

# Level 3 Diploma in Boatbuilding (Advanced) (2473-03)

July 2018 Version 1.0

**Qualification Handbook**

## Qualification at a glance

<b>Subject area</b>	Marine
<b>City &amp; Guilds number</b>	2473
<b>Age group approved</b>	16-19, 19+
<b>Entry requirements</b>	None
<b>Assessment types</b>	Multiple Choice; Short Answer; Assignment
<b>Approvals</b>	Qualification approval
<b>Support materials</b>	Qualification handbook; Assessment pack; Exemplar assignment; Centre-devised recording forms
<b>Registration and certification</b>	Consult the Walled Garden/Online Catalogue for last dates

<b>Title and level</b>	<b>City &amp; Guilds number</b>	<b>Accreditation number</b>
Level 3 Diploma in Boatbuilding (Advanced)	2473-03	603/3369/8

Version and date	Change detail	Section
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# 1 Introduction

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

Area	Description
Who is the qualification for?	This qualification is aimed at learners aged 16 and above who would like to gain the advanced knowledge and skills required during their training to become a boatbuilder, either as part of the development phase of their apprenticeship, or as full time students.
What does the qualification cover?	Following the skills and knowledge gained during the Level 2 Diploma in Boatbuilding (Foundation), learners will be trained at an advanced level in the following areas: <ul style="list-style-type: none"><li>• work methods, including using specialist equipment and minimising hazards and risks</li><li>• identifying and responding to customer needs</li><li>• planning and setting up projects</li><li>• manufacturing, assembling, disassembling and repairing components</li><li>• fitting out and finishing boats</li><li>• supporting commissioning of the boat.</li></ul>
What opportunities for progression are there?	Upon completion of this qualification, learners will be equipped with the level of competence required to progress into the end point assessment of their apprenticeship to become a boatbuilder.  On successful completion of the whole apprenticeship standard, learners will be recognised by the Institute of Marine Engineering, Science and Technology (IMarEST) at 'Engineering Technician' level.
Who did we develop the qualification with?	This qualification has been developed in collaboration with the Boatbuilder trailblazer group which is led by organisations including: Berthon Boat Company Ltd, Sunseeker International, Princess Yachts, Pioneer Sailing Trust, Pendennis Shipyard, Fairline Boats, Broom Boats, Green Marine, English Harbour Yachts, Windboats, Cockwells and the British Marine Federation.

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Is it part of an apprenticeship framework or initiative?

This qualification has been developed to be included within the development phase of the new Apprenticeship Standard for Boatbuilders, which will replace the current Level 2 and Level 3 Marine, Construction, Systems Engineering and Maintenance (Boatbuilding) SASE Frameworks.

The qualification will also be included in the SASW Frameworks for apprenticeships delivered in Wales.

The qualification can also be used for full time students who would like to gain the advanced knowledge and skills that will enable them to progress into further training to become a boatbuilder.

## Structure

To achieve the **Level 3 Diploma in Boatbuilding (Advanced)** learners must achieve mandatory units 203, 301, 302 and 304, and one optional unit from 305-307.

City & Guilds unit number	Unit title	GLH
Mandatory		
203	Business improvement techniques	50
301	Safe and effective working in the marine industry	100
302	Principles of boat construction	140
304	Construction and repair of hulls and boat structures	130
<b>Optional units – candidates must choose one optional unit</b>		
305	Producing and fitting boat assemblies and sub-assemblies	130
306	Servicing, maintaining and repairing boats	150
307	Fibre reinforced plastics technology for marine constructions	130

## 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 Boatbuilding (Advanced)	<b>550</b>	<b>700</b>

## 2 Centre requirements

### Approval

To offer this qualification, all 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 qualifications 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 area[s] for which they are delivering training and/or have experience of providing training. this knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

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

### Learner entry requirements

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

#### Age restrictions

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

## 3 Delivering the qualification

### Initial assessment and induction

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

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

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

### Support materials

The following resources are available for this qualification:

Description	How to access
Fast track approval form	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
Assessment pack	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

### Recording documents

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

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

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

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

## 4 Assessment

### Summary of assessment methods

#### Candidates must successfully complete:

- **one** multiple-choice test for **each** mandatory unit 301 and 302
- **one** internally marked short answer question assessment for mandatory unit 203
- **one** assignment and **one** internally marked short-answer question assessment for mandatory unit 304 and **each** chosen optional unit 305, 306 and 307.

#### Available assessments/assignments:

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

- evolve multiple-choice tests to be delivered on-screen
- exemplar internally marked short-answer questions
- guidance for centre devised assignments.

#### Centre set and marked assessments

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

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

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

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

#### Approval process for centre set assignments

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

## Assessment Types

Unit	Title	Assessment method	Where to obtain assessment materials
2473-203	Business improvement techniques	Short-answer questions 2473-203	<a href="http://www.walled-garden.com">www.walled-garden.com</a>
2473-301	Safe and effective working in the marine industry	Multiple-choice online test 2473-301  The assessment covers all the outcomes in this unit	E-volve
2473-302	Principles of boat construction	Multiple-choice online test 2473-302  The assessment covers all the outcomes in this unit	E-volve
2473-304	Construction and repair of hulls and boat structures	Centre-devised practical assignment and Short-answer questions 2473-304  These assessments cover all the outcomes in this unit	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
2473-305	Producing and fitting boat assemblies and sub-assemblies	Centre-devised practical assignment and Short-answer questions 2473-305  These assessments	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

Unit	Title	Assessment method	Where to obtain assessment materials
		cover all the outcomes in this unit	
2473-306	Servicing, repairing and maintaining boats	Centre-devised practical assignment and Short-answer questions 2473-306  These assessments cover all the outcomes in this unit	www.cityandguilds.com
2473-307	Fibre reinforced plastics technology for marine construction	Centre-devised practical assignment and Short-answer questions 2473-307  These assessments cover all the outcomes in this unit	www.cityandguilds.com

### Time constraints

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

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

## Assessment strategy

### Test Specifications

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

**Assessment title:** Safe and effective working in the marine industry

**Assessment type:** Multiple-choice on-line test

**Assessment conditions:** Invigilated examination conditions

**Grading:** X/P/M/D

Unit	Duration: 100 minutes		
301	Learning Outcome	Number of marks	%
	01: Understand the importance of compliance with statutory regulations and organisational requirements in the marine industry	17	34
	02: Understand safe working practices and procedures	15	30
	03: Know how to plan, organise and monitor work needed to carry out marine industry activities	13	26
	04: Understand safe and effective production systems used in the marine industry	5	10
<b>Total</b>		<b>50</b>	<b>100</b>

The grade boundaries for this test will be approximately:

Pass: 60%

Merit: 70%

Distinction: 80%

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

**Assessment title:** Principles of boat construction

**Assessment type:** Multiple-choice on-line test

**Assessment conditions:** Invigilated examination conditions

Grading: X/P/M/D

Unit	Duration: 100 minutes		
302	Learning Outcome	Number of marks	%
	01: Understand materials used in boat construction	16	32
	02: Understand the use of drawings and specifications used in boat construction	13	26
	03: Understand boat construction techniques	9	18
	04: Understand the ancillary equipment and systems used in a boat	5	10
	05: Understand the use of fittings and components in boat construction	7	14
<b>Total</b>		<b>50</b>	<b>100</b>

The grade boundaries for this test will be approximately:

Pass: 60%

Merit: 70%

Distinction: 80%

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

## 5 Grading

### Grading of individual assessments

Individual assessments will be graded Pass/Merit/Distinction.

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

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

### Grading of qualification

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

All assessments must be achieved at a minimum of Pass for the qualification to be awarded. All assessments graded Pass/Merit/Distinction contribute equally to the overall qualification grade.

For full details on how to grade the qualification, refer to the Assessment Pack available on the qualification page of [www.cityandguilds.com](http://www.cityandguilds.com).

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

- 907 Pass
- 908 Merit
- 909 Distinction.

## 5 Units

### Structure of the units

These units each have the following:

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

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

<b>Unit level:</b>	Level 2
<b>GLH:</b>	50
<b>Unit aim:</b>	This unit aims to provide the learner with the knowledge of lean business process and quality improvement in order to effectively monitor and make enhancements to production, manufacturing and maintenance processes.
<b>Assessment vtype</b>	Short answer questions

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### Learning outcome

The learner will:

- 1 Know what is meant by continuous improvement

### Assessment criteria

The learner can:

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

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### Range

(AC1.2) **Benefits**

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

(AC1.4) **Categories of work**

- value added
- non-value added
- waste

(AC1.4) **Categories of waste**

- transport
  - inventory
  - motion
  - waiting
  - over-production
  - over-processing
  - defects
  - skills/unrecognised people potential
- 

**Learning outcome**

The learner will:

- 2 Understand what is meant by workplace organisation

**Assessment criteria**

The learner can:

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

**Range**

(AC2.3) **Effects**

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

**Learning outcome**

The learner will:

- 3 Know what is meant by visual management
-

## Assessment criteria

The learner can:

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

## Range

### (AC3.2) **Good visual management**

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

### (AC3.3) **Types of visual management**

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

## Learning outcome

The learner will:

- 4 Understand problem solving techniques

## Assessment criteria

The learner can:

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

### (AC4.3) **Techniques**

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

## Unit 301

## Safe and effective working in the marine industry

<b>Unit level:</b>	Level 3
<b>GLH:</b>	100
<b>Unit aim:</b>	<p>This unit is concerned with safety awareness and communication skills needed to work effectively in the marine industry.</p> <p>The unit covers health and safety, interaction with other employees and an understanding of the terminology and structure of the industry.</p>
<b>Assessment type</b>	Multiple choice on-line test

### Learning outcome

The learner will:

- 1 Understand the importance of compliance with statutory legislation, regulations and organisational requirements in the marine industry

### Assessment criteria

The learner can:

- 1.1 describe the requirements of the health and safety legislation and regulations applicable to the marine industry
- 1.2 describe the requirements of environmental legislation and regulations relevant to the marine industry
- 1.3 state employers' responsibilities to maintain a safe working environment
- 1.4 state employees' responsibilities to maintain a safe working environment
- 1.5 describe how the Management of Health and Safety Regulations should be implemented and maintained
- 1.6 describe how the environmental regulations should be implemented and maintained
- 1.7 explain the roles, responsibilities and powers of people in health, safety and environmental positions
- 1.8 describe where and how health and safety and environmental information and advice can be accessed

- 1.9 describe the hazards and acts that can lead to observations, near misses, accidents and fatalities
- 1.10 describe methods of accident prevention in the workplace
- 1.11 describe the requirements of the Recreational Craft Directive
- 1.12 describe the requirements of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 2013
- 1.13 state the organisational procedures for reporting accidents or incidents
- 1.14 state how to carry out a risk assessment
- 1.15 identify potential health and environmental hazards

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## Range

### (AC1.1) Safety legislation/regulations

- Health and Safety at Work Act 1974 (HSAWA)
- Management of Health and Safety at Work Regulations 1999
- Workplace (Health, Safety and Welfare) Regulations 1992
- Control of Substances Hazardous to Health Regulations 2002 (COSHH)
- Supply of Machinery (Safety) Regulations 2008
- Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)
- Provision and Use of Work Equipment Regulations 1998 (PUWER)
- Electrical Equipment (Safety) regulations 1994
- Portable Appliance Testing Regulations. (PAT)
- Personal Protective Equipment at Work Regulations 1992
- Manual Handling Operations Regulations (MHOR) 1992
- Health and Safety (Display Screen Equipment) Regulations 1992
- Health and Safety (First Aid) Regulations 1981
- Health and Safety Information for Employees Regulations 1989
- Employers' Liability (Compulsory Insurance) Act 1969
- Work at Height Regulations 2005
- Safe Working in Confined Spaces Regulations and Code of Practice 1997
- Control of Major Accident and Hazards Regulations 2015
- Noise and Statutory Nuisance Act 1993
- Control of Noise at Work Regulations 2005
- Electricity at Work Regulations 1989
- Confined Spaces Regulations 1997
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995 and 2013
- Control of Vibration at Work Regulations 2005

### (AC1.2) Environmental legislation/regulations

- Environmental Protection Act 1990
- Pollution Prevention and Control Act 1999
- Clean Air Act 1993
- Controlled Waste Regulations 2012
- Control of Substances Hazardous to Health (COSHH)
- Preparations and Chemicals Regulations 2000
- Biocidal Products and Chemicals (appointment of Authorities and enforcement) Regulations 2013

- Control of Major Accident Hazards Regulations (COMAH) 2015
- Carriage of Dangerous Goods and the Use of Transportable Pressure Equipment Regulations 2013
- CRC Energy Efficiency Scheme Order 2013
- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DESAR)
- Environmental Permitting (England and Wales) Regulations 2010
- Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (EC) (REACH) 2006
- Recreational Craft Regulations 2004
- Hazardous Waste (England and Wales) (Amendment) Regulations 2016
- Waste (England and Wales) Regulations 2011
- Waste Batteries and Accumulators Regulations 2009
- Waste Electric and Electronic Equipment Regulations (WEEE) 2013

**(AC1.3) Employers' responsibilities**

- safe place of work – good housekeeping, provision of fire safety equipment and training, communicated health and safety policy, display health and safety information, training
- safe plant and equipment – method statements, periodical test for fixed electrical installations, portable appliance testing, control of vibrating tools, health surveillance, LOLER and PUWER
- safe system of work – risk assessment, safety data sheets, adequate management and supervision
- safe methods of handling, storing and transporting goods and materials
- reporting of accidents and near misses
- protect the environment

**(AC1.4) Employees' responsibilities**

- wear the appropriate Personal Protective Equipment (PPE)
- wear the appropriate Respiratory Protective Equipment (RPE)
- follow safe systems of work
- comply with organisational health, safety and environmental policies
- safe use and storage of equipment, tools, machinery and materials
- elevate health, safety and environmental concerns to appropriate persons
- protect self and others at all times
- ensure standards of personal hygiene
- follow organisational housekeeping standards
- working so that actions do not cause damage to the environment in terms of air, water, or ground pollution

**(AC1.5) How Management of Health and Safety Regulations and the Environmental Regulations should be implemented**

- specify and maintain a Health and Safety and Environmental policy in accordance with the respective legislation/regulations
- nominate a Health and Safety Officer
- set up a safety committee with cross company membership
- risk assessments
- encourage a strong safety culture
- provide regular Health, Safety and Environmental staff information, training and updating
- operate health screening

- maintain appropriate health and safety records
- keep up-to-date with health, safety and environmental matters by all means available, Internet etc
- establish and communicate safe working practices and procedures, encourage strong safety and environmental practices
- establish and maintain the control of waste streams
- establish and maintain the control of emissions
- establish and maintain the control of contractors and visitors
- establish and maintain emergency response procedures

**(AC1.7) Roles, responsibilities and powers**

- company director
- company safety manager/officer/advisor
- safety representative
- company trained first aider
- fire wardens
- competent crew
- occupational health provider
- appointed person for lifting operations
- Health and Safety Inspectors
- Environmental Health Officers

**(AC1.8) Access to Health & Safety and Environmental information**

- company health and safety and environmental officer(s)
- company health, safety and environmental management system
- company notice boards
- safety data sheets
- Health and Safety Executive
- internet - commercial safety organisations and companies selling safety equipment

**(AC1.9) Hazards and acts**

- not wearing or maintaining the appropriate PPE
- poor housekeeping
- lack of staff training in correct use of equipment and machinery
- lack of adequate supervision
- lack of respect for company health, safety and environmental policies and processes
- poorly maintained and serviced equipment
- unguarded machinery
- inadequate extraction/ventilation of workshops
- inappropriate use of tools, machinery and equipment
- misuse of lifting equipment; distractions in the workplace
- improper/careless behaviour in the workplace
- badly lit workplace
- staff fatigue
- drug-taking and drinking
- lack of collective protection

**(AC1.10) Methods of accident prevention**

- identify hazards and control risks
- adhere to risk assessments
- good planning

- information and awareness of hazards and ways to minimise these
- eliminating hazards
- being respectful of machinery and equipment and the risks they pose
- guard the hazard
- provision of personal protection
- safety training and publicity
- planned and reactive machinery/tooling maintenance
- shut down/lock out procedures
- quarantine procedures

**(AC1.11) Requirements of the Recreational Craft Directive**

- uniform level of safety in the design and manufacture of recreational craft throughout the European Economic Area
- relationship between the European Directive and UK Legislation
- RCD conformity assessment process
- compliance to 32 Essential Requirements of the RCD
- relationship between the RCD and International Standards
- RCD Annex II Components, installing the right vessel components.

**(AC1.13) Organisational procedures**

- report accident/incident to first aider or other relevant person
- complete accident book
- complete accident form/incident report form

**(AC1.15) Health and environmental hazards**

- slippery or uneven surfaces
- spillages
- scrap or waste material
- flammable materials
- faulty or missing machine guards or interlocks
- faulty, blunt or incorrectly set up of tools and equipment
- faulty electrical connections or damaged cables
- material ejection causing injury damage
- pressure
- stored energy
- unshielded processes
- volatile and toxic materials
- dust
- fumes
- hot works
- contaminants and irritants
- materials handling and transportation
- falls from working at heights
- working afloat
- untidy work habits
- weather conditions
- air pressure systems
- confined spaces
- moving machinery
- suspended loads
- noise
- vibration
- chemicals

- water borne infections
  - incorrect or poorly maintained PP
- 

### Learning outcome

The learner will:

2 Understand safe working practices and procedures

### Assessment criteria

The learner can:

- 2.1 describe Personal Protective Equipment (PPE) used for different tasks or operations
  - 2.2 describe types of Respiratory Protective Equipment (RPE) and when it should be used
  - 2.3 describe the safety rules for the use of mechanical lifting equipment
  - 2.4 identify accessories for lifting equipment
  - 2.5 describe how lifting equipment accessories are used
  - 2.6 state the different types of knots used in ropes and slings, and their application
  - 2.7 describe the current Manual Handling Operations Regulations
  - 2.8 identify vibrating tools associated with Hand Arm Vibration Syndrome (HAVS)
  - 2.9 explain Hand Arm Vibration Syndrome (HAVS) and how the associated risks can be managed
  - 2.10 state why it is necessary to have a permit to work
  - 2.11 identify who hazards should be reported to
  - 2.12 state situations in which it is unsafe to work in isolation.
- 

### Range

#### (AC2.1) Personal Protective Equipment (PPE)

- safety boots when moving heavy materials
- ear attenuators / defenders when working in a noisy machinery or environment
- safety goggles or glasses when grinding, etc.
- gloves when working with resins and chemicals, or sharps etc.
- overalls for working in dirty or unclean environment
- harnesses when working at heights
- buoyancy aids/life jackets when working on or near water
- high visible jackets when lifting or in transport situations
- hard hats when lifting anything overhead
- wet weather gear when working in adverse weather conditions
- thermal jackets when entering freezers

#### (AC2.2) RPE equipment and when it should be used

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- masks – dust masks when sanding wood/GRP and vapour masks when working with paints, chemicals or welding
- hoods – air fed hoods when paint spraying, shot blasting, laminating in confined spaces
- full breathing equipment when working in oxygen depleted environments or confined spaces, entering ovens
- fit testing

**(AC2.3) Safety rules for mechanical lifting**

- use authorised and trained personnel (banksman training, appointed person training, etc.)
- appropriate PPE
- ensure lifting equipment thoroughly examined and in date
- ensure all lifting tackle is tagged appropriately
- 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 the load does not move once the lifting equipment is removed
- check date of equipment tests
- do not work under suspended loads
- quarantine procedures

**(AC2.4) Accessories for lifting**

- forks
- hooks: swivel & safety hooks
- slings: chain & ropes of wire natural and man-made fibres
- chain and wire ropes
- eyebolts
- shackles
- rings
- strops/slings
- beams
- cargo nets
- rigging equipment - bosun chair, climbing ropes, descenders
- halyards
- winches
- chain pull/block
- wire pull
- spreaders
- special- to-purpose equipment

**(AC2.5) How lifting equipment accessories are used**

- always undertake with lifting plan
- always observe the SWL and its date of test
- check equipment is tagged and in date
- visual inspection of equipment before use

- use appropriate equipment for the task
- 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
- importance of the angle at the top, forces in the legs proportional to the angle at the top LOLER

**(AC2.6) 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

**(AC2.7) 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 equipment to support boats in a yard or marina
- correct posture and technique for manual lifting and carrying portable machinery, tools, equipment
- the provision and use of suitable clothing, footwear or other personal effects
- providing adequate or appropriate knowledge and training to the workforce about manual handling

**(AC2.8) Vibrating tools**

- sanders: orbital, DA, belt, disc
- needle gun
- jig saw
- nibbler
- reciprocating saws
- router
- grinder
- core grinder
- hammer drills
- planer
- belt sander
- buffer tools
- oscillating tools

**(AC2.9) HAVS**

- Control of Vibration at Work Regulations
- tool selection
- tool servicing
- tool vibrations measured
- vibration calculator used (exposure action value, exposure limit value)
- trigger times controlled
- annual health screening
- reporting and documentation

**(AC2.10) Permit to work**

- to ensure controls are in place

- awareness of people who are on site and work being undertaken
- to ensure safe practices are carried out
- to ensure no unauthorised people have access to a potentially dangerous environment
- to prevent theft or malicious damage - security
- to control and manage contracts and work being undertaken
- for reasons of industrial secrecy

(AC2.11) **Who hazards should be reported to**

- safety manager/officer/adviser
- supervisors
- fire officers
- works rescue team

(AC2.12) **Situations**

- working at heights (up the mast, on stage planks)
- in close proximity to moving machinery (running engines, rotating shafts)
- when a fire risk exists, with toxic, highly flammable or explosive substances
- when working in confined spaces
- where there is a danger of falling overboard or into water
- when working in adverse weather conditions
- when working out of normal working hours
- in extreme temperatures (oven/freezer)

## 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 explain the importance of maintaining accurate production records
- 3.4 state problems that may occur if documentation is 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 describe the purpose of the regulatory and compliance bodies that cover marine industry activities

- 3.10 state the checks used to ensure marine industry activities meet quality and design specifications
- 3.11 explain the considerations when planning boat construction schedules.
- 

## Range

### (AC3.1) **Efficiency and effectiveness**

- adhere to LEAN principles
- employ the right staff with appropriate skills
- provide training to enable staff to undertake their role
- good planning - review and verify design and plans, finalise time and cost of work to be done, identify, source equipment, machinery tools and materials, make, produce and use jigs and templates as required, set up tools and machinery correctly for tasks
- effective time management
- correct quality and quantity of tools
- equipment and materials
- effective use of working area and facilities

### (AC3.2) **Records**

- work schedule sheets
- time sheets
- requisitions sheets
- drawings and specifications
- batch numbers
- process forms
- safety data sheets
- technical data sheets
- tool records
- calibration records
- method statements
- critical path analysis charts, or other progress charts
- quality assurance certificate
- Recreational Craft Directive logs and files
- trials and equipment test records
- stock control records

### (AC3.4) **Problems**

- work may need to be reworked
- 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
- difficulty tracing work that has been undertaken
- the reputation of the company may be put at risk

### (AC3.5) **Key roles**

- Manager
  - Foreman
  - Chargehand
  - Store keeper
  - Buyer
-

- Quality manager (ISO9001)
- Health and Safety and Environmental Manager (OHSAS18001, ISO14001)
- Facilities manager
- Finance manager
- Designer
- Team leader
- Sales manager
- Production manager
- Administrative support
- Skilled workers
- Training staff
- Apprentices
- Mentors

**(AC3.6) Technical skills, tools and materials**

- up to date and effective working methods
- highly skilled workforce
- specialist tools and equipment
- specialist services
- materials and components

**(AC3.7) Information sources**

- internal information – new build specifications, scantlings lists, job instructions, sheets, line plans, working drawings, time sheets, requisition sheets, test records, drawing and specifications, tool records, calibration records, application records, risk assessments, methods statements, general arrangement drawings, schematic diagrams, hydraulic diagrams
- external information – designer's drawings and specifications, customer information, regulations, codes of practice, surveyor's reports, RCD, manufacturers' technical data and information, safety data sheets, H&S regulations and information, compliance regulations and standards

**(AC3.8) Action to be taken**

- notify relevant personnel
- re-schedule work
- implement contingency plans

**(AC3.9) Regulatory and compliance bodies**

- Lloyds
- Recreational Craft Directive (RCD)
- BS EN and ISO standards
- Environmental Protection Act 1990
- British Waterways Board
- Boat Safety Scheme
- Marine Coastguard Agency (MCA)
- Marine Safety Agency
- Royal Institute Naval Architects (RINA)
- Bureaux Veritas
- American Bureau of Shipping (ABS)
- American Boat and Yacht Council (ABYC)
- Royal Yachting Association (RYA)
- British Marine Electrical and Electronic Association (BMEEA)
- International Marine Electrical Association

- National Marine Electronics Association in America (NMEA)
- Flag state

**(AC3.10) Checks**

- measurement, checking - alignment, geometric shape, calibration, compass adjust
- testing with specialised equipment - barcol hardness tester, moisture content meter, thickness gauge
- destructive testing - the ash test, tensile testing, impact testing, non-destructive testing, etch testing of welds
- testing of TIG/MIG welds
- visual inspections - appearance, blemish free, matching grain, even colour
- operations and functional testing (for example - mechanical testing by checking correct operation of: winches & windlass, sliding hatches, sky-lights, portholes doors, drawers and cupboards, locks catches, cabin hooks, electrical testing)
- commission – functionality tests such as vibration, temperature, noise, smoke, humidity
- dock side tests – pre launch tests, safety equipment tests
- sea trials - steering and manoeuvrability functions, engine start & function, navigation lights & equipment
- bonding checks

**(AC3.11) Considerations**

- long term capacity
- timeframes
- design specification
- resources – skill set requirements
- availability of materials
- construction and production methods required
- production costs
- customer requirements
- transport logistics
- suppliers
- payment schedules
- relevant regulations.

---

**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 marine production system
- 4.2 describe factors that affect productivity
- 4.3 state the effect of industrial changes on productivity
- 4.4 state factors that affect marine business trading
-

4.5 state the factors that affect good customer relations.

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## Range

### (AC4.1) **Components of a typical production system**

- energy
- labour (person/hours)
- machinery and equipment
- materials
- land and buildings
- access to water
- available finance to cover costs

### (AC4.2) **Factors that affect productivity**

- availability and cost of materials
- cost and availability of labour
- machine and equipment availability and effective use of capacity
- supplier performance
- project time constraints
- effectiveness of planning processes
- working environment
- moral and fatigue of staff
- effect on costs of - lateness and absenteeism, machinery and equipment, breakdown/ failure, down time, need to rework, scrap, poor workmanship
- transport and logistics

### (AC4.3) **Effect of industrial change**

- reduced demand
- increased scale of competition
- lack of competitiveness in terms of - marketing, productivity & quality, introduction of new technology

### (AC4.4) **Factors that affect marine business trading**

- quality of work produced
- clean and well maintained premises
- ensuring good 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
- contract management
- motivated staff
- communication between business and customer
- robust warranties
- company reputation

### (AC4.5) **Factors that affect good customer relations**

- producing good quality work
- meeting customer expectations
- ensuring the product supplied is fit for purpose

- the cost is within the quoted price including any agreed extras
- the work is finished by the agreed delivery date
- the work is of the required quality and reliability
- handover/training
- provision of documentation
- after sales service and rectification of faults
- customer engagement
- robust warranties.

## Unit 302

## Principles of boat construction

Unit level:	Level 3
GLH:	140
Aim:	This unit is concerned with the selection and use of materials, tools and equipment and their application in boat building, boatbuilding maintenance and support operations.
Assessment type:	Multiple choice on-line test

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### 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 explain how to use calculations 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 particular applications
- 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

#### (AC1.1) **Materials**

- wood – timber and veneers
- composites
- plastics

- metals
- filler and filler compounds
- resins
- cloth
- bedding
- solvents
- organic peroxides

**(AC1.2) Properties of materials**

- tensile strength
- resistance to degradation/corrosion
- toughness/brittleness
- compressive/sheer strength
- hardness
- elasticity
- durability
- moisture content
- workability
- viscosity
- pot life
- fibre pattern
- ductility/malleability
- density/weight
- magnetism
- sustainability (renewable sources, cost)
- colour

**(AC1.3) Defects in materials**

- wood
  - infestation
  - woodworm
  - decay
  - knots
  - splits/shakes
  - distortion
  - seasoning defects
  - voids
  - water damage
  - UV reaction
  - colour changes
- metals
  - corrosion
  - oxidation
  - galvanic and electrolytic action
  - cavitation
  - fatigue
  - de-zincification
  - crevice corrosion
  - welding imperfections
  - cracks
- plastics
  - crazing
  - fibre pattern

- resin starvation
- resin rich laminates
- air entrapment
- under-cure
- FRP
  - under cured resin
  - gel coat contamination
  - incorrect mixing and application of materials
  - Incorrect workshop conditions (humidity, temperatures)
  - voids
  - pin holes
  - delamination
  - osmosis
  - gel streak
  - gel coat cracking
  - star crazing
  - stress crack

**(AC1.4) 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

**(AC1.5) Methods in which timber is converted/seasoned**

- conversion methods
  - through & through
  - quarter sawn
  - tangential/radial sawing, etc.
- seasoning methods
  - natural seasoning (air, water)
  - artificial seasoning (boiling, chemical, kiln)
  - storage requirements
  - reason for battens 'stickers' between boards when stacking
  - ways of reducing end splits by painting or strapping

(AC1.7) **Types of reinforcement and stiffening materials**

- carbon fibre
- aramid (Kevlar)
- pre-impregnated cloths
- polyurethane foam
- PVC foam
- wood (end grain Balsa)
- metals

(AC1.8) **Selection**

- interior /exterior
- decorative
- structural
- weatherproof
- size/length
- moisture resistant

**Fastenings**

- screws
- nails
- tacks and pins
- bolts
- specialist bolts, e.g. gallery bolts

(AC1.9) **Classifications**

- interior
- exterior
- moisture resistant
- weather and boil proof

**Adhesives**

- urea formaldehyde
- resorcinol
- resins
- glue
- epoxy resins
- polyurethanes
- PVA
- polyester resin
- mastics
- contact adhesive
- casein

(AC1.10) **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

(AC1.11) **Applications of sealing and bedding compounds**

- manufacturer's guidelines

- cleanliness
  - environmental conditions
  - isolation of dissimilar metal.
- 

### Learning outcome

The learner will:

- 2 Understand the use of drawings and specifications in boat construction

### Assessment criteria

The learner can:

- 2.1 identify the specification authorities and regulating bodies for boat construction and repair activities
  - 2.2 explain how to use common scales for drawings in boatbuilding
  - 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 how to set out a joiner's rod taking information from relevant drawings
  - 2.8 explain the method of lofting a simple hull shape
  - 2.9 state the methods used to find points, shapes and true shapes of figures, and components from plans and drawings
  - 2.10 explain the use of calculations relating to drawings and specifications in boatbuilding technology
- 

### Range

#### (AC2.1) **Specification authorities and regulating bodies**

- Recreational Craft Directive (RCD)
- BSI/EN
- ISO
- Lloyds
- Inland Waterways (Boat Safety Scheme)
- Bureau Veritax
- Maritime and Coastguard Agency (MCA)
- British Marine
- British marine electronics association (BMEA)
- American Bureau of Shipping (ABS)
- American Boat and Yacht Council (ABYC)

#### (AC.2.3) **Boat terms**

- port
  - starboard
  - forward
  - aft
-

- amidships
- bow
- stern
- outboard
- inboard
- deadweight
- bulkhead (watertight and structural)
- keel (drop, fin, bilge, tripple, long)
- keel bolts and fastenings
- foils
- mast
- rudder (balanced, unbalanced and semi-balanced)
- rubbing strakes
- rolling chocks
- sole boards
- bulwarks
- capping rail
- bathing platform
- transom
- chain locker
- wheel house
- engine room
- coach roof
- lazarette
- horn timber
- flare
- tumblehome
- camber
- bilge
- floor
- bridge
- cockpit
- deckhouse
- decks
- hatches
- vents
- saloon
- cabins
- deck equipment
- winch
- length
- breadth
- depth
- draught
- freeboard
- displacement
- superstructure
- frame

(AC2.5) **Reasons for drawing up a 'setting-out rod'**

- to determine appropriate sizes and proportions for components and joints
- to enable a cutting list to be drawn up
- to identify possible problems

- use to check component sizes when cut before assembly

(AC2.6) **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

(AC2.8) **Method of lofting**

- tools and equipment
  - loft nails or pins
  - chalk line
  - straight edges
  - squares
  - trammels
  - fairing battens profile curves
  - bevel board
  - CAD software
- 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

(AC2.09) **Methods**

- stability
- setting out beam cambers
- conic sections of ellipse parabola, hyperbola, flat and curved transom expansion
- determining the centre of effort of sail plans.

(AC2.10) **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, buoyancy, displacement, 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
- 3.6 describe the considerations for stresses and strains when constructing a vessel

---

## Range

### (AC3.1) **Type of propulsion**

- sails
- oars
- inboard and outboard marine engines driving propellers with direct, Z or V drives, Jet, hydraulic, electric drives
- air driven (hover craft)
- hybrid engines

### (AC3.2) **Boat building techniques**

- modern wood/epoxy (strip plank, cold moulding, clinker ply, stitch and tape)
- traditional techniques (carvel, clinker, double diagonal)
- fibre reinforced plastics FRP (wet lay-up, spray, resin infused)
- metals (steel, aluminium)
- fabrics
- plug construction techniques

### (AC3.4) **Techniques**

- strip planking
- cold moulding
- plaster of paris
- modelling with CNC routers
- flat panel construction
- 3D printing

### (AC3.5) **Considerations when building plugs**

- integrity of structure (made from stable material)
- quality of surface finish required
- work schedules
- release angles
- minimum radii
- split moulds.

(AC3.6) **Considerations for stresses and strains**

- hogging
  - sagging
  - pitching and rolling
  - lifting and shoring a vessel
  - moving a vessel on land
- 

**Learning outcome**

The learner will:

- 4 Understand the ancillary equipment and systems used on a boat

**Assessment criteria**

The learner can:

- 4.1 explain the use of communication systems used on boats  
4.2 explain the use of domestic 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**

(AC4.1) **Communication systems**

- radio
- navigation lights
- flags
- satellite support communication systems (sat phones)
- rockets and flares
- mobile phones
- EPIRB
- AIS

(AC4.2) **Domestic systems**

- heating
- water - fresh and reverse osmosis water maker (ROWM)
- waste – grey and black
- refrigeration
- ventilation and air-conditioning

(AC4.3) **Personal safety equipment**

- buoyancy equipment
  - lifejackets
  - safety harness
  - boson's chair
  - wet weather gear
  - helmets
  - ear defenders
-

- ear attenuators

**(AC4.4) General safety equipment**

- flares
- first aid box
- firefighting equipment
- gas alarm
- emergency locker
- life buoys
- flashlights
- life raft
- bilge pump
- fire pump
- salvage pump
- sea anchor

**(AC4.5) Ancillary systems**

- hydraulic (steering system, backstay tensioning, etc.)
- pneumatic (low pressure, high pressure)
- liquefied petroleum gas systems)
- electrical (batteries, distribution systems, lighting d.c. generators etc)
- water systems and calorifiers.

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## Learning outcome

The learner will:

- 5 Understand the use of fittings and components 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 describe the problems that can affect the work when installing equipment, fittings and components to boats.

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## Range

**(AC5.1) Location and purpose**

- function satisfactorily
- do not present a hazard in use
- allow easy access and operation
- meet operational requirements
- meet customer requirements
- meet safety requirements

(AC5.2) **Exterior fitting and components (function)**

- hull fittings:
  - bilge keels
  - rolling chocks
  - rudders
  - rudder stops
  - rudder gland
  - skeg fittings, heel fittings
  - pintles and gudgeons
  - skin fittings
  - hawse pipes
  - portlights
  - stern tubes, stern glands
  - 'A' and 'P' brackets
  - cutless bearings
  - bow thrusters, stern thrusters
  - transducers
  - anodes
  - stabilisers
  - trim tabs
  - shafts and props, rope cutter, rope guard
  - rudder tubes
  
- superstructure
  - hatches and skylights
  - windows
  - doors
  - vents
  - lockers
  - radar mast
  - aerials
  - upper steering position (USP)
  - seats
  
- deck fittings:
  - masts, spars and furlers
  - grab rails
  - pulpit and pushpit
  - mast step
  - guard rails
  - chain plates
  - forestay and backstay fittings
  - bow rollers
  - winches
  - windlasses
  - cleats
  - bollards
  - fairleads
  - sampson post and fairleads
  - mainsheet and headsail tracks
  - tabernacle
  - anchor stowage

- stanchions
- passerelle
- davits
- life-buoy and life-raft stowage

**(AC5.4) Problems that can affect the work**

- poor design
- quality of materials
- delivery of materials, etc.
- environment (heat, cold, wet, etc.)
- working practices and standard of workmanship (poor training)
  - lack of planning and preparation
  - incorrect / poor use of tools
  - incorrect use of materials
  - lack of protection (surfaces)
- access to working areas
- drawings and work instructions
  - incorrect drawings
  - unclear instructions
  - superseded documentation
  - incorrect reading of drawings and not understanding the work instructions
- incorrect specification of components
- location of existing installations.

## Unit 304

# Construction and repair of hulls and boat structures

<b>Unit Level:</b>	Level 3
<b>GLH:</b>	130
<b>Aim:</b>	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.
<b>Assessment type</b>	Centre devised practical assignment and short-answer questions

### 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 obtain sources of technical information for construction and repair of boats
- 1.2 prepare working drawings and materials lists
- 1.3 read and interpret information from lines plans, working drawings, specifications or computer generated data
- 1.4 identify safe working practices in the workplace
- 1.5 extract template and jig information
- 1.6 identify materials for producing templates and jigs
- 1.7 state the causes of defects in materials
- 1.8 select suitable tools and equipment for lofting and developing, marking and cutting out templates and jigs
- 1.9 carry out lofting on a lofting floor
- 1.10 state the marking out methods of transferring lines and data onto moulds, templates or jigs

- 1.11 set out and cut materials for template and jigs
  - 1.12 complete and check finished templates and jigs
  - 1.13 describe techniques for retaining the shapes of hulls and decks before a repair operation
  - 1.14 describe the correct sequence of operations for carrying out repairs to hulls and decks
  - 1.15 state the factors which influence the finish and quality of work
  - 1.16 complete and store records and data.
- 

## Range

### (AC1.1) Sources

- manufacturers'/supplier's data sheets
- technical journals
- Lloyds rules
- Recreational Craft Directive
- designers' drawings
- codes of practice
- surveyor's reports
- technical data sheets
- scheme of work
- customer /client specifications
- working drawings
- construction plan
- Boat Safety Scheme
- BS/EN Standards applicable to the marine industry
- ISO standards applicable to the marine industry
- contractual documentation

### (AC1.4) Safe working practices

- PPE/RPE
- safety data sheets
- environmental considerations
- dust and fume extraction
- adequate lighting
- noise control
- safe lifting and handling according to regulations LOLER 1998
- handling and removal of waste materials
- COSHH regulations
- safe use of fixed and portable woodworking machinery (PUWER and woodworking machinery regulations)

### (AC1.5) Template and jig information

- computer generated data
- lines plan
- working drawings
- specifications
- scantlings lists

### (AC1.6) Materials

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- softwood
- hardwood
- manufactured boards
- template card/paper
- metal

(AC1.7) **Causes**

- poor setting out
- poor cutting
- poor shaping
- template distortion
- timber defects (natural and seasoning)
- metal defects (corrosion, buckling, casting voids)
- FRP defects (layups: voids, dry areas, blisters)

(AC1.8) **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
- power tools

(AC1.10) **Marking out methods**

- direct measurement
- tracing/transfer
- spiling/scribing
- nesting for economic cutting
- use of face side and face edge
- use of templates and patterns
- setting out from a joiners rod/setting board
- nail head impressions
- placement technology
- CNC

(AC1.13) **Techniques**

- shores and temporary jigs
- bracings
- ties
- deck and hull support
- jacks
- wedges

(AC1.15) **Factors**

- standard of workmanship
- material selection
- material storage
- tool selection
- time constraints
- methods of visual and dimensional inspection
- temperature

- humidity.

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

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### Range

#### (AC2.6) Use materials economically and minimise waste

- marking out to minimise waste
- using templates
- nesting
- utilising appropriate off-cuts
- computer numerically controlled (CNC) cutting
- ISO14001

#### (AC2.7) 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)
    - composites
    - metal
- skin construction
  - carvel
  - clinker
  - double diagonal
  - cold moulded
  - strip plate metal
  - chine construction
  - 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

**(AC2.8) Tools**

- hand tools
- power tools
- machine tools

**(AC2.8) Techniques**

- wood
  - establishing 'sided and moulded' sizes
  - marking and working bearding and rabbet lines
  - grown and laminated frames, floors, beams and stems
  - techniques of steam bending
- composite
  - composite core and laminated construction
  - laminated members such as frames, floors, beams and stems
- metal
  - heat bending
  - steel fabrication

- rolling
- setting out beam cambers

#### (AC2.9) **Joints**

- wood
  - scarphs (plain, lipped and hooked)
  - tabling
  - skew/beam dovetails
  - chine logs/corner posts
  - butt straps
  - halvings
  - tennons
- composite
  - FRP laminated
- metal
  - welded (butt, fillet, webbed)
  - bolted
  - riveted

#### (AC2.10) **Steps**

- set up shaft line (laser, string, wire line)
- stern tube positioning
- cut out, align, fit stern tube opening
- align and fit A / P brackets
- fit and fix engine beds (wood, composite, steel)

#### (AC2.11) **Materials**

- wood
  - hardwoods
  - softwoods
  - manufactured boards
  - composite boards
- metals
  - steel
  - aluminium
  - copper
  - lead
  - alloys
- composites
  - GRP
  - FRP
  - thermoplastics and thermosetting plastics

#### (AC2.14) **Problems and faults**

- setting out
- selection of material
- material defects
- selection of tools
- poor workmanship
- reading of drawings specifications data sheets or work instructions
- lack of or insufficient seasoning.

---

## Learning outcome

The learner will:

- 3 Be able to assemble and finish hull and boat structures

## Assessment criteria

The learner can:

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

---

## Range

### (AC3.1) Prepare the work area

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

### (AC3.2) Methods of comparing the cost effectiveness

- material costs

- material availability
- production time
- design requirements
- client requirements

**(AC3.3) Manual and mechanical boat moving equipment**

- cranes
- gantries
- fork lifts
- telehandlers
- pull lifts
- chain blocks
- A frames
- blocks and pulleys
- jacks

**(AC3.4) Tools and equipment**

- measuring devices
- aligning equipment
- thermal equipment metal only welding brazing and soldering equipment
- levelling devices
- hand tools
- portable power tools
- temporary holding devices:
- fixing methods

**(AC3.7) Procedure**

- 'horning in'
- levelling and use of plumb-bob
- bracing and shoring techniques
- centre line and building board/batten
- measuring
- check to drawings
- welding (tack)

**(AC3.8) Problems**

- workmanship
- selection of tools
- material defects
- warping during welding
- adhesive cure times
- positions and alignment of fastenings
- movement of hull structure

**(AC3.9) Covering and sheathing systems**

- epoxy/glass
- gel coats
- protective and non-slip deck coverings
- wood sheathing techniques
- canvas sheathing
- paints and varnishes

**(AC3.10) Methods**

- wood
    - 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
  - composite
    - sealants
    - correct lay-up and curing
    - gel coats
    - gaskets
  - metal
    - welding
    - riveting
    - sealant
    - gaskets
- 

### Learning outcome

The learner will:

- 4 Be able to assemble and finish deck structures

### Assessment criteria

The learner can:

- 4.1 identify deck structures on boats
- 4.2 interpret deck and superstructure drawings, work instructions and specifications
- 4.3 identify tools and equipment used in marking, making, locating and fixing above deck components and use these appropriately
- 4.4 list sealing and bedding compounds used for securing superstructures
- 4.5 describe fixing and fastening devices for securing superstructures
- 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 describe features of deck structures to make them watertight
- 4.9 identify adhesives used for assembling and finishing deck structures
- 4.10 locate, position and fix superstructure components
- 4.11 mark out and manufacture superstructure components
- 4.12 inspect and check completed assemblies
- 4.13 identify methods used to protect components during assembly and until commissioning
- 4.14 identify problems that can occur during assembly of superstructures
- 4.15 Describe the records required on completion of the assembly and how to reinstate the work area following completion.

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## Range

### (AC4.1) **Deck structures**

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

### (AC4.3) **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

### (AC4.4) **Sealing and bedding compounds**

- marine silicones
- polysulphides
- polyurethanes
- oil based (putties and bedding compounds)
- acrylic and jointing tapes
- 

### (AC4.5) **Fixing and fastening devices**

- screws
- bolts
- gallery fastenings
- tie rods

### (AC4.6) **Operations:**

- wheelhouse and doghouse fronts
- expanded beam camber, as applied to raked or sloping fronts on coach-roof
- location, fitting and fastening of structures (e.g. hand rails, saloon doors, vent boxes)
- making, fitting and fastening hand rails

### (AC4.7) **Deck planking styles**

- straight
- swept and tapered plank decks

- covering board
- margins
- king plank and snapping 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 deck systems
- cork

**(AC4.8) Features of deck structures**

- anti-capillary grooves
- scuppers
- bonding of structures (e.g. wheelhouse, vents, lockers)

**(AC4.9) Adhesives**

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

**(AC4.13) Methods**

- protective covering
- cardboard
- hardboard
- wrapping
- polythene sheet
- painting
- preservatives
- resins
- metallic coatings (e.g. galvanising and anodising)
- powder coating
- varnishing
- peelable coatings

**(AC4.14) Problems**

- standard of workmanship
- material selection
- tooling
- inexperience of personnel
- poor planning and quality control
- incorrect drawings
- inadequate working practices
- positions and alignment of fastenings
- movement of hull structure

**(AC4.15) Records on completion**

- recording of hours
- recording of materials used
- inspection checklist and records
- quality control records
- owners RCD manual

- project plan
- batch numbers
- boat file

(AC4.14) **Reinstate work area**

- 5S approach
- clear away all waste and discarded material
- return all tools and equipment to the stores or tool boxes/shadow board
- dismantle or return jigs/templates to storage area
- clean and sharpen all tools ready for the next job
- ensure area is safe and free from dangers (risk assessment)
- floors and access panels replaced

---

### Learning outcome

The learner will:

- 5 Know methods for constructing and fitting masts

### Assessment criteria

The learner can:

- 5.1 describe the process in spar and mast construction  
5.2 describe the types of mast fixings

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### Range

(AC5.1) **Process**

- types of timber used
- conversion and jointing
- setting out and hollowing
- use of spar gauge
- shaping and finishing

(AC5.2) **Types**

- deck stepped
- keel stepped
- chain plates
- sail tracks
- back stays
- fore stays

## Unit 305

# Producing and fitting boat assemblies and sub-assemblies

<b>Unit level:</b>	Level 3
<b>GLH:</b>	130
<b>Unit aim:</b>	This unit is concerned with the manufacture and installation of structural assemblies and sub-assemblies, 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 accurate production, evaluation and use of machines and equipment and the construction of assemblies and sub-assemblies.
<b>Assessment type</b>	Centre devised practical assignment and short-answer questions.

### Learning outcome

The learner will:

- 1 Be able to produce assemblies and sub-assemblies for the outfitting of boats

### Assessment criteria

The learner can:

- 1.1 describe the sources of data required to mark out and manufacture assemblies and sub-assemblies
- 1.2 explain the characteristics and suitability of materials for manufacture of assemblies and sub-assemblies
- 1.3 describe the purpose of a structural bulkhead
- 1.4 describe how prepared timber should be protected from damage during storage and transport
- 1.5 identify common defects that will affect the selection of timber
- 1.6 explain why it is important to ensure prepared materials meet the required accuracy
- 1.7 explain the importance of marking out methods
- 1.8 describe the development of a production schedule and cutting list
- 1.9 state the checks that would be carried out to ensure assemblies and sub-assemblies meet the design specification

- 1.10 draw up a production schedule and cutting list for assemblies and sub-assembly from drawings and other data
  - 1.11 describe the most appropriate methods for cutting
  - 1.12 identify machines for cutting and shaping
  - 1.13 identify the setting up process and safety requirements of machines
  - 1.14 describe types of defects caused by machining and how to rectify them
  - 1.15 describe the constraints, considerations and conventions when producing assemblies and sub-assemblies
  - 1.16 identify methods of constructing sub-assembly furniture units
  - 1.17 select, mark out and cut materials for sub-assembly
  - 1.18 describe suitable jointing methods to construct sub-assemblies
  - 1.19 identify the problems that can occur during manufacturing operations
  - 1.20 explain how fixing methods can affect: strength, appearance, shape
  - 1.21 manufacture sub-assemblies
  - 1.22 explain the requirements that would affect the choice of final finish
  - 1.23 describe the methods used to protect sub-assemblies from damage caused by racking and surface damage
  - 1.24 describe the methods of identifying sub-assemblies and recording the inspection process
  - 1.25 finish and inspect sub-assemblies
  - 1.26 reinstate the work area following completion.
- 

## Range

### (AC1.1) Sources of data

- drawing (line)
- general arrangement drawings
- plans
- specification
- CAD data
- technical data
- technical journals
- Lloyds rules
- RCD
- manufacturers/ supplier data
- line drawings
- designer's drawings
- codes of practice
- surveyor's reports
- customer /client specs
- Boat Safety Scheme
- BE/EN standards
- ISO standards applicable to the marine industry
- contractual documentation

### (AC1.2) Characteristics and suitability

- strength
-

- stability
- durability
- colour and grain pattern
- cost
- availability
- environmental effects
- ease of working
- shrinkage and moisture content
- customer requirements

**(AC1.4) Protected from damage during storage and transport**

- safe, dry, clean environment
- restrict access
- correct labelling
- stacking
- covering
- wrapping
- coating end grain

**(AC1.5) Common defects**

- structural defects:
  - shakes
  - splits
  - rot and decay
  - worm
- cosmetic defects:
  - knots
  - sapwood
  - pith
- seasoning/ dimensional defects:
  - warping
  - twisting
  - shrinking

**(AC1.7) Marking out methods**

- nesting for economic cutting
- use of face side and face edge
- direct measurements
- tracing/transfer
- use of templates and patterns
- spiling and scribing
- setting out from a joiner rod/setting board
- nail head impressions

**(AC1.9) Checks**

- visual inspection
  - surface defects
  - blemish defects
  - matching grain
  - even colour
  - geometric shape
  - alignment
  - fit of joints

- fixing damage
- functional test
  - operation
  - water tight
  - no interference with other systems
- dimensional control
  - measurement
  - geometric alignment
- coding requirements

#### **Sub-assembly checks**

- doors
- drawers
- companionway steps
- galley front trim
- hatches
- dorade boxes
- bulkheads
- sleeping cabin furniture
- control consoles
- heads
- galley area
- navigation area
- main saloon
- soundproofing
- engine room
- lockers
- bathing platform
- fly bridge/USP
- bridge
- cabins

#### (AC1.11) **Methods for cutting**

- squares and rectangular sections
- angled and bevelled cuts
- shapes and profiles
- apertures

#### (AC1.12) **Machines for cutting and shaping**

- fixed woodworking machines
- portable power machines
- hand operated machines

#### (AC1.14) **Types of defects caused by machining**

- saw tooth marks
- planer nipple marks
- burn marks from blunt cutters
- chatter
- splintering
- distortion

(AC1.15) **Constraints**

- size
- shape
- access
- cost
- environmental (e.g. weatherproofing, salt water proofing, heat resistance, corrosion resistance)

**Considerations**

- cost
- customisation
- availability
- customer requirements
- regulatory

**Conventions**

- layout
- size/space
- height/width
- ergonomics
- weight

(AC1.16) **Methods of constructing sub-assembly furniture units**

- frame construction
- slab construction
- use of corner-posts
- door construction
- drawer construction

(AC1.19) **Problems that occur during manufacturing operations**

- splits
- joints (poor fit, incorrect joints)
- alignment
- geometry
- functional operation of fittings (fit for purpose)
- misinterpretation of drawings
- positioning

(AC1.22) **Requirements**

- environment
- customer requirements
- colour
- material
- cost
- durability
- regulatory

(AC1.26) **How to reinstate work area**

- 5s approach
- clearing away all waste and discarded material
- cleaning and sharpening all tools ready for the next job and return them to the correct area
- dismantling or returning all jigs/templates to storage areas

- ensuring the area is safe and free from dangers
  - ensuring protection and labelling in place
  - replacing floors and access panels.
- 

### Learning outcome

The learner will:

- 2 Be able to install structural assemblies, sub-assemblies, fittings, joinery and trim

### Assessment criteria

The learner can:

- 2.1 describe the sources of data required to accurately position sub-assemblies and interior joinery
  - 2.2 describe the stages required for the preparation of the work area
  - 2.3 identify tools, equipment and services required to position and fix sub-assemblies and joinery
  - 2.4 state the factors that define selection of various fixing methods
  - 2.5 identify methods for aligning and fitting sub-assemblies and joinery
  - 2.6 describe the load factors that affect securing decisions
  - 2.7 describe the conventions in positioning and fixing skin fittings
  - 2.8 describe the steps to fit and align engine bed/plates
  - 2.9 cut and fit stern tube and fit P or A brackets
  - 2.10 describe the steps required to ensure that windows, hatches, fittings and port lights are secure and watertight in accordance with current regulations
  - 2.11 explain the function of decorative capping, edging, covering strips, and linings and fiddle rails
  - 2.12 identify the features of materials used for headlinings and sidelinings
  - 2.13 position and fix sub-assemblies
  - 2.14 position and fix fittings and trim
  - 2.15 explain why it is important to report problems and defects that cannot be rectified to a responsible person
  - 2.16 identify methods of achieving surface finishes prior to coating
  - 2.17 explain the importance of ensuring the surface finish meets specifications and is suitable for the application
  - 2.18 explain the importance of adequate finished product protection
  - 2.19 explain the importance of recording inspections within the company quality control procedure
  - 2.20 describe the inspection checks that are suitable for completed sub-assemblies, joinery and fittings
  - 2.21 finish and inspect completed installation
  - 2.22 complete the required records and reinstate the work area following completion.
- 

Range

(AC2.2) **Preparation stages**

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- safe access and egress
- reference to drawings
- location identification
- prepare surfaces:
  - clean dry and dust free
  - abrading
  - coating
  - de-greasing
- temporary jigs and support equipment in place
- correct tooling in place
- levelling and alignment

**(AC2.3) Tools and equipment**

- hand tools
- portable power tools.
- equipment: clamps, cramps
- temporary supports
- services (e.g. power, lighting, ventilation, extraction)
- staging
- safe access/egress
- lifting equipment

**(AC2.4) Factors**

- strength
- corrosion resistant
- durability
- removal requirements
- aesthetics
- replaceability

**(AC2.5) Methods**

- splice
- cut
- trim and fit
- template
- level and align
- locate and temporarily fasten
- temporarily secure:
  - cramps
  - batons
  - packing
  - wedges

**(AC2.7) Conventions**

- underwater
  - black waste
  - grey waste
  - engine
  - generator inlets
  - fire pump
  - reverse osmosis
  - water maker (ROWM)
  - cooling system inlets

- drains
- exhaust
- bilge pumps
- above water
  - engine exhausts
  - heater exhausts
  - cockpit drain
  - breathers
  - syphon break outlets
  - fuel filling
  - tank pump out
  - vents

**(AC2.8) Steps to fit and align engine bed/plates**

- obtain data and manufacturer's recommendation
- set up shaft line to drawing
- install and align engine beds
- cut and fix engine beds

**(AC2.9) Cut and fit**

- obtain data and manufacturer's recommendation
- set up shaft line to drawings
- install and align stern tube
- align and fix propeller bracket

**(AC2.10) 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
- de-grease and apply appropriate sealant
- fasten and evenly tighten to correct torque
- chalk test
- water test

**(AC2.11) Importance**

- edge protection
- aesthetics
- spill protection
- damage protection

**(AC2.12) Features**

- hard wearing
- made from fire resistant materials (foam & fabrics)
- damp and mould resistant
- easily cleaned

**(AC2.16) Methods of achieving surface finishes**

- machine tools
- hand tools
- cutting compounds

- polishes

(AC2.20) **Inspection checks**

- visual inspection
- functional test
- dimensional test
- to customer requirements
- to specifications

(AC2.22) **Records**

- recording of hours
- recording of materials used
- inspection checklist and records
- quality control records
- owner's RCD manual
- project plan
- batch numbers
- boat file
- quality panels

**Reinstating work area**

- 5S approach
- clearing away all waste and discarded material
- cleaning and sharpening all tools ready for the next job
- returning all tools and equipment to the stores or tool boxes/shadow boards
- dismantling or returning all jigs and templates to storage areas
- ensuring the area is safe and free from dangers (risk assessment)
- ensuring protection and labelling in place
- replacing floor and access panels

## Unit 306

## Servicing, maintaining and repairing boats

<b>Unit level:</b>	Level 3
<b>GLH:</b>	150
<b>Unit aim:</b>	This unit is concerned with establishing requirements when establishing requirements when making repairs to boat structures and when servicing and maintaining boats.
<b>Assessment type</b>	Centre devised practical assignment and short-answer questions.

### Learning outcome

The learner will:

- 1 Know how to establish requirements for servicing, maintaining and repairing boats

### 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 the servicing, maintenance and repair of boats
- 1.3 state the publications and professional services available to advise on a full structural integrity of a repair
- 1.4 explain the need to use specialist services for certain servicing, maintenance and repairing of boats 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 describe the factors affecting the choice of repair options
- 1.7 describe the factors affecting the choice of servicing and maintenance options
- 1.8 describe the procedures for the servicing, maintenance and repair of boats
- 1.9 explain the benefits of servicing/maintenance/repair operations on the integrity of a boats structure and safety
- 1.10 explain how to determine and balance the time, materials, human resources and equipment costs for the work undertaken

- 1.11 describe the inspection procedures that are required to establish the effectiveness of the servicing/maintenance /repair procedures
  - 1.12 explain who should be communicated with and the methods of communication for servicing/maintenance/repair options
  - 1.13 distinguish between routine and non-routine servicing operations
- 

## Range

### (AC1.1) Sources of information

- manufacturer's information
- survey reports
- customer information
- insurance assessor

### (AC1.2) 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

### (AC1.1.3) Publications and professional services

- Lloyds rules
- RCD requirements
- professional surveyor
- naval architect
- Lloyds surveyor

### (AC1.4) Specialist services

- marine surveying
- ultrasound/x-ray
- coded welding
- non-destructive testing
- shot blasting

### (AC1.5) Techniques used to establish the extent and severity of damage

- visual

- audible (tapping with a hammer)
- experience and previous specialised knowledge
- resistance of a surface to pressure (wood rot)
- ultrasound
- x-ray
- dye penetration testing
- measurement
- non-destructive testing

**(AC1.6) Factors affecting the choice of repair option**

- surveyor's report
- safety
- structural integrity
- cost
- time
- longevity of repair
- availability of materials
- customer requirements
- insurance assessments
- resources available
- type of material
- coding requirements
- access to damage

**(AC1.7) Factors affecting the choice of servicing and maintenance option**

- safety
- structural integrity
- cost
- time
- availability of materials
- type of materials
- customer requirements
- resources available
- service schedule
- lifed items
- modifications
- access

**(AC1.8) Procedures**

- access/egress from vessel
- safety
- protection (for example adjacent surfaces)
- isolation of power
- carry out repair (for example cutting out and replacing corroded metal, rotted wood, delamination)
- carry out maintenance (for example surface cleaning and repainting)
- carry out servicing (for example renew anodes, bonding checks)

**(AC1.9) Benefits of operations**

- on the integrity of a boat's structure and safety watertight
- craft aesthetics
- craft performance
- systems performance

(AC1.11) **Inspection procedures**

- visual
- checking water tightness
- operational function e.g. repair to a sliding hatch
- conformity

(AC1.12) **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

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**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 establish safe access/egress to repair
- 2.4 protect adjacent work surfaces
- 2.5 describe how services should be disconnected, isolated or drained to ensure safe working procedures
- 2.6 describe how different types of components and sub-assemblies can be removed and replaced
- 2.7 describe fastenings used for repair operations
- 2.8 explain how to label and store safely components that have been removed but must be reinstated
- 2.9 explain methods used to maintain structural integrity when major items have been removed
- 2.10 explain the factors that might jeopardise the structural integrity of the vessel
- 2.11 describe the effects of electrolysis and osmosis
- 2.12 explain the importance of waste removal and maintaining a clear and tidy work environment
- 2.13 dispose of waste correctly
- 2.14 use the correct tools for the procedure to be undertaken
- 2.15 remove damaged material and components with minimal damage to surrounding area
- 2.16 prepare the work surface to receive the components

- 2.17 explain the factors which need to be taken into account when positioning replacement components
  - 2.18 set and position components using appropriate methods prior to securing them
  - 2.19 explain the safety issues when using sealants, bonding agents, adhesives and coatings
  - 2.20 secure replacement components using appropriate methods
  - 2.21 complete finishing operations
  - 2.22 describe the information sources that can assist the inspection process
  - 2.23 explain the consequences of neglecting the appropriate tests and reporting schemes
  - 2.24 explain causes of defects that can occur in repair work
  - 2.25 conduct tests on repaired items to ensure they meet company and regulatory bodies' quality control requirements
  - 2.26 explain the importance of informing customers of defects which are outside the current reinstatement specification
  - 2.27 complete the information required on appropriate report forms
  - 2.28 restore work area following completion of the repair
- 

## Range

### (AC2.1) Sources

- Lloyds surveyor
- manufacturer's drawings
- survey reports
- customer information
- insurance assessor
- company drawing office

### (AC2.2) 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

### (AC2.5) Services

- disconnection of electrical supplies
- disconnection of gas supplies
- emptying of tanks (water tanks and fuel tanks)
- safe isolation of raw water intakes/outlets

### (AC2.8) Label and store safely

- name of vessel
- location in vessel
- orientation (facing aft, fwd)
- wrapping or covering to minimise damage during storage

### (AC2.9) Methods used to maintain structural integrity

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- temporary moulds or frames
- bracing
- shores
- strops
- stays
- clamps
- cradles
- blanks

**(AC2.10) Factors that might jeopardise the structural integrity**

- incorrect materials
- defective materials
- workmanship
- techniques used
- incorrect specification

**(AC2.11) 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

**(AC2.12) Importance of waste removal**

- to comply with legislation (national and local)
- to reduce the risk of accidents
- to ensure material does not fall into bilges
- to prevent damage
- to maintain safe working area
- to stop blockage of limber holes

**(AC2.13) Dispose of waste correctly**

- use of waste hierarchy
- safe disposal of hazardous waste
- thorough removal of non-hazardous waste
- ensure material does not fall into bilges

**(AC2.14) Tools for the procedure**

- metal:
  - electric or pneumatic grinder/cutter
  - file
  - hacksaw
  - welder
  - drill
  - plasma cutter
  - oxy/acetylene cutter
- FRP:

- electric or pneumatic grinder/cutter
- rasp / file
- electric or pneumatic jigsaw
- reciprocating saw
- drill
- hole saw
- foam or pile roller
- consolidating roller
- vacuuming
- sander
- scissors
- wood:
  - saw: hand/jig
  - plane/spoke shave
  - electric plane/router
  - chisel
  - bevel gauge/combination square
  - marking/measuring equipment

**(AC2.16) Prepare the work surface**

- remove all damaged/decayed material
- abrade
- degrease
- test fit
- prime

**(AC2.17) Factors**

- dimensional accuracy
- alignment
- orientation
- constructional integrity
- other components

**(AC2.18) Methods of setting and positioning components**

- measuring
- aligning
- clamping
- jigs and templates

**(AC2.19) Safety issues**

- COSHH
- skin reactions
- fire risk
- confined spaces
- monitoring (for example oxygen depletion)

**(AC2.20) Methods**

- mechanical fastenings
- adhesives
- FRP bonding
- jointing
- thermal (welding brazing)

(AC2.21) **Finishing operations**

- fairing
- sealing
- protective coatings
- polishing
- protection of finished surfaces

(AC2.22) **Information sources**

- design specification
- equipment manufacturers' specifications
- customer's specification
- surveyor's specification
- reinstatement plans
- job instructions

(AC2.23) **Consequences**

- failure of component
- poor quality assurance
- loss of company reputation
- litigation
- insurance risk

(AC2.24) **Causes of defects**

- Defects:
  - incorrect dimensions
  - misalignment
  - poor finish
- Causes
  - poor setting out
  - incorrect materials
  - poor workmanship
  - incorrect technique
  - incorrect specification

(AC2.25) **Tests**

- visual
- dimensional
- alignment
- water-tight
- buoyancy

(AC2.26) **Importance**

- maintain the integrity and satisfactory completion of the work
- maintain the reputation of the company, to allow the customer to reconsider the continuation of the repair
- safety
- longevity of repair

(AC.27) **Information required on report forms**

- description of repair undertaken
- materials used
- time taken
- quality assurance signature

- approval signature
- name of employee
- emergent work (recommended actions)

(AC2.28) **Reinstate work area**

- 5S approach
- clearing away all waste and discarded material
- cleaning and sharpening all tools ready for next job
- returning all tools and equipment to the appropriate place
- dismantling or returning jig/templates to the storage area
- ensuring area is safe and free from dangers (risk assessment)
- replacing floor and access panels (as necessary)

### Learning outcome

The learner will:

- 3 Be able to service and maintain boats

### Assessment criteria

The learner can:

- 3.1 describe documentation used for routine and non-routine servicing and maintenance operations on boats
- 3.2 describe the locations and factors which will affect routine and non-routine servicing and maintenance operations
- 3.3 describe the use of tools and equipment required to carry out cleaning operations before servicing
- 3.4 state safety checks to be carried out on tools and equipment
- 3.5 explain the importance of checking components for wear and tear
- 3.6 explain the functions of different types of surface coatings
- 3.7 describe cleaning agents used for a variety of surface coatings
- 3.8 identify the application techniques for surface coatings
- 3.9 explain the procedures for safe removal and disposal of defective surface coatings
- 3.10 describe different types of servicing schedules
- 3.11 explain how the materials from which a boat is constructed affect the type and frequency of servicing
- 3.12 explain when it is acceptable to use alternative components
- 3.13 explain the information that should be recorded in pre-service and post service records
- 3.14 describe the correct storage method for deck equipment
- 3.15 describe the storage systems for safety and protection equipment
- 3.16 identify items on a boat that have a 'service life'
- 3.17 identify the common defects of the anchoring equipment and its connections

- 3.18 establish safe access and egress
  - 3.19 protect adjacent work surfaces
  - 3.20 carry out service or maintenance of boat components
  - 3.21 use correct tools for the procedure
  - 3.22 carry out checks to ensure quality of service or maintenance
  - 3.23 complete relevant documentation following organisational procedures
  - 3.24 restore the work area on completion of the task
- 

## Range

### (AC3.1) Documentation

- boat logs
- RCD handbook
- service records,
- service schedules
- job instructions
- material requisition sheets
- time sheets
- technical data sheets
- safety data sheets

### **Routine and non-routine servicing and maintenance operations**

- Routine:
  - annual customer servicing contract
  - cleaning and anti-fouling
  - touching up defective finishes
  - replacement of lifed items, such as filters
- Non-routine:
  - identification and replacement of defective components
  - recording identified defects not covered by service
  - re-painting and varnishing
  - shot blasting

### (AC3.2) Locations and factors

- location:
  - yard
  - shed
  - afloat
- factors:
  - temperature
  - weather
  - accessibility
  - human resources
  - budgets
  - customer requirements
  - availability of components

### (AC3.3) Tools and equipment

- hull cleaning equipment:
  - pressure washers
  - scrapers
  - sanders
- personal safety equipment:
  - masks
  - gloves
  - overalls
  - goggles
  - life jackets
  - hard hats
  - safety shoes
  - wet weather gear

**(AC3.4) Safety checks**

- P.A.T. certificate
- check cables for damage
- trigger times for vibrating tools
- correct tool for job

**(AC3.5) 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
- safety fittings
- anodes
- rigging
- seacocks

**(AC3.6) Functions**

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

**(AC3.7) Cleaning agents**

- detergents
- solvents
- natural astringents (lemon juice, vinegar)
- de-greasers
- abrasives

- alcohol wipes
- tack rags

#### (AC3.8) **Surface coatings**

- paints:
  - oil based
  - polyurethane
  - epoxy
  - water
  - cellulose
  - varnish
  - polyurethane
- oils
- resins:
  - epoxy resin
  - polyesters /gelcoats
  - vinylester
- manufactured laminates melamine
- preservatives
- decals/stickers
- anodising
- polishes

#### **Application techniques**

- brush
- roller
- spray
- rub
- foam brush / pad

#### (AC3.9) **Surface coating defects**

- peeling
- flaking
- erosion
- scratches
- scuffs
- blisters, orange peel
- pin holes
- fish eyes
- solvent entrapment
- runs
- dust inclusion
- fading

#### **Safe removal and disposal**

- use of PPE
- mechanical (scraping & sanding)
- heat
- chemical
- shot blasting
- long boards

- planers
- disposal procedures for waste materials, if hazardous, in accordance with COSHH

(AC3.10) **Servicing schedules**

- manufacturers' recommendations
- company guidelines
- customer requirements

(AC3.11) **Materials**

- wood
- metal
- FRP
- thermoplastic

(AC3.13) **Information**

- date
- make and model of vessel
- location
- defects found
- action taken
- time taken
- materials used
- quality control checks and signatures
- costs
- name of employee
- emergent work recommendations

(AC3.14) **Storage method**

- chocks
- straps
- brackets
- lockers
- clips
- davits
- stowages
- hawse pipe
- chain locker

(AC3.15) **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
- life raft – chocks
- ropes – deck locker
- anchor – hawse pipe, chain locker
- man overboard recovery

(AC3.16) **Items on a boat that have a 'service life'**

- anodes

- oils
- filters
- gas fitting hoses
- hydraulics
- flares
- filters
- fire extinguishers
- life rafts
- life jackets
- safety items with batteries (EPIRB - Emergency Position Indicating Radio Beacon)

(AC3.17) **Common defects**

- corrosion
- damage
- warps
- fraying
- loose housings
- missing /broken split pins
- missing/broken shackle pins
- seizing

(AC3.18) **Reinstate work area**

- 5S approach
- clearing away all waste and discarded material
- cleaning and sharpening all tools ready for next job
- returning all tools and equipment to the appropriate place
- dismantling or returning jig/templates to the storage area
- ensuring area is safe and free from dangers (risk assessment)
- replacing floor and access panels (as necessary)

## Unit 307

## Fibre reinforced plastics technology for marine construction

<b>Unit Level:</b>	Level 3
<b>GLH:</b>	130
<b>Aim:</b>	<p>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 to the application, position and size of a component together with safe working practices.</p>
<b>Assessment type</b>	Centre devised practical assignment and short-answer questions

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### Learning outcome

The learner will:

- 1 Be able to apply process techniques for FRP, matrix systems and vacuum bagging

### Assessment criteria

The learner can:

- 1.1 explain the health, safety and environmental requirements for given process applications (FRP, matrix systems and vacuum bagging)
- 1.2 describe component construction techniques and procedures used with FRP for marine construction
- 1.3 describe matrix systems and limitations of the systems
- 1.4 state the reasons for the selection of specific matrix systems
- 1.5 describe how to ensure consistency of matrix mixing for large component construction
- 1.6 describe techniques used to ensure dry reinforcing materials are completely wetted

- 1.7 describe recording procedure to be followed in the management and use of pre-impregnated reinforcing materials
- 1.8 evaluate the suitability of a process for a given application (FRP, matrix system, and vacuum bagging)
- 1.9 select a process for FRP, matrix systems, and vacuum bagging applications
- 1.10 prepare and manage resin systems in accordance with specification /manufacturer's recommendations
- 1.11 describe methods of recording details, data and process operations
- 1.12 prepare material usage records and record relevant information on these
- 1.13 record the details of materials, weights and ratios used
- 1.14 prepare reports to show progress and requirements
- 1.15 store and manage pre-impregnated reinforcing materials

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## Range

### (AC1.1) Health and safety requirements

- Health and Safety at Work Act Section 7
- handling and control of substances hazardous to health (COSHH)
- handling of resins
- handling of equipment
- safe disposal of materials
- personal protection
- lifting operations and handling equipment
- provision and use of equipment
- use of equipment
- cutting tools

### Environmental legislation/ regulations

- Environmental Protection Act 1990
- Pollution Prevention and Control Act 1999
- Clean Air Act 1993
- Controlled Waste Regulations 2012
- Control of Substances Hazardous to Health (COSHH)
- Preparations and Chemicals Regulations 2000
- Biocidal Products and Chemicals (appointment of Authorities and enforcement) Regulations 2013
- Control of Major Accident Hazards Regulations (COMAH) 2015
- Dangerous Substances and Explosive Atmospheres Regulations 2002 (DESAR)
- Environmental Permitting (England and Wales) Regulations 2010
- Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (EC) (REACH) 2006
- Recreational Craft Regulations 2004
- Waste (England and Wales) Regulations 2011

### (AC1.2) Component construction techniques

- Hand/wet lay ups
- spray lay ups
- contact moulding
- resin transfer moulding
- injection moulding
- resin infusion

- vacuum bagging

(AC1.3) **Matrix systems and limitations**

- polyester
  - secondary bonding
  - less water resistant
- vinylester
  - expensive
  - secondary bonding
- epoxy
  - expensive
  - used with advanced composites

(AC1.9) **Process**

- **FRP**
  - Hand/wet lay ups
  - spray lay ups
  - contact moulding
  - resin transfer moulding
  - injection moulding
  - resin infusion
  - vacuum bagging
- **Vacuum bag**
  - porous release film
  - absorption/bleeder cloth
  - non porous release cloth
  - air breather
  - vacuum bag
  - vacuum bag tape+
  - compressor
  - vacuum gauge
- **Matrix systems**
  - polyester
  - vinylester
  - epoxy.

---

### Learning outcome

The learner will:

- 2 Be able to select and use materials, consumables, tools, moulds, formers and ancillary equipment

### Assessment criteria

The learner can:

- 2.1 explain the function and physical properties of the materials used in FRP manufacture
- 2.2 identify a range of consumables/ancillaries required for process selection and application
- 2.3 describe types of cloth and weave patterns available
- 2.4 state reasons for the selection of weaves

- 2.5 describe storage and management procedures for the use of materials in FRP laminating
- 2.6 describe design features of moulds and formers for complex shapes
- 2.7 explain the use of moulds/formers and materials for a given application
- 2.8 select, prepare and use moulds/formers and vacuum bagging techniques for a given application
- 2.9 select and use materials for a given application
- 2.10 select and use ancillaries required to support the process selection
- 2.11 describe plug and mould construction details
- 2.12 describe design features for moulds for complete internal units
- 2.13 describe preparation for moulds for complex shapes in readiness for lay up
- 2.14 describe materials used for sandwich construction
- 2.15 describe the use of specialist equipment
- 2.16 describe preparation and setting of hot bond controller and autoclave units

## Range

### (AC2.1) Function and physical properties of materials used in FRP manufacture

Material	Function	Physical properties
Mould surface	Create shape	Strong and flexible
Fabric	Strength	Changes state, dry woven material, glass, carbon, Kevlar
Resin	Binds the fabric	2-part viscous liquid, short pot life once mixed, exothermic reaction, solidifies
Hardeners: slow, fast, tropical, standard, ultra-slow	Mixes with resin and cures	Curing rates differ when mixed with resin
Core materials: foam, plywood, block board, balsa, cork, honeycomb	Strength, stiffness, increases load bearing	Density, thickness and porosity varies across materials
Filleting compounds: colloidal silica, silica, glass bubbles, microfibers, micro balloons	Create radius to maintain strength	Mixed with resin to create a paste

### (AC2.3) Types of cloth and weave patterns

- plain weaves
- twill cloth
- satin weave
- unidirectional weave
- chopped strand mat
- continuous woven
- needle loom or needle mat cloth

- woven roving
- tissue
- multiaxial fabrics combination mats

**(AC2.5) Materials in FRP laminating**

- thermosetting plastics
- composite materials such as glass, carbon, aramid, hemp, woven cloths, combination mats, hybrid cloths, pre-impregnated cloth, bleed cloths, peel ply
- resins/adhesives
- associated hardeners and accelerators
- dry reinforcing materials
- sized reinforcing materials
- pre-impregnated reinforcing materials
- film adhesives
- melinex film
- ancillary materials including – catalysts, accelerators, colour pigments, thixotropic agents, fire retardants, fillers, sheet and pre shaped foam)
- solvents and cleaning agents

**(AC2.11) Plug and mould construction details**

- inserts for deck fittings
- non-skid surfaces
- skin fittings
- hull stiffening and datum points for internal fittings
- machinery spaces
- bulkheads

**(AC2.12) Internal units**

- galley units
- toilet compartments (heads)
- accommodation units

**(AC2.14) Materials used for sandwich construction**

- wood
- foam
- honeycomb constructions
  - glass
  - aluminium
  - composites

**(AC2.15) Specialist equipment**

- mould supports and cradling
- platforms
- heater blankets
- hot bond controller
- autoclave units
- composite oven

---

**Learning outcome**

The learner will:

- 3 Be able to plan an effective layup 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 prepare an ordered schedule of activities to produce component/parts
- 3.3 describe types and features of fibre used in composite construction for marine construction
- 3.4 describe use of weave orientation used to achieve maximum strength
- 3.5 describe procedures used to monitor fibre resin ratio
- 3.6 describe procedures involved in calculation of surface area, gel and resin requirements
- 3.7 apply calculations to determine surface area gel coat and resin quantities
- 3.8 state fibre resin ratios recommended by manufacturer's design specifications
- 3.9 state the reason for the tight control of fibre resin ratio
- 3.10 describe the standard formulae for the calculation of irregular areas and volumes
- 3.11 describe stages required to produce complex shapes/components using dry and pre-impregnated reinforcing materials
- 3.12 identify suitable weighing and mixing equipment for resins to ensure conformity of mixes
- 3.13 select tools, equipment, moulds, formers for a given process technique
- 3.14 state the requirement for stiffening and cradling in the support of hulls
- 3.15 describe methods used to incorporate stiffening and load bearing components in laminated and honeycomb structures
- 3.16 describe the construction sequence for plug making
- 3.17 explain the steps required to prepare moulds for lay up operations
- 3.18 describe procedures to be followed when using split moulds
- 3.19 describe procedures for trimming of finished moulds
- 3.20 describe the procedures to follow to ensure optimum quality of manufactured product.

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## Range

### (AC3.10) **Standard formulae**

- surface area and volume of plane figures
- mid- ordinate rule or Simpson's rule for the surface area of irregular figures
- CAD
- theorem of Pythagoras

### (AC3.11) **Stages**

- application of compatible release agents
- correct tailoring of reinforcement and upstand without compromising strength of reinforcement
- apply correct resin and correct resin ratios

(AC3.12) **Suitable weighing and mixing equipment**

- calibrated
- capable of weighing amount required

(AC3.15) **Methods**

- vacuum bagging
- weight to hold in place
- temporary hold fast

(AC3.17) **Steps to prepare the moulds**

- allow mould to acclimatise if brought in from outside in cold weather
- thoroughly clean
- make repairs if necessary
- surface rubbed down and polished to desired quality
- waxing and the application of release agents

(AC3.19) **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 carry out and monitor safe lay-up procedures

**Assessment criteria**

The learner can:

- 4.1 explain the requirements for safe working environment and the hazards that need to be considered
- 4.2 describe the requirements regarding environmental conditions which should be monitored and adjusted to comply with safety requirements
- 4.3 describe requirements for a clean and contaminate free work area
- 4.4 describe the correct operation of tools, equipment and machinery used in lay up of composite materials
- 4.5 describe how to prepare mould/former surfaces in readiness for lay ups
- 4.6 describe procedures to ensure effective composite construction
- 4.7 describe factors that affect the quality of a composite
- 4.8 set up moulds/formers for complex lay up using dry or pre- impregnated materials
- 4.9 prepare and set up ancillary equipment
- 4.10 use a stated procedure sheet
- 4.11 use correct sequence of operations for a given process
- 4.12 carry out and monitor a safe layup operation
- 4.13 complete process application records

- 4.14 green trim to comply with specification/drawing
  - 4.15 trim and finish moulds to comply with drawing
  - 4.16 carry out testing for resin cure
  - 4.17 state the requirements for trimming and removal of excess material
  - 4.18 describe non-destructive and destructive testing methods
  - 4.19 interpret results from test conducted
  - 4.20 restore work area following completion of layup activity.
- 

Range

**(AC4.1) Requirements for safe working environment**

- provision of PPE/RPE
- fume cabinets
- washing facilities
- dust proof lighting
- dedicated dust and fume extraction (LEV systems)
- temperature control and humidity recording
- permitted short and long term exposure limits
- safe access and egress
- risk assessment
- COSHH
- safe system of work
- LOLER
- safe disposal of materials
- noise at work
- PAT
- grinding bay
- cutting room
- material room
- mixing room
- down draft table

**(AC4.1) Hazards**

- curing agents
- dust
- broken fibres
- solvents
- resin vapours
- exothermic reactions
- weight of finished components
- static cuts and burns
- health hazards

**(AC4.7) 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

(AC4.17) **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

(AC4.18) **Testing methods**

- destructive tests
  - ash
  - tensile strength
  - sheer
  - compression
  - Barcol hardness
- non-destructive tests
  - visual
  - dye penetrant
  - tap
  - moisture content

(AC4.20) **Reinstatement of work area**

- 5S approach
- clearing away all waste and discarded materials
- cleaning and sharpening tools ready for next job
- returning all tools and equipment to the appropriate area
- dismantling or returning jigs/templates to the storage area
- ensuring area is safe and free from dangers (risk assessment)

## 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](http://www.cityandguilds.com)**.

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

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

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

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

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

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

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

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

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

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

### ***Linking to this document from web pages***

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

## Useful contacts

### UK learners

General qualification information

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**E:**  
[learnersupport@cityandguilds.com](mailto:learnersupport@cityandguilds.com)

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### International learners

General qualification information

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**E:** [intcg@cityandguilds.com](mailto:intcg@cityandguilds.com)

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### Centres

Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results

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**E:** [centresupport@cityandguilds.com](mailto:centresupport@cityandguilds.com)

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### 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

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**E:** [singlesubjects@cityandguilds.com](mailto:singlesubjects@cityandguilds.com)

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### International awards

Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports

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**E:** [intops@cityandguilds.com](mailto:intops@cityandguilds.com)

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### Walled Garden

Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems

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**E:** [walledgarden@cityandguilds.com](mailto:walledgarden@cityandguilds.com)

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### Employer

Employer solutions including, Employer Recognition: Endorsement, Accreditation and Quality Mark, Consultancy, Mapping and Specialist Training Delivery

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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 is a leader in global skills development. Our purpose is to help people and organisations to develop their skills for personal and economic growth. Made up of City & Guilds, City & Guilds Kineo, The Oxford Group and ILM, we work with education providers, businesses and governments in over 100 countries.

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