

# AEROSPACE MATERIAL SPECIFICATION

Issued JUL 2000  
Revised DEC 2003

Superseding AMS 2259C

## Chemical Check Analysis Limits Wrought Low-Alloy and Carbon Steels

### 1. SCOPE:

#### 1.1 Purpose:

This specification defines limits of variation for determining acceptability of the chemical composition of wrought low-alloy and carbon steel parts and material acquired from a producer. Check analysis limits for elements or for ranges of elements not listed herein shall be as specified in the applicable material specification or as agreed upon by purchaser and vendor.

#### 1.2 Application:

When specifically referenced in the material specification, the purchaser may apply check analysis limits to determine the acceptability of parts and materials at purchaser's final acceptance test or verification test operation. Use of check analysis limits is not permitted for ladle or ingot analyses, or for other acceptance testing by the producer.

### 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 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or [www.astm.org](http://www.astm.org).

ASTM E 1806 Sampling Steel and Iron for Determination of Chemical Composition

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 reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 2003 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: 724-776-4970 (outside USA)

Fax: 724-776-0790

Email: [custsvc@sae.org](mailto:custsvc@sae.org)

#### SAE WEB ADDRESS:

<http://www.sae.org>

### 3. TECHNICAL REQUIREMENTS:

#### 3.1 Analytical Procedures:

Referee analysis shall be by any method acceptable to purchaser and vendor.

#### 3.2 Definitions:

3.2.1 Check (Product or Verification) Analysis: Analysis made by purchaser of parts or materials to verify the composition of a heat or lot or to determine variations in the composition within a heat or lot. Acceptance or rejection of a heat or lot of material or batch of parts may be made by applying variation limits as described in 8.2.2. In the analysis of finished parts, limits do not apply to elements whose percentage can be varied by fabricating techniques employed (for example carbon in steel) unless the sample is taken in such a manner as to exclude such variations.

3.2.2 Variation Limit, Under Minimum or Over Maximum: Given in 3.3 is the amount an individual determination for a specified element may vary under or over the specified composition limit. In no case shall the reported determinations of any element (except lead) in a heat, using the same analytical procedure, vary both above and below the specified range. Lead may vary both above and below the specified range. Dimensional sizes shown in paragraph titles or text or in column headings refer to the cross-sectional area of the product being analyzed.

3.2.3 Remainder: Shows the basis element from which the alloy is made and is assumed to be present in an amount approximately equal to the difference between 100% and the sum percentage of the alloying elements and listed impurities. Analysis for and reporting of the basis element are not required.

3.2.4 Residual Elements, Each, Maximum: The maximum amount of an individual element not mentioned specifically in the specified composition that may be present. Producer normally will analyze only for elements which are possible to be present because of raw materials or manufacturing processes and which may affect the product significantly. Others will analyze for impurities as they deem necessary.

3.2.5 Residual Elements, Total, Maximum: The sum percentage of the residual elements (See 3.2.4) found. It is not inferred by this statement that an analysis need be made for each element of the periodic table not mentioned specifically in the composition section.

#### 3.3 Check Analysis Variation Limits:

3.3.1 Carbon Steels: Variations for carbon, phosphorus, and sulfur do not apply to rimmed or capped steels. Variations for phosphorous and sulfur do not apply to rephosphorized or resulfurized steels. Boron is not subject to check analysis variation limits.

3.3.1.1 Bars, Forgings, Wire, Seamless Tubing, and Stock for Forging or Heading: For product up to 100 square inches (645 cm<sup>2</sup>), inclusive in section area, check analysis variation limits shall be as shown in Table 1.

TABLE 1 - Check Analysis Variation Limits for Carbon Steel Bars, Forgings, Wire, Seamless Tubing, and Stock Up to 100 Square Inch Section Area

| Element    | Limit or Maximum of Specified Range, % | Variation Limit, % Under Min or Over Max |
|------------|----------------------------------------|------------------------------------------|
| Carbon     | Up to 0.25, incl                       | 0.02                                     |
|            | Over 0.25 to 0.55, incl                | 0.03                                     |
|            | Over 0.55                              | 0.04                                     |
| Manganese  | Up to 0.90, incl                       | 0.03                                     |
|            | Over 0.90 to 1.65, incl                | 0.06                                     |
| Silicon    | Up to 0.35, incl                       | 0.02                                     |
|            | Over 0.35 to 0.60, incl                | 0.05                                     |
| Phosphorus | Up to 0.040, incl                      | 0.008 (3.3.1.1.1)                        |
| Sulfur     | Up to 0.050, incl                      | 0.008 (3.3.1.1.1)                        |
| Copper     | All                                    | 0.02 (3.3.1.1.2)                         |
| Lead       | 0.15 to 0.35, incl                     | 0.03 (3.2.2)                             |

3.3.1.1.1 Variation applicable only to over maximum.

3.3.1.1.2 Variation applicable only to under minimum for copper bearing steels.

3.3.1.2 Forging Stock Over 100 Square Inches (645 cm<sup>2</sup>) in Section Area: Check analysis variation limits shall be as shown in Table 2.

TABLE 2 - Check Analysis Variation Limits for Carbon Steel Forging Stock Over 100 Square Inch Section Area

| Element                           | Limit or Maximum of Specified Range, % | Variation, %<br>Section Over 100 to 200<br>Square Inches (over 645<br>to 1290 cm <sup>2</sup> ), Incl | Variation, %<br>Section Over 200 to 400<br>Square Inches (over 1290<br>to 2581 cm <sup>2</sup> ), Incl | Variation, %<br>Section Over 400 to 800<br>Square Inches (over 2580<br>to 5161 cm <sup>2</sup> ), Incl |
|-----------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Carbon                            | Up to 0.25, incl                       | 0.03                                                                                                  | 0.04                                                                                                   | 0.05                                                                                                   |
|                                   | Over 0.25 to 0.55, incl                | 0.04                                                                                                  | 0.05                                                                                                   | 0.06                                                                                                   |
|                                   | Over 0.55                              | 0.05                                                                                                  | 0.06                                                                                                   | 0.07                                                                                                   |
| Manganese                         | Up to 0.90, incl                       | 0.04                                                                                                  | 0.06                                                                                                   | 0.07                                                                                                   |
|                                   | Over 0.90 to 1.65, incl                | 0.06                                                                                                  | 0.07                                                                                                   | 0.08                                                                                                   |
| Silicon (3.3.1.2.1)               | Up to 0.35, incl                       | 0.02                                                                                                  | 0.03                                                                                                   | 0.04                                                                                                   |
|                                   | Over 0.35 to 0.60, incl                | --                                                                                                    | --                                                                                                     | --                                                                                                     |
| Phosphorus<br>(3.3.1.1.1)         | Up to 0.040, incl                      | 0.008                                                                                                 | 0.010                                                                                                  | 0.015                                                                                                  |
| Sulfur (3.3.1.1.1)                | Up to 0.050, incl                      | 0.010                                                                                                 | 0.010                                                                                                  | 0.015                                                                                                  |
| Copper (3.3.1.1.2)<br>(3.3.1.2.1) | All                                    | 0.03                                                                                                  | --                                                                                                     | --                                                                                                     |
| Lead (3.2.2,<br>3.3.1.2.1)        | 0.15 to 0.35, incl                     | 0.03                                                                                                  | --                                                                                                     | --                                                                                                     |

3.3.1.2.1 Where no variation limit is shown, limits have not been established, and shall be subject to agreement between purchaser and vendor.

3.3.1.3 Sheet, Strip, Plate, and Welded Tubing: Check analysis variation limits shall be as shown in Table 3.

TABLE 3 - Check Analysis Variation Limits for Carbon Steel Sheet, Strip, Plate, and Welded Tubing

| Element    | Limit or Maximum of Specified Range, % | Variation, % Under Min | Variation, % Over Max |
|------------|----------------------------------------|------------------------|-----------------------|
| Carbon     | Up to 0.15, incl                       | 0.02                   | 0.03                  |
|            | Over 0.15 to 0.40, incl                | 0.03                   | 0.04                  |
|            | Over 0.40 to 0.80, incl                | 0.03                   | 0.05                  |
|            | Over 0.80                              | 0.03                   | 0.06                  |
| Manganese  | Up to 0.60, incl                       | 0.03                   | 0.03                  |
|            | Over 0.60 to 1.15, incl                | 0.04                   | 0.04                  |
|            | Over 1.15 to 0.65, incl                | 0.05                   | 0.05                  |
| Silicon    | Up to 0.30, incl                       | 0.02                   | 0.03                  |
|            | Over 0.30 to 0.60, incl                | 0.05                   | 0.05                  |
| Phosphorus | All                                    | --                     | 0.01                  |
| Sulfur     | All                                    | --                     | 0.01                  |
| Copper     | All                                    | 0.02                   | --                    |

3.3.2 Low-Alloy Steels:

3.3.2.1 Product Up to 100 Square Inches (645 cm<sup>2</sup>), Inclusive, in Section Area, Except Plate: Check analysis variation limits shall be as shown in Table 4.

TABLE 4 - Check Analysis Variation Limits for Low-Alloy Steel Product Up to 100 Square Inches (645 cm<sup>2</sup>) Section Area

| Element    | Limit or Maximum of Specified Range, % | Variation, % Under Min or Over Max |
|------------|----------------------------------------|------------------------------------|
| Carbon     | Up to 0.30, incl                       | 0.01                               |
|            | Over 0.30 to 0.75, incl                | 0.02                               |
|            | Over 0.75                              | 0.03                               |
| Manganese  | Up to 0.90, incl                       | 0.03                               |
|            | Over 0.90 to 2.10, incl                | 0.04                               |
| Silicon    | Up to 0.40, incl                       | 0.02                               |
|            | Over 0.40 to 2.20, incl                | 0.05                               |
| Phosphorus | All                                    | 0.005 (3.3.2.1.1)                  |
| Sulfur     | Up to 0.060, incl                      | 0.005 (3.3.2.1.1)                  |
| Chromium   | Up to 0.90, incl                       | 0.03                               |
|            | Over 0.90 to 2.10, incl                | 0.05                               |
|            | Over 2.10 to 10.00, incl               | 0.10                               |
| Nickel     | Up to 1.00, incl                       | 0.03                               |
|            | Over 1.00 to 2.00, incl                | 0.05                               |
|            | Over 2.00 to 5.30, incl                | 0.07                               |
|            | Over 5.30 to 10.00, incl               | 0.10                               |
|            | Over 10.00 to 20.00, incl              | 0.15                               |

TABLE 4 - Check Analysis Variation Limits for Low-Alloy Steel Product  
Up to 100 Square Inches (645 cm<sup>2</sup>) Section Area (Continued)

| Element                 | Limit or Maximum of<br>Specified Range, % | Variation, %<br>Under Min or Over Max |
|-------------------------|-------------------------------------------|---------------------------------------|
| Cobalt                  | Up to 1.00, incl                          | 0.03                                  |
|                         | Over 1.00 to 5.00, incl                   | 0.05                                  |
|                         | Over 5.00 to 10.00, incl                  | 0.10                                  |
| Molybdenum              | Up to 0.20, incl                          | 0.01                                  |
|                         | Over 0.20 to 0.40, incl                   | 0.02                                  |
|                         | Over 0.40 to 1.15, incl                   | 0.03                                  |
|                         | Over 1.15 to 2.50, incl                   | 0.05                                  |
|                         | Over 2.50 to 5.00, incl                   | 0.10                                  |
| Tungsten                | Up to 1.00, incl                          | 0.04                                  |
|                         | Over 1.00 to 4.00, incl                   | 0.08                                  |
| Aluminum                | Up to 0.10, incl                          | 0.03                                  |
|                         | Over 0.10 to 0.20, incl                   | 0.04                                  |
|                         | Over 0.20 to 0.30, incl                   | 0.05                                  |
|                         | Over 0.30 to 0.80, incl                   | 0.07                                  |
|                         | Over 0.80 to 1.80, incl                   | 0.10                                  |
| Vanadium<br>(3.3.2.1.2) | Up to 0.10, incl                          | 0.01                                  |
|                         | Over 0.10 to 0.25, incl                   | 0.02                                  |
|                         | Over 0.25 to 0.50, incl                   | 0.03                                  |
|                         | Over 0.50 to 1.10, incl                   | 0.04                                  |
| Copper                  | Up to 1.00, incl                          | 0.03                                  |
|                         | Over 1.00 to 2.00, incl                   | 0.05                                  |
| Zirconium               | Up to 0.50, incl                          | 0.02                                  |
| Lead                    | 0.15 to 0.35, incl                        | 0.03 (3.2.2)                          |

3.3.2.1.1 Variation applies only to over maximum.

3.3.2.1.2 If a minimum value is specified, check analysis variation limit is 0.01 under minimum for all ranges in all sizes and the tabulated limit applies only over maximum.

3.3.2.1.3 Boron is not subject to check analysis variation limits.

3.3.2.2 Semifinished Product Over 100 Square Inches (645 cm<sup>2</sup>) in Section Area, and Plate: Check analysis variation limits shall be as shown in Table 5.