PROCEDURES TASK GROUP
Task Group Chair: Eric Chesmar, United Airlines
Task Group Vice-Chair: Jeff Berner, Boeing
Task Group Mission Statement:

- Evolve composites repair practices into a model similar to that of metal industry through acceptance and implementation of standards.

Deliverables:


5 Year Review – No Action Required This Meeting:
  • AIR6291 – document will be revised, not re-affirm.

Immediate Action Required: None

Stabilized: None
**AIR6292 Composite Repair Guidelines:**

**SCOPE:**

To be used as a process verification guide for evaluating implementation of key factors in repair of composite parts or assemblies at a repair site.

The intent of the guide should be for it to be used in conjunction with a substantiated repair to promote consistency and reliability.

The verification guide will present a check list of best practice known for existing repair performed today on in service aircraft and can be used to assess quality of the repair instructions (damage assessment, removal, equipment/personnel level and training, repair steps, inspection, assembly/installation documentation release, traceability) and repair site capability.
**Differences between AIR6291 Metalbond and AIR6292 Composites**

- **Damage evaluation and removal** is more complicated for Fiber Reinforced Composites, e.g. fluid ingestion, damage propagation.

- **Moisture/Fluid removal** is a key process step. A number of industry best-practices are to be documented.

- Fiber Reinforced composite repairs are more **varied in size and complexity**. Document will address small repairs under heat lamp or heat blanket and extensive autoclave repairs.

- **Thermal management** is a key process to ensure the repair is processed as required by the Repair Document. Document will include discussion on thermocouple placement, thermal management, different types of heat sources, and best-practices for fully documenting the cure profile.

- Fiber Reinforced composite repairs have **less clearly defined quality inspection** points. Industry best-practices often incorporate a “second set of eyes” rather than discrete quality assurance inspection.
Examples of Lessons Learned

DAMAGE TO SURFACE PLIES AFTER FITTING REMOVAL
Composites are weak in out-of-plane loads. When separating parts, out-of-plane loads are needed. Even sealant is strong enough to cause fracture between the fiber layers.

CAUTION: Failure to use proper disassembly techniques on parts with fay surface sealant may cause damage to the base assembly, resulting in additional repairs or a scrapped part.

DAMAGE TO HOLES AFTER FASTENER REMOVAL
Fastener removal can cause damage in composite as the removal direction is a weak direction for the laminate. Removal with percussion tools should be avoided. Fiber breakout and delamination could occur.

BEST PRACTICE: A fastener can be easily removed, after drilling out of a fastener head or removal of the fastener collar (if present), by twisting the fastener shank using pliers before gently pressing out of the fastener.
Qualified Bonding Process / System

CMH-17 Vol 3 Chapter 10 Task Group is revising Sections 10.5 and 10.6. Draft Bonding Surface Preparation section to be posted soon to the CMH-17 bonding committee forum soon. One round of informal comment/resolution from the forum will be conducted and then it will go to the CMH-17 Yellow Pages balloting process. CMH-17 uses terminology of a bonding system.

ARAC Working Group is drafting revision C to AC20-107B COMPOSITE AIRCRAFT STRUCTURE.

CACRC Procedures Working Group developing AIR6292 Guidelines for Repair Process Evaluation of Fiber Reinforced Composite Bonded Structure. The document is intended to satisfy the need for a checklist of best practices in implementation of tooling, process steps, and quality controls that help to make sure that a previously substantiated repair design and process requirements are met.
Qualified Bonding Process / System

CMH-17 Draft Section covering Surface Preparation for Adhesive Bonding

5.9.5.1.1 Overall Surface Preparation Goal

... To validate/verify surface preparation meets the goals for an application, testing of the bonding system must be conducted based on the specific requirements of the application. This means testing all elements of the system (substrates, surface preparation(s), adhesive primer (if used), and adhesive) processed together as will be done for the actual application. Testing must evaluate both initial adhesion and long-term durability in service, particularly environmental durability, and consider all corners of the application and processing envelopes for the materials. For instance, adhesive and adhesive primer thicknesses should be considered at the low and high ends that could occur for the application. Potential variations in cure temperatures, heat-up rates, and material out times should be assessed at the extremes possible for the application. Evaluation of these variables should include the effects of environmental conditions expected in service (e.g., moisture, temperature, chemicals).

...
Qualified Bonding Process / System

CMH-17 Draft Section covering Surface Preparation for Adhesive Bonding

5.9.5.1.4 Additional Surface Preparation Considerations

... Validated procedures based on application requirements must be developed considering the above factors. Repair bonding, particularly on-aircraft or on-component, is especially challenging due to greater limitations associated with many of these factors. Validation testing must include the entire material system in the bonded joint processed as it will be for the application, including testing at the allowable limits of the process variables and perhaps beyond (to support engineering dispositions in the event processes deviate from requirements).

The validated processes must be well documented and properly executed. Though most surface preparation steps are not intrinsically difficult, many steps must be executed properly to achieve the desired result. Robust processes are of great help in this regard. In fact, stable materials and processes have been identified as necessary to successfully transition adhesive bonding technology [Intro-REF8, REF9].

...
Qualified Bonding Process / System

c. Structural Bonding. Bonded structures include multiple interfaces (e.g., composite-to-composite, composite-to-metal, or metal-to-metal), where at least one of the interfaces requires additional surface preparation prior to bonding. The general nature of technical parameters that govern different types of bonded structures are similar. A qualified bonding process is documented after demonstrating repeatable and reliable processing steps such as surface preparation. It entails understanding the sensitivity of structural performance based upon expected variation permitted per the process. Characterization outside the process limits is recommended to ensure process robustness. In the case of bonding composite interfaces, a qualified surface preparation of all previously cured substrates is needed to activate their surface for chemical adhesion. All metal interfaces in a bonded structure also have chemically activated surfaces created by a qualified preparation process. Many technical issues for bonding require cross-functional teams for successful applications. Applications require stringent process control and a thorough substantiation of structural integrity.
Qualified Bonding Process / System

Qualified Bonding Process

The characterization and control of specific parameters used when surface preparation is required to at least one of the structural interfaces prior to bonding. A qualified bonding process is documented after demonstrating repeatable and reliable processing steps. A qualified bonding process entails understanding the sensitivity of structural performance based upon expected variation permitted per the process. A qualified bonding process entails both development and documentation of the process, and demonstration that the process can be executed by the user. Refer to AC20-107B, para.6c.

Qualified Bonding System

The specific combination of substrate, adhesive, and type of surface preparation controlled and validated under a Qualified Bonding Process.
APPENDIX C – PROCESS CHECKLIST

Critical Process Checklist is developed from document by key word search:
- CAUTION
- strength
- durability
- critical
- integrity

Critical Process Checklist contains a brief statement of checklist item and cross-references paragraph where more detailed description is contained.

Critical Process Checklist requires validation by member community to ensure that it sufficiently captures the process check points required to ensure a reliable repair.
## PREPARATION STEPS PRIOR TO REPAIR ACCOMPLISHMENT

<table>
<thead>
<tr>
<th>Step Description</th>
<th>Notes</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consider Repair Option</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONSIDER REPAIR PROCESS CONTROLS</td>
<td>- Evaluate capability of controlling process for the repair options</td>
<td>4.3.4.D.</td>
</tr>
<tr>
<td>ASSESS COMPONENT FOR HEATING/REPAIR TEMPERATURES</td>
<td>- Make sure component can be cured at high temperature in oven or autoclave. Check for previous repairs.</td>
<td>4.3.4.D.</td>
</tr>
<tr>
<td>ADHERE TO REPAIR DOCUMENT APPROVED MATERIALS</td>
<td>- Make sure repair materials are qualified for the process</td>
<td>4.3.4.E.</td>
</tr>
<tr>
<td>Make Sure Facilities Are Satisfactory</td>
<td>- Make sure repair materials are qualified with each other</td>
<td></td>
</tr>
<tr>
<td>MINIMIZE RISK OF CONTAMINATION</td>
<td>- Confirm facilities are adequate to protect bond surfaces from contaminants.</td>
<td>4.3.8.A(2)</td>
</tr>
<tr>
<td>Remove Damage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHERE TO MACHINING PROCEDURES</td>
<td>- Use dry machining to remove damage, unless otherwise permitted by Repair Document</td>
<td>4.3.11.C(2)</td>
</tr>
<tr>
<td>REMOVAL OF LIQUID CONTAMINANTS</td>
<td>- Remove liquid contaminants.</td>
<td>4.3.11.A(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.11.D(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.11.D(2)</td>
</tr>
<tr>
<td>REMOVAL OF ABSORBED CONTAMINANTS</td>
<td>- Remove absorbed contaminants. Use NDI to detect moisture in core.</td>
<td>4.3.11.A(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.3.11.D(1)</td>
</tr>
<tr>
<td></td>
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<td>4.3.11.D(2)</td>
</tr>
<tr>
<td>ASSESS COMPONENT FOR HEATING/REPAIR TEMPERATURES</td>
<td>- When removing moisture using heat, make sure finishes, sealants, and metal parts are within temperature limits</td>
<td>4.3.11.D(2)</td>
</tr>
</tbody>
</table>
Progress Since Last Main Meeting

AIR 6292:

- Task Group meeting
- Teleconferences twice per month
- Technical Content Incorporated
- Critical Process Checklist completed
- Addressing issues list to confirm comprehensive description of repair process
## Implementation Ideas

<table>
<thead>
<tr>
<th>Members</th>
<th>General Advertising/Awareness</th>
<th>MRO</th>
<th>Internal</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEM</td>
<td>Magazine (such as Aero Magazine - Boeing)</td>
<td>Source control data/source substantiation of a repair and Repair Station</td>
<td>Communicate to repair engineers, esp Thermal Survey</td>
<td>Reference in repair requests approvals to MROs SRM reference as supplemental info</td>
</tr>
<tr>
<td>Regulatory Agencies</td>
<td>Communicate to repair engineers to use as Industry Standard practice, and considered Acceptable Data</td>
<td>Reference in repair requests approvals to MROs SRM reference as supplemental info</td>
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</tr>
<tr>
<td>MRO</td>
<td>Presentations at conferences, such as IATA, and A4A. Magazine articles</td>
<td>Repair Certification by 3rd Party Entity, such as CASE or PRI (NADCAP). Self-certification</td>
<td>Training of planner, in-process inspectors, purchasing, mechanics. Engineering substantiation reports. Assist in shop planning paperwork.</td>
<td>Written into Contracts when overseeing MROs Use as guidance for shop personnel for planning, paperwork and Repair Specifications.</td>
</tr>
<tr>
<td>Airlines</td>
<td>Presentations</td>
<td>Sub-contractor qualifications responsibility. Assist when Auditing</td>
<td>Internal Training of Technicians and Engineers. Assist when Auditing internal shops.</td>
<td></td>
</tr>
</tbody>
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CACRC Task Group Update – Auckland – March 2020
AIR6292

- Review paragraphs for Layup, Post Repair processes, Re-assembly, and Repair Records
- Check for completeness of all technical recommendations are incorporated
- Identify Critical Process steps for checklist
- Target to ballot by August 2020
Future Activities

AIR6291 Guidelines for Repair Process Evaluation of Aluminum Bonded Structure

- Add Key Process Checklist to appendix B
- Remove text where ARPs were revised to address shortcomings, and replace with references to ARPs
  - Review CCA content since was added to Prepreg Layup ARP5701
  - Delete Appendix B for Tool Thermal Profiling, which has been incorporated into ARP
- Target to finish by Spring 2021
Plans Until Next Main CACRC Meeting

- Target AIR6292 Completion date for ballot: August 2020
- Target AIR6292 Resolution of comments: October 2020
- Target AIR6291 Revision date for ballot: Spring 2021
Current Membership

Chair: Eric Chesmar, United Airlines

Vice-Chair: Jeff Berner, Boeing

Members: Ricky Boyd (Delta)  Faeq Shaikh (Boeing)
         Adam Leichliter (Delta)  Allen Rauschendorfer (FAA)
         Tjarko De Jong (Airbus)  Megan Watson (Boeing)
         David Gladson (UPS)    Tobias Agunda (LHT)
         Alexandra Chardon (Air France)  Travis Adams (Nordam)
         Dayalan Pillay (ANZ)    Keith McLean (Collins)

Consulting: Arne Lewis (Boeing)  Ray Kaiser (Delta)
            Francois Museux (Airbus)  Chris Reeves (AA)
            Ryan Rydell (UTAS)       Matt Haines (American)
            Pascal Paardekooper (KLM)  Mattias Nestor (Exova)
            Elio Pajares (Airborne)