AEROSPACE MATERIAL SPECIFICATION

AMS2767	
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Uphill Quenching of Aluminum Alloy Product

RATIONALE

AMS2767 defines and standardizes a process in current use by aerospace customers to reduce internal residual stress. The products covered by this specification include aluminum wrought or cast parts or semi-finished shapes.

1. SCOPE

This specification establishes engineering requirements for the uphill quenching process. Uphill quenching immerses product in liquid nitrogen followed by exposure to a high pressure/velocity steam blast or boiling water.

1.1 Application

1.1.1 These processes are applicable to both wrought and cast shapes.

1.1.2 This document is applicable when called out on an engineering drawing, required or permitted by a heat-treating specification or specified by a customer purchase order.

1.2 Classification

This process is categorized by types, classes and levels as follows:

Type I - Uphill quench using high velocity steam as the heating medium.

Type II -Uphill quench using boiling water as the heating medium.

Class 1 - Applications where uphill quench process is preceded by solution treatment and quenching (AQ).

Class 2-Applications where uphill quench process is performed on material in any other condition (e.g. F,O,W,T5,T6,T7,T8...) than as specified in class 1.

Level 1 process is controlled and qualified by a procedure developed by the processor.

Level 2 process is controlled and qualified by a procedure developed by the processor and approved by the customer that may include a stress reduction test method defined by the customer.

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http://www.sae.org/technical/standards/AMS2767

1.2.1 When no type, class or level is specified, Type I, Class1, Level 2 shall be the default condition.

2. APPLICABLE DOCUMENTS

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096 0001, Tel: 877 606 7323 (inside USA and Canada) or 724 776 4970 (outside USA), or www.sae.org.

AMS2770 Heat Treatment of Aluminum Alloy Parts

AMS2771 Heat Treatment of Aluminum Alloy Castings

AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

AMS2750 Pyrometry

3. TECHNICAL REQUIREMENTS

3.1 Equipment.

3.1.1 Liquid nitrogen source.

3.1.2 Liquid nitrogen processing tank.

3.1.3 Type I Processing:

3.1.3.1 Steam Boiler

3.1.3.2 Appropriate steam blast fixture designed, if needed or suitable for the individual part.

3.1.4 Type 2 processing

3.1.4.1 Water tank and heating apparatus

3.1.5 A digital surface temperature indicator with appropriate thermocouple.

3.1.6 When required by processing plan, refrigeration equipment with temperature control and recorder.

3.2 Temperature control and measuring equipment shall meet the requirements of AMS2750, Class 2, except that temperature uniformity survey for equipment used for uphill quenching steps is not required. Temperature uniformity survey is applicable to solution heat treatment and precipitation hardening performing in conjunction with AMS2770, AMS2771, AMS2772.

3.3 Procedures

3.3.1 Class 1 only

Product shall be solution heat treated and quenched in accordance with AMS2770, AMS2771, AMS2772 or other controlling specification as defined by the purchase order.

3.3.2 For Class 1 product only

Uphill quenching shall either commence within 30 minutes of quenching from solution heat treatment or, if the product is held in the AQ condition after solution heat treatment, the AQ product shall be placed in a freezer within 30 minutes and maintained at a temperature equal to or lower than 0 °F (-18 °C) for a maximum of 7 days and uphill quench shall be performed within 30 minutes after removal from the freezer

3.3.3 All Types / Classes / Levels

Cool the product in liquid nitrogen. Product shall be totally submerged in liquid nitrogen, allow the product thermally stabilize and should remain immersed 30 minutes after boiling around the product stops.

3.3.4 Product transfer

3.3.4.1 The transfer time from the liquid nitrogen bath to the heating medium should be minimized to avoid any ice buildup on the product and shall not exceed 20 seconds. Longer transfer times are acceptable if allowed with a level 2 approval.

3.3.5 Heating procedures

3.3.5.1 Type I Processing

Select the designated steam blast fixture for the part being processed. The fixture shall be capable of equally and simultaneously exposing all surfaces of the part to high velocity steam.

3.3.5.1.1 The steam blast fixture shall be preheated to 180ºF minimum.

3.3.5.1.2 The product shall have steam applied on all external surfaces and on internal surfaces as defined by the process.

3.3.5.1.3 The duration of the steam application is dependent upon the thickness of the part, and shall be continuous until the temperature sensor reading of the part is between 180 and 220 °F (82 and 104 °C). Exposure to 220 °F (104 °C) shall be less than 60 seconds in any one cycle.

3.3.5.1.4 The temperature of each part after application of the steam shall be determined by a digital temperature indicating device, the surfaces of the product shall be at a minimum of 180 °F (82 °C). The temperature indicator may be integrated into the holding fixture or utilized manually. After the part has been steamed, air-cool the part to room temperature.

3.3.5.2 Type II Processing

Transfer product from the liquid nitrogen to the boiling water tank using holding fixtures capable of withstanding the thermal shock and compatible with the material, quenching and heating medium.

3.3.5.2.1 The product shall be totally immersed in boiling water. Product surface should reach a minimum of 160 °F. After immersion the product shall be removed from the tank and air-cooled to room temperature.

3.3.6 When specified in Level 2, a stress reduction test method defined by the purchaser shall be used to quantify stress reduction. The test result shall comply with purchasers specified requirements.

3.3.7 Following uphill quenching, any further thermal treatment shall be in accordance with the drawing or purchase document

3.3.8 Reprocessing

For all Types / Classes / Levels, the product shall not be reprocessed without prior customer approval. The number of reprocessing cycles shall be in accordance with customer requirements. Reprocessing for Class 1 may include a solution heat treat and quench and additional uphill quench cycles. Reprocessing for Class 2 only includes additional uphill quench cycles.

3.3.9 Personnel Training

Suppliers performing stress relieving in accordance with this specification shall have a program of initial and periodic training and evaluation of its personnel.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

Except as specified by the purchasing documents, the processor shall be responsible for the performance of all tests and inspections specified herein. The procuring source reserves the right to perform any surveillance or tests or inspections of product, and to review records and results of processor's tests and inspections to verify that the process conformed to the specified requirements.

4.2 Logs

A record (written or electronic storage media), traceable to temperature recording information (chart(s) or electronic storage media and shop travelers or other documentation, shall be maintained for each lot of product processed. The information on the combination of these documents shall include: equipment identification, approved personnel's identification, date, part number or product identification, quantity of product, alloy, lot identification, (other applicable specification), and the actual thermal processing times and temperatures used, indicating total number of cycles. The log shall contain test data for validation of the process when required for Level 2 product.

4.3 Records

Records shall be maintained and made available for a minimum of 5 years. The records shall contain all data necessary to verify conformance to the requirements of this specification.

4.4 Approval:

The process and control factors for product produced and certified to level 1 shall be approved by the processors quality assurance organization. Level 2 approval requires customer concurrence of the processors procedures.

4.4.1.1 A process procedure is required that defines:

the liquid nitrogen tank size
the proximity of the liquid nitrogen tank to the heating media
the method and time for transferring the product from the liquid nitrogen to the uphill quench application.
the parameters of the heating media (steam, or water)
the temperature range of the heating media
the fixturing used to support the product or apply the steam (Type 1 only)
the number of times the product is to be immersed in the liquid nitrogen and the heating media that defines a single cycle
the number of cycles to be performed
the method and location for any residual stress measurements (level 2 only).

4.4.2 Level 2 requires customer approval of the procedure for uphill quenching. Process verification samples and test method shall be as defined by the customer.

4.4.3 The processor shall make no change to the approved processes, or process parameters defined in 4.4.1.1 without re-approval

4.5 Report/Certification

The processor shall furnish, with each shipment of products a certified quality assurance report, traceable to the heat treat control number(s), stating that the products were processed in accordance with the requirements of this document. This report shall include: purchase order number, lot number, AMS2767, part number or product identification, alloy, temper/strength designation, quantity of product in the shipment; identification of equipment used; actual processing times and temperatures used, the total number of cycles, the Type, Class and Level of the product. When applicable, the report shall include results, of the process validation tests and for Level 2 only a statement of their conformance/ non-conformance to customer requirements, or when specified, the numerical results of the stress reduction measurement test.

5. PREPARATION FOR DELIVERY

Not applicable.