Level 3 Certificate in Boat Building, Maintenance and Support (2451)

Qualification handbook
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Level 3 Certificate in Boat Building, Maintenance and Support

Introduction

This award is aimed at candidates who

- are following Advanced Modern Apprenticeship programmes
- do not have access to an N/SVQ
- wish for career progression within the industry
- require evidence towards the underpinning knowledge of the N/SVQ.

The award is designed to contribute towards the knowledge and understanding for the N/SVQ(s) in Boat Building and Maintenance while containing additional skills and knowledge which go beyond the scope of the National Occupational Standards. It provides a valuable alternative for those candidates who do not have access to the N/SVQ.

City & Guilds awards are available in a range of vocational areas. Please contact Customer Relations at City & Guilds for further information.
**General information**

This qualification has been designed by City & Guilds to support government initiatives towards the National Qualifications Framework. They can contribute towards the knowledge and understanding required for the related N/SVQ while not requiring or proving evidence of occupational competence.

**General structure**

The certificate is made up of units expressed in a standard format. Each unit is preceded by details of:

- the structure of the unit
- the aims and general coverage of the unit
- the relationship of the unit to the appropriate N/SVQ National Occupational Standards
- the outcomes
- the assessment methods
- signposting of opportunities to generate evidence for Key Skills.

For the Level 3 Certificate in Boat Building, Maintenance and Support the units are:

**Core units**

- Unit 116 Safe and effective working in a boatbuilding repair and service environment (online)
- Unit 117 Boat Building and repair materials and technology (online)
- Unit 118 Marine construction and components (online)

**Optional units**

- Unit 103 Production and finishing hulls and decks.
- Unit 104 Producing and fitting structural components.
- Unit 105 Establishing reinstatement requirements.
- Unit 106 Fibre reinforced plastics technology for marine construction.
- Unit 107 Vessel services.
- Unit 108 Marine engines.
- Unit 109 Marine propulsion systems.
- Unit 110 Installing electrical wiring and support systems.
- Unit 111 Principles of electrical engineering.
- Unit 112 Advanced mathematics and science.
- Unit 113 Advanced marine electronic systems.
- Unit 114 Prepare surfaces and marine coatings.
- Unit 115 Apply marine coatings.

To gain the Level 3 Certificate in Boat Building, Maintenance and Support, candidates must undertake the following assessments:

- For the Boat Building route they need to complete core units 116 and 117 plus two optional units from 103 to 109 (complex 02).
- For the Marine Engineering route they need to complete core units 116 and 118 plus two optional units from 103 to 113 (complex 04).
- For the Painting and Finishing route they need to complete core units 116 and 117 plus two of optional units 113, 114, 115 (complex 06).
For the certificate in Level 3 Boat Building, Maintenance and Support, the candidate must complete four assessments:

- **one** online test for each of the core units
- **one** assignment for each of the two optional units.
Assessment and quality assurance

National standards and rigorous quality assurance are maintained by the use of:

- City & Guilds online test(s)
- City & Guilds Assignments, marked by the centre according to externally set marking criteria, with quality assurance provided by the centre and monitored by City & Guilds’ external verification system, to ensure that national standards are maintained.

Quality assurance includes initial centre approval, scheme approval, the centre’s own procedures for monitoring quality and City and Guilds’ ongoing monitoring by an External Verifier. Details of City & Guilds criteria and procedures, including roles of centre staff and External Verifiers can be found in Providing City & Guilds Qualifications - a guide to centre and scheme approval.

There is an externally set and marked written test for each mandatory unit to assess knowledge and understanding (see Registration and Certification page 15).

Assignments (one per optional unit) assess practical application of skills and knowledge. City & Guilds provides an assessor’s guide and a candidate’s guide for the assignments. As assignments are designed to sample practical activities, it is essential that centres ensure that candidates cover the content of the whole unit.

Assessment components are graded (Pass, Credit, Distinction). A pass is the achievement level required for the knowledge and understanding in an NVQ and generally represents the ability to follow instructions and procedures. Credit and distinction represent increasing levels of ability to adapt to changing circumstances and to independently resolve problems. Generic grading criteria for Pass, Credit and Distinction are given on page 11.

Details of the availability of assessments and of the general regulations for their conduct are given in the ‘Directory of Assessments and Awards’. If there is any inconsistency between the scheme regulations in this pamphlet and the Directory of Assessments and Awards, the Directory shall prevail.

For candidates with particular requirements, centres should refer to City & Guilds policy document Access to assessment, candidates with particular requirements. This also applies to candidates who wish to seek examinations in language other than English.
Course Design

Tutors/assessors should familiarise themselves with the structure and content of the award before designing an appropriate course; in particular they are advised to consider the knowledge and understanding requirements of the relevant N/SVQ.

City & Guilds does not itself provide courses of instruction or specify entry requirements. As long as the requirements for the award are met, tutors/assessors may design courses of study in any way that they feel best meets the needs and capabilities of the candidates. Units are broadly the same size and centres may deliver them in any order they wish. Centres may wish to introduce other topics as part of the programme which will not be assessed through the qualifications, eg to meet local needs.

It is recommended that centres cover the following in the delivery of the course, where appropriate:

- health and safety considerations, in particular the need to impress to candidates that they must preserve the health and safety of others as well as themselves
- Key Skills (such as Communication, Application of Number, Information Technology, Working with Others, Improving own Learning and Performance, Problem Solving)
- equal opportunities
- spiritual, moral, social and cultural issues
- environmental education, related European issues.

It is recommended that 500 hours should be allocated for the two mandatory and two optional units required for certification.

Entry to qualification

No specific prior qualifications, learning or experience are required for candidates undertaking the qualification(s). However, centres will need to make an initial assessment of each candidate to ensure that the level of the scheme is appropriate. As this is a Certificate it is considered that candidates may have gained qualifications at a lower level. The nature of both the learning and assessment required for the qualification is such that candidates will need basic literacy and numeracy skills: ie the ability to read and interpret written tasks and to write answers in a legible and understandable form. Candidates will also need to be able to organise written information clearly and coherently, although they will not be assessed for spelling or grammatical accuracy unless this is part of the assessment criteria.

There are no restrictions on entry for this award. City & Guilds recommend that candidates entering for a qualification of the same level and the same content as that of a qualification they already hold should not apply to take the qualification.
Centre and scheme approval

Centres wishing to offer City & Guilds qualifications must gain approval.

New centres must apply for centre and scheme approval.

Existing City & Guilds centres will need to get specific scheme approval to run this Certificate.

Full details of the process for both centre and scheme approval are given in Providing City & Guilds Qualifications - a guide to centre and scheme approval which is available from City & Guilds' regional offices.

City & Guilds reserves the right to suspend an approved centre, or withdraw its approval from an approved centre to conduct a particular City & Guilds scheme or particular City & Guilds schemes, for reasons of debt, malpractice or for any reason that maybe detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds.

External verifiers act on behalf of City & Guilds to ensure that national standards are maintained. Full details of their role can be found in Providing City & Guilds’ Qualifications - a guide to centre and scheme approval.
Assessment of optional units

In each optional unit there are a number of learning outcomes and each of these learning outcomes specifies a number of practical activities. Each optional unit should be assessed by the use of an assignment.

The assignment should be produced by the centre in accordance with the template provided by City & Guilds. It will be made up of a number of practical tasks and one underpinning knowledge task. The resultant level of candidate achievement will be graded. Candidates must pass all tasks within an assignment.

Assignments will provide opportunities for candidates to be assessed for a sample range of the practical activities required for the unit. Assignments will usually consist of several tasks. The range of assignments developed by the centre for each unit should ensure that all the practical activities for all the outcomes are assessed as the centre uses a range of assignments over a period of time.

City & Guilds will provide assignment templates from which centres should produce the assignments for the units contained in this award. Centres are required to use the templates provided by City & Guilds. City & Guilds centre devised team must approve all assignments prior to use by the centre (see page 13).

Assignment templates

Detailed assignment templates for each optional unit are provided. Centres can access approved centre devised assignments in City & Guilds website www.cityandguilds.com. The password to open the documents is available in the Walled Garden.

Guidance for marking

Grading of assignments is Pass, Credit and Distinction; grades of Credit and Distinction are intended to distinguish those candidates who show greater degrees of autonomy in the way they organize themselves, or apply reflective thinking and originality in the completion of tasks.

Detailed marking and grading criteria are provided for each assignment in the Marking Criteria section of the assignment. The candidate must display satisfactory performance throughout the tasks. Failure to do so will result in the candidate requiring further training.
Marking assignments

Centres will be taking into account the following three aspects of candidate's performance:

- planning, preparation and recording
- practical activity
- underpinning knowledge.

Each aspect must be marked and awarded a Pass, Credit or Distinction. Specific guidance for marking is provided in the assignment template. Candidates must achieve a minimum of a Pass in each aspect of performance.

The marks that should be awarded for planning, preparation and recording and underpinning knowledge are as follows:

<table>
<thead>
<tr>
<th>Marks</th>
<th>Pass</th>
<th>Credit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

(Note: half marks are NOT available)

The marks that should be awarded for the practical activities are as follows:

<table>
<thead>
<tr>
<th>Marks</th>
<th>Pass</th>
<th>Credit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

(Note: these marks are NOT divisible, i.e., Pass candidates must be awarded 2 marks, Credit candidates 4 marks and so on)

The marks that should be awarded for the underpinning knowledge are as follows:

Grading criteria Pass = 1 mark Credit = 2 marks Distinction = 3 marks

<table>
<thead>
<tr>
<th>Marks</th>
<th>Pass</th>
<th>Credit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>50-64%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit</td>
<td>65-79%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distinction</td>
<td>80–100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To award an overall grade the number of marks given for each task are totalled and then a grade is applied as follows:

<table>
<thead>
<tr>
<th>Marks</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6</td>
<td>Pass</td>
</tr>
<tr>
<td>7-9</td>
<td>Credit</td>
</tr>
<tr>
<td>10-12</td>
<td>Distinction</td>
</tr>
</tbody>
</table>

Level 3 Certificate in Boat Construction, Maintenance and Support
Recording marks and grades

To record candidate marks and overall grades for each completed assignment, assessors should enter details onto the appropriate Assignment Mark Sheet.

For example, below is a completed Assignment Mark Sheet as it would appear in the candidates’ Assignment Guide. It shows how the overall grade was produced.

<table>
<thead>
<tr>
<th>Pass</th>
<th>Credit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning, preparation and recording</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Practical activity</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Underpinning knowledge</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Grade</strong></td>
<td><strong>CREDIT</strong></td>
<td></td>
</tr>
</tbody>
</table>

Underpinning knowledge questions for optional units

Assignments for optional units must also include underpinning knowledge questions and are designed to sample the underpinning knowledge of the unit. The questions included in the assignments do not need to be taken in formal examination conditions, however, they should be taken under supervision as assessors need to ensure the answers to the questions are the candidate's own work.

To preserve the integrity and useful life of the questions, candidates should not be given their answer sheets. A candidate's success in a written assessment should be recorded by a statement from the centre, quoting the relevant unit number or areas of knowledge assessed, which can then be used by candidates as evidence.

Original completed answer sheets should be kept for auditing purposes by the assessor in their own assessment records of candidates' performance. Please refer to City & Guilds General Regulations for confirmation of the period of time in which records should be maintained to meet regulatory requirements.

Feedback

The assignments are intended as a formal assessment of candidates' practical skills. They are not designed as teaching aids and candidates should not be entered until they are ready. Should a candidate fail any of these tasks other than on health & safety grounds, as stated above, appropriate feedback should be given by the assessor both to the candidate and the tutor concerned.

Assessors must ensure that candidates understand why a particular grade has been given for the award.

If a candidate's work is selected for verification, samples of work must be available to the appointed external verifier.
What centres need to do

Machinery, tools and equipment

Centres must have access to sufficient equipment in the college, training centre or workplace to ensure candidates have the opportunity to cover all of the practical activities.

It is acceptable for centres to use specially designated areas within a centre for some of the units: eg to train and assess the installation of compressed air systems, ventilation ducting, alignment and setting up of electric motors and driven devices (pumps, compressors, generators etc).

The equipment, systems or machinery must be of an industrial standard and be capable of being used under normal working conditions: eg hydraulic rigs must have a method of applying reasonable loads and not merely be connected up to show movement.

Producing assignments to assess optional units

The centre devised assignments must be made up of three sections:

1. **Assessor’s guidance notes**

   This section is intended for use by the assessor only. It should contain:
   - a health and safety statement
   - the location of where the assignment should be taken
   - the requirements for tools, equipment, materials and data
   - notes on the content of the assignment to include any preparatory work required by the assessor/centre
   - details of evidence and recording requirements
   - time consideration.

   Any new assignments set must have the same time allocated to the completion of the assignment as set in the guidance note in the assignment template.

2. **Candidate’s Instructions**

   The candidate’s instructions should contain:
   - general advice to candidates about the need to understand the assignment before starting work and the need to seek guidance if clarification is required
   - guidance on the time limits
   - the importance of health and safety
   - an assignment brief which sets the scene or a scenario to contextualise the task(s)
   - clearly defined tasks covering a range of practical activities – an outline of each task should be provided rather than a series of marking checklists
   - recording/report sheets for recording the progress of the activity
   - notes which refer to how the evidence they produce should be stored and labelled.

3. **Mark scheme (see Guidance for marking section on page 11)**
NOTE:

Where the use of drawings/specifications is essential for the activity, relevant pages can be photocopied from workshop manuals, etc – copyright and industrial confidentiality permitting. It is not usually necessary for such items to be copied out by the candidates, however, the use of sketches to show specific, important aspects of the work undertaken: eg points of wear, location of components within a system, alignment methods, etc should be encouraged.

CAD and word processing packages can be used but time spent on the presentation should not be excessive. The final grade awarded will not necessarily depend upon presentation provided the candidates' work is clear, neat and technically correct. Candidates generating evidence for IT Key Skills may wish to spend more time on this aspect of their work.

Submission of assignments

All assignments must be approved for use by City & Guilds. Each assignment should be submitted with a copy of the Centre-devised assignment submission report.

Centres must submit all centre devised assignments to Centre Devised Unit, City & Guilds, 1 Giltspur Street, London, EC1A 9DD

Six weeks before they intend to use the assignment if submitted electronically to the following email address: centredevised@cityandguilds.com

Eight weeks before they intend to use the assignment if a paper based submission is made (three copies must be provided).

A copy of the Centre-devised assignment submission report is at the end of this handbook and should be submitted with the assignment.
Registration and certification

To gain the Level 3 Certificate in Boat Building, Maintenance and Support, candidates must undertake the following assessments:

- For the Boat Building route they need to complete core units 116 and 117 plus two optional units from 103 to 109 (complex 02).
- For the Marine Engineering route they need to complete core units 116 and 118 plus two optional units from 103 to 113 (complex 04).
- For the Painting and Finishing route they need to complete core units 116 and 117 plus two of optional units 113, 114, 115 (complex 06).

Please see chart on page 17.

<table>
<thead>
<tr>
<th>Core units</th>
<th>Assessment components required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 116</td>
<td>Safe and effective working in a boatbuilding, repair and service environment</td>
</tr>
<tr>
<td></td>
<td>2451-02-116</td>
</tr>
<tr>
<td></td>
<td>2451-04-116</td>
</tr>
<tr>
<td></td>
<td>2451-06-116</td>
</tr>
<tr>
<td></td>
<td>Multiple choice online test</td>
</tr>
<tr>
<td>Unit 117</td>
<td>Boatbuilding and repair materials and technology</td>
</tr>
<tr>
<td></td>
<td>2451-02-117</td>
</tr>
<tr>
<td></td>
<td>2451-06-117</td>
</tr>
<tr>
<td></td>
<td>Multiple choice online test</td>
</tr>
<tr>
<td>Unit 118</td>
<td>Marine construction and components</td>
</tr>
<tr>
<td></td>
<td>2451-04-118</td>
</tr>
<tr>
<td></td>
<td>Multiple choice online test</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional units</th>
<th>Assessment components required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 103</td>
<td>Production and finishing hulls and decks</td>
</tr>
<tr>
<td></td>
<td>2451-02-103</td>
</tr>
<tr>
<td></td>
<td>2451-04-103</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 104</td>
<td>Producing and fitting structural components</td>
</tr>
<tr>
<td></td>
<td>2451-02-104</td>
</tr>
<tr>
<td></td>
<td>2451-04-104</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 105</td>
<td>Establishing reinstatement requirements</td>
</tr>
<tr>
<td></td>
<td>2451-02-105</td>
</tr>
<tr>
<td></td>
<td>2451-04-105</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 106</td>
<td>Fibre reinforced plastics technology for marine construction</td>
</tr>
<tr>
<td></td>
<td>2451-02-106</td>
</tr>
<tr>
<td></td>
<td>2451-04-106</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 107</td>
<td>Vessel services</td>
</tr>
<tr>
<td></td>
<td>2451-02-107</td>
</tr>
<tr>
<td></td>
<td>2451-04-107</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 108</td>
<td>Marine engines</td>
</tr>
<tr>
<td></td>
<td>2451-02-108</td>
</tr>
<tr>
<td></td>
<td>2451-04-108</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 109</td>
<td>Marine propulsion systems</td>
</tr>
<tr>
<td></td>
<td>2451-02-109</td>
</tr>
<tr>
<td></td>
<td>2451-04-109</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 110</td>
<td>Installing electrical wiring support systems</td>
</tr>
<tr>
<td></td>
<td>2451-04-110</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 111</td>
<td>Principles of electrical engineering</td>
</tr>
<tr>
<td></td>
<td>2451-04-111</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 112</td>
<td>Advanced mathematics and science</td>
</tr>
<tr>
<td></td>
<td>2451-04-112</td>
</tr>
<tr>
<td></td>
<td>2451-06-112</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 113</td>
<td>Advanced marine electronic systems</td>
</tr>
<tr>
<td></td>
<td>2451-04-113</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 114</td>
<td>Prepare surfaces and marine coatings</td>
</tr>
<tr>
<td></td>
<td>2451-06-114</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
<tr>
<td>Unit 115</td>
<td>Apply marine coatings</td>
</tr>
<tr>
<td></td>
<td>2451-06-115</td>
</tr>
<tr>
<td></td>
<td>Assignment</td>
</tr>
</tbody>
</table>
• Candidates must be registered at the beginning of their course. Centres should submit registrations using Form S (Registration), under the desired scheme/complex number.
• When assignments have been successfully completed, candidate results should be submitted on Form S (Results submission). Centres should note that results will not be processed by City & Guilds until verification records are complete.
• Online tests are available at any time of the year.
• Candidates achieving one or more assessment components will receive a Certificate of Unit Credit listing the assessment components achieved. Candidates achieving the number and combination of assessment components required for the Certificate will, in addition, be issued a Certificate.

Full details on all the above procedures, together with dates and times of written tests will be found in the Directory of Vocational Awards published annually by City & Guilds. This information also appears on City & Guilds' website http://www.cityandguilds.com
## Level 3 Certificate in Boat Building, Maintenance & Support (2451) routes and units

![Diagram of Level 3 Certificate in Boat Building, Maintenance & Support (2451) routes and units]

<table>
<thead>
<tr>
<th>Unit no</th>
<th>Title</th>
<th>Level</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>116</td>
<td>Safe and effective working in a boatbuilding, repair and service environment</td>
<td>3</td>
<td>Mandatory (core)</td>
</tr>
<tr>
<td>117</td>
<td>Boatbuilding and repair materials and technology</td>
<td>3</td>
<td>Mandatory (core)</td>
</tr>
<tr>
<td>118</td>
<td>Marine construction and components</td>
<td>3</td>
<td>Mandatory (core)</td>
</tr>
<tr>
<td>103</td>
<td>Production and finishing hulls and decks</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>104</td>
<td>Producing and fitting structural components</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>105</td>
<td>Establishing reinstatement requirements</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>106</td>
<td>Fibre reinforced plastics technology for marine construction</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>107</td>
<td>Vessel services</td>
<td>3</td>
<td>Optional</td>
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<tr>
<td>108</td>
<td>Marine engines</td>
<td>3</td>
<td>Optional</td>
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<tr>
<td>109</td>
<td>Marine propulsion systems</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>110</td>
<td>Installing electrical wiring support systems</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>111</td>
<td>Principles of electrical engineering</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>112</td>
<td>Advanced mathematics and science</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>113</td>
<td>Advanced marine electronic systems</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>114</td>
<td>Prepare surfaces and marine coatings</td>
<td>3</td>
<td>Optional</td>
</tr>
<tr>
<td>115</td>
<td>Apply marine coatings</td>
<td>3</td>
<td>Optional</td>
</tr>
</tbody>
</table>
Test Specification

Online tests

The knowledge requirements will be assessed by an online test based on the following test specifications:

Core units

| Paper 116: Safe and effective working in a boatbuilding, repair and service environment |
|---------------------------------|----------------------------------|
| Test duration: 1 hour           | Total number of questions: 30   |
| **Unit** | **Outcome** | **No of questions** |
| 116     | 1 Comply with statutory regulations and organisational requirements | 10 |
|         | 2 Apply safe working practices and procedures | 8 |
|         | 3 Plan, organise and monitor work activities needed to carry out the boat building, repair and service activities | 12 |

<table>
<thead>
<tr>
<th>Paper 117: Boatbuilding repair and service materials technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test duration: 1 hour</td>
</tr>
<tr>
<td><strong>Unit</strong></td>
</tr>
<tr>
<td>117</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Paper 118: Marine construction and components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test duration: 1 hour</td>
</tr>
<tr>
<td><strong>Unit</strong></td>
</tr>
<tr>
<td>118</td>
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</tbody>
</table>
Assignments

The practical requirements will be assessed by an assignment for each optional unit. The weightings indicate the minimum and maximum percentages of each outcome which will be covered in an individual assignment.

Optional units

### Assignment 103: Production and finishing hulls and decks

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>1 Produce templates, moulds and jigs for the construction and repair of boats</td>
</tr>
<tr>
<td></td>
<td>2 Cut and shape materials to form the structural components of boats</td>
</tr>
<tr>
<td></td>
<td>3 Assemble and finish hull and deck structures</td>
</tr>
<tr>
<td></td>
<td>4 Assemble and finish above deck structures</td>
</tr>
</tbody>
</table>

### Assignment 104: Producing and fitting structural components

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>104</td>
<td>1 Produce components and sub-assemblies for the outfitting of boats</td>
</tr>
<tr>
<td></td>
<td>2 Install structural components, modules, fittings, joinery and trim</td>
</tr>
<tr>
<td></td>
<td>3 Install domestic services systems</td>
</tr>
</tbody>
</table>

### Assignment 105: Establishing reinstatement requirements

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>1 Establish reinstatement requirements</td>
</tr>
<tr>
<td></td>
<td>2 Carry out repairs to boat structure</td>
</tr>
<tr>
<td></td>
<td>3 Carry out servicing and maintenance operations on boats</td>
</tr>
</tbody>
</table>

### Assignment 106: Fibre reinforced plastics technology for marine construction

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>106</td>
<td>1 Specify and justify a process technique for a given application</td>
</tr>
<tr>
<td></td>
<td>2 Specify consumables, moulds, formers and ancillary equipment</td>
</tr>
<tr>
<td></td>
<td>3 Plan an effective lay up procedure for a process technique</td>
</tr>
<tr>
<td></td>
<td>4 Monitor and control safe lay up procedures</td>
</tr>
</tbody>
</table>

### Assignment 107: Vessel services

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>107</td>
<td>1 Install service systems</td>
</tr>
<tr>
<td></td>
<td>2 Carry out repairs to boat systems</td>
</tr>
</tbody>
</table>
## Assignment 108: Marine engines

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>1. Demonstrate an understanding of the procedures, tools, equipment and materials required for diagnosis, removal, overhaul, refitting and evaluation of systems and components</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>2. Demonstrate an understanding of the layout and operating principles of marine engine systems and components</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3. Diagnose faulty systems and components, remove, rectify and refit</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>4. Evaluate system and component performance following fault diagnosis and rectification procedures</td>
<td>20</td>
</tr>
</tbody>
</table>

## Assignment 109: Marine propulsion systems

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>109</td>
<td>1. Identify hull characteristics of boats and recognise propulsion systems</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>2. Identify the layout and operating characteristics of systems and components</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3. Diagnose faulty systems and components, remove, rectify and refit</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>4. Evaluate system and component performance following fault diagnosis and rectification of propulsion systems</td>
<td>20</td>
</tr>
</tbody>
</table>

## Assignment 110: Installing electrical wiring support systems

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>1. Prepare for the installation of electrical wiring support systems</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>2. Identify equipment, materials and components for the installation of electrical wiring support systems</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3. Carry out the installation of electrical wiring support systems</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>4. Installing wiring</td>
<td>30</td>
</tr>
</tbody>
</table>

## Assignment 111: Principles of electrical engineering

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>1. Understand the functions of electrical systems/components</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2. Understand electrical supply systems, protection and earthing</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>3. Understand the functions of electrical machines and motors</td>
<td>30</td>
</tr>
</tbody>
</table>
### Assignment 112: Advanced mathematics and science

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>1 Use indices</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>2 Use algebraic methods</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3 Use logarithms and number bases</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4 Use trigonometry</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5 Use calculus</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6 Use statistics</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>7 Describe materials and their properties</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>8 Perform tests in stress, strain and elasticity</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>9 Describe the principles of kinematics (velocity and acceleration)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>10 Describe the principles of dynamics (force, mass and acceleration)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>11 Describe the principles of bending beams</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>12 Describe effects on fluids</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>13 Demonstrate the effects of electromagnetism and alternating current</td>
<td>10</td>
</tr>
</tbody>
</table>

### Assignment 113: Advanced marine electronic systems

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>113</td>
<td>1 Prepare for the installation of complex integrated electronic navigation systems</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2 Identify equipment materials and components for the installation of complex integrated electronic navigation systems</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3 Carry out the installation of complex integrated electronic navigation systems</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4 Commission and set up complex integrated electronic navigation systems</td>
<td>30</td>
</tr>
</tbody>
</table>

### Assignment 114: Prepare surfaces and marine coatings

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>114</td>
<td>1 Prepare marine material surfaces</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>2 Prepare coating materials</td>
<td>50</td>
</tr>
</tbody>
</table>

### Assignment 115: Apply marine coatings

<table>
<thead>
<tr>
<th>Unit</th>
<th>Outcome</th>
<th>Percentage of assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>1 Apply marine coatings</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>2 Identify and rectify defects and faults</td>
<td>40</td>
</tr>
</tbody>
</table>
### Generic grading descriptor for Assignments

<table>
<thead>
<tr>
<th>Pass</th>
<th>Credit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a practical activity involving some non-routine operations, the candidate demonstrated the use of skills in meeting the essential requirements of the outcomes of the unit.</td>
<td>In a practical activity involving some non-routine operations, the candidate demonstrated the use of skills in meeting the substantial majority of requirements of the outcomes of the unit.</td>
<td>In a practical activity involving some non-routine operations, the candidate demonstrated the use of skills in meeting the comprehensive requirements of the outcomes of the unit.</td>
</tr>
</tbody>
</table>

### Educational Health and Safety

The requirement to follow safe working practices is an integral part of all City & Guilds qualifications and assessments, and it is the responsibility of centres to ensure that all relevant health and safety requirements are in place before candidates start practical assessments. Should a candidate fail to follow health and safety practice and procedures during an assessment (eg practical assessment, assignment) the test must be stopped and the candidate advised of the reasons why. The candidate should be informed that they have failed the assessment Candidates may retake the assessment at a later date.
### Key Skills Signposting

**Identification of Key Skills summary relationship table**

<table>
<thead>
<tr>
<th>Unit No and Title</th>
<th>Communication</th>
<th>Application of Number</th>
<th>Information Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>116 Safe and effective working in a boatbuilding repair and service environment</td>
<td>C 3.1 C 3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>117 Boatbuilding and repair materials and technology</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>118 Marine construction and components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>103 Production and finishing hulls and decks</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>104 Producing and fitting structural components</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>105 Establishing reinstatement requirements</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>106 Fibre reinforced plastics technology for marine construction</td>
<td>C 3.3</td>
<td>N 3.3</td>
<td></td>
</tr>
<tr>
<td>107 Vessel services</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>108 Marine engines</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>109 Marine propulsion systems</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>110 Installing electrical wiring support systems</td>
<td>C 3.3</td>
<td>N 3.1</td>
<td></td>
</tr>
<tr>
<td>111 Principles of electrical engineering</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>112 Advanced mathematics and science</td>
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<td>N 3.1 N 3.2 N 3.3</td>
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<tr>
<td>113 Advanced marine electronic systems</td>
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</tr>
<tr>
<td>114 Prepare surfaces and marine coatings</td>
<td>C 3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>115 Apply marine coatings</td>
<td>C 3.3</td>
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</tr>
</tbody>
</table>
### Identification of opportunities for evidence generation of moral, ethical, spiritual, European dimension, environmental education and health and safety issues

<table>
<thead>
<tr>
<th>Unit No and Title</th>
<th>Moral, ethical and spiritual</th>
<th>European dimension</th>
<th>environmental education</th>
<th>health and safety</th>
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</thead>
<tbody>
<tr>
<td>116 Safe and effective working in a boatbuilding repair and service environment</td>
<td>3.5 – 3.9</td>
<td>1.1</td>
<td>1.1 – 1.7 4.7</td>
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<td>117 Boatbuilding and repair materials and technology</td>
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<td>1.5</td>
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<tr>
<td>118 Marine construction and components</td>
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<tr>
<td>103 Production and finishing hulls and decks</td>
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</tr>
<tr>
<td>104 Producing and fitting structural components</td>
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<td>105 Establishing reinstatement requirements</td>
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<td>3.19 3.30</td>
<td>3.30</td>
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<tr>
<td>106 Fibre reinforced plastics technology for marine construction</td>
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<td>3.3 4.1 4.6</td>
<td>4.1</td>
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<tr>
<td>107 Vessel services</td>
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<tr>
<td>108 Marine engines</td>
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<td>3.10</td>
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<tr>
<td>109 Marine propulsion systems</td>
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<td>3.4</td>
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<tr>
<td>110 Installing electrical wiring support systems</td>
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<td></td>
<td></td>
</tr>
<tr>
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<tr>
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<tr>
<td>113 Advanced marine electronic systems</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>114 Prepare surfaces and marine coatings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>115 Apply marine coatings</td>
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</tr>
</tbody>
</table>
Level 3 Certificate in Boat Building, Maintenance and Support (2451)

Units
116 Safe and effective working in a boat building repair and service

Rationale

This is a mandatory unit and with unit 117 forms the core of the qualification. It is concerned with developing safety awareness and acquiring non-technical skills which are essential to function effectively in the working environment. It covers general health and safety, conduct, interaction with colleagues, communication skills and working effectively.

This unit covers three learning outcomes. The candidate will be able to:

1. comply with statutory regulations and organisational requirements
2. apply safe working practices
3. plan, organise and monitor work activities needed to carry out the boat building, repair and service activities.

Connection with other awards

This unit combines and extends the knowledge and understanding contained in units:

- U1053051 Working safely in a boat building/repair environment
- U1053053 Contributing to self development and working relationships
- U1053053 Contributing to improving working practices and procedures
- U0153054 Planning the requirements to achieve boat building/repair activities of Level 3 NVQ in Boat Building and Maintenance.

Assessment

This unit will be assessed by means of a multiple choice online test.
Outcome 1: Comply with statutory regulations and organisational requirements

Practical activities

The candidate will be able to:

1. identify a range of safety equipment within the work area
2. select appropriate Personal Protective Equipment (PPE) and safety equipment for a designated task
3. recognise a series of warning, prohibition and mandatory safety signs
4. complete an accident report
5. carry out a risk assessment.

Underpinning knowledge

The candidate will be able to:

1. outline basic safety regulation awareness applicable to marine operations.
   b. Control of Substances Hazardous to Health Regulations 1999.
   d. Portable Appliance Testing Regulations.
   e. Control of Major Accident and Hazards Regulations 1999.
   g. Noise Act 1996.

2. state employers’ responsibilities to maintain safety in terms of providing:
   a. a safe place of work
   b. safe plant and equipment
   c. a safe system of work
   d. a safe working environment
   e. safe methods of handling, storing and transporting goods and materials
   f. reporting of accidents
   g. information, instruction, training and supervision of employees
   h. a safety policy.

3. describe the safety requirements for operator activities by
   a. wearing the appropriate Personal Protective Equipment (PPE)
   b. wearing the appropriate Respiratory Protective Equipment (RPE)
   c. maintain secure area’s free from danger to self or others
   d. working so that your actions do not cause damage to the environment in terms of air water or ground pollution.

4. describe briefly the sections relevant to engineering of the Reportable Diseases and Dangerous Occurrences Regulations (RIDDOR 1985)
5 describe briefly how the Management of Health and Safety Regulations 1998 is implemented in a company. For example:
   a  Establish and specify a health and safety policy in accordance with the act.
   b  Nominate a Health and safety officer.
   c  Set up a safety committee with cross company membership.
   d  Carry out regular risk assessments.
   e  Provide regular Health and Safety training and updating.
   f  Keep up-to-date with Health and Safety matters by all means available, Internet etc.
   g  Establish safe working practices and procedures.
   h  Encourage good safety practice.

6 recognise and describe the categories of safety signs such as
   a  warning or cautionary signs as having a triangular shape and yellow in colour such as caution slippery surface, caution dangerous chemicals, caution overhead hazard etc.
   b  prohibition signs as being round with a diagonal band and red in colour such as no smoking no admittance no naked flames etc.
   c  mandatory signs as Blue in colour and reminding employees that certain rules must followed when entering or working in specific environments.

7 outline the roles, responsibilities and powers of the following posts:
   a  The Safety officer in a company is responsible for ensuring that Health and Safety in the company is up to date on regular training and up dating is implemented.
   b  A safety representative is generally a member of the workforce who sits on a Safety Committee convened by the Safety officer who brings to attention safety matters within the company.
   c  Health and Safety Inspectors are employed by the Health and Safety Executive and have the power to inspect the premises if Health and Safety is below requirements and they have the power to close down companies or parts of a company who are at fault.
   d  Environmental Health Officers are employed to investigate and provide information on such matters as: fume, noise, waste or liquid pollution or other environmental issues such as the contamination of rivers and the sea and the presence of vermin etc.

8 state or describe where to access Health and Safety literature and advice. For example: Company Safety officer, notice boards, HMSO, the Health and Safety Executive, commercial safety organisations and companies selling safety equipment, the internet etc.

9 describe the human and environmental conditions leading to accidents in the workplace and the means of controlling them.
   a  Causes of accidents:
      i  human: carelessness; improper behaviour and dress; lack of training, supervision and experience; fatigue; drug-taking and drinking
      ii  environmental: unguarded or faulty machinery or tools; inadequate ventilation; untidy, dirty, overcrowded, badly lit workplaces.
   b  Accident prevention measures:
      i  eliminate the hazard
      ii  replace the hazard with something less dangerous
      iii  guard the hazard
      iv  personal protection
      v  safety education and publicity.
10 describe the procedures for reporting accidents.
   a Summary of what happened.
   b Name of victim.
   c Summary of events prior to accident.
   d Details of witnesses.
   e Information on injury or loss sustained.
   f Conclusions.
   g Recommendations.
   h Supporting material:
      i photographs
      ii video
      iii diagrams.
   i Date.
   j Signature of person(s) responsible for reporting.

11 describe how to carry out a risk assessment and prepare a report identifying potential health hazards:
   a slippery or uneven surfaces
   b spillages
   c scrap or waste material
   d inflammable materials
   e faulty or missing machine guards
   f faulty electrical connections or damaged cables
   g material ejection
   h pressure and stored energy
   i unshielded processes
   j volatile and toxic materials
   k dust and fumes
   l contaminants and irritants
   m materials handling and transportation
   n working at heights.

12 list the general rules for the observance of safe practices.
   a Be alert.
   b Maintain personal hygiene.
   c Protect yourself and other people.
   d Know emergency procedures.
   e Report all hazards.

13 explain environmental management systems (BSEN ISO 14001) in terms of the marine industry, by identifying:
   a environmental aspects in a marine company such as the quality of the noise, air and light
   b the storage and disposal of hazardous waste
   c the level of acceptable or non acceptable values for a & b above
   d procedures put in place for controlling and processing a, b & c above.

14 describe briefly environmental legislation as it applies to marine industry.
   a Environmental Protection Act 1990.
   c Clean Air Act 1993.
   e Controlled Waste Regulations 1998.
Outcome 2: Apply safe working practices and procedures

Practical activities

The candidate will be able to:

1. demonstrate how to safely manually handle a range of products of different size, shape and weight
2. recognize potential safety hazards within the workplace
3. complete a basic risk assessment for a task or operation using lifting equipment.

Underpinning knowledge

The candidate will be able to:

1. explain the range of Personal Protective Equipment (PPE) appropriate to the task or operation being undertaken, such as safety boots when moving heavy materials, ear defenders for working in a noisy workshop and safety goggles or glasses when grinding etc.
2. explain the range and necessity for using Respiratory Protective Equipment (RPE) when undertaking tasks involving exposure to:
   a. chemicals and solvents
   b. fumes
   c. dust or harmful particulates
   d. heat.
3. describe how to carry out a risk assessment for the use of mechanical lifting equipment.
4. explain the safety rules for the use of mechanical lifting equipment.
   a. As a general rule loads over 20kg need powered lifting gear.
   b. Never exceed the maximum safe working load (SWL) indicated on the equipment and the accessories.
   c. Avoid shock loading the lifting equipment, swinging and twisting.
   d. Estimate the centre of gravity.
   e. Position the lifting hook above the centre of gravity of the load to maintain an even balance.
   f. Avoid pushing or pulling the load to adjust the balance.
   g. Do not transport loads over the heads of people or walk under a load.
   h. Do not leave a load hanging unnecessarily and, in any event, have someone to watch over it.
   i. Always lower the load gently into position; make sure it will not move once the lifting equipment is removed.
   j. Check date of equipment tests.
explain the purpose and methods of use of accessories to lifting equipment as follows:

b. Slings.
c. The importance of the angle at the top; forces in the legs proportional to the angle at the top.
d. Design and construction of:
   i. rope slings: natural and man-made fibres
   ii. steel wire slings.
e. Rules for the use of slings:
   i. never bend around sharp corners and edges and avoid overbending; use of protective covers on corners of loads
   ii. never twist or kink the sling
   iii. never use a worn or damaged sling
   iv. always observe the SWL.
f. Eyebolts: design and construction to published standards; use when lifting engines, gearboxes; the importance of ensuring that the eyebolt shoulder is screwed flush to face of component.
g. Shackles: design and construction to published standards; the importance of SWL for different sizes.
h. Chains: design and construction; the importance of regular checking and testing to avoid failure from damage and metal fatigue
i. Rings: design and construction to published standards; importance of use with slings and chains.
k. Special-to-purpose equipment: use for lifting special equipment, regular lifting eg oil drums, production components.

describe the various knots used in ropes and slings and their application.

a. Reef knot – joining ropes of equal thickness.
b. Clove hitch – joining ropes to a pole or bar.
c. Single or double loop – preventing a sling from slipping off a crane hook.
d. Two half-hitches – connecting a rope to a sling.
e. Bowline – preventing a load from tightening a loop.

describe briefly the relevant sections of the Manual Handling Operations Regulations 1992 such as:

a. Carrying out a risk assessment on the types of manual handling in operation in a Boatyard or Marina.
b. Methods employed in transporting or supporting boats in a yard or marina.
c. Methods used for lifting boats and equipment both manual and mechanical
d. Correct posture and technique for manual lifting and carrying.
e. The use of suitable clothing, footwear or other personal effects.
f. Providing adequate or appropriate knowledge and training to the workforce.

give reasons for the necessity to have a permit to work or enter procedure such as:

a. For safety reasons to ensure no unauthorised people have access to a potentially dangerous workshop.
b. For security reasons, preventing theft, malicious damage and industrial secrecy.
9 describe the procedures used to notify/report hazards to the following appropriate people including work colleagues in or near the hazards.
   a Supervisors.
   b Safety officers or representatives.
   c Fire officers.
   d Works rescue team.

10 describe situations in which it is unsafe to work in isolation such as those listed from a to f including also where danger of falling overboard or in the water is possible.
   a In confined spaces.
   b Above ground or in trenches.
   c In close proximity to unguarded machinery.
   d When a fire risk exists.
   e With toxic or corrosive substances.
   f On site.
Outcome 3: Plan, organise and monitor work activities needed to carry out the boat building, repair and service activities

Practical activities

The candidate will be able to:

1. plan and organise a work activity making effective use of fixed resources
2. identify opportunities and suggest improvements to working practices and procedures.

Underpinning knowledge

The candidate will be able to:

1. describe how to maximise the efficiency and effectiveness of the resources in a Marine company in terms of:
   a. The use of labour by employing the right skills and level of training to produce the required quality of work.
   b. Careful management of time to ensure 1) there is little or no time wasted and 2) the job is completed on time.
   c. The correct amount and quality of materials are available to complete the work without delay.
   d. The use of the proper quality of tools and equipment so as to maximise their life.
   e. Making proper use of the working area and space available to ensure a safe environment in which to work.
   f. Support facilities such as adequate lighting and atmosphere (heating, dust extraction etc) a saw mill, joiners shop, engineering, electrical, plumbers, painters, riggers and stores etc.

2. explain the need to maintain up to date records of work in progress and the specific records that need to be maintained, such as:
   a. Work schedule sheets, time sheets, critical path analysis charts, or other progress charts etc
   b. Quality assurance certificate, Recreational Craft Directive logs and files, trials and equipments test records etc.
   c. Stock control records and reorder values in terms of numbers and delivery timescales to maintain stock levels.

3. identify the range of technical requirements needed to deliver the work outcome in terms of:
   a. working methods and techniques such as hand skills and degree of experience and knowledge, the use of machines such as woodworking machines, lathes, drilling machines welding equipment etc
   b. the use of specialist tools and equipment such as feeler gauges, dial gauges, pressure gauges and test equipment, levels, plumb bob, spileing batons, dummy sticks, shepherds crook, bevel boards, bending jigs and formers, frp spray or vacuum forming equipment etc
   c. materials and components such as glass and fibre reinforcements, specialist timbers and boards, marine quality stainless steel components such as push-pits and pull-pits, stanchions etc.
4 identify the range of information sources to identify the resources needed to deliver the work outcome such as those stated in a to d. It would also include things like Lloyds rules, RCD requirements and other regulatory bodies, manufactures’ and suppliers’ catalogues, specialist magazines and the internet.
   a  Design drawings.
   b  Specifications.
   c  Job instructions.
   d  Customer requirements.

5 describe how to extract relevant data from those listed to determine the resources required. For example: extracting information from a construction drawing which has a scantlings list showing sizes and nature of material, fastening types, sizes and materials or by referring to Lloyds rules to identify specific information etc.

6 describe action to be taken when required resources are not available or supply problems exist such as:
   a  notify relevant personnel
   b  re-schedule work.
   c  have contingency plan to obtain resources elsewhere.

7 identify the range of regulatory requirements (other than Health and Safety) that influence the boatbuilding, repair or servicing activity such as those listed from a to d including the British Waterways Boat Safety Scheme and the Marine Safety Agency.
   a  Recreational Craft Directive.
   b  Lloyds.
   c  BSI/ISO standards.
   d  Environmental Protection Act 1990.

8 list the basic components of a typical production system, and describe ways in which productivity can be increased.
   a  List components of a typical production system in terms of:
      i  energy
      ii  labour (person/hours)
      iii  machinery and equipment
      iv  materials
      v  land and buildings.
   b  Describe a simple increase in production, in terms of more substantial input of ingredients.
   c  Describe the simple relationship between an increase in cost of any of the components listed at (a) and a company's competitiveness and/or profitability.
   d  Describe ways of improving productivity, in terms of increasing output from the same:
      i  value of materials
      ii  person hour
      iii  machine hour
      iv  use of energy.
   e  Describe the effect on costs of:
      i  lateness and absenteeism
      ii  machinery and equipment failure
      iii  down time
      iv  need to rework
      v  scrap.
List factors causing industrial change, and describe their influence on working patterns and training needs.

a. List factors causing industrial change in terms of:
   i. reduced demand
   ii. increased scale of competition
   iii. lack of competitiveness in terms of:
       A. marketing
       B. productivity
       C. quality
   iv. introduction of new technology.

b. Describe effects of industrial change on working patterns and practices in terms of:
   i. broad-based skill requirement
   ii. transferable skill requirement
   iii. increased technological content of job
   iv. changeable and flexible working
   v. demand for increased organisational cohesiveness
   vi. need for continual retraining and updating
   vii. expectation of more frequent job change
   viii. development of new career patterns.

Describe the important factors, for continued trading, of maintaining good customer relations by: having friendly and well informed staff who give sound and practical advice; good quality, polite, trustworthy, neat and tidy workers; clean and well maintained premises, etc. Outline measures designed for customer protection by

a. being able to describe the importance of meeting customer expectations in terms of:
   i. ensuring the product service is fit for purpose (it works and performs as expected)
   ii. the cost is within the quoted price + any agreed extras
   iii. the product (boat) is finished by the agreed delivery date.
   iv. the product is of the required quality and reliability.

b. being able to outline the legal obligations of a sales contract such as:
   i. agreed delivery dates and the implications of penalty clauses.
   ii. the method of payment i.e. a deposit and final payment or a deposit and staged payments.
   iii. the legal standing of the designer’s specification as taking precedence over drawings.
   iv. after sales service and rectification of faults, which may occur within a stated warrantee period.
   v. the signatures of all parties in the contract.
117 Boatbuilding and repair materials and technology

Rationale

This is a mandatory unit and with 116 forms the core of the qualification. It is concerned with the identification and use of materials within boatbuilding and repair. It also covers the types of craft, and the associated construction methods.

This unit covers five learning outcomes. The candidate will be able to:

1 understand boat construction materials
2 interpret drawings and specifications
3 recognise types of boats and boat construction techniques
4 identify the purpose of ancillary systems
5 recognise fittings and components in boats.

Connection with other awards

This unit combines and extends the knowledge and understanding contained in units:

U1053055 Producing templates and jigs for the construction or repair of boats.
U1053067 Commissioning and testing completed boats of the Level 3 NVQ in Boat Building and Maintenance.

Assessment

This unit will be assessed by means of a multiple choice online test.
Outcome 1: Understand boat construction materials

Underpinning knowledge

The candidate will be able to:

1. identify types of materials used in boat construction.
   a. Wood – hardwoods, softwoods, manufactured boards
   b. Metals – ferrous, non-ferrous
   c. Composites – GRP/FRP
   d. Plastics.

2. evaluate and select materials for use based on:
   a. strength
   b. resistance to degradation/corrosion
   c. toughness
   d. hardness
   e. elasticity
   f. density/weight.

3. identify common defects in materials.
   a. Wood – infestation, decay, knots, splits, distortion.

4. describe methods of protection.
   a. Preservatives or timber.
   b. Sacrificial anodes.
   c. Coatings.

5. outline the common ways in which timber is converted/seasoned, market sizes and economical uses.

6. calculate material requirements for:
   a. areas
   b. volume.

7. identify types of reinforcement and stiffening materials other than glass fabrics.
   a. Carbon fibre.
   b. Aramid.
   c. Pre-impregnated cloths.
   d. Polyurethane foam.
   e. PVC foam.

8. select appropriate fastenings for structural and decorative purposes.

9. outline how to fasten assemblies together using appropriate fastening systems.

10. evaluate the comparative holding power of various adhesives:
    a. urea formaldehyde
    b. resorcinol
    c. epoxy
    d. polyurethane.

11. define primary bonds and secondary bonds when fixing FRP structures.
12 describe the techniques used for applying coating systems:
   a paints (water based, oil based)
   b varnishes
   c decorative laminates
   d oils
   e antifoulings.

13 evaluate materials with regard to:
   a safe storage
   b disposal of waste.
Outcome 2: Interpret drawings and specifications

Underpinning knowledge

The candidate will be able to:

1. identify the specification authorities and regulating bodies.
   a. RCD.
   b. BSI/EN.
   c. ISO.
   d. Lloyds.
   e. Boat Safety Scheme.
   f. DTI.

2. describe how to use scale rules to extract information from lines, construction and GA drawings.

3. describe how to draw up a setting-out rod for a piece of joinery taking information from the GA.

4. describe how to loft a simple hull shape from a lines plan.

5. describe how to access information from a CAD package.

6. describe how to work to specifications produced by an outside body.

7. identify boat terms from drawings and specifications:
   a. port, starboard, forward, aft, abaft, amidships, bow, stern.
   b. outboard, inboard.
   c. length, breadth, depth.
   d. draught, freeboard, displacement, deadweight.
   e. bulkhead, rise of floor, camber, flare, sheet, bilge, flat of bottom, superstructure, frame, floor, longitudinal, transverse, seam, butt.
   f. bridge, cockpit, deck house, decks, hatches, vents, saloon, cabins.
   g. deck equipment, winch, fairleads, bollards, bow rollers, davits, anchor.

8. use techniques to find true shapes of components from drawings.

9. calculate from drawings and specifications:
   a. areas.
   b. volumes.
   c. angles.
Outcome 3: Recognise types of boats and boat construction techniques

Underpinning knowledge

The candidate will be able to:

1. identify types of boats.
   a. Motor cruisers.
   b. Yachts.
   c. Speed boats.
   d. Narrow boats.
   e. Personal water craft.

2. identify the types of propulsion.
   a. Sails.
   b. Motors – inboard, outboard.

3. describe the various boat building techniques.
   a. Traditional (carvel, clinker, double diagonal).
   b. Modern wood/epoxy (strip plank, cold moulding, clinker ply, stitch and tape).
   c. GRP/FRP (mass produced and one-off).
   d. Metals (steel, aluminium).
   e. Fabrics.
   f. Plug construction techniques.

4. identify the purpose of:
   a. jigs
   b. templates
   c. framing.

5. identify techniques for building plugs for FRP moulding with respect to:
   a. speed
   b. cost effectiveness
   c. integrity of structure.

6. prepare typical work schedules for the construction of parts and components.
Outcome 4: Identify the purpose of ancillary equipment and systems

Underpinning knowledge

The candidate will be able to:

1. identify communication systems.
   a. Radio.
   c. Satellite support systems.

2. identify environmental systems.
   a. Heating.
   b. Water, fresh and waste.
   c. Ventilation and air-conditioning.

3. identify personal safety equipment.
   a. Buoyancy equipment.
   b. Lifejackets.
   c. Safety harness.

4. identify general safety equipment.
   a. Flares.
   b. First aid box.
   c. Fire fighting equipment.
   d. Emergency locker.

5. identify ancillary systems.
   a. Hydraulic.
   b. Pneumatic.
   c. Electrical.
Outcome 5: Recognise fittings and components in boats

Underpinning knowledge

The candidate will be able to:

1. read and interpret drawings, specifications, computer generated data and work instructions
2. specify installation activities in accordance with safe working practices, company procedures, codes of practice and legislation
3. state the importance of location and purpose of fittings and components so that they
   a. function satisfactorily
   b. do not present a hazard in use
   c. allow easy access and operation
   d. meet operational requirements.
4. identify the types of exterior fitting and components fitted to boats.
   a. Hull and superstructure fittings: bilge keels, rolling chocks, rudders, pintles and gudgeons, skin fittings, hawse pipes, portlights and windows, hatches and skylights, 'A' and 'P' brackets, bow thruster, echo sounders, logs, anodes.
   b. Deck fittings: masts and spars, grab rails pulpit and pushpit, chain plates, forestay and backstay fittings, bow rollers, winches and windlasses, cleats, bollards, Sampson post and fairleads, mainsheet and headsail tracks, tabernacle, anchor stowage, stanchions, davits, life-buoy and life-raft stowage.
5. state the importance of providing additional stiffening and support (eking pieces) in way of fittings and components subject to stress and appreciate the magnitude of forces which these components can be subjected to
6. select the appropriate type of fastening device for particular applications ie through bolts for fittings subject to stress, the use of locking devices
7. identify bedding and sealing techniques in way of fittings and dissimilar metals
8. recognise the correct tools and specialised equipment to use when installing fittings and components to boats.
   a. Hand tools.
   b. Portable power tools.
   c. Lifting equipment, blocks and tackle, slings, jacks.
   d. Special tools such as ‘the shepherd’s crook’ (hawse-pipe scriber).
   e. Thermal equipment (metal only).
9. predict the problems that can affect the work when installing exterior fittings and components to boats.
   a. Different trades wanting to access the same area.
   b. Working practices and workmanship.
   c. Access to working areas.
   d. Reading of drawings and understanding the work instructions.
   e. Location of existing installations.
118 Marine construction and components

Rationale

This is a mandatory unit. All candidates need to take this unit to obtain the qualification. This unit is concerned with the identification of materials used in marine construction, the interpretation of drawings along with the tools and equipment used. It also covers the identification of ancillary equipment and the ability to recognise marine fittings.

This unit covers five learning outcomes. The candidate will be able to:

1. understand marine construction materials
2. interpret drawings and specifications
3. recognise types of boats and boat construction techniques
4. identify the purpose of ancillary equipment and systems
5. recognise marine fittings and components.

Connection with other awards

This unit combines and extends the knowledge contained in units:

Unit 214 – Servicing ancillary systems and equipment in yachts and boats of Level 3 NVQ in Marine Engineering.

Assessment

This unit will be assessed by means of a multiple choice online test.
Outcome 1: Understand marine construction materials

Underpinning knowledge

The candidate will be able to:

1. identify types of materials used in boat construction.
   a. Wood – hardwoods, softwoods, manufactured boards.
   b. Metals – ferrous, non ferrous.
   c. Composites – GRP/FRP.
   d. Plastics.

2. evaluate and select materials for the use based on:
   a. strength
   b. resistance to degradation/corrosion
   c. toughness
   d. hardness
   e. elasticity
   f. density/weight
   g. conductivity/resistance
   h. magnetism.

3. identify common defects in materials.

4. describe methods of protection.
   a. Sacrificial anodes.
   b. Coatings.

5. select fastenings appropriate for use

6. describe the techniques used for re-instating coating systems.
   a. Paints (water based and oil based).
   b. Varnishes.
   c. Decorative laminates.
   d. Oils.
   e. Anti fouling.

7. evaluate materials with regard to:
   a. safe storage
   b. disposal of waste.
Outcome 2: Interpret drawings and specifications

Underpinning knowledge

The candidate will be able to:

1. identify the specification authorities and regulating bodies.
   a. RCD.
   b. BSI/EN.
   c. ISO.
   d. Lloyds.
   e. Boat safety scheme.
   f. DTI.
   g. BMF.
   h. BMEA.

2. describe how to access information from a CAD package

3. describe how to work to specifications produced by an outside body

4. identify boat terms from drawings and specifications.
   a. Port, starboard, forward, aft, amidships, bow, stern.
   b. Outboard, inboard.
   c. Length, breadth, depth.
   d. Draught, freeboard, displacement, deadweight.
   e. Bulkhead, camber, bilge, superstructure, frame, floor.
   f. Bridge, cockpit, deckhouse, decks, hatches, vents, saloon, cabins.
   g. Deck equipment, winch, fairleads, bollards, bow rollers, davits, anchor.

5. calculate from drawings and specifications
   a. areas
   b. volumes
   c. angles.
Outcome 3: Recognise types of boats and boat construction techniques

Underpinning knowledge

The candidate will be able to:

1. identify types of boats.
   a. Motor cruisers.
   b. Yachts.
   c. Speed boats.
   d. Narrow boats.
   e. Personal water craft.

2. identify the types of propulsion unit.
   a. Sails.
   b. Motors – inboard, outboard, water jet.

3. describe the various boat building techniques:
   a. traditional (carvel, clinker, double diagonal)
   b. modern wood/epoxy (strip plank, cold moulding, clinker ply, stitch and tape)
   c. GRP/FRP (mass produced and one off)
   d. metals (steel, aluminum)
   e. fabrics
   f. plug construction techniques.

4. identify the purpose of:
   a. jigs
   b. templates.

5. identify techniques for building plugs for FRP moulding with respect to:
   a. speed
   b. cost effectiveness
   c. integrity of structure.

6. prepare typical work schedules for the construction of parts and components.
Outcome 4: Identify the purpose of ancillary equipment and systems

Underpinning knowledge

The candidate will be able to:

1. identify communication systems.
   a. Radio.
   c. Satellite support systems.

2. identify environmental systems.
   a. Heating.
   b. Water, fresh and waste.
   c. Ventilation and air – conditioning.

3. identify personal safety equipment.
   a. Buoyancy equipment.
   b. Lifejackets.
   c. Safety harness.

4. identify general safety equipment.
   a. Flares.
   b. First aid box.
   c. Fire fighting equipment.
   d. Emergency locker.

5. identify ancillary systems.
   a. Hydraulic.
   b. Pneumatic.
   c. Electrical.
Outcome 5: Recognise marine fittings and components

Underpinning knowledge

The candidate will be able to:

1. read and interpret drawings, specifications, computer generated data and work instructions
2. specify installations activities in accordance with safe working practices, company procedures, codes of practice and legislation
3. state the importance of location and purpose of fittings and components so they
   a. function satisfactorily
   b. do not present a hazard in use
   c. allow easy access and operation
   d. meet operational requirements.
4. identify the types of exterior fitting and components fitted to boats.
   a. Hull and super structure fittings: bilge keels, rolling chocks, rudders, pintles and gudgeons, skin fittings, hawse pipes, port lights and windows, hatches and skylights, ‘A’ brackets and ‘P’ brackets, bow thruster, echo sounders, logs, anodes.
   b. Deck fittings, pulpit and pushpit, chain plates, forestay and backstay fittings, bow rollers, winches and windlasses, cleats, bollards, Sampson post and fairleads, mainsheet and head sail tracks, tabernacle, anchor stowage, stanchions, davits, life-buoy and life rafts stowage.
5. state the importance of providing additional stiffening and support (eking pieces) in way of fittings and components subject to stress and appreciate the magnitude of forces which these components can be subject to
6. select the appropriate type of fastening device for particular applications i.e through bolts for fittings subject to stress, the use of locking devices
7. identify bedding and sealing techniques in way of fittings and dissimilar metals
8. recognise the correct tools and specialised equipment to use when installing fittings and components to boats:
   a. hand tools
   b. portable power tools
   c. lifting equipment, blocks and tackle, slings, jacks
   d. special tools such as “the shepherds crook” (hawse-pipe scriber0
   e. gas arc cutting welding equipment (metal only).
9. predict the problems that can affect their work when installing exterior fittings and components to boats.
   a. Different trades wanting to access the same area.
   b. Working practices and workmanship.
   c. Access to working areas.
   d. Reading and drawings and understanding the work instructions.
   e. Location of existing installations.
10. identify the types of interior fitting and components fitted to boats.
a  Gearboxes, battery and battery boxes, calorifiers, gas systems.
b  Water systems, steering systems, black waters and grey water systems.
c  Lighting systems, distribution systems, d.c generators.
103 Producing and repairing of hulls and decks

Rationale

This is an optional unit. This unit covers the underlying technology and skills requirements for the successful construction of boats. It includes the interpretation of drawings and specifications, the terminology and techniques needed to obtain the shape of moulds and templates and the skills required to mark, cut-out, assemble and finish the items which make up a boat.

This unit covers four learning outcomes. The candidate will be able to
1 Produce templates, moulds and jigs for the construction and repair of boats.
2 Cut and shape materials to form the structural components of boats.
3 Assemble and finish hull and deck structures.
4 Assemble and finish above deck structures.

Connection with other awards

This unit combines and extends the knowledge and understanding contained in units
U1053055 Producing templates and jigs for the construction or repair of boats
U1053056 Cutting and shaping materials to form the structural components of boats
U1053057 Assembling and finishing hull and deck structures
U1053058 Assembling and finishing above deck structures
U1053059 Installing exterior fittings and components to boats
of Level 3 in NVQ Boat Building and Maintenance

Assessment

The outcomes of this unit will be assessed using evidence from a practical assignment covering the practical activities and the underpinning knowledge
Outcome 1: Produce templates, moulds and jigs for the construction and repair of boats

Practical activities

The candidate will be able to:

1. read and interpret information from lines plans, working drawings, specifications or computer generated data
2. prepare working drawings and materials lists
3. set out and cut materials for template and jigs
4. complete and check finished templates and jigs
5. complete and store records and data.

Underpinning knowledge

The candidate will be able to:

1. obtain sources of technical information from:
   a. manufacturers’/supplier’s data sheets
   b. technical journals
   c. Lloyds rules
   d. Recreational Craft Directive
   e. designers’ drawings.
2. extract template and jig information from:
   a. computer generated data
   b. lines plan
   c. working drawings
   d. specifications
   e. scantlings lists.
3. select suitable tools and equipment for developing, marking and cutting out templates and jigs.
   a. Lofting equipment, battens, hammer and loft nails, trammels, bevel board, chalk line, curves (ships, French, rams horn, tick sticks or transfer battens).
   b. Hand tools, saws, compass plane, smoothing, jack and try planes, spoke shaves.
   c. Power tools, jig saw, drill, screw driver, small band saw.
4. identify suitable/appropriate material for producing templates and jigs.
   a. Softwood.
   b. Hardwood.
   c. Manufactured boards.
   d. Template card/paper.
   e. Metal.
5 select the appropriate method of transferring lines and data onto moulds, templates or jigs using:
   a direct measurement
   b tracing/transfer
   c spiling/scribing
   d nail head impressions.

6 adopt the correct techniques for retaining the shapes of hulls and decks before a repair operation using:
   a shores and temporary jigs
   b bracings
   c ties
   d deck and hull support.

7 describe the correct sequence of operations for carrying out repairs to hulls and decks

8 identify safe working practice requirements in the workplace.
   a Personal protective equipment.
   b Dust and fume extraction.
   c Adequate lighting.
   d Noise control.
   e Safe lifting and handling regulations. LOLER 1998.
   f Handling and removal of waste materials. COSHH regulations and BS/EN 4001.
   g Safe use of fixed and portable woodworking machinery.

9 recognise the defects in materials caused by:
   a poor setting out
   b poor cutting
   c poor shaping
   d template distortion
   e timber defects:
      natural: knots, shakes, sap and timber decay
      seasoning: warping and twisting, splitting etc
   f metals: corrosion, buckling and casting voids etc.

10 recognise the factors which influence the finish and quality of work.
   a Standard of workmanship.
   b Material selection.
   c Time constraints.
   d Methods of visual and dimensional inspection
Outcome 2: Cut and shape materials to form the structural components of boats

Practical activities

The candidate will be able to:

1. select and mark out materials
2. cut materials to form structural components
3. shape materials to meet required configuration of hulls and decks
4. finish and inspect structural components.

Underpinning knowledge

The candidate will be able to:

1. read and interpret drawings, scantlings lists, specifications, moulds and patterns
2. state the importance of following work instructions and job sheets
3. describe the criteria for the selection of materials.
   a. Free from natural and seasoning defects.
   b. Grain direction.
   c. Working properties.
   d. Durability, stability.
   e. Strength requirements.
   f. Weight considerations.
4. identify materials used in boat construction and their characteristics.
   a. Hardwoods, softwoods, manufactured boards, composite boards.
   b. Metals, iron, steel, aluminium, copper, lead, alloys.
   c. Plastics, thermoplastics and thermosetting plastics.
5. recognise the main structural components which make up hulls and decks and their composition.
   a. Backbone structures, keels, stems, sternpost, apron, deadwood, knees, floors, chines, horn timber, transom, engine beds.
   b. Frames and bulkheads floors, grown, laminated, composites, metal plate and angle.
   c. Skin construction, carvel, clinker, double diagonal, cold moulded, strip or skin, plate metal, chine construction and composite.
   d. Beams, carlins, stringers, gunwales, beam shelf, mast clamp, sole bearers, thwarts, deck and decking arrangements, deck pads and eking pieces.
   e. Knees, breast hooks, quarter knees, thwart knees, hanging and lodging knees.
6. describe marking out methods for making components to hulls and decks.
   a. Direct measurement.
   b. Tracing transfer.
   c. Spiling/scribing.
   d. Nail head impressions.
   e. Use of templates.
7 describe the tools and techniques used to manufacture structural members of hulls and decks.
   a Establishing ‘sided and moulded’ sizes.
   b Marking and working bearding and rabbet lines.
   c Setting out beam cambers.
   d Methods used to form laminated members such as frames, floors, beams and stems etc.
   e Methods used to form ‘grown’ members such as frames, floors, beams and stems etc.
   f Techniques of ‘steam or heat bending’.
   g Specialist tools used: adze, draw knife, compass planes, bollow and moulding planes.

8 describe the steps to be taken when installing engine beds/plates and associated features.
   a Setting up shaft line.
   b Cut, fit and fix engine beds.
   c Cut out and align stern tube opening and fit stern tube.
   d Align and fix propeller brackets in accordance with RCD and Lloyds.

9 identify the best and most economic use of materials and minimise waste (ISO 14001) by:
   a using templates
   b nesting
   c utilising appropriate off-cuts.

10 describe the joints used to connect structural components.
    a Scarphs, plain and hooked.
    b Tabling and loose tenons.
    c Skew/beam dovetails.
    d Birds beaks.
    e Butt straps.

11 identify the problems and faults that can occur as a result of:
    a setting out
    b selection of material
    c workmanship
    d reading of drawings, specifications, data sheets or work instructions.
Outcome 3: Assemble and finish hull and deck structures

Practical activities

The candidate will be able to:

1. position and fix structural components of hulls and decks
2. check the alignment of structural components
3. carry out finishing operations to hulls and decks
4. inspect completed hulls and decks for quality.

Underpinning knowledge

The candidate will be able to:

1. describe the steps needed to prepare the work area for the assembly of hull and deck components.
   a. Free from obstructions and contamination (greasy/oily floor etc).
   b. Safe access, staging, gangways and ladders secure.
   c. Sufficient heating, lighting, ventilation, space.
   d. Assembly components to hand.
   e. Tools and equipment to hand.
   f. Establishment of building stocks and uprights.
   g. Levelling and declivity operations.

2. identify both manual and mechanical lifting equipment.
   a. Safe lifting techniques.
   b. Slings and strops.
   c. The importance of safe working loads and current certification.
   d. Identify appropriate lifting equipment: manual and mechanical.

3. state the correct procedure for positioning and bracing structural components during assembly operations.
   a. ‘Horning in’, levelling and plumbing operations.
   b. Bracing and shoring techniques.
   c. Centre line and building board/batten.

4. identify tools and equipment in assembly operations.
   b. Aligning equipment, levels including water levelling pipe, plumb bob and horning in battens, theodolite, laser levels.
   c. Hand tools, heavy maul, clenching hammer, rove punches, clenching spoon, nail cutting caulkling mallet, caulking irons, bolt drifts, dummy sticks for spiling, brace and boring bits, dowel cutters.
   d. Portable power tools, ‘skill’ saw, planer, drills, heavy duty grinders, sanding machines.
   e. Temporary holding devices, sash cramps, ‘g’ cramps
   f. Thermal equipment (metal only).

5. identify the fixing methods used to join hull and deck assemblies.
   a. Mechanical fastening devices (screws and bolts).
   b. Adhesives and silicones, FRP bonding techniques, epoxies/polyesters.
6. describe how the fixing methods can affect the integrity and strength of the assemble structure ie through fastenings on items subject to load.

7. identify the problems that can occur during alignment of hulls and decks.
   a. Adhesive cure times.
   b. Positions and alignment of fastenings.
   c. Spreading of hull structure.

8. identify methods of making hulls and decks watertight.
   a. Use of caulking mallets and caulking irons.
   b. Selection of caulking material, boat cotton, oakum, tape, pitch, polysulphides etc.
   c. Use of seam covering methods, wooden spleens, putty, synthetic rubbers.

9. define a range of covering and sheathing systems.
   a. Epoxy/glass.
   b. Cascover.
   c. Protective and non-slip deck coverings.
   d. Wood sheathing techniques.
   e. Canvas sheathing.
   f. Paints and varnishes.

10. compare the cost effectiveness of building FRP hulls and decks by:
    a. plug to female mould and female mould to male moulding
    b. production of female mould from existing or prototype hull or deck
    c. producing 'one off' mouldings.
Outcome 4: Assemble and finish above deck structures

Practical activities

The candidate will be able to:

1. interpret drawings and work instructions
2. mark out and manufacture superstructure components
3. locate, position and fix superstructure components
4. inspect and check completed assemblies.

Underpinning knowledge

The candidate will be able to:

1. interpret deck and superstructure drawings, specifications, and computer generated data and work instructions
2. identify and recognise above deck structures on boats.
   b. Doghouse.
   c. Wheelhouse.
   d. Bulwarks.
   e. Skylights.
   f. Lockers.
   g. Canopies.
   h. Tabernacle.
   i. Toe-rail and hand rails.
   j. Deck planking.
   k. Masts and spars.
   l. Hatches.
   m. Vent boxes.
3. describe the operations in assembling above deck structures.
   b. Expanded beam camber, as applied to raked or sloping fronts on coach-roof.
   c. Location and fitting corner posts (hopper bevels).
   d. Making, fitting and fastening hand rails.
4. describe the range of deck planking styles and joining and sealing arrangements.
   a. Straight, swept and tapered plank decks.
   b. Covering board, margins, king plank and snapping techniques.
   c. Use of caulking methods, boat cotton or oakum and pitch, proprietary tapes and silicones.
5 identify tools and equipment in marking, making, locating and fixing above deck components.
   a Measuring devices.
   b Hand tools.
   c Portable power tools.
   d Temporary holding devices, cramps and clamps.
   e Woodworking machines, saws, circular and band, planers, under & over, mortising machine.
   f Thermal equipment (metal only).

6 describe features in above deck structures to make them watertight.
   a Water tables and anti capillary groves.
   b Limber holes and baffles.

7 describe appropriate fixing and fastening devices when securing superstructures.
   a Screws.
   b Bolts.
   c Gallery fastenings.

8 list appropriate sealing and bedding compounds when securing superstructures.
   a Silicones
   b Polysulphides
   c Polyurethanes
   d Oil based (putties and bedding compounds)
   e Acrylic and jointing tapes

9 identify appropriate adhesives.
   a PVAs.
   b Epoxies.
   c Phenol/resorcinol formaldehyde.
   d Urea formaldehyde.
   e Casein.
   f Contact adhesives.

10 describe the operations in wooden mast and spar construction:
    a types of timber used
    b conversion and jointing
    c setting out and, if not solid, hollowing
    d use of spar gauge, shaping and finishing.

11 identify appropriate methods to protect components during assembly and until commissioning.
    a Protective covering, cardboard, hardboard, polythene sheet.
    b Painting, varnishing, peelable coatings.

12 identify the problems that can occur during assembly of superstructures.
    a Standard of workmanship.
    b Material selection.
    c Time constraints.
    d Adhesive cure times.
    e Positions and alignment of fastenings.
    f Spreading of hull structure.
104 Producing and fitting structural components

Rationale

This is an optional unit. It is concerned with the manufacture and installation of structural components, such as bulkheads, helm and navigational consoles, furniture units and deck boxes.

The unit also covers the installation of fittings and engine drive system mountings; the planning of component production, evaluation and use of machines and equipment, the accurate production of components for assembly and the construction of sub-assemblies and modules.

The unit also explains the installation of structural components, modules and sub-assemblies into boats and the positioning and fitting of internal fittings and underwater skin fittings. In addition, the unit goes through the planning and installation of domestic services systems, installing hot and cold water systems, tanks and heating/air conditioning systems.

This unit covers two learning outcomes. The candidate will be able to:
1 produce components and sub-assemblies for the outfitting of boats
2 install structural components, modules, fittings and joinery.

Connection with other awards

This unit combines and extends the knowledge and understanding contained in units:

U1053060 Producing components and sub-assemblies for outfitting of boats
U1053061 Installing interior sub-assemblies, fittings and trim to boat structures of the level 3 NVQ in Boat Building and Maintenance.

Assessment

The outcomes of this unit will be assessed using evidence from a practical assignment covering the practical activities and the underpinning knowledge.
Outcome 1: Produce components and sub-assemblies for the outfitting of boats

Practical activities

The candidate will be able to:

1. draw up a production schedule and cutting list for components and sub-assembly from drawings and other data
2. select, mark out and cut materials for sub-assembly
3. manufacture sub-assemblies
4. finish and inspect sub-assemblies.

Underpinning knowledge

The candidate will be able to:

1. describe the sources of data required to mark out and manufacture components.
   a. Drawing (line).
   b. General arrangement drawings.
   c. Specification.
   d. CAD data.
2. explain why a material was chosen, its characteristics and suitability for manufacture of sub-assemblies.
   a. Strength.
   b. Durability.
   c. Colour and grain pattern.
   d. Cost and availability.
   e. Environmental effects.
   f. Ease of working.
3. describe the development of a production schedule and cutting list
4. identify common defects that will affect the selection of timber.
   a. Structural defects:
      i. shakes
      ii. splits
      iii. rot and decay
      iv. worm.
   b. Cosmetic defects:
      i. knots
      ii. sapwood
      iii. pith.
   c. Dimensional defects:
      i. warping
      ii. twisting.
5 explain the importance of marking out methods considering
   a nesting for economic cutting
   b use of face side and face edge
   c direct measurements
   d use of templates and patterns
   e spiling and scribing
   f setting out from a rod/setting board
   g shrinkage

6 describe the most appropriate methods for cutting:
   a squares and rectangular sections
   b angled and bevelled cuts
   c shapes and profiles
   d apertures.

7 identify suitable machines for cutting and shaping:
   a wood/composites
      i soft wood
      ii hardwood
      iii manufactured board
      iv composite materials (MDF etc)
      v plastics.
   b machines
      i portable power
      ii fixed power.
   c type
      i cutting
      ii shaping
      iii surfacing
      iv thicknessing
      v sanding.
   d capacity
      i size
      ii power
      iii adjustment.

8 describe types of defects caused by machining and how to rectify:
   a chatter
   b splintering
   c distortion.
9 explain the setting up process and safety requirements of the following machines:
   a fixed woodworking machine
      i Circular saws.
      ii Band saws.
      iii Surfacing machine.
      iv Thicknessing machine.
      v Spindle moulder.
      vi Sanding machine.
   b portable power machines
      i Drilling machine.
      ii Jig saw.
      iii Sanding machines.
   c hand operated machines
      i Mitre cutting machine.

10 describe how prepared timber should be protected from damage during storage and transport.
   a Stacking to allow equal drying.
   b Covering.
   c Wrapping.

11 explain why it is important to ensure prepared materials meet the required accuracy.
   describe the
   a constraints
      i size
      ii shape
      iii access.
   b considerations
      i cost
      ii customisation
      iii availability
      iv customer requirements.
   c and conventions
      i layout
      ii size/space
      iii height/width
      iv ergonomics.
   when producing sub-assemblies.
   a Bulkheads.
   b Sleeping cabin furniture.
   c Control consoles.
   d Toilet compartment.
   e Galley area.
   f Navigation area.
   g Main saloon and companionway steps.

13 describe suitable jointing methods to assemble:
   a doors
   b drawers
   c companionway steps
   d galley front trim.

14 identify methods of constructing sub-assembly furniture units using:
   a frame construction
   b slab construction
   c use of corner-posts.
15 explain how fixing methods can affect:
   a strength
   b appearance
   c shape.

16 identify the problems that can occur during assembly operations.
   a Splits.
   b Joints.
   c Alignment.
   d Geometric.

17 state the purpose of a structural bulkhead

18 explain the requirements that would affect the choice of final finish.
   a Coating.
   b Paint.
   c Varnish.
   d Lacquer.
   e Oils.

19 state the checks that would be carried out to ensure sub-assemblies meet the design specification.
   a Measurement:
      i alignment
      ii geometric shape.
   b Appearance:
      i blemish free
      ii matching grain
      iii even colour.
   c Operation of doors, drawers and hatches.

20 describe the methods used to protect sub-assemblies from damage caused by
   a wracking
   b surface damage
protected by
   a bracing
   b wrapping and covering
   c coating.

21 describe the methods of identifying sub-assemblies and recording the inspection process.
Outcome 2: Install structural components, modules, fittings, joinery and trim

Practical activities

The candidate will be able to:

1. position and fix sub-assemblies
2. position and fix fittings and trim
3. finish and inspect completed installation.

Underpinning knowledge

The candidate will be able to:

1. identify tools, equipment and services required to position and fix modules and joinery.
   a. Tools:
      i. hand tools
      ii. portable power tools.
   b. Equipment:
      i. clamps
      ii. cramps
      iii. temporary supports.
   c. Services:
      i. power
      ii. lighting
      iii. ventilation.

2. describe the sources of data required to accurately position modules and interior joinery.
   a. Drawing (line).
   b. General arrangement drawings.
   c. Specification.
   d. CAD data.

3. describe the preparation stages in preparing the work area to receive modules and joinery units.
   a. Levelling.
   b. Location marks.
   c. Temporary jigs and support equipment in place.
   d. Inform other trade group.
   e. Prepare surfaces by:
      i. cleaning
      ii. abrading
      iii. coating
      iv. de-greasing.
4. Identify methods for accurately aligning and fitting modules and joinery.
   a. Spile.
   b. Cut, trim and fit.
   c. Level and align.
   d. Locate and temporarily fasten.
   e. Temporarily secure:
      i. Cramps
      ii. Batons
      iii. Packing
      iv. Wedges.

5. Explain the factors that define selection of various fixing methods.
   a. Strength.
   b. Speed.
   c. Corrosion resistant.
   d. Aesthetics.
   e. Replaceability.

6. Explain the load factors that affect securing decisions.

7. Describe the conventions in positioning and fixing underwater skin fittings to:
   a. WC systems
   b. Engine inlets
   c. Grey water waste
   d. In accordance with RCD requirements.

8. Describe the steps to fit and align engine bed/plates, cut and fit propeller shaft/tube and propeller support brackets.
   a. Obtain data and manufacturer’s recommendation.
   b. Set up shaft line.
   c. Cut and fix engine beds.
   d. Cut and align stern tube.
   e. Align and fix propeller bracket.
   f. Align engine and shaft couplings.
   g. All the above in accordance with RCD and Lloyds Register of Shipping Construction recommendations.

9. Explain the sequence ensuring that windows, hatches, fittings and port lights are both secure and watertight.
   a. Obtain data and manufacturer’s recommendation.
   b. Locate fitting accurately.
   c. Cut aperture and dry fit.
   d. Drill and temporarily fix.
   e. Clean, degrease and apply appropriate sealant.
   f. Fasten and evenly tighten to correct torque.
   g. All above in accordance with current regulations.

10. Explain the importance of decorative capping, edging covering strips and linings.
    a. Edge protection.
    b. Aesthetics.
    c. Spill protection.

11. Identify various soft furnishing materials used in the trimming and outfitting of boats.
    a. Fire resistant foam.
    b. Fabrics.

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12 explain why it is important to report problems and defects that cannot be rectified to a responsible person

13 describe the inspection checks that are suitable for completed modules, joinery and fittings.
   a Visual inspection.
   b Functional test.
   c Dimensional test.

14 explain the importance of ensuring the surface finish meets specifications and is suitable for the application

15 identify methods of achieving surface finishes prior to coating using:
   a machinery
   b hand tools
   c abrasive sheets and grading system
   d cutting components.

16 explain why rework is often caused by lack of finished product protection

17 explain the importance of recording inspections within the company quality control procedure.
105 Establishing reinstatement requirements 
(Service, repair and maintenance)

Rationale

This optional unit is intended to cover the skills and knowledge related to servicing and maintenance of boat structures. It is concerned with carrying out visual inspections of damaged boats and identifying the extent of the damage; the carrying out of repairs and reinstatement of structural components. The unit also covers the planned servicing of boats.

This unit covers three learning outcomes. The candidate will be able to:

1. establish reinstatement requirements
2. carry out repairs to boat structure
3. carry out servicing and maintenance operations on boats.

Connection with other awards

This unit combines and extends the knowledge and understanding contained in units:

U1053063 Establish reinstatement requirements.
U1053066 Carry out repairs to boat structure.
U1053067 Carry out service and maintenance operations on boats of the NVQ level 3 in Boat Building and Maintenance.

Assessment

The outcomes of this unit will be assessed using evidence from a practical assignment covering the practical activities and the underpinning knowledge.
Outcome 1: Establish reinstatement requirements

Practical activities

The candidate will be able to:

1. assess the extent of damage to a boat
2. identify and evaluate the reinstatement options
3. plan the reinstatement actions.

Underpinning knowledge

The candidate will be able to:

1. identify the sources of information regarding the condition of the boat.
   a. Survey reports.
   b. Customer information.
2. describe a range of inspections for:
   a. impact damage – structural; non structural; cosmetic
   b. material defects – rot; corrosion; delamination
   c. mechanical integrity – hull strength; watertight.
3. identify tests for:
   a. ultrasonic thickness
   b. FRP hardness
   c. delamination
   d. blistering
   e. moisture content
   f. timber softness
   g. core sampling
   h. corrosion
   i. stress.
4. describe the effects of the results of electrolysis and osmosis
5. identify the need to use specialist services for certain reinstatement work and how these services might be employed.
   a. Electrical.
   b. Engineering.
   c. Plumbing.
   d. Heating.
   e. Rigging.
   f. Shipwright.
   g. NDT.
6. describe a range of techniques to establish the extent and severity of damage to boats made of different materials:
   a. visual
   b. audible.
7. list the options for reinstatement.
   a. Repair.
   b. Refurbish.
   c. Replace.
8 describe the factors affecting the choice of reinstatement option.
   a Safety.
   b Structural integrity.
   c Cost.
   d Time.
   e Longevity of repair.
   f Materials availability.
   g Customer requirements.
   h Insurance assessments.
   i Resources available.

9 identify corrosion problems in a boat and its appendages and suggest reinstatement procedures.
   a Rust.
   b Pitting.
   c Depletion of anode.
   d Dezincification.

10 list publications and professional services available to advise in reinstating the full structural integrity of a repair.
   a Lloyds.
   b RCD.
   c Professional surveyor.
   d Naval architect.

11 identify services that should be disconnected, isolated or drained to ensure safe reinstatement.
   a Fuel.
   b Water.
   c Electricity.
   d Gas.
   e Waste.

12 list the possible effects of reinstatement on the integrity of boats structure and safety.
   a Structural integrity.
   b Watertight integrity.
   c Craft aesthetics.
   d Craft performance.
   e Systems performance.

13 list the tools and materials required to carry out a variety of reinstatement operations

14 describe how to determine and balance the time, materials, human resources and equipment costs for the reinstatement

15 state what inspection procedures are required to establish the effectiveness of a reinstatement procedure once it has been carried out.
   a Visual.
   b Watertight.

16 describe the procedure for communication of reinstatement options and plan to:
   a customer
   b management
   c suppliers/service providers.
Outcome 2: Carry out repairs to boat structure

Practical activities

The candidate will be able to:

1. prepare damaged area
2. repair damaged area
3. replace components and fittings
4. check effectiveness of repairs.

Underpinning knowledge

The candidate will be able to:

1. state where to obtain reports and drawings that detail area to be repaired
2. describe the safety and isolation procedures.
   a. Disconnection of electrical supplies.
   b. Disconnection of gas supplies.
   c. Emptying of fuel tanks.
   d. Emptying waste and water tanks.
3. describe procedures required prior to starting a repair.
   a. Locate the area for repair.
   b. Inform other personnel of your intentions.
   c. Identify any hazards that might exist.
   d. Identify services that need isolating.
4. describe how to remove damaged material and components with minimal damage to surrounding area.
   a. Removing mechanical fasteners.
   b. Sawing.
   c. Cutting using abrasive disks/wheels.
   d. Thermal cutting.
5. explain the necessity for correctly labelling and safely storing components that have been removed but must be reinstated.
   a. Vessel.
   b. Location in vessel.
   c. Minimise damage during storage.
6. describe methods used to maintain structural integrity when major items have been removed.
   a. Bracing.
   b. Shores.
   c. Strops.
   d. Stays.
7. describe the importance of waste removal and maintaining a clear and tidy work environment:
   a. safe disposal of hazardous waste
   b. thorough removal of non-hazardous waste
   c. ensure material does not fall into bilges.

8. select and use tools appropriate to the procedure to be undertaken:
   a. metal
      i. electric or pneumatic grinder/cutter
      ii. file
      iii. hacksaw
      iv. welder
      v. drill.
   b. FRP
      i. electric or pneumatic grinder/cutter
      ii. rasp / file
      iii. electric or pneumatic jig saw/reciprocating saw
      iv. drill
      v. hole saw
      vi. foam or pile roller
      vii. consolidating roller.
   c. wood
      i. saw: hand/jig
      ii. plane/spokeshave
      iii. electric plane/router
      iv. chisel
      v. bevel gauge/combination square
      vi. marking/measuring equipment.

9. describe the factors which need to be taken into account when positioning replacement components.
   a. Dimensional accuracy.
   b. Alignment.
   c. Orientation.
   d. Constructional integrity.

10. identify appropriate methods of securing replacement components.
    a. Mechanical fastenings.
    b. Adhesives.
    c. FRP bonding.
    d. Jointing.
    e. Thermal.

11. identify appropriate finishing operations.
    a. Fairing.
    b. Sealing.
    c. Protective coatings.

12. identify hazardous waste materials and describe safe disposal procedures.
13 identify the types of components which can be removed and replaced.
   a  Sub-assemblies.
   b  Bulk heads.
   c  Underwater skin fittings.
   d  Windows/portlights.
   e  Cappings and cover strips.
   f  Deck fittings.
   g  Furniture units.
   h  Domestic units.
   i  Linings.
   j  Soft furnishings.

14 explain the safety aspects of using sealants, bonding agents, adhesives and coatings.
   a  Fumes.
   b  Skin reactions.
   c  Flammability.

15 state the procedures required to prepare the work surface to receive the components.
   a  Remove all damaged/decayed material.
   b  Abrade.
   c  Degrease.
   d  Prime.

16 state the correct methods of setting and positioning components prior to securing them.
   a  Aligning.
   b  Measuring.

17 list appropriate fastenings.
   a  Screws: wood/self tapping.
   b  Bolts.
   c  Coach bolts.
   d  Nails/ring.
   e  Staples.

18 describe the factors that might jeopardise the structural integrity of the vessel.
   a  Incorrect materials.
   b  Workmanship.
   c  Technique.

19 list approved tests on repaired items to ensure they meet company and regulatory bodies’ quality control systems.
   a  Visual.
   b  Dimensional.
   c  Alignment.

20 state the consequences of neglecting the appropriate tests and reporting schemes.
   a  Failure of component.
   b  Poor quality assurance.
   c  Poor quality control.
21 describe typical defects that can be present in repair work.
   a Incorrect materials.
   b Poor workmanship.
   c Incorrect dimensions.
   d Misalignment.
   e Poor finish.
   f Incorrect technique.

22 state the need to inform customers of defects that have been identified which are outside the current reinstatement specification.

23 list the information required on report forms.
   a Repair undertaken.
   b Materials used.
   c Time taken.
   d Approval signature.

24 identify the information sources that can assist the inspection process.
   a Design specification.
   b Equipment manufacturers’ specifications.
   c Customer’s specification.
   d Surveyor’s specification.
   e Reinstatement plans.
   f Job instructions.
Outcome 3: Carry out servicing and maintenance operations on boats

Practical activities

The candidate will be able to:

1. prepare for servicing of a boat
2. carry out servicing operations
3. check servicing operations.

Underpinning knowledge

The candidate will be able to:

1. identify relevant documentation.
   a. Boat logs.
   b. Service records.
   c. Service schedules.
   d. Job instructions.

2. explain the need for specialist service personnel as may be required for non-routine service operations.
   a. Electrician.
   b. Engineer.
   c. Plumber.

3. describe the factors which will affect the choice of service location.
   a. Yard.
   b. Shed.
   c. Afloat.
   d. Temperature.
   e. Weather.

4. identify suitable equipment for supporting and transporting the boat.
   a. Lifting equipment.
   b. Trolleys.
   c. Cradles.
   d. Shoring wedges.

5. list the checks that must be made on lifting and handling equipment.
   a. Safe working load.
   b. Current test certificate.
   c. Damage to strops/slings.

6. list suitable lifting points and support areas on a boat.
   a. Manufacturer’s recommended lifting/supporting points.
   b. Location of bulkheads, ring frames.
   c. Location of main beams.
   d. Deadwood
   e. Ballast keel.
7 list the consequences of incorrect lifting and shoring practices.
   a Damage to boat.
   b Danger to personnel.

8 describe the need to use spreader bars to improve the loading on a vessel's sides when lifting with a crane and slings.
   a Reduce compressive load on hull sides and deck.

9 describe relationship between the length of slings used to lift a boat and the loads imposed upon the hull and deck structure

10 list the tools and equipment required to carry out a variety servicing operations and how to check that they are in a safe and usable condition.
   a Hull cleaning equipment.
   b Hand tools.
   c Portable power tools.
   d Personal safety equipment.

11 identify components which need checking for wear and tear.
   a Cleats.
   b Protection strip.
   c Sheet and sail fittings.
   d Sheet & sail control gear.
   e Masts.
   f Booms.
   g Steering fittings.
   h Domestic fittings.
   i Safety fittings.

12 identify routine servicing operations.
   a Identification and replacement of defective components.
   b Replacement of 'lifed' items such as filters.
   c Recording identified defects not covered by service.
   d Cleaning and anti fouling.
   e Re-pointing.
   f Touching up defective finishes.

13 list a range of surface coatings.
   a Paint:
      i oil based
      ii polyurethane
      iii epoxy
      iv water
      v cellulose.
   b Varnish:
      i oil based
      ii polyurethane
      iii water
      iv cellulose
      v oils.
   c Epoxy resin.
   d Polyester gelcoat.
   e Manufactured laminates.
   f Preservatives.
14 list the application techniques for a range of surface coatings.
   a  Brush.
   b  Roller.
   c  Spray.
   d  Rub.

15 state the functions of surface coatings
   a  physical protection of substrate
   b  decorative
   c  preservation of substrate
   d  prevention of corrosion

16 list appropriate cleaning agents for a variety of surface coatings.
   a  Detergents.
   b  Solvents.
   c  Cream cleaners.
   d  Natural astringents (lemon juice, vinegar).

17 describe surface coating defects.
   a  Peeled.
   b  Flaked.
   c  Eroded.
   d  Scratched.
   e  Scuffed.

18 describe the procedures for safe remove and dispose of defective surface coatings
   a  mechanical
   b  heat
   c  chemical

19 identify suitable alternative coatings depending on the service conditions that might be encountered

20 identify compatible finishing materials:
   a  paint
   b  lacquer
   c  polishes
   d  acrylics.

21 interpret servicing schedules and manufacturers servicing recommendations

22 describe how the materials from which a boat is constructed have an effect on the type and frequency of servicing:
   a  timber
   b  metal
   c  FRP
   d  thermoplastic.

23 describe the need to use acceptable alternative components when exact replacements are not available

24 identify defects that do not fall within the servicing schedule but which should be recorded and reported to the client
25 describe how to complete service records accurately and legibly and know what information should be recorded.
   a Date.
   b Vessel.
   c Location.
   d Defects found.
   e Action taken.

26 state how to complete post service check lists and use appropriate reporting procedures for post service defects

27 describe the correct storage method of deck equipment.
   a Anchors:
      i chocks
      ii stemhead fitting
      iii hawse pipe.
   b Spinnaker pole:
      i deck chocks
      ii up mast.
   c Life raft.
   d Winch handles.
   e Danbuoy.
   f Life ring.
   g MOB recovery gear.
   h Gas bottles.

28 describe storage systems for typical safety equipment:
   a fire extinguishers/fire blanket
   b flares
   c life jackets and harnesses
   d fenders.

29 identify items from the check list that have a ‘life’:
   a flares
   b filters
   c fire extinguishers
   d life rafts
   e life jackets.
   f

30 describe the correct procedures for the dispersal of inflammable and incendiary materials and devices

31 report on the condition of the ground tackle:
   a anchors
   b chain
   c connecting shackles.
106 Fibre reinforced plastics technology for marine construction

Rationale

This unit is concerned with the underlying process technology associated with wet lay ups involving dry cloths and resins together with pre-impregnated materials used in marine construction. It covers the process variables in detail, including the management of raw materials, plug and mould construction, incorporation of inserts for deck fittings, hull stiffening and datum points for internal fixings, the construction of vacuum bags for components and the various lay up techniques involved in composite manufacture within marine construction. It also covers the use of curing techniques appropriate the application, position and size of a component together with all safe working practices.

This unit covers four learning outcomes. The candidate will be able to:

1. specify and justify a process technique for a given application
2. specify consumables, moulds, formers and ancillary equipment
3. plan an effective lay up procedure for a process technique
4. monitor and control safe lay up procedure.

Connection with other awards

This unit combines and extends knowledge and understanding contained in units:

013 Produce engineering products by manual forming of materials
014 Produce engineering products by manual forming operations which are complex to achieve
020 Bond materials to achieve engineering objectives
041 Determine the requirements to achieve engineering objectives
045 Prepare resources for routine engineering activities
046 Prepare resources for engineering activities under complex conditions
054 Contribute to improving the organisation’s work practices and procedures
056 Contribute to the effectiveness of work activities
057 Co-ordinate activities with others of the NVQ (1692) Engineering Production of the NVQ level 3 in Boat Building and Maintenance.

Assessment

The outcomes of this unit will be assessed using evidence from a practical assignment covering the practical activities and the underpinning knowledge.
Outcome 1: Specify and justify a process technique for a given application

Practical activities
The candidate will be able to:

1 select a process for a given application
2 evaluate the suitability of a process for a given application
3 record details and process operation requirements
4 prepare reports to show progress and requirements.

Underpinning knowledge
The candidate will be able to:

1 describe a range of component construction techniques used with FRP for marine construction.
   a Hand lay ups.
   b Spray lay ups.
   c Contact moulding.
   d Resin transfer moulding.
2 describe matrix systems available, reasons for their selection, and limitations of the system.
   a Polyester.
   b Vinylester.
   c Epoxy.
3 describe preparation and management of resin systems in accordance with specification/manufacturer’s recommendations
4 describe range of techniques used to ensure dry reinforcing materials are completely wetted
5 describe measures taken to ensure consistency of matrix mixing used for large component construction
6 describe preparation and management of pre-impregnated reinforcing materials
7 describe recording procedure to be followed in the management and use of pre-impregnated reinforcing materials
8 describe use and preparation of the vacuum bag.
   a Porous release film.
   b Absorption/bleeder cloth.
   c Non porous release cloth.
   d Air breather.
   e Vacuum bag.
   f Vacuum bag tape.
9 describe preparation and use of material usage records
10 describe procedures for range of component construction techniques listed in 1

11 describe methods of recording details, data and process operations to enable a construction technique to be used effectively.
Outcome 2: Specify consumables, moulds, formers and ancillary equipment

Practical activities

The candidate will be able to:

1. identify the range of consumables/ancillaries required for process selection and application
2. select and justify materials for a given application
3. select and justify moulds/formers for a given application
4. select ancillaries required to support the process selection
5. prepare and set up of ancillary equipment for effective production.

Underpinning knowledge

The candidate will be able to:

1. describe types of cloth and weave patterns available.
   a. Plain weaves.
   b. Twill cloth.
   c. Satin weave.
   d. Unidirectional weave.
   e. Chopped strand mat.
   f. Needlemat or needle mat cloth.
   g. Woven rovings.
2. state reasons for the selection of weaves stated in 1
3. describe storage and management procedures for the use of
   a. resins/adhesives, associated hardeners and accelerators
   b. dry reinforcing materials
   c. sized reinforcing materials
   d. pre-impregnated reinforcing materials
   e. film adhesives
   f. melinex film.
4. describe documentation required to be held and completed in the use of consumable materials stated in 3
5. describe design features of moulds and formers for complex shapes
6. describe plug and mould construction including incorporation of
   a. inserts for deck fittings
   b. non skid surfaces
   c. skin fittings
   d. hull stiffening and datum points for internal fittings
   e. engine seating arrangements.
7 describe design features for moulds for complete internal units
   a galley units
   b toilet compartments (heads)
   c accommodation units
8 describe preparation for moulds for complex shapes in readiness for lay up
9 describe procedures used to produce sandwich construction using
   a wood
   b foam
   c honeycomb constructions - glass, paper, metal.
10 describe use of specialist equipment:
    a mould supports and cradling
    b platforms
    c heater blankets
    d hot bond controller
    e autoclave units.
11 describe preparation and setting of hot bond controller and autoclave units.
Outcome 3: Plan an effective lay up procedure for a process technique

Practical activities

The candidate will be able to:

1. identify materials and resin requirements from specifications/drawings in readiness for component construction
2. apply calculations to determine:
   a. surface area
   b. gel coat and resin quantities
3. prepare an ordered schedule of activities to produce component/parts
4. select tools, equipment, moulds, formers for a given process technique.

Underpinning knowledge

The candidate will be able to:

1. describe types and features of fibre used in composite construction for marine construction
2. describe use of weave orientation used to achieve maximum strength
3. describe stages required to produce complex shapes/components using:
   a. dry reinforcing materials
   b. pre-impregnated reinforcing materials
4. state fibre resin ratios recommended by manufacturer’s design specifications
5. describe source of standard formula for the calculation of:
   a. surface area and volume of plane figures
   b. mid-ordinate rule or Simpson’s rule for the surface area of irregular figures
   c. theorem of Pappus.
6. describe procedures involved in calculation of surface area, gel and resin requirements
7. state reason for tight control of fibre resin ratio to ensure quality components
8. describe procedures used to monitor fibre resin ratio
9. describe methods and operation of equipment in the weighing and mixing of resins to ensure conformity of mixes
10. describe methods used to incorporate stiffening and load bearing components in:
    a. laminated structures
    b. honeycomb structures.
11. state the need for stiffening and cradling required in the support of hulls
12. describe construction sequence for plug making
13 describe procedures to be followed when using split moulds

14 describe procedures for trimming of finished moulds.
   a Marking out to design tolerances, apertures, flanges.
   b Excess removal using the appropriate equipment.
   c Safe disposal of waste material.
   d Personal dust protective clothing.
   e Extraction and filtration equipment.

15 describe methods and procedures to ensure optimum quality of manufactured products.
Outcome 4: Monitor and control safe lay up procedures

Practical activities

The candidate will be able to:

1. set up moulds/formers for complex lay up using dry or pre-impregnated materials
2. implement and monitor of a safe lay up operation
3. interpret and apply a stated procedure sheet
4. use correct sequence of operations for a given application
5. green trim to comply with specification/drawing
6. trim and finish moulds to comply with drawing
7. test for resin cure.

Underpinning knowledge

The candidate will be able to:

1. describe current regulations in regard to health and safety
   a. handling of resins
   b. handling of equipment HSAW section 7
   c. relevant parts of COSHH
   d. safe disposal of materials
   e. personal protection
   f. lifting and handling
   g. cutting tools.
2. describe preparation of mould/former surfaces in readiness for lay ups
3. describe requirements for clean and contaminated free surfaces
4. describe correct operation of tools, equipment and machinery used in lay up of composite materials
5. describe factors that affect quality of a composite:
   a. use of correct process parameters at each stage of the process.
6. state requirements regarding environmental conditions which should be monitored and adjusted to meet safe repair requirements
7. state requirements for trimming and removal of excess material:
   a. area to repair marked out to design tolerances
   b. material removed using the appropriate equipment
   c. safe disposal of waste material
   d. adequate extraction and filtration during material removal
   e. personal dust protective clothing to be worn.
8. describe use of the Barcol test for resin cure
9. describe choice of non-destructive and destructive testing methods
10 outline methods used in testing
11 describe interpretation of test results from any test conducted
12 describe methods and procedures to ensure effective composite construction
107  **Vessel Services**

**Rationale**

This unit covers the knowledge and understanding required to install and test domestic service systems within a boat. The unit covers the positioning and fixing of pipework, brackets and associated components of hot and cold water systems, waste and sanitary systems, deck drains, air conditioning and vacuum systems. It should be noted that dependent on the end use of the craft it may be necessary for installation and servicing work to be undertaken by specialist tradesman, eg Corgi registered.

This unit covers two learning outcomes. The candidate will be able to:

1. install service systems
2. carry out repairs to boat systems.

**Connection with other awards**

This relates to a combination of unit 12 Installing domestic service systems and unit 16 Carry out repairs to boat systems of the NVQ level 3 in Boat Building and Maintenance.

**Assessment**

The outcomes of this unit will be assessed using evidence from a practical assignment covering the practical activities and the underpinning knowledge.
Outcome 1: Install service systems

Practical activities

The candidate will be able to:

1. plan and route service systems
2. install components to form service systems
3. inspect and test completed service systems.

Underpinning knowledge

The candidate will be able to:

1. identify the documentation necessary for planning and routing systems.
   a. Layout drawings.
   b. System specifications.
   c. Job instructions.
   d. Component manufacturers.
   e. Installation instructions.

2. identify the components of domestic service systems and describe their use.
   a. Piping.
   b. Pipe connectors.
   c. Tanks.
   d. Pumps.
   e. Valves.
   f. Drains.
   g. Utility fittings.
   h. Heaters.

3. describe the basic principles of operation of domestic service systems.
   a. Cold water.
   b. Hot water.
   c. Waste.
   d. Sanitary.
   e. Deck drains.
   f. Air conditioning.
   g. Vacuum.

4. identify the relevant codes of practice and regulations relevant to quality of work and operating environment of vessel.
   a. ISO 1400.
   b. RCD.
   c. Lloyd's.
   d. HSE e.g. Gas regs.

5. state the criteria for planning and installing a hot and cold freshwater system within a boat.
   a. Specification and layout drawings.
   b. Access for installation and maintenance.
   c. Material usage.
   d. Sufficient water pressure for number of outlets.
   e. Tank capacity and positioning.
6 explain the function of and the installation criteria for:
   a black water system
   b grey water system
   c deck and cockpit drain system
   d installation criteria
      i specification and layout drawings
      ii access for installation and maintenance
      iii material optimisation
      iv tank capacity and positioning
      v ventilation and filtering.

7 explain why it is important that the layouts are agreed with other trade groups and properly communicated

8 list the key criteria for planning and installing air conditioning and heating systems.
   a Air conditioning:
      i specification and manufacturer's instructions
      ii position of unit
      iii pipe and outlet runs for effective operation
      iv access for installation and maintenance
      v provision for waste heat
      vi provision for waste water
      vii relevance of standards (BSI, RCD).
   b Heating systems (fixed and hot air):
      i specification of manufacturer's instructions
      ii position of units
      iii heat exhaust system
      iv insulation and fire resistance of the system
      v position for efficiency of heat transfer
      vi relevance of standards (BSI, RCD).

9 describe the components and fixing methods of a waste water system.
   a Deck and cockpit drains:
      i sea cocks
      ii inlet/outlet fittings
      iii piping (PVC, SS, moulded)
      iv pipe clip and brackets.
   b Black water system:
      i pumps
      ii tanks (polypropylene, SS, galvanised steel)
      iii piping (sanitary specification)
      iv fitting, sea cock, vent, deck pump, outlet, inlet
      v filters.
   c Grey water system:
      i pumps
      ii tanks (polypropylene, SS)
      iii piping (PVC)
      iv pipe clip and brackets
      v venting
      vi fitting and sink/shower drains.

10 explain why it is important to involve other specialist trades in electrical or electronic sensor installation
11 describe the components and fixing methods of a hot and cold water system.
   a Tanks.
   b Pumps.
   c Divert and shut-off valves.
   d In line filters.
   e Calorification.
   f Immersion heater.
   g Desalination units.
   h Connectors:
      i compression joints
      ii screw joints
      iii cemented/glued joints
      iv outlet taps/shower units.

12 explain why it is important to configure and connect components with regard to equipment orientation and the direction of the flow.

13 identify the forms of system installation problems that may occur and how to prevent them.
   a Free from contaminants.
   b Poor connections.
   c Incorrect orientation.
   d Positioning of filters.
   e Incorrect pipe runs.
   f Pinching, tight bends and crushing of pipes.
   g Head of water.

14 identify the need for tests to be carried out by appropriately qualified engineers when testing
   a gas
   b electronics
   c electrical systems.

15 explain the inspection and testing checks that are suitable for service installation.
   a Visual checks:
      i mechanical joints, clips tight
      ii pipe runs, correct orientation
      iii sufficient clips/brackets to avoid sagging
      iv insulation in position
      v other trade connections completed
      vi units and tanks secure
      vii visual inspection for leaks.
   b Pressure/leak tests:
      i pressure test to manufacturer's instruction/ISO standards
      ii manometer.
   c Functional test:
      i system operation
      ii flow checks
      iii automatic pump function
      iv control system function
      v heat delivery
      vi cool air delivery
      vii sea cock operation
      viii filter operation.
16 describe why it is important to record test results and report discrepancies to a responsible person.
Outcome 2: Carry out repairs to boat systems

Practical activities

The candidate will be able to:

1. determine the performance and condition of the system
2. carry out repairs to the system
3. check the effectiveness of the repair.

Underpinning knowledge

The candidate will be able to:

1. identify the sources of information regarding the condition of the boat systems.
   a. Workshop manuals.
   b. Boat data sheets.
   c. Repair history.
   d. Parts lists.
   e. Job instructions.
2. describe a range of inspections for damage to:
   a. mechanical systems – power; drive; steering
   b. electrical/electronic systems – power; lighting
   c. domestic systems – water; waste; sanitary; utility.
3. identify the need to use specialist services for certain reinstatement work and how these services might be employed.
   a. Electrical.
   b. Engineering.
   c. Plumbing.
   d. Heating.
4. describe common fault finding procedures:
   a. visual inspections
   b. function test
   c. operational test
   d. static test
   e. leak test
   f. electrical tests.
5. identify the options for restoration.
   a. Replacement.
   b. Repair
   c. Adjustment.
6. identify specification limits which will affect options for restoration.
   a. System performance.
   b. Craft operating environment.
   c. Safety limits.
   d. System manufacturer's recommendations.
   e. Company specifications.
   f. Surveyors reports.
   g. Customer requirements.
7 describe common faults on various boat systems:
   a defective minor components
   b defective major components
   c maladjusted system components.

8 describe the safety and isolation procedures:
   a disconnection of electrical supplies
   b disconnection of gas supplies
   c emptying of fuel tanks
   d emptying waste and water tanks.

9 describe procedures required prior to starting a repair:
   a locate the area for repair
   b inform other personnel of your intentions
   c identify any hazards that might exist
   d identify services that need isolating.

10 identify tools used for repair and replacement of system components

11 identify potentially defective system components.
   a Piping
   b Pipe Connectors.
   c Pumps.
   d Valves.
   e Tanks.
   f Utility Fittings.
   g Heaters.
   h Mechanical Mechanisms.
   i Switches/Relays.
   j Electrical/Electronic Control Units.

12 identify preparatory work needed to check systems.
   a Filling system.
   b Venting.
   c Purging.
   d Attaching suitable test equipment.

13 identify common defects following repair.
   a Leaks.
   b Faulty connections.
   c Defective components.
   d Aesthetic damage.

14 describe the importance of recording results of test procedures and inspections

15 describe test equipment and calibration

16 describe how to complete inspection and test reports.
108  Marine engines

Rationale

The aim of this unit is to equip the candidate with the skill, knowledge and understanding needed to carry out diagnosis, removal, rectification, refitting and evaluation activities associated with Marine Engines and Power Units.

This unit covers four learning outcomes. The candidate will be able to:

1. demonstrate an understanding of the procedures, tools, equipment and materials required for diagnosis, removal, overhaul, refitting and evaluation of systems and components
2. demonstrate an understanding of the layout and operating principles of marine engine systems and components
3. diagnose faulty systems and components, remove, rectify and refit
4. evaluate system and component performance following fault diagnosis and rectification procedures.

Connection with other awards

This unit does not specifically relate to the current NVQs within the sector. It does however offer an opportunity for those involved with the servicing and repair of marine engines to follow a course to meet their needs.

Assessment

The outcomes of this unit will be assessed using evidence from a practical assignment covering the practical activities and the underpinning knowledge.
Outcome 1: Demonstrate an understanding of the procedures, tools, equipment and materials required for diagnosis, removal, overhaul, refitting and evaluation of systems and components

Practical activities

The candidate will be able to:

1. identify and gain access to systems and components
2. access manufacturers’ data supplied in various forms
3. identify, adjust and use special purpose tools, equipment and materials needed to diagnose and rectify systems and components.

Underpinning knowledge

The candidate will be able to:

1. describe the use and application of special purpose tools, equipment and materials needed to diagnose and rectify faults in systems and components.
   a. Strobe light.
   b. Dwell meter.
   c. Tachometer.
   d. Coolant system pressure tester.
   e. Equipment for testing thermostat.
   f. Injector pressure tester.
   g. Small hand tools specified by manufacturer.
   h. Cylinder compression tester.
   i. Cylinder leaker tester.

2. describe the main differences between the construction of a CI and SI engine.
   a. Need for greater strength in CI engine.
   b. Differences in combustion chamber design.
   c. Piston design.

3. describe the functional requirements and purpose of the systems and components requiring diagnosis and rectification of faults.
   a. Air cooling systems.
   b. Lubrication systems.
   c. Electrical equipment.
   d. Ignition systems.
   e. Starting systems.
   f. Charging systems.
4 describe the functional requirements and purpose of the systems and components requiring diagnosis and rectification of faults.
   a SI and CI engines incorporating fixed and variable valve lift and timing systems
      i SI engine management and fuel systems
      ii CI engine management and fuel systems
   b liquid cooling systems
   c air supply and control system
      i crankcase emission control systems
      ii normally aspirated
   d exhaust systems
      i catalytic converters
      ii sensors
   e drive shafts
      i dynamic dampers
   f electrical and electronic systems
      i starting
      ii charging
      iii ancillaries
Outcome 2: Demonstrate an understanding of the layout and operating principles of marine engine systems and components

Practical activities

The candidate will be able to:

1. plan the methods of diagnosing system or component faults
2. plan the rectification procedures for the system or component
3. select and prepare hand, special purpose tools, equipment and materials needed to diagnose system or component faults
4. prepare systems and components for diagnosis and rectification.

Underpinning knowledge

The candidate will be able to:

1. describe the operating principles of systems and components which require removal, overhaul and refitting.
   a. SI and CI engines.
      i. Variable valve timing.
      ii. Variable lift.
      iii. Multi-valve arrangements.
   b. SI and CI engine management and fuel systems.
      i. Control valves and relays.
      ii. Sensors.
      iii. ECU.
      iv. Pumps.
      v. Wiring systems and connections.
      vi. Break out boxes.
   c. Engine lubrication systems.
      i. Pumps: rotor, gear, vane and crescent.
      ii. Filters, full flow and by pass valves.
      iii. Pressure relief valves.
      iv. Pressure indicating and warning systems.
      v. Lubricants.
   d. Cooling systems.
      i. Coolants.
      ii. Temperature control systems.
   e. Air supply and control system.
      i. Crankcase emission control systems.
      ii. Normally aspirated.
   f. Drive shafts.
      i. Constant velocity joints.
      ii. Dynamic dampers.
   g. Hubs and bearings.
      i. Front.
      ii. Rear.
h Electrical and electronic systems.
   i Starting.
   ii Charging.
   iii Ancillaries.

2 describe how to prepare and use hand, special purpose tools, equipment and materials
   needed to remove and refit systems and components listed in 1 (a to h)

3 describe how to prepare the systems and components listed in 1 (a to h) for diagnosis and
   rectification.
**Outcome 3: Diagnose faulty systems and components, remove, rectify and refit**

**Practical activities**

The candidate will be able to:

1. diagnose faults in systems and components
2. rectify in situ as required
3. rectify by replacement as required
4. repair by dismantling as required
5. overhaul as required.

**Underpinning knowledge**

The candidate will be able to:

1. describe the methods used to diagnose faulty systems and components.
   a. Sea trials.
   b. Simulated tests.
   c. Measurements.
   d. Fault code analysis.
   e. Interpreting data obtained from electronic system tests:
      i. fault code analysis
      ii. sensor measurements
      iii. control unit outputs/signals.

2. describe the methods of obtaining and interpreting diagnostic information for:
   a. mechanical condition
   b. wear
   c. pressures
   d. flow
   e. leakage
   f. efficiency.

3. describe how to diagnose, remove, rectify and refit faulty systems and components in SI and CI engines.
   a. SI and CI engines:
      i. variable valve timing
      ii. variable lift
      iii. multi-valve arrangements.
   b. Cylinder blocks, heads, pistons, connecting rods and gaskets.
   c. Camshafts, valve timing, timing belts, chains and tensioners.
   d. Drive mechanisms for ancillary equipment.
   e. Balancers and dampers.
   f. Crankshafts and flywheels.
4 describe how to diagnose, remove, rectify and refit faulty systems and components in engine lubrication systems.
   a Pumps: rotor, gear, vane and crescent.
   b Filters: full flow and by pass valves.
   c Pressure relief valves.
   d Pressure indicating and warning systems.
   e Lubricants.

5 describe how to diagnose, remove, rectify and refit faulty systems and components in cooling systems:
   a Coolants
   b Temperature control systems.

6 describe how to diagnose, remove, rectify and refit faulty systems and components in petrol fuel supply systems:
   a Petrol injectors – single and multi point
   b Petrol pumps – mechanical and electrical (submerged)
   c Supply and return lines and filters.

7 describe how to diagnose, remove, rectify and refit faulty systems and components in engine management systems:
   a SI engines:
      i Electronic control units
      ii Sensors and relays
      iii Switches.
   b CI engines:
      i Electronic control units
      ii Sensors and relays
      iii Switches.

8 describe how to diagnose, remove, rectify and refit faulty systems and components in diesel fuel supply systems:
   a Rotary pumps
   b In-line pumps
   c Fuel injectors - single/multi-hole
   d Common rail and pressure time systems
   e Lift pumps
   f Cold starting aids.

9 describe how to diagnose, remove, rectify and refit faulty systems and components in electrical systems:
   a Starting systems:
      i Starter motors
      ii Electrical connections, switches and solenoids.
   b Charging systems:
      i Alternators and drive systems
      ii Electrical connections.

10 state the procedures for disposing of waste materials resulting from the above activities to BS 14001.
Outcome 4: Evaluate system and component performance following fault diagnosis and rectification procedures

Practical activities

The candidate will be able to:

1. select, prepare and use special tools and equipment needed to evaluate system and component performance following fault diagnosis and rectification.
2. evaluate the performance of repaired systems and components against legal and manufacturer’s standards.
3. record the fault diagnosis and rectification adjustment activities.

Underpinning knowledge

The candidate will be able to:

1. describe the procedures for evaluating the operational efficiency of systems and components following diagnosis and rectification:
   a. SI and CI engines and components
   b. liquid cooling system and components
   c. lubrication system and components
   d. air supply system components
   e. petrol fuel supply system components
   f. engine management components on SI engines
   g. engine management components on CI engines
   h. diesel fuel supply system components
   i. electronic spark-ignition systems and components
   j. electrical systems and components.

   NOTE – The details for systems and components are as in outcome 3.
109  Marine propulsion systems

Rationale
The aim of this unit is intended to equip candidates with the skills and knowledge needed to carry out diagnosis and rectification associated with marine propulsion systems.

This unit covers four learning outcomes. The candidate will be able to:

1  identify hull characteristics of boats and recognise propulsion systems
2  identify the layout and operating characteristics of systems and components
3  diagnose faulty systems and components, remove rectify and refit
4  evaluate system and component performance following fault diagnosis and rectification.

Connections with other awards
This unit does not specifically relate to the current NVQs within the sector. It does however offer an opportunity for those involved with the servicing and repair of propulsion systems to follow a course to meet their needs.

Assessment
The outcomes from this unit will be assessed using evidence from an assignment covering practical and underpinning knowledge requirements.
Outcome 1: Identify hull characteristics of boats and recognise propulsion systems

Practical activities

The candidate will be able to:

1. identify types of hull in marine use
2. identify marine propulsion systems and components.

Underpinning knowledge

The candidate will be able to:

1. identify the various hull forms and types of construction.
   a. Mono hulls:
      i. displacement
      ii. semi-displacement
      iii. planning Hard-chine Deep Vee
      iv. VSV (Very Slender Vessel/wave piercing).
   b. Multi-hulls:
      i. catamarans
      ii. trimarans
      iii. SWATH (Small Water plane Area Twin Hull).

2. state the relationship between hull waterline length, wave making and speed

3. identify the type and positioning of the main mechanical assemblies for various hull forms:
   a. engine/multi-engine power layouts
      i. diesel
      ii. diesel-electric
   b. gearbox
   c. propeller shaft
   d. rudders/steering systems.

4. state the effect of weight and position on trim and performance in respect of:
   a. shaft length
   b. shaft angle
   c. shaft location
   d. stern tube
   e. stern glands
   f. plummer blocks
   g. outdrive
   h. outboard.
5. state the relationship between wetted surface area and drag in respect of:
   a. shaft/s
   b. A brackets
   c. P brackets
   d. rudder/s
   e. outdrive
   f. propeller/s
   g. inlets/outlets
   h. grills/gratings
   i. thrusters inlets/outlets.
Outcome 2: Identify the layout and operating characteristics of systems and components

Practical activities

The candidate will be able to:

1. identify and gain access to systems
2. prepare systems for diagnosis and rectification.

Underpinning knowledge

The candidate will be able to:

1. identify features of propulsion systems and mode of operation.
   a. In board engines:
      i. assembly fixtures
      ii. transmission systems
      iii. fuel fixtures
      iv. electrical connections
      v. controls.
   b. Out board engines:
      i. assembly and mounting
      ii. control systems
      iii. fuel fixtures
      iv. electrical connections.

2. identify the main components of propulsion systems and auxiliaries and state the purpose and operating characteristics.
   a. Gearbox and reduction gear:
      i. epicyclic gearbox
      ii. step-down/angled gearbox
      iii. hydraulic drive gearbox
      iv. thrusters bow/stern
      v. clutches, manual, hydraulic, single-plate, multi-plate.
   b. Drive systems:
      i. outdrives, mounting, trimming, controls, kill-cords/auto-stops, steering wires
      ii. Z drives
      iii. hydraulic
      iv. electric
      v. jet/water pump, centrifugal, turbine, nozzles, steering rams
      vi. Voith Schneider, blade position, number, angle, controls.
   c. Lubrication systems:
      i. pumps
      ii. filters
      iii. valves
      iv. controls
      v. lubricants.
   d. Cooling systems:
      i. wet/dry
      ii. coolants
      iii. controls.
e  Propellers:
   i  two/three/four bladed
   ii twin screws
   iii effects of diameter, pitch, slip, aspect, cavitation.
f  Drive shafts:
   i  couplings, flange, flexible, universal, hydraulic
   ii lock methods, key ways, splines, pins, cotters.
g  Rudders/steering systems:
   i  spade
   ii balanced
   iii un-balanced
   iv controls, cable, morse, telefax, worm, chain/sprocket, hydraulic, electric
   v  fixings, pintles, gudgeons, cross-head, stems/tubes, packing/seals.

3  identify tools and equipment required for fault diagnosis and rectification.
   a Test equipment.
   b  Measuring devices/meters.
   c  Hand tools.
   d  Manufacturers recommended tools.

4  identify data required for fault diagnosis and rectification.
   a  Manufacturer's data and information sheets.
   b  Service schedules.
   c  Parts lists.
   d  Trade Association check lists.
   e  Legal and technical data reference books.

5  state the precautions required and the hazards associated in working with marine propulsion systems.
   a  Use of Personal Protective Equipment (PPE): goggles, gloves, safety equipment.
   b  Legislation: COSHH, HaSW, Codes of Practice.
   c  Danger from power transmission systems rotating, reciprocating machinery and parts.
   d  Lubricants and fuels: skin protection and ventilation.
   e  Application and safe use of lifting equipment.
   f  Electrical equipment and systems; isolation, low-voltage systems.
   g  Fire risks, precautions with fuels.
   h  Safe storage and disposal of materials.
   i  Good housekeeping procedures and environmental awareness.
Outcome 3: Diagnose faulty systems and components, remove rectify and refit

Practical activities

The candidate will be able to:

1 rectify faulty systems and components in situ
2 rectify faulty systems and components by replacement
3 repair faulty systems and components by dismantling
4 overhaul faulty systems and components.

Underpinning knowledge

The candidate will be able to:

1 state basic principles of fault diagnosis as:
   a system/component knowledge
   b collection of data
   c analysis of evidence
   d interpretation of tests
   e functional checks.
2 describe the methods used to diagnose faulty systems and components.
   a Sea trials.
   b Simulated tests.
   c Measurements.
   d Interpreting data from system tests.
   e User evidence.
3 describe methods of obtaining and interpreting diagnostic information for
   a mechanical condition
   b wear
   c pressures
   d flow
   e leakage
   f efficiency
4 describe how to diagnose and rectify faults in propulsion systems/components:
   a gearboxes
   b drive systems
   c lubrication systems
   d cooling systems
   e propellers
   f drive shafts
   g rudders/steering systems.
5 state factors which influence whether to repair or replace:
   a cost of repair/replacement
   b availability of replacement parts
   c time for refit.
state procedures for disposing of waste materials from the above activities.
Outcome 4: Evaluate system and component performance following fault diagnosis and rectification of propulsion systems

Practical activities

The candidate will be able to:

1. select prepare and use tools and equipment to evaluate system/component performance
2. record and report on appropriate actions.

Underpinning knowledge

The candidate will be able to:

1. describe the procedures for evaluating operational performance of propulsion systems and components:
   a. gearboxes
   b. drive systems
   c. lubrication systems
   d. cooling systems
   e. propellers
   f. drive shafts
   g. rudders/steering systems.

2. state methods of recording outcomes using
   a. computers
   b. manufacturer’s recording sheets
   c. trade association recording sheets

3. make and record appropriate recommendations resulting from activities, complete schedule as appropriate and report problems to customer/manager/supervisor.
110 Installing electrical wiring support systems

Rationale

This unit is concerned with the processes and equipment essential to the installation of 110 and 230 volt electrical wiring support systems.

The candidate should develop an awareness of the 16th Edition IEE Regulations and the Electricity at Work Act.

The unit covers four performance outcomes. The candidate will be able to:

1. prepare for the installation of electrical wiring support systems
2. identify equipment, materials and components for the installation of electrical wiring support systems
3. carry out the installation of electrical wiring support systems
4. installing wiring.

Connection with other awards

This unit does not specifically relate to the current NVQs within the sector.

Assessment

The outcomes from the unit will be assessed by means of an assignment which will cover practical and underpinning knowledge.
Outcome 1: Prepare for the installation of electrical wiring support systems

Practical activities

The candidate will be able to:

1. gather, read, and interpret safety and job instructions
2. produce a detailed work plan.

Underpinning knowledge

The candidate will be able to:

1. describe sources of drawings, and technical information required and the procedures for their care and safe keeping
   a. installation drawings
   b. wiring schedules
   c. guidance and regulations relating to the forming and installation of conduit, trunking or traywork using metallic or plastics materials
2. state the need to plan work activities, methods of producing work plans and the information they must contain
3. state the need to ensure that components are clear of other services
   a. gas
   b. water
   c. fuel
   d. electricity
   e. communications cables
   f. data cables.
4. state the need to use appropriate techniques to pass cables through watertight bulkheads.
Outcome 2: Identify equipment materials and components for the installation of electrical wiring support systems

Practical activities

The candidate will be able to:

1. prepare for the installation of electrical wiring support systems
2. select suitable conduit, ducting, trunking or traywork and appropriate fittings
3. determine which bending and cutting methods are required
4. check the condition and availability of all necessary tools and equipment
5. identify quality control documentation.

Underpinning knowledge

The candidate will be able to:

1. state the factors which affect the selection of appropriate conduit, ducting, trunking or traywork components for different marine applications and environments to ensure compliance with relevant codes of practice:
   a. Does the specification/environment require plastics or metallic materials?
   b. What size/section of materials are required to meet the segregation and spacing factors?
   c. The effects of ambient temperatures within conduit and trunking systems
   d. What effect does the proximity of low voltage and data cabling have on the proposed installation?

2. state the range of conduit, trunking and traywork components and connectors that are used.
   a. Screwed fittings.
   b. Glued fittings.
   c. Straight connectors.
   d. Bends.
   e. Tees.
   f. Inspection fittings.
   g. Light, power and control outlet boxes.

3. describe the range of equipment and tools used for the cutting, bending, forming and installation operations to be undertaken.
   a. Saws.
   b. Files.
   c. Stocks and dies.
   d. Hot air guns.
   e. Vices.
   f. Pipe bending techniques.
   g. Levels.
   h. Plumb bobs.
   i. Screwdrivers.
   j. Spanners.
   k. Hammers.
   l. Hole punches and cutters.
   m. Battery and power tools (110v).
   n. Access equipment.
4 state the importance and use of inspection fittings such as elbows and junction boxes

5 state the need to check that conduit, ducting, trunking and components are not damaged and free from internal foreign bodies, burrs and sharp edges.
Outcome 3: Carry out the installation of electrical wiring support systems

Practical activities

The candidate will be able to:

1. cut materials to length, ensuring efficient use of materials
2. use appropriate tools and techniques to manufacture the support system
3. join system components supporting and securing components
4. check during installation for visual faults
5. check the installation conforms to specification and dimensional accuracy.

Underpinning knowledge

The candidate will be able to:

1. state the responsibilities under regulations relevant to the work undertaken
2. state the precautions to be taken when using cutting and bending tools and equipment
3. state the need for protective equipment such as:
   a. overalls
   b. safety shoes
   c. eye protection
   d. gloves
   e. barrier creams.
4. describe the safe practices and procedures required when carrying out assembly and installation activities on electrical wiring support systems including the use of access equipment and when using solvents and adhesives
5. describe how to mark out lengths to be cut taking into account any allowances for:
   a. bending
   b. screwing
   c. use of adhesives
   d. fabricating
   e. joining operations.
6. describe the methods of holding work pieces without damaging them
7. state how to bend and fabricate conduit, trunking, ducting and traywork to produce:
   a. bends
   b. offsets
   c. bridge sets
   d. tee junctions
   e. double and saddle sets to a tolerance within + or - 5mm
8. describe how to bend plastic conduit using hot air guns and springs
9. describe how to form screw threads on ends of conduit
10 state how to use screw fittings, glued fittings, fabricated components, nuts and bolts as appropriate

11 state how to make visual checks for:
   a ripples/deformation around bends
   b absence of burrs and sharp edges
   c overall dimensions
   d position of bends or sets
   e angle of bends
   f out of alignment
   g loose connections
   h insufficient supports.

12 state the need to ensure that all components and installations are free from:
   a projections
   b burrs
   c sharp edges
   d swarf
   e foreign bodies

13 state the need to check:
   a correct outlets for
      i sockets
      ii switches
      iii light fittings
      iv wire junction
      v inspection fittings
   b a neat and tidy appearance
   c general compliance with specification.

14 state how to mark out and check alignment of components including use of
   a plumb bobs
   b levels
   c visual means.

15 state the methods of securing system components:
   a to ensure correct position and spacing of supporting brackets and devices
   b use of
      i saddles
      ii supports.
   c drilling and using appropriate fixing devices
   d joints
      i screw
      ii adhesive

16 describe the methods of electrical bonding and ensuring earth continuity of the support system where metal support systems are used

17 state how to deal with problems concerning components
   a which are damaged in some way
   b when there are shortages of fittings or fixing devices
   c the correct tools are not available
   d conduit, ducting, trunking or traywork fittings do not fit together as required
   e the required specification can not be achieved.
state the importance of
a  leaving the work area free of unused consumables
b  cleaning down work area
c  putting tools and equipment into safe storage
d  labelling and recording finished work.
Outcome 4: Installing wiring

Practical activities
The candidate will be able to:
1. selection of correctly routed cables
2. use of appropriate tools to cut cables and trim wires
3. check the wiring conforms to specifications and dimensional accuracy
4. making correct connections.

Underpinning knowledge
The candidate will be able to:
1. state the responsibilities under the regulations which are relevant to the work undertaken
2. state the need for protective equipment such as
   a. overalls
   b. safety shoes
   c. eye protection
   d. gloves
   e. barrier creams
3. describe the safe practices and procedures required when carrying out assembly and installation activities on wiring systems
4. describe how to make out wiring lengths to be cut with allowances for joining operations
5. state how to make visual checks for
   a. correct number of cables
   b. snags
   c. colour coding
6. make appropriate connections
   a. following circuit system
   b. installation instruction
   c. safety requirements
   d. fusing requirements
   e. with correct unit space allowances
111 Principles of electrical engineering

Rationale

This is concerned with the underlying principles that govern the installation and maintenance of electrical and electronic systems on small leisure and commercial craft.

The unit covers four performance outcomes. The candidate will be able to:

1. understand the functions of electrical components
2. understand electrical supply systems, protection and earthing
3. understand the functions of electrical machines and motors.

Connection with other awards

This unit does not specifically relate to the current NVQs within the sector.

Assessment

The outcomes from this unit will be assessed by means of an assignment which will cover practical and an examination.
Outcome 1: Understand the functions of electrical components

Practical activities

The candidate will be able to:

1. carry out workshop tests to demonstrate electrical circuits and components
2. carry out workshop tests to demonstrate magnetism.

Underpinning knowledge

The candidate will be able to:

1. state the basic electrical units and describe their relationship.
   a. Energy – Joule
   b. Current – Charge per unit time
   c. Charge – I.t
   d. Voltage – Energy per unit charge
   e. Power - Energy per unit time – V.I
   f. Resistance – Voltage per unit current.

2. describe resistors.
   a. Define the term resistance and state that resistance depends on the dimensions, type of material and temperature.
   b. Define resistivity.
   c. State the relationship between the resistance of a conductor and its length, cross-sectional area and its resistivity.
   d. Determine the current, voltage, resistance and power in simple series and parallel circuits using Ohm’s Law; calculate the power dissipated.

3. describe magnetism and magnetic circuits.
   a. Define magnetic fields.
   b. State that magnetic fields are considered to consist of lines of magnetic flux.
   c. State the rules applicable to lines of magnetic flux.
   d. Describe and sketch the flux paths of typical magnetic circuits.
   e. State the relationship between magnetic flux, cross-sectional area and magnetic flux density.

4. describe inductance and inductive components.
   a. Describe inductors as wound components.
   b. State how an electric current may be generated by dynamic or static induction.
   c. Define magnetic flux.
   d. Explain the difference between self and mutual induction.
   e. Determine the emf of self or mutual induction, given the:
      i. inductance and change of rate of current
      ii. number of turns and rate of change of flux
      iii. rate of cutting flux by conductor.
   f. State Lenz’s Law.
   g. Identify inductive components in electrical machines (e.g. field coils, transformer winding).
   h. Determine the force on a current carrying conductor in a magnetic field.
   i. Describe an electro-magnet and the effect of an iron core.
5 describe the Earth’s magnetic field and the operation of compasses.
   a Identify the effects of variation.
   b Identify the effects of deviation.
   c State methods of minimizing deviation.
   d Identify suitable compass types for typical small craft.

6 describe capacitors.
   a Define capacitance the electrical field, electric stress, dielectrics; relate potential difference, charge and capacitance.
   b Identify the constructional features of different types of capacitor; parallel plate, variable and semi-variable air spaced, solid dielectric.
   c Determine capacitance given \( \varepsilon_0 \), \( \varepsilon_r \), area and distance between plates.
   d State the dangers associated with capacitors.
   e Calculate resultant capacitance for capacitors in series and parallel.

7 describe graphically the effect of inductance and capacitance when connected to a dc supply:
   a R and L in series
   b R and C in series (charge and discharge)
   c Identify time constant, transient state and steady state.

8 state the effects of resistance and inductance in ac circuits.
   a Sketch the circuit, waveform and phasor diagrams for the following circuits:
     i purely resistive
     ii purely inductive
     iii R and L in series.
   b State the effects of resistance and capacitance in an ac circuit.
   c Sketch the circuit diagram and phaser diagram for:
     i a purely capacitive circuit
     ii R and C in series.
   d State the effects of R, L & C in an ac circuit:
     i R, L & C in series
     ii R L & C in parallel.
   e Describe the effects of series and parallel resonance.
   f Determine the power developed (or dissipated) in single phase circuits using V, I and power factor.
   g State the average power in a:
     i resistor is VI
     ii pure inductance is zero
     iii pure capacitance is zero.
   h Determine
     i power
     ii power factor
     iii kVA, kW and kVAR.

9 describe the types and use of test instruments including the use of:
   a multimeters for measurement of current, voltage and resistance
   b insulation testers
   c wattmeter to measure power
   d instruments to measure earth loop impedance
   e tachometer and stroboscope to measure rotational speed
   f CRO to measure
     i the magnitude of direct voltage
     ii the amplitude and frequency of alternating voltages.
10 describe semiconductor devices.
   a Describe the action of semiconductor devices in simple rectifier circuits.
   b State that the diode is a device which allows current to flow in one direction.
   c Define PIV.
   d State that the conduction in a thyristor is controlled by a gate electrode.
   e Describe the requirement for heatsinks.
   f Recognise circuits and input/output waveforms for half wave, full wave and bridge circuits.
   g Describe the action of smoothing circuits.
   h Describe the action of both bi-polar and uni-polar transistors when used:
      i as a switch
      ii as an amplifier.

11 describe basic electronic circuits and components.
   a Identify listed components from their packaging:
      i resistor
      ii capacitor
      iii transistor
      iv diode
      v integrated circuit
      vi amplifier
      vii oscillator
      viii filter
      ix power supply
      x state the functions of listed components.

12 describe the operating conditions and typical applications of:
   a photocell
   b photodiode
   c phototransistor
   d optocoupler
   e infra-red source and sensor
   f fibre optic link
   g solid state temperature measurement device
   h hall effect device
   i vacuum fluorescent display
   j gas plasma display.
Outcome 2: Understand electricity supply systems, protection and earthing

Practical activities

The candidate will be able to:

1. carry out workshop tests to demonstrate the effect of switch gear on electrical circuits and demonstrate protection systems
2. use a transformer.

Underpinning knowledge

The candidate will be able to:

1. describe electricity supply systems.
   a. State the reasons for 12, 24, 110, and 230 volts on board systems.
   b. Identify geographic areas which use 110 and 230 volt mains supply systems.
   c. Explain the importance of voltage drop and losses in mains voltage systems and carry out simple calculations.
   d. Explain the importance of voltage drop and losses in 12 and 24 volt systems and carry out simple calculations.

2. describe transformers:
   a. state the principle of operation of transformers
   b. state the relationship between input, output and losses
   c. perform simple calculations on input, output and losses
   d. perform calculations involving current, voltage and turns for ideal transformers
   e. explain the term 'rating of a transformer' and the reason for rating in kVA
   f. state the principles of operation of inverters
   g. state the principles of operation of switched mode battery chargers.

3. state the function of listed switchgear:
   a. fuses
   b. circuit breakers
   c. switches
   d. isolators
   e. contactors
   f. relays
   g. residual current devices.

4. describe earthing systems:
   a. state the reasons for earthing 110 and 230 volt systems
   b. state the advantages and disadvantages of earthing 12 and 24 volt systems on boats
   c. state the reasons for providing residual current protection systems on boats.

5. describe protection systems:
   a. list the abnormal conditions for which protection systems need to be provided.
      i. Dangerous currents due to short circuits.
      ii. Earth leakage.
      iii. Overload.
   b. state methods of protection to counteract abnormal conditions listed in 5a.
      i. Fuses.
      ii. Circuit breakers.
      iii. Residual current devices.
Outcome 3: Understand the functions of electrical machines and motors

Practical activities

The candidate will be able to:

1. demonstrate the use of generators and motors.

Underpinning knowledge

The candidate will be able to:

1. describe the principles of operation of electrical rotating machines.
   a. State the principles of operation of the alternating current generator.
   b. Describe the interdependence of:
      i. frequency, speed and pole pairs
      ii. emf, speed and fields strength.
   c. Describe the principle of operation of the alternator as the 12 or 24 volt dc generator used on a marine engine.
   d. Describe the principle of operation of the d.c machine as a motor, with particular reference to its application as a starter motor on a marine engine.
   e. Determine synchronous speed using frequency and pole pairs
   f. Distinguish between synchronous and asynchronous machines

2. identify single phase ac motors (rated below 1 kW). Distinguish between:
   a. series wound
   b. split phase
   c. capacitor
   d. capacitor start\run.
112 Advanced Mathematics and Science

Rationale

This optional unit is designed for candidates who require a level of understanding of Mathematics and Science which goes beyond that of the underpinning knowledge required for the units in the award. It is primarily aimed at those candidates who wish to progress to higher education. It has been applied to practical engineering principles of mathematics topics.

There are thirteen outcomes to this unit. The candidate will be able to:

1. use indices
2. use algebraic methods
3. use logarithms and number bases
4. use trigonometry
5. use calculus
6. use statistics
7. describe materials and their properties
8. perform tests in stress, strain and elasticity
9. describe the principles of kinematics (velocity and acceleration)
10. describe the principles of dynamics (force, mass and acceleration)
11. describe the principles of bending beams
12. describe effects on fluids
13. describe the effects of electromagnetism and alternating current.

Connection with other awards

This unit does not specifically relate to the current NVQs within the sector.

Assessment

The outcomes from this unit will be assessed using evidence from a centre devised assignment which will cover both practical activities and underpinning knowledge.
Outcome 1:  Use indices

Practical activities

The candidate will be able to:

1  use formulae involving powers and roots to solve practical problems.

Underpinning knowledge

The candidate will be able to:

1  state the meanings of the terms: base, index, power, root and reciprocal.
   a  Deduce that $a^0 = 1$
   b  State that $a^{-n} = 1/a_n$
   c  State that $a^{1/n} = nXa$
   d  Evaluate:
   e  $a^m.a^n$
   f  $a^{n+m}$
   g  $a^{n/m}$
   h  $a^{m-n}$
   i  $(a^n)^n$
   j  $a^{mn}$
   k  $a^{mn}$

2  express decimal fractions in standard form

3  solve algebraic problems involving transposition of terms with indices.
Outcome 2: Use algebraic methods

Practical activities

The candidate will be able to:

1. apply graphical methods to solve practical problems
2. form and solve quadratic equations which are mathematical models of practical problems
3. calculate ranges of gear ratios suitable for use in reduction gearboxes
4. solve statistical problems requiring the use of factorial notation.

Underpinning knowledge

The candidate will be able to:

1. use algebraic and graphical methods to solve simultaneous and quadratic equations
2. define the roots of an equation
3. use a calculator to solve simultaneous and quadratic equations
4. recognise perfect squares and the difference of two squares
5. describe the use of simple arithmetic and geometric series
6. describe the use of factorial notation for combinations and permutations.
Outcome 3: Use logarithms and number bases

Practical activities

The candidate will be able to:
1. use logarithms to manipulate and simplify algebraic functions and produce graphical solutions to problems involving logarithmic and exponential functions
2. apply binary and hexadecimal numbering systems to practical activities including data transmission and storage.

Underpinning knowledge

The candidate will be able to:
1. define a logarithm as a power applied to a base number
2. use logarithms to the base 10
3. use logarithms to the base ‘e’ stating its application
4. use logarithms to simplify calculations
5. describe the binary numbering system and its uses in data transmission and storage
6. describe the hexadecimal numbering system and its uses in data transmission and storage
7. perform calculations using binary and hexadecimal numbers
8. perform conversions of numbers between denary, binary and hexadecimal bases.
Outcome 4: Use trigonometry

Practical activities

The candidate will be able to:

1. apply trigonometry to problems such as mensuration problems, simple structures, angular motion, phasors

2. use complex numbers to generate an argand diagram.

Underpinning knowledge

The candidate will be able to:

1. solve problems involving trigonometric ratios for the four quadrants

2. apply the Sine Rule \( \frac{A}{\sin A} + \frac{B}{\sin B} + \frac{C}{\sin C} \) to practical problems

3. apply the Cosine Rule \( a^2 = b^2 + c^2 - 2bc \cos \theta \) to practical problems

4. plot graphs of the functions \( y = R \sin (\theta + \phi) \) and \( y = R \cos (\theta + \phi) \)

5. use a calculator to solve problems involving areas of
   a. non right-angled triangles
   b. angles between lines
   c. true length of lines
   d. true angle between planes.

6. state the basic trigonometric identities
   a. \( \tan = \frac{\sin}{\cos} \)
   b. \( \cot = \frac{1}{\tan} \)
   c. \( \sec = \frac{1}{\cos} \)
   d. \( \csc = \frac{1}{\sin} \).

7. explain that a complex number is a combination of \( j \) notation and a rational number

8. describe vector representation of
   a. complex numbers
   b. modulus
   c. argument.

9. describe polar representation of
   a. complex numbers
   b. argand diagrams
   c. rotating vector
   d. polar to cartesian form and vice-versa.
Outcome 5: Use calculus

Practical activities

The candidate will be able to:

1. complete calculations that apply differentiation to problems such as velocity and acceleration
2. determine the minimum material required to produce a regular-shaped square or circular container of maximum volume
3. complete calculations that apply integration to problems such as summation of irregular areas, volumes of revolution, centroid of area and second moment of area.

Underpinning knowledge

The candidate will be able to:

1. state that $\frac{dy}{dx} = nx^{n-1}$
2. solve problems involving maxima and minima related to practical applications
3. differentiate
   a. a product
   b. a quotient
   c. function of a function.
4. show the general form of a second derivative
5. differentiate algebraic expressions including
   a. polynomial expressions
   b. exponential expressions
   c. simple trigonometrical functions.
6. determine the value of the dependent variable at turning points in
   a. a quadratic equation
   b. a cubic equation.
   c.
7. apply Simpson’s Rule to the calculation of areas of irregular sections
8. state that $\int ax^n \, dx = \frac{a}{n+1}x^{n+1}$
9. apply the rules of integration for
   a. polynomial expressions
   b. exponential expressions
   c. simple trigonometric functions.
10. describe the process of integration by substitution and integration by parts.
Outcome 6: Use statistics

Practical activities

The candidate will be able to:

1. determine mean and standard deviation for a sample of engineering artefacts
2. perform simple estimates of failure rates of engineering artefacts or systems.

Underpinning knowledge

The candidate will be able to:

1. gather and collate data from various sources and solve problems involving:
   a. frequency distributions (mean, median, mode, standard deviation)
   b. extrapolated data
   c. interpolated data
2. use a calculator to perform statistical calculations
3. define probability
4. define dependent and independent events
5. describe addition and multiplication laws of probability
6. describe how permutations and combinations are applied to probability
7. describe the normal probability distribution
8. describe confidence limits and statistical testing.
**Outcome 7: Describe materials and their properties**

**Practical activities**

The candidate will be able to:

1. describe the probable reasons for failure of a number of material samples
2. describe the types of corrosion present in given samples
3. use micro-examination to describe the characteristics of chemically etched metal samples
4. select materials that are suitable for given engineering applications from a range of metals and non-metals.

**Underpinning knowledge**

The candidate will be able to:

1. state what is meant by the terms
   a. creep
   b. fatigue
   c. describe the methods of measuring each of a and b.
2. describe the common causes and methods of prevention of the following types of corrosion/decay in a marine environment
   a. atmospheric
   b. chemical
   c. electrolytic/dissimilar metals
   d. fretting
   e. stress
   f. crevice corrosion
   g. ultra-violet.
3. describe the crystallisation process of metals and the formation of cubic and hexagonal lattices
4. with reference to the Iron/Carbon Thermal Equilibrium diagram:
   a. describe the effects on microstructure of varying the amount of carbon in irons and steels
   b. state the temperatures at which hardening, tempering and annealing for steels of varying carbon contents are carried out.
5. describe typical properties and uses of the following non-ferrous metals in a marine environment:
   a. aluminium and magnesium alloys
   b. brasses
   c. bronzes
   d. zinc alloy
   e. lead
   f. tin/lead alloys (solders/white metal).
6. describe the properties and uses of the following ferrous metals in a marine environment:
   a. cast iron
   b. low carbon steel
   c. stainless steel (A4).
describe the properties and uses of the following plastics and composite materials in a marine environment:

a. Nylon
b. Kevlar
c. epoxy resin/fibre reinforced composites
d. Polytetrafluoroethylene (PTFE/Teflon)
e. Polyvinylchloride (PVC)
f. Polypropylene
g. compressed laminates (Tufnol/Formica)
h. polyester resin/glass reinforced composites (GRP)
i. Polythene (Polyethylene).

describe the properties and applications of ceramic materials.
Outcome 8: Perform tests in stress, strain and elasticity

Practical activities

The candidate will be able to:

1. perform tensile tests on a range of materials and hence deduce Young's Modulus for each material
2. perform shearing tests and deduce the modulus of rigidity of a sample of material.

Underpinning knowledge

The candidate will be able to:

1. state what is meant by the terms
   a. direct stress
   b. direct strain
   c. elastic limit
   d. yield point
   e. Modulus of Elasticity
   f. factor of safety.
2. perform calculations comparing the properties of different materials
3. state what is meant by the terms
   a. shear stress
   b. shear strain
   c. Modulus of Rigidity
   d. Poisson's ratio
   e. perform calculations comparing the properties of different materials.
Outcome 9: Describe the principles of kinematics (velocity and acceleration)

Practical activities

The candidate will be able to:

1. solve practical problems involving bodies in linear motion and trajectories
2. use vector addition to calculate achieved tracks (e.g., ships in tides, aircraft in winds) and relative velocities.

Underpinning knowledge

The candidate will be able to:

1. state the following
   a. velocity is a vector quantity
   b. velocity is the rate of change of distance with respect to time
   c. the area under a velocity/time curve represents the distance travelled
   d. acceleration is the rate of change of velocity with time
   e. the area under an acceleration/time curve represents velocity

2. solve problems for linear and rotary motion both graphically and using the formulae
   a. \( s = \frac{1}{2}(u + v)t \)
   b. \( a = \frac{(v - u)}{t} \)
   c. \( v = u + at^2 \)
   d. \( s = ut + \frac{1}{2}at^2 \)
   e. \( v^2 = u^2 + 2as \)

3. use vector diagrams to calculate relative velocities of bodies subjected to linear motion
Outcome 10: Describe the principles of dynamics (force, mass and acceleration)

Practical activities
The candidate will be able to:

1. use observed data to calculate the acceleration due to gravity
2. verify the conversion of energy from one form to another
3. measure the strain energy in a helical spring.

Underpinning knowledge
The candidate will be able to:

1. state Newton’s Laws of Motion
2. define the Earth’s acceleration due to gravity as 9.81 ms\(^{-2}\)
3. state that the Newton is the force required to accelerate a mass of 1 kg at the rate of 1 ms\(^{-2}\)
4. solve problems for accelerating/decelerating masses both graphically and using the formulae \(f = ma\)
5. define momentum as the product of mass and velocity
6. define impulse as the product of force and time
7. solve problems involving colliding bodies
8. calculate the moment of inertia of disks and rimmed flywheels
9. calculate the momentum of flywheels of given shapes and masses
10. explain the term ‘radius of gyration’
11. define potential energy \(P.E = mgh\)
12. relate work done in raising a body to potential energy
13. define linear and angular kinetic energy in terms of \(1/2mv^2\)
14. solve energy conversion problems both graphically and by using a formula
15. define strain energy in terms of force and extension of an elastic body
16. solve problems associated with stored energy both graphically and using the formulae \(S.E = 1/2fx\).
Outcome 11: Describe the principles of bending beams

Practical activities

The candidate will be able to:

1. calculate maximum bending and shear loading for beams and cantilevers under given load conditions
2. demonstrate the relationship between the loading and deflexion of a beam

Underpinning knowledge

The candidate will be able to:

1. construct shear force and bending moment diagrams for simply supported beams and cantilevers
2. determine maximum bending moments for:
   a. point loads
   b. uniformly distributed loads
   c. combinations of a) and b).
3. identify points of contraflexure
4. state the assumptions made in calculating stress due to bending
5. derive the standard equation for bending \( \sigma_y = \frac{M}{I} = \frac{E}{R} \)
6. derive the second moments of area for rectangular and circular sections
7. define units of second moment of area as \( \text{m}^4 \)
8. solve problems associated with the stresses produced in bending beams
9. compare the resistance in bending of 'T', 'I' and channel beam cross-sections
Outcome 12: Describe effects on fluids

Practical activities
The candidate will be able to:

1. demonstrate the relationship between pressure and volume of a given mass of gas
2. demonstrate the relationship between the temperature and volume of a given mass of gas
3. demonstrate the relationship between potential energy, kinetic energy and pressure energy of non-compressible fluid flow in inclined tapered conduits.

Underpinning knowledge
The candidate will be able to:

1. state Boyle's Law
2. state Charles' Law
3. state the Combined Gas Laws
4. solve problems associated with the above
5. define
   a. velocity rate of flow
   b. volume rate of flow
   c. mass rate of flow.
6. state the continuity equation for an incompressible liquid
7. solve problems associated with 6
8. state how fluid can possess potential, kinetic and pressure energy
9. describe how kinetic and pressure energy in a fluid can be expressed in terms of 'head'
10. describe Bernoulli's equation
11. use Bernoulli's equation to solve problems associated with incompressible fluid flow
12. describe the power developed by a jet in terms of velocity and mass flow rate
Outcome 13: Demonstrate the effects of electromagnetism and alternating current

**Practical activities**

The candidate will be able to:

1. demonstrate the effect of a magnetic field on a current carrying conductor
2. demonstrate the effect of a magnetic field on a moving conductor.

**Underpinning knowledge**

The candidate will be able to:

1. describe the effect on a current carrying conductor that is exposed to a magnetic field
2. use Fleming’s Left-hand Rule to establish the direction of the force on a current flowing at right angles to the direction of a magnetic field
3. state that the units of magnetic field strength are the Tesla and the Weber
4. calculate the magnitude of the force on a current flowing at right angles to a magnetic field using the formula $F = BIL$
5. describe practical applications of force exerted on a current in a magnetic field.
   a. An electric motor.
   b. A moving coil loudspeaker.
6. describe the effect of moving a conductor across a magnetic field
7. state Faraday’s law of electromagnetic induction
8. state Lenz’s law
9. use Fleming’s Left-hand Rule to establish the direction of induced emf
10. calculate the value of an induced emf using the formula $E = Blv$
11. describe practical applications of electromagnetic induction:
    a. an electric generator
    b. an eddy-current brake.
12. describe the method of generating an alternating emf
13. sketch the graph of instantaneous conductor emf against angular position of coil
14. define the period and frequency of an alternating current
113 Advanced marine electronic systems

Rationale

This is concerned with the complex electronic navigation systems used on leisure and commercial small craft.

The unit covers four performance outcomes. The candidate will be able to:

1. prepare for the installation of complex integrated electronic navigation systems
2. identify equipment, materials and components for the installation of complex integrated electronic navigation systems
3. carry out the installation of complex integrated electronic navigation systems
4. commission and set up complex integrated electronic navigation systems.

Connection with other awards

This unit relates to the City & Guilds 2451 level 2 unit Principles of marine electrical systems.

Assessment

The outcomes from this unit will be assessed by means of an assignment which will cover practical and underpinning knowledge.
**Outcome 1: Prepare for the installation of complex integrated electronic navigation systems**

**Practical activities**

The candidate will be able to:

1. gather, read, and interpret safety and job instructions
2. produce a detailed work plan.

**Underpinning knowledge**

The candidate will be able to:

1. describe sources of drawings, and technical information required and the procedures for their care and safe keeping:
   a. Installation drawings.
   b. Manufacturer’s instructions.

2. state the:
   a. need to plan work activities
   b. methods of producing work plans
   c. the information they must contain.

3. state the need to ensure that components are clear of other services:
   a. gas
   b. water
   c. fuel
   d. electricity
   e. communications cables
   f. data cables.

4. state the need to use appropriate techniques to pass cables through watertight bulkheads.
Outcome 2: Identify equipment materials and components for the installation of complex integrated electronic navigation systems

Practical activities

The candidate will be able to:

1. prepare for the installation of complex navigation systems
2. select suitable cables, glands, terminals and appropriate fittings
3. determine which appropriate positions for the installation of radomes, aerials, sensors, instruments and cabling
4. check the condition and availability of all necessary tools and equipment
5. identify quality control documentation.

Underpinning knowledge

The candidate will be able to:

1. state the factors which affect the selection of appropriate positions for radomes, compass senders, aerials, log, wind, depth sensors, for different marine applications and environments to ensure compliance with relevant codes of practice.
   a. Take due regard to the effect on the vessels stability.
   b. Select positions which allow access and maintenance.
   c. Allow for appropriate routing of data cables and supply cables.
   d. Provide suitable protection to electrical circuits.

2. state the factors which affect the selection of appropriate positions for
   a. radar sets
   b. chart plotters
   c. computers
   d. wind instruments
   e. depth instruments and fish finders
   f. logs and depth instruments
   g. position finding systems
   h. autopilots.

3. describe the factors which affect the routing of cables between
   a. mast mounted transducers and sendors
   b. cockpit and flying bridge mounted instruments
   c. wheelhouse mounted instruments
Outcome 3: Carry out the installation of complex integrated electronic navigation systems

Practical activities

The candidate will be able to:

1. cut materials to length, ensuring efficient use of materials
2. use appropriate tools and techniques to install equipment
3. join system components supporting and securing components
4. check during installation for visual faults
5. check the installation conforms to specification and dimensional accuracy.

Underpinning knowledge

The candidate will be able to:

1. state the responsibilities under regulations relevant to the work undertaken
2. state the precautions to be taken when using tools and equipment, as well as when working on mast mounted equipment.
3. state the need for protective equipment such as
   a. overalls
   b. safety shoes
   c. eye protection
   d. gloves
   e. barrier creams.
4. describe the safe practices and procedures required when carrying out assembly and installation activities on systems including the use of access equipment and when using solvents and adhesives
5. describe how to mark out and cut openings for
   a. bulkhead mounted instruments
   b. mast mounted transducers and sensors
   c. cockpit and bridge mounted instruments.
6. describe the methods of holding work pieces without damaging them
7. state the need to ensure that all components and installations are free from
   a. projections
   b. burrs
   c. sharp edges
   d. swarf
   e. foreign bodies.
8. state the importance of
   a. leaving the work area free of unused consumables
   b. cleaning down work area
   c. putting tools and equipment into safe storage
   d. labelling and recording finished work.
Outcome 4: Commission and set up complex integrated electronic navigation systems

Practical activities

The candidate will be able to:

1 power up and test newly installed systems
2 set up and test interfaces with other equipment
3 calibrate and set up equipment for use
4 check the installation conforms to specification and dimensional accuracy
5 demonstrate completed installations to customers.

Underpinning knowledge

The candidate will be able to:

1 demonstrate an understanding of the function and operation of a wide range of instrumentation including:
   a radar sets
   b chart plotters
   c computers
   d wind instruments
   e depth instruments and fish finders
   f logs and depth instruments
   g position finding systems
   h autopilots.
2 demonstrate an understanding of NMEA interfacing requirements and the protocols by which integrated instruments communicate with each other
3 demonstrate an understanding of the ways in which different systems are programmed to use data from other parts of the system.
4 demonstrate an understanding of the operation and use of a range of integrated navigation systems.
Prepare surfaces and marine coatings

Rationale

This is an optional unit. The unit covers the underpinning knowledge and skills requirements for the successful preparation of surfaces to apply marine coatings. It includes the interpretation of instructions and specifications, the identification of existing defects and the terminology and techniques needed to identify/prepare surfaces and to select the appropriate tools and equipment.

This unit covers two learning outcomes. The candidate will be able to:
1. prepare marine material surfaces
2. prepare coating materials.

Connection with other awards

This unit combines and extends the knowledge and understanding contained in units:

Unit 181 Preparing marine material surfaces using hand and mechanical tools.
Unit 182 Preparing marine coatings materials for application of the Level 3 NVQ in Marine Engineering.

Assessment

The outcome of this unit will be assessed using evidence from a practical assignment covering the practical activities and underpinning knowledge.
Outcome 1: Prepare marine material surfaces

Practical activities

The candidate will be able to:

1. obtain and interpret specification from manufacturer's/supplier's technical data sheets, customer's specification and manufacturer's safety and data sheets
2. visually inspect surfaces and identify defects and surface prep requirements
3. carry out preparation activities
4. check prepared surfaces meet the specified standards
5. complete and store application records and data.

Underpinning knowledge

The candidate will be able to:

1. state the requirements for preparation activities:
   a. identify the correct contractual, manufacturer's and customer's specification
   b. identify the appropriate Health and Safety documentation including:
      i. CHIPS data
      ii. risk assessment.
   c. identify appropriate personal protective equipment (PPE)
   d. identify customer contractual acceptance criteria
   e. identify Insurance contractual requirements where appropriate
2. identify hazards associated with surface preparation activity.
   a. Sparks.
   b. GRP dust particles.
   c. Explosive materials.
   d. Acids.
   e. Hearing damage.
   f. Hand/arm vibration.
   g. Allergic reactions.
   h. Fumes.
   i. Cutting tools such as grinders.
3. identify the required work procedures, specifications and instructions, and how to interpret their requirements
4. identify the reasons for carrying out surface preparation, and the effects on the final finishing activities if preparations are not carried out correctly.
   a. technical
      i. promote adhesion
      ii. coating performance
      iii. anti-corrosion treatment.
   b. cosmetic
      i. smooth surface
      ii. no dust inclusions
      iii. no contamination
      iv. adequate gloss levels
      v. no orange peel.
5. Identify the various types of substrate that may require preparation including:
   a. unpainted surfaces
   b. painted surfaces,
   c. ferrous materials
   d. non-ferrous materials
   e. wood
   f. composite materials
   g. ferro cement.

6. Identify the types of tools, equipment and preparation methods that may be used:
   a. degreasing solvents
   b. chemical paint remover
   c. hand abrasives
   d. brushes or vacuum cleaner
   e. power caulking tool/chisel
   f. hand tools
   g. needle guns
   h. powder wire brush
   i. angle grinder
   j. flame cleansing
   k. power planer
   l. power disking
   m. vacuum blasting
   n. high pressure washers.

7. Identify why different types of substrate require different preparation techniques to be used:
   a. Adhesion character of surface.
   c. Maximum coating performance.

8. Identify the types of defects and contamination to be found on unpainted and painted surfaces, and their causes.
   a. Surface corrosion
   b. Surface contamination
   c. Coating detachment
   d. Coating cure
   e. Paint coating defects e.g.
      i. Cracking/crazing
      ii. Flaking
      iii. Blistering
      iv. Cissing
      v. Pinholing
      vi. Wrinkling
      vii. Chalking
      viii. Adhesion
      ix. Sweating
      x. Telegraphing

9. Identify the damage that may result from using inappropriate tools and techniques.
   a. Premature corrosion.
   b. Premature loss of gloss.
   c. Premature coating adhesion failure.
10  state the importance of the maintenance of a register of power tools, and the need to check tools, equipment and their consumables against certification:
   a  Hand tools.
   b  Portable electrical tools.
   c  Portable pneumatic tools.

11  identify quality control techniques and procedures used during the preparation activities.
   a  Substrate surface profile.
   b  Temperature.
   c  Humidity.
   d  Visual examination.
   e  Testex press tape.
   f  Swabs.
   g  Bresle test.
   h  Cross hatch test.
   i  Dolly test.
   j  Shore D.
   k  Solvent test.
   l  Visual examination (angle mirror).

12  state how the environmental conditions such as temperature, humidity, dew point may have an effect on surface.
   a  No full cross linkage of paint chemicals.
   b  Moisture on substrate leading to premature coating failure.
   c  Inadequate cure cycle of fairing compounds.

13  identify approved methods of safe and economic disposal of waste materials, including the environmental impact of the materials, and the minimisation of this impact
Outcome 2: Prepare coating materials

Practical activities

The candidate will be able to:

1. obtain the required material and check for quantity and quality
2. estimate the volume of coating material to be prepared
3. carry out preparation activities using suitable equipment
4. reinstate work area on completion of preparation activities
5. check prepared materials against the manufacturer’s specification and customer’s contractual acceptance criteria.

Underpinning knowledge

The candidate will be able to:

1. state the requirements for coating preparation activities:
   a. identify the correct contractual and manufacturer’s specification
   b. identify the customer’s contractual acceptance criteria and insurance requirements when appropriate
   c. identify the appropriate Health and Safety documentation including:
      i. CHIPs data
      ii. risk assessment.
   d. identify appropriate personal protective equipment (PPE).

2. describe the activities required for preparing marine coatings:
   a. obtain the correct type and quantities of materials
   b. ensure the stored materials are within date and at the recommended temperature for use
   c. ensure the correct mixing ratios are adhered to
   d. check that the prepared coating material is of the correct viscosity
   e. ensure the prepared materials has been in the container for induction period (if applicable)
   f. ensure the prepared material is at the temperature recommended for application.

3. identify the hazards associated with the storage of, the preparation of, and the disposal of marine coating products and solvents:
   a. inhalation of fumes/dust
   b. fire and explosion
   c. contact with solvents and other chemicals, allergic reactions.

4. identify the types of marine coatings in common use and their characteristics.
   a. Water based epoxies.
   b. Solvent based epoxies.
   c. Conventional alkyd or silicone alkyd.
   d. Acrylic urethane coatings.
   e. Polyester polyurethane coatings.
   f. Fairing compounds.
   g. Water based urethane coatings.
   h. Anti-fouling paint.
5 state the importance of product/shelf life, stock control and the use of batch numbers.
   a Customer contractual requirements.
   b Good working practice.
   c Coating insurance requirements.
   d Manufacturer’s application data requirements.
   e General warranty and/or guarantee.

6 identify the storage requirements, for marine coating products and solvents such as thinners, cleaners
   a environmental conditions
      i temperature
      ii humidity
   b containment arrangements eg: explosion proof storage containers

7 identify the containers appropriate to defined products and usages:
   a metallic: solvent based epoxies and urethanes
   b plastic: water based epoxies and urethanes.

8 identify preparation requirements including:
   a pot-life
   b induction times
   c temperature conditioning
   d stabilising requirements
   e solvent requirements
   f coating interval times.

9 describe methods for estimation of the product volume to be prepared for a defined usage:
   a estimation of areas to be covered
   b theoretical and practical paint consumption
   c loss factors
   d manufacturer’s specification
   e ratio calculations
   f effect of application method such as pads, brushes, rollers, spray.

10 state the importance of stirring single pack paints and epoxys and the use of thinners for marine coating products.
    a Adding of solvents improves flow characteristics of the paint film and enhances the cure cycle.
    b Achieve homogeneous mixture of coating ingredients.
    c Achieve maximum coating performance.
    d Achieve correct coating cure cycles.

11 describe the importance of mixing ratios for two-pack products.
    a Maximum coating performance.
    b Achieve correct coating cure cycles.
    c Achieve homogenous mixture of coating ingredients.

12 identify the requirements and procedures for reinstatement of work area.
    a Disposal procedures for redundant materials.
    b Appropriate procedures for the disposal of, or the cleaning of, used containers.
    c The importance of the maintenance of records of paint and solvent consumption.
    d Customer contractual requirements.
    e Manufacturers requirements.
115 **Apply marine coatings**

**Rationale**

This is an optional unit. The unit covers the underlying knowledge and skills requirements for the successful application of a range of marine coatings. It includes the techniques and procedures for application of coatings manually and using spray methods and the checking of the finished coating to identify and rectify surface defects.

This unit covers two learning outcomes. The candidate will be able to:

1. apply marine coatings
2. identify and rectify defects and faults.

**Connection with other awards**

This unit combines and extends the knowledge and understanding contained in units:

- Unit 191 Inspecting marine coatings.
- Unit 183 Applying marine coatings manually.
- Unit 184 Applying marine coatings using spray methods of the Level 3 NVQ in Marine Engineering.

**Assessment**

The outcome of this unit will be assessed using evidence from a practical assignment covering the practical activities and underpinning knowledge.
Outcome 1:  Apply marine coatings

**Practical activities**

The candidate will be able to:

1. evaluate surface prior to coating application
2. apply coatings by hand and spray
3. visually check coating.

**Underpinning knowledge**

1. state the importance of maintaining appropriate environmental conditions for the application and curing of the marine coating products.
   a. To ensure maximum coating performance.
   b. To ensure correct coating/fairing compound cure cycles.
   c. To avoid premature loss of gloss.
   d. To avoid premature corrosion.
   e. To adhere to manufacturers specification.
   f. To adhere to coating insurance guarantee requirements.
2. identify the time intervals that are required between coats and why these must be adhered to.
   a. To ensure maximum coating performance.
   b. To ensure cure cycles.
   c. To ensure adhesion in between coating layers.
   d. To avoid solvent entrapment within the coating.
   e. To adhere to manufacturers specification.
   f. To adhere to coating insurance guarantee requirements.
3. describe the procedures for the handling and safe use of coating materials and solvents.
   a. Use appropriate Health & Safety documentation including CHIPS data and risk assessment.
   b. Wear appropriate personal protective equipment (PPE) at all times.
   c. Ensure appropriate exclusion zones and containment facilities are set up.
   d. Ensure that environmental condition meet requirements.
4. describe the use of paint thinners to adjust the viscosity of the product being applied.
   a. To ensure better flow character of the coating film.
   b. To adhere to customer’s acceptance cosmetic acceptance criteria.
   c. To adhere to manufacturers specification.
   d. To ensure correct application of the product by hand or spray.
   e. To ensure product transport to the surface by hand or spray.
5. describe the various methods of applying the required coating.
   a. Brushes.
   b. Rollers.
   c. Paint pads.
   d. Cloths.
   e. Sprays.
6 identify application equipment to suit the materials and the finish required.
   a Brushes.
   b Rollers.
   d Conventional spray.
   e Airless spray.
   f Air-assisted airless spray.
   g Bottom feed (deck) lance.
   h Hopper gun.
   i Electrostatic spray.
   j Plural pump system.
   k High volume low pressure.

7 identify the techniques required to avoid defects arising from application errors.
   a Good workmanship.
   b Follow manufacturer's specification and recommendations.
   c Correct environmental conditions during and after application.
   d Project planning prior to application.

8 describe the correct use of stripe coating as an extra coat of material usually applied by
   brush to build up thickness along edges of beams, around nuts and bolts and in less
   accessible areas.

9 describe the principles of correct extraction/air flow:
   a to avoid overspray particle contamination
   b to ensure correct drying characteristics of the coating eg physical and chemical
   c to ensure safe working place.

10 identify the effect on quality and safety of correct extraction/air flow.
   a Curing.
   b Performance.
   c Appearance.

11 describe the requirements for working afloat, on outer/hull bottoms and at heights.
   a Scaffolding.
   b Shrink foil.
   c Tarp covers.
   d Safety harness.
   e Helmets.
   f Approved foot material (shoes).
   g Goggles.

12 describe the procedure to contain and to clear away spillages, and the safe and
   appropriate disposal of waste materials:
   a company's procedure
   b legislative requirements
   c environmental requirements.

13 describe methods of carrying out visual checks of coated surfaces.
   a angle mirrors
   b flash light
   c magnifying glass.
Outcome 2: Identify and rectify defects and faults

Practical activities

The candidate will be able to:

1. identify and confirm inspection checks and acceptance criteria
2. carry out all required inspections
3. identify any defects or variations/deviations from specification and report/rectify accordingly
4. record results of inspection in daily application reports.

Underpinning knowledge

The candidate will be able to:

1. inspect previously painted surfaces to determine:
   a. percentage breakdown of coating
   b. general condition
   c. film thickness
   d. sources of corrosion e.g. bi-metallic, filliform, electrolysis
   e. remedial action required.
2. inspect prepared surfaces to confirm readiness for coating:
   a. surface cleanliness
   b. surface profile
   c. compatibility of surface condition of existing coatings with coatings to be applied
   d. application of stripe coating where required.
3. inspect coated surfaces to determine:
   a. correct coating system has been applied
   b. over coating conditions are correct such as intercoat inspections
   c. coatings are of specified thickness
   d. coatings are applied without surface defects
   e. adequate adhesion/cohesion.
4. describe the importance of using recommended methods of application for particular marine coating systems, and of complying with re-coating intervals
   a. to adhere to manufacturer’s specification and recommendations
   b. to adhere to insurance requirements
   c. to adhere to customer’s contractual criteria.
5 list the types of defect to be found in both newly applied and in existing paint systems, their causes and methods of rectification.
   a Orange peeling.
   b Pinholing.
   c Runs.
   d Drips.
   e Cracking/crazing.
   f Chalking.
   g Cissing.
   h Adhesion.
   i Sweating.
   j Telegraphing.
   k Flaking.
   l Wrinkling.
   m Detachment.
   n Contamination.

6 identify methods and procedures for the rectification of coating defects.
   a Sanding and flattening.
   b Stripping.
   c Recoating.
   d Polishing and burnishing.
   e Re-fairing.
   f Blasting (water, grit, sand or other) of the complete surfaces.
   g Spot repairs.
   h Scraping (runs, sags etc).

7 describe the importance of complete and comprehensive inspection including obscured areas and areas of difficult access
   a to adhere to manufacturer’s specification and recommendations
   b to adhere to insurance requirements
   c to adhere to customer’s contractual criteria.

8 identify the types of inspection/measuring equipment available, and the use of the inspection equipment.
   a Sling psychrometer.
   b Dew point calculator.
   c Surface thermometer.
   d Wet film thickness gauge.
   e Dry film thickness gauge.
   f Camera.
   g Syringe and sample bottle.
   h Magnifier/pocket microscope.
   i Angle mirror.
   j Ph paper.
   k Conductivity meter.
   l Adhesion tester.
   m Humidity meter.
   n Shore d gauge.
   o Gloss meter.

9 identify the limitations of your knowledge and the need to seek sources of specialist advice
10 identify quality control requirements, and the importance of producing comprehensive reports to demonstrate compliance with contractual requirements
   a to adhere to manufacturers specification and recommendations
   b to adhere to insurance requirements
   c to adhere to customer’s contractual criteria
   d to adhere to in-house contractual standards
   e to adhere to good working practises.

11 describe the importance of keeping the inspection equipment clean and free from damage

12 describe methods of carrying out the inspection checks of the coatings.
   a visual
   b touch
   c equipment

13 identify the sources of information for level of defects that are acceptable in the coatings.
   a Job specification.
   b Customer acceptance criteria.
   c In-house standards.
   d Manufacturers technical specifications.
Centre devised assignment submission report

Part A – To be completed by centre

BOX 1
Centre details
Centre number Sub centre Centre name Date sent to City & Guilds (dd/mm/yyyy)

Name of Examinations Office contact Telephone number Fax number
e-mail

Name of author of question paper Telephone number

Assignment details

BOX 2
Assignment component number Component title
2 4 5 1 -

Please complete the following checklist:
The assignment submitted
Covers all practical activities from the assignment's template
Will take a minimum of TEN hours to complete
Can be marked according to the grading criteria provided
Includes the required underpinning knowledge questions

* Please provide justification for the assignment NOT meeting the set criteria (add separate sheets if required)
Please attach a copy of the proposed assignment to this Assignment Submission Form

**BOX 3**

The centre confirms that the assignment contains:

1. **Assessor’s guidance notes including:**
   - A health and safety statement
   - The location where the assignment will take place
   - The requirements for tools, equipment, materials and data
   - Notes on the content of the assignment
   - Notes on preparatory work required by the assessor
   - Details of evidence and recording requirements
   - Time considerations

2. **Candidate’s instructions include:**
   - An assignment brief setting the scene or giving a scenario
   - General guidance notes advising candidates to check they understand requirements
   - Time consideration
   - The importance of health and safety
   - Clearly defined tasks – covering all practical activities from the assignment template
   - Recording/reporting sheets to record progress through the tasks
   - Notes advising candidates on how their evidence should be stored
   - Any required engineering drawings provided to current standards

Note the centre should allow 6 weeks from the date of submission by e-mail for City and Guilds to agree the assignment

Name (block capitals)  
Date  
Signed

Please e-mail to centredevised@cityandguilds.com

Centres which are unable to submit via e-mail must post THREE copies of the proposed assignment to City & Guilds, Centre Devised, 1 Giltspur Street, London, EC1A 9DD. This must be sent EIGHT weeks before intended use.