (greasy/oily floor), safe access, staging, gangways and ladders secure, sufficient heating, lighting, ventilation, space, assembly components, tools and equipment, establishment of building stocks and uprights, levelling operations

Manual and mechanical lifting equipment

Slings, strops, chains, spreaders, shackles, eyebolts, wires

Procedure

'Horning in', levelling and use of plumb-bob, bracing and shoring techniques, centre line and building board/batten

Tools and equipment

Measuring devices, aligning equipment, thermal equipment metal only welding brazing and soldering equipment

Levels: water levelling pipe, plumb bob and horning in battens, theodolite, laser levels

Hand tools: heavy maul, clenching hammer, rove punches, clenching spoon, nail cutting caulking mallet, caulking irons, bolt drifts, dummy sticks for spiling, brace and boring bits, dowel cutters

Portable power tools: 'skill' saw, planer, drills, heavy duty grinders, sanding machines

Temporary holding devices: sash cramps, 'g' cramps, 'f' cramp

Fixing methods - Mechanical fastening devices (screws and bolts), drifts, trunnels, roved copper nails and rod, adhesives, FRP bonding techniques, epoxies/polyesters

Problems

Adhesive cure times, positions and alignment of fastenings, movement of hull structure

Methods

Use of caulking mallets and caulking irons, selection of caulking material, boat cotton, oakum, tape, pitch, polysulphides, use of seam paying-up methods, wooden splines, putty pitch, synthetic rubbers

Covering and sheathing systems

Epoxy/glass, protective and non-slip deck coverings, wood sheathing techniques, canvas sheathing, paints and varnishes

Methods of comparing the cost effectiveness

Plug to female mould and female mould to male moulding, production of female mould from existing or prototype hull or deck, producing 'one off' mouldings via strip plank methods

Learning outcome	**The learner will:**
4. Be able to assemble and finish above deck structures	
Assessment criteria	
The learner can:	
4.1	interpret deck and superstructure drawings, work instructions and specifications
4.2	mark out and manufacture superstructure components
4.3	locate, position and fix superstructure components
4.4	inspect and check completed assemblies
4.5	identify **deck structures** on boats
4.6	describe the **operations** in assembling above deck structures
4.7	describe the range of **deck planking styles** and joining and sealing arrangements
4.8	identify **tools and equipment** used in marking, making, locating and fixing above deck components
4.9	describe **features of deck structures** to make them watertight
4.10	describe **fixing and fastening devices** for securing

superstructures

4.11 list **sealing and bedding compounds** used for securing superstructures

4.12 identify **adhesives** used for assembling and finishing deck

4.13 describe the **procedures** used in wooden mast and spar construction

4.14 identify **methods** used to protect components during assembly and until commissioning

4.15 identify **problems** that can occur during assembly of superstructures

Range

Deck structures

Coach-roof, doghouse, wheelhouse, bulwarks, skylights, lockers, canopies, tabernacle, toe-rail and hand rails, deck planking, masts and spars, hatches, vent boxes

Operations

wheelhouse and doghouse fronts, expanded beam camber, as applied to raked or sloping fronts on coach-roof, location and fitting of corner posts (hopper bevels), making, fitting and fastening hand rails

Deck planking styles

Straight, swept and tapered plank decks, covering board, margins, king plank and snaping techniques, use of caulking methods, boat cotton or oakum and pitch, proprietary tapes, polysulphide, plywood sub decks with veneers to simulate traditional systems, modern synthetic systems

Tools and equipment

Measuring devices, hand tools, portable power tools, temporary holding devices, cramps and clamps, woodworking machines, saws, circular and band, planers (under and over) mortising machine, application guns

Features of deck structures

Anti capillary grooves, scuppers

Fixing and fastening devices

Screws, bolts, gallery fastenings, tie rods

Sealing and bedding compounds

Marine silicones, polysulphides, polyurethanes, oil based (putties and bedding compounds), acrylic and jointing tapes

Adhesives

PVAs, epoxies, phenol/resorcinol formaldehyde, urea formaldehyde, casein, polyurethane

Procedures

Types of timber used, conversion and jointing, setting out and hollowing, use of spar gauge, shaping and finishing

Methods

Protective covering, cardboard, hardboard, polythene sheet, painting, varnishing, peelable coatings

Problems

Standard of workmanship, material selection, time constraints, adhesive cure times, positions and alignment of fastenings, movement of hull structure

Unit 305 Producing and fitting structural boat components

UAN:	**D/503/2392**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 207, 208, 214, 216, 218, 219, 220, 221, 222, 223, 224, 225 and 226.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. It is concerned with the manufacture and installation of structural components, such as bulkheads, helm and navigational consoles, furniture units and deck boxes. The unit also covers the installation of fittings and engine drive system mountings; the planning of component production, evaluation and use of machines and equipment, the accurate production of components for assembly and the construction of sub-assemblies and modules.

Learning outcome	**The learner will:**
1. Be able to produce components and sub-assemblies for the outfitting of boats	
Assessment criteria	
The learner can: 1.1 draw up a production schedule and cutting list for components and **sub-assembly** from drawings and other data 1.2 select, mark out and cut materials for sub-assembly 1.3 describe the **constraints, considerations and conventions** when producing sub-assemblies 1.4 manufacture sub-assemblies 1.5 finish and inspect sub-assemblies 1.6 describe the **sources of data** required to mark out and manufacture components 1.7 explain the **characteristics and suitability** of materials for manufacture of sub-assemblies 1.8 describe the development of a production schedule and cutting list 1.9 identify **common defects** that will affect the selection of timber 1.10 explain the importance of **marking out methods**	

1.11 describe the most appropriate **methods for cutting**

1.12 identify **machines for cutting and shaping**

1.13 describe **types of defects** caused by machining and how to rectify them

1.14 identify the setting up process and safety requirements of machines

1.15 describe how prepared timber should be **protected from damage** during storage and transport

1.16 explain why it is important to ensure prepared materials meet the required accuracy

1.17 describe suitable jointing methods to assemble sub assemblies

1.18 identify **methods of constructing sub-assembly furniture units**

1.19 explain how fixing methods can affect: strength, appearance, shape

1.20 identify the **problems that can occur during assembly** operations

1.21 state the purpose of a structural bulkhead

1.22 explain the **requirements** that would affect the choice of final finish

1.23 state the **checks** that would be carried out to ensure sub-assemblies meet the design specification

1.24 describe the **methods used to protect** sub-assemblies from damage caused by wracking and surface damage

1.25 describe the methods of identifying sub-assemblies and recording the inspection process

Range

Sub-assemblies Doors, drawers, companionway steps, galley front trim, hatches, dorade boxes, bulkheads, sleeping cabin furniture, control consoles, toilet compartment, galley area, navigation area, main saloon

Constraints, considerations and conventions

Constraints – size, shape, access

Considerations – cost, customisation, availability, customer requirements.

Conventions – layout, size/space, height/width, ergonomics

Sources of data Drawing (line), general arrangement drawings, specification, CAD data

Characteristics and suitability Strength, durability, colour and grain pattern, cost, availability, environmental effects, ease of working

Common defects

Structural defects: shakes, spilts, rot and decay, worm

Cosmetic defects: knots, sapwood, pith

Dimensional defects: warping, twisting, shrinking

Marking out methods Nesting for economic cutting, use of face side and face edge, direct measurements, use of templates and patterns, spiling and scribing, setting out from a rod/setting board, shrinkage and moisture content

Methods for cutting Squares and rectangular sections, angled and bevelled cuts, shapes and profiles, apertures

Machines for cutting and shaping

Mortice machine, Lathe, pillar drill, bench grinder

Fixed woodworking machine: circular saws, band saws, surfacing

machine, thicknessing machine, spindle moulder, sanding machine

Portable power machines: drilling machine, jig saw, sanding machines

Hand operated machines; mitre cutting machine

Types of defects Chatter, splintering, distortion

Protected from damage Stacking, covering, wrapping, coating end grain

Methods of constructing sub-assembly furniture units Frame construction, slab construction, use of corner-posts

Problems that occur during assembly Splits, joints, alignment, geometric

Requirements Coating, paint, varnish, lacquer, oils

Checks

Measurement: alignment, geometric shape

Appearance: blemish free, matching grain, even colour, operation of doors, drawers and hatches

Methods used to protect Bracing, wrapping, covering, coating

Learning outcome	**The learner will:**
2. Be able to install structural components, modules, fittings, joinery and trim	
Assessment criteria	
The learner can:	
2.1	position and fix sub-assemblies
2.2	position and fix fittings and trim
2.3	finish and inspect completed installation
2.4	identify **tools, equipment** and services required to position and fix modules and joinery
2.5	describe the sources of **data** required to accurately position modules and interior joinery
2.6	describe the **preparation stages** required to prepare the work area
2.7	identify **methods** for aligning and fitting modules and joinery
2.8	state the **factors** that define selection of various fixing methods
2.9	describe the load factors that affect securing decisions
2.10	describe the conventions in positioning and fixing **underwater skin fittings**
2.11	describe the **steps to fit and align engine bed/plates,** cut and fit propeller shaft/tube and propeller support brackets
2.12	describe the **steps required to ensure that windows, hatches, fittings and port lights** are secure and watertight in accordance with current regulations
2.13	explain the **importance** of decorative capping, edging covering strips linings and fiddles
2.14	identify **soft furnishing materials** used in the trimming and outfitting of boats
2.15	explain why it is important to report problems and defects that cannot be rectified to a responsible person
2.16	describe the **inspection checks** that are suitable for completed modules, joinery and fittings
2.17	explain the importance of ensuring the surface finish meets specifications and is suitable for the application

2.18	identify **methods of achieving surface finishes** prior to coating
2.19	explain the importance of adequate finished product protection
2.20	explain the importance of recording inspections within the company quality control procedure

Range
Tools, equipment Hand tools, portable power tools. Equipment: clamps, cramps, temporary supports Services: power, lighting, ventilation **Data** Drawing (line), general arrangement drawings, specification, CAD data **Preparation stages** Levelling, location marks, temporary jigs and support equipment in place, inform other trade groups Prepare surfaces: cleaning, abrading, coating, de-greasing **Methods** Spile, cut, trim and fit, level and align, locate and temporarily fasten Temporarily secure: cramps, batons, packing, wedges **Factors** Strength, speed, corrosion resistant, aesthetics, replaceability **Underwater skin fittings** WC systems, engine inlets, grey water waste to tanks (to comply with RCD requirements) **Steps to fit and align engine bed/plates** Obtain data and manufacturer's recommendation, set up shaft line, cut and fix engine beds, cut and align stern tube, align and fix propeller bracket **Steps required to ensure that windows, hatches, fittings and port lights** Obtain data and manufacturer's recommendation, locate fitting accurately, cut aperture and dry fit, drill and temporarily fix, clean, degrease and apply appropriate sealant, fasten and evenly tighten to correct torque **Importance** Edge protection, aesthetics, spill protection **Soft furnishing materials** Fire resistant foam, fabrics **Inspection checks** Visual inspection, functional test, dimensional test **Methods of achieving surface finishes** Machinery, hand tools, abrasive sheets and grading system, cutting components

Unit 306 Establishing reinstatement requirements when servicing, repairing and maintaining boats

UAN:	**H/503/2393**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 209, 210, 211, 212, 213, 214 and 215.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. It is concerned with establishing reinstatement requirements, carrying out repairs to boat structures, and servicing and maintaining boats.

Learning outcome	**The learner will:**
1. Know how to establish reinstatement requirements	
Assessment criteria	
The learner can:	
1.1	explain the **sources of information** regarding the condition of the boat
1.2	explain a range of **inspections and tests** for reinstatement requirements
1.3	describe the **effects of electrolysis and osmosis**
1.4	explain the need to use **specialist services** for certain reinstatement work and how these services might be employed
1.5	explain the **techniques used to establish the extent and severity of damage to boats** made of different materials
1.6	explain the various **options for reinstatement operations**
1.7	describe the **factors affecting the choice of reinstatement** option
1.8	describe **reinstatement procedures**
1.9	state the **publications and professional services** available to advise in reinstating the full structural integrity of a repair
1.10	explain the **benefits of reinstatement operations** on the integrity of a boats structure and safety
1.11	explain how to determine and balance the time, materials, human resources and equipment costs for the reinstatement
1.12	describe the **inspection procedures** that are required to establish

the effectiveness of a reinstatement procedure

1.13 explain **who should be communicated with and the methods of communication** for reinstatement options.

Range

Sources of information Survey reports, customer information, insurance assessor

Inspections and tests

Inspections: impact damage – structural, non structural, cosmetic

Material defects – rot, corrosion, delamination

Functional integrity – hull strength, watertight

Tests: ultrasonic thickness, FRP hardness (Barcol tester), delamination, blistering, moisture content, timber softness, core sampling, corrosion, stress

Effects of electrolysis and osmosis

Electrolysis - Oxidation (rust on iron, verdigris on copper), electrolytic action (dissimilar metals or stray current), pitting, depletion of anode, dezincification, crevice crack corrosion

Osmosis – blistering, moisture retention, heavier displacement

Specialist services Electrical, engineering, plumbing & heating, rigging & sailmaking, shipwright/ boatbuilder, painting/varnishing and finishing, upholstery & furnishing

Techniques used to establish the extent and severity of damage

Visual, audible (taping with a hammer), experience and previous specialised knowledge, resistance of a surface to pressure (wood rot)

Options for reinstatement operations Repair, refurbish, replace/renew

Factors affecting the choice of reinstatement Safety, structural integrity, cost, time, longevity of repair, availability of materials, customer requirements, insurance assessments, resources available

Reinstatement procedures Surface cleaning (Shot-blasting, etching treatments) & repainting, cutting out corroded area and replacing with new (i.e. welding in a new plate), renew anodes, bonding in metallic fittings to sacrificial anodes

Publications and professional services Lloyds rules, RCD requirements, professional surveyor, naval architect, Lloyds surveyor

Benefits of reinstatement operations On the integrity of a boat's structure and safety watertight, craft aesthetics, craft performance, systems performance

Inspection procedures Visual, checking water tightness, operational function e.g. repair to a sliding hatch

Who should be communicated with and methods of communication

Communication to customer by formal letter and detailed estimate

Communication to management by detailed list of requirements needed to carry out reinstatement operations (labour hours, materials)

Communication to suppliers/service providers by formal requests in writing or by phone, fax or internet

Learning outcome	The learner will:
2. Be able to carry out repairs to boat structure	
Assessment criteria	
The learner can: 2.1 explain **sources** of reports and drawings that detail the area to be repaired 2.2 explain **procedures** to be followed prior to starting a repair 2.3 describe **services** that should be disconnected, isolated or drained to ensure safe reinstatement 2.4 describe the types of components which can be removed and replaced 2.5 remove damaged material and components with minimal damage to surrounding area 2.6 explain how to **label and store safely** components that have been removed but must be reinstated 2.7 explain **methods used to maintain structural integrit**y when major items have been removed 2.8 explain the **importance of waste removal** and maintaining a clear and tidy work environment 2.9 explain how to **dispose of waste correctly** 2.10 Use the correct **tools for the procedure** to be undertaken 2.11 explain the **factors** which need to be taken into account when positioning replacement components 2.12 secure replacement components using appropriate **methods** 2.13 complete **finishing operations** 2.14 explain the **safety issues** when using sealants, bonding agents, adhesives and coatings 2.15 **prepare the work surface** to receive the **components** 2.16 set and position components using appropriate **methods** prior to securing them 2.17 describe **fastenings** used for repair operations 2.18 explain the **factors that might jeopardise the structural integrity** of the vessel 2.19 explain **tests** on repaired items to ensure they meet company and regulatory bodies' quality control requirements 2.20 explain the **consequences** of neglecting the appropriate tests and reporting schemes 2.21 explain **causes of defects** that can occur in repair work 2.22 explain the **importance** of informing customers of defects which are outside the current reinstatement specification 2.23 explain the **information required on report forms** 2.24 describe the **information sources** that can assist the inspection process	

Range
Sources Lloyds surveyor, survey reports, customer information, insurance assessor, company drawing office **Procedures** Locate the area for repair, inform other personnel of your intentions, identify any hazards that might exist, identify services that need isolating, determine a sequence of operations

Services Disconnection of electrical supplies, disconnection of gas supplies, emptying of fuel tanks, emptying waste and water tanks

Label and store safely Name of vessel, location in vessel, orientation (facing aft, frd), wrapping or covering to minimise damage during storage

Methods used to maintain structural integrity Temporary moulds or frames, bracing, shores, strops, stays

Importance of waste removal To comply with legislation (national and local), to reduce the risk of accidents

Dispose of waste correctly Safe disposal of hazardous waste, thorough removal of non-hazardous waste, ensure material does not fall into bilges

Tools for the procedure

Metal: electric or pneumatic grinder/cutter, file, hacksaw, welder, drill

FRP: electric or pneumatic grinder/cutter, rasp / file, electric or pneumatic jig, saw/reciprocating saw, drill, hole saw, foam or pile roller, consolidating roller

Wood: saw: hand/jig, plane/spokeshave, electric plane/router, chisel, bevel gauge/combination square, marking/measuring equipment

Factors Dimensional accuracy, alignment, orientation, constructional integrity

Methods Mechanical fastenings, adhesives, frp bonding, jointing, thermal (welding brazing)

Finishing operations Fairing, sealing, protective coatings, polishing

Safety issues Fumes and respiratory hazards, skin reactions, fire risk

Prepare the work surface Remove all damaged/decayed material, abrade, degrease, prime

Components Sub-assemblies (hatches, skylights rudders, planking, stem, decking, coamings, beams, bulk heads, underwater skin fittings, windows/portlights, cappings and cover strips, deck fittings, furniture units, domestic units, linings, soft furnishings

Methods of setting and positioning components Measuring, aligning, clamping

Fastenings Screws: wood/self tapping, coach screws, bolts & machine screws nuts and washers, coach bolts, nails/ring &other types, staples, copper nails & roves, aluminium rivets

Factors that might jeopardise the structural integrity Incorrect materials, workmanship, technique

Tests Visual, dimensional, alignment, water-tight, buoyancy

Consequences Failure of component, poor quality assurance, lose of company reputation, litigation

Causes of defects

Defects - Incorrect dimensions, misalignment, poor finish

Causes - Poor setting out, incorrect materials, poor workmanship, incorrect technique

Importance To maintain the integrity and satisfactory completion of the work, to maintain the reputation of the company, to allow the customer to reconsider the continuation of the repair

Information required on report forms Description of repair undertaken, materials used, time taken, quality assurance signature, approval signature

Information sources Design specification, equipment manufacturers' specifications, customer's specification, surveyor's specification, reinstatement plans, job instructions

Learning outcome	The learner will:
3. Know how to service and maintain boats	
Assessment criteria	
The learner can: 3.1 describe **documentation** for servicing & maintenance operations on boats 3.2 state the **specialist personnel** required when carrying out non-routine service & maintenance operations 3.3 describe the **locations and factors** which will affect service & maintenance operations 3.4 describe **equipment** used for supporting and transporting boats 3.5 explain the **checks** required prior to using lifting and handling equipment 3.6 state the **suitable lifting points and support areas** on a boat for hooks, strops & slings 3.7 explain the **consequences of incorrect lifting and shoring practices** 3.8 explain the use of spreader bars to improve the loading on a vessel's sides when lifting with a crane and slings 3.9 explain the relationship between the length of slings used to lift a boat and the loads imposed upon the hull and deck structure 3.10 describe the **tools and equipment** required to carry out cleaning operations before servicing 3.11 state **safety checks** to be carried out on tools and equipment 3.12 list **components** which need to be checked for wear and tear 3.13 distinguish between **routine and non-routine** servicing operations 3.14 describe a range of **surface coatings** 3.15 identify the **application techniques** for surface coatings 3.16 explain the **functions** of surface coatings 3.17 describe **cleaning agents** used for a variety of surface coatings 3.18 describe **surface coating defects** 3.19 explain the procedures for **safe removal and disposal** of defective surface coatings 3.20 describe types of **servicing schedules** 3.21 explain how the **materials** from which a boat is constructed affects the type and frequency of servicing 3.22 explain when it is acceptable to use alternative components 3.23 describe what **information** should be recorded in pre-service and post service records 3.24 describe the correct **storage method** for deck equipment 3.25 describe the **storage systems for safety and protection equipment** 3.26 identify **items on a boat that have a 'service life'** 3.27 identify the condition of the **ground tackle** and its connections	

Range
Documentation Boat logs, RCD handbook, service records, service schedules, job instructions, material requisition sheets, time sheets

Specialist personnel Electrician/ electronics engineer, engineer/marine fitter, plumber, rigger and sail maker, shipwright/ boat builder/joiner, painter/french polisher, upholsterer

Locations and factors

Location: Yard, shed, afloat

Factors: Temperature, weather

Equipment

Lifting and moving equipment: slipway, cranes, mobile hoists, fork lift, tractor, greasy ways, rollers

Supporting equipment: trolleys, cradles, trailers, keel blocks, shores, pads & wedges

Checks Safe working load, current test certificate, damage to strops/slings, are there competent personnel to operate, is the movement area safe & clear

Suitable lifting points and support areas Manufacturer's recommended lifting/supporting points, location of bulkheads, ring frames, location of main beams, deadwood, ballast keel

Consequences of incorrect lifting and shoring practices Damage to boat, danger to personnel, cost of damage repair, litigation

Tools and equipment Hull cleaning equipment (pressure washers), scrappers, sanders, personal safety equipment (masks, groves, overalls, goggles

Safety checks P.A.T. certificate, check cables for damage

Components Cleats, fairleads, bollards, sampson post, protection strip, decking & nonslip components, sheet and sail fittings, sheet & sail control gear, masts, mast track, gooseneck fitting, booms, steering fittings, domestic fittings, safety fittings

Routine and non-routine

Routine: annual customer servicing contract, cleaning and anti fouling, touching up defective finishes

Non-routine: identification and replacement of defective components, replacement of 'lifed' items such as filters, recording identified defects not covered by service, re-painting and varnishing

Surface coatings

Paints: oil based, polyurethane, epoxy, water, cellulose, varnish, polyurethane, water, cellulose, oils

Resins: epoxy resin, polyesters /gelcoats

Manufactured laminates melamine

Preservatives

Application techniques Brush, roller, spray, rub, foam brush / pad

Functions Physical protection of substrate, decorative, preservation of substrate, prevention of corrosion, to cover unsightly features (fibre pattern in fibre reinforced plastics)

Cleaning agents Detergents, solvents, cream cleaners, natural astringents (lemon juice, vinegar)

Surface coating defects Peeling, flaking, erosion, scratches, scuffes, blisters, orange peel, pin holes

Safe removal and disposal Use of PPE, mechanical (scrapping & sanding), heat, chemical, disposal procedures for waste materials, if hazardous, in accordance with the hazardous waste directive 2005

Servicing schedules Manufacturers' recommendations, company guidelines, customer requirements

Materials Timber, metal, fibre reinforced plastics, thermoplastic

Information Date, vessel, location, defects found, action taken, time taken, materials used, quality control checks and signatures, costs

Storage method

Anchors: chocks, stemhead fitting, hawse pipe

Spinnaker pole: deck chocks, up mast

Life raft, winch handles, danbuoy, life ring, mob recovery gear, gas bottles, boathook, dinghy(davits)

Storage systems for safety and protection equipment

Fire extinguishers/fire blanket – kept internally next to an escape route or possible source of fire

Flares and distress signals – watertight container, to hand

Life jackets and harnesses – dry storage area when not in use

Fenders – pulpit rack or cockpit locker

Items on a boat that have a 'service life' Flares, filters, fire extinguishers, life rafts, life jackets, safety items with batteries (EPIRB - Emergency Position Indicating Radio Beacon)

Ground tackle Anchors, chains, connecting shackles, chain swivels, warps, mooring buoys, mousings

Unit 307 Fibre reinforced plastics technology for marine construction

UAN:	**T/503/2396**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 216 and 217.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This unit is concerned with the underlying process technology associated with wet lay ups involving dry cloths and resins together with pre-impregnated materials used in marine construction. It covers the process variables in detail, including the management of raw materials, plug and mould construction, incorporation of inserts for deck fittings, hull stiffening and datum points for internal fixings, the construction of vacuum bags for components and the various lay up techniques involved in composite manufacture within marine construction. It also covers the use of curing techniques appropriate the application, position and size of a component together with all safe working practices.

Learning outcome	**The learner will:**
1. Understand process techniques for given applications	
Assessment criteria	
The learner can:	
1.1	select a process for a given application
1.2	evaluate the suitability of a process for a given application
1.3	record details and process operation requirements
1.4	prepare reports to show progress and requirements
1.5	describe **component construction techniques** used with FRP for marine construction
1.6	describe **matrix systems and limitations** of the systems
1.7	state the reasons for the selection of specific matrix systems
1.8	prepare and manage resin systems in accordance with specification

/manufacturer's recommendations

1.9 describe techniques used to ensure dry reinforcing materials are completely wetted

1.10 describe how to ensure consistency of matrix mixing for large component construction

1.11 store and manage pre-impregnated reinforcing materials

1.12 describe recording procedure to be followed in the management and use of pre-impregnated reinforcing materials

1.13 describe **components required to vacuum bag**

1.14 describe preparation and use of material usage records

1.15 describe procedures for component construction techniques

1.16 describe methods of recording details, data and process operations to enable a construction technique to be used effectively.

Range
Component construction techniques Hand lay ups, spray lay ups, contact moulding, resin transfer moulding, injection moulding, resin infusion, vacuum bagging
Matrix systems and limitations
Polyester – secondary bonding, less water resistant
Vinylester – expensive, secondary bonding
Epoxy – expensive, used with advanced composites
Components required to vacuum bag Porous release film, Absorption/bleeder cloth, Non porous release cloth, Air breather, Vacuum bag, Vacuum bag tape, compressor, vacuum gauge

Learning outcome	**The learner will:**
2. Be able to specify consumables, moulds, formers and ancillary equipment	
Assessment criteria	
The learner can:	
2.1 identify the range of consumables/ancillaries required for process selection and application	
2.2 select materials for a given application and justify their use	
2.3 select moulds/formers for a given application and justify their use	
2.4 select ancillaries required to support the process selection	
2.5 prepare and set up ancillary equipment	
2.6 describe **types of cloth and weave patterns** available	
2.7 state reasons for the selection of weaves stated	
2.8 describe storage and management procedures for the use of **materials in FRP laminating**	
2.9 describe design features of moulds and formers for complex shapes	
2.10 describe **plug and mould construction details**	
2.11 describe design features for moulds for complete **internal units**	
2.12 describe preparation for moulds for complex shapes in readiness for lay up	
2.13 describe **materials used for sandwich construction**	
2.14 describe the use of **specialist equipment**	

2.15	describe preparation and setting of hot bond controller and autoclave units

Range
Types of cloth and weave patterns Plain weaves, twill cloth, satin weave, unidirectional weave, chopped strand mat, needle loom or needle mat cloth, woven rovings, multiaxial fabrics combination mats
Materials in frp laminating Resins/adhesives, associated hardeners and accelerators, dry reinforcing materials, sized reinforcing materials, pre-impregnated reinforcing materials, film adhesives, melinex film, solvents and cleaning agents
Plug and mould construction details Inserts for deck fittings, non skid surfaces, skin fittings, hull stiffening and datum points for internal fittings, engine seating arrangements
Internal units Galley units, toilet compartments (heads), accommodation units
Materials used for sandwich construction Wood, foam, honeycomb constructions – glass, aluminium, composites
Specialist equipment Mould supports and cradling, platforms, heater blankets, hot bond controller, autoclave units

Learning outcome	**The learner will:**
3. Be able to plan an effective lay up procedure for a process technique	
Assessment criteria	
The learner can:	
3.1	identify materials and resin requirements from specifications/drawings in readiness for component construction
3.2	apply calculations to determine surface area gel coat and resin quantities
3.3	prepare an ordered schedule of activities to produce component/parts
3.4	select tools, equipment, moulds, formers for a given process technique
3.5	describe types and features of fibre used in composite construction for marine construction
3.6	describe use of weave orientation used to achieve maximum strength
3.7	describe **stages** required to produce complex shapes/components using dry and pre-impregnated reinforcing materials
3.8	state fibre resin ratios recommended by manufacturer's design specifications
3.9	describe the **standard formulas** for the calculation of irregular areas and volumes
3.10	describe procedures involved in calculation of surface area, gel and resin requirements
3.11	state the reason for the tight control of fibre resin ratio
3.12	describe procedures used to monitor fibre resin ratio
3.13	identify **suitable weighing and mixing equipment** for resins to ensure conformity of mixes
3.14	describe **methods** used to incorporate stiffening and load bearing components in laminated and honeycomb structures

3.15	state the requirement for stiffening and cradling in the support of hulls
3.16	describe the construction sequence for plug making
3.17	describe procedures to be followed when using split moulds
3.18	describe **procedures for trimming of finished moulds**
3.19	describe the procedures to follow to ensure optimum quality of manufactured products

Range
Stages Application of compatible release agents, correct tailoring of reinforcement and upstand without compromising strength of reinforcement, apply correct resin and correct resin ratios
Standard formula Surface area and volume of plane figures, mid-ordinate rule or Simpson's rule for the surface area of irregular figures, theorem of Pythagoras
Suitable weighing and mixing equipment Calibrated, capable of weighing amount required
Methods Vacuum bagging, weight to hold in place, temporary hold fast
Procedures for trimming of finished moulds Marking out to design tolerances, apertures, flanges, excess removal using the appropriate equipment, safe disposal of waste material, personal dust protective clothing, extraction and filtration equipment

Learning outcome	**The learner will:**
4. Be able to monitor and control safe lay-up procedures	
Assessment criteria	
The learner can:	
4.1	set up moulds/formers for complex lay up using dry or pre-impregnated materials
4.2	implement and monitor a safe lay up operation
4.3	use a stated procedure sheet
4.4	use correct sequence of operations for a given application
4.5	green trim to comply with specification/drawing
4.6	trim and finish moulds to comply with drawing
4.7	carry out testing for resin cure
4.8	describe **current regulations** in regard to health and safety
4.9	describe how to prepare mould/former surfaces in readiness for lay ups
4.10	describe requirements for a clean and contaminate free work area
4.11	describe the correct operation of tools, equipment and machinery used in lay up of composite materials
4.12	describe **factors that affect the quality of a composite**
4.13	describe the requirements regarding environmental conditions which should be monitored and adjusted to comply with safety requirements
4.14	state the **requirements for trimming and removal** of excess material
4.15	describe non-destructive and destructive **testing methods**
4.16	interpret results from test conducted
4.17	describe procedures to ensure effective composite construction

Range
Current regulations Handling of resins, handling of equipment HSAWA section 7, COSHH, safe disposal of materials, personal protection, lifting and handling, cutting tools **Factors that affect quality of a composite** Use of: Correct process parameters at each stage of the process, clean and uncontaminated equipment and materials, controlled workshop conditions in respect of humidity and temperature **Requirements for trimming and removal** Area to repair marked out to design tolerances, material removed using the appropriate equipment, safe disposal of waste material, adequate extraction and filtration during material removal, personal dust protective clothing to be worn **Testing methods** Destructive – ash test, Barcol hardness tester Non destructive – visual

Unit 308 Installation and repair of vessel services

UAN:	**F/503/2398**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 207, 208, 209, 210, 211, 212, 213, 214 and 215.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. It is concerned with installation of vessel service systems and carrying out inspection and repairs of boat systems.

Learning outcome	**The learner will:**
1. Be able to describe and install vessel service systems	
Assessment criteria	
The learner can: 1.1 select and use **documentation** necessary for planning and routing systems 1.2 select and use the **components** of domestic service systems and describe their use 1.3 install a vessel's **service systems** 1.4 identify the **codes of practice and regulations** relating to quality of work and the operating environment of a vessel 1.5 state the **criteria for planning and installing marine systems** within a boat 1.6 explain the **key criteria** for planning and installing air conditioning and heating systems 1.7 explain why it is important to involve and **communicate with other specialist trades** in electrical or electronic sensor installation 1.8 explain why it is important to configure and connect components with regard to equipment orientation and the direction of the flow 1.9 identify the forms of **system installation problems** that may occur and how to prevent them 1.10 identify the **specific tests** to be carried out by appropriately qualified engineers 1.11 carry out **inspection and testing checks** that are necessary for service installation	

1.12 explain the importance of recording test results and reporting any discrepancy to an appropriate person

Range
Documentation Layout drawings, system specifications, job instructions, component manufacturers data sheets, installation instructions
Components Piping, pipe connectors, tanks, pumps, valves, drains, ancillary fittings, heaters
Service systems Cold water, hot water, domestic waste (grey water system), sanitary (black water system), air conditioning, vacuum, deck and cockpit drain system (air conditioning and vacuum optional on practical, cover in theory as specialised)
Codes of practice and regulations ISO 1400, RCD, Lloyds, HSE
Criteria for planning and installing marine systems
Specification and layout drawings, access for installation and maintenance, material usage, sufficient water pressure for the number of outlets, tank capacity and positioning, method and location of discharge arrangements
Black water system: pumps, tanks (polypropylene, SS, galvanised steel), piping (sanitary specification), fitting, sea cock, vent, deck pump, outlet, inlet filters
Grey water system: pumps, tanks (polypropylene, SS), piping (PVC), pipe clip and brackets, venting, fitting and sink/shower drains
Cockpit water system: sea cocks/ball valve, outlet fittings, piping (PVC, SS, moulded), pipe clip and brackets, crossover drainage pipes
Hot and cold water systems: Tanks, pumps, divert and shut-off valves, in line filters, calorifier, immersion heater, desalination units, connectors (compression joints, screw joints, cemented/glued joints, soldered joints, outlet taps/shower units)
Key criteria
Air conditioning: system specifications and manufacturer's instructions, position of unit, pipe and outlet runs for effective operation, access for installation and maintenance, provision for waste heat removal, provision for waste water removal, relevance of standards (BSI, RCD).
Heating systems (fixed and hot air): specification of manufacturer's instructions, position of units, heat exhaust system, insulation and fire resistance of the system, position for efficiency of heat transfer, relevance of standards (BSI, RCD)
Communicate with other specialist trades
Plumbers, electrical/electronic installers, shipwrights, joiners, fitters, engineers, painters, upholsterers
Planning installation (critical path analysis) duplication of work, sequencing of work, timescales, damage limitation
System installation problems
Contaminants, poor connections, incorrect orientation, positioning of filters, incorrect pipe runs, pinching, tight bends and crushing of pipes, head of water
Specific tests Gas safe (CORGI), electronics/electrical systems (BMEA qualified engineer)
Inspection and testing checks
Visual checks: mechanical joints, clips tight, pipe runs, correct orientation, sufficient clips/brackets to avoid sagging, insulation in

position, other trade connections completed, units and tanks secure, visual inspection for leaks

Pressure/leak tests: pressure test to manufacturer's instruction/ISO standards, manometer

Functional test: system operation, flow checks, automatic pump function, control system function, heat delivery, cool air delivery, sea cock operation, filter operation.

Learning outcome	**The learner will:**
2. Be able to carry out an inspection and repair a boat system	
Assessment criteria	
The learner can: 2.1 identify the **sources of information** relating to the condition of the boat systems 2.2 describe the **range of inspections** carried out when looking for systems damage 2.3 describe the **specialist services** needed for certain reinstatement work and how these services might be employed 2.4 undertake **inspection, fault finding and testing procedures** 2.5 identify the **options available for restoration** 2.6 identify the **specification limits** which will affect options for restoration 2.7 describe **common faults** on various boat systems 2.8 describe **safety and isolation** procedures 2.9 plan and carry out the required **procedures**, then undertake the **system repair** and **reinstatement** as identified 2.10 identify and use the **tools** required for the testing, repair and replacement of system **components** 2.11 identify potentially defective system components 2.12 identify the **common defects** that may occur following a repair 2.13 complete and record results of inspection and repairs carried out	

Range
Sources of information Workshop manuals, boat data sheets, repair history, parts lists, job instructions
Range of inspections
Mechanical systems – power; drive; steering
Electrical/electronic systems – power; lighting
Domestic systems – water; waste; sanitary; utility
Specialist services Electrical, engineering, plumbing, heating
Inspection, fault finding and testing procedures Visual inspections, function test, operational test, static test, leak test, electrical tests (system dependant)
Options available for restoration Replacement, repair, adjustment
Specification limits System performance, craft operating environment, safety limits, system manufacturer's recommendations, company specifications, surveyors reports, customer requirements
Common faults Defective minor components and major components, maladjusted system components
Safety and isolation Disconnection of electrical and gas supplies,

emptying of fuel tanks, emptying waste and water tanks

Procedures required prior to starting a repair Locate the area for repair, inform other personnel, identify hazards that might exist, identify services that need isolating

Procedures required after reinstating a system repair Filling system correctly with no leaks, Venting system with no leaks, purging, attaching suitable test equipment (by qualified engineer)

Tools Specialist trade fault finding equipment, pipe grips, stilsons, spanners, sockets, screwdrivers, mole grips, hammer, pliers, metal cutting saw, pipe cutters, pipe benders, soldering iron or brazing torch

Components Piping, pipe connectors, pumps, valves, tanks, utility fittings, heaters, mechanical mechanisms, switches/relays, electrical/electronic control units

Common defects Leaks, faulty connections, defective components, aesthetic damage

Unit 309 Installation and repair of marine engines

UAN:	**J/503/2399**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 206, 209 and 213.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. It is concerned with using tools, equipment and materials to diagnose and rectify faults in marine systems. It also covers the layout and operating principles of marine systems.

Learning outcome	**The learner will:**
1. Be able to use the tools, equipment and materials required to diagnose and rectify faults in marine engine systems and components	
Assessment criteria	
The learner can: 1.1 describe the special purpose **tools, equipment and materials** needed to diagnose and rectify faults in systems and components 1.2 explain the **principal differences** between the construction of a CI and SI engine 1.3 describe the functional requirements of ancillary systems, engine systems and components 1.4 describe the purpose of **ancillary systems, engine systems and components**	

Range
Tools equipment and materials Strobe light, dwell meter, tachometer, coolant system pressure tester, equipment for testing thermostat, injector pressure tester, small hand tools specified by manufacturer, cylinder compression tester, cylinder leak tester, battery drop test, multi meters
Principal differences
Compression ignition (diesel), spark ignition (petrol)
Need for greater strength in CI engine, differences in combustion chamber design, piston design, use of materials, combustion requirements (temperature)

SI and CI engines incorporating fixed and variable valve lift and timing systems: SI engine management and fuel systems, CI engine management and fuel systems

Air supply and control system: crankcase emission control systems, normally aspirated

Exhaust systems: catalytic converters

Ancillary systems, engine systems and components

Air cooling systems, lubrication systems, electrical equipment (alternators, starting, charging, ancillaries), ignition systems (control unit (ecu/distributor)), starting systems, charging systems, liquid cooling systems, exhaust systems (silencing, noise, vibration control, emission control, water cooled control), sensors (lambda, oxygen), drive shafts (dynamic dampers)

Learning outcome	**The learner will:**
2. Understand the layout and operating principles of marine engine systems and components	

Assessment criteria

The learner can:

2.1 describe the **operating principles of systems and components** which require removal, overhaul and refitting

2.2 describe how to prepare the systems for diagnosis and rectification

2.3 describe how to prepare hand tools, special purpose tools, equipment and materials required to remove and refit systems and components

2.4 describe how to use hand tools, special purpose tools, equipment and materials required to remove and refit systems and components

Range

Operating principles of systems and components

SI and CI engines: variable valve timing, variable lift, multi-valve arrangements

SI and CI engine management and fuel systems: control valves and relays, sensors, ecu, pumps, wiring systems and connections, break out boxes

Engine lubrication systems: pumps: rotor, gear, vane and crescent, filters, full flow and by pass valves, pressure relief valves, pressure indicating and warning systems, lubricants

Cooling systems: coolants, temperature control systems

Air supply and control system: crankcase emission control systems, normally aspirated

Drive shafts: constant velocity joints, dynamic dampers

Hubs and bearings: front, rear

Electrical and electronic systems: starting, charging, ancillaries

Learning outcome	The learner will:
3. Be able to diagnose faulty systems and components including removal, rectification/refit and evaluation	

Assessment criteria

The learner can:

3.1 describe the **methods used to diagnose** faulty systems and components

3.2 describe the **methods to obtain and interpret diagnostic information**

3.3 diagnose and rectify faulty systems and components in

- **SI and CI engines**
- **engine lubrication systems**
- **cooling systems**
- **petrol fuel supply systems**
- **engine management systems**
- **diesel fuel supply systems**
- **electrical systems**

3.4 state the requirements for disposing of waste materials during fault diagnosis and rectification in accordance with BS 14001

3.5 evaluate the operational efficiency of the **systems and components** following diagnosis and rectification.

Range

Methods used to diagnose

Sea trials, simulated tests, measurements, fault code analysis

Interpreting data obtained from electronic system tests (manufacturer's computer diagnostics): fault code analysis, sensor measurements, control unit outputs/signals

Methods to obtain and interpret diagnostic information

Mechanical condition, wear, pressures, flow, leakage, efficiency

SI and CI engines Variable valve timing, variable lift, multi-valve arrangements, cylinder blocks, heads, pistons, connecting rods and gaskets, camshafts, valve timing, timing belts, chains and tensioners, drive mechanisms for ancillary equipment, balancers and dampers, crankshafts and flywheels

Engine lubrication systems

Pumps: rotor, gear, vane and crescent

Filters: full flow and by pass valves

Pressure relief valves, pressure indicating and warning systems, lubricants

Cooling systems Coolants, temperature control systems

Petrol fuel supply systems

Petrol injectors: single and multi point

Petrol pumps: mechanical and electrical (submerged)

Supply and return lines and filters

Engine management systems

SI engines: electronic control units, sensors and relays, switches

CI engines: electronic control units, sensors and relays, switches

Diesel fuel supply systems Rotary pumps, in-line pumps, fuel injectors - single/multi-hole, common rail and pressure time systems, lift pumps, cold starting aids

Electrical systems

Starting systems: starter motors, electrical connections, switches and solenoids

Charging systems: alternators and drive systems, electrical connections

Systems and components SI and CI engines and components, liquid cooling system and components, lubrication system and components, air supply system components, petrol fuel supply system components, engine management components on SI engines, engine management components on CI engines, diesel fuel supply system components, electronic spark-ignition systems and components, electrical systems and components

Unit 310 Installation and repair of marine propulsion systems

UAN:	**T/503/2401**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 206, 209 and 213.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. The aim of this unit to equip candidates with the skills and knowledge needed to carry out diagnosis and rectification associated with marine propulsion systems.

Learning outcome	**The learner will:**
1. Understand the characteristics of hull forms and propulsion systems	
Assessment criteria	
The learner can: 1.1 identify types of hull in marine use 1.2 identify marine propulsion systems and components 1.3 identify the various **hull forms** and types of construction 1.4 state the relationship between hull waterline length, wave making and speed 1.5 identify the type and positioning of the **main mechanical assemblies** for various hull forms 1.6 state the **propulsion components** which effect the weight, position, trim and performance on a vessel 1.7 state the **factors** that affect the relationship between the wetted surface area and drag	

Range
Hull forms
Mono hulls: displacement, semi-displacement, planning hard-chine deep vee, very slender vessel/wave piercing (VSV)
Multi-hulls: catamarans, trimarans
Small water plane area twin hull (SWATH)
Main mechanical assemblies
Engine/multi-engine power layouts: diesel, diesel-electric
Gearbox, propeller shaft, rudders/steering systems
Propulsion components Shaft length, shaft angle, shaft location, stern

tube, stern glands, plummer blocks, outdrive, outboard

Factors Shaft/s, A brackets, P brackets, rudder/s, outdrive, propeller/s, inlets/outlets, grills/gratings, thrusters inlets/outlets, anodes, hull form

Learning outcome	**The learner will:**
2. Understand the layout and operating characteristics of systems and components	

Assessment criteria

The learner can:

2.1 identify and gain access to systems

2.2 prepare systems for diagnosis and rectification

2.3 identify **features of propulsion systems** and mode of operation

2.4 identify the main **components of propulsion systems and auxiliaries** and state the purpose and operating characteristics

2.5 identify **tools and equipment** required for fault diagnosis and rectification

2.6 identify **data** required for fault diagnosis and rectification

2.7 state **hazards** when working with marine propulsion systems and **precautions** to be taken

Range

Features of propulsion systems

In board engines: assembly fixtures, transmission systems, fuel tanks and fixtures, electrical connections, controls

Out board engines: assembly and correct transom mounting, control systems, fuel tanks and fixtures, electrical connections

Components of propulsion systems and auxiliaries

Gearbox and reduction gear:

Epicyclic gearbox, step-down/angled gearbox, hydraulic drive gearbox, thrusters bow/stern, clutches (manual, hydraulic, single-plate, multi-plate, dog)

Drive systems:

Outdrives, mounting, trimming, controls, kill-cords/auto-stops, steering wires, z drives, vee drives, hydraulic, electric, jet/water pump, centrifugal, turbine, nozzles, steering rams, Voith Schneider (blade position, number, angle, controls)

Lubrication systems:

Pumps, filters, valves, controls, lubricants

Cooling systems:

Wet/dry, coolants, controls, thermostat

Propellers:

Two/three/four bladed, twin screws, effects of diameter, pitch, slip, aspect, cavitation, cleaver pitch, surface piercing

Drive shafts:

Couplings, flange, flexible, universal, hydraulic, lock methods, key ways, splines, pins, cotters

Rudders/steering systems:

Spade, balanced, un-balanced, controls, cable, morse, telefax, worm, chain/sprocket, hydraulic, electric fixings, pintles, gudgeons, cross-head, stern tubes, packing/seals, bow thrusters

Tools and equipment Test equipment (computer engine software), Measuring devices/meters (dial gauges, feeler gauges), Hand tools (pullers, sockets and spanners, screwdrivers, torque wrench, hammers), Manufacturers recommended tools

Data Manufacturer's data and information sheets, service schedules, parts lists, trade association check lists, legal and technical data reference books

Hazards Danger from power transmission systems rotating, reciprocating machinery and parts, use of lifting equipment, lubricants and fuels, electrical equipment and systems, fire risks

Precautions

Lubricants and fuels: skin protection and ventilation

Use of Personal Protective Equipment (PPE): goggles, gloves, safety equipment

Legislation: COSHH, HASAW, Codes of Practice

Electrical equipment and systems: isolation, low-voltage systems.

Fire risks: precautions with fuels

Application and safe use of lifting equipment

Safe storage and disposal of materials

Good housekeeping procedures and environmental awareness

Learning outcome	**The learner will:**
3. Be able to diagnose faulty systems and components including removal, rectification/refit	
Assessment criteria	
The learner can: 3.1 overhaul faulty systems and components using **common procedures** 3.2 state **basic principles of fault diagnosis** 3.3 describe the **methods to diagnose faulty systems and components** 3.4 describe the **methods of obtaining and interpreting diagnostic information** 3.5 describe how to diagnose and rectify **faults in propulsion systems and components** 3.6 state **factors** which influence whether to repair or replace 3.7 state procedures for disposing of waste materials	

Range
Common procedures In situ repair and/or rectification, by removal and replacement
Basic principles of fault diagnosis System and component knowledge, collection of data, analysis of evidence, interpretation of tests, functional checks
Methods to diagnose faulty systems and components Sea trials, simulated tests, measurements, interpreting data from system tests, user evidence
Methods of obtaining and interpreting diagnostic information Mechanical condition, wear, pressures, flow, leakage, efficiency
Faults in propulsion systems and components Gearboxes, drive systems, lubrication systems, cooling systems, propellers, drive shafts,

rudders/steering systems **Factors** Cost of repair/replacement, availability of replacement parts, time for refit

Learning outcome	**The learner will:**
4. Be able to evaluate system and component performance following fault diagnosis and rectification of propulsion systems	
Assessment criteria	
The learner can: 4.1 select, prepare and use tools and equipment to evaluate system and component performance 4.2 state **actions** to be taken following evaluation of the system 4.3 describe the procedures for evaluating operational performance of **propulsion systems and components** 4.4 state **methods of recording and reporting** outcomes 4.5 make and record appropriate recommendations resulting from activities 4.6 complete schedule as appropriate and report problems **relevant persons**	

Range
Actions Identify time, component and labour costs, report to client/manager, fit new components, carry out repairs/rectification, check to see if work is fit for purpose **Propulsion systems and components** Gearboxes, drive systems, lubrication systems, cooling systems, propellers, drive shafts, rudders/steering systems **Methods of recording and reporting** Computers, manufacturer's recording sheets, trade association recording sheets, company specific recording sheets, RCD log **Relevant persons** Customer, manager, supervisor, manufacturer

Unit 311 Maintaining electrical marine engineering equipment and systems

UAN:	**H/503/6024**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 202, 203, 205, 210 and 211.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. It is concerned with the maintenance of electrical equipment and systems, re-commissioning equipment and reinstating the work area.

Learning outcome	**The learner will:**
1. Know how to maintain electrical equipment and systems	
Assessment criteria	
The learner can:	
1.1	describe how to obtain equipment circuit drawings and other related information
1.2	describe requirements for the care and safe keeping of equipment circuit drawings and other **related information**
1.3	explain how to correctly identify, label and store components and cables during disconnection
1.4	identify **documentation** that can be used to aid fault diagnosis
1.5	identify the **test parameters** relating to test equipment
1.6	describe **typical faults** with equipment and circuits that are being checked and their probable causes
1.7	describe **specialist electrical** tools used for maintenance and how to use them
1.8	state the **units of electrical measurements** and their multiples and sub-multiples
1.9	explain how to obtain units of electrical measurements in a circuit using the relevant measuring equipment
1.10	describe the **checks** that test equipment is subjected to before use
1.11	identify **test points** on the circuit from information provided on the circuit diagrams and specifications
1.12	describe how to select cables for different applications
1.13	describe the methods of coding wires and components
1.14	describe the use of component reference manuals to select

equivalent components

Range
Related information Manuals, circuit drawings, block diagrams, test schedules, manuals, safety guidance and job instructions, equipment and system specifications, specific fault diagnosis and testing instructions, advice on special tools that may be needed **Documentation** Manufacturers trouble shooting guide, functional diagrams, flow charts, systems circuits and wiring diagrams **Test parameters** Voltage drop, continuity of earth conductors, continuity of ring main conductors, insulation resistance between live conductors and each live conductor and earth, polarity, earth fault loop impedance, functional testing, systems, residual current device **Typical faults** Open circuit, short circuit, resistance fault, mechanical component fault **Specialist electrical tools** Cable strippers, side cutters, torches, soldering irons, solders and fluxes, cable terminating equipment, multimeter **Units of electrical measurements** Voltage (KV, mV), current (amps, milliamps) resistance (ohms), power (KW, W, mW) **Checks** Safe to use, suitable for the intended activities, within current calibration approval dates, able to cover the range of values to be measured **Test points** Voltage and current carrying capacities, voltage drops in 230 volt systems, marine environmental requirements (correction factors, vibration, chemical, ultra violet), prevention of interference

Learning outcome	**The learner will:**
2. Be able to maintain electrical equipment and systems	
Assessment criteria	
The learner can:	
2.1	explain the need for a permit to work system in a marine environment
2.2	explain the importance of verifying the power supply and integrity of fuses/circuit protection devices before proceeding further
2.3	carry out **visual checks** on circuits and components when looking for obvious signs of damage
2.4	use appropriate **methods** of identifying components and cables to ensure correct replacement and reconnection
2.5	connect instruments into a circuit correctly
2.6	explain **how to check circuits** prior to work
2.7	compare test results obtained against specification requirements
2.8	use calculations to assess the accuracy of electrical measurements
2.9	identify **diagnostic aids** used in electrical systems
2.10	explain how to use fault finding techniques for tracing electrical faults
2.11	identify **remedial actions** that could be taken
2.12	interpret information in order to determine the most likely causes of a fault
2.13	explain the importance of re-fitting heat shunts/shields correctly to prevent overheating of components and cables

2.14	record electrical faults, symptoms and their identified causes
2.15	use **principal electrical termination methods and devices**
2.16	explain how the **types of faults** can occur and how they can be overcome
2.17	identify **problems** encountered when maintaining electrical equipment/systems
2.18	ensure that **operational checks** have been carried out correctly
2.19	use **tests** to check that the equipment or system is re-commissioned and operating to specification

Range
Visual checks Broken connections, burnt or over heated casings, contact surfaces, cables or components and short circuits in components and cables
Methods Function testing, substitution, half split technique, emergent problem sequence
How to check circuits Isolate equipment, prove circuits are dead, use approved voltage testers, and suitably fused test probes
Diagnostic aids Circuit/wiring diagrams, equipment manuals, functional system charts, probability charts, maintenance/history records, equipment self diagnostics, electronic testing equipment
Remedial actions The unit should be replaced, the fault be further traced to component level, the repair is going to be cost effective, the repair being undertaken is a temporary measure whilst a new unit is ordered
Principal electrical termination methods and devices Terminal blocks, crimped connections, junction boxes, glands, supports, clips, earthing devices, cable connectors
Types of faults Open circuit, short circuit, resistance fault, mechanical component fault
Problems Ineffective Fault finding procedures, tools unavailable, damaged equipment, components cannot be removed, replacements parts not available, equipment cannot be re-commissioned
Operational checks All disconnections have been remade, all components correctly orientated, fuses/protection devices are installed, equipment and systems are free from wire ends, solder blobs and screws which could cause short circuits
Tests Operating functionality, use of test equipment (meters), calibration test

Learning outcome	**The learner will:**
3. Know how to re-commission equipment and re-instate the work area	
Assessment criteria	
The learner can:	
3.1	identify problems with instruments, tools, equipment or installation activities
3.2	explain how to deal with problems when they occur
3.3	explain the importance of recording faults, symptoms and their identified causes
3.4	identify the **responsibilities and regulations** relevant to the work being undertaken

3.5 explain the need for **good housekeeping arrangements**

Range
Responsibilities and regulations Use of approved forms, compliance with current regulations/legislation (BMEA, NMEA, RCD, classification societies' requirements) correct reporting procedures
Good housekeeping arrangements Cleaning down work areas, putting serviced instruments, tools and equipment into safe storage, keeping the work area free of waste/surplus materials, tools and equipment, labelling, and recording finished work

Unit 312 Principles of marine electrical systems

UAN:	**J/503/9840**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 202, 203 and 205.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering
Aim:	This optional unit is concerned with principles of marine electrical systems. It covers the functions of electrical components, electricity supply systems and functions of electrical machines and motors.

Learning outcome	**The learner will:**
1. Understand the functions of electrical components	
Assessment criteria	
The learner can: 1.1 state the **basic electrical units and relationships** 1.2 construct a circuit to demonstrate the function a resistor 1.3 describe the effect of stray magnetic fields and their effect on the operation of a magnetic compass 1.4 describe an electromagnetic circuit 1.5 describe inductance and capitance 1.6 plot a graph showing the effect of inductance and capacitance when connected to a dc supply 1.7 describe and use a range of electrical **test instruments** 1.8 use electronic **components** to construct a closed circuit applicable to the marine industry 1.9 describe the function of listed components	

Range
Basic electrical units and their relationships Energy – Joule, Current – Charge per unit time, Charge – I.t, Voltage – Energy per unit charge, Power - Energy per unit time – V.I, Resistance – Voltage per unit current. **Test instruments** Oscilloscope, multi-meter, ammeter, voltmeter **Components** Breakers, fuses, resistor, capacitor, transistors, batteries, printed circuit board (PCB), diode, integrated circuit, amplifier, filters,

Learning outcome	The learner will:
2. Understand electricity supply systems, protection and earthing	
Assessment criteria	
The learner can: 2.1 describe the range of **electricity supply systems** and their characteristics 2.2 describe **transformers** and their characteristics 2.3 demonstrate the function of electrical **switchgear** within a 12v/24v dc system 2.4 describe the functions of internal and external earthing systems 2.5 describe the function of fuses and breaker **protection** systems.	

Range
Electricity supply systems Battery (12volt, 24volt), generator (110volt, 230/240volt and 400volt 3 phase) mechanical, aero, water, photo voltaic (pv) **Transformers** Inverter, step-up, step-down **Switchgear.** Fuses**,** circuit breakers, switches, isolators, contactors, relays, residual current devices. **Protection systems,** Dangerous currents due to short circuits, earth and stray current leakage, overloads. The use of anodes

Learning outcome	The learner will:
3. Understand the functions of electrical machines and motors	
Assessment criteria	
The learner can: 3.1 describe the basic principles of **electricity generation systems** 3.2 identify the characteristics of single phase ac motors (rated below 1 kW).	

Range
Electricity generation systems Generators, wind power, solar power, electrical rotating machines (alternator, inverter)

Unit 313 Principles of integrated marine electronic systems

UAN:	**K/503/2413**
Level:	Level 3
Credit value:	14
GLH:	125
Relationship to NVQ:	This unit is linked to the following NVQ units: 202, 204, 205 and 212.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. It is covers the heath and safety requirements relating to installation of electronic navigation systems, preparation of and installation of these systems and how to commission them.

Learning outcome	**The learner will:**
1. Understand the Health and Safety requirements relating to the installation of integrated electronic navigation systems	
Assessment criteria	
The learner can: 1.1 state the precautions to be taken when using tools and equipment, including mast mounted equipment 1.2 explain why there is a need for personal **protective equipment (PPE)** 1.3 describe the safe practices and procedures required when carrying out assembly and installation activities on systems including the use of access equipment 1.4 describe the safe practices and procedures required when using sealants 1.5 identify the safety precautions to be observed when marking out and cutting openings for **instruments** 1.6 describe the methods of holding work pieces without damaging them 1.7 explain why it is necessary to protect components from **types of damage** 1.8 describe the **tasks** to be undertaken after completion of an installation	

Range
Personal Protective Equipment (PPE) Overalls, safety shoes, eye protection, gloves, barrier creams, anti static wristbands

Instruments Bulkhead mounted instruments, mast mounted transducers and sensors, cockpit and bridge mounted instruments **Types of damage** Projections, burrs, sharp edges, swarf/foreign bodies **Tasks** Leave the work area free of unused consumables, cleaning down work area, putting tools and equipment into safe storage, labelling and recording finished work

Learning outcome	**The learner will:**
2. Understand the preparations required to install integrated electronic navigation systems	
Assessment criteria	
The learner can: 2.1 evaluate and use **technical information** to plan the installation of integrated electronic navigation systems 2.2 explain procedures for the care and safe keeping of sources of drawings, and technical information 2.3 describe the importance of planning work activities 2.4 state the methods of producing work plans 2.5 explain information that must be contained in work plans 2.6 identify the **existing services** to be considered when installing integrated electronic navigation systems 2.7 carry out work planning activities 2.8 describe the techniques to be used to pass cables through watertight bulkheads	

Range
Technical information Installation drawings, manufacturer's instructions **Existing services** Gas, water, fuel, electricity, communications cables, data cables

Learning outcome	**The learner will:**
3. Be able to install the equipment, materials and components required for integrated electronic navigation systems	
Assessment criteria	
The learner can: 3.1 state the **factors which affect positioning** of **electronic systems** to ensure compliance with the industry codes of practice 3.2 describe the **factors which affect routing** of cables within **electronic installations** 3.3 install electronic navigation systems	

Range
Factors which affect the positioning Vessel stability, access and maintenance, routing of data cables and supply cables, protection to electrical circuits, operational functionality **Electronic systems** Radar sets, chart plotters, computers, wind instruments, depth instruments and fish finders, logs and depth instruments, position finding systems, autopilots

Factors which affect routing Aesthetics, watertight integrity, compliance with manufacturer's specifications, access and maintenance, stability, interference with moving parts **Electronic installations** Mast mounted transducers and senders, cockpit and flying bridge mounted instruments, wheelhouse mounted instruments

Learning outcome	**The learner will:**
4. Know how to commission integrated electronic navigation systems	
Assessment criteria	
The learner can: 4.1 demonstrate the function, operation and programming of **marine electronic instrumentation** 4.2 describe British Marine Electronics Association (BMEA) interfacing requirements and the protocols by which integrated instruments communicate with each other	

Range
Marine electronic Instrumentation Radar sets, chart plotters, computers, wind instruments, depth instruments and fish finders, logs and depth instruments, position finding systems, autopilots, satellite navigation, satellite communications, VHF (DSC)/SSB communication

Unit 314 Prepare surfaces and marine coatings

UAN:	**D/503/2277**
Level:	Level 3
Credit value:	11
GLH:	100
Relationship to NVQ:	This unit is linked to the following NVQ units: 224, 232, 233 and 237.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. The unit covers the practical skills requirements for the successful preparation of surfaces to apply marine coatings. It includes the interpretation of instructions and specifications, the identification of existing defects and the terminology and techniques needed to identify/prepare surfaces and to select the appropriate tools and equipment

Learning outcome	**The learner will:**
1. Be able to prepare marine material surfaces	
Assessment criteria	
The learner can: 1.1 obtain and interpret specification from manufacturer's/supplier's technical data sheets, customer's specification and manufacturer's safety and data sheets 1.2 visually inspect surfaces, identify and record defects and surface prep requirements 1.3 state the **considerations** to be made prior to carrying out preparation activities 1.4 carry out surface preparation activities 1.5 check prepared surfaces meet the specified standards 1.6 complete and store application records and data 1.7 identify **hazards** associated with surface preparation activity 1.8 identify the **reasons for carrying out surface preparation**, and the effects on the final finishing activities if preparations are not carried out correctly 1.9 identify the **types of substrate** that may require preparation 1.10 identify the **tools, equipment and preparation methods** required to prepare marine material surfaces 1.11 explain **reasons** why different types of substrate require different	

preparation techniques

1.12 identify the types of **defects and contamination** to be found on unpainted and painted surfaces and their causes

1.13 identify the **damage** that may result from using inappropriate tools and techniques

1.14 explain **why it is important to maintain a register of power tools**

1.15 Explain the importance of using appropriate tools, equipment and consumables

1.16 identify **quality control techniques and procedures** used during preparation activities

1.17 describe **environmental conditions and effects** on the surface finish

1.18 describe approved methods for disposal of waste materials

Range

Considerations Contractual, manufacturer's and customer's specification, health and safety documentation such as CHIPS datarisk assessment, personal protective equipment (PPE), customer contractual acceptance criteria, insurance contractual requirements where appropriate

Hazards Sparks, GRP dust particles, explosive materials, acids, hearing damage, hand/arm vibration, allergic reactions, fumes, cutting tools such as grinders

Reasons for carrying out surface preparation Technical: promote adhesion, coating performance, anti-corrosion treatment

Cosmetic: smooth surface, no dust inclusions, no contamination, adequate gloss levels, no orange peel

Types of substrate Unpainted surfaces, painted surfaces, ferrous materials, non ferrous materials, wood, composite materials, ferro cement

Tools, equipment and preparation methods Degreasing solvents, chemical paint remover, hand abrasives, brushes or vacuum cleaner, power caulking tool/chisel, hand tools, needle guns, powder wire brush, angle grinder, flame cleansing, power planer, power disking, vacuum blasting, high pressure washers

Reasons Different adhesion characteristics of surface, different corrosion treatment used, to maximise coating performance, when etching primers used

Defects and contamination

Unpainted: Surface corrosion, surface contamination, coating detachment, coating cure

Painted: Cracking/crazing, flaking, blistering, cissing, pinholing, wrinkling, chalking, adhesion, sweating, telegraphing

Damage Premature corrosion, premature loss of gloss, premature over-coating, adhesion failure

Why it is important to maintain a register of power tools To ensure up to date PAT testing, to prevent against theft, to ensure regular maintenance

Quality control techniques and procedures Substrate surface profile, temperature, humidity, visual examination, testex press tape, swabs, bresle test, cross hatch test, dolly test, shore d, solvent test, visual examination (angle mirror)

Environmental conditions and effects
Conditions - temperature, humidity, dew point, conditions that prevent full cross linkage of coating chemicals Effects – premature coating failure, inadequate cure cycle

Learning outcome	**The learner will:**
2. Be able to prepare coating materials	
Assessment criteria	
The learner can: 2.1 estimate the volume of coating materials and thinners required 2.2 source materials and check that quantity and quality **meet manufacturer's specification and customer's requirements** 2.3 carry out preparation activities using suitable equipment 2.4 describe the **activities for preparing marine coatings** 2.5 identify the **hazards** associated with the storage, preparation and disposal of marine coating products and solvents 2.6 describe the **types of marine coatings** in common use and their characteristics 2.7 explain **the importance of product shelf life, stock control and batch numbers** 2.8 identify the **storage requirements**, for marine coating products and solvents such as thinners, cleaners 2.9 identify the **containers** to be used with specific products 2.10 describe **preparation requirements for marine coatings** 2.11 describe **how to estimate the product volume** required 2.12 describe the **importance of stirring single pack paints and epoxys** 2.13 explain the use of thinners for marine coating products 2.14 describe the **importance of mixing ratios for two-pack products** 2.15 explain the **procedures for reinstatement of work area**	

Range
Meet manufacturer's specification and customer's requirements Contractual, health and safety documentation such as CHIPS data, risk assessment, personal protective equipment (PPE), customer contractual acceptance criteria, insurance contractual requirements where appropriate **Activities for preparing marine coatings** Correct type and quantities of materials, ensure the stored materials are within date and at the recommended temperature for use, ensure the correct mixing ratios are adhered to check that the prepared coating material is of the correct viscosity, ensure the prepared materials has been in the container for induction period (if applicable), ensure the prepared material is at the temperature recommended for application **Hazards** Contact with solvents and other chemicals, allergic reactions, inhalation of fumes/dust, fire and explosion **Types of marine coatings** Water based epoxies, solvent based epoxies, conventional alkyd or silicone alkyd, acrylic urethane coatings, polyester polyurethane coatings, fairing compounds, water based urethane coatings, anti-fouling paint

The importance of product shelf life, stock control and the use of batch numbers Customer contractual requirements, good working practice, coating insurance requirements, manufacturer's application data requirements, compliance with General warranty and/or guarantee, for security reasons, to maintain stock levels, batch numbers ensure same product used on a specific job

Storage requirements

Environmental conditions: temperature, humidity, ventilation

Containment arrangements: explosion proof storage containers

Containers

Metallic: solvent based epoxies and urethanes

Plastic: water based epoxies and urethanes

Preparation requirements for marine coatings Pot-life, induction times, temperature conditioning, stabilising requirements, solvent requirements, coating interval times

How to estimate product volume

Areas to be covered, theoretical and practical paint consumption, loss factors, manufacturers' specification, ratio calculations, effect of application method such as pads, brushes, rollers, spray

Importance of stirring single pack paints and epoxys To achieve homogeneous mixture of coating ingredients, to achieve maximum coating performance and correct coating cure cycles; adding of solvents improves flow characteristics of the paint film and enhances the cure cycle

Importance of mixing ratios for two-pack products Maximum coating performance, achieve correct coating cure cycles, achieve homogenous mixture of coating ingredients

Procedures for reinstatement of work area Disposal of redundant materials, disposal or cleaning of used containers, maintenance of records of paint and solvent consumption, customer contractual requirements, manufacturers' requirements, company requirements

Unit 315 Apply marine coatings

UAN:	**H/503/2278**
Level:	Level 3
Credit value:	11
GLH:	100
Relationship to NVQ:	This unit is linked to the following NVQ units: 224, 234, 235, 236 and 237.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA, the Sector Skills Council for Engineering.
Aim:	This is an optional unit. The unit covers the skills requirements for the successful application of a range of marine coatings. It includes the techniques and procedures for application of coatings manually and using spray methods and the checking of the finished coating to identify and rectify surface defects

Learning outcome	**The learner will:**
1. Be able to apply marine coatings	
Assessment criteria	
The learner can: 1.1 evaluate surface prior to coating application 1.2 apply coatings by hand and spray 1.3 visually check coating finish 1.4 explain the **importance of maintaining appropriate environmental conditions** for the application and curing of the marine coating products 1.5 state the **time intervals** that are required between coats and the **importance of adhering to them** 1.6 use correct **procedures for the handling and safe use of coating materials and solvents** 1.7 **use paint thinners** to adjust the viscosity of the product being applied 1.8 apply required coating using the appropriate **method** 1.9 select **application equipment** to suit the materials and the finish required 1.10 describe the **techniques** to avoid defects arising from application errors 1.11 describe **when strip coating would be used** 1.12 describe the **principles of extraction/air flow** 1.13 identify the effect on **quality and safety of correct extraction/air** flow	

1.14 describe the **requirements for working afloat** on outer, hull bottoms and at heights

1.15 describe the **procedures** to contain and to clear away spillages, and the safe disposal of waste materials

1.16 describe **methods of carrying out visual checks** of coated surfaces

Range

Importance of maintaining appropriate environmental conditions To ensure maximum coating performance, ensure correct coating/fairing compound cure cycles, avoid premature loss of gloss, avoid premature corrosion, adhere to manufacturers' specification, adhere to coating insurance guarantee requirements

Importance of adhering to time intervals To ensure maximum coating performance, ensure cure cycles, ensure adhesion in between coating layers, avoid solvent entrapment within the coating, adhere to manufacturers' specification, adhere to coating insurance guarantee requirements

Procedures for the handling and safe use of coating materials and solvents Health & Safety documentation including CHIPS data, risk assessment, personal protective equipment (PPE), exclusion zones and containment facilities, ensure that environmental condition meet requirements

Use of paint thinners To ensure better flow character of the coating film, adhere to customer's cosmetic acceptance criteria, adhere to manufacturers' specification, to ensure product transfer to the surface by brushing or spraying

Method Brushes, rollers, paint pads, cloths, sprays

Application equipment Brushes, rollers, conventional spray, airless spray, air-assisted airless spray, bottom feed (deck) lance, hopper gun, electrostatic spray, plural pump system, high volume low pressure

Techniques Good workmanship, follow manufacturer's specification and recommendations, correct environmental conditions during and after application, project planning prior to application

When strip coating would be used To build up thickness along edges of beams, around nuts and bolts, in less accessible areas

Principles of extraction/air flow Avoid overspray particle contamination, ensure correct drying characteristics of coating e.g. physical and chemical, ensure safe working place

Quality and safety of correct extraction/air flow Curing, performance, appearance

Requirements for working afloat Scaffolding, shrink foil, tarp covers, safety harness, helmets, approved footwear, goggles, life jacket

Procedures Company procedures, legislative requirements, environmental requirements

Methods of carrying out visual checks Angle mirrors, flash light, magnifying glass

Learning outcome	The learner will:
2. Be able to identify and rectify defects and faults	
Assessment criteria	
The learner can: 2.1 identify and confirm inspection checks and acceptance criteria 2.2 carry out inspections 2.3 identify defects or variations/deviations from specification and report/rectify accordingly 2.4 record results of inspection in daily application reports 2.5 inspect prepared surfaces **to confirm readiness for coating** 2.6 describe the **importance of using recommended methods** of application for particular marine coating systems and of complying with re-coating intervals 2.7 list the **types of defect** to be found in newly applied and existing paint systems 2.8 describe the causes and methods of rectification of defects in newly applied and existing paint systems 2.9 identify **methods and procedures** for the rectification of coating defects 2.10 identify the **types of inspection and measuring equipment** available 2.11 identify the limitations of own knowledge and the need to seek sources of specialist advice 2.12 identify quality control requirements and the **importance of producing comprehensive records** 2.13 describe the importance of keeping the inspection equipment clean and free from damage 2.14 describe **methods of carrying out the inspection checks** of the coatings 2.15 identify the **sources of information** for level of defects that are acceptable in the coatings	

Range
To confirm readiness for coating Surface cleanliness, surface profile, compatibility of surface condition of existing coatings with coatings to be applied, application of stripe coating where required **Importance of using recommended methods** To achieve satisfactory surface finish, to ensure over coating conditions are correct, to ensure coatings are of specified thickness, to ensure coatings are applied without surface defects, to ensure adequate adhesion/cohesion, to comply with manufacturer's specification and recommendations, to comply with insurance requirements, to comply with customer's contractual criteria **Types of defect** Orange peeling, pinholing, runs, drips, cracking/crazing, chalking, cissing, adhesion, sweating, telegraphing, flaking, wrinkling, detachment, contamination; breakdown of coating (General condition, film thickness), corrosion (bi-metallic, filliform, electrolysis) **Methods and procedures**Sanding and flattening, stripping, recoating, polishing and burnishing, re-fairing, blasting (water, grit, sand) of the

complete surfaces, spot repairs, scraping (runs, sags)

Types of inspection and measuring equipment Sling psychrometer, dew point calculator, surface thermometer, wet film thickness gauge, dry film thickness gauge, camera, syringe and sample bottle, magnifier/pocket microscope, angle mirror, ph paper, conductivity meter, adhesion tester, humidity meter, shore d gauge, gloss meter

Importance of producing comprehensive records To demonstrate compliance with contractual requirements, To have an audit trail, to establish good practice in quality control, to adhere to insurance requirements, to adhere to customer's contractual criteria, to adhere to in-house contractual standards, to adhere to good working practises

Methods of carrying out the inspection checks Visual, touch, use of equipment (light meter)

Sources of information Job specification, customer acceptance criteria, in-house standards, manufacturers' technical specifications

Appendix 1 Relationships to other qualifications

Links to other qualifications

Mapping is provided as guidance and suggests areas of commonality between the qualifications. It does not imply that candidates completing units in one qualification have automatically covered all of the content of another.

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

This qualification has connections to the:

- 2463 Level 2 Marine Construction, Systems Engineering and Maintenance

Literacy, language, numeracy and ICT skills development

These qualifications can develop skills that can be used in the following qualifications:

- Functional Skills (England) – see **www.cityandguilds.com/functionalskills**
- Essential Skills (Northern Ireland) – see **www.cityandguilds.com/essentialskillsni**
- Essential Skills Wales – see **www.cityandguilds.com/esw**

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**.

Centre Manual - Supporting Customer Excellence 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:

- 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 such 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.

Useful contacts

UK learners **General qualification information**	**T: +44 (0)844 543 0033** **E: learnersupport@cityandguilds.com**
International learners General qualification information	T: +44 (0)844 543 0033 F: +44 (0)20 7294 2413 E: **intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 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	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) E: **singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **walledgarden@cityandguilds.com**
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 E: **business@cityandguilds.com**
Publications Logbooks, Centre documents, Forms, Free literature	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413

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

The City & Guilds Group operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Land Based Services (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

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