MERITOR®
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Material Specification

Specification: B-1
Revision Date: 09/06/2016
Revision Level: AE

GENERAL WROUGHT STEEL STANDARD
(SCHEMATIC INCLUDED)

1.0 SCOPE:

This specification outlines general requirements for wrought steel delivered directly to Meritor or through its suppliers as forgings or components. All steel shall be produced by pre-qualified mills listed in Materials Specification B-1-A.

All special bar quality (SBQ) mills must be able to produce high quality steel in order to achieve the design intents. The mills must have good steel making practices which shall include but not limited to electromagnetic stirring, vacuum degassing and practices and processes that minimize the absorption of undesirable gases or contamination from impurities. No open stream is permitted in any of the teeming processes.

Wherever Material Specification B-1 is in conflict with an individual Meritor material specification, the individual requirements take precedence over B-1.

The "applications" section contained within individual material specifications serves only as a guideline. Individual material specifications may be used for other applications if required by the part drawing.

2.0 TESTING REQUIREMENTS:

2.1 Steel producers and/or suppliers shall demonstrate by appropriate testing or certification (when authorized) that all materials, referenced against this standard, conform to requirements of the individual material specifications.

2.2 When required, mechanical property tests shall be conducted on the material in the condition delivered to Meritor or its suppliers.

2.3 The nominal chemical limits or ranges for steels listed in Meritor material specifications are given in SAE J403-2009 (12), J404-2009 (01), J405-1998 (06), J1081-2000 (11), J1249-2008 (12), J1268-2010 (05). Limits are subject to standard variations in check analysis stated in SAE J409-1995 (02) or other appropriate world steel standards.

2.4 Certain residual elements may be present in steel which are not specified or required. Unless directly called out, the **maximum** acceptable limits for residual elements are listed in Table 1.

Table 1. Maximum Limits for Residual Elements

Element	Bar Stock	Plate
Aluminum	See section 2E	See section 2E
Copper (Cu)	0.30% (plain carbon) 0.35% (alloyed)	0.40%
Nickel (Ni)	0.25%	0.40%
Chromium (Cr)	0.20%	0.30%
Molybdenum (Mo)	0.06%	0.12%
Tin (Sn)	0.02%	
Arsenic (As)	0.01%	
Antimony (Sb)	0.01%	
(Sn+As+Sb)	0.03%	
Lead (Pb)	0.01%	0.01%
Vanadium (V)	<0.01%	<0.01%

Remark: For steels having copper greater than 0.20%, Ni/Cu ratio >0.4 is required.

2.5 All steels shall be grain refined to have an ASTM E112-10 rated prior austenite grain size number of 5 or finer unless otherwise specified. The etchant used for revealing the prior austenite grain boundaries shall be selected so the microstructure of the final rolled product is viewable with the use of light microscopy. If the prior austenite grain size as measured in a hot rolled bar is coarser than ASTM 5, and the final application is a hot forged and/or through heat treated product, it is permissible to rate using a method described in ASTM E112-10 A.3, recognizing an inherent reheating and quenching step may be necessary.

Resulphurized or rephosphorized steels (such as SAE 1100 and 1200 series steels, or grades equivalent to them) shall be considered inherently coarse grained unless specified otherwise. Inherently coarse grain steel shall have a prior austenite grain size number of ASTM 3 or finer unless otherwise approved by Meritor - Materials Engineering. Aluminum grain refined steel shall contain the aluminum content specified in Table 2. Plate products for structural applications may exceed the upper limit of the aluminum content with the approval of Materials Engineering. Steels utilizing grain refiners other than aluminum require approval of the Meritor Materials Engineering prior to the steels initial application.

Table 2. Aluminum Content Limits

Aluminum	Weight Percent
Total	0.015-0.050
Total "Aim"	0.020-0.040
Acid Soluble*	0.015 min.

* Applicable only when acid soluble aluminum is reported.

2.6 Hardenability testing for "H" band steels shall be conducted in accordance with SAE J406-2009 (03). Unless otherwise specified in the individual specification the hardenability aim shall be the center 50% of the hardenability band specified in SAE J1268. To qualify H BANDS, limited data points namely - J4, J8, J12 will be used. Hardenability of NON "H" grades shall be calculated by the "Caterpillar" procedures (SAE J406-2009 (03) Appendix A) using DI. Steel producers may calculate DI using ladle analysis. DI aim shall be the center 50% of the DI band unless otherwise specified. All applicable residual elements shall be included in hardenability calculations.

Certain material specifications and/or applications require a "mandatory" chemistry or hardenability rather than an "aim". An "aim" should meet the requirement 90% of the time.

2.7 All steel heats shall be subject to microscopic examination for cleanliness. Steel sources supplying bar/billet products shall demonstrate a capability to achieve internal cleanliness quality levels within the maximum inclusion rating values shown in Table 3 (NOTE: For sheet and plate, the level of microcleanliness must not adversely affect manufacturing or part performance). ASTM E45-11a, paragraph 4, 9, 11, method A, plate I-r will be used.

Table 3. Permitted Ratings of Microscopic Inclusions for Steel

	Type A	Type B	Type C	Type D
	(sulfides)	(aluminates)	(silicates)	(oxides)
Thin	3.0	3.0	3.0	2.0
Heavy	2.0	2.0	2.0	1.0*
* Maximum allowable diameter of heavy oxide inclusions is 0.0015 inch				

Resulphurized steels or steels having specified minimum sulfur content, and leaded steels will not be subject to type "A" MnS inclusion limits.

2.8 Bars that have not undergone any mechanical surface removal shall exhibit a maximum allowable total

decarburization depth of 0.008 in. (0.2 mm) for bar diameters 0.500 in. (12.70 mm) and smaller or 1.6% of the diameter on sizes over 0.500 in. The existing decarburization shall at least meet SAE J419-198312, Type 1 requirements. Bars that have undergone surface removal shall meet SAE J419-1983 (12), Type 3 requirements.

2.9 Bars shall be free from pipe, excessive chemical segregation, laps, cracks, or surface defects of sufficient severity to affect product performance. Seam depth of bars produced to special bar quality (SBQ) shall not exceed 0.001 in. (0.025 mm) per 0.060 in. (1.52 mm) of section.

2.10 Surface finish (roughness height rating) of peeled bar supplied to Meritor may extend to but not exceed 125 microinches - Arithmetical Average (AA). Peeled and burnished finished bar cannot exceed 40 microinches.

2.11 Steel color codes are defined in material specification B-39.

2.12 Commodity Product (For Ingot): The semi-finished plate or bar shall show no evidence of cracks, center looseness, pinholes, blowholes or original dendritic structure. It may exhibit a perceptible amount of centerline segregation.

2.13 Sheet or plate products shall be free from excessive chemical segregation, laps, cracks, or surface defects of sufficient severity to affect product performance. Structural products that exhibit injurious defects during subsequent fabrication are deemed not to comply with the applicable product specification.

2.14 Carbon Equivalent (C.E.) requirements for welded components contained within individual material specifications will be determined utilizing the formula below, unless a different method of determination is listed within the individual material specification.

$$C.E. = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

3.0 CONCAST STEEL:

3.1 Concast porosity and a general lack of cohesiveness is characteristic of "as cast" steel whether produced by the ingot or continuous cast process. Much of this looseness is healed during subsequent rolling, however, due to the lower reduction ratios inherent with the use of continuous cast steels, some looseness may be retained in the commodity product. Hence there is a need for "as cast" quality requirements and minimum reduction ratios.

3.2 **STRAND AND BLOOM:** The "as cast" product must exhibit, after proper etching (ASTM E 381-01(2006)) or sulfur printing, three zones of solidification; chill, columnar and equiaxed (from surface to center). Mill checks will be made on the "as cast" or semi finished billet product and must conform to criteria below.

3.2.1 A few halfway cracks of a length not exceeding 8% of the minimum thickness of cast section are permitted.

3.2.2 Small, low frequency subsurface pinholes are allowable.

3.2.3 Diagonal cracks are not permitted.

3.2.4 A few cracks (hinge cracks), not exceeding 6mm in length in the as cast product and not interrupting the surface, may exist along the inboard edge of the chill zone.

3.2.5 Some center looseness is permitted. However, no linear ruptures are allowed.

3.2.6 Centerline segregation is permitted to a minor extent(Defects shown in Figure 1).

3.2.7 Steel mill must submit bloom or billet sections off each stand at the front, middle and end of a heat for steel grade approval.

3.3 Surfaces of strands and blooms shall be free of defects such as cracks, tears and pinholes, which will generate surface defects on the rolled bars in non-conformance with surface quality specified in Item 2.9. This state may be achieved by appropriate conditioning.

3.4 Rhomboidity of strand or bloom shall be limited to 5% (diagonally).

$$\frac{\text{Longer diagonal} - \text{Shorter diagonal}}{\text{Shorter diagonal}} \times 100 \leq 5\%$$

3.5 Billet, Bloom and Slab: Casters must demonstrate by adequate quality control procedures and practices capability of supplying quality product.

3.6 REDUCTION RATIO:

Continuous cast steel properties vary according to the amount of "working" it receives, and is determined by the size ratio of the original strand to the rolled bar.

The minimum purchased commodity reduction ratio for forged parts[1] is 5:1. Exceptions to this rule are listed in Table 4. Machining[2] applications will be limited to a purchased commodity minimum reduction ratio of 10:1.

3.6.1 A forged part, is a product that has experienced substantial working throughout its entire section.

3.6.2 Machined products will include any part machined directly from bar stock or upset forgings where the "as rolled" bar remains a portion of the part.

4.0 REPORTS:

4.1 Producers shall report test results in accordance with manufacturing practice or as specified by the applicable Meritor plant quality function.

4.2 All reports shall show the Meritor purchase order number, a description of the commodity, the material specifications to which it was made, the steel mill, heat numbers and test results. Such documents shall be supplied to the using plant prior to or at the time of steel delivery.

4.3 Warehouses shall be in a position to report as set forth in A and B above when requested. All warehouse purchased steel must meet Material Specification B-1 and B-1-A stipulations.

TABLE 4. Approved reduction ratios for forged parts produced from continuously cast steel.**

STRUCTURAL PARTS	MINIMUM REDUCTION RATIO
Axle Centers	3.0:1
Axle Shafts	11.0:1
Drive Line Shafts	10.0:1
Steering Knuckles	3.0:1
Steering Knuckle Cap & Pin - off highway	2.4:1
Steering Arms and Cross Tube Arms	9.0:1
Anchor Pins	10.0:1
Differential Case Flange Half	1.0:1
Differential Case Plain Half	2.5:1
Drive Axle Spindles - (Linehaul)	2.5:1
Drive Axle Spindles (Forged at the Meritor Morristown Plant)	2.5:1
Integral Spindle Trailer Axles	14.0:1
Weld Yokes	3.0:1
End Yokes	3.0:1
Wing Bearing Caps	3.0:1
Shifter Forks	5.0:1
Forged Ferrous Trailer Hubs	1.5:1
Trailer Brake Spider	7.0:1
Brake Cams	10.0:1
Steering Knuckle-Cap & Pin (Drive Axle)	2.7:1
Hydraulic Disc Brake Pistons	5.0:1
GEARS	
Differential Pinions-Precision Forged	4.0:1
(Mack Prec. Forged Diff Pinion & Gear)	11.9:1
Side Gears-Precision Forged	4.2:1
(Mack Prec. Forged Side Gear)	10.0:1
Drive Pinions	4.2:1
Drive Gears	4.3:1
Cut tooth gear (Bar stock)	10.0:1
(AxleTech Products)	7.0:1
Forged Planetary Ring Gear Hub	3.6:1
SUSPENSION PARTS	
Stabilizer Bars	15.0:1
Hollow Stabilizer Bars	15.0:1
Helical Springs	15.0:1
Torsion Bars	15.0:1

** Approvals listed in this table apply only to parts manufactured for Meritor. Approval for application to non-Meritor parts must be received from the customer through the supplying Meritor plant.

5.0 QUALITY RESPONSIBILITY

Material procured by Meritor.

5.1 The responsibility for providing material of the specified quality shall rest with the supplier.

5.2 The fulfillment of this or any corollary specification for such materials in no sense constitutes approval of or obligation to use any material which is subsequently found to be deficient.

6.0 REFERENCE SPECIFICATIONS:

Any Meritor specification that references Material Specification B-1 is to follow the appropriate specification and revision levels listed in Table 5. For reference industry specifications that are not listed in Table 5, the appropriate revision level shall be the active version according to the revision date on the specific Meritor Material Specification.

Example: Meritor Specification has a revision date of June 5, 2000 and references another industry standard. The industry standard was issued in 1997 and has a revision in 2007. The required industry standard to use is the revision dated in 1997.

Table 5. Reference Specifications

Industry Affiliation	Standard Number and Revision Date	Title of Standard
Meritor	B-1-A	General Wrought Steel Standard (Pre-Qualified Steel Sources)
Meritor	B-39	Steel Color Code
ASTM	ASTM E45-11a	Standard Test Methods for Determining the Inclusion Content of Steel
ASTM	ASTM E112-10	Standard Test Methods for Determining Average Grain Size
ASTM	ASTM E381-01(2006)	Standard Test Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings
SAE	SAE J403 2009 (12)	Chemical Composition of SAE Carbon Steels
SAE	SAE J404 2009 (01)	Chemical Composition of SAE Alloy Steels
SAE	SAE J405 1998 (06)	(R) Chemical Composition of SAE Wrought Stainless Steels
SAE	SAE J406 2009 (03)	Methods of Determining Hardenability Of Steels
SAE	SAE J409 1995 (02)	Product Analysis – Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel
SAE	SAE J419 1983 (12)	Methods of Measuring Decarburization
SAE	SAE J1081 2000 (11)	Potential Standard Steels
SAE	SAE J1249 2008 (12)	Former SAE Standard and Former SAE Ex-Steels
SAE	SAE J1268 2010 (05)	Hardenability Bands for Carbon and Alloy H Steels

Date	Change
09/06/2016 Level AE PR-04821	Section 1."pre-qaulified " was "Approved" Added SBQ requirement paragraph in Section 1. Added Section 3.2.7 on grade approval sampling requirements. Editorial changes in referencing the proper tables. Editorial changes in Section 6.
03/15/2016 Level AD PR-03567	Updated section 2.5. Specified prior austenite grain size as grain size to be measured. Added an alternate rating method if the prior austenite grain size is coarser than ASTM 5.
10/23/2014 Level AC Request 30272-173	Updated header and reformatted specification. Re-numbered sections and tables. Added Reference Specification section.
07/16/2012 Level AB Request 32847-1	Changed Section 2F hardenability revised SAE J406 appendix B, to reflect most current specification (now appendix A). Re-formatted 2G into Table 1 Reformatted Table 2 (was formerly Table 1). Added reference specifications section 6.
08/05/2011 Level AA Request 32495-4	Added section 2n – carbon equivalent equation
11/05/2010 Level Z Request 30272-145	Added "resulphurized and rephosphorized…. inherently coarse grain…Group" to section 2-E for clarification. Changed higher to finer in 2-E for clarification. Added apostrophe in 2-E (grammar). Clarified approval in 2-E and reporting in 4A.
4/05/2008 Level Y Request 30272-17	Corrected mis-understanding for machined from bar stock reduction ratio requirements in section 3F. Moved "Exceptions to this rule are listed in Table 1" from after the machined section to after the forged section. Added the word "Forged" to heading in Table 1.
12/05/2007 Level X Request 30276-1	Added "The "applications" section…part drawing" paragraph to the Scope
5/17/2007 Level W Request 26356-5	Added exception for plate products in Paragraph 2E. Modified Change box for Request 26956-4
5/05/2007 Level V Request 26956-4	Section 2E was "aluminum content must be reported as total aluminum, not soluble". Clarified the aluminum content for aluminum grain refined steel.

12/05/2006 Level U Request 25807-4	-Reworded section 3F from " and is determined by the ratio of the original strand size to the finished size of the bar or forging."
6/05/2006 Level T Request 25807-3	Added maximum vanadium residual of <0.01% for bar stock and plate
4/05/2006 Level S Request 25807-2	Added section 2M. Changed allowable amount of residual lead to 0.01% for both bar stock and flat rolled material
2/05/2006 Level R Request 25807-1	-Added maximum lead residual of 0.001% for bar stock and 0.005% for plate -Listed all maximum residuals in section 2D in table format
10/5/2005 Level Q Request 25434-3	In section 2E, added the following sentence: "The aluminum content for all metallic materials must be reported as total aluminum, not soluble aluminum"
9/5/2005 Level P Request 25434-2	Corrected the date on the header and change box.
8/5/2005 Level N Request 25434-1	Added statement - (NOTE: For sheet and plate, the level of microcleanliness must not adversely affect manufacturing or part performance) to paragraph 2G.
7/15/2003 Level M Request 23362-1	Added provision for Mack Truck steel reduction ratio requirements of 11.9 and 10.0:1
1/15/2002 Level L Request 21627-1	Added reduction ratio of 7.0:1 for Cut tooth gear (bar stock) for Off-Highway Products in Table I.
4/15/2001 Level K Request 20291-1	Tin content in Section D was 0.04% max. Added 0.01% max. for Arsenic, 0.01% max. for Antimony, with the sum of Sn, As, and Sb not to exceed 0.03%.
4/15/2000 Level J Request 19837-1	Table 1 previously stated Drive Axle Spindles - on highway. Added Drive Axle Spindles forged at the Meritor-Morristown plant.
10/15/98 Level H	Editorial change in section 2E: rephrased "fine grain" to "grain refined"
9/26/97 Level G	Major revisions: Para.2E: Clarified provision for qualification of non-aluminum grain refined steel. Para. 2G:Excluded sheet & plate steels from cleanliness requirements. para. 3A2 Deleted ladle addition requirements, this will be emphasized in the Steel Approval Procedure. Para.6 Deleted this is covered in QA policy. Table 1: Added Forged Planetary Ring Gear Hubs with 3.6:1 reduction ratio.
6/15/97 Level F	Added "Bar stock" in Table 1 (Gears).

2/1/97 Level E	Sect. 3: ASTM plate was 3.,Sect. 3B2: Added Drive Gear 4.3:1
4/15/96 Level D	Added reduction ratio for steering knuckle cap & pin & Hydraulic Brake piston. Editorial changes in Section 3. In 2H, replaced E45 paragraph 12 with 11, plate 3 added.. All reduction ratios increased to one place significant decimal.
6/15/94 Level C	Removed narrow band requirement sect. #7. Removed steel mill sources from Table 1. Consolidated 2F hardenability and 7 narrow band requirements into 2F Section 2H added. Added "optional grain ..." at 2E. Ni/Cu was Cu/Ni at 2D. Added Vanadium requirement in Sect. 2E.
4/15/93 Level B	Deleted in section 3.E2 forged part examples, and axle center from sec. 7 - narrow band table.
12/15/92 Level A	Changed Anchor Pin Reduction from 14:1. Added SAE Grade 8822H Steel.
4/15/92	Changed reduction ratio for drive pinion from 7.6:1.
12/15/91	Deleted approved suppliers list.
12/15/90	Added approved suppliers to the list.

Approved By: S. Doyle
Director - Materials Engineering

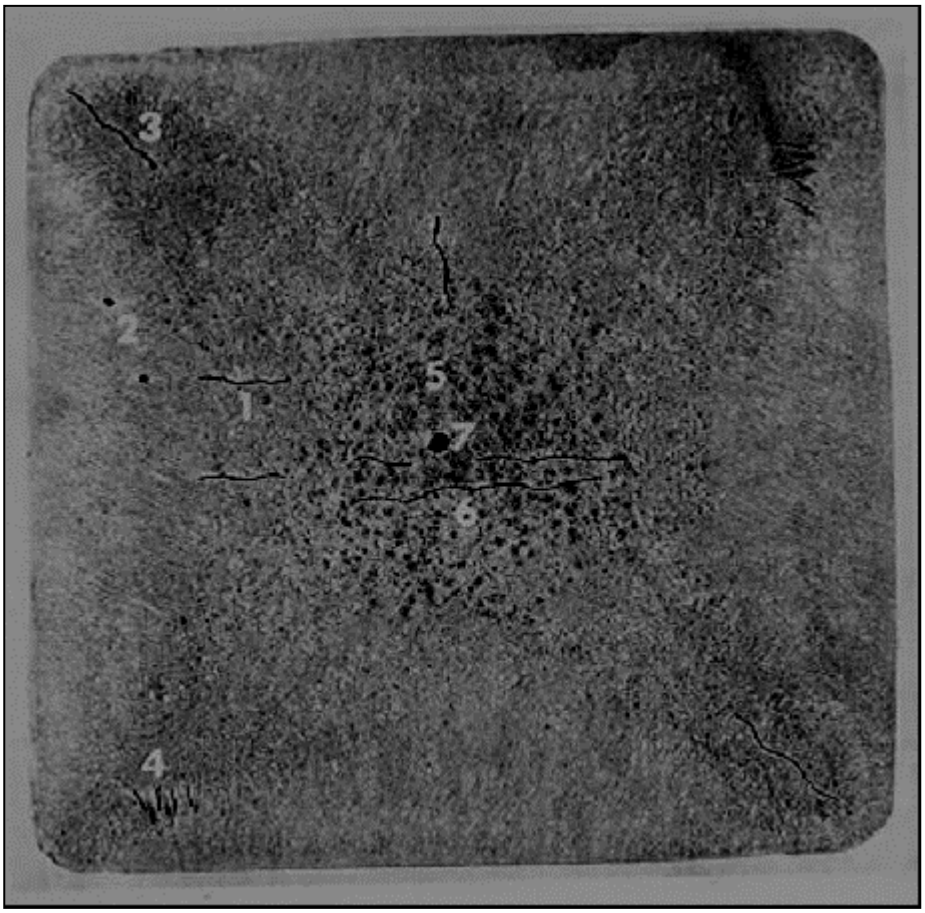

Figure 1. Strand and Bloom Defects

1 Halfway Cracks
2 Pinholes
3 Diagonal Cracks
4 Hinge Cracks - Inboard of chill zone
5 Center Looseness
6 Linear rupture
7 Centerline segregation (Black Hole)