



AEROSPACE RECOMMENDED PRACTICE

ARP4991**REV. A**

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Superseding ARP4991

Core Restoration of Thermosetting Composite Components

RATIONALE

ARP4991A has been reaffirmed to comply with the SAE five-year review policy.

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Documents

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FIGURE 1 - SANDWICH STRUCTURES DAMAGE TYPES

FIGURE 2 - RESTORATION WITH RESIN METHOD

FIGURE 3 - CORE RESTORATION WITH POTTING - METHOD 1 PARTIAL DAMAGE REMOVAL

FIGURE 4 - CORE RESTORATION WITH POTTING - METHOD 2 FULL DAMAGE REMOVAL

FIGURE 5 - CORE RESTORATION WITH HONEYCOMB.....

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FIGURE 8 - FULL DEPTH CORE RESTORATION WITH HONEYCOMB - METHOD 1.....

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FIGURE 10 - PARTIAL DEPTH CORE RESTORATION WITH HONEYCOMB - METHOD 1

FIGURE 11 - PARTIAL DEPTH CORE RESISTANCE WITH HONEYCOMB - METHOD 2

FIGURE 12 - C ORE CLOSING WITH ADHESIVE PASTE - METHOD 1

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) describes standard methods for restoring damaged core on commercial aircraft sandwich structures. The methods shall only be used when specified in an approved repair procedure or with the agreement of the Original Equipment Manufacturer (OEM) or regulatory authority. The repair materials shall be defined in the approved repairs referencing these methods.

1.1 Purpose

The purpose of this document is to provide a set of standard methods 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. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AIR4844	Composite and Metal Bond Glossary
ARP4916	Masking and Cleaning of Epoxy and Polyester Matrix Thermosetting Composite Materials
ARP4977	Drying of Thermosetting Composite Materials
ARP5143	Vacuum Bagging of Thermosetting Composite Repairs
ARP5144	Heat Application for Thermosetting Resins Curing
ARP5256	Mixing Resins, Adhesives and Potting Compounds
ARP5319	Ply Impregnation
AIR5367	Machining of Epoxy and Polyester Matrix Thermosetting Composite Structures

2.2 Applicable References

Original Equipment Manufacturers (OEM) Repair Manuals

3. GENERAL

Sandwich structures can suffer various types of damage (Figure 1):

- a. Disbonding of the skins with or without core damage.
- b. Damage to one or both skins. The core is generally also damaged.
- c. Contamination by water, hydraulic fluid, oil, etc.
- d. Delamination of the plies within the skin. This is often associated with other damage at an impact site.

As one of the elements in restoring the structural integrity of the part, the load carrying capability of the core will, in general, have to be restored either by stiffening the core or replacing it.

This document addresses the various techniques found in repair manuals. Only a selection of those commonly used are proposed as methods. These methods are given a name and number to allow further development of the document and to facilitate referencing.

In this document, it is assumed that the damaged area has been cleaned, dried and that the damage has been evaluated, the repair area prepared and one skin has been repaired or is undamaged.

4. MATERIALS

4.1 Repair Materials

In addition to repair design considerations, material selection is often influenced by the repair conditions (aircraft or shop repair), and by the part orientation. Exothermic effects (heat generated by resin curing) should be also considered, especially when potting is used. The approved repair procedure shall specify which materials to use. The type of material that may be used will be discussed in the following paragraphs or sections with each technique.

4.2 Associated Materials

In addition to the repair materials, various other materials are needed such as cleaning agents, bagging materials, etc. Information on these materials may, in general, be found in associated ARPs or manufacturer's documentation.

5. CORE RESTORATION

5.1 Core Filling With Resin

When using this method, consideration should be given to the skin strength reduction due to the holes.

5.1.1 Applicability

This method applies to small damage when skins are not punctured. The skins can be disbanded from the core or dented with possible degradation of the honeycomb underneath. To be effective this process should only be applied to a part with an uncontaminated core.

CAUTION: When the core is thicker than 0.5 in (12.5 mm), it is preferable not to fill the core completely as exothermic effects can damage the part or cause a fire. Complete filling of the cells also cause distortion of the opposite skin due to the shrinkage of the resin during cure.

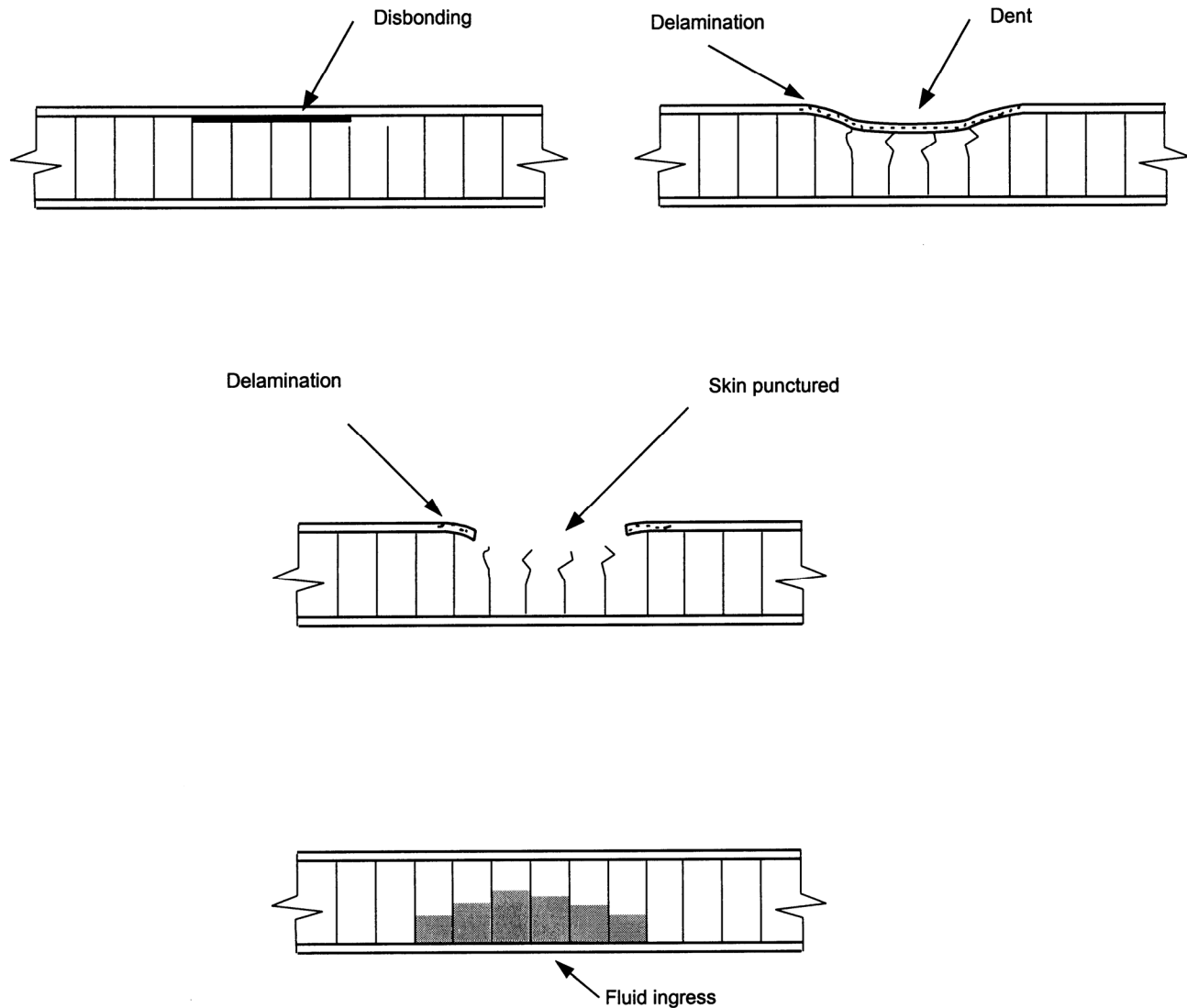


FIGURE 1 - SANDWICH STRUCTURES DAMAGE TYPES

5.1.2 Materials

Low viscosity resins or adhesives for injection with a syringe and preferably with a fast cure time and a low cure temperature should be used.

5.1.3 Core Filling With Resin Method (Figure 2)

Procedure:

- a. Refer to the repair instructions for the following information:
 1. The type of resin to use.
 2. Cure time and temperature.
- b. Drill (without lubrication) 0.1 in (2.5 mm) diameter holes 0.4 in (10 mm) apart in the damage area. Drill a minimum of two holes. Use a vacuum cleaner to remove dust while you drill the holes.

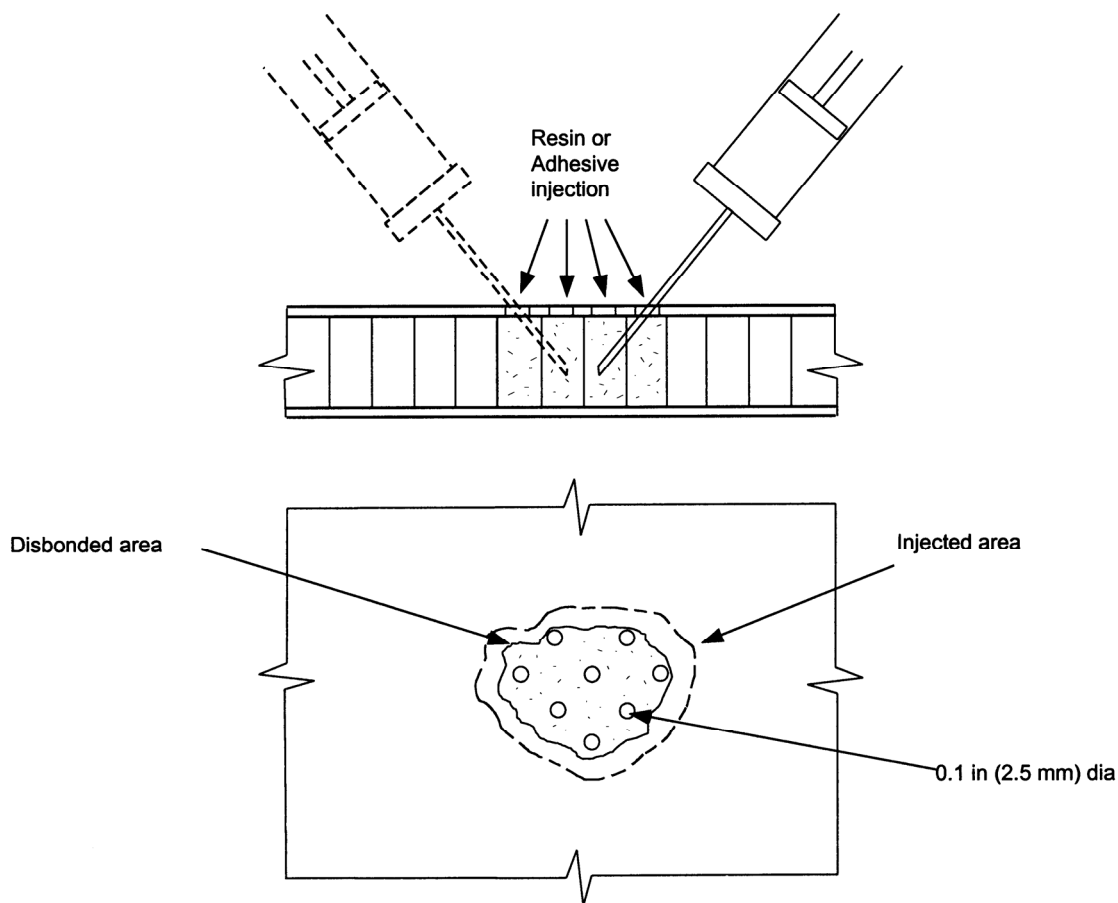


FIGURE 2 - RESTORATION WITH RESIN METHOD

- c. Remove any remaining dust.
- d. Look for liquid contamination. (Refer to ARP4977) If contamination is found, the part is not repairable by this method.
- e. Calculate the amount of resin that will be needed to fill the core to the depth specified. Prepare the resin in accordance with ARP5256 or OEM Repair Instruction.

CAUTION: When using air or mechanically operated syringes, avoid applying too much pressure as it can damage the honeycomb cells.

- f. Fill a clean syringe with the resin.

CAUTION: Depending on the design used, when the part cannot be turned over, the core should be filled and cured in steps if thicker than 0.5 in. This is recommended to avoid exothermic effects and possible damage to the part.

- g. Through each hole insert the syringe at an angle to reach the surrounding cells and fill them to an approximate height of 0.3 to 0.5 in (7 to 12.5 mm). If the part cannot be turned so that the repair surface is down, fill the honeycomb cells fully.
- h. Put an adhesive tape that can be readily released over the holes and, if possible turn the component so that the repair surface faces down.

- i. Let the resin cure.
- j. Remove the tape. Make sure that the holes are sealed with resin. If any holes are not sealed, repeat the procedure for the unfilled holes.

5.2 Core Restoration With Potting Compound

When core restoration with potting is requested in a repair directive it should be specified as a core restoration method (see 5.2.4) combined to a potting application method (see 5.2.3).

5.2.1 Applicability

Core restoration with potting generally applies to relatively small damage when one skin only is punctured. Potting quantity may be limited for weight reasons or to avoid damage due to exothermic effects and partial core filling might be required. As a general rule, potting thickness should not exceed 0.5 in (12.5 mm).

5.2.2 Materials

Different potting materials may be used for this application.

- a. Resin or adhesive filled with an additive to obtain a thick paste (refer to ARP5256).
- b. Ready to use potting compound.

5.2.3 Potting Application

The remaining honeycomb in the area to be potted may be filled partially or completely (Potting application Method 1 and Method 2 respectively). When no honeycomb remains, the cavity has to be completely filled (Potting application Method 3).

5.2.3.1 Potting Application - Method 1 - Complete Honeycomb Core Filling

A spatula or a pressure gun can be used.

- a. Method with a spatula:
 - 1. Apply part of the potting in the core cavity.
 - 2. Force the potting inside each cell by moving the spatula over the honeycomb in different directions.
 - 3. Add more potting and force it into the honeycomb until no more potting can be pushed into the cells.
 - 4. Fill the remaining core cavity and make the surface smooth and above the surface contour of the surrounding area to take into account resin shrinkage.

CAUTION: Take care when applying pressure to the potting in the cells. Damage can occur.