

# **T Level Technical Qualification in Engineering, Manufacturing, Processing and Control (8713-33)**

## **Composites Manufacturing Technologies (333)**

### **Guide Standard Exemplification Material**

### **Distinction – Sample 2022**

**First teaching from September 2022  
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## Introduction

The sample assessment materials within this document refers to the Composite Manufacturing Technologies sample occupational specialism assignment. The aim of these materials is to provide centres with examples of knowledge, skills and understanding that attest to distinction grade.

The examples provided do not reflect all evidence from the sample assignment as the focus of this material is the quality and standards that need to be achieved rather than the volume of exemplar evidence provided. However, the examples provided are representative of all tasks in the sample assignment. The evidence presented here has been developed to reflect **distinction** grade within each task but is not necessarily intended to reflect the work of a single candidate. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and the standard of performance will vary across tasks. A distinction grade boundary will be based on a synoptic mark across all tasks.

The materials in this Guide Standard Exemplification Material (GSEM) are separated into the sections as described below. Materials are presented against a number of tasks from the assignment.

### Task

This section details the tasks that the candidate has been asked to carry out. What needs to be submitted for marking and any additional evidence required. Also referenced in this section are the assessment themes the candidates will be marked against when completing the tasks within it. In addition, candidate evidence that has been included or not been included in this GSEM has been identified within this section.

In this GSEM there is candidate evidence from:

- Task 1 - Planning
- Task 2 - Production
- Task 3 - Quality review and evaluation

### Candidate evidence

This section includes exemplars of candidate work, photographs of the work in production (or completed) and practical observation records of the assessment completed by centre assessors. This will be exemplar evidence that was captured as part of the assessment and then internally marked by the centre assessor.

Photographs in this GSEM demonstrate the full process that the candidate has undertaken to complete the spacer block assembly. Commentary sections detail where performance is considered to be at a level reflective of a distinction grade. Note, due to the nature of this process, not all individual work activities would provide opportunity to demonstrate a defined level of differentiation beyond a pass – but these images are shown in order to show the cohesiveness of the process being undertaken, and to draw out where differentiation is possible.

## Commentary

This section includes detailed comments to demonstrate how the candidate evidence attests to the performance standard of **distinction** by directly correlating to the grade descriptors for this occupational area. Centres can compare the evidence against the performance indicators in the marking grid descriptors within the assessor packs, to provide guidance on the standard of knowledge, skills and understanding that need to be met for **distinction**.

It is important to note that the commentary section is not part of the evidence or assessment but are evaluative statements on how and why that piece of evidence meets a particular standard.

## Grade descriptors

**To achieve a distinction, a candidate will typically be able to:**

Competently and thoroughly interpret technical information, applying technical skills to plan, assess risk and follow safe working methods to practical tasks and procedures to an exemplary standard in response to the requirements of the brief, producing an excellent quality of work that meets regulations and standards.

Thoroughly prepare working area, mitigating potential risks prior to commencing tasks and consistently apply exemplary housekeeping techniques during tasks.

Demonstrate exemplary technical practical skills in preparing moulds, shaping composite materials and cores, laying-up, debulking, consolidating, curing and de-moulding, assembling and finishing that are in line with industry standards and meet the requirements of the brief.

Demonstrate exemplary ability to follow laminating and assembly procedure to produce composite components to meet the requirements of the brief.

Demonstrate exemplary knowledge and understanding of the principles and processes required for composite engineering to produce a product that meets the required tolerances within the brief.

Work safely and make informed and appropriate use of tools, materials and equipment within the working environments for preparing moulds, shaping composite materials and cores, laying-up, debulking, consolidating, curing and de-moulding, assembling and finishing composite assemblies.

Identify causes and diagnose problems or common issues related to composites manufacturing and have a thorough understanding and the skills to be able resolve and rectify them.

Consistently and accurately use industry and technical terminology across different communication methods with full consideration of technical and non-technical audiences.

## **Task 1 – Planning**

**(Assessment themes: Health and safety, Planning and preparation)**

For task 1, candidates need to produce the following pieces of evidence:

- a resources list with justifications for the selections, and measuring equipment calibration check recorded
- a risk assessment
- a method statement with justifications
- a quality check sheet (for use in task 3b).

For task 1 candidates will be expected to produce a quality check sheet to use in task 3b during the quality inspection task. This is supporting evidence for assessors to gauge the candidate's planning skills and will not be marked.

No photographic or video evidence is required for task 1.

## Candidate evidence

### 1. Resources list with justifications for the selections, and measuring equipment calibration check recorded

Requirements and resources	Task	Quantity	Justification
<b>Tools/equipment/materials/consumables</b>			
Pen and paper	1	N/A	So that I can plan my work and add any notes needed for the job. I can also keep records of issues that I face and amendments that I want to make in the future.
Mould tool	2	1	The mould tool is what will produce the 'A' side of the assembly that is what will be the side that shows.
Mould tool scraper and preparation equipment	2	1 scraper (plus one spare blade)	The mould tool will inevitably have residue left on it from previous moulding exercises so this needs to be scrapped off with knife-edge tools and equipment.
Mould tool cleaner	2	1	To remove traces of grease or uncured resins from the mould tool. If not removed this residue will have an adverse effect on the quality of the 'A' side.
Lint free wipes	2	1 pack	In order to ensure that there is no airborne materials in the preparation area, lint free wipes should be used to ensure no FOD is present in the room.
Release agent	2	1	The carbon epoxy pre-preg will adhere to any surface that is not treated so a release agent such as Frekote, this needs to be applied in three coats to the entire surface in counter directions to ensure that the pre-preg does not stick.
Pre-preg carbon fibre 210g/sqm 2x2 twill weave 3K tow.	2	800mmx400mm	To produce the laminates. The roll needs to be removed from the freezer where it has been stored at -16°C to prevent it from curing. When it is thawed-out, I will cut from the roll of pre-preg, a piece of material a rectangle at least 800mmx400mm that I have marked out. I will then wrap the roll back up, fill out the record and place the roll back into the freezer so that it does start to cure.



Marking out equipment: waterproof pens, rule and protractor	2	1 of each	So that I can cut my plies in the correct orientation, I will mark on the material the warp and weft directions and then mark out the plies in accordance with the drawings in the brief.
Cutting tools suitable for cutting pre-cured material and core foam	2	1	I will use a pair of scissors to rough out the 800x400mm rectangle then I will mark out the actual plies and cut them with a craft knife.
Core material	2	51mmx121mm	I need to cut a section of core material at least 1mm oversize and then shape it to meet the dimensions on the drawing.
Moulding tools (Knerkers and rollers)	2	2	Various tools to ensure that the plies are consolidated onto each other, that there is no bridging or air spaces and that the plies are pressed into gaps and transitions.
Peel ply film	2	Roll	This I will use to ensure that the rest of the consumables do not stick to the moulding and it also produces a good surface for bonding to.
Breather fabric	2	Roll	This I will use to make sure that there is an air path to get the vacuum applied to the whole moulding, so that consolidation pressure acts on all areas.
Bagging film	2	Roll	This is needed to act as a barrier between the vacuum inside the bag and the outside environment so that consolidation occurs.
Tacky tape	2	Roll	Tacky tape is used to seal the vacuum bag to the mould to prevent ingress of air.
Vacuum Breach Unit (VBU)	2	1	The VBU allows the vacuum hose to be connected to the bag and a vacuum to be pulled causing consolidation of the moulding.
Vacuum hoses and pump	2	1 of each	The pump provides the vacuum consolidation pressure and I will use the hose to connect the VBU to the pump. The operation of the pump will be checked to make sure it can provide a high level of vacuum.
Negative pressure gauge	2	1	This piece of equipment allows me to measure the vacuum and see that it does not drop more than the specified amount in five minutes.
Curing oven	2	1	The curing oven allows me to set the temperature and time that the moulding and mould will be cured for. I

			can keep the vacuum applied during cure to ensure that the plies are well consolidated and stuck together.
De-moulding wedges and scrapers	2	1 each	The vacuum bag and other consumables will inevitably be stuck to the mould. The consumables can be peeled off but the moulding will need to be lifted out using a scraper to get a corner lifted and the wedge can be inserted. The mould is ceramic so will not be damaged in the process.
Abrading equipment and extraction	2	N/A	When it is cured the moulding will be too stiff to cut with scissors or knives so I will need to use abrasives to get the moulding to the required shape. The process of removing material means that airborne material is produced and these need to be removed.
Bonding agent	2	1	The bonding agent is a two part epoxy adhesive that will be mixed and applied to the prepared surface.
Clamps	2	4	These are needed to ensure that the mating surfaces are in close contact meaning that the upper and lower parts are bonded together.
Measuring equipment with calibration record and specification (metal rule, vernier calliper)	3	N/A	The measuring equipment is used to ensure that I have met the requirements of the specification and that the dimensions are correct. The equipment needs to have been calibrated to ensure that I can have an accurate assessment of whether I have completed the tasks to the required level.
Computer access	3	N/A	Needed to write up the report and to note all of the measurements once I have quality checked the workpiece to ensure it is in line with the drawing specification.
<b>Personal Protective Equipment (PPE)</b>			
Gloves (rigger and nitrile)	2	1 pair	Needed to protect hand from any cuts or scrapes when working on the safe edging and abrading activities. I also need nitrile gloves to ensure that I do not contaminate the workpieces.
Barrier cream	2	N/A	Needed to protect hands from harmful substances and to protect against dermatitis and other skin irritations. For example, when handling

			workpieces contaminated with Frecote or acetone.
Safety boots or safety shoes	All	1 pair	Needed to be worn in the workshop to prevent injury to feet if any objects are dropped and to ensure that you can change footwear to prevent dirt being tracked outside of the work area.
Overalls	All	1 pair	Needed to protect yourself and clothing from dirt and debris from the work carried out. Ensure no loose clothing is worn around the power tools due to risk of entanglement. To also create a 'clean room' environment to avoid contamination during composite manufacturing processes.
Safety glasses	2	1 pair	Needed to protect eyes from grinding dust.
<b>Technical Information/documentation</b>			
Assignment brief	All		Needed for the technical drawing and tolerances and assessment information. The drawings will form the basis of my planning so that I can work out what processes I need to use and in what order so that I can produce a part that meets the specification.
Calibration record	2 and 3		Needed to check that the equipment used is within calibration and up to date.
User manuals	2		For the oven, to enable the correct setting up and programming of the oven and achieving the correct temperatures.
Material Safety Data Sheets (MSDS)	1 and 2		The material data safety sheets will give me a reference so that I can ensure the correct PPE and processes are selected to protect myself, my peers and the environment.
Material Technical Data Sheets (TDS)	1 and 2		This document sets out how to handle the material, the properties that it has and information for the cure cycle.
Method statement	All		The method statement sets out what I need to do and the order that I need to do it in. Composites needs a methodical approach and a sequence of activities so that the quality requirements can be met.
Risk assessment	All		This is a document that I will prepare to record the risks and hazards that may present during the creation of the spacer block assembly. I will mitigate against the risks to reduce the likelihood of injury.
Safety Equipment Inventory	All		The inventory allows me to ensure that the correct health and safety equipment is available and that it is suitable for the application.
Quality check sheet	1 and 3		This is a document that I am going to prepare so that I can record the results of the quality check and evaluate whether the spacer block produced meets the specification.
<b>General Workshop resources</b>			

Waste disposal bins	All	Waste to be segregated to ensure all waste is disposed of correctly and to ensure materials can be recycled and hazardous substances are disposed of with registered waste carriers.
First aid kit	2 and 3	Needed in the case of any minor injury when carrying out the task.
Eye wash station	2 and 3	In case of any emergencies, access to an eye wash station to treat any eye incidents can minimise injury before seeking medical treatment.
Warning signs and notices	2 and 3	To inform people of required PPE requirements, fire exits, first aid information and any hazards in the workshop such as wet floors spillages etc.
Dust pan and brushes and spill kits	2 and 3	Needed to clean work area and to clear up any spillages that may occur.
Mop and bucket	2 and 3	To clean up any spillages and clean the work area once job has been completed.
<b>Calibration of measuring equipment</b>		
All measuring equipment has been checked for calibration against the workshop record. Last calibration date was November 2021.		

## Commentary

The candidate has carried out a thorough analysis covering all factors relevant to the brief with all justifications provided. They have applied their understanding to produce a comprehensive list of resources and methods required, demonstrating comprehensive technical knowledge of the requirements required for producing the composite assembly.

The candidate has indicated the amounts for each resource that they have planned to use and has given detailed justifications for their selections. The candidate has given longer justifications for their choice of processes, giving an indication of the intended use. The candidate has given consideration for other resources that should be available in the workshop, for example, access to a first aid kit and the provision of an eye wash station.

The candidate has recognised the need to refer to supporting technical documentation in order to complete the task. Specific elements are referenced that show the candidate's awareness of the areas of the task where technical documentation is most required, for example detail on the cure cycle and ensuring the correct preparation of the oven which is critical to the success of the curing.

The candidate has demonstrated planning for safe working by identifying the correct PPE and stating why each piece should be used, including providing guidance on what type of gloves should be used. For example, the use of nitrile gloves when handling composite materials to prevent contamination. They have included the use of a barrier cream to prevent dermatitis from handling materials with the substances such as acetone.

# 1. Risk assessment

## Mould preparation

Hazard	Risk	Control	Likelihood	Severity
Manual handling of moulds and tooling.	Musculoskeletal injury.	Observe MOHR. Avoid lifting weights that are too heavy for the individual. Use lifting equipment where practical and consider getting help from others to reduce the lift weight (team lifting). Ensure training has been given.	2	3
Reaction to chemical cleaners.	User is sensitive to chemical cleaners and develops a sensitisation to exposure on a spectrum from mild to very severe.	Test exposure to small amounts of chemicals to check for sensitisation e.g. Acetone. Limit, in all cases, exposure to chemicals by the use of PPE and adherence to COSHH.	2	4
Fumes and vapours	Respiratory irritation, headaches, dizziness, nausea, light-headedness from fumes given off from composite materials and resins.	Limit exposure to fumes by use of PPE (masks) and adherence to COSHH data sheets and recommended procedures. Ensure good workshop ventilation.	3	1
Use of sharp tools to prepare or scrape mould tool surfaces.	Cutting through skin with tools.	Only use sharp tools where other means of removing residue are not suitable. Use protective gloves and employ safe working practices.	3	2
Exposure to hot surfaces during or post mould preparation and drying.	Burns to hands or other body parts.	Ensure the temperature of materials and surfaces is assessed before they are touched. Thermally insulated gloves to be worn during handling of suspected hot materials.	2	2
Dropping of materials and tools onto body parts or feet.	Feet, fingers or other body parts are crushed by falling moulds.	Ensure adequate handling equipment and processes are in place and that PPE requirements are correctly	2	3

		identified and utilised, safety footwear is worn at all times. Ensure workstation is kept tidy and tools are managed and not allowed to pile up and get knocked off the workstation.		
Spillage of consumables.	Slip, trip or fall.	Ensure any spills are cleaned up correctly, waste disposed of and floor dried to prevent slippage. Signage used to warn others of wet floors. Ensure good housekeeping at all times.	2	1

### Production of the spacer block

Hazard	Risk	Control	Likelihood	Severity
Use of sharp tools to cut uncured materials.	Cutting through skin with tools.	Only use sharp tools where shears are not suitable. Use protective gloves and employ safe cutting practices on self-healing surfaces and protective mats.	3	2
Reaction to chemicals or resins.	User is sensitive to chemicals or resins and develops a sensitisation to exposure on a spectrum from mild to very severe.	Test exposure to small amounts of chemicals to check for sensitisation. Limit, in all cases, exposure to chemicals and resins by the use of PPE and adherence to COSHH data sheets and recommended procedures.	2	3
Use of sharp tools to prepare consolidation consumables.	Cutting through skin with tools.	Only use sharp tools where shears are not suitable. Use protective gloves and employ safe cutting practices on self-healing surfaces and protective mats.	2	3
Exposure to hot surfaces during or post-curing.	Burns to hands or other body parts.	Ensure the temperature of materials and surfaces is assessed before they are touched. Thermally insulated gloves to be worn during handling of suspected hot materials.	2	2

Use of scrapers and knife edge tools to remove mouldings from moulds.	Cuts or abrasions resulting from using sharp tools to de-mould laminates.	Use safe edge tools and wedges to remove mouldings from tools and where these are not suitable, ensure PPE is used, e.g. gloves.	2	2
Sharp edges of the mouldings left by the moulding process.	Cuts or abrasions resulting from coming into contact with sharp edges.	Wear PPE at all times e.g. mask and gloves, when handling mouldings and “safe-edge” the products. Use abrasives to remove the sharp edges as soon as possible after moulding is released.	2	3
Dust formed from removal of material using abrasive processes.	Inhalation of resin and short fibre material causing possible long-term health or respiratory issues.	Use of down-draught benches and LEV equipment. Wear correct PPE, a suitable mask and gloves must be selected and utilised.	2	3

Likelihood		Severity	
1	Very unlikely to happen	1	Minor injury
2	Unlikely to happen	2	Major injury
3	Possible to happen	3	Loss of limb
4	Likely to happen	4	Death of an individual
5	Very likely to happen	5	Multiple deaths

## Commentary

The candidate evidence demonstrates a thorough knowledge and understanding of the different types of risks and hazards associated with composite manufacturing activities. The candidate has considered and identified all the major hazards and associated risks for each of the tasks.

The candidate has demonstrated an excellent understanding of the mitigations required that can minimise the risks and hazards and has identified thorough detail for the controls necessary.

The candidate has considered a wide variety of scenarios and situations that may arise, for example including visitors who may be affected if they were in the workshop. This demonstrates that the candidate has a thorough knowledge and understanding of risk.

The potential for harm and probability of occurrence has have been identified throughout. The likelihood and severity have also been identified in respect of the hazards and risks

occurring based on the composite manufacturing processes the candidate will be using for the task.



# 1. Method statement

## Method statement – Spacer block assembly

### Planning and preparation:

1. I will interpret and analyse the brief and review the health and safety hazards for each task. I will create a risk assessment to ensure compliance with safe practice and use control measures to reduce the risk of harm, for the completion of all the tasks. I will identify any specific regulations that need to be checked e.g. waste regulations and Control of Substances Hazardous to Health (COSHH) and apply the recommended control measures.
2. From the brief, I will identify the stages of the task activities that require personal protective equipment (PPE) and select the appropriate PPE that is required to be worn, in order that the tasks can be completed with minimal risk. I will complete a list of materials that will be required to complete the assembly so that a check can be made of whether there are supplies of materials, consumables and equipment. It is important to have all the required resources available to prevent time being lost during the manufacturing process. I will check the material data sheet for the recommended defrosting time, curing information and recommended waste disposal methods for the pre-preg composite materials and the consumables being used, referring to the waste regulations for disposal of composite materials. I will create a quality check sheet to record the results of the spacer block assembly during the quality review (at the end of the manufacturing process).

### Production:

3. To produce the spacer block assembly to the given specification I will need to follow a series of composite manufacturing processes. These include preparing a mould, measuring and marking out the components on the composite material, laying up, consolidation, curing and finishing. I will work safely following the risk assessment and method statement.

I will need to create the spacer block components and then assemble the components to create the final assembly.

### Mould preparation:

4. I will prepare my work area, cleaning away any rubbish from the area to give me a clean area to prepare the mould. The mould preparation needs to be planned, so that there is a process that will result in a usable mould. It should allow for the production of an artefact that is free from defects on the “A” side. To do this I will select a suitable mould and carry out suitability checks to determine if the mould is fit for purpose and will produce a quality moulding. I will check that the surface of the mould is flat, checking for any cracks, scratches or faults within the surface that cannot be removed with cleaning. If the mould is good and fit for purpose, I will prepare the mould. If the mould is not suitable for preparation, I will place the defective mould in the allocated area for later disposal. To prepare the mould I will first clean any leftover resin residue or dirt from the mould using a suitable scraper and sharp blade, being careful to not damage the mould surface. When free of old residue I will clean the mould with a proprietary cleaner, an acetone based solvent to remove the sticky residue. I will select a suitable cleaning fluid from the COSHH cupboard, check the COSHH data sheet and apply the cleaner as per the instructions on the tin. I will leave it for the recommended duration before removal and then repeat this cleaning process to ensure the mould is clean and free of all residues. If any residue remains on the mould, the adhesion of the peel ply will be effected and it could be difficult to get a good seal

with the vacuum bag. Once cleaned, I will set the prepared mould in a 'clean area' ready for laminating.

**Measuring and marking out:**

I will change into my clean PPE and thoroughly clean my workstation to create a 'clean area'. A 'clean area' is needed to ensure no foreign object debris is captured in the lamination process as this will affect the final product. When the 'clean area' is set up, I will check the brief to understand which pre-preg composite material is required and collect the roll of material from the freezer. I will complete the freezer log with the date and time of removal. I will leave the roll to defrost in the clean area and set up my workstation for lamination. I will check the workstation is clean before rolling out the pre-preg material. I will cut the required amount of pre-preg material from the roll before returning the remainder of the roll to the freezer, completing the freezer log with the time.

Using the drawings I will use a felt pen and ruler to measure and mark out the dimensions of the sections needed to make up the plies. I will cut out the plies with scissors. The orientation of plies will be marked on the backing film. I will measure and mark out for the core using a closed core foam sheet. The foam sheet will be cut with a sharp utility knife or scalpel and shaped. The angles will be cut as per the drawings to make the core component. The core and plies will be set aside for the laying up and consolidation process.

**Laying up and consolidation:**

5. I will start the laying up process by laying the first ply onto the prepared mould surface. This needs to be laid flat to prevent any imperfections in the finished moulding. I will apply the other plies in order onto the mould and the core will be placed on the upper sheet. These need to be laid square. With all plies added, they will be consolidated using a moulding tool and de-bulked accordingly. I will apply a layer of wrinkled release film on top of the final ply. Peel ply is applied to the mould ensuring a good adhesion to the mould. Breather fabric is cut to size to make an air passage out of the moulding. The lower portion of a vacuum breach unit (VBU) is placed on top of the breather fabric. The material for the vacuum bag is cut to size, draped over the mould. A corner is created first, a pleat is added to create the vacuum tight seal, this is repeated on all sides until all edges are tightly sealed. A hole is made for the VBU and this is placed on top of the bagging material. A vacuum is applied to the VBU to consolidate the laminate. I will check for any leaks and rectify any found. I will check the wrinkles in the bagging material are evenly spaced around the moulding. I will perform a drop test to check for any loss of vacuum.

**Curing:**

6. I will refer to the manufacturer's information to obtain the curing information for the resin material and set the oven accordingly. The mould is placed in the oven, centrally on a shelf and not touching the sides to ensure good air flow. Air hoses will be moved to the side. The moulding will be left to cure for the required duration of 7 hours and 15 minutes.

**Finishing:**

7. Once curing time has completed, the moulding will be left to cool. Once cool it will be inspected to check the performance of the vacuum bag and curing. The vacuum bag and all consumables will be removed and discarded. The mould will be checked for evidence of good consolidation. All waste will be disposed of. I will use a scraper to gently lift one corner of the laminate to free it from the mould, then using a plastic wedge I will complete the demoulding. The wedge will work free the sides and I will apply less pressure on the laminate to avoid cracking or damaging it. Once free I will check the "A" side. I will use an abrasion tool, a sanding block, to remove the

sharp edges of the spacer block. I will abrade the edges to the correct dimensions as per the brief. On completion I will clean the dust from the work area and dispose of all waste.

With the upper component complete, I will cut and prepare the lower plies which will be used to create the complete assembly.

**Assembly:**

8. To complete the spacer block assembly I will carry out steps 5 to 7 again to bond the upper and lower plies. The final assembly will be cured for the designated duration before going through the same finishing process, abrading the edges to the required dimensions. Once complete this will be quality inspected.

**Quality inspection process:**

9. The completed spacer block assembly will be quality inspected. The assembly will be checked for any defects and the final dimensions will be recorded and checked against the brief to see if the component meets the specified requirements and tolerances.

**Reporting, evaluation and handover:**

10. I will write a summary report to present findings from quality inspection to my supervisor. The report will cover the finished sizes of the components and assembly, the quality checks and tests undertaken, evaluation of the final purpose, defects found with reasons for their occurrence and preventions and give recommendations for improvements to the spacer block design or process.
11. Finally I will participate in a handover meeting with my supervisor. The meeting will cover the process of manufacturing the spacer block assembly, the findings of the quality inspection report and to give an overview of the processes taken, any problems encountered during the manufacturing of the spacer block assembly and I will make any suggestions to the design or process. I will present the finished assembly and report to my supervisor.

## Commentary

The candidate has comprehensively interpreted and analysed the given brief in order to plan the activities and have produced a comprehensive method statement; it is clear and well-presented and fully justified. This demonstrates a comprehensive knowledge and understanding to analyse and interpret technical documentation to plan all the activities for the composites manufacturing processes needed to produce the spacer block assembly.

The method statement sets out the intended steps that the candidate will take during the manufacturing process which shows a comprehensive understanding of planning for future tasks and takes into consideration any problems they might encounter during the processes such as adherence to timings or within the availability of the resources or considerations of issues such as: thawing time, handling of cured and uncured resins as well as fibres and cured mouldings.

The candidate has included reference to working to procedures and regulatory requirements. For example, working to COSHH procedures and the use of COSHH data sheets when working with the cleaning liquids and referring to the waste regulations for the correct disposal of composite materials. The candidate has identified a range of technical documentation which they will need for each part of the process.

## 1. Quality check sheet

Item to be checked	Criteria to be met:	Met	Not met	Comments
Base dimensions (length and width)	180mm X 80mm $\pm$ 0.5mm			
Thickness (dimension)	2mm $\pm$ 0.5mm			
Core height (dimension)	10mm $\pm$ 0.5mm			
"A" side	Free of defects, no FOD and flat			
Moulding	Consolidated and laminate layers are bonded No bridging or wrinkling of surface			
Core	Alignment is square to the base (orientation $\pm$ 3mm)			
All edges	No sharp edges, suitably prepared and safe edged			
Final spacer block assembly	Upper and lower sections sufficiently bonded			
	No dry fibres are apparent			
	No resin rich areas are apparent			
	No fibre mis-alignment			
	Overall appearance			

## Task 2a – Preparing the mould

(Assessment themes: Health and safety, Planning and preparation, Production (moulding, tools and equipment)).

For task 2a candidates need to produce the following piece of evidence:

- prepared mould.

For task 2a, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - mould preparation
  - preparation of materials.
  - work area during and on completion of the tasks.

### Photographic evidence required:

- photographic evidence showing preparation of the work area and on completion of the task - *Illustrated in task 2 photographic evidence section below (photographs 1 - 2)\**  
**\*Note: to avoid duplication, the assessor only needs to provide photographic evidence of work area set up and reinstatement once to show the candidate has met the criteria.**
- photographic evidence showing mould preparation - *Illustrated in task 2 photographic evidence section below (photograph 3 - 6)*
- photographic evidence showing preparation of materials - *illustrated in task 2 photographic evidence section below (photographs 7 - 9)*

*Photographs in this GSEM demonstrate the full process that the candidate has undertaken to complete the spacer block assembly. Commentary sections detail where performance is considered to be at a level reflective of a distinction grade. Note, due to the nature of this process, not all individual work activities would provide opportunity to demonstrate a defined level of differentiation beyond a pass – but these images are shown in order to show the cohesiveness of the process being undertaken, and to draw out where differentiation is possible.*

## 2a. Photographic evidence – Preparation

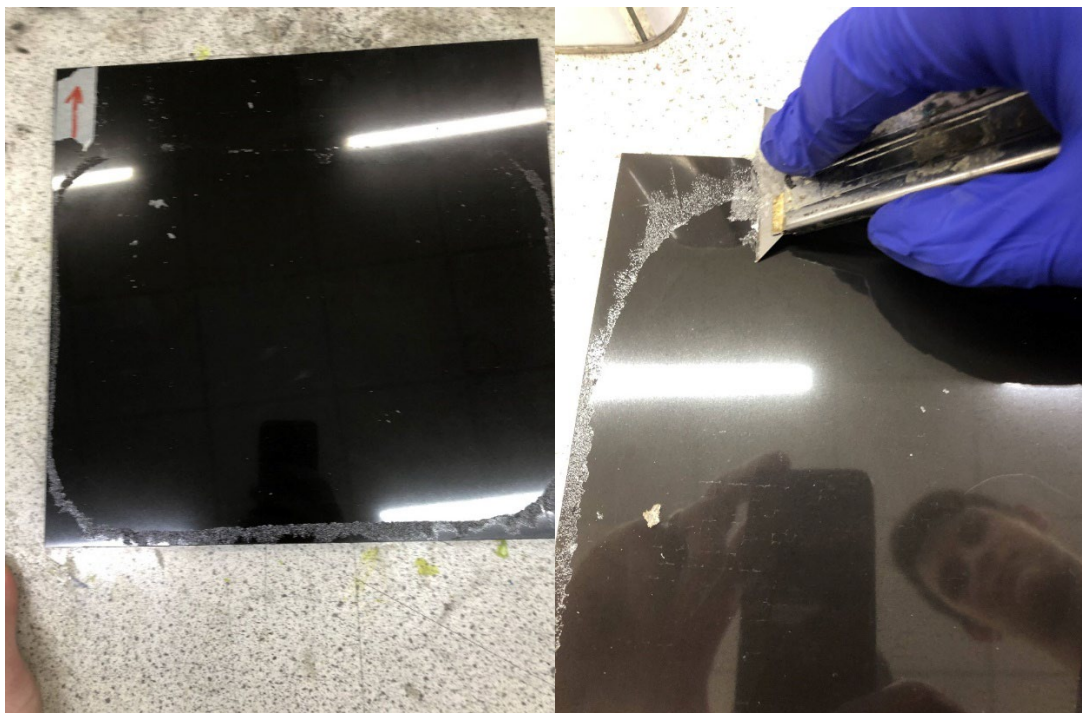
### Work area (photographs 1 – 2)

Photographs 1 and 2 – showing the prepared work area cleaned and the resources selected. The photograph should show the materials required for the first task which includes the selected mould, shown here as a black ceramic tile, all presented on a clean workstation or work area.



### Photographs 3 – 6: Mould preparation

Photographs 3 and 4 – showing mould prior to preparation and cleaning. Residue from previous mould activities is present and needs to be removed without damage to the mould occurring. Candidate is seen using a scraper to remove the residue. Note: The selected scraper must be suitable for the mould material to prevent damage to the mould surface during cleaning.



Photographs 5 and 6: showing the mould being prepared with a release agent. Note: candidate is wearing appropriate gloves whilst using the solvent and removing any residue and excess solvent with disposable cloths.



### Preparation of composite materials (photographs 7 – 8)

Photograph 7 – showing candidate wearing suitable PPE which has been checked for integrity. The candidate is wearing full PPE when simulating a clean room environment. The overall is done up, covering the candidate's clothes and no exposed skin. Note: a mask will be worn when handling the pre-preg material.



Photograph 8 – showing composite material removed from storage (freezer). The material is correctly kept in its bag and allowed to thaw for a period of time at room temp.





## 2a. Practical observation form - Preparation

<b>Assessment ID</b>	<b>Qualification number</b>
8713-333	8713-333
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	Planning and preparation, Health and safety, Production (moulding)

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</b>
Work area preparation	The candidate put on their PPE and prepared their workstation, checks were made for any residue left by a previous job. No residue was found. All surfaces and floor areas swept clean. A moulding tool had been left on the bench by another user, this was cleaned and checked before being placing back in the store. Referring to their resource list, they selected their resources and set out their workstation, checking the tools were suitable to use with the mould. An efficient set-up with no overcrowding of materials. A porcelain ceramic tile was selected as the mould. Suitability checks were completed for visible surface defects and flatness. The mould was deemed fit for purpose.
Mould	They selected a suitable metal scraper to clean off resin residue left over from a previous moulding. A proprietary mould cleaning product was selected from the COSHH cupboard. They reviewed the manufacturers information and COSHH data sheet for the cleaning fluid, noting the specified drying times and PPE recommendations. The product was correctly applied in the direction as designated in their method statement. Allowed to dry for the manufacturer’s recommendation, then repeated the process in the perpendicular direction and left to dry in accordance with the manufacturer’s specifications. The mould was checked for cleanliness and surface treated with a preparatory release agent, the COSHH instructions checked and followed. Release agent was applied evenly, checks were completed ensuring no areas were missed. Final checks completed on the mould. No defects or residue observed. Prepared mould was set aside in a clean area for later use. The work area was thoroughly cleaned of all dust and residue, creating a ‘clean room’ for the laying up process.
Materials	They collected and completed condition checks on their PPE. All clean PPE was put on. The candidate checked the brief confirming the type of resin and fibre system to be collected. They selected the correct material roll from the freezer, first checking the roll was in-date, recording the date and time of the removal from the

<b>Task</b>	<b>Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</b>	
	<p>freezer on the inventory. The roll was put aside in a clean area to thaw to room temperature.</p> <p>All tools were thoroughly cleaned, given a visual check and returned to storage. Cleaning product and release agent returned to COSHH cupboard. All health and safety procedures were adhered to, as per the risk assessment and method statement. PPE worn at all times.</p>	
<b>Assessor signature</b>	<b>Date</b>	
<b>Assessor A</b>	<b>16.12.2021</b>	

## Commentary

The observation evidence has captured that the candidate demonstrated exemplary knowledge and comprehensive understanding of the processes and practices required to produce a composite product to meet the requirements of the brief by demonstrating the careful preparation of the mould, correctly selecting and cleaning the mould surface to check the mould was free from surface defects and that it was fit for purpose and had the potential to create a high-quality moulding.

The candidate has demonstrated a comprehensive understanding of how to prepare a work area for working with composites, understanding the need to maintain a 'clean room' environment to prevent debris being introduced to the manufacturing process which could cause defects in the completed artefact.

The candidate has demonstrated a comprehensive awareness of health and safety, for example, clearing excess materials away from the work area, checking the COSHH data sheet instructions for the cleaning liquids and PPE recommendations.

## **Task 2b – Production of the spacer block components**

**(Assessment themes: Health and safety, Production (moulding, laminating, consolidation, curing and demoulding, tools and equipment).**

For task 2b candidates need to produce the following pieces of evidence:

- completed spacer block components.

For task 2b, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - production of the spacer block components
  - the finished (demoulded and cured) spacer block components.

### **Photographic evidence required:**

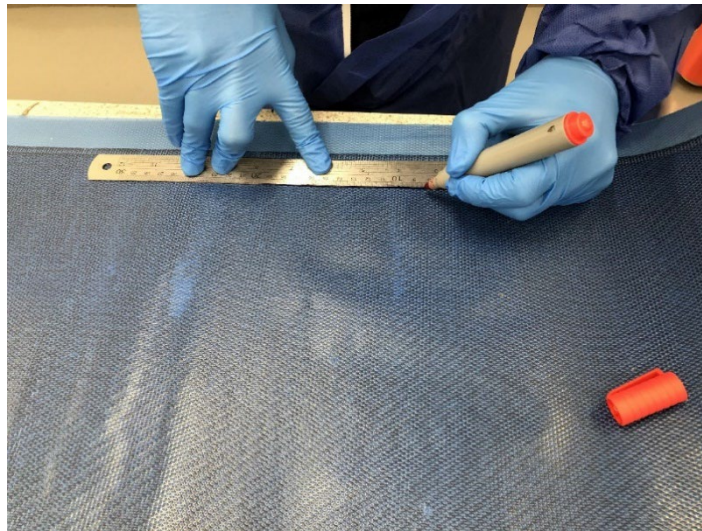
- photographic evidence showing marking out and cutting materials - *illustrated in task 2b photographic evidence section below (photographs 9 - 14)*
- photographic evidence showing the laying up and consolidation process - *illustrated in task 2 photographic evidence section below (photographs 15 - 20)*
- photographic evidence of the curing process - *illustrated in task 2 photographic evidence section below (photographs 21 - 23)*
- photographic evidence of demoulding process and the finished (demoulded and cured) spacer block components – *illustrated in task 2 photographic evidence section below (photographs 24 - 31)*

**For the purpose of this GSEM additional photographs have been included, however it is not expected that Providers will capture this level of evidence for each candidate. A sample is recommended to show the key points within a process and to highlight any defects or issues encountered etc.**

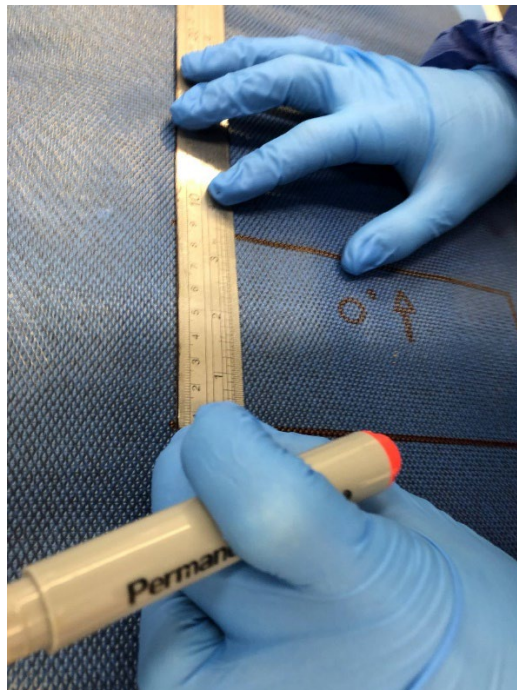
## 2b. Photographic evidence – Production of the spacer block components

### Marking out and cutting materials (photographs 9 - 14)

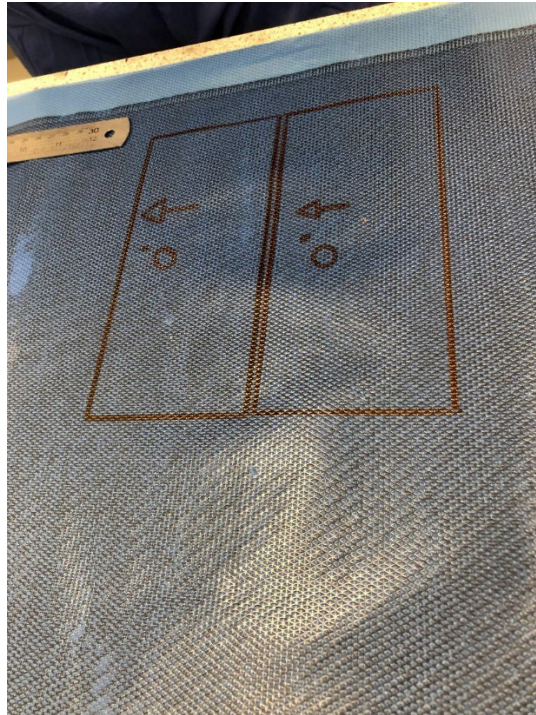
Photograph 9 - showing the pre-preg composite material thawed and removed from bag. Sufficient material is rolled from the roll to ensure that material can be cut out and the required orientation can be accommodated.



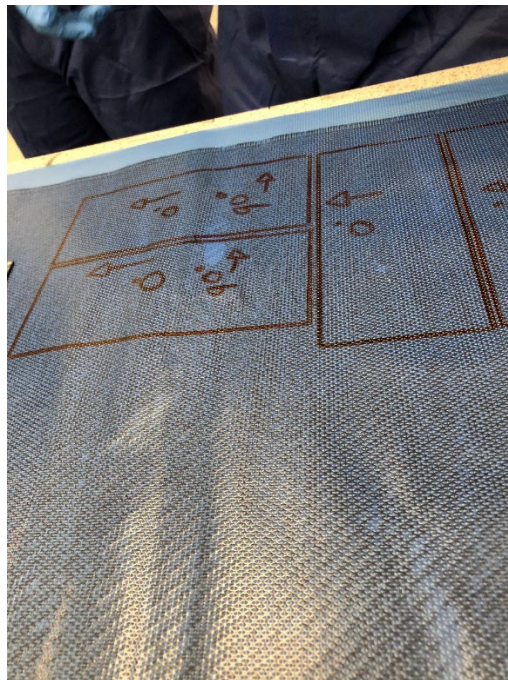
Photograph 10 – showing material being marked out ready for cutting. Orientation of plies is identified and marked on the backing film.



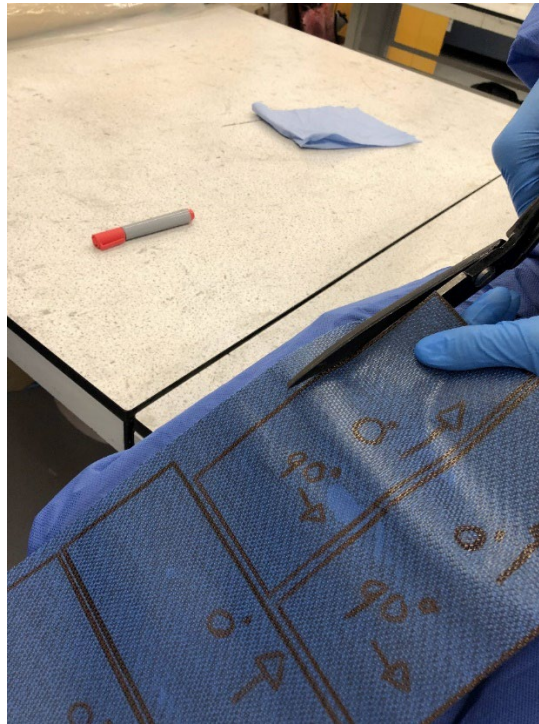
Photograph 11 – showing lower laminates marked out for cutting with warp fibres in the 0° direction.



Photograph 12 – showing 90° warp direction identified and backing material marked out.



Photograph 13 - showing material being cut-out to form the “kit” of parts using scissors.  
Note: the positioning of the component pieces to minimise the wastage of material. The roll edge is correctly discarded as it is compromised and would not create a good ply.

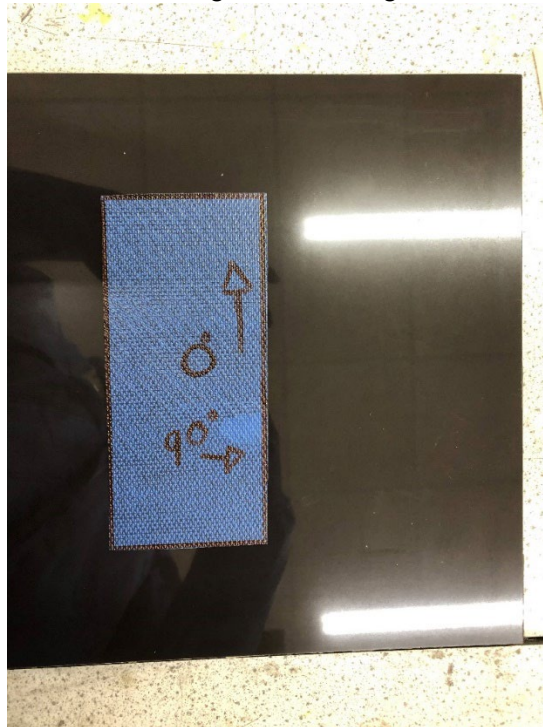


Photograph 14 – showing the core material cut to final dimensions and chamfered at the required angle.

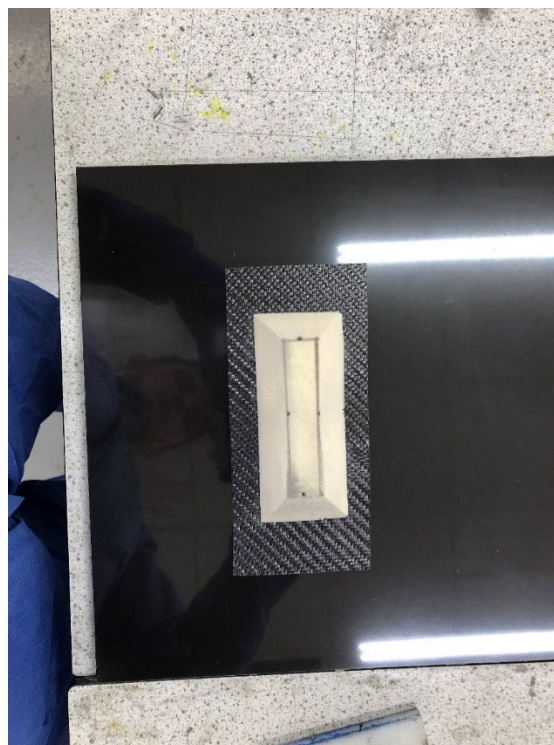


## Laying up and consolidation process (photographs 15 – 20)

Photograph 15 - showing the first ply laid onto the prepared mould surface. Candidate has taken care to orient the material according to the orthogonal convention.



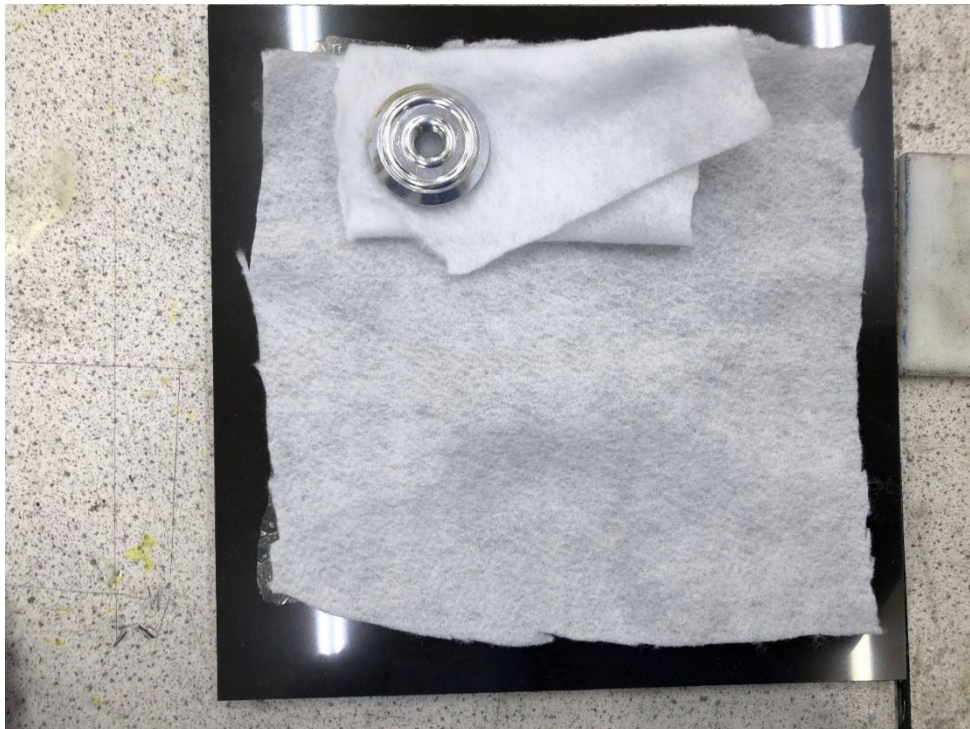
Photograph 16 - showing subsequent plies laid up onto the mould and the core placed in the correct location. Some evidence of “out-of-square” but sufficient material has been allowed for trimming subsequent to curing.



Photograph 17 - showing the upper plies applied and consolidated using a moulding tool. De-bulk applied according to method statement. Release film has been “distressed” to allow for better drape and placed on top of the final ply, this is good practice.

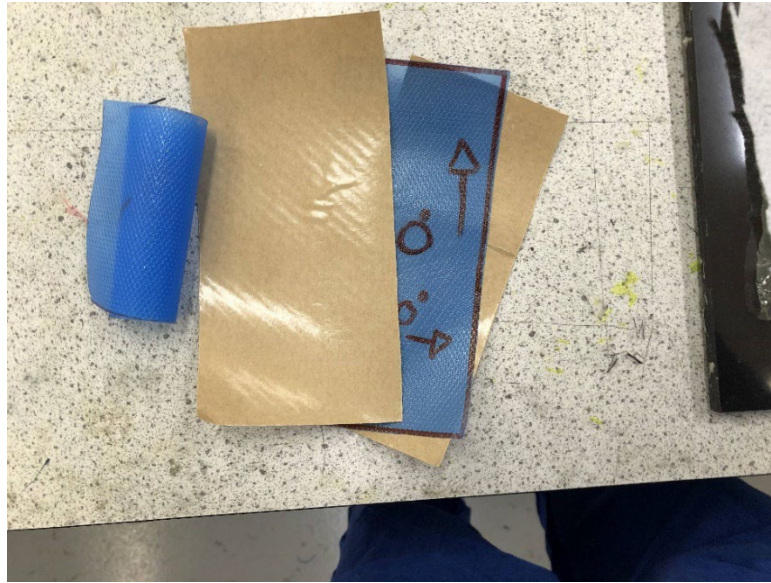


Photograph 18 - showing the peel ply applied on top of the release film with additional breather fabric cut to make an air passage out of the moulding. VBU lower portion placed on top of breather fabric but on the moulding.





Photograph 19 - showing the backing material count-back performed to ensure that there is none left in the laminate stack. Backing material count is equal to twice the number of plies.



Photograph 20 – showing the vacuum applied to the VBU to consolidate the laminate. Candidate will be checking for, and rectifying any leaks, and will ensure the wrinkles are spaced equally around the moulding.



## Curing process (photographs 21 – 23)

Photographs 21 and 22 – showing the preparation of the oven for the curing cycle. Manufacturer's information obtained to set the oven for the required temperature and duration.

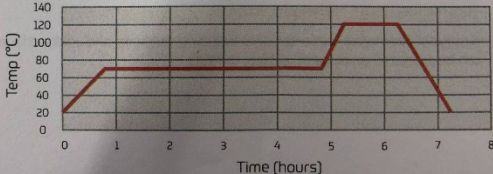
**CURING**

XPREG® XC110 is designed to be oven cured in a vacuum bag at full vacuum pressure however it can also be cured in an autoclave or hot-press. Minimum vacuum pressure is 10mbar.


For best results, an accurately controlled multi-stage temperature cycle with final cure temperature of 120°C should be followed:

**STANDARD CURE CYCLE**

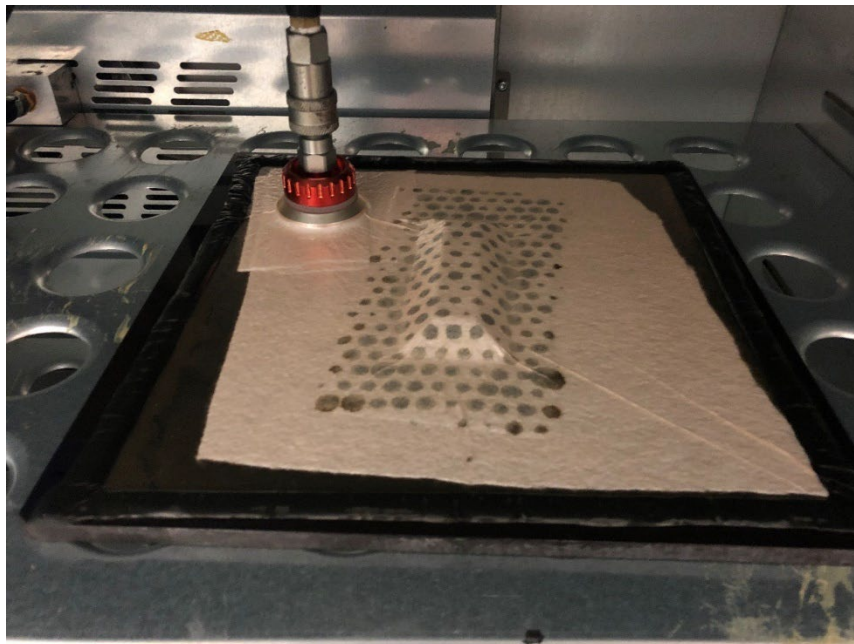
Step	Start Temp	Ramp Rate	Duration	End Temp	Elapsed Time
1	~ 20°C	1°C /min	00:50	70°C	00:50
2	70°C	Soak	04:00	70°C	04:50
3	70°C	2°C /min	00:25	120°C	05:15
4	120°C	Soak	01:00	120°C	06:15
5	120°C	Natural Cool	--	~20°C	07:15



For detailed information, including alternative cure cycles from 85°C see the XC110 Processing Handbook.

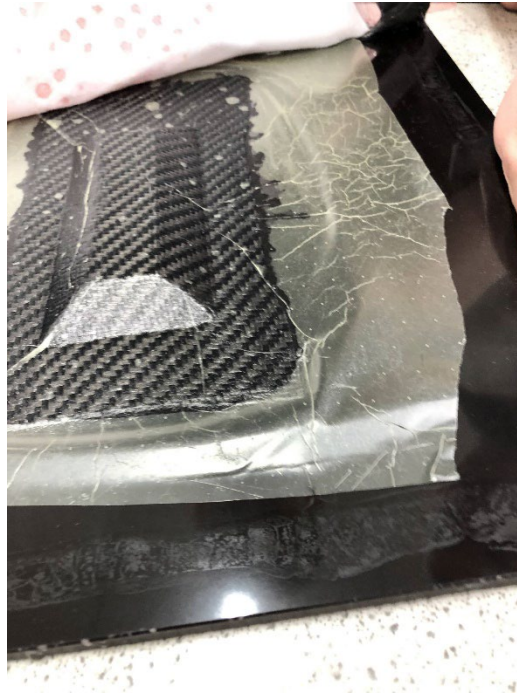


Photograph 23 - showing the mould placed in the oven, not touching the sides, with the vacuum applied to the VBU in the oven.

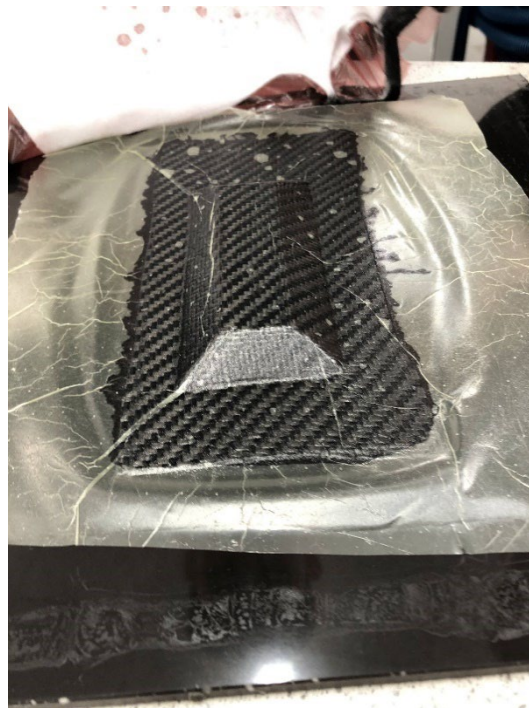


## Demoulding and finishing process (photographs 24 – 31)

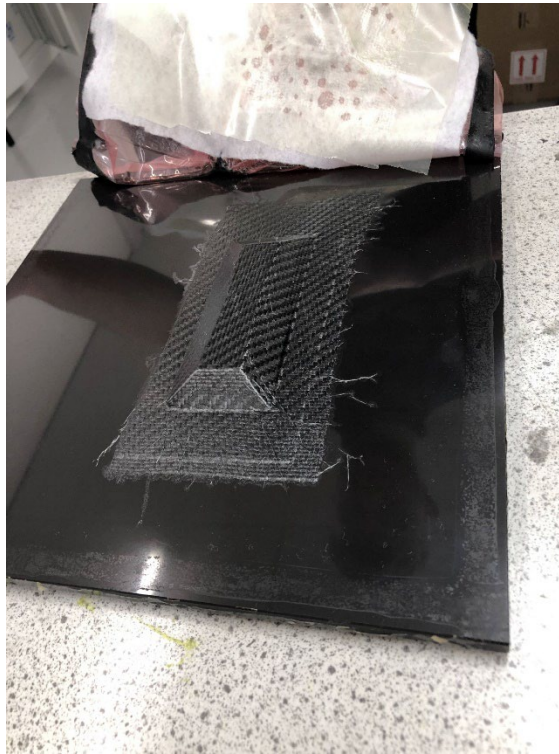
Photograph 24 - showing the cured mould with bagging film being removed to reveal the release film. Evidence of good consolidation and curing. Some wrinkling of release film but the surface of the moulding is good.



Photograph 25 – showing the breather fabric removed and release film inspected. There is evidence of some resin bleed which is to be expected. Sufficient material around the block to allow for trimming and squaring.



Photograph 26 – showing the release film being removed and moulding is further inspected.



Photograph 27 – showing detail of edges, corners and transitions showing good definition and orientation of fibre.



Photographs 28 and 29 – showing a scraper being used to lift one corner at the beginning of the demoulding, followed by a plastic wedge to complete the process of demoulding, ensuring that the lift is not too abrupt to overstress or crack the laminate.



Photograph 30 – showing successful demoulding showing no damage or cracking to the moulding.



Photograph 31 – showing candidate performing measurement checks post safe-edging to ensure dimensions meet specification.



## 2b. Practical observation form – Producing the spacer block components

<b>Assessment ID</b>	<b>Qualification number</b>
8713-333	8713-333
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	<b>Production (Laminating, consolidation, curing and demoulding, tools and equipment), Health and safety.</b>

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</b>
Measuring, marking out and cutting	<p>Work area prepared as previous observation. PPE correctly worn. The candidate unrolled the material from the roll, marked out the material to usable size using a steel rule and a felt pen. The material was cut to size with scissors. The remaining material was correctly sealed and returned to the freezer. The candidate completed the freezer inventory log with the date and time the roll was returned.</p> <p>Referring to the drawings, each component was marked out, care taken to allow for drape of the top layer, avoiding any unnecessary wastage. The material was cut out according to the marking-up, using suitable shears and knives. No excessive waste of material was observed. Cuts made were accurate, maintaining the measurements taken. The layers of material were labelled and sorted into the correct orientation and ply number as per their lamination plan. The foam core material was cut to size. The edges of the core were chamfered to the required angle, care was taken to maintain the marked measurements.</p>
Laying up and consolidation	<p>The backing film of the first layer of material was removed before being applied to the mould and consolidated using a recognised procedure. The lower laminate was built up and de-bulked. On completion of the lower laminate, the core was placed on peel ply, creating a surface for bonding, on top of the prepared mould surface in the specified position.</p> <p>The top laminates were placed onto the core and mould, checks made to ensure no draping or wrinkling of the layers of composite material. Moulding tools used appropriately to consolidate the layers; no imperfections observed. Care was taken to ensure the pressure applied did not crush the core material. The</p>

<b>Task</b>	<b>Notes</b> – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>
Curing	<p>candidate was observed referring back to their laminating plan and the method statement throughout, checking the order.</p> <p>The backing film of the upper layer of pre-preg material was removed and a count-back instigated, checks made to ensure that no Foreign Object Debris (FOD) was left between the laminates. Peel ply was cut to size and placed over the laminates. Release film was cut to size and placed on top of the peel ply. The candidate distressed the release film to allow for better drape, this is good practice. This was placed on top of the final ply. Finally, breather fabric section was cut to size and placed over the peel ply.</p> <p>The candidate referred to their consolidation plan to check the positioning of the Vacuum Breach Unit (VBU). This was carefully considered, allowing a passage for air to be facilitated from the laminate to the VBU area. The outer periphery (10mm approx.) of the mould, was cleaned of release agent to facilitate good adhesion of the vacuum bag. The vacuum bag was prepared according to the method statement and the vacuum was applied. A standard vacuum 'drop test' was performed. Checks made for air leakage, no leakage identified or observed. A stable vacuum was achieved.</p> <p>The candidate checked the curing times for the pre-preg material against the manufacturer's recommendations. Oven was prepared correctly using a stepped approach. The mould was placed in the pre-heated oven, no contact with the oven sides or hoses. The mould was left to cure to the full cure cycle. The candidate recorded the data for the curing process, including the temperature and duration.</p> <p>The work area was reinstated to the original condition as found. All waste disposed of in accordance with workshop waste procedures and waste management regulations. Tools and equipment were checked, cleaned and returned to storage.</p>
<b>Assessor signature</b>	<b>Date</b>
<b>Assessor A</b>	<b>17.12.2021</b>

## Commentary

The candidate evidence has demonstrated exemplary knowledge and comprehensive understanding of the laying up, consolidation and curing processes. The candidate completed the processes in the correct sequence.

The candidate demonstrated a comprehensive understanding of the need to maintain accuracy, for example, ensuring the marking out and cutting of the components from the material was done carefully to maintain the dimensions and to avoid creating an excess waste of material.



The candidate demonstrated comprehensive knowledge and understanding to refer to technical documentation throughout the manufacturing process, for example, referring to their method statement, laminating and consolidation plans and manufacturers information for curing the material.

The laminating process was followed with repeated reference back to their laminating plan. The material was consistently applied to the mould, for example, the candidate ensured the plies were placed according to their plan and the technical drawings supplied and ensured all cut components were marked up with a ply number and their orientation allowing for a check to be made to ensure the lamination order was correct. The candidate showed a comprehensive understanding and awareness of the risk of contamination during the laminating process, for example, creating a clean work area, wearing PPE correctly and using a count back to check for Foreign Object Debris (FOD) at all stages during the process.

The candidate demonstrated the process of consolidation prior to the curing process, ensuring the consumables were laid out on the mould correctly and in the correct order, making best use of their properties, manipulating the consumables to make best use of their properties during the consolidation and then the curing process. For example, distressing the release film enabled the film to drape more efficiently and ensure an even consolidation. The candidate checked the manufacturer's information to determine the curing temperature and times. The candidate performed a successful drop test to check the vacuum had been applied effectively and no leaks.

The candidate has shown very good knowledge of the practices needed to ensure the end product is of good quality and is free from defects which may arise if processes are carried out incorrectly or does not comply with regulations and standards.

## 2b. Practical observation form – Demoulding

<b>Assessment ID</b>	<b>Qualification number</b>
8713-333	8713-333
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	Production (curing and demoulding, tools and equipment), Health and safety)

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</b>
Demoulding	<p>The candidate removed the mould from the curing oven using the correct PPE. They checked the mould was cool and able to be handed. The moulding was inspected for signs of vacuum depletion that may have occurred during the cure cycle. No evidence of depletion was found. The bagging film and consumables were removed from the mould. All waste disposed of in accordance with the method statement and disposal regulations. Some resin bleed identified but not excessive.</p> <p>The condition of the cured mould was checked prior to starting the demoulding process. All tools required to remove the laminate from the mould were considered, selecting appropriately sized tool for the mould material selected.</p> <p>They selected a metal scraper to lift one corner of the moulding, followed by a smaller plastic wedge, slowly working the laminate free from the mould. The demoulding was successful with no noticeable damage or cracking to the laminate.</p>
Finishing	All sides were safe edged using an abrasive sanding block. The “A” side was carefully inspected for FOD. Dimensions were checked against the specification. The moulding was abraded to near size and further inspected for dimensional accuracy.
Health and safety	Correct PPE worn throughout. Work area was comprehensively reinstated, thoroughly cleaned down, all visible dust removed, and all waste disposed of in accordance with workshop practices and waste management regulations. All tools and equipment were thoroughly cleaned, checked for damage and returned to store.
<b>Assessor signature</b>	<b>Date</b>
Assessor A	18.12.2021

## Commentary

The observation evidence provided shows the candidate has demonstrated exemplary knowledge and understanding of the demoulding process.

The result of the consolidation and curing was good. There was minimal wrinkling observed across the top of the mould showing the candidate had carefully adjusted the vacuum bag before placing in the curing oven. This allowed for even pressure during the consolidation and allowed even circulation of air during the curing.

The moulding was removed safely from the mould using suitable tools and appropriate techniques. For example, the candidate selected suitable tools to use for the type of mould to avoid damaging the mould or the moulding. The candidate chose a smaller lifting tool to release the moulding from the mould, being careful not to overstress the material which could result in a crack.

The candidate demonstrated a comprehensive approach to ensuring accuracy, for example, performing regular measurement checks during the abrading process to avoid removing too much material.

The candidate followed the appropriate health and safety procedure demonstrating a comprehensive knowledge and understanding of adhering to health and safety, for example, ensuring all dust was cleared away and disposed of and all tools cleaned as not to cause a hazard to other.

## Task 2c – Assembly

**(Assessment themes: Health and safety, Planning and preparation, Production (laminating, consolidation, curing and demoulding, assembly, tools and equipment)).**

For task 2c candidates need to produce the following pieces of evidence:

- the completed spacer block assembly.

For task 2c, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - assembly of the spacer block in stages, including bonding, curing, trimming and finishing processes
  - the completed spacer block assembly
  - the handling and application of composite materials
  - the application and use of tools and equipment
  - work area during and on completion of the tasks.

### **Photographic evidence required:**

- photographic evidence of assembly process of the spacer block (incorporating evidence of bonding, curing and trimming) - *illustrated in task 2 photographic evidence section below (photographs 32-41)*
- photographic evidence of completed spacer block assembly - *illustrated in task 2b photographic evidence section below (photograph 42).*

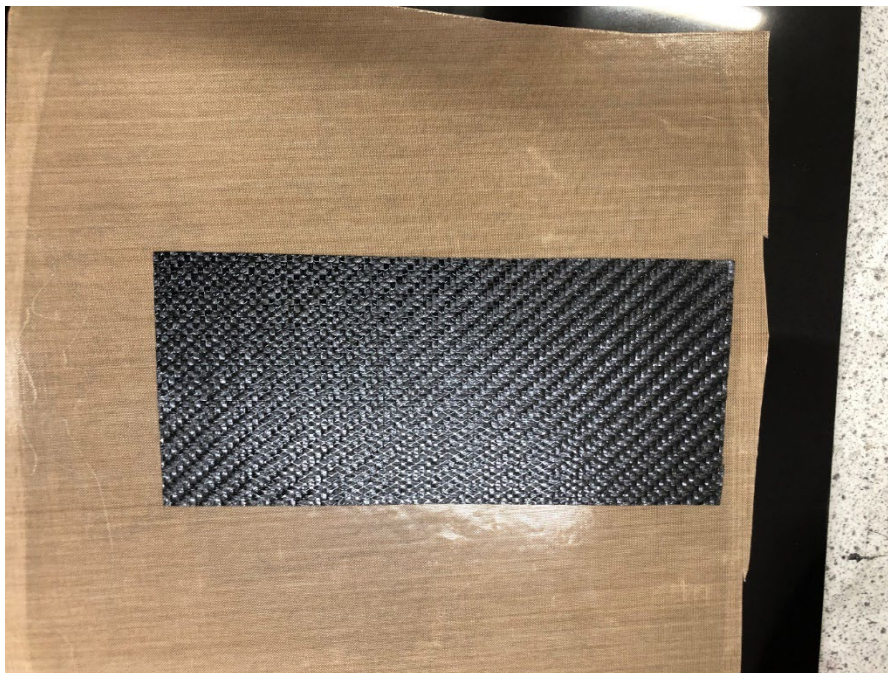
## **2c. Photographic evidence - Assembly**

### **Assembling the spacer block (photographs 32 – 42)**

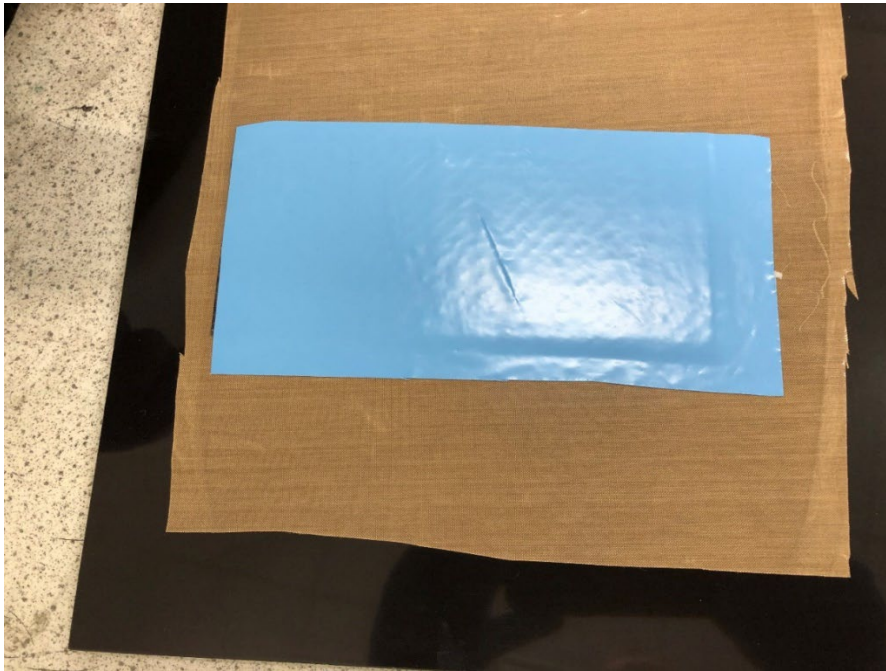
Photograph 32 – showing the underside of the spacer block on completion of being abraded to ensure good adhesion to the lower laminate. There is good abrasion of the lower surface showing consistent application of abrasive medium and consistent colouration and texture.



Photograph 33 – showing the first ply placed onto PTFE release film and consolidated. Preparation of mould surface with release agent or in this case, PTFE release film which shows good selection of alternative processes.



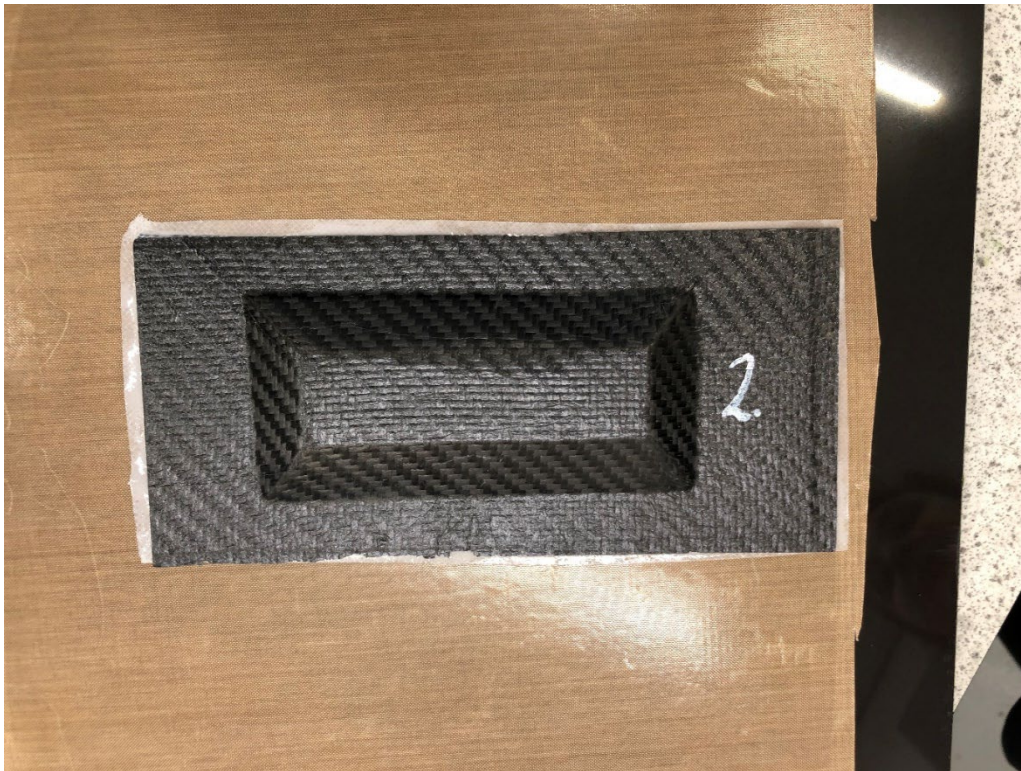
Photograph 34 – showing the film adhesive placed onto the second ply and consolidated with the backing film still applied.



Photograph 35 – showing the backing film removed from the adhesive film and cut to size to ensure minimum bleed out.



Photograph 36 – showing the spacer block component placed on top of release film.



Photograph 37 – showing release film placed on top of the moulding. Note: the release film is sufficiently wrinkled to aid draping.

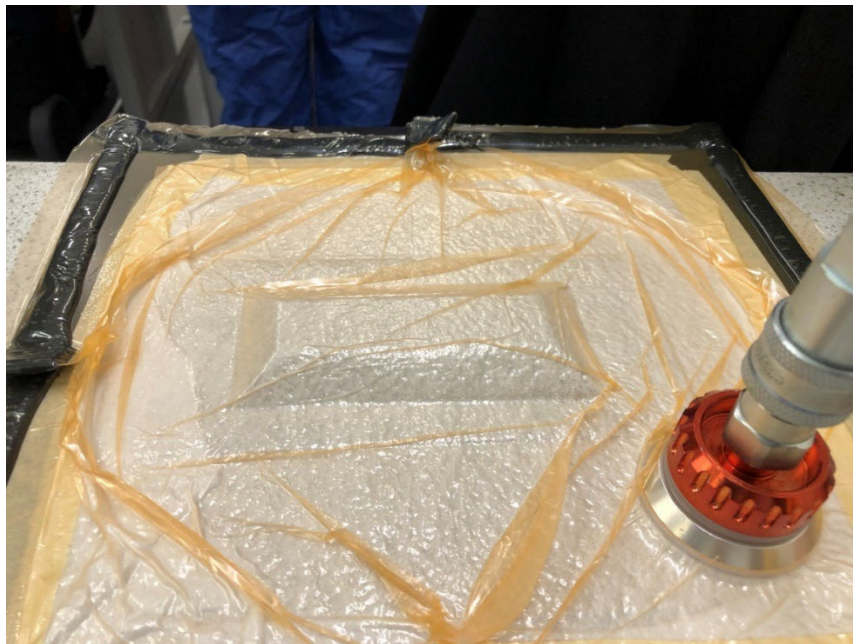


Photograph 38 – showing breather fabric placed onto moulding and taped down with VBU being trial placed to ensure no interference with the moulding. The vacuum bag has been created. The four pleats allow for effective consolidation. With partial consolidation vacuum applied to ensure pleats and wrinkles are equally placed.

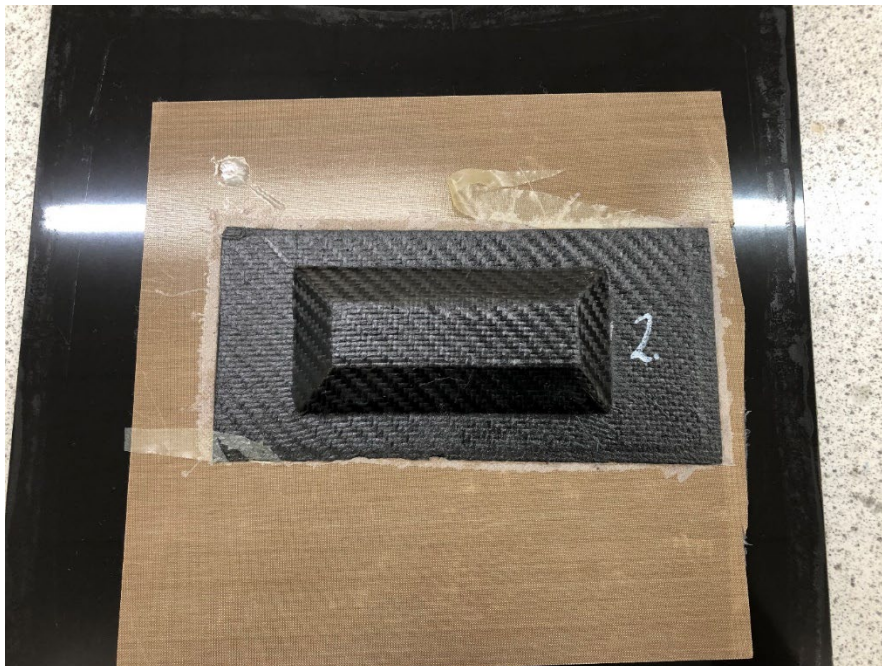




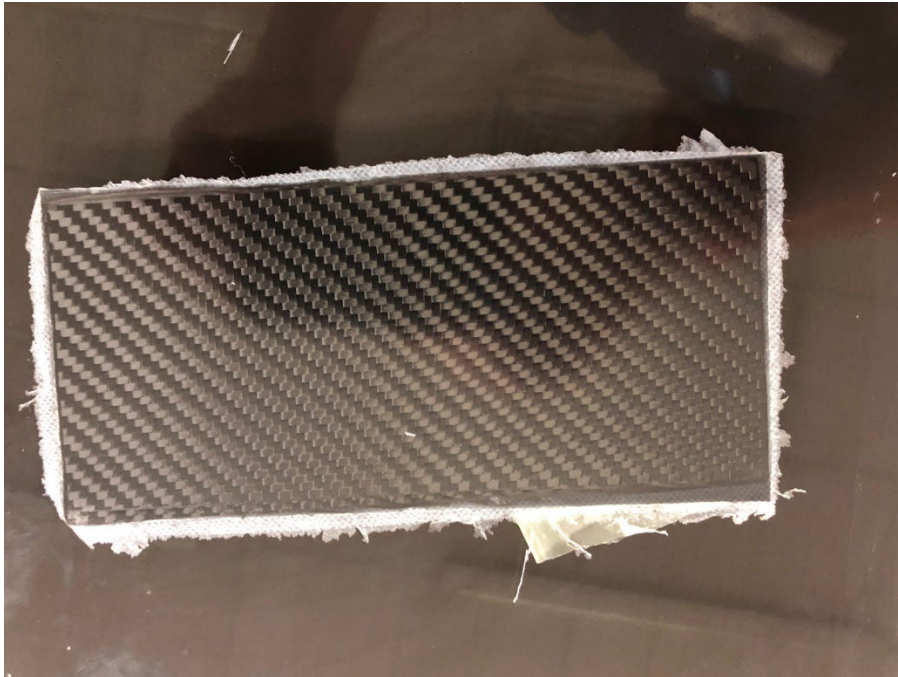
Photograph 39 – showing full consolidation pressure applied, wrinkles and pleats spaced out ready for curing in the curing oven.



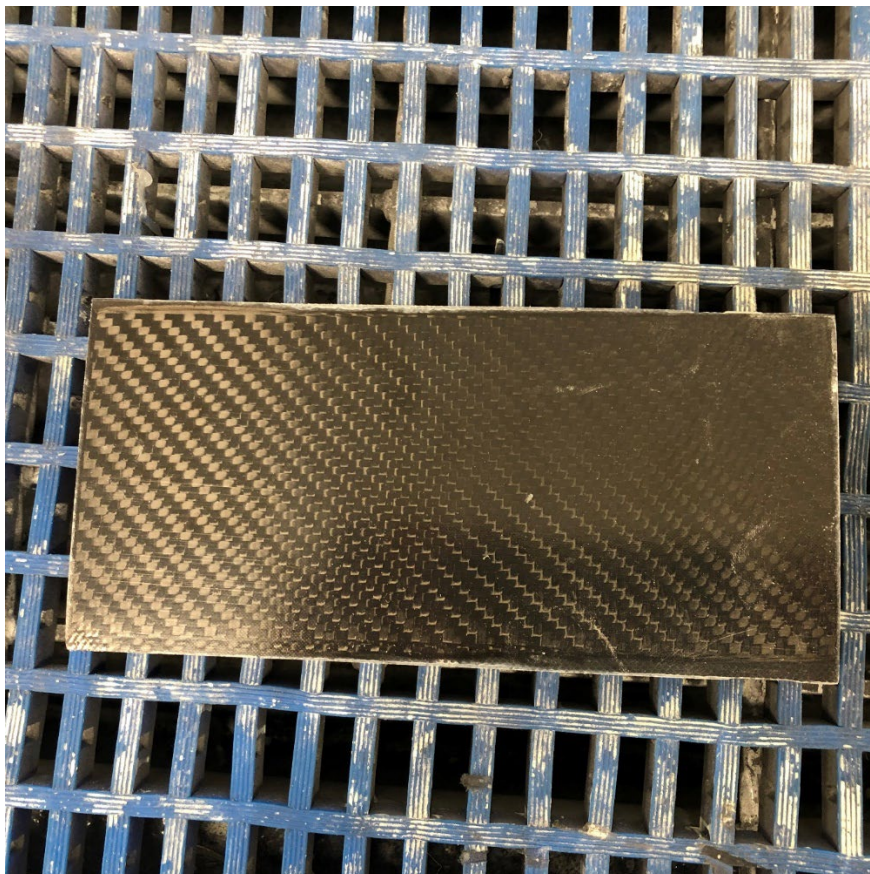
Photograph 40 – showing result of the curing. Assembly sitting on top of PTFE release layer. Evidence of complete bonding as a result of resin bleeding out evenly from the upper and lower sections.



Photograph 41 – showing the checking of “A” side for defects, clear of FOD.



Photograph 42 – showing the final assembly which has been safe edged and ready for machining to final dimensions.



## 2c. Practical observation form – Assembly of the spacer block

<b>Assessment ID</b>	<b>Qualification number</b>
8713-333	8713-333
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	Production (assembly, tools and equipment), Health and safety.

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</b>
Assembly	<p>The candidate put on their PPE and prepared their work area, creating a clean area for the assembly.</p> <p>They performed a dry test fit of the upper and lower sections to check for overlap and orientation. They checked their method statement for the bonding process, namely the agent, orientation and consolidation needed to permanently bond the upper and lower sections. They proceeded to correctly bond the upper and lower laminates using peel ply, ensuring surfaces were evenly abraded to manufacturer’s recommendations, consistent colour and texture observed. Consolidation was applied according to the method statement. Care was taken to cut adhesive film to size to minimise bleed out during curing. The vacuum bag was applied as before, VBU placed correctly, no interference with the moulding. Pleats and wrinkles evenly distributed around the moulding. The candidate checked the curing times in the manufacturer’s information.</p> <p>The cured moulding was inspected for signs of debonding and any non-conformities. Even resin bleeding from both upper and lower sections showing good consolidation and even bonding. The “A” side was checked, no warping was identified on the underside, no FOD contained within the laminate. All edges checked for any excess bonding agent. The moulding was abraded to dimensions according to the drawings.</p> <p>The work area was correctly reinstated. All tools and equipment were thoroughly cleaned, checked and returned to store. All waste was disposed of in accordance with waste procedures.</p>
<b>Assessor signature</b>	<b>Date</b>
Assessor A	18.12.2021

## Commentary

The candidate evidence shows the candidate has successfully followed an assembly process to produce the final spacer block.

The candidate has shown a comprehensive understanding of the bonding processes needed and the consolidation and curing needed to complete the assembly, for example, performing a dry fit of the components prior to starting the bonding procedure to check for a good fit.

A compatible bonding agent was used and the candidate evenly trimmed the film accurately resulting in an even resin bleed between the upper and lower layers, resulting in an effective consolidation and bonding, with no visible areas of lifting and no loss of rigidity. See photograph 40. The overall alignment of the assembled components was very good.

The candidate's ability to follow processes resulted in achieving the desired quality, for example, by maintaining a clean working area throughout the manufacturing process the final product with no inaccuracies found within the cured laminates. They were free of any foreign object debris (FOD) and the 'A' surface was flat, see photograph 41.

## **Task 3a – Defect identification**

**(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover))**

For task 3a, candidates need to produce the following piece of evidence:

- list of identified defects with cause and prevention indicated.

For task 3a, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - defect identification process.

Photographic evidence

- the defect identification process being undertaken.

The following task 3a, assessor evidence has not been included for this version of the GSEM:

Photographic evidence

- the defect identification process being undertaken.

## Candidate evidence

### 3a. Defect identification

Name: Candidate A		
Defect	Cause	Prevention
Non-conformity to dimensions.	Inaccurate marking out or cutting of materials. Failing to consider the implications of drape and fitting of material over the core.	Ensure that the material is cut to shape to at least meet the dimensional requirements of the finished artefact. A test fit should be carried out and the material should not be used if it does not fit with sufficient dimensional allowance.
Out of square	Insufficient care not to ensure the laying up of the components, this is noticeable by the base and upper components being out of square.	Ensure plies and components are checked for squareness before consolidation.
Bridging of material over the core.	Insufficient care not being taken to ensure that the plies are properly applied to each other, the features of the core are not identified, and the plies are not pressed into corners and transitions. Not using sufficient consolidation pressure during the de-bulk or curing. Not producing sufficient pleats in the vacuum bag to ensure corners and transitions can have consolidation pressure to act.	Moulding tools such as knerkers are utilised to get the plies well pressed into the corners and transitions. The vacuum bag must be capable of applying consolidation pressure to the flat areas of the moulding, corners and transitions around the core. The vacuum needs to have sufficient pleats and "slack" to allow the consolidation pressure to act all over the laminate.
Tear-out of the "A" side.	Release agent not being properly applied to the mould, thereby causing the matrix to adhere to the mould. When the moulding is removed from the mould, it leaves matrix material on the mould and an area of moulding that is damaged.	Ensure that the moulding is "released" in accordance with the authorised process and care is taken when removing the moulding.
Dry areas on the "A" side.	Matrix material has been depleted from areas of the "A" side as result of breather fabric coming into contact with the uncured moulding.	Ensure that the breather fabric is separated from the moulding by release film.
Delamination of the laminate.	Foreign material has been allowed to get onto or into the laminates during the laminating process. Consolidation pressure has not been applied to the moulding during be-bulk or curing.	Ensure that best practice is adhered to during the laminating process and appropriate PPE is used to protect the operative and material.

	Bridging of the laminates has occurred around the core.	The bag needs to be capable of holding vacuum for sufficient periods of time to ensure complete consolidation. Care needs to be taken to ensure that the pre-preg is properly pressed into corners and around transitions.
Core crushing.	The core has been distorted as a result of too much force being applied to the laminate. Damage has been caused resulting in the dimensions of the core being not as required.	The core material needs to be selected according to requirements of the process and care needs to be taken to ensure that it does not get damaged during laminating.

## Commentary

The candidate has identified all of the visible defects in the given test sample that have arisen as result of the manufacturing process. They have attributed a cause and offered a prevention for all of the defects identified demonstrating a comprehensive knowledge of defect occurrence, rectification and prevention.

The processes to identify and rectify defects identified are explained and the implications for prevention or repair are understood and articulated, demonstrating that the candidate has a comprehensive understanding of the processes and the likely defects resulting from the process.

The candidate has recorded their findings in a table which is suitable for the task.

### 3a. Practical observation form – Defect identification process

<b>Assessment ID</b>	<b>Qualification number</b>
8713-332	8713-332
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	Quality review and evaluation

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes</b> – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>	
Defect identification process	<p>The candidate prepared for the task by gathering a range of measuring equipment and materials. This was laid out with consideration for how the inspection would be undertaken.</p> <p>The candidate performed an initial visual observation of the assembly, noting a number of areas where defects appeared to be present. The candidate took care to review each area further, using measuring equipment to confirm the extent to which dimensions were outside of tolerance.</p> <p>The candidate performed a ring test using a small tap hammer to check for areas of delamination.</p> <p>The candidate followed a clear, methodical, and logical process to inspect the assembly, ensuring that all elements were inspected. All defects were identified.</p> <p>The identified defects were clearly and logically noted in a table. The candidate, provided justifications for the cause and suggested preventative measures for each defect identified.</p>	
<b>Assessor signature</b>		<b>Date</b>
Assessor A		19.12.2021



## Commentary

The candidate has carried out a thorough examination and inspection of the defective sample and has identified all of the defects within the spacer block assembly. The candidate has provided comprehensive justification for the cause and preventative measure for each defect identified.

The candidate has used a methodical approach to inspecting the sample showing good planning and organisational skills. The candidate has used the appropriate equipment to carry out the inspection and testing of the sample, for example, using a tap hammer to carry out the ring test which would provide more accurate results than using a pen or hard surface.

The results of the testing were recorded in a table which was clear and logical and suitable for the task.

## Task 3b – Quality review and recording

**(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover))**

For task 3b, candidates need to produce the following pieces of evidence:

- completed quality check sheet
- quality inspection report.

For task 3b, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - quality checking process
  - application of measuring equipment.

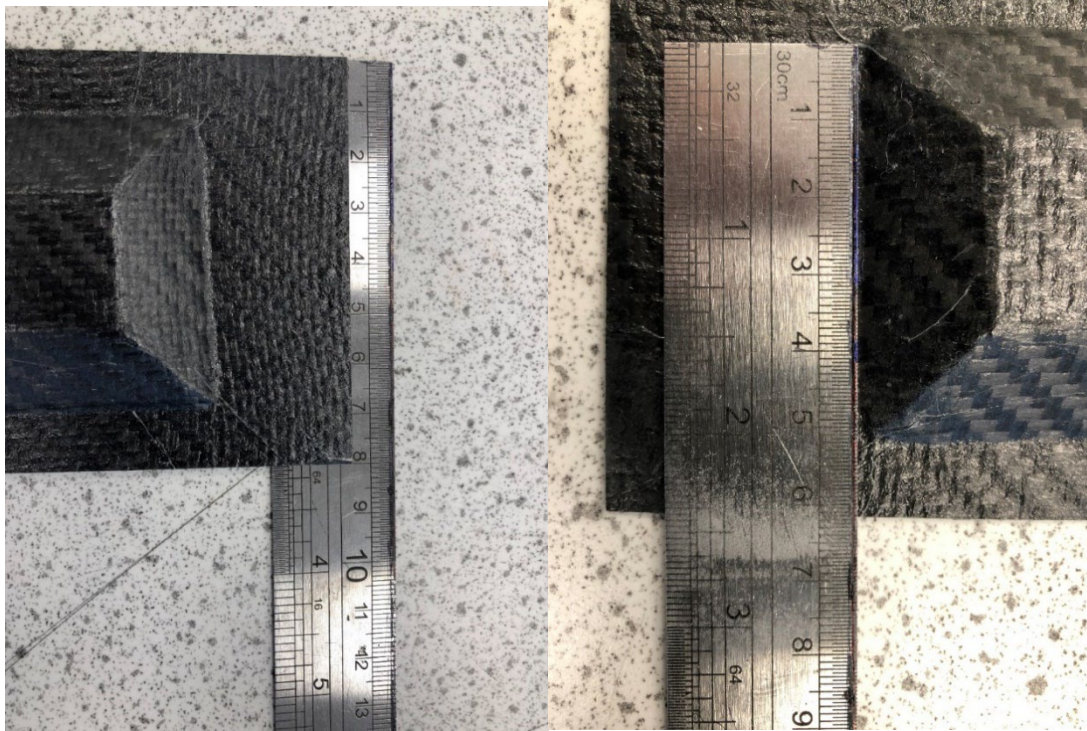
### **Photographic evidence required:**

- photographic evidence of the quality checking process being undertaken and the use of the quality check sheet – *Illustrated in task 3 photographic evidence section below (photographs 43 - 46).*

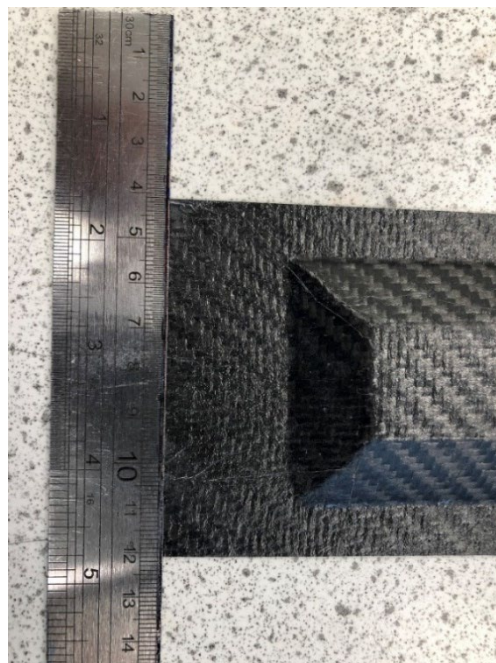
### 3b. *Photographic evidence – Quality process*

#### Quality checking process (photographs 43 – 46)

Photographs 43 and 44 – showing candidate checking the dimensions of the assembly.  
Note: some run-out of the core in terms of not being parallel with the edge.



Photograph 45 – showing candidate correctly checking straightness of short edge.



Photograph 46 - showing final check of surface finish and warp and weft pattern.



## Candidate evidence

### 3b. Completed quality check sheet

Item to be checked	Criteria to be met:	Met	Not met	Comments
Dimensions of base	180mm X 80mm $\pm$ 0.5mm	✓		base: 79.8mm wide, 180.05 mm long. Within tolerance.
Thickness of base	2mm $\pm$ 0.5mm	✓		2.01mm Meets specification
Core height	10mm $\pm$ 0.5mm	✓		Finished height: 10.05mm
"A" side	Free of defects. No visible FOD. Flat.	✓		Flat to within 0.05mm of flatness. NO FOD.
Moulding	Consolidated and laminate layers are bonded. No wrinkling of the surface.	✓		Tap test performed. Good consolidation. No obvious wrinkling to surface.
Core	No bridging, core is square with base. (orientation $\pm$ 3mm)	✓		No bridging of the material. Core is square to base. Orientation met.
All edges	No sharp edges, suitably prepared and safe edged.	✓		All safe edged using a sanding block. Measurements observed.
Final spacer block assembly	Upper and lower sections are sufficiently bonded	✓		Bonding complete, no excess bonding agent visible in joint,
	No dry fibres are apparent	✓		None
	No resin rich areas are apparent	✓		Good even distribution.
	No fibre mis-alignment	✓		Good alignment.
	Overall appearance	✓		Final appearance is very good. No FOD.

### 3b. Practical observation form – Quality review

<b>Assessment ID</b>	<b>Qualification number</b>
8713-332	8713-332
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	Quality review and evaluation

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes</b> – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>
Quality inspection and application of measuring equipment	<p>The candidate used their quality check sheet to record their findings whilst carrying out a quality check of the spacer block. The candidate referred back to the brief to confirm the final dimensions and tolerances.</p> <p>Visual checks were completed. Checks were made to the surface finish, soundness, rigidity and for FOD. No FOD or visual defects present within the finished spacer block. Rigidity was good. A tap test was performed producing good responses. The candidate checked the spacer block met the design in the brief.</p> <p>Measuring tools were selected and cleaned before use. The appropriate measuring equipment was selected and used when measuring each part of the spacer block. All dimensions were accurately measured and checked before recording on their quality check sheet.</p> <p>All tolerances within the brief were met.</p> <p>Overall an excellent attempt with excellent dimensional accuracy and a good surface finish and a usable spacer block.</p>
<b>Assessor signature</b>	<b>Date</b>
Assessor A	19.12.2021

## Commentary

*This commentary also covers the completion of the quality check sheet.*

The observation report shows that the candidate has demonstrated a comprehensive understanding of the quality review process and the checks needed to be performed.

The candidate performed dimensional checks, soundness checks and a surface check for defects, recording all findings on their check sheet (from task 1). The candidate has made no changes to the form showing a good understanding of planning and what is required for a quality check. The check sheet contains a comprehensive level of information, is set out clearly and shows the candidate has recorded the findings and provided additional observations from their quality inspection.

The candidate utilised the appropriate measuring equipment to perform dimensional checks on each of the components, recording the final dimensions achieved and checked for compliance with the tolerances against the brief.

The candidate showed a comprehensive understanding of accuracy, for example, by performing pre-use checks for cleanliness on the measuring equipment, ensuring the equipment was clean and accurate readings could be taken and whilst performing the dimensional checks the candidate took dimensions more than once to confirm the final dimension was accurate before recording the result.

All dimensions and components were checked for accuracy against the dimensions and tolerances in the given brief and accurately recorded. All dimensions were within the given tolerances.

The candidate performed checks for soundness by completing a tap test to detect the presence of delamination or debonding which is good practice for this type of composite structure.

*Note: The candidate may choose to use the quality inspection report in the task 3b to record their reasonings for the defects analysis. The assessor should utilise all the evidence presented within task 3 when attributing the marks in the marking grid.*

## Candidate evidence

### 3b. Quality inspection report

#### Quality inspection report

##### Assignment: Spacer block assembly

##### Introduction

The brief was to produce an assembly to be used as a spacer block within the aerospace industry to ensure the correct spacing of wing skins in a jig during the manufacturing process. To produce the block I followed a series of composite manufacturing processes including mould preparation, measuring and marking up, laying up, consolidation, curing and finishing. The spacer block assembly was quality inspected and tested to determine whether the assembly met the requirements of the brief.

##### Composite manufacturing processes

The spacer block was constructed using pre-preg composite material and a porcelain ceramic mould. The assembly consisted of an upper ply and lower ply arrangement each requiring a number of plies and a foam core. These were measured, marked out on the pre-preg material before being cut to the required size. These were arranged into the correct orientation and order before being laid up onto the prepared mould and directly on the foam core material to form the main component part.

The mould was then consolidated and debulked using the vacuum bagging method. A vacuum was applied to remove the air between the vacuum bag and the mould causing the composite material to be consolidated to form the laminate. A drop test was performed to check for air leaks. The mould was then cured, applying a stepped approach up to a temperature of 120 degrees centigrade, in an oven for 7 hours and 15 minutes. Once cured, the upper ply component was removed from the moulding, safe edged and abraded to the required dimensions. The assembly process repeated the laminating, consolidation and curing processes to bond the upper and lower layers to create the completed assembly. Once cured, the spacer block assembly was trimmed to the required dimensions.

In-production checks were carried out to check the positioning of the plies prior to lamination and to ensure the orientation correct was achieved. Further checks were made to ensure no foreign object debris (FOD) became encased in the plies during the laying up and lamination process which would affect the quality of the end product.

##### Product testing

A full quality inspection was carried out on the completed spacer block assembly. This included a visual check; dimensional accuracy check and a test for soundness.

I prepared my work area and collected my tools and measuring equipment. I selected a steel rule and a digital vernier calliper to measure the finished dimensions. The vernier calliper was checked for cleanliness and had been recently calibrated ensuring accurate readings could be taken.



I completed a visual check of the completed assembly, checking the finish and identifying any visible defects. There were no visible defects within the laminate, the “A” side was flat to within 0.05mm and there was no presence of FOD. The overall appearance was very good with no obvious wrinkling to the surface from the consolidation consumables. The core angles were clean and the core was square to the base. There was no excess bonding agent visible in the joint. There was a good even distribution of the resin. All dimensional checks were completed using the steel rule to measure the sides of the block and the vernier calliper to measure the core height. The final dimensions and findings were recorded on the quality check sheet. All tolerances were met.

A ring test was performed to check the soundness of the assembly and to identify any areas of delamination. The ring test is performed by lightly tapping the laminate with a coin or a tap hammer to get an acoustic response. An even pitch denotes a well bonded area and the dull or dead sound denotes areas of disbonded material. The ring test did not identify any areas of delamination. A good consolidation had been achieved.

A copy of my quality check sheet is included below:

Item to be checked	Criteria to be met:	Met	Not met	Comments
Dimensions of base	180mm X 80mm $\pm$ 0.5mm	✓		base: 79.8mm wide, 180.05 mm long. Within tolerance.
Thickness of base	2mm $\pm$ 0.5mm	✓		2.01mm Meets specification
Core height	10mm $\pm$ 0.5mm	✓		Finished height: 10.05mm
"A" side	Free of defects. Flat	✓		Flat to within 0.05mm of flatness. NO FOD.
Moulding	Consolidated and laminate layers are bonded. No wrinkling of the surface.	✓		Tap test performed. Good consolidation. No obvious wrinkling to surface.
Core	No bridging, core is square with base. (orientation $\pm$ 3mm)	✓		No bridging of the material. Core is square to base. Orientation met.
All edges	No sharp edges, suitably prepared and safe edged	✓		All safe edged using a sanding block. Measurements observed.
Final spacer block assembly	Upper and lower sections are sufficiently bonded	✓		Bonding complete, no excess bonding agent visible in joint,
	No dry fibres are apparent	✓		None
	No resin rich areas are apparent	✓		Good even distribution.
	No fibre mis-alignment	✓		Good alignment.
	Overall appearance	✓		Final appearance is very good. No FOD.

I confirm the above is a true reflection of my work.

<b>Signature:</b>	<b>Date:</b>
Candidate A	17.12.2021

### Evaluation

If I were to repeat this assessment I would like to improve on my accuracy when safe edging and finishing the block to the required dimensions. My base measurements were just within the tolerances and I would like to improve this in future runs. I would pay more attention when abrading the edges to avoid removing too much material at once and to be well within the tolerance allowed.

I would also carry out more in-production checks and spend more time ensuring each ply and component were cut to the required dimensions. For example, my core height was just within the tolerance and higher than I expected, I was too cautious with my measurements and the amount of pressure I used to debulk as not to crush the core. I would improve this by shaving off some of the

excess material to meet the required dimensions and debulk the layers before laminating the spacer block to achieve the required height.

### **Conclusion**

The design for the spacer block is good and would be suitable for the purpose it was intended as pre-preg composite materials are commonly used in the aerospace sector.

However, pre-preg composite materials are expensive and the vacuum bag consolidation method used in this process could result in non-conformities within the spacer blocks if the consolidation is not good, for example, if the bag is not sufficiently adhered to the mould and there is a loss of vacuum, or, if consumables used in the process such as the breather fabric and vinyl bagging material, leave imprints within the surface of the laminate.

The processes used to create the spacer block assembly are standard composite manufacturing processes and are more than appropriate for the task. The use of the pre-preg material and the vacuum bag consolidation method may cause longer term efficiency and financial issues if spacers have to be scrapped due to non-conformity. There is also the added burden of waste disposal costs as the materials used within the production process cannot be recycled due to the presence of resins.

### **Commentary**

The candidate has given a comprehensive description of the methods and techniques undertaken to produce the spacer block assembly and the process of performing the quality testing.

Evaluation is thorough and the candidate has identified a comprehensive range of improvements to their own performance and has provided a suggestion to improve the design and manufacturing process. For example, the candidate has identified that they would like to improve their accuracy, namely when producing the components and to carry out more in-production checks to ensure the dimensions are met in order to be well within the given tolerances.

The report contains accurate information and the correct industry terminology has been used throughout the report. The report is laid out correctly with an overview of the given task, an overview of the production process undertaken, an account of the processes taken during the quality testing and has evaluated their performance. The candidate has concluded the report with their suggestions for process improvements. The candidate has identified that the use of pre-preg composite materials is expensive and there is a risk of a higher non-conformity rate with the application of the vacuum bagging method.

The inclusion of the completed quality check sheet gives the finished sizes of the components and has captured the key data showing whether the spacer block assembly has met the required dimensions.

## **Task 3c – Handover meeting**

**(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover))**

For task 3c, candidates must provide the following evidence for handover:

- quality inspection report
- the completed spacer block assembly.

For task 3c, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - handover meeting.

### **Video evidence required:**

- video evidence of the handover meeting being undertaken.

The following task 3c supporting evidence has not been included for this version of the GSEM:

Video evidence

- video evidence showing the handover meeting.

### 3c. Practical observation form – Handover meeting

<b>Assessment ID</b>	<b>Qualification number</b>
8713-333	8713-333
<b>Candidate name</b>	<b>Candidate number</b>
Candidate A	CG12345
<b>Centre name</b>	<b>Assessment theme</b>
City & Guilds	Quality review and evaluation

Complete the table below referring to the relevant marking grid, found in the assessment pack. Do not allocate marks at this stage.

<b>Task</b>	<b>Notes – detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</b>
Handover meeting	<p>The handover meeting was very good. The candidate handed over their completed moulding and quality inspection report. The candidate was able to confidently present their moulding, describing the processes undertaken to manufacture the spacer block assembly and explained how the finished moulding meets the requirements of the assignment brief. The candidate explained their quality review process, performing dimensional checks and visual checks for defects and presence of FOD within the final assembly. They described the tap test and how the sound from the test identifies debonded areas of the composite structure.</p> <p>The candidate identified only minor defects with the spacer block. The candidate explained how they avoided cracking the laminate when demoulding and they were pleased with the overall finish and no FOD in the final assembly. The candidate explained they would have preferred a higher quality finish to the top layer and if they did this again, they would attempt to improve their adherence to tolerances, giving the example of making more in-production checks to check the tolerances were 100% accurate.</p> <p>The candidate presented their completed spacer block, confidently identifying an area for improvement during the manufacturing process. The candidate stated that the vacuum consolidation method used, the vacuum bag, was difficult to form and adjust to their satisfaction. The finish to the top layer could have been improved if they had had more control of the wrinkles and pleats after consolidation. They said they would consider using a different method if they were to do it again. They explained how the vacuum bag if not carried out well could affect the efficiency of the production and could in the long term cause some financial impact if spacers had to be scrapped due to non-conformity.</p>

<b>Task</b>	<b>Notes</b> – <i>detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.</i>
	They spoke clearly, used the correct industrial terminology throughout and conducted themselves with professionalism whilst in the handover meeting.
<b>Assessor signature</b>	<b>Date</b>
<b>Assessor A</b>	<b>18.12.2021</b>

## Commentary

The observation evidence has captured the requirements of the handover assessment themes.

The account of the handover is good, indicating the candidate had shown comprehensive subject knowledge and understanding in accurately describing in detail the composite manufacturing processes undertaken to produce the spacer block assembly. The candidate described how the quality checks were carried out and why they performed the tap test, showing good understanding of testing and the quality checks used in industry.

The candidate described the processes undertaken to avoid incurring defects within the manufacturing process and how to remedy any in a future run, for example, the final finish of the top layer and how the vacuum bag method of consolidation was difficult to assemble and when pressure was added to the bag, it was difficult to distribute all the pleats and wrinkles to achieve a high quality finish. The candidate highlighted this as one area that could be improved in a future manufacturing run.

The report states that the candidate demonstrated good communication skills, spoke clearly, presented themselves professionally and used the correct industry terminology throughout, showing a comprehensive level of understanding of industry terminology.

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