LHD SANDWICH STRUCTURES APPLICATION AND EXPERIENCIES

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AgustaWestland Products

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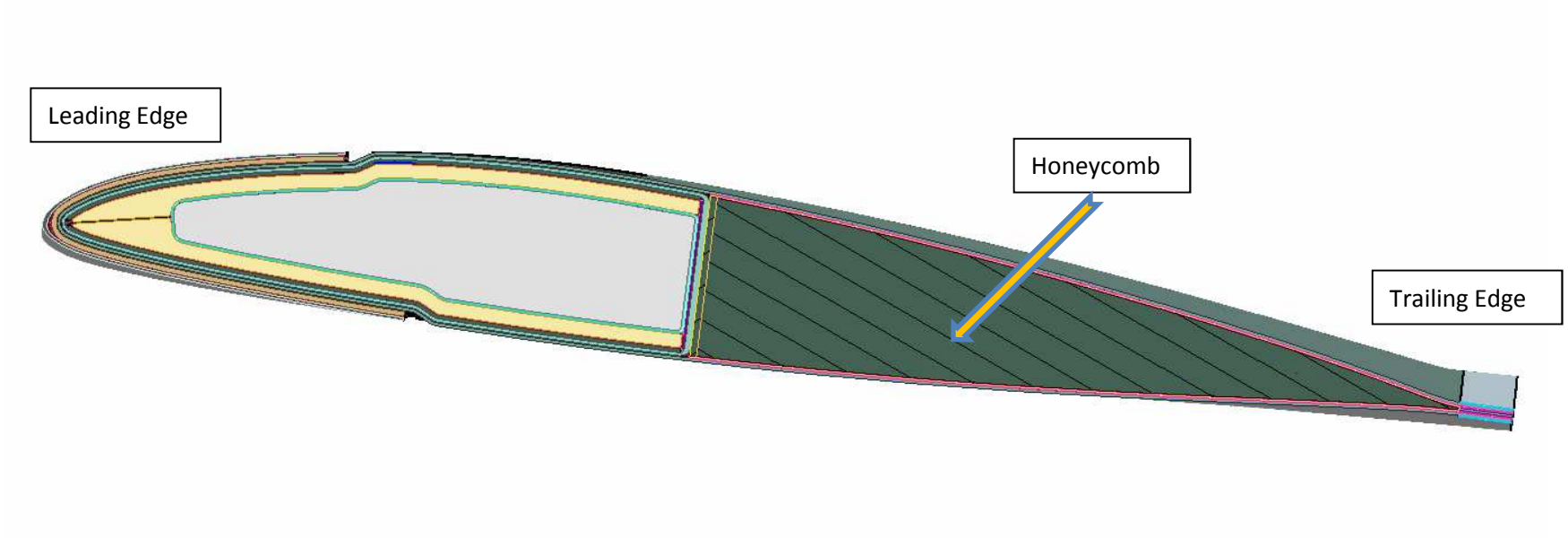
SANDWICH panels used on all AGUSTAWESTLAND Products

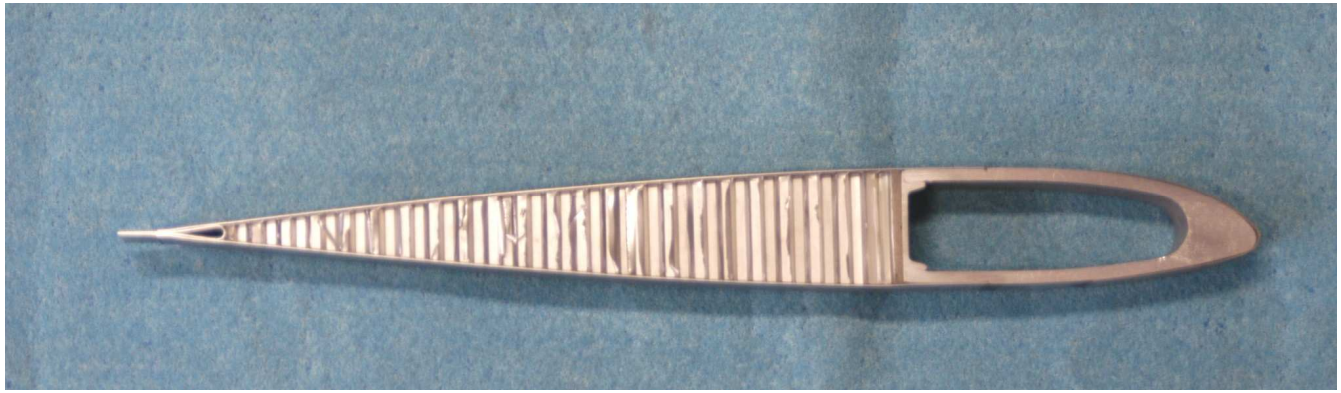
Sandwiches are widely used for primary and secondary structures, with both metallic and composite materials.
The presentation is focused on airframe primary structures

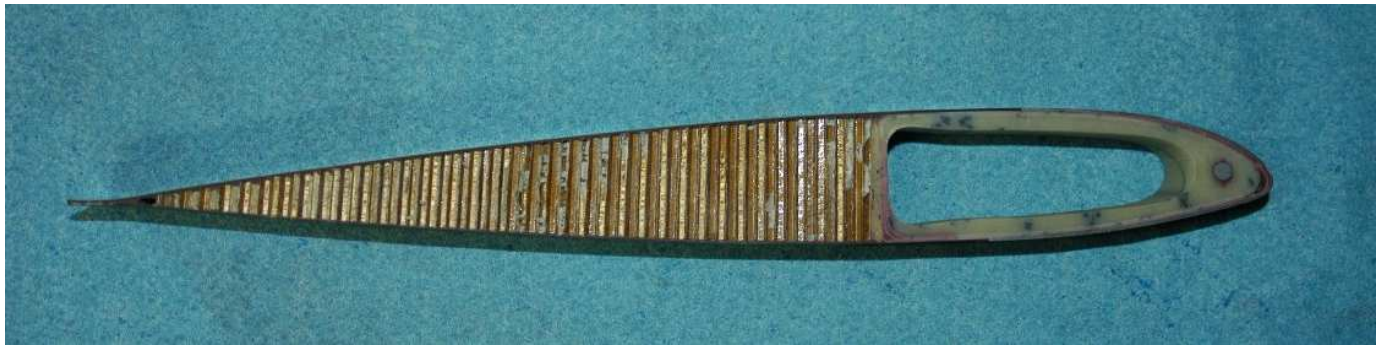
Application of sandwich construction in Rotor Blades



Typical blade section showing the trailing part of the body made by honeycomb covered by upper and lower skins.

Evolution from metallic to composite materials in Rotor Blades





Blade sections showing the metallic construction A109 A/AmarkII and the composite one (A109 C) Nowadays typical on AW101,119,139,169,189

AW109 line

Metallic sandwich for roof panels, keel (lower structure made by single sandwich panel) and fuel compartment

40 years with metallic sandwich used

'Grand New'

Same materials of the previous variant, but with the side panels changed to CFC sandwich, including lower longerons

10 years with CFC sandwich used

AW139

Metallic sandwiches widely used:

roof panels, floor panel, keel, side panel, fin and tail boom.

CFC sandwich for the longeron of the tail plane

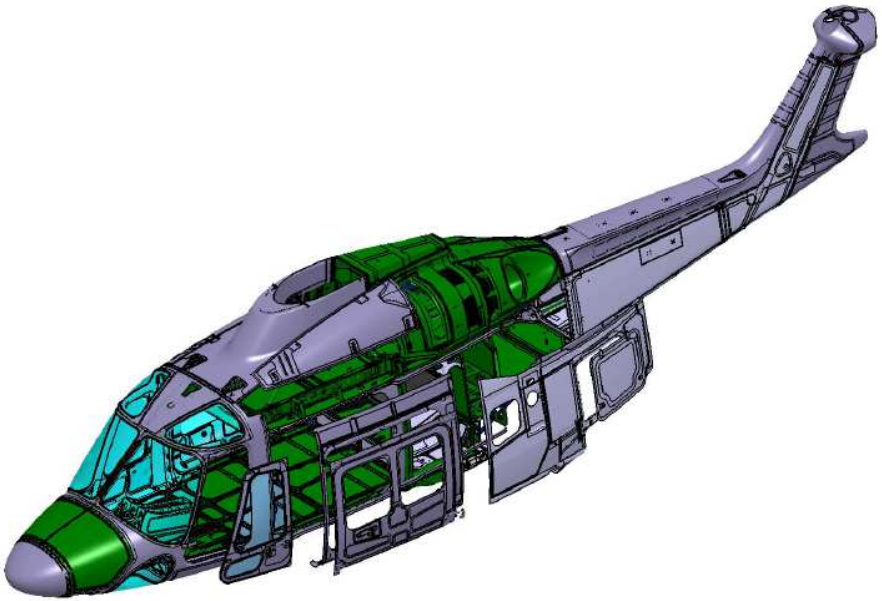
15 years of experinces on the fleet

AW169 and AW189; last generation

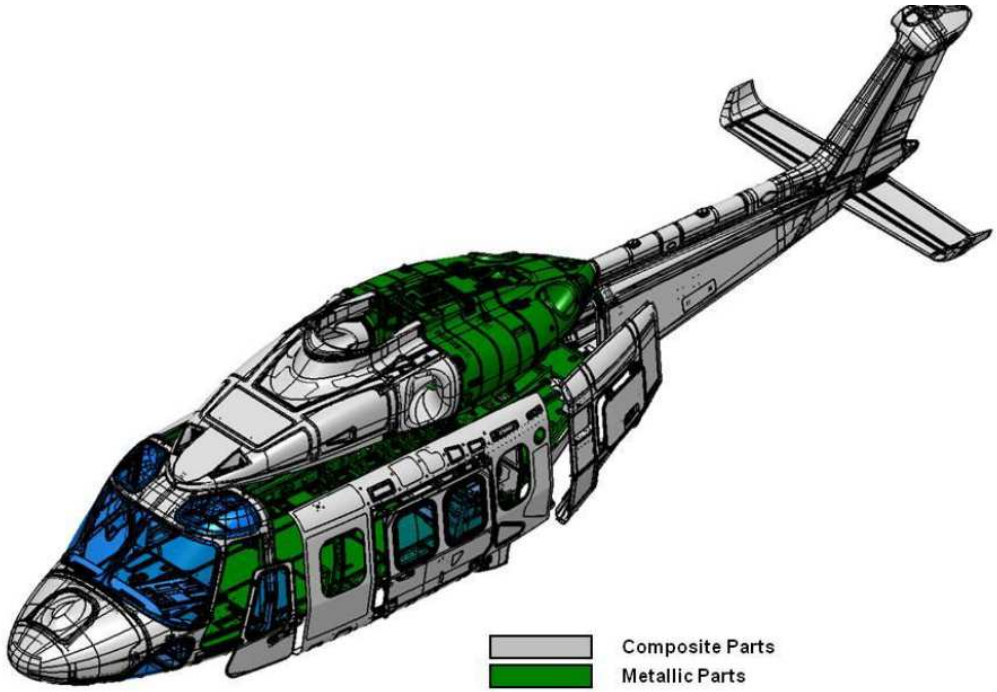
Sandwiches widely used, both metallic and composite.
Metallic:
roof panels, floor panels, keel.
Composite:
Side panel, fuel bay, rear structure, fin and tail boom, longeron of the tail plane (only on the AW189)

More details in the next slide

AW169 and AW189; details



Composite parts
Metallic parts



Composite Parts
Metallic Parts

EH101/AW101

Metallic sandwiches widely used:
roof panels, floor panels, belly panel, side panels, lower bulkheads.

All CFC sandwich:
fin and tail boom, including ribs and longerons.

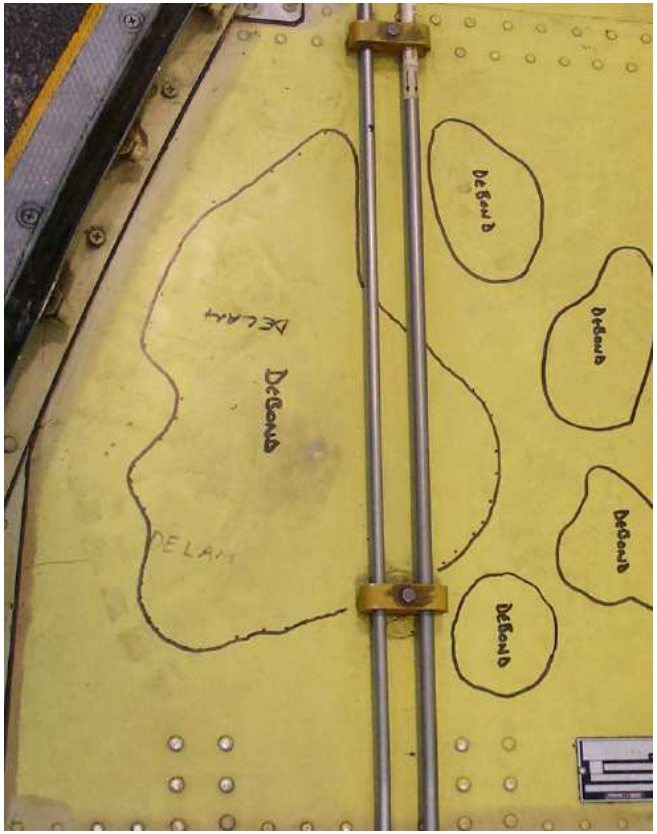
30 years of experinces on the fleet

PROBLEMS TYPOLOGY

Corrosion on Metallic Sandwich

it is not a coincidence that the corrosion is in the inserts area

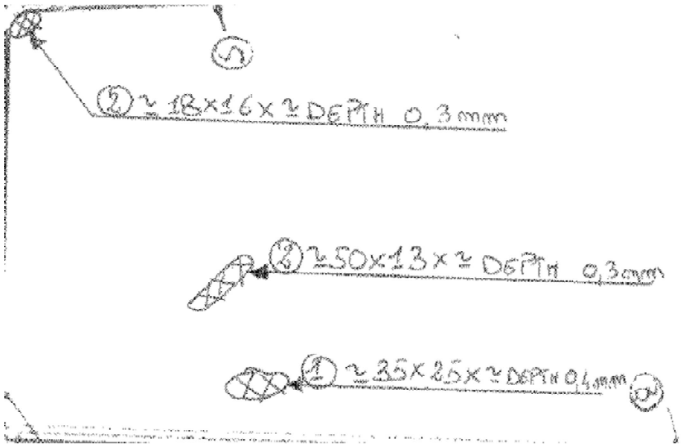
PROBLEMS TYPOLOGY

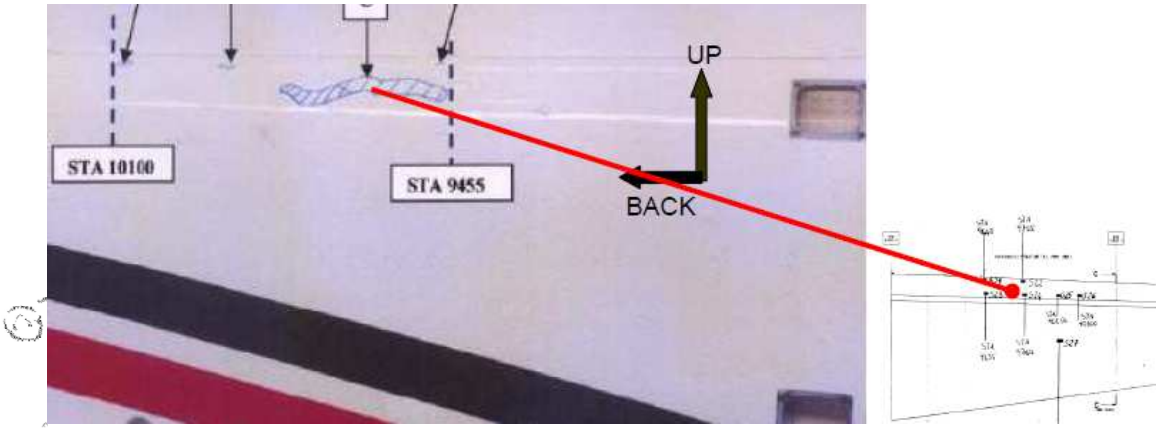


Debonding of the skin on Metallic Sandwich

Problem repetitive on hot spots (roof panels)

PROBLEMS TYPOLOGY





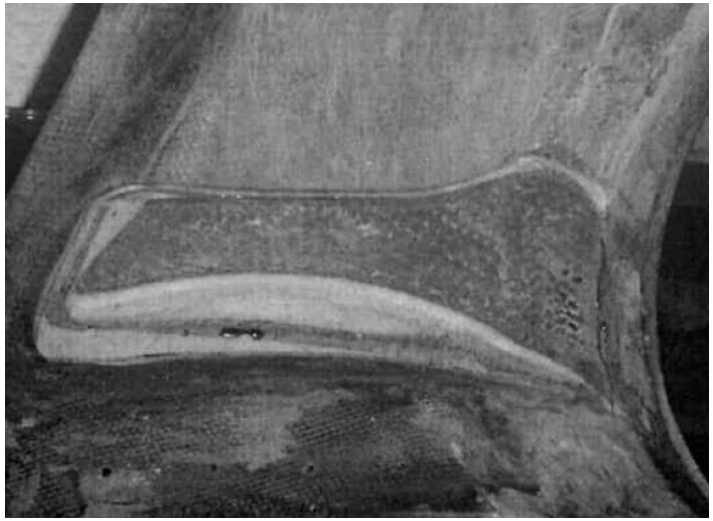
Dimension from minimum up to greater, for example 300x80 mm

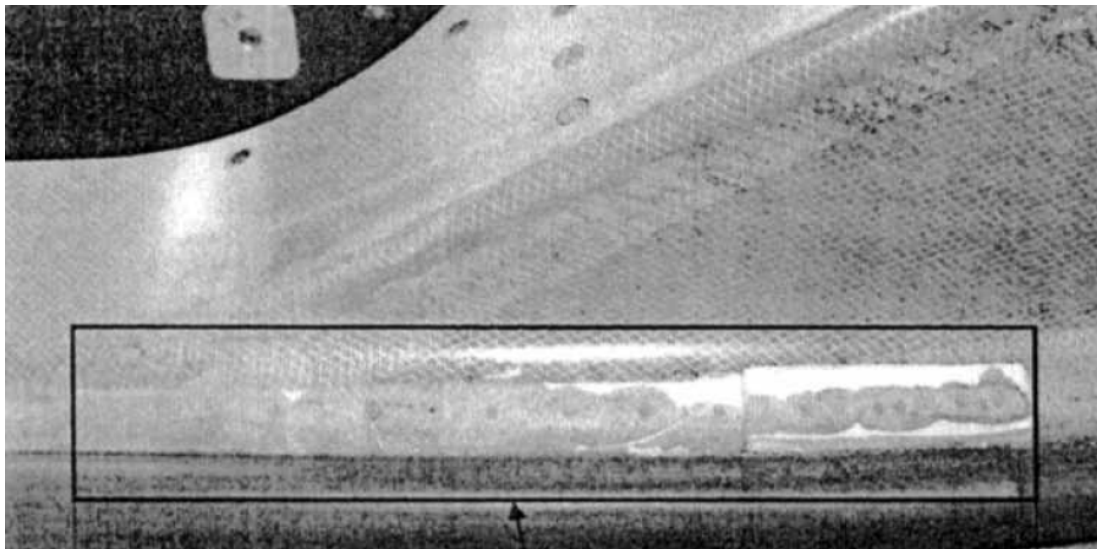
Debonding of the skin on Metallic Sandwich.
Also crash with debond in limited area.

Problems due to manufacturing oversight
and/or tool degradation/needing optimization

Well detected by the NDI process

PROBLEMS TYPOLOGY





Debonding of the skin on Composite Sandwich
Problem due to manufacturing oversight and/or tools degradation
Well detected by the NDI process

Metallic versus Composite

It has been possible note the following main improvement:
Corrosion and improvement for bonding, reduction of the problem raised by the preparation of the metallic material

EASA POLICY Ref. Proposed CM-S-010

… failures have been associated with one or more of the potentially large number of competing damage modes possible in sandwich structures, …

… it is considered appropriate to more explicitly emphasise the importance of strict manufacturing processes and a robust Fatigue & Damage Tolerance (F&DT) philosophy …

LHD policies on procedure of design and process specifications governing manufacturing are in line with the guidelines highlighted in CM-S-010

EASA POLICY Ref. Proposed CM-S-010 3.1.1

Qualification of the manufacturing process

The manufacturing process has to be fully qualified before starting. The qualification is intended to demonstrate that the combination of material, tooling, equipment, procedures, and other controls, making up the process, will produce representative parts having consistent material properties that conform to design requirements.
production of the parts As part of the process qualification, destructive and non-destructive inspection (NDI)…

Activity performed to assure the requirement, production of the first parts with improvement on the tools and process to assure the requirement

↳ FAI with NDI and destructive test + repetitive inspection on the parts (including destructive test)

EASA POLICY Ref. Proposed CM-S-010 3.1.2

Process specifications

Specifications covering fabrication procedures have to be established to ensure that repeatable and reliable structure can be manufactured…

Set of company specifications existes to define processes and instructions to manufacturing

EASA POLICY Ref. Proposed CM-S-010 3.1.3

Material strength and determination of design allowable

Strength properties of the sandwich panels should be established in order to ensure that the probability of structural failure due to material and process variability be minimised …

For each new material used in the company a full qualification campaign is performed to obtain all the information for allowable and behavior of the material. The characteristics are reported into a Data-set used during the design

EASA POLICY Ref. Proposed CM-S-010 3.1.4

Damage tolerance and residual strength

Threat survey and damage modes

As part of compliance with the applicable F&DT requirements, the applicant should clearly demonstrate that a robust structure has been produced by showing: …

Residual strength

Unless the applicant can demonstrate, to the satisfaction of the regulator, robust experience using similar materials and processes in similar configurations at similar strain levels and in similar service environments, then the monocoque sandwich structures being used in the critical single load path application should be demonstrated to sustain no less than LL capability with obviously detectable damage …*

For the certification/qualification activities, threat assessment, analyses and tests are perfomed.

EASA POLICY Ref. Proposed CM-S-010 3.1.5

Safety Management System

Recognising that several structural failures have resulted from various combinations of design, production, and continued airworthiness deficiencies, the applicant must clearly demonstrate that the structure has been subjected to the appropriate co-ordinated involvement of material suppliers, the design organisation (TC Holder), production organisations, and those with appropriate continued airworthiness experience throughout the supply, design, development, and certification processes.
The intent of such a co-ordinated effort should be the early identification of hazards and the assessment of potential risks relative…

Continuous application of procedures regarding these aspects, regarding also the supply chain

EASA POLICY Ref. Proposed CM-S-010 3.1.6

Instructions for Continued Airworthiness

The ICA must include clear instructions to inspect, both internally and externally:*

- all load paths, e.g. up to load transfer fittings, joints, other significant changes in stiffness and section, for damage following an overload event, e.g. impact, heavy landing, excessive gust etc.,

- all structure regularly exposed to extreme temperatures, e.g. local to engine outlets or aircraft used extensively in hot climates, etc. Although inspection intervals should have been justified according to the level of detectability and residual strength capability during certification substantiation based upon a damage threat survey, experience has indicated the potential for interaction between heat and damage can be problematic.

**paying particular attention to:*

- *repaired structures …*

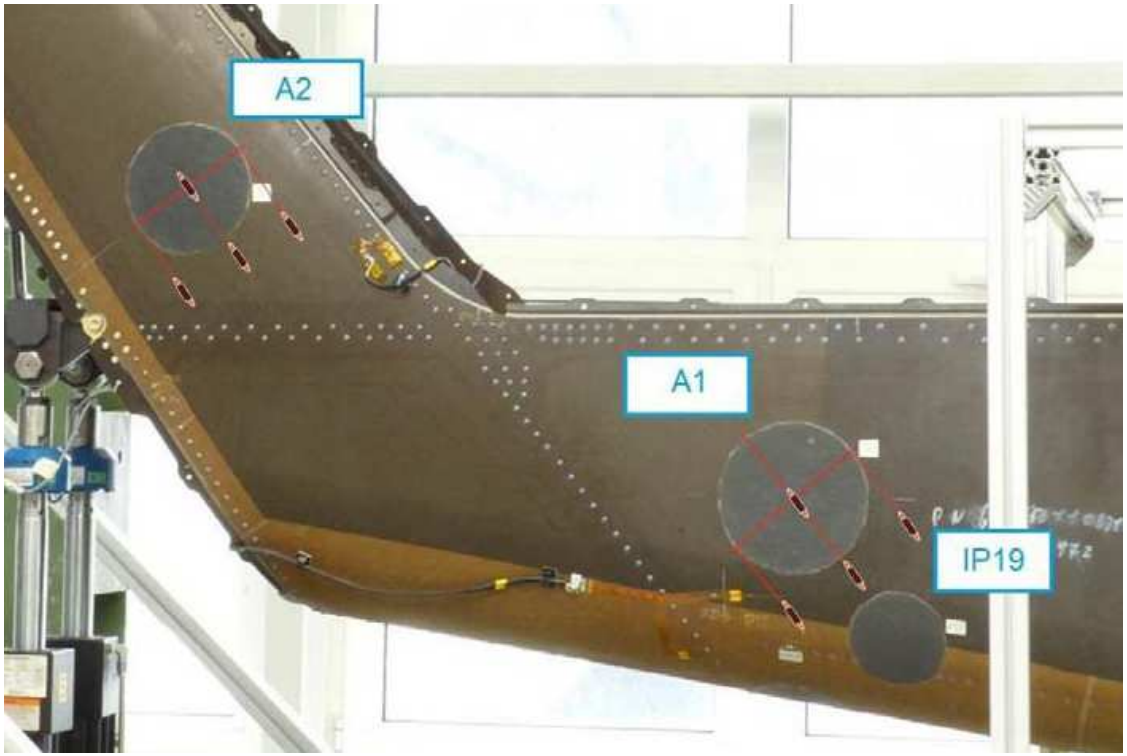
Dedicated manual for each product exists with adequate structure and function inside the company.

Activity of test on possible repair is performed (see next slide)

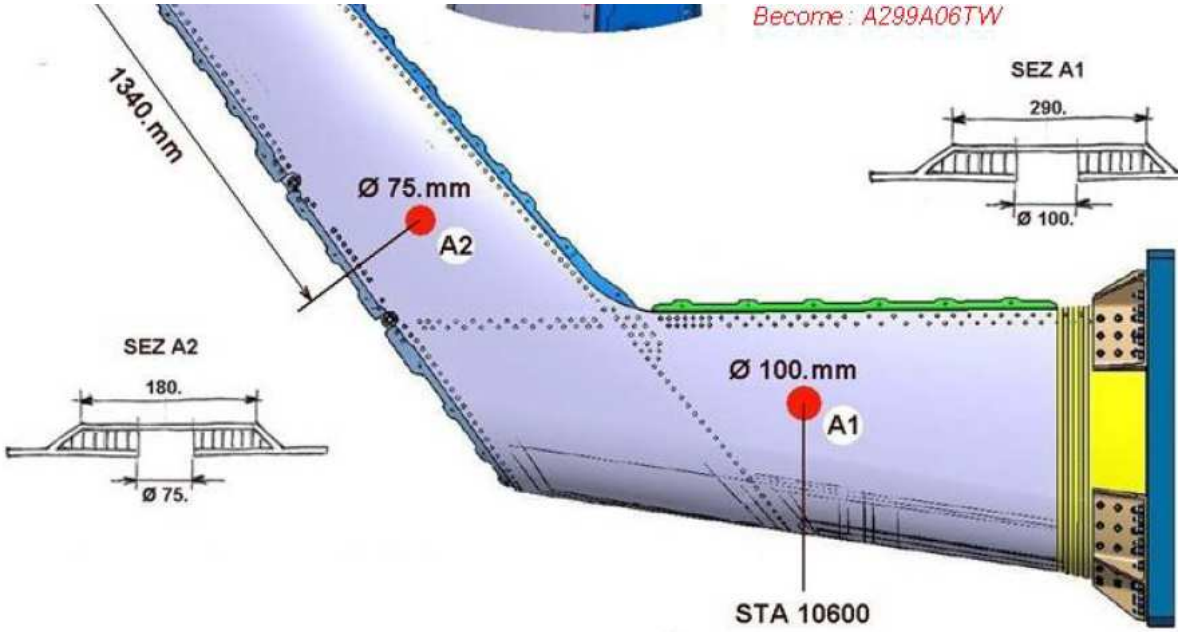
REPAIR

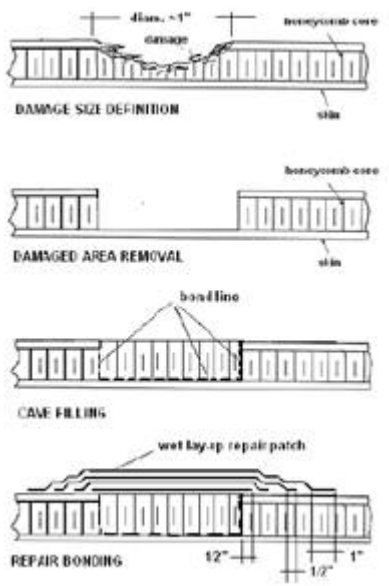
On the components std or well-established, by experiences, procedure for repairs are applied.

Repairs with wet lay-up process and with controlled temperature cycles have been successfully tested



AW169 Tail
Fin and Cone Joint
Area in which
structural repairs of the
already existing CVID
impact damages in
the composite parts
(plus some additional
ones) have been
applied





Fatigue test of the repair up to 5600 FH, and then static tested up to 160% of factorized limit loads without failure

THANK **YOU** FOR YOUR ATTENTION

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HELICOPTERS

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