



AEROSPACE MATERIAL SPECIFICATION

AMS2315™**REV. J**

Issued 1963-01
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Revised 2025-05

Superseding AMS2315H

(R) Determination of Delta Ferrite Content

RATIONALE

AMS2315J is the result of a Five-Year Review and update of the specification. The revision updates sample selection (see 3.1.3 and 3.1.3.4), revises heat-treatment requirements (see 3.1.4), modifies procedure for limited delta ferrite control (see 3.2), modifies grid counts (see 3.2.1.1), removes exceptions to reporting %RA (see 3.2.1.3.6), reduces sampling (see 4.3.1.2), and addresses retesting (see 4.5.2.5).

1. SCOPE

This specification covers two methods for determining the percentage of delta ferrite in steels and other iron alloys. When applicable, this specification will be invoked by the material specification.

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.

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.

AS7766 Terms Used in Aerospace Metals Specifications

2.2 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 E3 Preparation of Metallographic Specimens

ASTM E1245 Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis

2.3 Definitions

Terms used in AMS are defined in AS7766.

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3. TECHNICAL REQUIREMENTS

3.1 Specimen Preparation

3.1.1 Heat Qualification

Sampling for heat qualification shall be in accordance with 4.3.1. Samples shall be converted into test specimens in accordance with 3.1.3.

3.1.2 Product Qualification

Product from a heat not qualified shall be qualified based on sampling as in 4.3.1 and shall be sampled in accordance with 4.3.2. Samples shall be converted into test specimens in accordance with 3.1.3.

3.1.3 Specimen Selection

Samples of sufficient size to provide specimens having an area sufficient to select the required number of fields to accurately examine the sample shall be cut from the product as in 3.1.3.1, 3.1.3.2, or 3.1.3.3, as applicable. Each specimen shall be marked in such a manner that its orientation with respect to the direction of rolling, drawing, or extruding is easily identifiable.

3.1.3.1 For round, hexagonal, or square product, specimens shall be selected from an area midway between the edge and the center of the sample.

3.1.3.2 For rectangular product, specimens shall be selected from an area midway between the longitudinal edge and the center of the sample.

3.1.3.3 For tubing and other hollow shapes, specimens shall be selected from samples that include the full wall thickness of the product if the full wall thickness is 0.500 inch or under and mid-wall if the full wall thickness is over 0.500 inch.

3.1.3.4 For product geometries other than the above, specimens shall be selected at 1/4 thickness or diameter for solid product and 1/2 wall thickness for hollow/ring products. Alternate specimen locations may be agreed upon between the purchaser and producer.

3.1.4 Heat Treatment

Specimens, except as specified in 3.1.4.1, may be austenitized at the normal recommended temperature for the grade of steel being examined and adequately quenched. Quenched specimens shall be tempered at a sufficiently high temperature to develop good metallographic contrast, unless good metallographic contrast can be achieved without tempering.

3.1.4.1 Solution- and precipitation-hardenable steels may be solution heat treated and may be precipitation heat treated to develop good metallographic contrast.

3.1.5 Polishing

After heat treatment as in 3.1.4, a face of each specimen, perpendicular to the direction of maximum deformation, shall be ground and polished using standard metallographic polishing techniques in accordance with ASTM E3 to produce a surface suitable for microscopic examination.

3.1.6 Etching

The polished surface of each specimen shall be suitably etched to reveal delta ferrite (see 8.3).

3.2 Procedure for Limited Delta Ferrite Criterion

Inspect the specimen surface at a magnification appropriate to observe the relative amount and distribution of delta ferrite present. If it is evident that many fields will have a zero value, and no single field shall have a value exceeding the material specification maximum when that maximum is 2% or over or no more than five fields shall have a value exceeding the material specification maximum when that maximum is less than 2%, then measure a set number of fields defined in a laboratory procedure sufficient to ensure the upper control limit of the mean (mean + 95% CI) is less than 50% of the material specification maximum as in 3.2.1 or 3.2.2. A 10% relative accuracy level is not required in this case. For dispute over the percentage of delta ferrite, the value determined as in 3.2.2 shall govern.

3.2.1 Point Count Method

3.2.1.1 Field Measurement

Project the image of the microstructure of each specimen onto the ground-glass screen of a reflection-type microscope or metallograph. Place a transparent point-counting grid template either in front of or behind the ground glass. The template should consist of systematically spaced grid points, such as 100, either in the form of fine crosses or a grid lattice. The magnification chosen should be high enough to clearly resolve the delta ferrite grains but not so high that the number of grid points falling in the ferrite grains exceeds one, on average. For each specimen, count the number of grid points (i.e., the intersection point of the crosses or grid blocks) that fall within the ferrite grains as one and those that fall on the phase boundaries as one-half.

3.2.1.2 Field Selection

Select the fields to be measured randomly (that is, without looking at the image) by moving the stage controls. Do not alter the position so that grid points fall on or miss ferrite grains. Space the fields selected around the specimen surface in a systematic pattern. Measure a sufficient number of fields so that the relative accuracy (see 3.2.1.3.5) is 10% or less. The relative accuracy of the measurement is influenced by the volume fraction of the ferrite, the magnification, the grid point density, the number of fields measured, and the field-to-field variation of the ferrite phase.

3.2.1.3 Calculation

3.2.1.3.1 Ferrite per Field

Calculate the volume fraction of ferrite using Equation 1 for each field measured.

$$V_{\delta,i} = \frac{P_{\delta,i}}{P_t} \times 100 \quad (\text{Eq. 1})$$

where:

$V_{\delta,i}$ = volume fraction of ferrite in percent of each field

$P_{\delta,i}$ = number of grid points in the ferrite phase or on the phase boundaries

P_t = number of grid points