

<b>MONITORING INSTRUCTION FOR INSPECTION</b>		Issue No. 01 Rev. No. 03
		Date of Issue 09.10.2019
<b>STEEL BAR DIA. 80mm</b>		<b>HAPP/QA/SC/G/003</b>
Rev no	Amendment	Date
3	i) As per ASTM A322-1995 GRADE 4340, ASTM A29 was ASTM A322-91 grade 4340 ii) Outer Ø80 + 1.2/-0.0 mm was Ø80 ± 1.2 iii) Chemical, Mechanical properties and for all other parameters as applicable under Table "A" from NABL accredited/ Govt. approved / P.S.U lab iv) Photomicrographics Removed.	09.10.2019

**SPECIFICATION : AS PER ASTM A322-1995 GRADE 4340, ASTM A29**

**SAMPLING SPECIFICATION : AS PER MIL -STD-105 OR ANSI ASQC Z 1.4**

**END USE : TAIL UNIT 120 mm FSAPDS MK -II, 125 mm FSAPDS ( DOP 550mm)**

**A. INSPECTION CHECKS TO BE CARRIED OUT BY FIRM AT FIRM'S PREMISES.**

SL. NO.	CHARACTERISTICS	SPECIFICATION / REQUIREMENT	SAMPLE SIZE
1	WORKMANSHIP (VISUAL)	THE MATERIAL SHALL BE UNIFORM AND FREE FROM DEFECTS SUCH AS RUST, SCALE, BURRS, AND ANY OTHER HARMFUL DEFECTS.	100 %
2	DIMENSIONS	OUTER DIA : 80.00+1.2/-0.0mm LENGTH : TO BE SUPPLIED IN THE LENGTH OF 3m OR MULTIPLES	AS PER DEF 131A
3	CHEMICAL COMPOSITION (%)	C - 0.38 - 0.43 Si - 0.15 - 0.35 Mn - 0.60 - 0.80 P - 0.035 max S - 0.040 max Ni - 1.65 - 2.00. Cr - 0.7 - 0.9. Mo - 0.20 - 0.30.	ONE SAMPLE PER HEAT
4	ULTRASONIC TESTING	SHOULD CONFIRM TO MIL STD-2154 TYPE-1 CLASS A	100%
5	HARDNESS	225 BHN MAX ANNEALED CONDITION (OR) 270-300 HB QUENCHED + TEMPERED VACUUM DEGASSED	100 %
6	MAGNETIC PARTICLE INSPECTION (MPI)	AS PER IS:4075 (STEP TURN AND MAGNETIC PARTICLE CRACK DETECTION TEST) OR AS PER IS:10138 PART -III (MAGNETIC PARTICLE INSPECTION)	A) 2 NOS PER HEAT B) 100%
7	CLEANLINESS TEST	AMS 2301K With Frequency Rating - 0.34Max, Severity Rating - 0.25Max	2 SAMPLES PER HEAT
8	RESPONSE TO HEAT TREATMENT & MECHANICAL TEST	TURN A BAR TO 77mm DIA L-100mm AND SUBJECT IT TO HEAT TREATMENT (HARDENING +TEMPERING ) TO ACHIEVE HARDNESS OF 32 0-360HB UTS - 1000 TO 1310 MPa 0.2% PS -862 TO 1172 MPa	
9	PACKING	PACKING OF THE MATERIAL SHALL BE DONE IN SUCH A MANNER TO AVOID CORROSION AND DAMAGE IN HANDLING AND TRANSIT	100 %
10	MARKING	EACH PACKING SHALL BE LEGIBLY MARKED WITH MANUFACTURER'S IDENTITY, QUANTITY, HEAT NUMBER AND HAPP SUPPLY ORDER NUMBER ETC.	100 %

**NOTE:**

1. THE RAW MATERIAL TO BE TESTED BY THE FIRM BY SELECTING THE SAMPLE BY THE FIRM ITSELF, T.C FOR CHEMICAL, MECHANICAL, UT, MPI AS APPLICABLE UNDER TABLE "A" FROM NABL ACCREDITED/ GOVT. APPROVED / P.S.U LAB.
2. AFTER COMPLETION OF TESTS AS PER NOTE- 1, THE FIRM HAS TO CHECK /ENSURE FOR THE VISUAL DEFECTS, DIMENSIONS, PACKING AND MARKING AS PER TABLE A REQUIREMENT. THE FIRM HAS TO SUBMIT THE FOLLOWING DOCUMENTS TO HAPP.
  - i) THE RAW MATERIAL CERTIFICATE FROM THE ORIGINAL MANUFACTURER, HEAT NUMBER, AND QUANTITY PURCHASED, AND NUMBER OF BARS IS TO BE MENTIONED IN THE INSPECTION LETTER TO HAPP.
  - ii) T.C FOR CHEMICAL, MECHANICAL, UT, MPI etc., AS APPLICABLE UNDER TABLE "A" FROM NABL ACCREDITED/ GOVT. APPROVED / P.S.U LAB.
  - iii) VISUAL & DIMENSIONAL REPORTS AS PER TABLE A SI No 1&2.
  - iv) GUARANTEE /WARRANTEE CERTIFICATE OF SUPPLIER.

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3	i) As per ASTM A322-1995 GRADE 4340,ASTM A29 was ASTM A322-91 grade 4340 ii) Outer Ø80 + 1.2/-0.0 mm was Ø80 ± 1.2 iii) Chemical , Mechanical properties and for all other parameters as applicable under Table "A" from NABL accredited/ Govt. approved / P.S.U lab iv)Photomicrographics Removed.	09.10.2019

3. THE ABOVE DOCUMENTS MENTIONED AT NOTE NO.2 ARE TO BE FORWARDED TO GM/HAPP.
4. HAPP WILL VERIFY ALL THE DOCUMENTS AS ABOVE AND ACCORD CLEARANCE FOR DESPATCH OF THE MATERIAL TO HAPP IF ALL DOCUMENTS ARE IN ORDER.

#### B. INSPECTION CHECK TO BE CARRIED OUT AT HAPP AFTER RECEIPT OF MATERIAL

SL. NO.	CHARACTERISTICS	SPECIFICATION / REQUIREMENT		SAMPLE SIZE
1	WORKMANSHIP (VISUAL)	THE MATERIAL SHALL BE UNIFORM AND FREE FROM DEFECTS SUCH AS RUST, SCALE, BURRS, AND ANY OTHER HARMFUL DEFECTS.		100 %
2	DIMENSIONS	OUTER DIA : 80.00+1.2/-0.0mm LENGTH : TO BE SUPPLIED IN THE LENGTH OF 3m OR MULTIPLES		AS PER DEF 131A
3	CHEMICAL COMPOSITION (%)	C - 0.38 - 0.43 Si - 0.15 - 0.35 Mn - 0.60 - 0.80 P - 0.035 max.	S - 0.040 max Ni - 1.65 - 2.00. Cr - 0.7 - 0.9. Mo - 0.20 - 0.30.	1 SAMPLE PER HEAT
4	HARDNESS	225 BHN MAX ANNEALED CONDITION (OR) 270-300 HB QUENCHED + TEMPERED VACUUM DEGASSED		2 SAMPLES PER HEAT
5	RESPONSE TO HEAT TREATMENT & MECHANICAL TEST	TURN A BAR TO 77MM DIA AND SUBJECT IT TO HEAT TREATMENT (HARDENING +TEMPERING ) TO ACHIEVE HARDNESS OF 320-360HB UTS - 1000 TO 1310 MPA 0.2% PS -862 TO 1172 MPA		
6	PACKING	PACKING OF THE MATERIAL SHALL BE DONE IN SUCH A MANNER TO AVOID CORROSION AND DAMAGE IN HANDLING AND TRANSIT		100 %
7	MARKING	EACH PACKING SHALL BE LEGIBLY MARKED WITH MANUFACTURER'S IDENTITY, QUANTITY, HEAT NUMBER AND HAPP SUPPLY ORDER NUMBER ETC.		100 %

1. HAPP/TRICHY SHALL VERIFY ALL THE PARAMETERS AS ABOVE AND AFTER SATISFACTORY RESULTS, THE MATERIAL WILL BE ACCEPTED / CLEARED ACCORDINGLY.
2. MATERIAL HAS TO BE REPLACED 100% BY THE FIRM IN CASE OF NON CONFORMITY TO SPECIFICATION AS PER TABLE-A,DURING INSPECTION AT HAPP, TRICHY.

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**C. VERIFICATION OF INSPECTION DOCUMENTS.**

FOLLOWING INSPECTION DOCUMENTS MUST BE ENCLOSED WITH EACH SUPPLY.

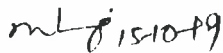
SL. NO.	INSPECTION DOCUMENTS
1	THE RAW MATERIAL ORIGINAL MANUFACTURER'S CERTIFICATE, DETAILS OF HEAT NUMBER, QUANTITY PURCHASED AND NUMBER OF BARS ETC.
2	TEST CERTIFICATE FOR CHEMICAL, MECHANICAL , UT, MPI etc., AS APPLICABLE UNDER TABLE "A" FROM NABL ACCREDITED/ GOVT. APPROVED / P.S.U LAB.
3	VISUAL & DIMENSIONAL REPORTS AS PER TABLE A SI No 1&2 SUBMITTED IN SEPARATE (OR) CERTIFY ALONG WITH TEST CERTIFICATE
4	PACKING SLIP DETAILS
5	IN ADDITION TO THE ABOVE SOFT COPIES OF ALL THE CERTIFICATES MENTIONED IN TABLE - C SHALL BE SENT TO E-MAIL ID's. <a href="mailto:happqa.ofb@ofb.gov.in">happqa.ofb@ofb.gov.in</a> , <a href="mailto:mmhapp.ofb@ofb.gov.in">mmhapp.ofb@ofb.gov.in</a>
Note	EXPLICIT DEVIATION(S) IF ANY SUCH AS TYPOGRAPHICAL ERROR, VALUES, NUMERIC, OTHER PARAMETER, ETC IS/ARE FOUND IN MONITORING INSTRUCTION OF THE ABOVE STORES, THE RELEVANT STANDARDS CONFORMING TO THE CONCERNED SPECIFICATIONS SHALL BE REFERRED TO CONFIRM THE PARAMETER




**AKHILESH GAUR**  
AWM / P  
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WM / PM  
MEMBER / MI COMMITTEE



**P. KAVIN MAHARAJ**  
WM / QA  
CHAIRMAN / MI COMMITTEE

<b>ISSUED BY</b>	
<b>STANDARD CELL</b>	
MPS NO.: 210371	
DATE: 12/10/19	SIGNATURE: 

range under suitable conditions to prevent imperfections caused by too rapid cooling.

5.5 *Thermal Treatment*—Various thermal treatments such as annealing, stress relief, quench and temper, normalize, etc., are available. Such treatments must be specified as a Supplementary Requirement.

6. Chemical Composition

6.1 The heat analysis shall conform to the requirements for chemical composition in Table I for the grade specified.

TABLE 1 Grade Designations and Chemical Compositions of Hot-Wrought Alloy Steel Bars<sup>A,B</sup>

UNS Designation <sup>C</sup>	Grade <sup>D</sup> Designations	Chemical Composition, Ranges and Limits, %							
		Carbon	Manganese	Phosphorus, max	Sulfur, <sup>E</sup> max	Silicon <sup>F</sup>	Nickel	Chromium	Molybdenum
G13300	1330	0.28–0.33	1.60–1.90	0.035	0.040	0.15–0.35	...	...	...
G13350	1335	0.33–0.38	1.60–1.90	0.035	0.040	0.15–0.35	...	...	...
G13400	1340	0.38–0.43	1.60–1.90	0.035	0.040	0.15–0.35	...	...	...
G13450	1345	0.43–0.48	1.60–1.90	0.035	0.040	0.15–0.35	...	...	...
G40230	4023	0.20–0.25	0.70–0.90	0.035	0.040	0.15–0.35	...	...	0.20–0.30
G40240	4024	0.20–0.25	0.70–0.90	0.035	0.035–0.050	0.15–0.35	...	...	0.20–0.30
G40270	4027	0.25–0.30	0.70–0.90	0.035	0.040	0.15–0.35	...	...	0.20–0.30
G40280	4028	0.25–0.30	0.70–0.90	0.035	0.035–0.050	0.15–0.35	...	...	0.20–0.30
G40370	4037	0.35–0.40	0.70–0.90	0.035	0.040	0.15–0.35	...	...	0.20–0.30
G40470	4047	0.45–0.50	0.70–0.90	0.035	0.040	0.15–0.35	...	...	0.20–0.30
G41180	4118	0.18–0.23	0.70–0.90	0.035	0.040	0.15–0.35	...	0.40–0.60	0.08–0.15
G41200		0.18–0.23	0.90–1.20	0.035	0.040	0.15–0.35	...	0.40–0.60	0.13–0.20
G41210		0.18–0.23	0.75–1.00	0.035	0.040	0.15–0.35	...	0.45–0.65	0.20–0.30
G41300	4130	0.28–0.33	0.40–0.60	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41370	4137	0.35–0.40	0.70–0.90	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41400	4140	0.38–0.43	0.75–1.00	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41420	4142	0.40–0.45	0.75–1.00	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41450	4145	0.43–0.48	0.75–1.00	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41470	4147	0.45–0.50	0.75–1.00	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41500	4150	0.48–0.53	0.75–1.00	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15–0.25
G41610	4161	0.56–0.64	0.75–1.00	0.035	0.040	0.15–0.35	...	0.70–0.90	0.25–0.35
G43200	4320	0.17–0.22	0.45–0.65	0.035	0.040	0.15–0.35	1.65–2.00	0.40–0.60	0.20–0.30
G43400	4340	0.38–0.43	0.60–0.80	0.035	0.040	0.15–0.35	1.65–2.00	0.70–0.90	0.20–0.30
G43406	E4340	0.38–0.43	0.65–0.85	0.025	0.025	0.15–0.35	1.65–2.00	0.70–0.90	0.20–0.30
G46150	4615	0.13–0.18	0.45–0.65	0.035	0.040	0.15–0.35	1.65–2.00	...	0.20–0.30
G46200	4620	0.17–0.22	0.45–0.65	0.035	0.040	0.15–0.35	1.65–2.00	...	0.20–0.30
G46210	4621	0.18–0.23	0.70–0.90	0.035	0.040	0.15–0.35	1.65–2.00	...	0.20–0.30
G46260	4626	0.24–0.29	0.45–0.65	0.035	0.040	0.15–0.35	0.70–1.00	...	0.15–0.25
G47150		0.13–0.18	0.70–0.90	0.035	0.040	0.15–0.35	0.70–1.00	0.45–0.65	0.45–0.60
G47200	4720	0.17–0.22	0.50–0.70	0.035	0.040	0.15–0.35	0.90–1.20	0.35–0.55	0.15–0.25
G48150	4815	0.13–0.18	0.40–0.60	0.035	0.040	0.15–0.35	3.25–3.75	...	0.20–0.30
G48170	4817	0.13–0.20	0.40–0.60	0.035	0.040	0.15–0.35	3.25–3.75	...	0.20–0.30
G48200	4820	0.18–0.23	0.50–0.70	0.035	0.040	0.15–0.35	3.25–3.75	...	0.20–0.30
G51170	5117	0.15–0.20	0.70–0.90	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G51200	5120	0.17–0.22	0.70–0.90	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G51300	5130	0.28–0.33	0.70–0.90	0.035	0.040	0.15–0.35	...	0.80–1.10	...
G51320	5132	0.30–0.35	0.60–0.80	0.035	0.040	0.15–0.35	...	0.75–1.00	...
G51350	5135	0.33–0.38	0.60–0.80	0.035	0.040	0.15–0.35	...	0.80–1.05	...
G51400	5140	0.38–0.43	0.70–0.90	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G51500	5150	0.48–0.53	0.70–0.90	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G51550	5155	0.51–0.59	0.70–0.90	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G51600	5160	0.56–0.64	0.75–1.00	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G51986	E51100	0.98–1.10	0.25–0.45	0.025	0.025	0.15–0.35	...	0.90–1.15	...
G52986	E52100	0.98–1.10	0.25–0.45	0.025	0.025	0.15–0.35	...	1.30–1.60	...
G61180	6118	0.16–0.21	0.50–0.70	0.035	0.040	0.15–0.35	...	0.50–0.70	Vanadium 0.10–0.15
G61500	6150	0.48–0.53	0.70–0.90	0.035	0.040	0.15–0.35	...	0.80–1.10	0.15 min
G86150	8615	0.13–0.18	0.70–0.90	0.035	0.04	0.15–0.35	0.40–0.70	0.40–0.60	Molybdenum 0.15–0.25
G86170	8617	0.15–0.20	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86200	8620	0.18–0.23	0.70–0.90	0.035	0.04	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86220	8622	0.20–0.25	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86250	8625	0.23–0.28	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86270	8627	0.25–0.30	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86300	8630	0.28–0.33	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86370	8637	0.35–0.40	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86400	8640	0.38–0.43	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86420	8642	0.40–0.45	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25

**TABLE 1 Continued**

UNS Designation <sup>C</sup>	Grade <sup>D</sup> Designations	Chemical Composition, Ranges and Limits, %							
		Carbon	Manganese	Phosphorus, max	Sulfur, <sup>E</sup> max	Silicon <sup>F</sup>	Nickel	Chromium	Molybdenum
G86450	8645	0.43–0.48	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G86550	8655	0.51–0.59	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.15–0.25
G87200	8720	0.18–0.23	0.70–0.90	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.20–0.30
G87400	8740	0.38–0.43	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.20–0.30
G88220	8822	0.20–0.25	0.75–1.00	0.035	0.040	0.15–0.35	0.40–0.70	0.40–0.60	0.30–0.40
G92590	9259	0.56–0.64	0.75–1.00	0.035	0.040	0.70–1.10	...	0.45–0.65	...
G92600	9260	0.56–0.64	0.75–1.00	0.035	0.040	1.80–2.20	...	...	...
Standard Boron Steels <sup>G</sup>									
G50441	50B44	0.43–0.48	0.75–1.00	0.035	0.040	0.15–0.35	...	0.20–0.60	...
G50461	50B46	0.44–0.49	0.75–1.00	0.035	0.040	0.15–0.35	...	0.20–0.35	...
G50501	50B50	0.48–0.53	0.75–1.00	0.035	0.040	0.15–0.35	...	0.40–0.60	...
G50601	50B60	0.56–0.64	0.75–1.00	0.035	0.040	0.15–0.35	...	0.40–0.60	...
G51601	51B60	0.56–0.64	0.75–1.00	0.035	0.040	0.15–0.35	...	0.70–0.90	...
G81451	81B45	0.43–0.48	0.75–1.00	0.035	0.040	0.15–0.35	0.20–0.40	0.35–0.55	0.08–0.15
G94171	94B17	0.15–0.20	0.75–1.00	0.035	0.040	0.15–0.35	0.30–0.60	0.30–0.50	0.08–0.15
G94301	94B30	0.28–0.33	0.75–1.00	0.035	0.040	0.15–0.35	0.30–0.60	0.30–0.50	0.08–0.15

<sup>A</sup> Small quantities of certain elements are present in alloy steels which are not specified or required. These elements are considered as incidental and may be present to the following maximum amounts: copper 0.35 %, nickel 0.25 %, chromium 0.20 %, and molybdenum 0.06 %.

<sup>B</sup> Standard alloy steels can be produced with a lead range of 0.15 to 0.35 %. Such steels are identified by inserting the letter "L" between the second and third numerals of the number, that is, 41L40. A cast or heat analysis is not determinable when lead is added to the ladle stream.

<sup>C</sup> New designation established in accordance with Practice E 527.

<sup>D</sup> Grade designations correspond to the respective AISI and SAE designations. Grade compositions correspond to the respective AISI compositions.

<sup>E</sup> Where minimum and maximum sulfur contents are shown, it is indicative of resulfurized steel.

<sup>F</sup> Silicon may be specified by the purchaser as 0.10 % maximum. The need for 0.10 % maximum generally relates to severely cold-formed parts.

<sup>G</sup> These steels can be expected to contain 0.0005 to 0.003 boron %. If the usual titanium additive is not permitted, the steels can be expected to contain up to 0.005 % boron.

6.2 The composition of the steel furnished under this specification may be other than listed in Table 1 when agreed upon between the manufacturer and the purchaser as out-lined in Specification A 29/A 29M (Table on Heat Analysis Chemical Ranges and Limits of Alloy Steel Bars).

## 7. Workmanship, Finish, and Appearance

7.1 *Workmanship*—The bars shall be free of pipe, cracks, and flakes. Within the limits of good manufacturing and inspection practices, the bars shall be free of injurious seams, laps, segregation, or other imperfections which due to their nature, degree, or extent, will interfere with the use of the material in machining or fabrication of suitable parts.

7.2 *Descaling*—When descaled bars are required, Supplementary Requirement S12 on Pickling or S13 on Blast Cleaning must be specified.

## 8. Certification and Test Reports

8.1 When specified by the purchaser, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the cast or heat analysis test results for the specified elements, shall be furnished. The report shall include the name of the manufacturer, ASTM designation and year date and revision letter, if any, type and grade, heat number, and size.

8.2 When Supplementary Requirements are specified, the report shall include a statement of compliance with the requirement of the results of tests when the requirement involves measured test values.

## SUPPLEMENTARY REQUIREMENTS

One or more of the following Supplementary Requirements shall apply when specified by the purchaser.

### S1. Axle Shaft Quality

S1.1 Axle shaft quality applies to hot-rolled steel bars intended for the manufacture of power-driven axle shafts of the automotive or truck type, which by their design or method of manufacture are not machined all over or have less than recommended stock removed for the proper clean-up of normal surface imperfections.

### S2. Ball and Roller Bearing Quality and Bearing Quality

S2.1 This quality applies to steel intended for antifriction bearings.

### S3. Cold Shearing Quality

S3.1 When the bar size exceeds certain limits, it is recommended that cold shearing quality steel be ordered. This quality

**TABLE 3 Heat Analysis Chemical Ranges and Limits of Carbon Steel Bars**

Element	Chemical Ranges and Limits, %		
	When Maximum of Specified Elements is:	Range	Lowest Maximum
Carbon <sup>A</sup>	...	...	0.06
	to 0.12, incl	...	...
	over 0.12 to 0.25, incl	0.05	...
	over 0.25 to 0.40, incl	0.06	...
	over 0.40 to 0.55, incl	0.07	...
	over 0.55 to 0.80, incl	0.10	...
Manganese	over 0.80	0.13	...
	...	...	0.35
	to 0.40, incl	0.15	...
	over 0.40 to 0.50, incl	0.20	...
Phosphorus	over 0.50 to 1.65, incl	0.30	...
	to 0.040, incl	...	0.040 <sup>B</sup>
	over 0.040 to 0.08, incl	0.03	...
Sulfur	over 0.08 to 0.13, incl	0.05	...
	to 0.050, incl	...	0.050 <sup>B</sup>
	over 0.050 to 0.09, incl	0.03	...
	over 0.09 to 0.15, incl	0.05	...
	over 0.15 to 0.23, incl	0.07	...
Silicon <sup>C</sup>	over 0.23 to 0.50, incl	0.09	...
	...	...	0.10
	to 0.10, incl	...	...
	over 0.10 to 0.15, incl	0.08	...
	over 0.15 to 0.20, incl	0.10	...
Copper	over 0.20 to 0.30, incl	0.15	...
	over 0.30 to 0.60, incl	0.20	...
Lead <sup>D</sup>	When copper is required 0.20 min is generally used		
Bismuth <sup>E</sup>	When lead is required, a range of 0.15 to 0.35 is specified		
Calcium <sup>E</sup>			
Selenium <sup>E</sup>			
Tellurium <sup>E</sup>			

<sup>A</sup> The carbon ranges shown in the column headed "Range" apply when the specified maximum limit for manganese does not exceed 1.10 %. When the maximum manganese limit exceeds 1.10 %, add 0.01 to the carbon ranges shown above.

<sup>B</sup> For steels produced in merchant quality the phosphorus maximum is 0.04 % and the sulfur maximum is 0.05 %.

<sup>C</sup> It is not common practice to produce a rephosphorized and resulfurized carbon steel to specified limits for silicon because of its adverse effect on machinability.

<sup>D</sup> A cast or heat analysis is not determinable when lead is added to the ladle stream.

<sup>E</sup> Element specification range as agreed upon between purchaser and supplier.

## 5. Grain Size Requirement

### 5.1 Austenitic Grain Size:

5.1.1 When a coarse austenitic grain size is specified, the steel shall have a grain size number of 1 to 5 exclusive as determined in accordance with Test Methods E 112. Conformance to this grain size of 70 % of the grains in the area examined shall constitute the basis of acceptance. One test per heat shall be made.

5.1.2 When a fine austenitic grain size is specified, the steel shall have a grain size number of 5 or higher as determined in accordance with Test Methods E 112. Conformance to this grain size of 70 % of the area examined shall constitute the basis of acceptance. One test per heat shall be made unless the provisions of 5.1.2.1 or 5.1.2.2 are exercised.

5.1.2.1 When aluminum is used as the grain refining element, the fine austenitic grain size requirement shall be deemed to be fulfilled if, on heat analysis, the aluminum content is not less than 0.020 % total aluminum or, alternately, 0.015 % acid soluble aluminum. The aluminum content shall be reported. The grain size test specified in 5.1.2 shall be the referee test.

5.1.2.2 By agreement between purchaser and supplier, columbium or vanadium or both may be used for grain refining instead of or with aluminum. When columbium or vanadium is used as a grain refining element, the fine austenitic grain size requirement shall be deemed to be fulfilled if, on heat analysis, the columbium or vanadium content is as follows (the content of the elements shall be reported with the heat analysis):

Steels having 0.25 % carbon or less:	
Cb	0.025 min
V	0.05 min
Steels having over 0.25 % carbon:	
Cb	0.015 min
V	0.02 min
The maximum contents shall be:	
Cb	0.05 max
V	0.08 max
Cb + V	0.06 max

5.1.2.3 When provisions of 5.1.2.1 or 5.1.2.2 are exercised, a grain size test is not required unless specified by the purchaser. Unless otherwise specified, fine austenitic grain size shall be certified using the analysis of grain refining element(s).

5.1.2.4 *Referee Test*—In the event that the chemical analysis of columbium or vanadium does not meet the requirements of 5.1.2.2, the grain size test shown in 5.1.2 shall be the referee test unless an alternative test method is agreed upon between the manufacturer and the purchaser.

**TABLE 4 Heat Analysis Chemical Ranges and Limits of Alloy Steel Bars**

NOTE 1—Boron steels can be expected to have 0.0005 % minimum boron content.

NOTE 2—Alloy steels can be produced with a lead range of 0.15–0.35 %. A cast or heat analysis is not determinable when lead is added to the ladle stream.

Element	Chemical Ranges and Limits, %			
	When Maximum of Specified Element is:	Open-Hearth or Basic-Oxygen Steel	Electric Furnace Steel	Maximum Limit, % <sup>A</sup>
Carbon	To 0.55, incl	0.05	0.05	
	Over 0.55–0.70, incl	0.08	0.07	
	Over 0.70 to 0.80, incl	0.10	0.09	
	Over 0.80–0.95, incl	0.12	0.11	
	Over 0.95–1.35, incl	0.13	0.12	
Manganese	To 0.60, incl	0.20	0.15	
	Over 0.60–0.90, incl	0.20	0.20	
	Over 0.90–1.05, incl	0.25	0.25	
	Over 1.05–1.90, incl	0.30	0.30	
	Over 1.90–2.10, incl	0.40	0.35	
Phosphorus	Basic open-hearth or basic-oxygen steel			0.035
	Acid open-hearth steel			0.050
	Basic electric-furnace steel			0.025
	Acid electric-furnace steel			0.050
Sulfur	To 0.050, incl	0.015	0.015	
	Over 0.050–0.07, incl	0.02	0.02	
	Over 0.07–0.10, incl	0.04	0.04	
	Over 0.10–0.14, incl	0.05	0.05	
	Basic open-hearth or basic-oxygen steel			0.040
Silicon	Acid open-hearth steel			0.050
	Basic electric-furnace steel			0.025
	Acid electric-furnace steel			0.050
	To 0.20, incl	0.08	0.08	
Nickel	Over 0.20–0.30, incl	0.15	0.15	
	Over 0.30–0.60, incl	0.20	0.20	
	Over 0.60–1.00, incl	0.30	0.30	
	Over 1.00–2.20, incl	0.40	0.35	
	Acid steels <sup>B</sup>			
Chromium	To 0.50, incl	0.20	0.20	
	Over 0.50–1.50, incl	0.30	0.30	
	Over 1.50–2.00, incl	0.35	0.35	
	Over 2.00–3.00, incl	0.40	0.40	
	Over 3.00–5.30, incl	0.50	0.50	
	Over 5.30–10.00, incl	1.00	1.00	
Molybdenum	To 0.40, incl	0.15	0.15	
	Over 0.40–0.90, incl	0.20	0.20	
	Over 0.90–1.05, incl	0.25	0.25	
	Over 1.05–1.60, incl	0.30	0.30	
	Over 1.60–1.75, incl	c	0.35	
	Over 1.75–2.10, incl	c	0.40	
	Over 2.10–3.99, incl	c	0.50	
Tungsten	To 0.10, incl	0.05	0.05	
	Over 0.10–0.20, incl	0.07	0.07	
	Over 0.20–0.50, incl	0.10	0.10	
	Over 0.50–0.80, incl	0.15	0.15	
	Over 0.80–1.15, incl	0.20	0.20	
Vanadium	To 0.50, incl	0.20	0.20	
	Over 0.50–1.00, incl	0.30	0.30	
	Over 1.00–2.00, incl	0.50	0.50	
	Over 2.00–4.00, incl	0.60	0.60	
	To 0.25, incl	0.05	0.05	
Aluminum	Over 0.25–0.50, incl	0.10	0.10	
	Up to 0.10, incl	0.05	0.05	
	Over 0.10–0.20, incl	0.10	0.10	
	Over 0.20–0.30, incl	0.15	0.15	
	Over 0.30–0.80, incl	0.25	0.25	
Copper	Over 0.80–1.30, incl	0.35	0.35	
	Over 1.30–1.80, incl	0.45	0.45	
	To 0.60, incl	0.20	0.20	
	Over 0.60–1.50, incl	0.30	0.30	
	Over 1.50–2.00, incl	0.35	0.35	

<sup>A</sup> Applies to only nonrephosphorized and nonresulfurized steels.

<sup>B</sup> Minimum silicon limit for acid open-hearth or acid electric-furnace alloy steels is 0.15 %.

<sup>C</sup> Not normally produced in open-hearth.

**TABLE 5 Permissible Variations for Product Analysis of Carbon Steel**

Element	Limit, or Maximum of Specified Range, %	Over Maximum Limit, %	Under Minimum Limit, %
Carbon <sup>A</sup>	0.25 and under	0.02	0.02
	over 0.25 to 0.55, incl	0.03	0.03
	over 0.55	0.04	0.04
Manganese	0.90 and under	0.03	0.03
	over 0.90 to 1.65, incl	0.06	0.06
Phosphorus <sup>A,B</sup>	basic steels	0.008	...
	acid bessemer steel	0.01	0.01
Sulfur <sup>A,B</sup>		0.008	...
Silicon	0.35 and under	0.02	0.02
	over 0.35 to 0.60, incl	0.05	0.05
Copper	under minimum only	...	0.02
Lead <sup>C</sup>	0.15 to 0.35, incl	0.03	0.03

<sup>A</sup> Rimmed and capped steels are not subject to rejection on product analysis unless misapplication is clearly indicated.

<sup>B</sup> Resulfurized or rephosphorized steels are not subject to rejection on product analysis for these elements unless misapplication is clearly indicated.

<sup>C</sup> Product analysis tolerance for lead applies both over and under to a specified range of 0.15 to 0.35 %.

**TABLE 6 Permissible Variations for Product Analysis of Alloy Steel**

Elements	Limit, or Maximum of Specified Range, %	Permissible Variations Over Maximum Limit or Under Minimum Limit, %
Carbon	0.30 and under	0.01
	over 0.30 to 0.75, incl	0.02
	over 0.75	0.03
Manganese	0.90 and under	0.03
	over 0.90 to 2.10, incl	0.04
Phosphorus	over maximum only	0.005
Sulfur	0.060 and under	0.005
Silicon	0.40 and under	0.02
	over 0.40 to 2.20, incl	0.05
Nickel	1.00 and under	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
Chromium	0.90 and under	0.03
	over 0.90 to 2.10, incl	0.05
	over 2.10 to 3.99, incl	0.10
Molybdenum	0.20 and under	0.01
	over 0.20 to 0.40, incl	0.02
	over 0.40 to 1.15, incl	0.03
Vanadium	0.10 and under	0.01
	over 0.10 to 0.25, incl	0.02
	over 0.25 to 0.50, incl	0.03
	minimum value specified, under minimum limit only	0.01
Tungsten	1.00 and under	0.04
	over 1.00 to 4.00, incl	0.08
Aluminum	0.10 and under	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
Lead <sup>A</sup>	0.15 to 0.35, incl	0.03
Copper	to 1.00 incl	0.03
	over 1.00 to 2.00, incl	0.05

<sup>A</sup> Product analysis tolerance for lead applies both over and under to a specified range of 0.15 to 0.35 %.

## 6. Mechanical Property Requirements

### 6.1 Test Specimens:

6.1.1 *Selection*—Test specimens shall be selected in accordance with the requirements of the applicable product specification or in accordance with Supplement I of the latest issue of Test Methods and Definitions A 370, in the sequence named.

6.1.2 *Preparation*—Unless otherwise specified in the applicable product specification, test specimens shall be prepared in accordance with the latest issue of Test Methods and Definitions A 370, and especially Supplement I thereof.

6.2 *Methods of Mechanical Testing*—All mechanical tests shall be conducted in accordance with the latest issue of Test Methods and Definitions A 370, and especially Supplement I thereof, on steel bar products.

6.3 *Retests:*

6.3.1 If any test specimen shows defective machining or develops flaws, the specimen may be discarded and another substituted.

6.3.2 If the percentage elongation of any tension specimen is less than that specified and any part of the fracture is more than ¼ in. [20 mm] from the center of a 2-in. [50-mm] specimen, or is outside the middle half of the gage length of an 8-in. [200-mm] specimen as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

6.3.3 For “as-wrought” material, if the results for any original tension specimen are within 2000 psi [14 MPa] of the required tensile strength, within 1000 psi [7 MPa] of the required yield point, or within 2 % of the required elongation, retesting shall be permitted. If the original testing required only one test, the retest shall consist of two random tests from the heat or lot involved. If the original testing required two tests of which one failed by the amounts listed in this paragraph, the retest shall be made on one random test from the heat or lot. If the results on the retest specimen or specimens meet the specified requirements, the heat or test lot will be accepted. If the results of one retest specimen do not meet the specified requirements, the material is subject to rejection.

6.3.4 For thermally treated bars, if the results of the mechanical tests do not conform to the requirements specified, two more tests may be selected for each bar failing, and each of these retests shall conform to the requirements of the product specification.

6.3.5 If a bend specimen fails, due to conditions of bending more severe than required by the specification, a retest shall be permitted from the heat or test lot involved for which one random specimen for each original specimen showing failure shall be used. If the results on the retest specimen meet the requirements of the specification, the heat or test lot will be accepted.

## 7. Dimensions, Mass, and Permissible Variations

7.1 *Hot-Wrought Bars*—The permissible variations for dimensions of hot-wrought carbon and alloy steel bars shall not exceed the applicable limits stated in Annex A1 for inch-pound values and Annex A2 for metric values.

## 8. Workmanship, Finish, and Appearance

8.1 The material shall be free of injurious defects and shall have a workmanlike finish.





## 9. Rework and Retreatment

9.1 For thermally treated bars only, the manufacturer may retreat a lot one or more times, and retests shall be made in the same manner as the original tests. Each such retest shall conform to the requirements specified.

## 10. Inspection

10.1 The inspector representing the purchaser shall have entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests (except product analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

10.2 All required tests and inspection shall be made by the manufacturer prior to shipment.

## 11. Rejection

11.1 Unless otherwise specified, any rejection because of noncompliance to the requirements of the specification shall be reported by the purchaser to the manufacturer within 30 working days after receipt of samples.

11.2 Material that shows imperfections capable of adversely affecting processibility subsequent to its acceptance at the purchaser's works will be rejected, and the manufacturer shall be notified.

## 12. Rehearing

12.1 Samples that represent rejected material shall be preserved for two weeks from the date rejection is reported to the manufacturer. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

## 13. Product Marking

13.1 *Civilian Procurement*—Bars of all sizes, when loaded for shipment, shall be properly identified with the name or brand of manufacturer, purchaser's name and order number, the ASTM designation (year date is not required), grade number where appropriate, size and length, weight of lift, and the heat number for identification. Unless otherwise specified, the method of marking is at the manufacturer's option and may be made by hot stamping, cold stamping, painting, or marking tags attached to the lifts of bars.

13.1.1 Bar code marking may be used as an auxiliary method of identification. Such bar-code markings shall be of the 3-of-9 type and shall conform to AIAG B1. When barcoded tags are used, they shall conform to AIAG B5.

### 13.2 *Government Procurement:*

13.2.1 Marking for shipment shall be in accordance with the requirements specified in the contract or order and shall be in accordance with MIL-STD-163 for military agencies and in accordance with Fed. Std. No. 123 for civil agencies.

13.2.2 For government procurement by the Defense Supply Agency, the bars shall be continuously marked for identification in accordance with Fed. Std. No. 183.

## 14. Packaging

14.1 *Civilian Procurement*—Unless otherwise specified, the bars shall be packaged and loaded in accordance with Practices A 700.

14.2 *Government Procurement*—MIL-STD-163 shall apply when packaging is specified in the contract or order, or when Level A for preservation, packaging, and packing is specified for direct procurement by or direct shipment to the government.

## 15. Keywords

15.1 alloy steel bars; carbon steel bars; cold finished steel bars; general delivery requirements; hot wrought steel bars; steel bars

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the contract or order.

### S1. Flat Bar Thickness Tolerances

S1.1 When flat bars are specified in metric units to a thickness under tolerance of 0.3 mm, the thickness tolerance of Table S1.1 shall apply.