Foreign Part-145 approvals - Composite Repair Workshop

UG.CAO.00135-003

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DOCUMENT CONTROL SHEET

Reference documents
a) Contextual documents
Applicable requirements are listed in the form "FO.CAO.00136-XXX - Foreign Part-145 approvals – Documentation Index".
b) Internal documents
Applicable document are listed in the form "FO.CAO.00136-XXX - Foreign Part-145 approvals – Documentation Index".

Log of issues

Issue	Issue date	Change description
001	13/11/2013	First issue. This document is aimed to provide the applicant with guidance material supporting the application/approval, and as such has been reviewed by Rulemaking Product Support Continuing Airworthiness Section (R.4.2).
002	01/09/2014	Update of Quality documents to implement the new corporate image of the Agency and the changes to the organization structure.
003	22/10/2015	Endorsement of comments received from stakeholders

0. Introduction

0.1. Table of contents.

0.2. Definitions and abbreviations.

Abbreviations	
AMC	ACCEPTABLE MEANS OF COMPLIANCE
AMO	APPROVED MAINTENANCE ORGANISATION
AMTO	APPROVED MAINTENANCE TRAINING ORGANISATION
AOG	AIRCRAFT ON GROUND
BIPM	INTERNATIONAL BUREAU OF WEIGHTS AND MEASUREMENTS
CAO	CONTINUING AIRWORTHINESS ORGANISATION
CAP	CORRECTIVE ACTION PLAN
CIPM	INTERNATIONAL COMMITTEE ON WEIGHTS AND MEASUREMENTS
C/S	CERTIFYING STAFF
CC/S	COMPONENT CERTIFYING STAFF
EASA	EUROPEAN AVIATION SAFETY AGENCY
EU	EUROPEAN UNION
GM	GUIDANCE MATERIAL
ILAC	INTERNATIONAL LABORATORY ACCREDITATION COOPERATION
IORS	INTERNAL OCCURENCE REPORTING SYSTEM
MOA	MAINTENANCE ORGANISATION APPROVAL
MOAP	MAINTENANCE ORGANISATION APPROVAL PROCEDURES
MOC	MAINTENANCE OVERSIGHT COORDINATOR
MOE	MAINTENANCE ORGANISATION EXPOSITION
MOR	MANDATORY OCCURRENCE REPORTING
MRA	MUTUAL RECOGNITION ARRANGEMENT
NAA	NATIONAL AVIATION AUTHORITY
NRAB	NATIONAL RECOGNISED ACCREDITATION BODY
OEM	ORIGINAL EQUIPMENT MANUFACTURER
PPB	PRINCIPAL PLACE OF BUSINESS
QE	QUALIFIED ENTITY
RAB	REGIONAL ACCREDITATION BODY
S/S	SUPPORT STAFF
STCH	SUPPLEMENTAL TYPE CERTIFICATE HOLDER
TCH	TYPE CERTIFICATE HOLDER
WH	WORKING HOURS
WHOC	WORKING HOURS EASA OVERSIGHT COORDINATOR

0.3. Scope and applicability.

EASA is the Competent Authority for maintenance organisations having their principal place of business located outside the EU, as established by EASA Part 145.1 "General" and is therefore responsible for the final approval of these maintenance organisations and for establishing procedures detailing how EASA Part-145 applications and approvals are managed.

This user Guide is applicable to EASA Part-145 applicant and EASA Part-145 AMOs' (hereafter referred as maintenance organisations) having their principal place of business located outside the EU Member States and which are not certified under the provisions of a bilateral agreement signed with the EU.

The provisions of this user guide are complementary to the requirements of Part-145 regulation "as amended" and does not supersede or replace the associated regulatory requirements.

0.4. Purpose.

This user guide is issued to provide a guidance to maintenance organisations to identify key elements, to be considered as minimum requirements to comply with the EASA Part-145 regulation, when dealing with repairs on composite aircraft structure with particular reference to the development of a composite repair workshop for bonded repairs.

It is not the intent of this document to provide instructions on the repair techniques and/or to supersede the regulation requirements and/or the relevant maintenance data.

This user guide is aimed to be used by both maintenance organisations and assigned inspectors.

0.5. Entry into force

This user guide comes into effect 90 days after publication on the EASA website.

0.6. Associated instructions.

EASA has developed associated instructions (user guides, Forms, templates and work instructions), that detail specific matters, which have to be considered as an integral part of this procedure.

A complete listing of these documents, together with their applicability to the maintenance organisation or NAA / QE / EASA, is addressed in the current revision of the "Foreign Part-145 approvals – documentation Index", FO.CAO.00136-XXX (XXX identifies the revision number). Documents which are applicable to both NAA/QE/EASA and maintenance organisation are made available on the EASA Web site: http://easa.europa.eu - Continuing Airworthiness Organisations page.

Each time a cross reference is provided to another document or another chapter / paragraph of the same document, this reference is identified with grey text.

0.7. Communication.

All documents and correspondences between the maintenance organisation, the overseeing authority and EASA shall be in the English language unless otherwise agreed by EASA.

1. EASA Part-145 regulation overview

1.1 *Maintenance and/or manufacturer.*

Composites aircraft structure activities in a maintenance organisation may be considered in terms of maintenance (e.g., repair, overhaul, etc.) and/or in terms of parts fabrication (normally limited to "Fabrication of secondary structural elements").

In particular, requirements for the fabrication of parts under the scope of an EASA Part-145 approval is given in 145.A.42 (c) and related AMC. Additional guidance is provided in the User Guide UG.CAO.00131-XXX "Foreign Part-145 approvals- Parts Fabrication".

1.2 *EASA Part-145 approval (Ratings required).*

The activities described in chapter 1.1 may be performed under an Ax rating (Line or Base aircraft maintenance scope of work), under Cx rating (components maintenance scope of work) or Bx rating (engines/APU). In addition, an NDT capability is needed (e.g., to establish the presence/extent of a damage, inspect the repair at the end of the process, etc.) which may be, as an example, performed by the maintenance organisation "in the course of maintenance" within one of the above mentioned ratings.

In order to establish the correct EASA Part-145 approval for the intended level of maintenance, the requirements of Appendix IV to Annex I (EASA Part-M) apply (class and rating system to be used for the approval of maintenance organisations). The decision of whether to perform such activity within the Ax, Bx or Cx rating is determined by the maintenance data, when particular equipment and/or facilities are required for which a Workshop (Components maintenance environment) needs to be considered..

As general guidance, maintenance of aircraft composite structure may be considered under:

- an A rating (Line or Base) when performed in accordance with the aircraft maintenance data (e.g., SRM) or if agreed by the competent authority in accordance with component maintenance data, only whilst such components are fitted to the aircraft, the normal objective being for example the recovery of an AOG condition (Line Maintenance) and/or the performance of a temporary repair (Line or Base Maintenance);

  Note 1: The temporary removal of the component for maintenance, in order to improve access to that component, may be also allowed except when such removal generates the need for additional maintenance. This will be subject to a control procedure in the MOE to be approved by the competent authority. The limitation section will specify the scope of such maintenance thereby indicating the extent of approval.

  Note 2: Maintenance of aircraft composite structure outside the hangar should be avoided

- a Bx rating (engine and/or APU), when the activity is carried out on an installed engine/APU and engine and/or APU components, in accordance with engine and/or APU maintenance data or, if agreed by the competent authority, in accordance with component maintenance data, only whilst such components are fitted to the engine and/or APU. In the case of composite repairs done according to the component maintenance manual, which require the component to be removed from the engine/APU a Cx rating is to be normally expected.
- a Cx -rating (component maintenance):
  - in all cases when a component overhaul task is performed in accordance with component maintenance data;
  - In the case of components repair, when it is necessary to work on the uninstalled component and at the same time particular facilities and equipment are required for which a Workshop is to be expected, the normal objective being the performance of a permanent repair.

Fabrication of parts could be considered under both ratings provided it remains within the limitations of EASA Part- 145.

2 Composite structure repair

Basic families of composite structure.

There are two basic types of composite structures:

- Sandwich: Thin, high strength skins are separated by, and bonded to lightweight honeycomb cores;
- Solid Laminate: assembled so that the fibre orientation provides most of the desired mechanical properties and the solid matrix largely determines the environmental performance.

2.1 *Basic types of composite repairs.*

There are two basic types of composite repairs: bonded and bolted.

The choice between the two types of repairs (which is not a Part-145 decision) is associated with advantages and disadvantages in both case (e.g., bonded repairs provide more uniform stress distribution but require a more rigid process regarding control and time, etc.). In general terms non-critical repairs may be bonded or bolted, while critical repairs will be bolted.

2.2 *Compliance of the composite repairs workshop to EASA Part-145*

The bonded repair dominates today and in order to perform such repairs the maintenance organisation shall be specifically organised in terms of personnel, facilities and equipment, process control, etc.

In the following chapters of this user guide minimum requirements have been established for the set-up of a composite repairs workshop.

In the "Annex I" of this User Guide a check-list has been developed to facilitate the verification by the maintenance organisation and/or allocated inspector.

Note: This guidance material does not supersede the need to comply with any applicable maintenance data or requirement

3 General requirements

3.1 *Approved data.*

As stated in 145.A.45 (a) "The maintenance organisation shall hold and use applicable current maintenance data in the performance of maintenance, including modifications and repairs". In the 145.A.45 (b) and related AMC it is clarified what is intended to be the applicable "maintenance data".

The EASA Part-145 organisation, shall take particular care to the following topics:

- as stated in 145.A.65.(b).(4) "maintenance procedures shall be established to ensure that damage is assessed and modifications and repairs are carried out using data specified in point M.A.304".

- when specific repair data is approved outside of the European Community, conditions for acceptance may be defined in the bilateral arrangements between the Community and the competent authority of a third country. In the absence of such arrangement, the repair data shall follow the approval route as if it was designed and approved within the Community (ref. GM 21A.431(a));

- as stated in AMC 20-29 "operators and maintenance repair organisations (MRO) wishing to complete major repairs or alterations outside the scope of approved repair documentation should be aware of the extensive analysis, design, process, and test substantiation required to ensure the airworthiness of a certificated structure. Documented records and the certification approval of this substantiation should be retained to support any subsequent maintenance activities".

3.2 *Maintenance records.*

Composite aircraft structures repair is to be considered a complex maintenance task. The maintenance organisation shall use work cards to record the repair, which shall be subdivided into clear stages to ensure a record of the accomplishment of the complete maintenance task. Particular care shall be taken to record:

- Part identification: P/N, approved repair data used;

- Raw material traceability: adhesives, Prepreg[1], resins, fasteners, etc. by using a reference which allows traceability to the relevant Certificate;

- Process application, curing time, out of fridge time, etc..

- Product conformity: the records shall be able to demonstrate compliance with approved repair procedures.

3.3 *Training for composite technicians.*

The maintenance organisation is required by 145.A.30.(e) to "establish and control the competence of personnel involved in any maintenance……in accordance with a procedure and to a standard agreed by the competent authority".

A training program should be therefore developed for qualification of composite technicians. The SAE AIR 5719 and FAA AC 65-33 documents (refer to chapter 7) provide detailed guidelines and a sample course syllabus, which can be used in order to develop training/qualification programs for composite maintenance technicians.

In addition to that, It is recommended that the technicians training would include an aircraft type training module (limited to the Structure ATA chapters) at least for those structural repair technicians which are authorised for aircraft on-board repairs (e.g., requiring interpretation of the SRM to define corrective actions). Such structural repair technicians should be authorised on the specific aircraft type.

[1] Prepreg means « pre-impregnated » composite fibres, where material such as epoxy is already present.

3.4 *Safety precautions.*

Aircraft maintenance chemicals (e.g., abrasives, cleaners, corrosion preventatives, paint stripes, surface treatments, sealants, paints, solvents, etc.) may be hazardous. The maintenance organisation is responsible for the evaluation of the hazards in the workplace, awareness of personnel and to address safety precautions. The following elements should be taken into account:

- Understand the warnings for using specific chemicals as published by the chemical manufacturer. Refer to the Material Safety Data Sheet which accompany the material. This is the primary source of information when determining the risk associated with any substance used in the workplace;
- observe the aircraft/component manufacturer`s warning and cautions in the applicable maintenance data;
- Use personal protective equipment (e.g., gloves, respirators, glasses, boots, etc.) to prevent skin, eyes, respiratory and digestive tracts from being exposed to chemicals;
- Make sure that sufficient ventilation exist;
- Many combination of chemicals are incompatible and may produce toxic fumes and violent reactions. Extreme caution is required to ensure that maintenance chemicals are only mixed in accordance with the specific mixing procedure;
- Set up first-aid measures in the workplace (e.g., eye washers, etc.).

4 Peculiarities of maintenance organisation s facilities and processes

4.1 *Incoming inspection of raw material.*

145. A.42 (a) and AMC M.A.501 (d) requires the Maintenance organisation to ensure that purchased raw and consumable materials meet the required specification and has appropriate traceability (to the manufacturing and supplier source). In the case of materials used for composite repairs (e.g., Prepreg, resins, etc.) Supplier laboratory test reports should also accompany each batch of material received. In addition the maintenance organisation may perform sample verification testing (by itself or using an independent laboratory) in order to establish confidence in the quality of materials received from the suppliers.

4.2 *Material handling and storage.*

Materials used for bonded repairs are subject to specific handling and storage conditions, which requires adequate facilities and equipment (see also chapter 4.5 “NDT to support the composite”) to be available.

The conditions of storage and shelf life limitation shall be in accordance with the manufacturer`s instructions to prevent deterioration and damage to the stored items. In particular, the maintenance organisation shall refer to the Material Safety Data Sheet which accompany the material plus any other instructions which may be published in the relevant maintenance data.

In particular the maintenance organisation needs to establish procedures to cover the following aspects.

4.2.1 *Shelf life and temperature considerations.*

Materials specifications normally specify shelf life when the material is stored at the specified temperatures. Prepreg and adhesives need to be stored in sealed containers often near -18° C in order to retard the “aging” or partial curing and extend the shelf life. The period of time the material is outside the freezer shall be recorded (ex. “out time” record log) in order to demonstrate that the total allowable out of freezer time is not exceeded.

4.2.2 *Storage and handling recommendations.*

Particular care should be taken to prevent contamination of Prepreg materials and film adhesives during handling (e.g., skin oil), by the use of appropriate gloves, protective container/moisture-tight bags;

Freezer storage conditions shall be strictly controlled (regularly monitored temperature, highest allowed temperature, location/orientation of the stored roll to prevent fiber breaking or resin migration).

If the maintenance organisation cuts the roll into “kits” before refreezing, procedures should be in place to ensure the materials are not contaminated during handling and kitting process (i.e. the out time is recorded and the material is correctly bagged before refreezing).

4.2.3 *Unserviceable aircraft components incoming area.*

An incoming area for unserviceable components is expected at least in the case of maintenance organisation working under the Cx rating (components maintenance). In this area an inspection process should be carried out to ensure as a minimum the availability of a “clear work order”, approved data for the required repair, all required information from the customer/operator necessary for the issue of the CRS (e.g., identification, hours, cycles, origin, AD/SB, etc.).

4.3 *Composite bonded repair workshop.*

The workshop represents the core area of the repair process and may have different layout and size depending on the intended scope of work. For:

- an Ax/Bx rated maintenance organisation, as a minimum, a support workshop area should be expected. The possibility to perform such repairs "on-wing" outside the hangar/workshop should be evaluated case by case by the organisation;

- a Cx rated maintenance organisation, the repair process flow should be evaluated in order to establish the workshop layout that is tailored to the needs. A possible basic example is the following:

  a) Sanding room: where paint removal is performed in order to have complete access to the damaged area;

  b) Preparation room: where the component is prepared for the repair (e.g., cleaning, surface preparation, etc);

  c) Clean room: this is the area where the structural bonding is performed. Care should be taken to accomplish the repair within the remaining allowable "out time" of the material and the maintenance organisation should specify in its procedures the maximum time for accomplishment. Additional information is provided in chapter 5.2 "bonded repairs"

  d) Cure room: curing should be accomplished by controlling the appropriate parameters such as vacuum, pressure, temperature, etc. with respect to time in accordance with maintenance data;

  e) Inspection: the final inspection process is performed (e.g., NDT, CRS, records, etc.).

4.4 *Tools and equipment.*

Regardless the identified layout of the facilities, the following tools and equipment should be available and managed in accordance with 145.A.40, depending on the intended scope of work:

- Autoclave: capable of providing positive pressure and temperatures consistent with the repair process;
- Oven: an air-circulating oven capable of providing the required cure or drying temperature and equipped with vacuum capability when required;
- Temperature and pressure controller: a method of temperature and pressure control (e.g., vacuum bag, thermal blanket, heat lamp, etc.);
- Lay-up and Clean rooms: shall be environmentally and operationally controlled in terms of temperature and humidity, air filtration and pressurization (capable of providing slight positive over-pressure), designed to minimize dirt traps (e.g., sealed floors, recessed lights, etc.), subject to routine cleaning schedule (established and recorded), restricted to avoid potential contaminations (ex. eating, smoking, cutting, uncontrolled sprays, dust, oily vapours, etc.);
- Freezer: capable of maintaining the required storage conditions of materials (e.g., adhesives, Prepreg, etc.);
- Cleaning: equipment to accomplish the various cleaning processes;
- Spray room: for spraying the primer & paint finish (adhesively bonded metallic structures);
- Honeycomb core cutters: capability to cut, rout and profile the honeycomb;
- Part drying capability: should be used to dry the part from moisture before lay-up and bonding of the repair (ex. large oven with integral vacuum capability and dry air input into the vacuum bag of the part);
- Laboratory test facilities: recommended to perform in-process quality control;
- Cutting tools: diamond or carbide saws and router bits are suitable for cutting and trimming of composites;
- Kit storage area: a dedicated area for storage of kitted detail parts prior to bond helps to reduce contamination of detail parts;

4.5 *NDT to support composite repairs*

Various NTD methods should be available in order to perform the required inspections before (to establish the extent of the damage) and after the repair process (to confirm the condition of repair). The need of specific training in composite repair NDT techniques shall be assessed.

4.6 *Workshop procedures*

The maintenance organisation shall ensure the overall composite repair processes is controlled according to procedures which are available to the maintenance personnel, relevant for the work to be carried out and up to date. In particular, those procedure shall ensure that the minimum requirement of this user guide are followed (i.e. records of material handling, tooling, clean room control, work cards, etc.).

In case company procedures are used to establish material/adhesive alternatives, the associated equivalency assesment shall be appropriately documented and compliant with approved data.

5 Samples of repairs

5.1 *Bolted repairs.*

The basic concept of the bolted repair is that the damaged area is covered by a doubler which is mechanically joined to the structure using fasteners.

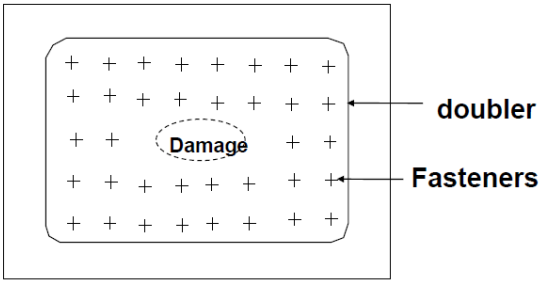

Fig. 1 *Basic elements of a bolted repair*

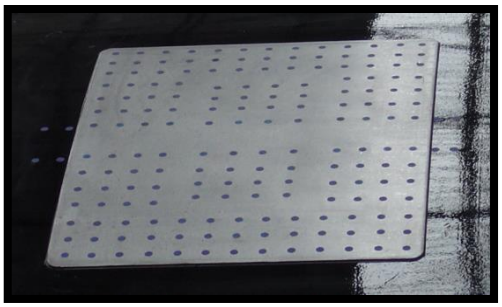

Fig. 2 *Example of bolted repair*

5.2 *Bonded repairs.*

Various types of bonded repairs are possible: resin injection, core replacement, structural repairs using Prepreg and adhesive film, bonding plates and wire mesh replacement, etc.

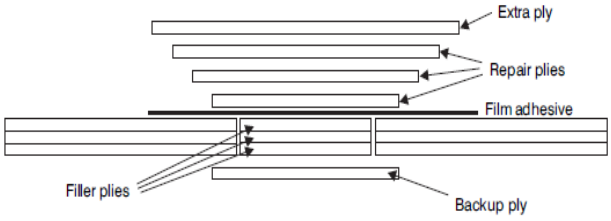

Fig.3 *Typical laminate bonded repair*

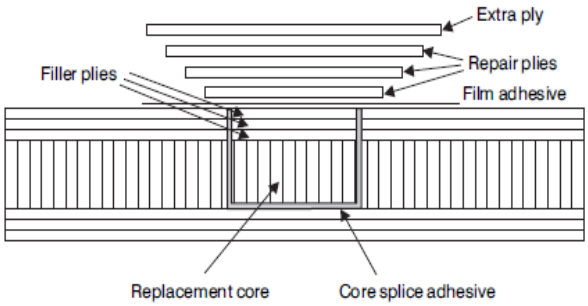

Fig.4 *Typical sandwich panel bonded repair*

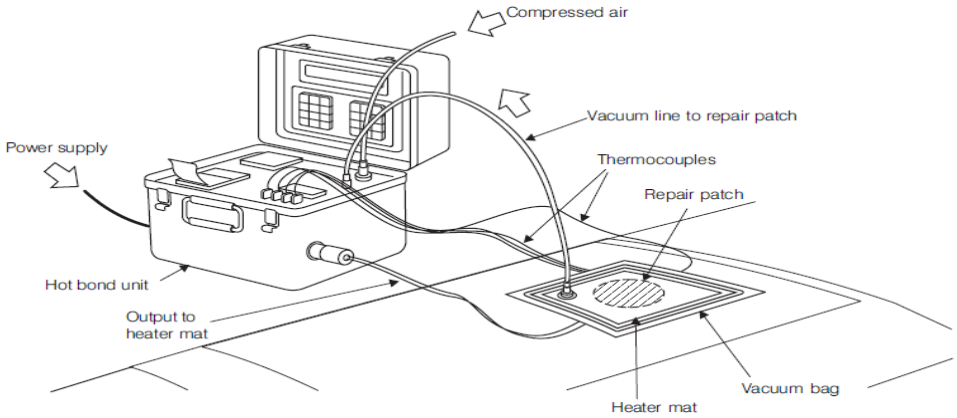

Fig. 5 *Example of portable equipment for one side access bonded repair.*

1. Reference documentation.

EASA AMC 20-29	Composite Aircraft structures
SAE AIR 5719	Teaching Points for an awareness class on “critical issues in composites maintenance and repair”
FAA AC 145-6	Repair Stations for composite and bonded aircraft structure
FAA AC 65-33	Development of Training/Qualification Programs for Composite Maintenance Technicians
FAA AC 20-107B	Composite Aircraft Structure
USAF TO 1-1A-1	General Manual for structural repair

6 Annex I – Composite repairs workshop compliance check-list

Subject	Y/N	MOE ref. LPM ref.	Remarks
Approved Data For further guidance refer to UG.CAO.00135-XXX ch. 3.1.			
Applicable/current maintenance data is used for the performance of composite repairs.			
Maintenance Records For further guidance refer to UG.CAO.00135-XXX ch. 3.2.			
Work cards records allow to prove that all maintenance requirements have been complied with. Examples include drying times, atmospheric workshop conditions during the repair, batch numbers of materials etc.			
Training for composite technicians For further guidance refer to UG.CAO.00135-XXX ch. 3.3.			
Maintenance personnel: ☐ adequately trained, qualified and authorised by the maintenance organisation for composite repairs. ☐ Staff authorised for a/c "on-wing" repairs shall receive a/c type structural course			
Training syllabus: ☐ available ☐ syllabus contents is adequate for the type of repairs carried out ☐ SAE AIR 5719 & FAA AC 65-33 Guidelines			
Training records are available			
Safety Precautions For further guidance refer to UG.CAO.00135-XXX ch. 3.4.			
Safety precautions are observed (refer to Material Safety Data Sheet)			
Incoming Inspection of raw materials For further guidance refer to UG.CAO.00135-XXX ch. 4.1.			
Incoming inspection of raw/consumable materials ensures they meet the required specification and have appropriate traceability: ☐ Conformity statement to specification ☐ Manufacturer and supplier traceability ☐ Laboratory test reports			

Subject	Y/N	MOE ref. LPM ref.	Remarks
Material handling and storage For further guidance refer to UG.CAO.00135-XXX ch. 4.2.			
Material handling and storage is done in accordance with the manufacturer`s instructions: ☐ Controlled temperature storage area for materials/adhesives (i.e. freezer) ☐ Manufacturers specifications for storage conditions and shelf life followed (refer to Material Safety Data Sheet) ☐ Quarantine area available			
Procedures exist to ensure the rolls of prepreg are handled correctly. The out time is recorded during the goods-in inspection and the roll is not contaminated during the thawing out process prior to inspection. Any faults in the levels of resin saturation of the prepreg should be noted			
If the maintenance organisation cuts the roll into “kits” before refreezing, procedures shall be in place to ensure the materials are not contaminated during handling and kitting process (i.e. the out time is recorded and the material is correctly bagged before refreezing)			
Facility Requirements For further guidance refer to UG.CAO.00135-XXX ch. 4.3.			
The size and structure of facilities is appropriate for the type of work carried out: ☐ Sanding room ☐ Preparation room ☐ Clean room (* see next check item) ☐ Cure room ☐ Inspection room			
(*) A Clean room for structural bonding is in place. Cross refer to the maintenance data (i.e. SRM, CMM, etc.) for special environmental conditions required for the repairs. ☐ Temperature/humidity control ☐ Positive pressure ☐ Air filtration system available ☐ Adequate lighting available. ☐ Records of the environmental conditions available, if applicable			
Cleanliness and adequate separation of dirty and clean areas. (rub down area segregated from lay-up shop): ☐ cleaning schedule ☐ check if any vent areas into facility are local to contamination sources (i.e. kitchen vent outlet, etc.)			
Racking to store the repaired items awaiting repair/ finished items and adequate segregation/identification of the two.			

Subject	Y/N	MOE ref. LPM ref.	Remarks
Tools & equipment For further guidance refer to UG.CAO.00135-XXX ch. 4.4. For tools management and calibration refer to UG.CAO.00132-XXX			
Overall tool record listing all tooling kept in the workshop			
Tools are adequate for the type of repairs carried out in the scope of work (Includes hand tools, air tools, vacuum tools, lay-up moulds etc., where applicable.) ☐ special tools/equipment required by the maintenance data (i.e. Autoclave, Oven, Vacuum Bag, Honeycomb cutters) ☐ Use of alternative tools			
Control of composite workshop tooling if used outside the workshop. Record keeping of what tooling was used on what area or aircraft registration.			
Calibration of tooling including vacuum, temperature measuring and general measuring instruments.			
NDT For further guidance refer to UG.CAO.00135-XXX ch. 4.5.			
NDT capability to support composite repairs: ☐ If NDT is used to determine damage level prior to repair or integrity of repair, evaluate technique used. ☐ NDT after damage removal, if appropriate, to ensure no further damage caused by removal process			
Personnel is trained in composite repair NDT techniques.			
Workshop procedures For further guidance refer to UG.CAO.00135-XXX ch. 4.5.			
Workshop procedures are: ☐ Available and up to date ☐ Relevant for the work carried out			
Workshop procedures cover the minimum requirement of UG.CAO.00135-XXX. In example: ☐ recording method used to monitor “out time” of materials Handling of materials ☐ Use of tooling including autoclaves and specific vacuum equipment used			
In case company procedures are used for material/adhesive alternatives, check equivalency assessment is appropriately documented and in accordance with approved data.			