



AEROSPACE RECOMMENDED PRACTICE

ARP5319™

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Impregnation of Dry Fabric and Ply Lay-Up

RATIONALE

ARP5319 has been reaffirmed to comply with the SAE Five-Year Review policy.

TABLE OF CONTENTS

1. SCOPE	2
1.1 Purpose	2
2. REFERENCES	2
2.1 Applicable Documents	2
2.1.1 SAE Publications	2
2.1.2 Applicable References	2
3. GENERAL	3
4. PERSONAL PROTECTIVE EQUIPMENT	4
5. TOOLS AND MATERIALS	5
5.1 Tools	5
5.2 Consumable Materials	5
6. PREPARATION OF THE REPAIR AREA	6
7. PREPARATION FOR PLY IMPREGNATION	10
8. IMPREGNATION AND PLY LAY-UP OF DRY FABRIC	12
8.1 Ply Impregnation and Lay-up Method 1 - "Manual Impregnation & Squeeze-Out"	12
8.2 Ply Impregnation and Lay-up Method 2 - "Manual Impregnation & Vertical Bleed"	14
8.3 Ply Impregnation and Lay-up Method 3 - "Vacuum Impregnation & Vertical Bleed"	16

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1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) describes and gives general guidelines on use and applicability of standard methods for impregnating dry fabric and lay-up of the impregnated plies.

The methods of impregnating dry fabric and ply lay-up described in this document have specific application and are not interchangeable. The methods should only be used when specified in an approved repair procedure or with the agreement of the Original Equipment Manufacturer (OEM) or regulatory authority.

1.1 Purpose:

The purpose of this document is to provide standard methods for impregnation of dry fabric and ply lay-up that may be referenced in repair documents produced by airlines or airframe and engine manufacturers. It is intended that this document be one of a number of ARPs that will cover other aspects of the techniques required to perform composite repairs. This will provide a suite of available repair techniques that are acceptable for use throughout the commercial aircraft industry.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of all SAE technical reports shall apply. In the event of a conflict, the OEM Manuals take precedence over this document.

2.1.1 SAE Publications: Available from SAE, Commonwealth Drive, Warrendale, PA 15096-0001.

AIR4844	Composites and Metal Bonding Glossary
ARP4916	Masking and Cleaning of Epoxy and Polyester Matrix Thermosetting Composite Materials
ARP4977	Drying of Thermosetting Composite Materials
ARP4991	Core Restoration of Thermosetting Composite Components
ARP5143	Vacuum Bagging of Thermosetting Composite Repairs
ARP5256	Resin Mixing
AIR5367	Machining of Epoxy and Polyester Matrix Thermosetting Composite Structures

3. GENERAL:

The impregnation of dry fabric with mixed resin is a very critical step in the wet lay-up process. The techniques and care used here will greatly influence the outcome of the repair.

The pot life of laminating resin systems is short and dependent on the quantity mixed, ambient temperature, and humidity. Make sure that all the preparatory tasks are completed prior to mixing the resin and impregnating the fabric.

The warp and fill (also called weft) direction of the fabric is an important part of the fabric behavior. The detailed definitions can be found in AIR4844. The warp direction is considered to be the 0° direction of the fabric. The type (style) and weight of the fabric plays a key role in the wetting behavior and capability.

The impregnation process is designed to replace the air between the fibers of the fabric weave with resin. Air can be easily trapped within the weave and between plies if care is not taken. An excess of trapped air can result in unacceptable levels of porosity or delamination. It is essential that the person performing the repair has been trained in the specific techniques and methods to be used.

For the purposes of this document, it will be considered that the impregnation process has two steps. The first step is to wet the fabric with the laminating resin. The second step is to remove the remaining air from the plies following lay-up on the repair area.

3.1 Techniques to Wet the Fabric with Laminating Resin:

The “Manual Impregnation” technique uses light pressure from a spatula, hard roller or brush to spread the resin and remove the air from the fabric.

The “Vacuum Impregnation” technique uses vacuum pressure to assist in removing the air from the fabric whilst a squeegee is used to spread the resin.

3.2 Techniques to Remove Air from the Lay-up:

The “Squeeze Out” technique uses the pressure of a squeegee or roller to force the resin into the lay-up, thereby displacing the air. This removes the air before the start of the resin cure cycle.

The “Vertical Bleed” technique relies on vacuum pressure and capillary action to move the resin into the lay-up and transport the air into a bleeder ply. This removes the air during the resin cure cycle.

3.3 The Combined Techniques:

The aforesaid techniques have been combined by industry into three methods that are presented in this document:

Method 1 – “Manual Impregnation & Squeeze Out” – This method requires a hard back-up surface capable of withstanding the force applied by the squeegee. This technique cannot therefore be used when open cell core is exposed in the repair area. Variation in the resin content of the cured laminate can occur due to variation or pressure applied to the squeegee.

Method 2 – “Manual Impregnation & Vertical Bleed” – This is the classic method. Variation in resin content of the cured repair laminate can occur due to the particular bleeder material used and the number of repair plies.

Method 3 – “Vacuum Impregnation & Vertical Bleed” – This method facilitates impregnating large quantities of material in a short period of time. Variation in resin content of the cured repair laminate can occur due to the particular bleeder material used and the number of repair plies.

4. PERSONAL PROTECTIVE EQUIPMENT:

General guidelines are given throughout this document regarding the relative hazards to the user and the environment from the materials and equipment listed. However, the user should obtain the Material Safety Data Sheet (MSDS) or equivalent from the supplier prior to using any of the materials. The relevant environmental health and safety organizations should be consulted regarding safe use of the materials. Material suppliers are also a good source of information for the safe use of their materials.

The personal protective equipment required to safely handle a specific material is identified in the supplier's MSDS.

The areas of the body most likely to be affected when working with resins are the skin, eyes, and respiratory tract. Guidance is given on the typical kinds and uses of personal protective equipment that may be required.

Before using any type of personal protective equipment, training should be given to ensure that the equipment is used safely and correctly.

- a. Exhaust System: It should be capable of providing a good flow of fresh air to personnel and keeping fume concentrations below the allowable limits. Control of the emission shall be in accordance with local and national regulations.
- b. Eye Wash: Eye wash facilities shall be used if eyes are exposed to resin, hardener, cleaning materials or solvents. The eye wash facility should conform to the local standards and should be capable of hands-free operation to allow the user to hold the eyelids open while operating the eye wash.

4. (Continued):

- c. **Gloves:** Gloves are needed to protect the user's hands from contact with the resin. Refer to the material MSDS sheet for the appropriate type of gloves. The gloves should allow full hand dexterity and shall not be made from, or coated with, any material that may contaminate the repair materials or repair area.

5. TOOLS AND MATERIALS:

The basic tools and consumable materials that are used for impregnation and repair ply application are identified below. Due to the large range of products commercially available, only general guidance is given in this document. The user of these tools and materials is required to evaluate the repair application and determine the appropriate selection.

5.1 Tools:

- a. **Spatula:** A clean spatula is used to transfer the resin from the mixing container and, in some cases, spread the resin throughout the fabric. Typically a metal spatula or a wooden tongue depressor is used.
- b. **Squeegee:** A squeegee is used to force the resin into the fabric and to move the entrapped air out of the lay-up. Typically a nylon squeegee with rounded ends is used. A hard roller can be used in place of a squeegee.
- c. **Roller:** A hard roller (e.g., nylon, metal) can be used to spread resin or instead of a squeegee to move entrapped air out of the lay-up. A soft roller (e.g., short nap) is used to apply thickened resin to the surface of exposed honeycomb core. The material used for the soft roller must not contaminate the repair materials or the repair area.
- d. **Knife:** A knife capable of cutting fabric and films is needed. Typically a razor utility knife is used.
- e. **Scissors:** Scissors capable of cutting fabric and films can be used in place of a knife.
- f. **Marking Pen:** A permanent marker that will not contaminate the resin.
- g. **Marking Pencil:** A colored pencil that will not contaminate the resin.

5.2 Consumable Materials:

- a. **Parting Film:** A parting film or release film is used to support the fabric and contain the resin during the impregnation process. A color film is recommended to visibly determine if the parting film is on or off the plies prior to lay-up. Typically a nylon bagging film, polyethylene film, polyester film, polytetrafluoroethylene (PTFE) film, polyvinylfluoride (PVF) or fluorinated ethylene propylene (FEP) film is used. The film thickness should be 0.003 inch (0.076 mm) or thicker.

5.2 (Continued):

- b. **Drawing Film:** A drawing film is used to draw the outlines of the repair plies and to make templates. It may also be used to support the fabric and contain the resin during the impregnation process. The film should readily allow lines to be drawn on it. Typically a polyester film, polyethylene film, or nylon bagging film is used. The film thickness should be 0.003 inch (0.076 mm) or thicker.
- c. **Peel Ply:** A peel ply is an open-weave material applied directly over the surface of a laminate. It is removed from the laminate following cure and protects the surface from contamination during repair operations. Peel ply is typically a polyester or heat-set nylon material. Refer to the Repair Document for specific materials.
- d. **Thermoplastic Film Tape:** Thermoplastic film tape, commonly known as flashbreaker tape, is used to cover areas around the repair where excess resin can flow. The tape used is typically nylon, polyester or polytetrafluoroethylene (PTFE) film, coated on one side with a pressure sensitive adhesive.
- e. **Container:** A clean container is needed to contain the resin during measuring and mixing. The container must be suitable for the resins used. The recommended containers are translucent high density polyethylene (HDPE), glass, metal, uncoated paper or non-waxed paper, polytetrafluoroethylene (PTFE), or polypropylene, with a height-to-diameter ratio of one. Contaminated or corroded containers or wax-coated paper cups or containers should not be used. Such containers will result in contamination of the resin. A disposable plastic or non-waxed paper container is typically used to contain the resin prior to applying it to the fabric.
- f. **Brush:** A short-bristled brush is used to spread the resin for impregnation and to wet dry areas. The bristles on the brush must be suitable for the resins used. Natural bristles are recommended.

6. PREPARATION OF THE REPAIR AREA:

This section outlines the preparation of the repair area for a wet lay-up repair. These tasks must be completed prior to resin mixing because the pot life of the laminating resin is time limited. It is assumed that the repair area is appropriately abraded for a scarfed, stepped, or scab (non-flush) repair. Refer to the Repair Document and AIR5367 for abrading information.

- a. Clean and dry the repair area. Refer to ARP4916, Composite Cleaning Method 4 or 5, ARP4977 and the Repair Document.
- b. Draw a reference outline on the component to be repaired as illustrated in Figure 1. This outline should extend beyond the largest repair ply, plus approximately 0.5 inches (13 mm). This is the line for the surface abrasion limit.
- c. Mask the area outside the drawn reference outline for easy removal of the excess cured resin and auxiliary materials. Refer to ARP4916, Masking Method 5.