A350 In Service Repair events
A350 XWB
CACRC June 2017
Summary of in service repair cases

- Lightning Strike

- Mechanical impacts and bird strike
Summary of in service repair cases

- Lightning Strike
- Mechanical impacts and bird strike
130 Repair queries received, mainly caused by accidental or environmental origin:
- Lightning Strike
- Mechanical impacts
- Bird strike

- Lightning strike: 34%
- Mechanical impact: 32%
- Other: 27%
- Bird strike: 7%
Summary of in service repair cases

- Lightning Strike

- Mechanical impacts and bird strike
A350XWB fleet: Lightning strike mapping
Lightning strike repairs on fuselage

Damage type

› Scrapped paint, burnt ECF
› 1-2 carbon plies
› Fastener heads
Lightning strike repairs on fuselage

**Damage type**
- Scrapped paint, burnt ECF
- 1-2 carbon plies
- Fastener heads

**Inspections and repair**
- **Temporary release**: 600FC
  - Detailed Visual Inspection / Line Tool and High Speed Tape
- **Permanent Repair**: Non structural bonded repair
Lightning strike repairs on fuselage

**Damage type**
- Scrapped paint, burnt ECF
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- Fastener heads

**Inspections and repair**
- **Temporary release:** 600FC
  - Detailed Visual Inspection / Line Tool and High Speed Tape
- **Permanent Repair:** Non structural bonded repair

**Mitigation**
- ASR generic tasks publication
- Analysis of in service queries for further improvements
Lightning strike repairs on wing and horizontal tail

Damage type
› Scrapped paint, burnt ECF
› 2 carbon plies
› Fastener heads
Lightning strike repairs on wing and horizontal tail

Damage type
› Scrapped paint, burnt ECF
› 2 carbon plies
› Fastener heads

Inspections and repair
› Temporary release: 50 to 600FC
  Detailed Visual Inspection
› Permanent Repair: Non structural repairs. Blend out of edges and reprotection for CFRP parts.
Lightning strike repairs on wing and horizontal tail

**Damage type**
- Scrapped paint, burnt ECF
- 2 carbon plies
- Fastener heads

**Inspections and repair**
- Temporary release: 50 to 600FC
- Detailed Visual Inspection
- Permanent Repair: Non structural repairs. Blend out of edges and reprotection for CFRP parts.

**Mitigation**
- Winglet and horizontal tail plane: lightning strike tasks publication by Q2 2017
Summary of in service repair cases

- Lightning Strike

- Mechanical impacts and bird strike
A350XWB fleet: Bird strike, mechanical impact and accidental damage mapping

Bird strike damage locations

Mechanical impact & accidental damage locations
Accidental damages / mechanical impacts

Inspections and repair

1) Visual inspection and temporary allowance 50 FC. Permanent repair: part replacement

2) Ultrasonic inspection to detect delamination. Temporary repair by installing blind fasteners for 250FC.

3) Line tool inspection and temporary allowance for 600 FC. Permanent repair: non structural bonded repair

(1) Impact scuff plate  (2) Impact cargo door  (3) Scratch on fuselage
Accidental damages / mechanical impacts

Inspections and repair

1) Tap test inspection and temporary repair with High Speed Tape. Permanent repair: Wet lay up

2) Tap test inspection and temporary repair with High speed tape. Permanent repair: Hot bond repair
Accidental damages / mechanical impacts

**Inspections and repair**

1) Tap test inspection and temporary repair with High Speed Tape. Permanent repair: Wet lay up

2) Tap test inspection and temporary repair with High speed tape. Permanent repair: Hot bond repair

**Mitigation**

- Spare parts in stock
- Repairability methods available in Airbus in a short lead time.
- ASR improvements launched
- Focus to release the aircraft on temporary basis
Bird strike

Damage type
Dent, delamination and disbonding

Inspections and repair
Tap test and ultrasonic inspection. Temporary allowance and similar repair principles as previous programs

Mitigation
› Repairability methods available in Airbus in a short lead time.
› Focus to release the aircraft on temporary basis
› Similar repair principles as previous programs
Conclusion

› Robustness of the structure against normal threats is confirmed

› Airbus repair capability demonstrated to support A350XWB, adapting to the customer needs and minimizing the grounding time.

Growing together
Further Dvpt?

› LS ADL
  • Energy dissipation on LS protection
  • Fastener fatigue

› Improvement for bonded repair capacity: material-processes

› Innovation in embodiment minimizing human factor – improving quality – reducing time
  • Thermal mapping
  • Debulking
  • NDT techniques

› New concept
  • Reinforcement
  • Hard patch
A350XWB reparability
A350 XWB
CACRC 2017
Structure Robustness

Allowable Damage Limit

Composite Repairs
Structure Robustness

› Design

› Validation & benefit

Allowable Damage Limit

Composite Repairs
A350XWB Composite Structure

› Hexcel IMA/M21E is baseline material for primary structure

› Expanded Copper Foil (ECF) for Lightning strike protection

› 4 omega-stiffened fuselage panel concept

› Monolithic structures extended to Flaps, Elevators, Rudder & MLGD

Extensive use of CFRP in ASR areas
A350XWB Robustness by Design

› The A/C has been sized considering in service threats, validated by test pyramid at all levels, up to flight test.
Structure Robustness

Allowable Damage Limit
› Overview
› ASR improvement
› Simplifications
› Delamination Example

Composite Repairs
Overview Allowable Damage Limits

 › ASR coverage focuses on Prone to Damage Areas

Lightning strike

Mechanical impact & scratch

Allowable Damage Limits (ADL) defined in these areas to enable A/C dispatch

ASR publication released at Entry Into Service
ASR Damage assessment – New chapter ASR 51-77-10

Actual damage found after visual inspection?

- Yes
  - Proceed as per relevant chapter in SEE MP-65-XX

- No
  - Clean wipe or wipe off dirt/scuff and cleaning agent
  - Inspect damage area for paint defects and cleaning agent base or dried for unpainted area and do visual inspection
  - See MP-65-XX

Damage found after visual inspection?

- Yes
  - Proceed as per relevant chapter in SEE MP-65-XX

- No
  - Clean wipe or wipe off dirt/scuff and cleaning agent
  - Inspect damage area for paint defects and cleaning agent base or dried for unpainted area and do visual inspection
  - See MP-65-XX

Damage found after visual inspection on fuselage doors?

- Yes
  - Proceed as per relevant chapter in SEE MP-65-XX

- No
  - Clean wipe or wipe off dirt/scuff and cleaning agent
  - Inspect damage area for paint defects and cleaning agent base or dried for unpainted area and do visual inspection
  - See MP-65-XX

Mechanical impact

- = Line tool or Line sizing

Scratch

- = Optical micrometre

Lightning strike

- = Visual assessment

Guided steps

Terminative actions

Damage assessment thru chapter 51

No need for NDT specialist
ASR simplification - Focus on ADL fuselage - New chapters

› Simplified flow charts for Allowable Damage Limits (ADL fuselage)
  › Mechanical impact/delamination-disbond
  › Scratch
  › Lightning strike

› Activity shared with Operators

› Available Second half 2017
ASR simplification - New flow chart concept

**Guided steps**

1. Damage assessment from chapter 51
2. Applicability mapping
   - When existing
3. Density criteria
4. Proximity criteria
5. ADL size

**Terminative actions**

- Non structural Repair as per ASR51-77-11
- New architecture
  - Validated with Operators
ASR simplification - New Generic chapter - fuselage

In order to secure a minimum coverage of ADL very easily usable by mechanics, Airbus will introduce generic tasks (ie 53-00-**) on CFRP fuselage structure.

Same values applicable on the whole fuselage monolithic CFRP without mapping.

<table>
<thead>
<tr>
<th>Type</th>
<th>Riveted area</th>
<th>Unriveted Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delamination</td>
<td>300mm²</td>
<td>600mm²</td>
</tr>
<tr>
<td>Scratch</td>
<td>1 ply 100mm</td>
<td>3 plies 100mm</td>
</tr>
<tr>
<td>Lightning strike</td>
<td>1Inch Ø / 600mm²</td>
<td>1Inch Ø / 600mm²</td>
</tr>
</tbody>
</table>

Generic tasks for workers
ASR simplification - **Specific chapter fuselage delamination - fuselage**

› In order to simplify ASR & **avoid Weight variant management**, Airbus has validated Allowable Delamination with **simple mapping**

<table>
<thead>
<tr>
<th>Type</th>
<th>Yellow area</th>
<th>Green Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delamination</td>
<td>600 mm²</td>
<td>1500mm²</td>
</tr>
</tbody>
</table>

**ADL Delamination mapping**

S16-18

**Specific task with**
- Simple mapping / 2 values.
- Independent from WV
Structure Robustness

Allowable Damage Limit

Composite Repairs
  › Bolted repair
    › Std practice update
    › Repair design
  › Bonded repair
    › Non structural Repair
    › Structural bonded repair
  › Major repair Pre-defined
## Standard Practices

- **Adaptation of existing process is required**

<table>
<thead>
<tr>
<th>Process</th>
<th>Characteristics</th>
<th>ASR reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>Compdrill used for Bolted repairs (hybrid)</td>
<td>51-44-21</td>
</tr>
<tr>
<td></td>
<td>Specific drills, limited number of holes (30 per drillbit)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limited feed rate using special dampener</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blind Drilling: no need for NDT &amp; Back up plate</td>
<td></td>
</tr>
<tr>
<td>Blind bolt</td>
<td>Composi-loks™</td>
<td>51-42-21</td>
</tr>
<tr>
<td></td>
<td>Blind Bolt mainly used for temporary repairs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Removal with dedicated tool “RK5100 kit “</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Or e drill</td>
<td></td>
</tr>
<tr>
<td>Corrosion Protection</td>
<td>When aluminium and carbon in contact</td>
<td>51-22-XX</td>
</tr>
<tr>
<td></td>
<td>Depends on zoning and expected duration</td>
<td></td>
</tr>
</tbody>
</table>

- **CFRP competences/training required for CFRP handling**
Structural repairs – Temporary repair in ASR

Materials
- Aluminium (alodine & paint)
- Blind bolts

Temporary Bolted repair
- Life = 3 years
- 1 year inspection in bilge

Applicability on CFRP fuselage, below window belt with few exclusions

Bolted repair validated
Structural repairs – Permanent repair & Pre Defined repair Solution

› CFRP External skin Bolted repair
  › 6 Standard doublers cover 80% of AC area
  › Copy/paste process in other area

› CFRP Omega or L angle repair parts, for stringer
  › 33 Omega
  › 1 L-angle

› Material ready to support unschedule event

Available in ASR end 2017
Quick Non structural Bonded Repair – ASR kits

› Goal: restoration of Expanded Copper Foil (ECF), filling of small damages, flush result

› New standard practice
  • Process: Task 51-77-11: Quick cure cycle at 100°C: total duration ~1h
  • Material: Repair kit P/N SR5100-50C00000 can be ordered thru SATAIR

Size ~200x100mm

Small quantity Ordering
Bonded repair material validated for structural repair

Sandwich component

Monolithic component IMA/M21E

<table>
<thead>
<tr>
<th>Parent Material</th>
<th>Repair Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMA/M21E (low grade)</td>
<td>EP52 A/B / G0904 EA9390 / G0904</td>
</tr>
<tr>
<td>AS4 / 8552 (5 HS)</td>
<td>EP52 A/B / G0904 EA9390 / G0904</td>
</tr>
<tr>
<td>HTA / MTM44-1</td>
<td>EP52 A/B / G0904 EA9390 / G0904</td>
</tr>
<tr>
<td>T300 / F593</td>
<td>EP52 A/B / G0904 EA9390 / G0904</td>
</tr>
<tr>
<td>AS4 / M26T</td>
<td>EP52 A/B / G0904 EA9390 / G0904</td>
</tr>
</tbody>
</table>

Kitting under finalization
Structural repairs - Bonded repair

- **Environment conditions.**
  - Controlled humidity & temperature

- **Stepping**
  - *either* by hand *or* with portable automated machining GSE

- **Curing.**
  - Conventional hot bonder & heating blanket and vacuum bag

- **Checks & inspection:**
  - Conventional ultrasonic method.

Bonded flush repairs applicable Second half 2017
Airbus has anticipated repair instructions & material supply in order to reduce to overall lead-time of a repair associated to known major incident.

Repair instructions & demonstration under finalization

GSE (transport & manufacturing) capability being developed
Conclusion

Airbus Key Objectives

- Simplify ASR & Secure good coverage
- Innovate & invest to propose best repairs possible
- Minor & major