SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

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Superseding ARP4915

(R) Disposition of Landing Gear Components Involved in Accidents/Incidents

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

This document establishes a procedure for disposition of landing gear components that have been involved in accidents/incidents. The recommendations in this document apply to components made of ferrous and non-ferrous alloys.

2. REFERENCES:

2.1 British Civil Aviation Authority, Airworthiness Notice No. 97 (Issue 1, May 10, 1982) Return to Service of Aircraft Items Recovered From Aircraft Involved in Accidents/Incidents

2.2 AMS 2759, Heat Treatment of Steel Parts, General Requirements

2.3 FAA Advisory Circular 21-38, Disposition of Unsalvageable Aircraft Parts and Materials

2.4 AMS 2770, Heat Treatment of Wrought Aluminum Alloy Parts

2.5 AMS 2801, Heat Treatment of Titanium Alloy Parts

2.6 AMS 2658, Hardness and Conductivity Inspection of Wrought Aluminum Alloy Parts

3. DEFINITIONS:

3.1 RESIDUAL STRESS:

Stress present in a component that is free of external forces or thermal gradients.

3.2 RESIDUAL STRAIN:

Plastic deformation that remains permanently after removal of the load that caused it.

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3.3 FERROUS ALLOY:

High strength alloys such as: medium-carbon low alloy steel (examples: 300M, 4340, D-6ac, ...); medium-alloy air hardening steels (examples: H11 Mod., 9Ni-4Co, AerMet 100, ...); precipitation-hardening stainless steels (examples: 15-5PH, PH13-8Mo, 17-4PH, ...).

3.4 NON-FERROUS ALLOYS:

High strength aluminum alloy in the artificially aged and overaged condition (examples: 7075-T6, -T73, 7050-T74, ...) and titanium alloys (examples: Ti-6Al-4V, Ti-10V-2Fe-3Al, ...).

3.5 INORGANIC COATING:

Metallic and non-metallic coating such as: electroplating (chrome, nickel, cadmium); anodizing (chromic, sulfuric, hard); non-metallic (chemical conversion, phosphating); ceramic (carbide, HVOF); metallic (thermal spraying, ion vapor deposition).

3.6 ORGANIC COATING:

Coating having an organic base. General terms for paint (primer and top coat).

4. IDENTIFICATION OF DAMAGE:

4.1 Landing gear components involved in accidents/incidents can be classified under four different types.

Type I: Components with visible severe mechanical damage (gouged, pierced, etc.).

Type II: Components suspected to be exposed to temperature above the designed limits (fire, frictional heat caused by aborted take-off/hard landing), and when damage is suspected due to a failed wheel bearing.

Type III: Components with visible or measurable dimensional distortion.

Type IV: Components with no visible or measurable defect, but known to have been involved in an accident/incident (no heat damage).

These types of damage are not normally identified in repair and overhaul manuals; therefore separate dispositions are required. A damage assessment is essential to determine the applicable category.

4.2 Identification of Materials:

Class 1: Ferrous Alloys
Class 2: Aluminum Alloys
Class 3: Titanium Alloys

5. DISPOSITION:

5.1 Type I:

These components are to be considered scrap unless subjected to detail evaluation by cognizant engineers and approved by the airworthiness authorities. However, if the components are to be returned to service, it is strongly recommended to follow steps shown for types II, III, and IV to ensure the removal of residual stresses.

5.2 Type II:

Type II damage will likely cause a reduction in strength, ductility, fatigue properties and/or stress corrosion cracking, due to changes in material properties. The severity of damage caused by intense heat cannot be accurately evaluated with normal shop procedures. Investigation by approved engineering personnel is essential.

NOTE: Do not remove any paint, primer or plating and do not apply any chemicals prior to the investigator viewing the part. Essential evidence may be lost.

For class 1 components:

Examination of cadmium coated surfaces for evidence of blistering and any color change to primer and enamel, together with accurate testing methods involving hardness and non-destructive methods are required for the proper assessment of damage. Examination of other coatings (such as chrome) for evidence of discoloration is also essential. Unless a thorough investigation is performed, these components are not to be returned to service. For components exposed to local heating effects, a local nital etch inspection is required.

The following are the recommended steps when investigating a type II damage:

a. The part should be thoroughly cleaned using solvent or detergent and water. Abrasives or chemicals which may bleach or discolor must be avoided.

b. Prior to stripping the part:

1. Examine primer or painted surfaces for color changes or blistering.
2. Examine cadmium coated surfaces for blistering.
3. Examine other coatings (such as chrome) for evidence of discoloration.

5.2 (Continued):

c. Based on the evidence found during the initial examination the following other steps may need to be undertaken:

1. Remove all bushings and finishes.
2. Partially or completely strip the part.
3. Perform a nital or ammonium persulphate etch.
4. Hardness and other non-destructive tests.

d. Parts that required etch, hardness, or non-destructive testing should be re-shot-peened to the original manufacturing requirements. Parts that have been nital etched should be stress relieved before shot peening.

WARNING: Unless a thorough investigation by properly qualified personnel is performed, these parts are not to be returned to service.

For Class 2 and 3 components:

Examination of organic coated surfaces for evidence of blistering and any color change to organic finishes, together with accurate testing methods involving hardness and non-destructive methods are required for the proper assessment of damage.

The following are the recommended steps when investigating a type II damage:

a. The part should be thoroughly cleaned using solvent or detergent and water. Abrasives or chemicals which may bleach or discolor must be avoided.

NOTE: Use of chlorinated solvents on titanium should be followed by an alkaline cleaning to prevent stress corrosion cracking.

b. Prior to stripping the part:

1. Examine primer or painted surfaces for color changes or blistering.
2. For class 2 only, examine inorganic coated surfaces for discoloration.

c. Based on the evidence found during the initial examination, the following additional steps may need to be undertaken:

1. Remove all bushings.
2. Partially or completely strip all organic and inorganic coatings.
3. For class 2, immerse in alkaline etch solution for temper change detection. For class 3, immerse in acid etch solution for discoloration.
4. For class 2, perform a conductivity test on suspected areas in conjunction with hardness test using HRB scale (AMS 2658).

WARNING: Unless a thorough investigation by properly qualified personnel is performed, these parts are not to be returned to service.

5.3 Type III:

Any measurable dimensional distortion indicates that the component has been subjected to loads in excess of its material yield limits. Residual stress will reduce its effective strength even if its function is not affected. In addition, straightening the component will contribute to an increase of the residual stress level and will reduce the part resistance to fatigue cracking due to the two cycles of reversed bending overload.

For Class 1 components:

The recommended minimum requirements to reduce residual stresses are:

a. From the inspection report on the subject component, determine if the part is functionally acceptable.

   1. If the part is functionally unacceptable, it should be considered scrap. Cold working a deformed part is structurally unacceptable.
   2. If the part is functionally acceptable, rework per steps (b thru i).

b. Remove all bushings and finishes. The part should be completely stripped.

c. Bake at 50 °F below material tempering temperature for 24 h. AMS 2759 can be used as a guide to locate material tempering temperature.

d. Magnetic particle inspect

e. Nital or ammonium persulphate etch inspect.

f. Bake at 50 °F below tempering temperature for 24 h.

g. Hardness test inspect.

h. Store for an extended period (a minimum of 6 months is recommended).

i. Magnetic particle inspect.

j. Shot peen entire component to the original manufacturing specifications. Qualification of the shot peening technique is essential since component is to be brought to original drawing requirements.

NOTE: Due to the embrittling effect of cadmium, chrome, and nickel plating, if excessive tensile residual stresses are still present after the residual stress reduction procedures, the component may fail during the plating procedures.