SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP823 REV. E

Issued 1964-01
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Superseding ARP823D

Minimizing Stress-Corrosion Cracking in Wrought Heat-Treatable Aluminum Alloy Products

RATIONALE

ARP823E has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 The purpose of this recommended practice is to provide the aerospace industry with recommendations concerning minimizing stress-corrosion cracking (SCC) in wrought high-strength aluminum alloy products.

1.2 The detailed recommendations are based on practical engineering experience and reflect those design practices and fabricating procedures which have been found to be most effective in minimizing stress-corrosion cracking in wrought high-strength aluminum alloy products.

1.3 This ARP provides general guidelines. For further information see references in 4.3.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM G 64 Classification of Resistance to Stress-Corrosion Cracking of High-Strength Aluminum Alloys (Volume 03.02 of the ASTM 1986 Book of Standards)

2.1.2 NASA Publications

Available from NASA, Documentation, Marshall Space Flight Center, AL 35812, www.nas.nasa.gov.

MSFC-SPEC-522A Design Criteria for Controlling Stress Corrosion Cracking, issued 1977 November 18 by George C. Marshall Space Flight Center

MSFC-STD-3029 Guidelines for the Selection of Metallic Materials for Stress-Corrosion Cracking Resistance in Sodium Chloride Environments Materials, Processes, and Manufacturing Department Metallic Materials and Processing Group

2.1.3 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch.

MIL-HDBK-1568 Materials and Processes for Corrosion Prevention and Control in Aerospace Weapons Systems

2.1.4 Other Publications

Metallic Materials Properties Development and Standardization (MMPDS-03)

NBS Monograph 156, "Stress Corrosion Cracking Control Measures", by B. F. Brown, Chapter 4 on Aluminum Alloys, 1977 June

3. GENERAL

Stress-corrosion cracking failures of wrought, high-strength aluminum alloy parts have been attributed to the following combination of factors:

a. Presence of a sustained surface tensile stress developed as a result of assembly stresses and/or residual stresses due to heat treatment, forming, or service stresses acting in a direction perpendicular to the plane of predominant grain flow.

b. Presence of a corrosive environment, which need not be severe (atmospheric water vapor may be sufficient), and

c. Existence, in the product, of a metallurgical condition which makes the product susceptible to stress-corrosion cracking.

3.1 Al-Cu-Mg alloys and Al-Li alloys of the 2XXX series, 5XXX alloys with magnesium greater than 3%, Al-Zn-Mg and Al-Zn-Mg-Cu alloys of the 7XXX series are most susceptible to stress-corrosion cracking especially in the short-transverse direction. Tempers of particular concern are T3XX and T6X in 2XXX and 7XXX alloys respectively. MMPDS-3 which superseded MIL-HDBK 5 provides specific threshold stress levels and exposure times. Acceptance criteria and corrosion capability for 5XXX alloys with magnesium greater than 3%, specified for marine use and citing H116 and H321, are defined by ASTM B 928.

3.1.1 Control of the fabrication process is important for the avoidance of stress-corrosion cracking susceptibility in select 2XXX and 7XXX alloys in the T8 and T7 tempers respectively. This specifically applies to peak aged T8XX and over-aged tempers such as T73XX, T74XX, T76XX and T79XX. These products were engineered to guarantee a demonstrated level of Stress Corrosion and Exfoliation Resistance. Tensile loading in the short transverse direction is an important design parameter. Achieving this level of corrosion resistance requires very good understanding of the aging process and controls which assure consistent response. Quality assurance tests include conductivity and tensile properties.

4. RECOMMENDATIONS

4.1 General

Applied stresses in the short-transverse direction should be minimized. Besides material susceptibility, residual forming stresses, stresses from machining, and stresses from assembly or misfit of parts can contribute to stress-corrosion cracking. Such stresses should not be overlooked in the design phase.

- Use alloys and tempers resistant to SCC.
- Use stress-relieved parts.
- Perform severe forming on product in the annealed condition, followed by heat treatment, if required.
- Perform forming and straightening on newly quenched product to lessen forming stresses.
- Avoid fitup stresses by careful attention to tolerances. Misaligned parts should not be forced into place.
- Where surface tensile stresses cannot be avoided, consider techniques like shot peening, surface rolling, or thermal stress relief to reduce undesirable stresses. When using thermal treatments for stress relief, consideration also needs to be given to the effect of time at elevated temperature on the properties of the product.
- Heat treat weldments after welding. To avoid stress-corrosion cracking while the product is in the W temper, parts should be stored in a dry environment for as short a time as possible before artificial aging.
- Quenching causes desirable surface compressive stresses and undesirable internal tensile stresses. This should be considered when machining the parts.
- Use heat treating specifications that require process controls, (e.g., AMS 2770, 2771, 2772) for solution heat treating and overaging treatments as applicable.

4.2 Die Forgings

4.2.1 Grain Flow

Die design should be such as to preclude excessive grain run-out at the parting line and to avoid re-entrant grain flow at any point in the forging.

4.2.2 Heat Treatment

Solution heat treatment should be accomplished when the part is as close to finished machine size as practicable. Preferably, the forging envelope should closely approximate the machined part envelope to preclude the need for excessive machining after heat treatment. Quenching from the solution temperature should be performed in such a manner as to provide uniform cooling on all surfaces of the part. The quench medium temperature should be as high as possible, commensurate with maintaining satisfactory mechanical properties and general corrosion resistance.

4.2.3 Preservation

Parts and parts in process, except those made of product alclad on both sides, should be coated with AMS 3065 compound, or equivalent, until such time as the final protective coating is applied.