# PIABC LEVEL 2 AWARD IN COMPOSITE MANUFACTURING

Qualification Number: 610/5936/5

## Qualification Specification

Updated: 20 November 2025

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## PURPOSE

PIABC Level 2 Award in Composite Manufacturing is a regulated qualification. Its main purpose is to provide candidates with a basic introduction of composite materials and some of the manufacturing and repair techniques used in industry.

The qualification has been designed to be used by a range of different composite manufacturing sectors.

## GENERAL OUTCOMES

The general objectives of the PIABC Level 2 Award in Composite Manufacturing are to:

1. Provide those employed in composite manufacturing sectors with the skills, knowledge and understanding to underpin and enhance job experience
2. Provide candidates with a portable qualification to enable job movement throughout the industry
3. Provide candidates with a means of progression to higher level qualifications
4. Provide employers throughout the composite manufacturing sectors and related industries with a firm basis for judging suitability of candidates
5. Raise the status of those employed in the composite manufacturing sector

## TARGET GROUP

This Level 2 qualification is appropriate for those candidates wanting to enhance their employment and progression opportunities in composite manufacturing industries.

For example, candidates may be those who are:

- From composite manufacturing sectors (such as marine, automotive, aerospace etc.)
- Working within the supply chain of composite materials
- Liaising with packaging suppliers
- New recruits to composite manufacturing, who require an introduction to the basics of composite materials and manufacturing processes
- Those looking for a broad qualification in composite manufacturing as a basis for career development
- Candidates not currently employed in the industry, but wish to start career in composite manufacturing

## ENTRY REQUIREMENTS

There are no entry qualifications or age limits required for this qualification. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully.

## STAFFING

It is expected that staff involved with the delivery of the course will be appropriately qualified and/or experienced in composite manufacturing. The PIABC Limited (PIABC) approval process requires prospective centres to provide details of the staff involved in delivery and assessment including their qualifications and relevant training/employment experience, plus staff development arrangements. Whilst these details are passed on to the external moderator appointed by PIABC, it is the centre's responsibility to ensure tutors' qualifications are both bona fide and appropriate to the level of the qualification.

## QUALITY ASSURANCE

PIABC requires that each centre has a quality assurance and enhancement procedure in respect of the programme, and a means of monitoring its implementation.

There should be a team that is responsible for preparing an annual self-assessment of the programme and for monitoring the improvement measures resulting from this.

This self-assessment process should use evidence from different sources including:

- Candidate self-evaluation
- The views of external individuals and organisations, for example those companies sending candidates
- Staff working on the award
- In addition, it is also expected that there will be an internal moderation procedure to ensure standardisation of unit delivery. This will include the following elements:
    - Classroom observation
    - Peer review of award materials
    - Moderation of any internally assessed elements

There should be a named and appropriately qualified individual (Centre Co-ordinator) who has the necessary authority, with whom the awarding body can liaise directly on all matters of management, administration and quality assurance.

## EXTERNAL MODERATION

PIABC will appoint external centre monitors to visit centres to ensure the maintenance of standards of quality. The role of the centre monitor includes:

- Liaison between the centre and PIABC to ensure standardisation in terms of the quality of award delivery
- Providing advice and support for the centre in understanding and implementing the requirements of the units and the PIABC

An External Quality Assurance (EQA) desktop monitoring exercise is required for centres that have registered candidates and will formally report on the outcome of this visit to the centre and PIABC. All items contained in the report will be discussed with the centre and any action(s) that the centre needs to take will be agreed at that stage. Any visits in addition to the annual visit may incur an additional fee. The scope and frequency of assessment monitoring activities will be in part determined by the centre assessment standard strategy for this qualification.

PIABC's monitoring strategy will ensure that all centre marked assessments remain fit for purpose and that criteria against which candidates' performance is differentiated are being accurately and consistently applied for this qualification regardless on assessor, candidate, or centre.

The focus of EQA for this qualification is the detailed examination of candidate evidence. The sample selection will be determined by PIABC in line with its centre assessment standard strategy and external quality assurance sampling policy. During this exercise, the EQA will be able to agree to certification claims and sign off documentation relating to certification claims.

This EQA is conducted remotely as PIABC does not want to add additional financial burden to its centres which can be caused by EQA physical monitoring visits.

## PROGRAMME ORGANISATION

PIABC Level 2 Award in Composite Manufacturing is designed to provide candidates with a basic introduction to manufacturing and repairing composite components including, materials and consumables used to produce composite parts and different methods of manufacturing composite parts.

To achieve the qualification, candidates need to successfully gain 5 credits.

It is expected that courses leading to the qualification will take a minimum of 32 guided learning hours (GLH), which is the average hours a candidate may require guidance and support from teaching, learning and assessment professional to achieve the qualification. Candidates may be expected to carry out additional reading and other work to complete each unit and prepare for the assignments.

It is anticipated that the qualification will require a minimum of 40 hours of total qualification time (TQT) for satisfactory completion for an average candidate.

The organisation of the award is at the discretion of the centre and will consider the aims, aspirations and experience of the candidates.

Centres are encouraged to choose the most suitable curriculum model for their candidates. Whilst the sequential delivery of units is a possibility and may provide the most straightforward way of determining completion of individual units, it may be that some degree of integration of units will occur, or that other methods of delivery are more appropriate to meet the needs of candidates. It should be noted however that each unit will be individually assessed.

Centres must ensure that adequate arrangements are in place for supporting candidates. This could be either through separate tutorial sessions or through the use of time within structured study sessions.

## GUIDANCE ON LEARNING AND TEACHING STRATEGY, METHODS AND ASSESSMENT

Composite manufacturing is a practical subject, based on theoretical principles. As far as possible, it is important that the course is taught by relating the underlying theory to practical examples and applications.

Two factors which will help in this regard are:

1. The use of lecturers with direct experience in the composite manufacturing industry is likely to offer the most appropriate level of practical knowledge. This must, of course, be balanced against a sound understanding of the theoretical principles, as anecdotal experience alone is unlikely to meet the requirements of the course.

2. Those candidates employed in the composite manufacturing industries, will come to the course with varying levels of existing knowledge and/or practical experience of some parts of the syllabus. Lecturers should utilise this, through group work and other structured interactive activities, thus encouraging the sharing of knowledge which has the potential to lead to a better level of understanding.

The relation of theory and practice is a theme that will be reflected in the assessments for each unit and for the programme as a whole. Therefore, in structured learning and individual work, candidates should be aware of the requirement to develop a practical dimension to their understanding.

# QUALIFICATION LEVEL

PIABC Level 2 Award in Composite Manufacturing has been developed as a Level 2 qualification. When working for this qualification it is important to realise that evidence will be sought which demonstrates the following features:

**Level 2 Descriptor**

**Summary**
The descriptors set out the generic knowledge and skills associated with the typical holder of a qualification at Level 2. The level descriptors are framed as outcomes, and each category starts with a stem statement ("the holder can...") which then links into the outcomes associated with each level of the framework.

**Knowledge descriptor** (the holder...)
- Has knowledge and understanding of facts, procedures and ideas in an area of study or field of work to complete well-defined tasks and address straightforward problems.
- Can interpret relevant information and ideas.
- Is aware of a range of information that is relevant to the area of study or work.

**Skills descriptor** (the holder...)
- Select and use relevant cognitive and practical skills to complete well-defined, generally routine tasks and address straightforward problems.
- Identify, gather and use relevant information to inform actions.
- Identify how effective actions have been.

*Source: Ofqual Handbook: General Conditions of Recognition (Updated 20/02/2025)*

## QUALIFICATION STRUCTURE

The unit design of each unit includes an informative title, a level, a credit value, learning outcomes and assessment criteria. The assessment process is based on those learning outcomes and assessment criteria. The learning and teaching strategy must be designed so that candidates can meet the learning outcomes in an effective manner by demonstrating that they can achieve the assessment criteria.

To complete this qualification, candidates must complete the three mandatory units and a minimum of one optional unit.

| Mandatory/ Optional | Ofqual Unit Ref. | Unit Ref. | Unit Title | Level | GLH | TUH | Credits |
|---|---|---|---|---|---|---|---|
| M | M/651/6556 | CM1 | Introduction to Composite Materials | 2 | 7 | 7 | 1 |
| M | R/651/6557 | CM2 | Effective Engineering in Composite Manufacturing | 2 | 7 | 7 | 1 |
| M | T/651/6558 | CM3 | Curing Composite Components | 2 | 4 | 4 | 1 |
| O | Y/651/6559 | CM4 | Resin Infusion Techniques | 2 | 14 | 18 | 2 |
| O | F/651/6560 | CM5 | Introduction to Prepreg Techniques | 2 | 14 | 18 | 2 |
| O | H/651/6561 | CM6 | Composite Assembly | 2 | 14 | 18 | 2 |
| O | J/651/6562 | CM7 | Introduction to Wet Lay-Up Techniques | 2 | 14 | 18 | 2 |
| O | K/651/6563 | CM8 | Composite Repair | 2 | 14 | 18 | 2 |
| O | L/651/6564 | CM9 | Composite Mould Tool Production | 2 | 14 | 18 | 2 |
| Qualification Level | | | | 2 | | | |
| Minimum Guided Learning Hours (GHL) | | | | | 32 | | |
| Minimum Total Qualification Time (TQT) | | | | | | 40 | |
| Minimum Total Credits | | | | | | | 5 |

# UNIT CONTENT

## UNIT CM1 - INTRODUCTION TO COMPOSITE MATERIALS

Ofqual Unit No: M/651/6556
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 7
Unit Credits: 1

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes<br>*The candidate will:* | | Assessment Criteria<br>*The candidate can:* | |
|---|---|---|---|
| 1. | Understand the main constituents of a composite material | 1.1<br>1.2<br>1.3 | Identify the main purpose of the matrix and reinforcement<br>List the properties of four different resin and fibre types<br>Briefly describe the terms thermoplastic and thermoset in relation to resin systems |
| 2. | Understand common fibre forms used in composite manufacture | 2.1<br>2.2 | Identify the main properties of uni-directional (UD), Non-Crimped Fabric (NCF) and Chopped-Strand Mat (CSM)<br>List three common woven fabrics |
| 3. | Understand common composite manufacturing processes | 3.1<br>3.2 | List the benefits and challenges of four common manufacturing processes<br>State the purpose of orientation and the terms warp and weft |
| 4. | Understand the basic prepreg manufacturing process | 4.1 | Briefly describe a basic prepreg lamination process |
| 5. | Understand the importance of safety when working with composite materials | 5.1<br>5.2 | State the purpose of PPE and the most common types of PPE used in composite manufacture<br>List potential issues for the user and material if health & safety processes are not followed |

***Indicative Content***

**1. Understand the main constituents of a composite material**

- Fibre provides strength and stiffness, resin supports, protects and maintains the fibre orientation, resin transfers loads, imparts toughness and governs the service temperature of the component. Resin will maintain the shape of the component once cured
- Pros and cons of Polyester, Vinyl ester, Epoxy and Phenolic resins and give examples of where they are commonly used
- Pros and cons of Carbon, Glass, Aramid and High Strength Glass fibres and give examples of where they are commonly used
- Thermoset resins go through an irreversible change and cannot be remoulded, thermoplastics are processed using heat and can be heated, soften and remoulded

**2. Understand common fibre forms used in composite manufacture**

- Properties of fabric types: UD, strong, flat fibres, tightly packed together, Non-Crimped Fabric (NCF) Layers of UD stitched together in various orientations, Chopped Strand Mat (CSM) randomly orientated short fibres

- The differences in Plain, Twill and Satin weave types, their properties (how crimp effects strength and how the weave aids stability and drapability) and give examples of where they are commonly used

**3. Understand common composite manufacturing processes**

- The pros and cons of wet lay-up, resin infusion, Resin Transfer Moulding (RTM) and prepreg manufacturing processes and give examples of common sectors using the different manufacturing processes
- The terms warp and weft and how these relate to a role of fabric, the differences in warp and weft and how they can be identified. The importance of following a ply lay-up and how orientation affects the characteristics of a composite component

**4. Understand the basic prepreg manufacturing process**

- A basic prepreg lamination process (including ply kitting and orientation and lamination of plies).

**5. Understand the importance of safety when working with composite materials**

- Common forms of PPE used during composite manufacturing such as gloves, coveralls, lab coats, safety footwear, eye protection, Respiratory protection
- How PPE protects the user and the component from potential contamination
- Common Health and Safety issues such as skin contact, dust and cut risks and the associated issues that can arise from not protecting yourself from composite materials and processes

## UNIT CM2 - EFFECTIVE ENGINEERING IN COMPOSITE MANUFACTURING

Ofqual Unit No: R/651/6557
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 7
Unit Credits: 1

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes<br>*The candidate will:* | | Assessment Criteria<br>*The candidate can:* | |
|---|---|---|---|
| 1. | Understand the importance of working in a safe manner and following legislation and company safety procedures | 1.1<br>1.2<br>1.3 | List a minimum of four current health & safety legislation and their purpose<br>List four potential outcomes of not working in a safe manner<br>Identify appropriate PPE for three workshop tasks |
| 2. | Understand the importance of following manufacturing drawings and instructions | 2.1<br>2.2<br>2.3 | List 5 pieces of information from a basic drawing or manufacturing instruction document and explain why that information is important<br>State why processes should be signed off and the reason for periodic quality checks<br>State why documents such as Risk Assessments and COSHH assessments need to be available during manufacturing |
| 3. | Understand the importance of working in an organised, clean and tidy manner | 3.1<br>3.2<br>3.3 | State why it is important to check all tools and equipment before and after work is carried out<br>List three potential outcomes if tools and equipment are not returned to their correct locations<br>List three potential outcomes of not working in a clean organised environment |
| 4. | Understand the reasons for following company policies and procedures during manufacturing | 4.1<br>4.2<br>4.3 | Briefly describe the importance of following workplace policies and procedures<br>List the potential outcomes of not following workplace policies and procedures<br>Identify the importance of reporting any problems/issues to the appropriate person |
| 5. | Understand the importance of adopting a right first-time approach and being aware of company and customer standards | 5.1<br>5.2<br>5.3 | Briefly describe the importance of aiming for work to be completed right first time<br>List four potential outcomes of work not being produced to company or customer standards<br>State how safety implications can be linked to company and customer standards |

***Indicative Content***

**1. Understand the importance of working in a safe manner and following legislation and company safety procedures**

- Current health & safety legislation such as HASAWA, COSHH, Risk Assessments, RIDDOR, PUWER and cover the basic principles of each
- Potential outcomes of not working in a safe manner such as injury, death, damage to property, loss of income, potential lawsuits, reduced standard of living, loss of reputation etc.

- Common PPE - eye protection, respiratory equipment, safety footwear, body coverings, ear defenders, gloves. How PPE relates to the task risk assessment and where PPE may be used.

**2. Understand the importance of following manufacturing drawings and instructions**

- Pieces of information from manufacturers drawings/instructions such as Size, shape, ply stacking sequence, orientation, ply joints, core placement, materials to be used, consumables to be used, cure information, debulking sequence etc. Understand why these are important and potential problems that could occur if manufacturing instructions are not followed
- Importance of process steps being signed off and why periodic QC checks should be carried out such as knowing which stage the manufacturing process is at, having recorded documentation on who has carried out the tasks, work is being checked as the manufacturing is carried out, any faults or issues are captured early, general good practice etc.
- Health & safety documentation should be available to the persons producing the part, discuss Risk Assessments, COSHH assessments etc. and how these are in place to ensure the manufacturing process is as safe as possible, and the manufacturing team need to know where to access the relevant safety information and have the responsibility to follow the assessments to ensure safe use for them and others around them

**3. Understand the importance of working in an organised, clean and tidy manner**

- The importance of checking tools before and after use to include safety checks to ensure there is no damage to the tools before using, selecting the correct tool for the job returning tools to the correct location for efficiency, ensuring they are accounted for so no tools are lost or potentially left in parts being manufactured (FOD), tools should be checked when returned to ensure no damage has occurred in use and if there is the tool is quarantined to avoid accidents or damage
- Understand why working in an organised, clean environment is important when it comes to composite manufacturing to include less chance of accidents, more efficient working, professional image, less chance of FOD and inclusions, less chance of mistakes

**4. Understand the reasons for following company policies and procedures during manufacturing**

- The reason for following workplace policies and procedures during manufacturing processes to include ensuring documentation is followed to ensure the component is manufactured to the appropriate standard and with customer satisfaction in mind, ensuring all work is completed to health & safety standards, work to align with budget and time constraints, company standards and reputation to be upheld etc.
- Potential outcomes of not following company policies and procedures to include, sub-standard work, potential accidents and damage, delays or cost implications to company or customer, loss of reputation, potential disciplinary procedures etc.
- Importance of reporting issues and concerns with the appropriate people to include safety aspects, time and cost implications, making the customer aware early of any potential delays

**5. Understand the importance of adopting a right first-time approach and being aware of company and customer standards**

- Understand why “right first time” is important when it comes to manufacturing to include completing work to the correct standard (following drawings etc.) meeting deadlines, working within agreed costs, customer satisfaction, company reputation etc.

- The importance of working to company and customer standards including safety and industry standards, company reputation, customer satisfaction, potential legal issues if standards are not met
- How safety can be linked to customer and company standards especially in specific industries such as aerospace and how industry standards may be applicable to customers which means the manufacturer must be adhering to any relevant standards

## UNIT CM3 - CURING COMPOSITE COMPONENTS

Ofqual Unit No: T/651/6558
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 4
Unit Credits: 1

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes<br>*The candidate will:* | | Assessment Criteria<br>*The candidate can:* | |
|---|---|---|---|
| 1. | Understand the importance of correctly curing composite components | 1.1<br>1.2 | Briefly describe the importance of curing composite components<br>List the potential issues that could arise from not curing correctly |
| 2. | Understand the difference between ambient and elevated temperature cures and how these can be achieved | 2.1<br>2.2<br>2.3 | Outline the difference between ambient and elevated temperature cures<br>List three different methods of curing composite components<br>List the pros and cons between ambient and elevated temperature cures |
| 3. | Understand how the cure process with affect the properties of the composite component | 3.1<br>3.2<br>3.3 | Outline the basic change in polymer chains as the cure temperature increases<br>Briefly describe the term Tg and outline how this change depending on curing<br>Identify the term post cure and outline how this relates to the curing process |
| 4. | Understand the main stages of a composite cure cycle and the importance of each stage | 4.1<br>4.2<br>4.3 | Briefly describe the terms ramp up, intermediate dwell, dwell and cool down<br>Outline the basics of why out each curing step is carried out<br>List where the cure information can be obtained |
| 5. | Understand how to carry out cure cycles and how they can be monitored | 5.1<br>5.2<br>5.3 | Outline the process of setting up an ambient and elevated temperature cure<br>List any health & safety issues/concerns that need to be considered when completing any cure process<br>Outline how the cure profile could be monitored and recorded |
| 6. | Understand common problems that can happen during the curing process | 6.1<br>6.2<br>6.3 | List at least four potential problems that could occur during the curing process<br>Identify the potential outcomes of cures going wrong<br>State how the issues created due to incorrect curing could be resolved |

*Indicative Content*

**1. Understand the importance of correctly curing composite components**

- The importance of curing correctly to include achieving a solid component, keeping the desired shape, having the correct strength and temperature capabilities, being safe to handle and the ability to carry out post processing work (trimming, drilling etc.)
- Potential issues that could arise from incorrect curing such as the component being soft and tacky, not having the desired strength and temperature properties expected, over curing which could damage the resin and lead to brittleness and moisture absorption

**2. Understand the difference between ambient and elevated temperature cures and how these can be achieved**

- The difference between ambient and elevated temperature cures in basic terms, ambient temperature resins will have a chemical reaction and cure at room temperature, state most will have an ideal temperature range when manufacturing, elevated temperature will need additional heat to create the chemical reaction to facilitate the cure
- Different methods for curing composite components, curing at room temperature without added curing equipment, state that there may be different types of hardeners that can affect the cure to aid manufacturing (slow, medium, fast etc.). For elevated temperature cure the use of ovens, autoclaves, heated moulds and presses, IR heaters and the pros and cons of each
- Pros and cons of ambient and elevated temperature cures such as ambient is a cheaper process without the need for specialist equipment, but the component strength and temperature capabilities will be limited, the cure generally will not be accurately monitored so very difficult to know the cure profile. Elevated temperature components will generally have higher strength and temperature capabilities (depending on resin and cure profile), parts can be made quicker and depending on equipment the cure can be monitored and recorded but curing equipment can be expensive

**3. Understand how the cure process with affect the properties of the composite component**

- The crosslinking of the polymer chains in a thermoset resin will be greater at elevated temperatures which will generally give the component higher strength and temperature capabilities, however state that the manufactures Technical Data Sheet (TDS) should be followed to ensure curing is carried out to the resin's capabilities
- The term Tg Glass Transition Temperature, that this is basically the maximum use temperature of the resin, and the component will loss strength, shape and absorb moisture if the Tg is exceeded. Tg is generally higher with elevated temperature cure resins
- Post cures and how this can lead to higher strength and Tg, that post cures can be in the mould or sometimes the part can be free-standing, that generally the ramp up and cool down cycles will generally be much longer during a cost cure to prevent any damage to the resin and component

**4. Understand the main stages of a composite cure cycle and the importance of each stage**

- Terms ramp up, intermediate dwell, dwell and cool down in relation to a resin cure cycle
- The basic reason each curing step is carried out to include ramp up to allow everything to get to the required temperature (oven, part, tooling etc.) to allow the resin to flow when required, intermediate dwell (not always used) to allow everything to get to the required temperature to allow the resin to flow and at this point any trapped air or

volatiles are easier to be removed, dwell will be the time and temperature required to allow the polymer chains to complete the crosslinking process to lead to a solid component, cool down is important to allow the part to cool at a pre-determined rate to avoid thermal stresses in the part
- Cure information can be found on manufacturers Technical Data Sheet (TDS)'s but that some companies will do their own trials and testing to get accurate information

**5. Understand how to carry out cure cycles and how they can be monitored**

- The process of setting up a cure ambient temperature cure and elevated temperature cure to include correct mixing ratios and required hardeners etc. observing pot life and gel time. For elevated temperature cures how to set up heating equipment adhering to manufactures cure profile information
- Health & safety concerns such as correct PPE for handling resins (gloves, eye protection, coveralls, safety shoes, respirators if required) and PPE required for handling parts going into ovens etc. (Gloves, eye protection, coveralls, safety shoes). Ovens and other heating equipment should only handle at low temperatures to avoid burn hazards and should not be handled at cure temperatures. Potential need for extraction during some cure cycles
- Thermocouples and how these can be used to monitor cure profiles and how these can be linked to readers that can record the cure profile for accuracy

**6. Understand common problems that can happen during the curing process**

- Potential cure problems such as temperature fluctuations, equipment failing during cure, not following manufacturers Technical Data Sheet (TDS)'s, programming wrong cure, curing too quickly or to the incorrect temperature which could all lead to incorrect cure or damaged components
- Outcomes of incorrect cures such as, components not cured or over cured which would lead to the components not having the expected properties
- Incorrect cures could be resolved, secondary cures may resolve the issue, or the component may have to be scrapped/quarantined, if unsure testing would have to take place to ensure the correct properties have been achieved

**UNIT CM4 - RESIN INFUSION TECHNIQUES**

Ofqual Unit No: Y/651/6559
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 14
Unit Credits: 2

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes *The candidate will:* | | Assessment Criteria *The candidate can:* | |
|---|---|---|---|
| 1. | Understand the basic principles of the resin infusion process | 1.1 | Outline the infusion process and the importance of vacuum and atmospheric pressure on the process |
| 2. | Understand the use of the essential equipment required to carry out an infusion | 2.1<br>2.2<br>2.3 | List the main considerations when choosing a vacuum pump<br>Select an appropriate resin catchment system<br>Identify the potential benefits and challenges of having a resin infusion station |
| 3. | Understand how to plan and execute a basic small infusion to produce a component | 3.1<br>3.2<br>3.3 | Use appropriate consumables to ensure resin flow<br>Select an appropriate infusion strategy<br>Create a vacuum bag to the correct integrity |
| 4. | Understand the importance of material selection and use | 4.1<br>4.2<br>4.3<br>4.4 | Select the correct fibre and fibre format and laminate onto the mould surface<br>Prepare dry fabrics in a safe manner ensuring fibre orientation is correct<br>Obtain information on the selected resin via the material Technical Data Sheet (TDS)<br>Mix resins in a safe and correct manner |
| 5. | Understand common infusion faults and their potential causes | 5.1<br>5.2 | Identify common infusion faults<br>State the likely cause of the fault and how it could be avoided |
| 6. | Understand the importance of safety when using resin infusion | 6.1<br>6.2 | Select and use appropriate PPE<br>Follow appropriate health & safety policies and use any equipment deemed necessary for health & safety |

***Indicative Content***

**1. Understand the basic principles of the resin infusion process**

- The general principle of resin infusion to include dry fibre placement, specific resin infusion vacuum bag consumables, the purpose of the vacuum bag and the importance of vacuum integrity when it comes to the infusion process. How atmospheric pressure aids the infusion process, resin inlet and vacuum outlet and how they aid resin being drawn through the fibres

**2. Understand the use of the essential equipment required to carry out an infusion**

- Different vacuum pumps and considerations when choosing an appropriate pump, vacuum level, volume of air removed, size and capability of pump etc.
- The importance of having a resin catchment system, size and type of catchment (catch pot, bag etc.) catch pot liners, issues that could arise if no catchment system is in place
- Types of resin infusion station and considerations when choosing the equipment (size, capability, number of vacuum lines etc.)

**3. Understand how to plan and execute a basic small infusion to produce a component**

- Apply dry fibres to a tool surface following drawings/ply stacking sequence
- Select an appropriate infusion strategy and apply vacuum bag consumables accordingly
- Create a vacuum bag that conforms to the shape of the part and achieves correct vacuum integrity
- Mix resin and infuse component

**4. Understand the importance of material selection and use**

- The properties of infusion/injection resins (lower viscosity, longer pot life etc.) and potential issues if infusion/injection resins are not used
- How fibre architecture can affect the infusion process such as woven forms being easier to infuse than Uni-directional due to the gaps in fibre bundles that are created in the weaving process
- How to handle dry fabrics, ensuring personal safety and reducing the risk of contamination
- Marking out plies to ensure the correct shape, size and orientation is achieved
- Reading a resin Technical Data Sheet (TDS) and obtaining the correct mixing ratio, which hardener should be used, the pot-life and recommended cure cycle
- Mix resins safely using correct PPE and equipment, ensuring mixing ratio is correct, recommended mixing times are adhered to, and any waste resin is disposed of correctly while being aware of exotherm risks

**5. Understand common infusion faults and their potential causes**

- Resin infusion faults such as: bridging, poor consolidation, resin rich areas, dry spots, poor wet-out, incomplete infusion
- Likely causes of resin infusion faults such as poor lamination of plies, poor vacuum bagging (bag too small, incorrect consumables used, not adjusting bag correctly, leaking vacuum bag), Poor infusion strategy, incorrect selection of resins/hardeners, race tracking

**6. Understand the importance of safety when using resin infusion**

- Select and use the correct PPE such as lab coats/coveralls, gloves when handling release agents, resins and dry fabrics etc, eye protection when mixing and using resins etc. safety footwear in the workshop environment
- Follow company policies and procedures, use additional equipment that reduces health & safety risks (extraction, correct waste receptacles)

## UNIT CM5 – INTRODUCTION TO PREPREG TECHNIQUES

Ofqual Unit No: F/651/6560
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 14
Unit Credits: 2

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes *The candidate will:* | | Assessment Criteria *The candidate can:* | |
|---|---|---|---|
| 1. | Understand the basic principles of the prepreg manufacturing process | 1.1 | List the three stages of prepreg manufacture (lamination, consolidation, cure) |
| | | 1.2 | Outline the benefits and challenges of using prepreg to manufacture components |
| 2. | Understand the importance of handling and storing prepreg materials | 2.1 | Identify how a prepreg material should be stored |
| | | 2.2 | Briefly describe the terms shelf life and out life |
| | | 2.3 | Outline how to thaw prepreg material and the potential issues if not done correctly |
| | | 2.4 | Outline how shelf life and out life can be monitored and the importance of this |
| 3. | Understand the importance of the environment when using prepreg materials | 3.1 | List three factors that need to be constant in a clean room |
| | | 3.2 | Outline why keeping track of prepreg backers is important |
| | | 3.3 | Outline why the environment should be clean and clutter free |
| | | 3.4 | Identify how PPE protects the user and the material |
| 4. | Understand the role of the consolidation during prepreg manufacturing | 4.1 | Briefly describe the term de-bulk and state two reasons for this process |
| | | 4.2 | Select and use appropriate consumables for a de-bulk bag |
| | | 4.3 | Select and use appropriate consumables for a cure bag |
| | | 4.4 | State how to complete a vacuum bag “drop check” and state why this is required |
| 5. | Understand the importance of correct curing in relation to prepreg materials | 5.1 | List the three stages of a prepreg cure cycle |
| | | 5.2 | Briefly describe the terms ramp rate, dwell, cool down |
| | | 5.3 | State the potential problems if the cure cycle is not followed |
| | | 5.4 | Briefly describe the terms shelf-life, out life, cure profile (including ramp up, dwell and cool down) and glass transition temperature (Tg) from a prepreg Technical Data Sheet (TDS). |
| 6. | Understand how to plan and produce a basic multi ply prepreg component | 6.1 | Cut plies to ensure they are the correct size, shape and orientation |
| | | 6.2 | Laminate a 3D part to include lap and butt joints |
| | | 6.3 | Create de-bulk and cure bags |
| | | 6.4 | Follow a basic component drawing |
| | | 6.5 | Cure the part using an oven following material Technical Data Sheet (TDS) |
| 7. | Understand common prepreg faults and their potential causes | 7.1 | List common prepreg faults |
| | | 7.2 | Identify the likely cause of the faults and how it could be avoided |

***Indicative Content***

**1. Understand the basic principles of the prepreg manufacturing process**

- Three stages of prepreg manufacture lamination via hand or automated, consolidation via vacuum bag, autoclave or press, cure via oven, autoclave, press, heated tooling etc.
- The benefits of using prepreg to manufacture components such as repeatability, accurate fibre to resin ratio, accurate thickness and weight control, clean working conditions, high fibre content and strong components
- The challenges of using prepreg to manufacture components such as material life and out life, having to be stored frozen, cost implications, labour intensive process, cost of curing (especially with autoclaves)

**2. Understand the importance of handling and storing prepreg materials**

- Prepreg material should be stored frozen, generally at -18C, ideally freezers should be monitored for any temperature fluctuations and the information should be logged
- Prepregs come with a predetermined shelf life and the Date of Manufacture should be noted. Out life is the time it can be out of the freezer and still usable. This information should be on the Technical Data Sheet (TDS)
- Prepregs should be thawed to include: inside a sealed bag to avoid moisture ingress from condensation, time to thaw will vary with the amount of prepreg required to thaw (especially in roll format). If moisture gets into the prepreg this will expand during the cure cycle leaving voids in the part which will lead to weakness
- Importance of prepreg monitoring documentation to ensure out life is accurately recorded

**3. Understand the importance of the environment when using prepreg materials**

- The importance of working in a clean room when it comes to working with prepregs and how the environment should be consistent: temperature, humidity, cleanliness, lighting, pressure, filtered airflow. Potential effects of not working in a regulated clean room
- How to carry out a ply count back and why it is important to keep a track of prepreg backers and the faults that can be caused by backers being left it the component
- The importance of keeping the work area clean, tidy and clutter free to reduce the risk of FOD in parts, state how tools should be stored and accounted for
- Common forms of PPE used during prepreg manufacturing such as gloves, coveralls, lab coats, safety footwear, eye protection, Respiratory protection
- How PPE protects the user and the component from potential contamination
- Common Health and Safety issues such as skin contact, dust and cut risks and the associated issues that can arise from not protecting yourself from prepreg materials and processes

**4. Understand the role of the consolidation during prepreg manufacturing**

- Term de-bulk and it’s use for removing volatiles and air and how it aids consolidation of plies
- Select and use appropriate vacuum bagging consumables for a de-bulk bag, such as perforated release film to aid the withdrawal of air and volatiles, breather fabric to help communicate vacuum across the component, tacky tape and vacuum bag. All consumables need to be compatible with the materials used and any temperatures that will be encountered
- Select appropriate vacuum bagging consumables for a cure bag such as peel ply to leave a textured surface, solid release films to stop resin being drawn out of the part, breather fabric to help communicate vacuum across the component, tacky tape and

vacuum bag. All consumables need to be compatible with the materials used and any temperatures that will be encountered
- How to carry out a vacuum test on vacuum bags. Read peak vacuum level, know that a drop check is needed on a cure bag, and perform a drop check to ensure the vacuum bag is to the appropriate standard. Monitor the check and compare against acceptable vacuum loss requirement. Outline potential issues if the vacuum bag is not up to standard

**5. Understand the importance of correct curing in relation to prepreg materials**

- Three stages of a prepreg cure cycle to include ramp up, dwell and cool down
- Ramp up, dwell, cool down, intermediate dwell and post cure and what happens to the resin in prepreg during these stages.
- Potential problems if the cure is not followed correctly such as, incorrect flow of resin, incomplete cure, over cure and thermal shock
- Shelf-life, out life, cure profile (including ramp up, dwell and cool down) and glass transition temperature (Tg) from a prepreg Technical Data Sheet (TDS).

**6. Understand how to plan and produce a basic multi ply prepreg component**

- Cut plies to ensure they are the correct size, shape and orientation and all plies are marked accordingly
- Laminate a 3D part to include lap and butt joints, incorporating good lamination techniques such as correctly reading ply markings, draping, using masks and correct alignment
- Create de-bulk and cure bags using appropriate consumables and carrying out a drop check to pre-determined tolerances
- Follow a basic component drawing and complete a quality control sheet ensuring component drawing is followed correctly and signatures are completed at the correct stages of manufacture
- Load parts into an oven or autoclave and programme as per manufacturers Technical Data Sheet (TDS) to include ramp up, dwell and cool down

**7. Understand common prepreg faults and their potential causes**

- Common prepreg faults such as: bridging, poor consolidation, material contamination (banned items in the cleanroom, incorrect thawing etc.), FOD (glove tips, backing papers etc.), wrinkles, missed plies, incorrect lay-up (plies not in correct location, incorrect ply joins etc.), incorrect cure cycle
- Likely cause of the above and how this can be avoided/rectified
- How QC documentation can help prevent the above

**UNIT CM6 - COMPOSITE ASSEMBLY**

Ofqual Unit No: H/651/6561
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 14
Unit Credits: 2

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes<br>*The candidate will:* | | Assessment Criteria<br>*The candidate can:* | |
|---|---|---|---|
| 1. | Understand different ways of joining materials and which processes are predominately used to join Composite assemblies | 1.1<br>1.2 | Outline the differences between mechanical fixing, bonding and fusion joining<br>List the pros and cons of joining composites by mechanical fixings and bonding |
| 2. | Understand the different types of mechanical fastenings commonly used with composites and the processing required | 2.1<br>2.2<br>2.3 | List five mechanical fixings and state why they would be used<br>Outline common problems that can occur when using mechanical fixings<br>Identify potential issues that can occur from processing components in readiness to accept mechanical fixings |
| 3. | Understand the importance of correct processes and equipment when preparing components for mechanical joining (drilling etc.) | 3.1<br>3.2<br>3.3 | State the potential outcome if using standard drill bits etc. to work with carbon<br>Outline how to drill correctly to avoid break out, peel up etc.<br>Identify appropriate equipment to prepare composite components for mechanical joining |
| 4. | Understand the benefits and challenges of bonding composite components and the processing required | 4.1<br>4.2<br>4.4 | Outline the difference between adherend and adhesive<br>State the importance of cleanliness and preparation when bonding<br>List different ways in which you can prepare the surfaces in readiness for bonding |
| 5. | Understand the importance of the correct PPE and equipment during joining processes | 5.1<br>5.2 | Select and use appropriate PPE for composite joining processes<br>Select and use appropriate safety equipment for composite joining processes |
| 6. | Understand how to plan and carry out joining composite components together using mechanical and bonding techniques | 6.1<br>6.2<br>6.3<br>6.4 | Prepare all surfaces due to be bonded<br>Mark out and drill holes for mechanical fastenings<br>Mix and apply adhesives as per drawings and adhesive Technical Data Sheet (TDS)<br>Correctly insert and tighten mechanical fastenings |

***Indicative Content***

**1. Understand different ways of joining materials and which processes are predominately used to join Composite assemblies**

- Different joining methods mechanical, physical and chemical and give examples of each mechanical (nuts and bolts) Physical (Welding) Chemical (bonding)
- Pros and cons of joining composite components by mechanical fixings. Pros include being a known, proven method, many fixings to choose from, enables components to be removed easily. Cons can be many fixings require drilling of components which compromises strength, potential mismatch of materials, added weight and streamline issues
- Pros and cons of joining composite components by adhesive bonding such as no drilling of fibres required retaining original strength of component, less weight, more streamlined, lower part count, potentially less cost. Cons, difficult to disassemble components once bonded, difficult to determine bond strength apart from destructive testing

**2. Understand the different types of mechanical fastenings commonly used with composites and the processing required**

- Mechanical fixings such as nuts and bolts, rivets, screws, bonded inserts, threaded inserts, anchor nuts
- Different types of bolts such as hex head, socket head, button head, counter sunk socket and different nut types such as hex head, Nyloc locking nuts, wing nuts, castellated nuts and different washer types such as flat washers, serrated lock washers, spring washers
- Where above would be used and why that type of fixing may have been chosen
- Common faults when using mechanical fixings such as added weight, loss of streamlining, galvanic corrosion, potential micro cracking, potential crush damage of components if too tight, risk of loosening if not done up correctly or maintained effectively
- Potential problems that can occur from processing components in readiness for mechanical fixings such as delamination, break out and peel up from drilling, incorrect angle when drilling leading to elongation, generating too much heat, incorrect size or location of hole

**3. Understand the importance of correct processes and equipment when preparing components for mechanical joining (drilling etc.)**

- Recommended drill bits (PCD, carbide, dagger etc) for drilling composite components (especially carbon) and the potential problems of using standard drill bits for carbon such as rapid wear which generally results in excessive pressure used, excessive heat and poor-quality holes
- Using back up blocks to avoid break out when drilling, explain why high speed-low feed is important when drilling to avoid peel up and break out. How to drill perpendicular to the panel and tools that can be used to aid this
- Equipment that can be used to prepare surfaces for bonding, such as DA sanders, blasting, etching. The importance of careful preparation so additional damage is not created to the component during the process. Must be more careful with composite materials compared to metallic materials

**4. Understand the benefits and challenges of bonding composite components and the processing required**

- The adhered is the parent materials being bonded and that the adhesive is the material bonding the parts together
- Important the cleaning process is when it comes to adhesive bonding, state that pre-cleaning is vital to remove any contaminates before any preparation commences and there will be various cleaning stages during the process to ensure a good bond. If a surface is not clean or contaminated, then the bond will be comprised. There are many different cleaning agents available, and the correct one must be chosen and used according to company documentation
- Importance of correct preparation in relation to composite materials and the importance of using the correct type and grade of abrasive to ensure no additional damage is created. The need to continually check the preparation process to ensure it is completed to the correct standard
- The water break test and how this gives a good indication of surface prep, ensure candidates are aware that there should be a drying cycle after a water break test
- Mixing ratio, correct hardener to be used, pot life, surface preparation, cure time, handling time information from an adhesive Technical Data Sheet (TDS)
- Different ways of preparing surfaces using equipment such as vapour blasting using sanders and grinders to hand sanding and the pros and cons of each

**5. Understand the importance of the correct PPE and equipment during joining processes**

- Select and use appropriate PPE during joining processes to include: safety shoes, coveralls, eye protection, hearing protection, gloves and respiratory equipment. Importance of PPE and the potential outcomes if not used such as: injury/damage to user, injury/damage to co-workers, potential legal action, loss of reputation, delay to customer
- Safety equipment that may be used during joining processes such as: extraction, tool guards, safety screens etc

**6. Understand how to plan and carry out joining composite components together using mechanical and bonding techniques**

- Prepare surfaces due to be bonded to include pre-cleaning, de-burring, preparation of bond area using appropriate techniques and abrasives
- Marking out drill holes following drawings using appropriate methods such as chinagraph pencils, approved marker pens, laying down masking tape and marking on to the tape etc.
- Mix and apply adhesives after obtaining information from the manufacturers Technical Data Sheet (TDS), apply adhesives using dispensing guns and hand mixing and applying
- How to insert mechanical fastenings to include using the correct type and size (as directed by drawings), how to tighten, correct tightening sequences, torque settings etc.

## UNIT CM7 – INTRODUCTION TO WET LAY-UP TECHNIQUES

Ofqual Unit No: J/651/6562
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 14
Unit Credits: 2

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes<br>*The candidate will:* | | Assessment Criteria<br>*The candidate can:* | |
|---|---|---|---|
| 1. | Understand the basic principles of wet/hand lay-up process | 1.1 | Outline the main stages of wet lay-up manufacture (prep, apply and wet out fibres, consolidation, cure) |
| | | 1.2 | List the benefits and challenges of using wet lay-up to manufacture components |
| 2. | Understand how to prepare tool surfaces in readiness for wet lay-up manufacturing | 2.1 | Checks on tooling to ensure they are free from dirt and damage |
| | | 2.2 | Application of release agents following manufacturers Technical Data Sheet (TDS) |
| 3. | Understand different materials and material types commonly used in wet lay-up | 3.1 | List the pros and cons of different fibre types |
| | | 3.2 | List the pros and cons of different resin types |
| | | 3.3 | Outline the differences of using different fibre formats such as Chopped-Strand Mat (CSM) and woven materials |
| | | 3.4 | State the use of gel and flow coats and how they can be applied |
| 4. | Understand how to plan and produce a basic component using wet lay-up methods | 3.1 | Use appropriate tools and equipment |
| | | 3.2 | Apply fibres ensuring they follow the contours of the tool surface |
| | | 3.3 | Correctly mix resin and apply to fibres ensuring correct wet out |
| | | 3.4 | Cure in an appropriate manner following manufacturers Technical Data Sheet (TDS) |
| 5. | Understand how vacuum bagging consolidation can support some wet lay-up processes | 4.1 | Select and use appropriate consumables for a vacuum bag |
| | | 4.2 | Outline how to complete a vacuum bag “drop check” and state why this is required |
| 6. | Understand the importance of the correct PPE and health & safety equipment during wet lay-up processes | 5.1 | Select and use appropriate PPE for wet lay-up processes |
| | | 5.2 | Select and use appropriate safety equipment for wet lay-up processes |

### *Indicative Content*

### 1. Understand the basic principles of wet/hand lay-up process

- The main stages of wet lay manufacture to include: Tool preparation, application of gel coats, preparation of fibres, mixing and applying resin to fibres, consolidation and curing and state the importance of each of these stages and the possible outcomes stages are not completed correctly
- The benefits and challenges of wet lay-up to include: cost-effective start-up costs, basic process, minimal equipment required, challenges include health & safety issues due to open mould process, difficult to achieve consistency, higher resin content

**2. Understand how to prepare tool surfaces in readiness for wet lay-up manufacturing**

- Carry out checks on tooling to ensure there is no damage or resin residue, surface finish is to the required standard and the tool has been released prior to lay-up
- Apply appropriate release agents following manufacturer's instructions ensuring the following is adhered to: Correct release agent used, correct number of coats, time between coats adhered to, time between final release coat and lay-up is followed, correct health & safety procedures followed

**3. Understand different materials and material types commonly used in wet lay-up**

- Pros and cons of different fibre types such as carbon, glass, aramid and natural fibres
- Pros and cons of different resin types such as Polyester, Vinyl ester and Epoxy
- Differences of different fibre formats such as CSM, surface tissue, plain and twill weave fabrics, why they are used and how they conform to geometries
- Why gel coats are used and their purpose, the difference between Polyester, Vinyl ester and Epoxy gel coats, how they can be applied (brush, roller, spray) and when they are ready to be laid up on. Flow coats and their purpose to include decorative and protective

**4. Understand how to plan and produce a basic component using wet lay-up methods**

- Produce a product using the appropriate tools and equipment such as brushes, consolidation rollers, mixing scales, extraction (if required) and PPE including coveralls, gloves, safety footwear, safety glasses and respirators (if required)
- Apply appropriate fibres (following drawings/specifications) such as CSM or woven fabrics, glass, carbon, aramid or natural etc. following the contours of the tool surface
- Select the correct resin (as directed by the drawings/specifications) mix following the resin Technical Data Sheet (TDS) and following safety procedures and wet out the fibres ensuring all fibres are wetted out without excess resin being used
- Resin is cured in an appropriate manner (as directed by the drawings/specifications) and as directed by the resin Technical Data Sheet (TDS), this could be an ambient or elevated cure

**5. Understand how vacuum bagging consolidation can support some wet lay-up processes**

- Select and use appropriate consumables for a vacuum bag such as peel ply, perforated and solid release films, breather fabric, bleeder cloths, tacky tape and vacuum bag
- Ensure consumables are fit for purpose and are compatible with the resins being used and any temperatures that may be encountered during the curing process
- Carry out a drop check to a pre-determined tolerance and state the implications if the vacuum bag is leaking

**6. Understand the importance of the correct PPE and health & safety equipment during wet lay-up processes**

- Select and use appropriate PPE for wet lay-up processes to include coveralls, eye protection, gloves, safety footwear and respirators, purpose of each and why they are important
- Use appropriate safety equipment such as extraction and when and where this would be required

**UNIT CM8 - COMPOSITE REPAIR**

Ofqual Unit No: K/651/6563
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 14
Unit Credits: 2

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes *The candidate will:* | | Assessment Criteria *The candidate can:* | |
|---|---|---|---|
| 1. | Understand different types of composite damage and how the damage can be detected | 1.1 | List a minimum of three types of common damage on composite components |
| | | 1.2 | State if the damage happened in service or during manufacture |
| | | 1.3 | List three different damage detection methods |
| 2. | Understand common repair methods used to repair composite components | 2.1 | List four common composite repairs |
| | | 2.2 | List three repair methods and state the type of damage they would correct |
| 3. | Understand the importance of selecting and using the appropriate materials when completing repairs | 3.1 | List two resin systems for standard repairs |
| | | 3.2 | List three fibre types and forms for Standard Repairs |
| | | 3.3 | Identify the terms warp, weft & selvedge |
| 4. | Understand how to plan and carry out 3 repairs to include stepped, scarf and cosmetic (scratch) repair | 4.1 | Select and use the correct fibre and fibre form for the repair |
| | | 4.2 | Select, mix and use the correct resin type for the repair |
| | | 4.3 | Prepare the repair area to the required standard |
| | | 4.4 | Prepare and apply the correct materials (fibre, resin, filler etc.) to achieve the required repair |
| | | 4.5 | Ensure orientation (if appropriate) is correct following drawing specification |
| 5. | Understand how vacuum bags can support certain composite repair techniques | 5.1 | Select appropriate consumables to produce an effective vacuum bag |
| | | 5.2 | Create a vacuum bag to the correct size and shape |
| | | 5.3 | Complete a drop check on the vacuum bag |
| 6. | Understand the importance of safety when carrying out repairs | 6.1 | Select and use appropriate PPE |
| | | 6.2 | State appropriate health & safety policies and outline why PPE is necessary for health & safety |

***Indicative Content***

**1. Understand different types of composite damage and how the damage can be detected**

- Three types of common damage found on composite components such as, delamination, impact, inclusion
- Damage could be caused in service or during the manufacturing or post processing stages, such as inclusions could happen during manufacturing and may have to be repaired, break out and delamination could be caused by drilling and trimming etc. Impact, delamination, erosion could be caused by in service incidents
- Damage can be identified by visual inspection, tap testing and ultrasonic NDT and state the pros and cons of each type of detection method

**2. Understand common repair methods used to repair composite components**

- Common repair methods used to repair composite components such as cosmetic surface, injection, scarf and step repairs
- Pros and cons and what type of damage they would correct i.e. cosmetic surface repairs for minor surface defects but not for structural repairs, scarf and step repairs to correct deeper structural damage

**3. Understand the importance of selecting and using the appropriate materials when completing repairs**

- Resin systems used in composite repair such as Polyester and Epoxy and state that generally you will replace “like for like” or the resin type and grade will be specified by the approved repair procedure (depending on company and sector)
- Fibre types and forms used in composite repair such as Carbon, glass and aramid fibres and CSM, plain and twill weave fabric forms. Generally, you will replace “like for like” or the resin type and grade will be specified by the approved repair procedure (depending on company and sector)
- Terms warp, weft and selvedge, how these can be identified on a roll of woven fabric and why the warp fibre is generally used as the load bearing fibre. How the warp fibre should be marked during the fibre preparation process

**4. Understand how to plan and carry out 3 repairs to include stepped, scarf and cosmetic (scratch) repair**

- Select and use the correct fibre and fibre form for a stepped and scarf repair, fibres could be glass, carbon, aramid etc. and forms could be CSM, plain or twill weave etc. Choices should be based on replacing “like for like” or approved repair documentation
- Select, mix and use the correct resin and resin type for a stepped and scarf repair, resins could be polyester, vinyl ester, epoxy etc and could be ambient or elevated temperature cure. Choices should be based on replacing “like for like” or approved repair documentation
- Remove damaged material and prepare the repair area using the correct techniques (scarf or step) and selecting the correct tools (grinders, routers etc.) and using the correct grades of abrasives
- Prepare the materials in readiness for the repair process to include fibre preparation, resin preparation, filler mixing and application for a cosmetic repair. Ensure fibres are wetted out effectively for the type of repair being completed
- Ensure the repair with a woven fabric has the correct orientation as directed by the repair or original manufacturing drawing. The orientation should be marked when the plies are taken form the roll and checked when the repair patches are put onto the repair area

**5. Understand how vacuum bags can support certain composite repair techniques**

- Select appropriate consumables to produce an effective vacuum bag that will improve consolidation and withdraw excess resin to achieve a higher fibre to resin ratio to include peel ply, perforated release film, bleeder materials, solid release film, breather fabric, tacky tape and vacuum bag
- Layup consumables in the correct sequence/size to ensure maximum benefit from the vacuum bagging process
- Ensure consumables are fit for purpose and are compatible with the resins being used and any temperatures that may be encountered during the curing process
- Carry out a drop check to a pre-determined tolerance. Implications if the vacuum bag is leaking

## 6. Understand the importance of safety when carrying out repairs

- Select and use appropriate PPE to include coveralls, gloves, safety footwear, eye protection, respirators, ear defenders etc. and state the likely outcomes if incorrect or lack of PPE is used
- Follow company health & safety policies and ensure any additional equipment (such as extraction) are used in the correct manner to reduce health & safety risks

## UNIT CM9 - COMPOSITE MOULD TOOL PRODUCTION

Ofqual Unit No: L/651/6564
Unit Level: 2
Grading Structure: Pass

Guided Learning Hours: 14
Unit Credits: 2

To gain this unit, the candidate must meet the following learning outcomes:

| Learning Outcomes<br>*The candidate will:* | | Assessment Criteria<br>*The candidate can:* | |
|---|---|---|---|
| 1. | Understand the purpose of the mould tool in relation to composite manufacture | 1.1<br>1.2 | Identify the main purpose of the mould tool when manufacturing composite components<br>List three considerations when choosing a mould tool to use for manufacturing |
| 2. | Understand the basic principles of manufacturing a composite tool and associated terminology | 2.1<br>2.2<br>2.3 | Briefly describe the terms plug/pattern/master and how this relates to manufacturing a composite tool<br>List the steps in making a mould tool<br>Identify four considerations when designing a mould tool |
| 3. | Understand different materials that mould tooling could be made of and considerations to be considered when making that decision | 3.1<br>3.2 | List a minimum of five different materials that mould tools could be made from<br>Identify some considerations when making the decision of which material would be best for the mould tool |
| 4. | Understand different types of tooling commonly used in composite manufacture | 4.1<br>4.2 | Identify internal and external tooling and state why each may be used<br>State the purpose of one piece or multi-part tooling and considerations when choosing which would be appropriate |
| 5. | Understand how to prepare a mould tool before manufacturing a composite component | 5.1<br>5.2<br>5.3 | List three checks that should be carried out prior to using a mould tool<br>Identify different release agents that could be used on the mould tool and considerations when choosing<br>Outline common problems that could occur from not releasing a mould tool correctly |
| 6. | Understand the manufacturing of a basic composite mould tool from an existing component | 6.1<br>6.2<br>6.3<br>6.4 | Prepare existing component and base board<br>Choose appropriate materials to produce the mould tool<br>Prepare resins and fibres and apply to the component<br>Cure, demould and inspect mould tool |
| 7. | Understand different ways of manufacturing a plug for a new component | 7.1 | List a minimum of three ways to produce a plug to produce a mould tool |

*Indicative Content*

**1. Understand the purpose of the mould tool in relation to composite manufacture**

- The mould tool is to support the fibre and resin in a pre-determined shape until the resin has cured and then the composite component will keep its form
- Considerations when a mould tool such as, accuracy, surface finish, durability, temperature range, cost etc.

**2. Understand the basic principles of manufacturing a composite tool and associated terminology**

- To manufacture a composite mould tool a plug (often referred to as a master or pattern) is required to lay the material onto to create the shape
- If making a metallic mould tool this could be directly machined, if making a composite mould tool this would require a plug or an existing component and this may be a multi-stage process if the plug is not to the required standard or if modifications need to be made
- Considerations when designing a mould tool such as, accuracy, surface finish required, if it will be used with vacuum bagging processes (does it need a flange area?) geometry (does it have undercuts, is there a draft angle etc.) size of mould tool (does it need a backing structure to keep its shape?) etc.

**3. Understand different materials that mould tooling could be made of and considerations to be considered when making that decision**

- Different materials mould tools could be made from such as, wood, MDF, GRP, CFRP, Tooling block, metallics such as steel, aluminium, Invar etc.
- Considerations when choosing an appropriate material to produce a mould tool such as, cost, compatibility, durability, accuracy, thermal stability and CTE, surface finish

**4. Understand different types of tooling commonly used in composite manufacture**

- Internal and external tooling and why these may be selected i.e. surface finish, ease of manufacture etc.
- One piece tooling is easier to produce and make air-tight but restricts the shape of the part (any undercut or negative draft angle would result in lock-in). Multi part tooling allows complex shapes to be produced but the tools are more difficult and costly to produce, and sealing methods must be considered if vacuum bagging processes are to be used

**5. Understand how to prepare a mould tool before manufacturing a composite component**

- Three checks that should be carried out before using a mould tool to include checking mould tools are complete and do not leak air (if multi-part tooling), ensuring there is no damage to the mould tool, checking for dirt, debris, resin residue etc. and ensuring the mould tool has been released
- Different release agents that can be used on a mould tool, such as release films, PVA, waxes, chemical and water-based release agents and considerations when choosing such as, temperature range, compatibility, cost, health & safety implications, number of pulls etc.
- Common problems that could occur from poor release such as difficulty in releasing part, poor surface finish, damage to component and/or tool, scrappage of component and/or tool, loss of time and/or profit, failure to meet deadlines, expensive rework of component and/or tool, health & safety risks to operative

**6. Understand the manufacturing of a basic composite mould tool from an existing component**

- Prepare existing component ensuring compatibility with materials to be used (coat if required), apply appropriate release agent to component and base board, use filleting wax to seal component to base board
- Choose appropriate materials for mould tool i.e. CSM and Polyester resin for a basic low temperature mould tool
- Prepare fibres and mix resins as required, apply gel coats and surface tissue (if applicable) then fibres and resin to get the desired strength required for the mould tool
- Cure the mould tool and remove original component and check mould tool for any defects

**7. Understand different ways of manufacturing a plug for a new component**

- Different ways of producing a plug for a new component such as, shaping from foam or wood, machining from a solid material, modifying an existing part etc.

# ASSESSMENT & GRADING

PIABC Level 2 Award in Composite Manufacturing is assessed by completing theory tests and practical assessments depending on the units chosen.

**Mandatory Units (CM1, CM2 & CM3)**

These mandatory units are assessed by multiple choice questions test papers with a pass mark of 70%. The pass threshold of these mandatory units is not subject to change.

These tests should be designed for a holistic approach to the assessments and confirm learners have a full contextualised understanding of all the assessment criteria.

**Optional Units (CM4, CM5, CM6, CM7, CM8 & CM9)**

The optional units are assessed by a practical assessment (with additional questioning where appropriate) to confirm competence and have no grading; candidates need to pass all assessment criteria.

These assessments should be designed for a holistic approach to the assessments and confirm learners have a full contextualised understanding of all the assessment criteria. The assessments should be monitored and evaluated by the centre to ensure a consistent skills standard is maintained.

The tests and practical assessments are set, internally assessed and internal quality assured by the centre.

Both assessment methods and their management are externally quality assured by PIABC. A sample selection of the tests/assessments will be externally quality assured by PIABC. For each cohort a sample selection will be external quality assured by PIABC. The sample selection will be determined by PIABC in line with its centre assessment standard strategy and external quality assurance sampling policy. This will be undertaken before qualification certification.

PIABC's centre assessment standard strategy will ensure that all centre devised and marked assessments remain fit for purpose and that criteria against which candidates' performance is differentiated are being accurately and consistently applied for this qualification.

# QUALIFICATION CERTIFICATION

This is not a graded qualification, and the full award is only available at *Pass* to candidates who successfully complete the qualification.

# FURTHER INFORMATION

Please contact PIABC Limited directly at:
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