



<b>AEROSPACE MATERIAL SPECIFICATION</b>	<b>AMS2771™</b>	<b>REV. F</b>
	Issued	1987-10
	Revised	2017-04
Superseding AMS2771E		
Heat Treatment of Aluminum Alloy Castings		

### RATIONALE

AMS2771F results from limited scope ballots with changes to refrigeration equipment (3.1.5), solution treatment batch furnace interruption (3.2.6.1), quenchant temperature rise (3.2.9.4.1), refrigeration processing (3.2.10.2), solution treatment (Table 1) for A201 and A206, and adding A206-T71 precipitation treatment (Table 2).

#### 1. SCOPE

##### 1.1 Purpose

This specification covers the engineering requirements for heat treatment of aluminum alloy castings and for parts machined from castings.

##### 1.2 Application

This specification is applicable to castings of the following aluminum alloys and modifications (see 8.2.8):

201.0	328.0	520.0
203.0	333.0	705.0
206.0	336.0	707.0
222.0	354.0	712.0
242.0	355.0	713.0
243.0	356.0	850.0
295.0	357.0	851.0
296.0	358.0	852.0
319.0	359.0	

1.3 When AMS2771 is specified and specific heat treat processing instructions are included in the material specification, the equipment and control requirements of AMS2771 shall apply. For alloys not specifically covered, the provisions of this specification shall be applicable, but temperatures, times, and quenching procedures shall be as specified by the purchaser.

#### 2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2017 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)  
Tel: +1 724 776 4970 (outside USA)

**SAE values your input. To provide feedback on this Technical Report, please visit [771E](#)**

This is a preview. [Click here to purchase the full publication.](#)

SAE WEB ADDRESS:

## 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AMS2750 Pyrometry

AMS3025 Polyalkylene Glycol Heat Treat Quenchant

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

ARP1962 Training and Approval of Heat-Treating Personnel

## 2.2 ANSI Accredited Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ANSI H35.1/H35.1M Standard Alloy and Temper Designation System For Aluminum

## 3. TECHNICAL REQUIREMENTS

### 3.1 Equipment

Equipment used for thermal processing shall conform to the requirements of this specification and AMS2750, except (1) requirements for working zone controls, instruments and sensors shall apply to all heating zones of continuous and semi-continuous furnaces and (2) recordings from instruments may be stored on magnetic or optical media providing a hard copy is available on request.

#### 3.1.1 Pyrometry

Shall meet the requirements of AMS2750.

#### 3.1.2 Furnaces

##### 3.1.2.1 Heating Media

Shall be air, protective atmosphere, combusted gases, molten salt bath, oil bath, or fluidized bed. Electrical heating elements and radiant tubes shall be shielded to prevent direct radiation from striking any part. The products of combustion in the furnace, and the composition and maintenance of salt baths and fluidized beds shall be such as to prevent attack or contamination of the castings. Ammonium fluoroborate, or equivalent, may be used in air furnaces as necessary. Nitrate salt baths shall not be used to heat treat 520.0 alloy due to a potential explosion safety hazard.

##### 3.1.2.1.1 Salt Entrapment

Castings that will entrap salt shall not be heated in a molten salt bath.

##### 3.1.2.2 Temperature Uniformity Survey Requirements

Temperature uniformity surveys shall be performed as defined in AMS2750.

3.1.2.2.1 Solution Heat Treating and Aging Furnaces shall be Class 2 minimum as defined in AMS2750.

3.1.2.2.2 Annealing Furnaces shall be Class 5 minimum as defined in AMS2750.

### 3.1.3 Quenching

Unless otherwise approved by the cognizant engineering organization, the following provisions apply. Equipment shall be provided for quenching in water, air blast, oil, or in polymer quenchant and for measuring quenchant temperature. Provisions shall be made for mechanical, hydraulic, or air agitation of the quenching medium or agitation of the castings or both and for heating and cooling of the quenchant, as required. Air agitation shall be allowed provided the air doesn't come in contact with the castings being quenched. The volume of quenching medium for immersion quenching shall be sufficient so that its temperature rise due to quenching meets the requirements of 3.2.9.4.1.

#### 3.1.3.1 Polymer Quenchants

Polyalkylene glycol shall meet the requirements of AMS3025. Other synthetics may be used provided that they are not detrimental to the material and that the parts meet the required specified properties in the final heat treated condition. Polymer concentration shall be established for the particular casting configuration prior to use.

#### 3.1.3.2 Salt Contamination of Polymer Quenchants

Shall not exceed 6% by weight.

### 3.1.4 Cleaning

Equipment shall be provided to clean castings, as necessary for heat treatment, and to remove residual quenchant after solution heat treatment. Examples include: water rinse to remove polymer quenchant residue, detergent and rinse to remove oil quenchant residue, and fresh water overflow to remove salt quenchant residue.

### 3.1.5 Refrigeration

Refrigeration or liquid baths shall be provided for cold storage of castings when prevention of natural aging is necessary to produce required properties or is used at the discretion of the producer to facilitate straightening.

## 3.2 Procedures

### 3.2.1 General

Cast parts that require heat treatment to a T4X, T6X, or T7X temper (refer to ANSI H35.1/H35.1M) shall be solution heat treated (including quenching), refrigerated after quenching, when necessary, and aged, when required, as specified herein. Castings in the T5X condition shall be refrigerated after casting, when necessary, and aged as specified herein. Heat treatment shall be performed only on entire castings, never on a portion of a part.

### 3.2.2 Racking and Spacing

Product shall be supported or hung and spaced to permit flow of the heating and cooling media over all surfaces to ensure that the castings will meet the specified requirements. Alternate racking methods are acceptable if tests have been performed to demonstrate that all castings so racked will meet specified requirements. Written instructions, drawings, photographs, etc., shall be used to ensure proper spacing.

3.2.2.1 Small castings as defined in 8.2.4 may be heated and soaked in baskets or continuous furnaces. Care must be used to provide access for heating and quench media and to prevent damage during loading and quenching. Arrangement in baskets may be either orderly or random provided that the castings meet the required specified properties in the final heat treated condition.

#### 3.2.2.2 Water Entrapment

Racks and fixtures used for solution heat treatment shall be constructed to preclude entrapment of water.

### 3.2.3 Loading

The temperature of the furnace during part loading shall not exceed the solution treating temperature of the castings being heat treated.

### 3.2.4 Post Quench Reload to Furnace

Batch type furnaces that momentarily reload the freshly quenched material back into the furnace work zone as part of the unloading/quench tank transfer sequence is allowed provided objective evidence is available to qualify this process. The evidence shall demonstrate the thinnest material processed is not heated above 212 °F (100 °C) by this post quench process using radiation survey process in AMS2750. The castings shall not be held in the furnace for more than 5 minutes during this post-quench sequence. The process used to provide the objective evidence shall be performed at the minimum furnace open time established by the heat treater's documented process after quenching the castings. The documented process shall include the maximum temperature of the furnace as measured by the control thermocouple or a specified minimum furnace cooling time prior to raising the load into the furnace.

### 3.2.5 Set Temperature

Control instrument(s) shall be set at the temperature specified in 3.2.9 for solution treating and 3.2.11 for aging, and should be set at the recommended annealing temperature specified in 3.2.12. Sensor/control offsets, if used, shall comply with AMS2750.

### 3.2.6 Soaking

Soaking time starts when all temperature control sensing elements and load thermocouples (if used) are within 10 °F (6 °C) of the set or offset temperature.

#### 3.2.6.1 Batch Furnaces

Interruptions during solution treatment are permitted provided the minimum soak time is met and at least a 2 hour soak time occurs after the interruption. When acceptable to the cognizant engineering organization, producer may use a shorter soak time after interruption that is documented and based on test results and data applicable to the castings being processed. During aging and annealing treatments, a maximum of four interruptions are permitted for removal or loading of castings. The time between door opening and furnace or load thermocouple recovery is not to be counted as part of the total aging time.

#### 3.2.6.2 Continuous and Semi-Continuous Furnaces

During soaking, a drop-in temperature indicated by furnace instrument(s) is permissible provided (1) that temperature does not drop more than 20 °F (11 °C) below the minimum of the specified range, (2) time below the minimum of the specified range does not exceed 5 minutes, and (3) soaking is continued for not less than 10 minutes after recovery before quenching.

3.2.6.2.1 If furnace temperature does not drop more than 20 °F (11 °C) below the minimum of the specified range, but does not recover to the minimum of the specified range within 5 minutes, the total soaking time, if less than 1 hour was required, shall be increased by 1/2 hour. If 1 hour or more was required, the total soaking time shall be increased by 1 hour.

3.2.6.3 Load thermocouples shall be used, when needed, to determine and control metal temperature and heating time or when required by the cognizant engineering organization (see 8.2.7).

### 3.2.7 Logs

A record (written or electronic storage media), traceable to temperature recording information (chart(s) or electronic storage media) and to shop travelers or other documentation, shall be kept for each furnace and load. The information on the combination of documents shall include: equipment identification, approved personnel's identification, date, part number or product identification, number of castings, alloy, lot identification, AMS2771 or other applicable specification, actual thermal processing times and temperatures used. When applicable, atmosphere control parameters, quench delay, quenchant type, polymer concentration, and quenchant temperature shall also be recorded. The maximum thickness, when process parameters are based on thickness, shall be recorded and shall be taken as the minimum dimension of the heaviest section of the part. The log data shall be recorded in accordance with the heat treater's documented procedures.