



Repair Design Approval

Structure damage assessment using Repair Manager

Damage to aircraft structure causes severe operational interruptions and the restoration to an airworthy condition needs to be shown before the next flight. It can also be difficult to assess damage, find and collect relevant information from a wide variety of data sources, while complying with the regulatory record keeping requirements. This article will explain the regulatory requirements to report such damages (Part 1) and will guide you through an overview of a damage case using the new on-line service developed by

Airbus, Repair Manager (Part 2). This software provides airlines a simple and efficient method to view, locate concessions and in-service damage and repairs, on a 3D (three-dimensional) simplified model of the aircraft, enabling them to record and safely store the details. Repair Manager allows the operator to build a comprehensive database of all of the structural damages on an aircraft and maintain it together with the associated approval documentation.



Alain BALEIX
Head of Repair Approval
Airbus Customer Services



Colin SMART
Structure Engineer /
SRM development
Airbus Customer Services

Part 1: Repair Design Approval

BACKGROUND

Since the early 1990s, Airbus supports the approval of repairs' actions or damage allowance with a 'Repair design Approval Sheet' (RAS) form (See Structure Repair Manual chapter 51-11-14).

From 1996, Airbus has been granted by the French DGAC (Direction Générale de l'Aviation Civile) with the privilege to approve minor repair designs within its Design Organisation Approval (DOA). This privilege was extended to the major repair design in 2003. In 2004, the DOA was transferred from the DGAC to the EASA (European Aviation Safety Agency), so the approvals are now issued under an EASA DOA. This article will only describe the Repair Design Approval process within the EASA regulatory framework.

The equivalence of the regulatory frame can be found in each country having signed the Convention on International Civil Aviation (also known as the Chicago Convention).

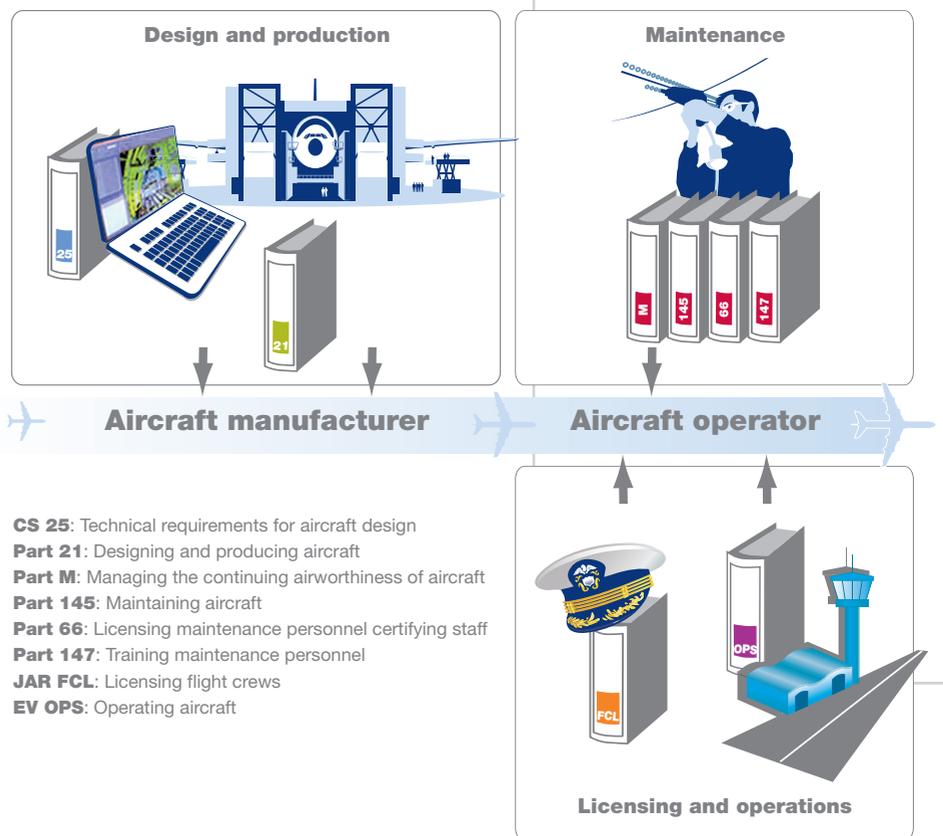
THE AIRWORTHINESS OF AN AIRCRAFT

The airworthiness aims to obtain an acceptable level of safety for civil flights. An airworthy aircraft is:

- Designed and built according to applicable requirements,
- Operated within its intended environment and within its quantified and declared limitations,
- Maintained in accordance with procedures acceptable to the responsible authority.

The first responsible of the airworthiness of an aircraft is its owner. Airbus is involved as being the designer and manufacturer in this chain of responsibility.

Airbus is a Type Certificate (TC) holder to design large transport aircraft and relative activities with a Design Organisation Approval (DOA). Airbus aircraft are certified in compliance to the certification basis issued from the airworthiness codes for large aircraft (JAR 25 / FAR 25).



Structural issue

Figure 1

With an optimized design of light structure, modern aircraft are susceptible to fatigue damage. Their structural strength is slowly entailed by potential cracks under cyclic loadings of the aircraft. It shall be maintained at an acceptable level through a monitoring.

Regulations take into account this phenomena and rule it through CS25 and Part 21

Compliance to CS25.571 by test and analysis determines these areas and their damage tolerance capability. The resulting monitoring is published as a maintenance task in accordance to CS25.1529 and CS25 appendix H, so in the Airworthiness Limitation Section (ALS) for the more critical areas

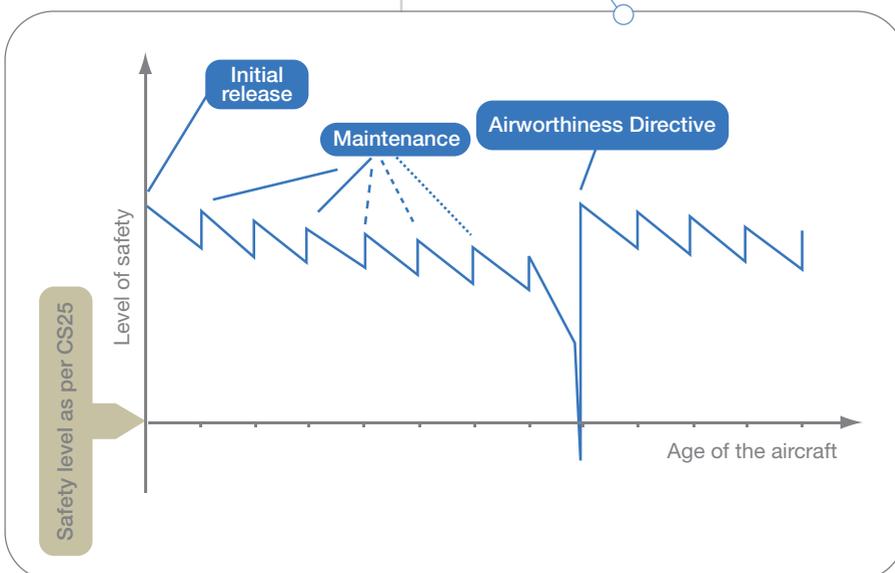
Instructions for Continued Airworthiness (ICA) (Part 21.A61 or Part 21.A107 including ALS, attached to type design Part 21.A31)

The maintenance programme is established and approved according to Part M.A.302, including ICA.

The maintenance programme is performed to comply with Part M.A.201 a) 4).

Safety level

Figure 2



INSTRUCTIONS FOR CONTINUED AIRWORTHINESS (ICA)

ICA result from the certification exercise, issued and linked to the Type Certificate (TC) and its modifications. All are compulsory according to the airworthiness codes; ones largely depend on the aircraft usage and may be customized when the Airworthiness Limitation Section (ALS) has to be strictly observed. The structural issue illustrates the process (see figure 1).

THE CONTINUED AIRWORTHINESS

Ages of service may reveal unexpected defects not contemplated at the issuance of the TC, either by the airworthiness code or the designer. The regulation prevents the decrease of the level of safety by ruling reports of unsafe conditions:

- The operator of the aircraft according to EU-OPS 1.420,
- The responsible of the maintenance according to Part M.A.202,
- The maintenance station according to Part 145.A.60,
- The design or production organisation according to Part 21A.3.

Additional duties of Airbus, as a TC holder, are:

- To investigate and to analyze failures, malfunctions and defects linked to its products.
- When an Airworthiness Directive (AD) is issued against the unsafe condition:
 - To propose the appropriate corrective action,
 - To make them available to all known operators' accomplishment instructions.

ICA and ADs contribute to maintain a high level of safety as per figure 2.

RESTORING THE CONTINUED AIRWORTHINESS WITH THE REPAIR DESIGN

A damaged aircraft shall be assessed also from an airworthiness standpoint before the return to service and to show evidence of an acceptable level of safety.

This assessment requires the organisations to inspect the damaged aircraft, design and approve the repair, embody the repair and inspect the repair according to the repair approval.

Basically, the tasks of an organisation designing a repair are similar to a modification to a TC, such as to draw/design the repair, show compliance to the requirements and obtain, or to approve, the repair design.

SOME HIGHLIGHTS ON THE PART 21

The scope of the Part 21 subpart M (21A.431) is the approval of the repair. This means the elimination of damage and/or restoration to an airworthy condition of in-service aircraft. In Airbus DOA, a RAS is the issuance of the Repair Design Approval as per Part 21A.437, its design certificate.

Some repair data do not need this specific approval such as:

- A replacement without a design activity,
- Explicitly approved data, such as the Structure Repair Manual (SRM), Service Bulletins or Production Concessions as part of the Aircraft Individual Certificate (AIC).

A Repair design Approval Sheet (RAS) is dedicated to structural damage, mainly ATA structure chapters (52 to 57) and interface with systems like flight controls of ATA 27. The Airbus process for system damages is called a Technical Adaptation (TA).

A RAS cannot be used for a modification to TC. Airbus does not update its documentation (Illustrated Part Catalog - IPC, Aircraft Maintenance Manual - AMM, Structure Repair Manual - SRM, etc.) for a repair.

The classification of the repair design (Part 21A.435) into minor or major follow the same criteria than for a modification to TC (Part 21A.91), having the same means which are to report (see figure 3) the relevant information to the authorities.

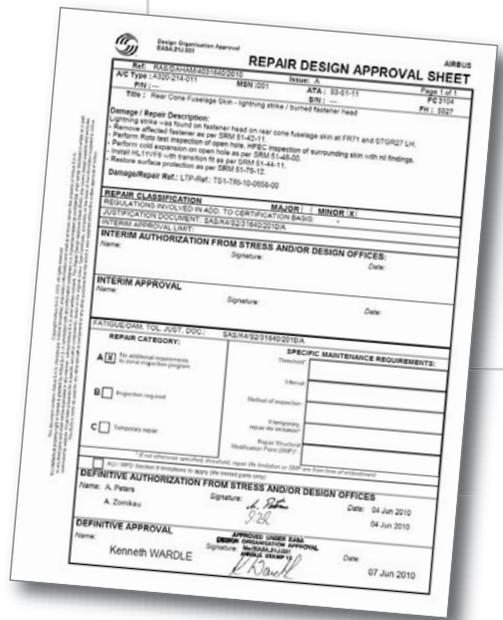
n

notes

The operator needs to meet the airworthiness requirements for ageing aircraft (FAA Part 26):

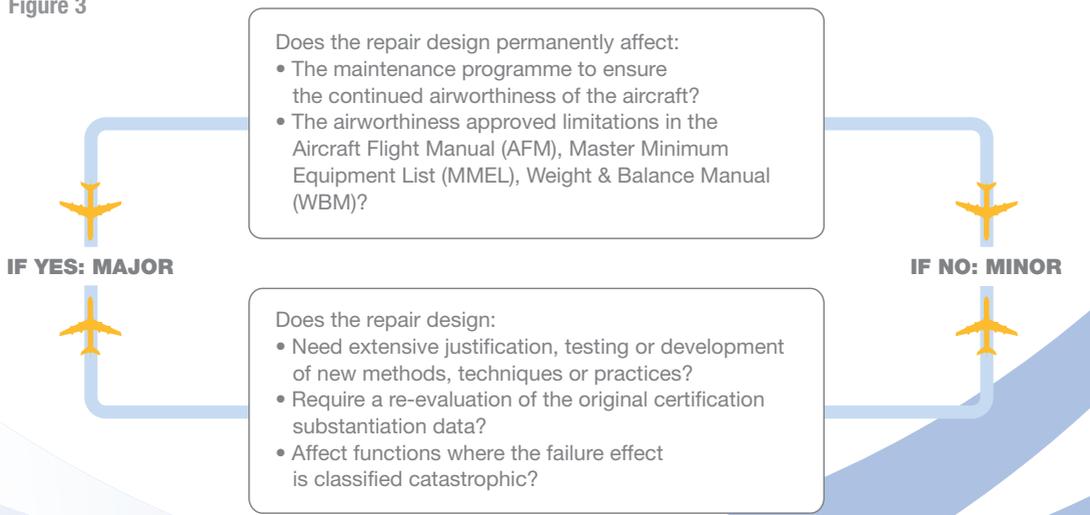
- To demonstrate damage tolerance of repairs to Fatigue Critical Structure (FCS),
- To include inspections associated with these repairs in the Maintenance Programme,

These requirements are being implemented by EASA through the Part M (see Acceptable Means of Compliance AMC20-20).



Questions for reporting

Figure 3



LIMITATIONS AND INSTRUCTIONS FOR CONTINUED AIRWORTHINESS FROM REPAIRS' DESIGN

As for a Type Certificate (TC), structural repairs on light optimized structures (a fortiori allowable damages) are susceptible to fatigue and as for the TC, they require inspection leading to ICA and limitations.

The Airbus Repair design Approval Sheet (RAS) form supports compliance in areas dedicated to maintenance requirements to Parts:

- 21A.449 (unrepaired damage),
- 21A.443 (limitations),
- 21A.449 (ICA).

Areas dedicated to repair maintenance requirements

REPAIR CATEGORY:	SPECIFIC MAINTENANCE REQUIREMENTS:
<p>A <input type="checkbox"/> No additional requirements to zonal inspection programme</p> <p>B <input type="checkbox"/> Inspection required</p> <p>C <input type="checkbox"/> Temporary repair</p>	<p>Threshold*: _____</p> <p>Interval: _____</p> <p>Method of inspection: _____</p> <p>If temporary, repair life limitation*: _____</p> <p>Repair Structural Modification Point (SMP)*: _____</p>
<p><small>* If not otherwise specified; Threshold, repair life limitation or SMP are from time of embodiment</small></p>	
<p><input type="checkbox"/> ALI (Airworthiness Limitation Item) limitations to apply (life limited parts only)</p>	

LIMITATIONS

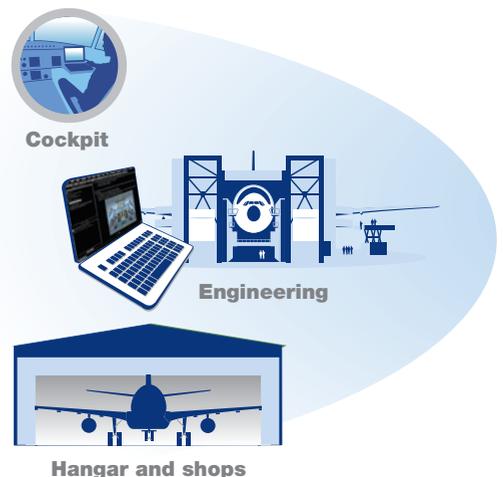
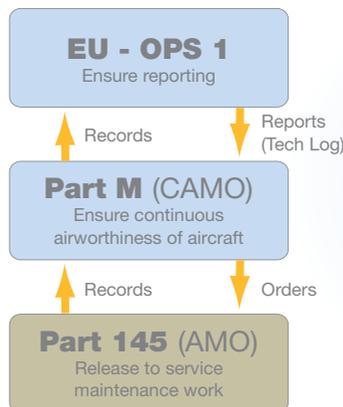
When the limitations affect a life limited part, the RAS indicates the life of the damaged area and not the life of the entire part, itself being dictated by the Airworthiness Limitation Section (ALS) Part 1:

- When the RAS limit is lower than the ALS limit, the new part life is that of the RAS.
- When the RAS limit is higher than the ALS limit, this is still applicable and the Continuing Airworthiness Maintenance Organisation (CAMO) needs to observe the ALS limitation.
- The ALS limitation can vary through time and the CAMO is required to update the life limited parts' maintenance accordingly, including the repaired ones.

Some limitations can result when the structural (damage or its repair) affects the performances of the aircraft, like the aerodynamics. They may decrease the maximum weight of the aircraft, the One Engine Inoperative (OEI) ceiling or other performance penalties. These limitations have to be recorded and communicated to the flight operations of the company. All these limitations comply with the applicable requirements.

AOC - Operator EU-OPS 1

- Part M.A.302:**
- Instructions from competent authority,
 - ICA issued by TC holders or any other relevant approval,
 - ICA issued by major repair approval holder.



INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

The compliance to CS25.571 for the repair results in an ICA like for TC. Then, the task is compared with the actual maintenance programme of the aircraft, as established by Airbus.

- When a 'zonal' task is adequate, no inspection is indicated in the RAS,
- When another maintenance task is adequate, it is repeated as a 'method' in the RAS without threshold and interval,
- When a maintenance task is to be adapted locally for the repair inspection, the maintenance task and its adaptation are indicated in the RAS,
- When there is no maintenance task, the RAS supports all details for the inspection and it is classified as major.

All the ICA for major repairs shall be incorporated by the CAMO into the maintenance programme of the aircraft, according to the Part M 302 requirement.

Part 2: Repair Manager

OBJECTIVE AND OPERATIONAL BENEFITS

Repair Manager on-line software provides airlines with a simple method to view and locate non-conformities and in-service damage and repairs on a 3D simplified model of the aircraft, to record and safely store the details. Its objective is to ease line maintenance's structural damage reporting, to reduce elapsed time to assess damage and authorize the aircraft's return to service. In addition, the tool allows the operator to build a comprehensive database of all the structural damages on an aircraft and maintain it together with the associated approval documentation.

KEY FUNCTIONS

Repair Manager mainly serves the following areas of activity within an airline:

- Line and heavy maintenance for damage reporting, assessment and follow up,
- Engineering services for assessment and data analysis,
- Ease aircraft dispatch by direct access and compilation of the aircraft status reports (also known as a Dent and Buckle Chart).

At any time, a user can directly access to:

- The structural status of the entire fleet or a specific MSN (Manufacturer Serial Number),
- The structural damage and repair history of any MSN by accessing all its repair files including approval documentation,
- The aircraft status report of each MSN.

When damage is found, a user is able to report it through a series of process based steps to compile a full and comprehensive damage report, with just a laptop connected to AirbusWorld, the Airbus customer portal.

This guidance provides the required information for the damage evaluation and reporting back the necessary data to the airline Maintenance Control Centre (MCC), Airbus, or a non-Airbus OEM (Original Equipment Manufacturer). Repair Manager also allows the operator to delegate access to the tool for third party maintenance organisations, so they can use the tool for the operator's fleet during maintenance checks.

STRUCTURAL DAMAGE REPORT CREATION

This guides the user through the different steps of the compilation of a report: Location, description and assessment. It also helps the user to fill in repair and approval data in the relevant tab of the Structure Damage Report (SDR).

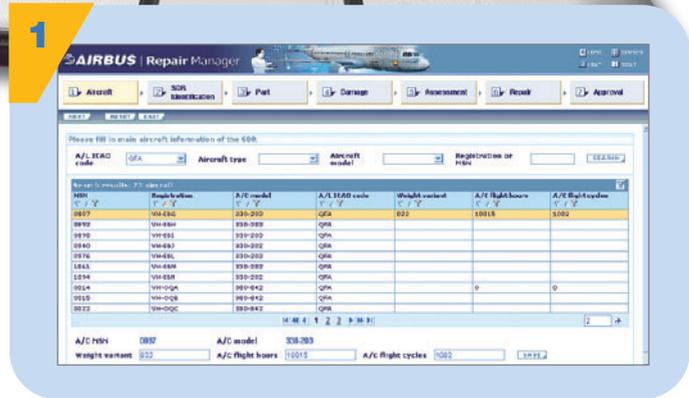


Repair Manager overview of the process for a repair requiring a Repair Design Approval



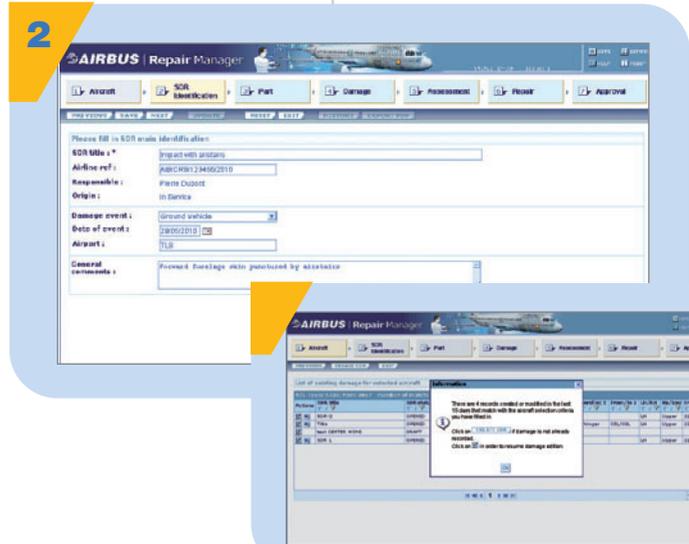
Step 1 - Aircraft

The user selects the aircraft type and selects the relevant aircraft from the list. The list contains all the aircraft of this type operated by the airline. MROs will see the aircraft list for the airline when access delegation has been given by the operator. The user checks if the aircraft Weight Variant (WV) information is up to date and updates the flight cycles and flight hours' information. The system will automatically list all the damage reports created within the last 15 days to reduce the possibility of the user entering a duplicate damage report. The location and details of these reports can be accessed directly from the list.



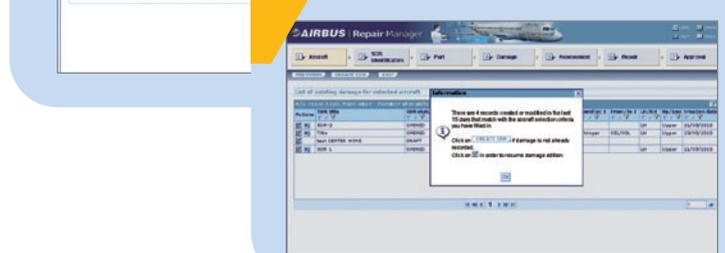
Step 2 - SDR Identification

A damage report title is entered to easily identify the damage report in the future, (the only mandatory field on this page). The operator has the ability to enter their own damage report reference in addition to the unique damage report reference created by the system. The damage event fields are used to link several damage reports together following a major event and make them easier to find.

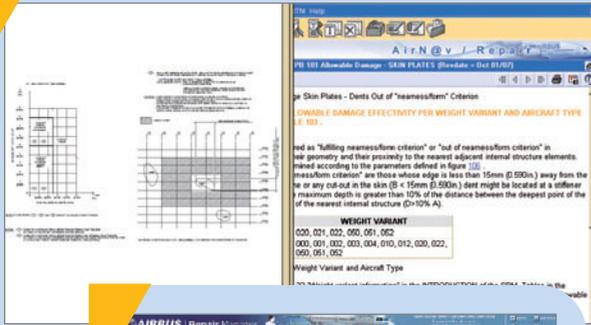


Step 3 - Part identification

The user sees the whole aircraft 3D model on screen and then selects the aircraft section that has been damaged.

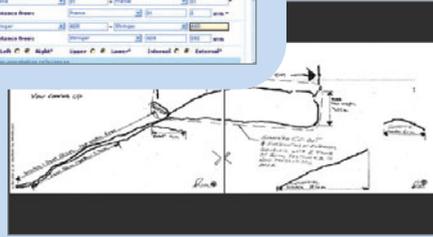


4



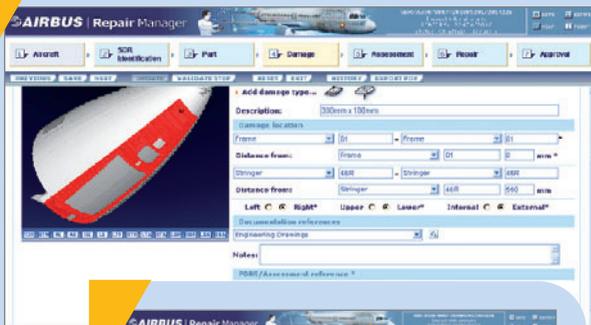
Step 4 - Damage description

The next step is to locate the position of the damage on the 3D model and to identify the damage type and main details. The surrounding structure is easily identified by clicking on the items on the 3D simplified model. The general location of the damage is entered relative to the surrounding structure selected. A direct access is then available to AirN@v/Repair, AirN@v/Maintenance and Engineering drawings (AirbusWorld services), to perform the detailed assessment of the damage. A detailed damage report or Pre-Defined Reporting Sheet (PDRS) is then attached describing the details of the damage and the assessment performed.



Photographs of the damage including dimensions can also be loaded.

5



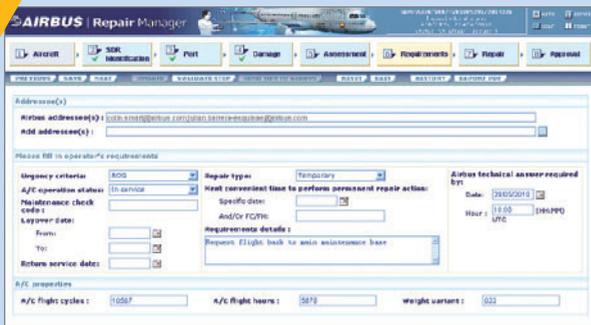
Step 5 - Assessment

The assessment is performed according to the instructions provided in the aircraft manuals, SRM, AMM, CMM, etc. If the damage is within the limits of the approved documentation or the repair solution is covered by the SRM, then the line mechanics can validate the damage description and finalize the approved process. If the damage is outside the approved document limits, then the next steps need to be performed by the engineering or maintenance control departments. They can then decide whether a damage report needs to be sent to Airbus and/or the Original Equipment Manufacturer (OEM) for approval, or whether they can approve the damage or repair themselves.

- SRM: Structure Repair Manual
- AMM: Aircraft Maintenance Manual
- CMM: Component Maintenance Manual



6



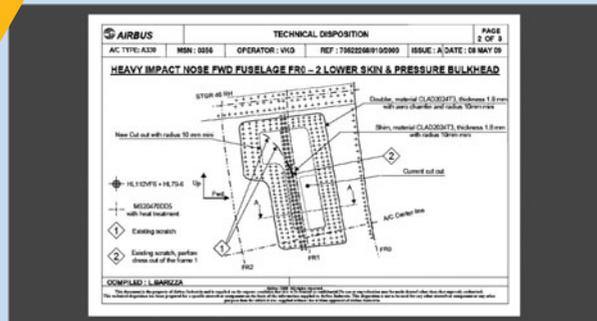
Step 6 - Requirements

If the damage is outside the SRM limits, the user then fills out the details of their request for assistance, describing the current status of the aircraft and the date the answer is required.

Step 7 - Repair

Once the technical statement is available (from Airbus, non-Airbus OEM or from the SRM), the user completes the repair page to record/load the repair proposal into the tool, the date that the repair has been performed may also be completed, if different from the date the damage was discovered. More than one repair can be added so that the repair history is retained (temporary repair followed by a permanent repair).

7



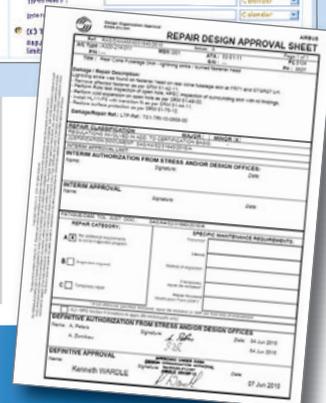
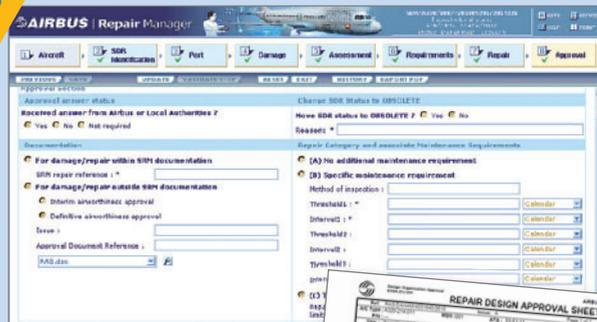
Step 8 - Approval

Once the technical statement is available (from Airbus, non-Airbus OEM or from the SRM), the user (the same or a different one with the necessary rights) fills the approval page. The approval page includes all the required information depending on the damage category. It also allows specifying the type of repair (Temporary or Permanent) and the existence of additional maintenance requirements and inspections.

In this section, you can attach the Repair design Approval Sheet (RAS) or other approval documents associated with the repair. These can also include documents such as a 'Permit to Fly', 'Alternative Means Of Compliance' (AMOC), etc., as described in the Repair Design Approval (Part 1). Any approval documents can be attached to a damage report whether they are internal to the operator or from a non-Airbus OEM.

As with the repairs page, multiple approvals can be attached on separate tabs keeping the history of the repair approvals available.

8



CONTACT DETAILS

Alain BALEIX
 Head of Repair Approval
 Airbus Customer Services
 Tel: +33 (0)5 62 11 04 15
 Fax: +33 (0)5 61 93 28 73
 alain.baleix@airbus.com

Colin SMART
 Structure Engineer /
 SRM development
 Airbus Customer Services
 Tel: +33 (0)5 62 11 09 41
 Fax: +33 (0)5 61 93 21 81
 colin.smart@airbus.com



Conclusion

An accurate damage assessment and its relevant reporting are fundamental for expediting the repair design. A complete and precise report is the first requirement for an efficient repair design. The observance of the Instructions for Continued Airworthiness (ICA) is key for safety. This encompasses the ICA issued, not only by an Airworthiness Directive, a Type Certificate or a modification, but also from a Repair design Approval Sheet which you may find in AirbusWorld.

In that context, Repair Manager is a decision tool for speeding up and easing structural damage report compilations during the assessment phase. Its easy-to-use interface with simplified 3D models will guide you, step by step, towards a more accurate and effective reporting and to be in compliance with airworthiness authorities' regulations for damage record keeping. Repair Manager is available for all the Airbus aircraft families from mid July 2010.