Designation: A 600 – 92a (Reapproved 2004)

Standard Specification for Tool Steel High Speed[1]

This standard is issued under the fixed designation A 600; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers tungsten-type and molybdenum-type high-speed steels available as annealed, hot-rolled bars, forgings, plate, sheet, or strip, and annealed, cold-finished bars or forgings used primarily in the fabrication of tools.

1.2 Seven types of tungsten high-speed tool steels designated T1, T2, etc., seventeen types of molybdenum high-speed tool steels designated M1, M2, etc., and two intermediate high speed steels designated as M50 and M52 are covered. Selection will depend upon design, service conditions, and mechanical properties.

1.3 The term "high-speed steel" is described and its minimum requirements are covered in the Annex.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 388/A 388M Practice for Ultrasonic Examination of Heavy Steel Forgings

A 561 Practice for Macroetch Testing of Tool Steel Bars

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment

E 3 Methods of Preparation of Metallographic Specimens

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron

E 45 Practice for Determining the Inclusion Content of Steel

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition

2.2 *Military Standard:*

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage[3]

2.3 *Federal Standards:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[3]

Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products[3]

3. Classification

3.1 Material in accordance with this specification is classified by chemical composition. Types correspond to respective AISI designations.

3.1.1 Types T1, T2, T4, T5, T6, T8, and T15 are characterized by a controlled high tungsten content along with other alloying elements.

3.1.2 Types M1, M2, M3, M4, M6, M7, M10, M30, M33, M34, M36, M41, M42, M43, M44, M46, M47, M48, and M62 are characterized by a controlled high molybdenum content along with other alloying elements.

3.1.3 Types M2, M3, and M10 are further classified according to carbon range. Type M3 is further classified according to vanadium range.

3.1.4 Types M50 and M52 are considered intermediate high speed steels in view of their lower total alloy content than the standard types. These leaner alloy grades normally are limited to less severe service conditions.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information, as required to describe adequately the desired material:

4.1.1 Name of material (high-speed tool steel),

4.1.2 Type,

4.1.3 Shape (sheet, strip, plate, flat bar, round bar, square bar, hexagon bar, octagon, special shapes),

4.1.4 Dimensions (thickness, width, diameter, length). (For coils, include the minimum inside diameter or inside diameter range, the maximum outside diameter, and maximum or minimum coil weight if required. (Minimum coil weights are subject to negotiation.)),

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys , and is the direct responsibility of Subcommittee A01.29 on Tool Steel.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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4.1.5 Finish (hot rolled, forged, blasted or pickled, cold drawn, rough machined, ground, precision ground and polished),

4.1.6 Condition (annealed),

4.1.7 ASTM designation and date of issue, and

4.1.8 Special or supplementary requirements.

5. Materials and Manufacture

5.1 Unless otherwise specified, material covered by this specification shall be made by an electric melting process.

6. Chemical Composition

6.1 An analysis of each heat of steel shall be made by the manufacturer to determine the percentage of the elements specified and these values shall conform to the requirements as to chemical composition specified in Table 1. If requested or required, the chemical composition shall be reported to the purchaser or his representative.

6.2 Analysis may be made by the purchaser from finished bars and forgings by machining off the entire cross section and drilling parallel to the axis of the bar or forging at any point midway between the center and surface in accordance with the latest issue of Method E 59. The chemical analysis of the drilling chips shall be made in accordance with the latest issue of Methods E 30. The chemical composition thus determined shall not vary from the limits specified in Table 1.

7. *Hardness Requirements* Hardness Requirements

7.1 Annealed hardness values when obtained in accordance with the latest issue of Test Methods and Definitions A 370 shall not exceed the Brinell hardness values (or equivalent Rockwell hardness values) specified in Table 2.

7.2 Specimens for determination of minimum response to hardening shall be ¼-in. (6.4-mm) thick disks cut so as to represent either the full cross-sectional area or that midway between the center and outer surface of the material. If the material form or size does not lend itself to accurate hardness determination on ¼-in. thick cross-sectional disks, then longitudinal specimens may be used for hardness testing. Examples are round bars less than ½ in. (12.7 mm) in diameter; sheet; and strip. In this case, the specimen shall be a minimum of 3 in. (76.2 mm) in length, and parallel flats shall be ground on the original mill surfaces. The specimens shall be heat treated in two furnaces, one operating as a preheat furnace and the other

TABLE 1 Chemical Requirements, %[A]

UNS Designation[B]	Type		Carbon		Manganese		Phosphorus	Sulfur[C]	Silicon		Chromium		Vanadium		Tungsten		Molybdenum		Cobalt	
			min	max	min	max	max	max	min	max	min	max	min	max	min	max	min	max	min	max
Tungsten-Type High-Speed Steels																				
T12001	T1		0.65	0.80	0.10	0.40	0.03	0.03	0.20	0.40	3.75	4.50	0.90	1.30	17.25	18.75	...	...	...	...
T12002	T2		0.80	0.90	0.20	0.40	0.03	0.03	0.20	0.40	3.75	4.50	1.80	2.40	17.50	19.00	...	1.00	...	...
T12004	T4		0.70	0.80	0.10	0.40	0.03	0.03	0.20	0.40	3.75	4.50	0.80	1.20	17.50	19.00	0.40	1.00	4.25	5.75
T12005	T5		0.75	0.85	0.20	0.40	0.03	0.03	0.20	0.40	3.75	5.00	1.80	2.40	17.50	19.00	0.50	1.25	7.00	9.50
T12006	T6		0.75	0.85	0.20	0.40	0.03	0.03	0.20	0.40	4.00	4.75	1.50	2.10	18.50	21.00	0.40	1.00	11.00	13.00
T12008	T8		0.75	0.85	0.20	0.40	0.03	0.03	0.20	0.40	3.75	4.50	1.80	2.40	13.25	14.75	0.40	1.00	4.25	5.75
T12015	T15		1.50	1.60	0.15	0.40	0.03	0.03	0.15	0.40	3.75	5.00	4.50	5.25	11.75	13.00	...	1.00	4.75	5.25
Molybdenum-Type High-Speed Steels																				
T11301	M1		0.78	0.88	0.15	0.40	0.03	0.03	0.20	0.50	3.50	4.00	1.00	1.35	1.40	2.10	8.20	9.20	...	...
T11302	M2	regular C	0.78	0.88	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.50	1.75	2.20	5.50	6.75	4.50	5.50	...	...
		high C	0.95	1.05	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.50	1.75	2.20	5.50	6.75	4.50	5.50	...	...
T11313	M3	Class 1	1.00	1.10	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.50	2.25	2.75	5.00	6.75	4.75	6.50	...	...
T11323		Class 2	1.15	1.25	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.50	2.75	3.25	5.00	6.75	4.75	6.50	...	...
T11304	M4		1.25	1.40	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.75	3.75	4.50	5.25	6.50	4.25	5.50	...	...
T11306	M6		0.75	0.85	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.50	1.30	1.70	3.75	4.75	4.50	5.50	11.00	13.00
T11307	M7		0.97	1.05	0.15	0.40	0.03	0.03	0.20	0.55	3.50	4.00	1.75	2.25	1.40	2.10	8.20	9.20	...	...
T11310	M10	regular C	0.84	0.94	0.10	0.40	0.03	0.03	0.20	0.45	3.75	4.50	1.80	2.20	...	...	7.75	8.50	...	...
		high C	0.95	1.05	0.10	0.40	0.03	0.03	0.20	0.45	3.75	4.50	1.80	2.20	...	...	7.75	8.50	...	...
T11330	M30		0.75	0.85	0.15	0.40	0.03	0.03	0.20	0.45	3.50	4.25	1.00	1.40	1.30	2.30	7.75	9.00	4.50	5.50
T11333	M33		0.85	0.92	0.15	0.40	0.03	0.03	0.15	0.50	3.50	4.00	1.00	1.35	1.30	2.10	9.00	10.00	7.75	8.75
T11334	M34		0.85	0.92	0.15	0.40	0.03	0.03	0.20	0.45	3.50	4.00	1.90	2.30	1.40	2.10	7.75	9.20	7.75	8.75
T11336	M36		0.80	0.90	0.15	0.40	0.03	0.03	0.20	0.45	3.75	4.50	1.75	2.25	5.50	6.50	4.50	5.50	7.75	8.75
T11341	M41		1.05	1.15	0.20	0.60	0.03	0.03	0.15	0.50	3.75	4.50	1.75	2.25	6.25	7.00	3.25	4.25	4.75	5.75
T11342	M42		1.05	1.15	0.15	0.40	0.03	0.03	0.15	0.65	3.50	4.25	0.95	1.35	1.15	1.85	9.00	10.00	7.75	8.75
T11343	M43		1.15	1.25	0.20	0.40	0.03	0.03	0.15	0.65	3.50	4.25	1.50	1.75	2.25	3.00	7.50	8.50	7.75	8.75
T11344	M44		1.10	1.20	0.20	0.40	0.03	0.03	0.30	0.55	4.00	4.75	1.85	2.20	5.00	5.75	6.00	7.00	11.00	12.25
T11346	M46		1.22	1.30	0.20	0.40	0.03	0.03	0.40	0.65	3.70	4.20	3.00	3.30	1.90	2.20	8.00	8.50	7.80	8.80
T11347	M47		1.05	1.15	0.15	0.40	0.03	0.03	0.20	0.45	3.50	4.00	1.15	1.35	1.30	1.80	9.25	10.00	4.75	5.25
...	M48		1.42	1.52	0.15	0.40	0.03	0.07	0.15	0.40	3.50	4.00	2.75	3.25	9.50	10.50	4.75	5.50	8.00	10.00
...	M62		1.25	1.35	0.15	0.40	0.03	0.07	0.15	0.40	3.50	4.00	1.80	2.10	5.75	6.50	10.00	11.00	...	...
Intermediate High Speed Steels																				
T11350	M50		0.78	0.88	0.15	0.45	0.03	0.03	0.20	0.60	3.75	4.50	0.80	1.25	...	...	3.90	4.75	...	...
T11352	M52		0.85	0.95	0.15	0.45	0.03	0.03	0.20	0.60	3.50	4.30	1.65	2.25	0.75	1.50	4.00	4.90	...	...

[A] Chemistry limits include product analysis tolerances. Unless otherwise specified, nickel plus copper equals 0.75 % max for all types.
[B] New designation established in accordance with Practice E 527 and SAE J 1086.
[C] Where specified, sulfur may be 0.06 to 0.15 % to improve machinability.

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TABLE 2 Maximum Brinell Hardness in Annealed or Cold Drawn Condition

Type	Annealed BHN	Cold Drawn Annealed BHN	Cold Drawn BHN
M1	248	255	262
M2 (regular C)	248	255	262
M2 (high C)	255	262	269
M3, Class 1 and Class 2	255	262	269
M4	255	262	269
M6	277	285	293
M7	255	262	269
M10 (regular C)	248	255	262
M10 (high C)	255	262	269
M30	269	277	285
M33	269	277	285
M34	269	277	285
M36	269	277	285
M41	269	277	285
M42	269	277	285
M43	269	297	285
M44	285	293	302
M46	269	277	285
M47	269	277	285
M48	311	321	331
M50	248	255	262
M52	248	255	262
M62	285	293	302
T1	255	262	269
T2	255	262	269
T4	269	277	285
T5	285	293	302
T6	302	311	321
T8	255	262	269
T15	277	285	293

as a high-heat furnace. The furnaces may be either controlled atmosphere or molten-salt bath. The austenitizing temperature ranges stipulated in Table 3 cover both furnace types.

7.2.1 After being austenitized for the proper time, the samples may be oil quenched or quenched in molten salt plus air cooling. When a salt quench is employed, its temperature shall be 1050 to 1175°F (566 to 635°C) except for M3, M4, M41, , M42,M43 , M46, M47, M48, M62, and T15, when it shall be 1000 to 1075°F (538 to 579°C). All samples shall be double tempered at 1025°F (552°C) for 2 h each cycle except for M0 and M52 which shall be given two tempering cycles of 2 h each at 1000°F and M41, M42, M43, M44, M46, M47, M48, M62, and T15, which shall be given three tempering cycles of 2 h each at 1000°F.

7.2.2 The hardness of the specimen after the specified heat treatment shall meet the minimum hardness value for the particular type of steel shown in Table 3. Rockwell C tests should be used where possible but light-load tests may be necessary on thin specimens. These tests should be specified by agreement between seller and purchaser. The hardness value shall be obtained in accordance with the latest issue of Test Methods and Definitions A 370 and shall be the average of at least five readings taken in an area midway between the center and surface of the largest dimension of the cross-sectional specimen or along the parallel surfaces of the longitudinal specimen. The surface to be tested shall be ground sufficiently to remove any surface condition, scale, carburization, or decarburization which might affect readings.

8. Macrostructure

8.1 The macrostructure of a specimen representing the entire cross-sectional area in the annealed condition and prepared in accordance with the latest issue of Practice A 561 shall exhibit a structure free of excessive porosity, slag, dirt, or other nonmetallic inclusions, pipes, checks, cracks and other injurious defects.

8.2 Macroetch severity levels for center porosity and ingot pattern, illustrated photographically in Practice A 561, shall not exceed the ratings specified in Table 4 for the appropriate material size and composition.

9. Decarburization

9.1 Decarburization shall be determined on a specimen representing a cross section of the material and prepared in accordance with the latest issue of Methods E 3. When examined at 20× or greater magnification, it shall not exceed the values given in Tables 5-8 for the appropriate size and shape of the material.

9.2 Material ordered as drill rod, ground and polished, centerless ground, ground finished, or machine finished flats and squares shall be free of scale and decarburization.

10. Permissible Variations in Dimensions

10.1 Permissible variations in dimensions shall not exceed the applicable limits stated in Tables 8-22, incl. Where out-of-round or square requirements are shown, they shall be determined as follows:

10.1.1 *Out-of-Round*—Difference between high and low readings as determined by micrometers or other suitable measuring instruments.

10.1.2 *Out-of-Square*—The amount required to be removed from each edge in order to square the edge with the face as determined with a square and suitable measuring instruments.

11. Workmanship, Finish, and Appearance

11.1 High-speed tool steel shall be free of heavy scale, deep pitting, laps, porosity, injurious segregations, excessive nonmetallic inclusions, seams, cracks, checks, slivers, scale marks, dents, soft and hard spots, pipes, or any defects that would detrimentally affect the suitability of the material, after removal of the recommended stock allowance. (See Tables 5-8)

11.2 Visual examination shall be made to ensure compliance with the requirements for workmanship, finish, dimensions and tolerances, identification marking, and packaging.

12. Sampling

12.1 Unless otherwise specified, a lot shall consist of all material submitted for inspection at the same time, of the same heat, type, finish, and size, and must conform to the provisions of this specification.

13. Inspection

13.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. The supplier may utilize his own facilities or any other acceptable to the purchaser.

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TABLE 3 Heat-Treating Requirements

NOTE—The austenitizing temperatures are stipulated for the response to hardening test only. Other combinations of austenitizing and tempering temperatures may be used for particular applications.

Class	Preheat Temperature °F (°C)	Austenitizing Temperature, °F (°C)[A]		Tempering Temperature, °F (°C)[B]	Minimum Hardness, Rockwell C
		Salt Bath	Controlled Atmosphere Furnace		
M1	1350–1550 (732–843)	2185 (1196)	2205 (1207)	1025 (552)	64
M2 (regular C)	1350–1550 (732–843)	2220 (1216)	2240 (1227)	1025 (552)	64
M2 (high C)	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	65
M3, Class 1	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	64
M3, Class 2	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	64
M4	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	64
M6	1350–1550 (732–843)	2170 (1188)	2190 (1199)	1025 (552)	64
M7	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	65
M10 (regular C)	1350–1550 (732–843)	2185 (1196)	2205 (1207)	1025 (552)	63
M10 (high C)	1350–1550 (732–843)	2185 (1196)	2205 (1207)	1025 (552)	64
M30	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	64
M33	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	65
M34	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	64
M36	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1025 (552)	64
M41	1350–1550 (732–843)	2175 (1190)	2195 (1202)	1000 (538)	66
M42	1350–1550 (732–843)	2150 (1177)	2170 (1188)	1000 (538)	66
M43	1350–1550 (732–843)	2150 (1177)	2170 (1188)	1000 (538)	66
M44	1350–1550 (732–843)	2170 (1188)	2190 (1199)	1000 (538)	66
M46	1350–1550 (732–843)	2200 (1204)	2220 (1216)	1000 (538)	66
M47	1350–1550 (732–843)	2175 (1190)	2195 (1202)	1000 (538)	66
M48	1350–1550 (732–843)	2175 (1190)	2195 (1202)	1000 (538)	66
M50	1350–1550 (732–843)	2020 (1104)	2040 (1116)	1000 (538)	61
M52	1350–1550 (732–843)	2125 (1163)	2145 (1174)	1000 (538)	63
M62	1350–1550 (732–843)	2175 (1190)	2195 (1202)	1000 (538)	66
T1	1500–1600 (816–871)	2330 (1277)	2350 (1288)	1025 (552)	63
T2	1500–1600 (816–871)	2330 (1277)	2350 (1288)	1025 (552)	63
T4	1500–1600 (816–871)	2330 (1277)	2350 (1288)	1025 (552)	63
T5	1500–1600 (816–871)	2330 (1277)	2350 (1288)	1025 (552)	63
T6	1500–1600 (816–871)	2330 (1277)	2350 (1288)	1025 (552)	63
T8	1500–1600 (816–871)	2330 (1277)	2350 (1288)	1025 (552)	63
T15	1500–1600 (816–871)	2240 (1227)	2260 (1238)	1000 (538)	65

[A] Temperature limit shall be ±10°F (±5°C). If samples are austenitized in salt, the sample shall be immersed in the austenitizing salt bath for 5 min minimum. If austenitized in a controlled atmosphere furnace, the sample shall be at the austenitizing temperature for 5 to 15 min. The time at temperature is the time after the sample reaches the austenitizing temperature. This range in time is given because of the difficulty in determining when the sample reaches the austenitizing temperature in some types of controlled atmosphere furnaces.

Quenching may be done in oil or molten salt.

[B] Tempers at 1025°F (552°C) are for 2 + 2 h. Tempers at 1000°F (538°C) are for 2 + 2 + 2 h.

TABLE 4 Macroetch Standards
Maximum Allowable Rating[A]

Bar Size, in. (mm)	T Classification Steels[B]		M Classification Steels[C]	
	Porosity	Ingot Pattern	Porosity	Ingot Pattern
Up to 2 (50.8), incl	3½	5	3	5
Over 2 to 3 (50.8 to 76), incl	4	5	3½	5
Over 3 to 4 (76 to 102), incl	4½	5	4	5
Over 4 to 5 (102 to 127), incl	5	5	4	5
Over 5 to 6 (127 to 152), incl	5	5	4½	5
Over 6 (152)	As negotiated between supplier and purchaser			

[A] Refer to macroetch photographs in Practice A 561.

[B] Types T1, T2, T4, T5, T6, T8, and T15.

[C] Types M1, M2, M3, M4, M6, M7, M10, M30, M33, M34, M36, M41, M42, M43, M44, M46, M47, M48, M50, M52, and M62.

TABLE 5 Maximum Decarburization Limits Rounds[A]

NOTE—The recommended minimum allowance for machining prior to heat treatment is 25 % greater than the maximum decarburization allowed.

Specified Diameter, in. (mm)	Decarburization Limits per Side, in. (mm), Drawn Finish
Up to ½ (12.7), incl	0.013 (0.33)
Over ½ to 1 (12.7 to 25.4), incl	0.025 (0.64)
Over 1 to 2 (25.4 to 50.8), incl	0.038 (0.96)
Over 2 to 3 (50.8 to 76), incl	0.050 (1.27)
Over 3 to 4 (76 to 102), incl	0.070 (1.78)

[A] Rounds to be free of decarburization except drawn finish. Maximum decarburization of drawn finish rounds to be in accordance with the table above.

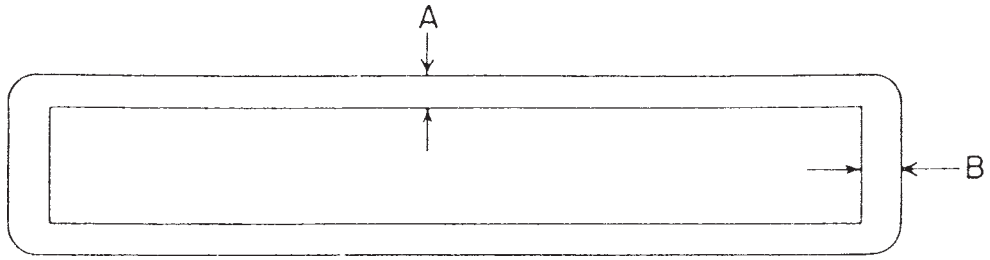
13.2 When specified in the purchase order, the inspector representing the purchaser shall have access to the material subject to inspection for the purpose of witnessing the selection of samples, preparation of test pieces, and performance of the tests. For such tests, the inspector shall have the right to indicate the pieces from which samples will be selected. Otherwise the seller shall report to the purchaser, or his representative, the results of the chemical analysis and the physical property tests made in accordance with this specification.

13.3 The purchaser may perform any of the inspections set forth in the specification on the as-received material where such inspections are deemed necessary to assure that supplies and services conform to the prescribed requirements.

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TABLE 6 Maximum Decarburization Limits
Hot Rolled Square and Flat Bars
Maximum Limit Per Side

NOTE—The recommended minimum allowance for machining prior to heat treatment is 25 % greater than the maximum decarburization allowed.



Specified Thickness, in. (mm)		Specified Widths, in. (mm)										
		0 to ½ (0 to 12.7) incl.	Over ½ to 1 (12.7 to 25.4), incl	Over 1 to 2 (25.4 to 50.8), incl	Over 2 to 3 (50.8 to 76), incl	Over 3 to 4 (76 to 102), incl	Over 4 to 5 (102 to 127), incl	Over 5 to 6 (127 to 152), incl	Over 6 to 7 (152 to 178), incl	Over 7 to 8 (178 to 203), incl	Over 8 to 9 (203 to 229), incl	Over 9 to 12 (229 to 304), incl
0 to ½ (0 to 12.7), incl	A	0.020 (0.51)	0.020 (0.51)	0.024 (0.61)	0.028 (0.71)	0.032 (0.81)	0.036 (0.91)	0.040 (1.02)	0.044 (1.12)	0.048 (1.22)	0.048 (1.22)	0.048 (1.22)
	B	0.020 (0.51)	0.026 (0.66)	0.032 (0.81)	0.038 (0.97)	0.044 (1.12)	0.054 (1.37)	0.062 (1.57)	0.066 (1.68)	0.078 (1.98)	0.082 (2.08)	0.096 (2.44)
Over ½ to 1 (12.7 to 25.4), incl	A	...	0.036 (0.91)	0.036 (0.91)	0.036 (0.91)	0.040 (1.02)	0.044 (1.12)	0.052 (1.32)	0.056 (1.42)	0.060 (1.52)	0.060 (1.52)	0.060 (1.52)
	B	...	0.036 (0.91)	0.042 (1.07)	0.046 (1.17)	0.056 (1.42)	0.064 (1.63)	0.082 (2.08)	0.090 (2.29)	0.098 (2.49)	0.102 (2.59)	0.108 (2.74)
Over 1 to 2 (25.4 to 50.8), incl	A	...	...	0.052 (1.32)	0.052 (1.32)	0.056 (1.42)	0.056 (1.42)	0.060 (1.52)	0.060 (1.52)	0.064 (1.63)	0.068 (1.73)	0.072 (1.83)
	B	...	...	0.052 (1.32)	0.056 (1.42)	0.060 (1.52)	0.072 (1.83)	0.086 (2.18)	0.098 (2.49)	0.112 (2.84)	0.118 (3.00)	0.122 (3.10)
Over 2 to 3 (50.8 to 76), incl	A	...	...	...	0.064 (1.63)	0.064 (1.63)	0.068 (1.73)	0.068 (1.73)	0.072 (1.83)	0.072 (1.83)	0.080 (2.03)	0.080 (2.03)
	B	...	...	...	0.064 (1.63)	0.072 (1.83)	0.082 (2.08)	0.094 (2.39)	0.110 (2.79)	0.122 (3.10)	0.130 (3.30)	0.136 (3.45)
Over 3 to 4 (76 to 102), incl	A	...	...	...	...	0.080 (2.03)	0.080 (2.03)	0.086 (2.18)	0.092 (2.34)	0.094 (2.39)	0.100 (2.54)	0.100 (2.54)
	B	...	...	...	...	0.080 (2.03)	0.090 (2.29)	0.100 (2.54)	0.120 (3.05)	0.132 (3.35)	0.132 (3.35)	0.150 (3.81)

14. Rejection

14.1 Unless otherwise specified, any rejection based on tests made in accordance with this specification should be reported to the seller within 30 days from the date of receipt of the material.

14.2 Material that shows injurious defects subsequent to its acceptance by the purchaser shall be rejected and the seller notified.

15. Rehearing

15.1 Samples tested in accordance with this specification that represent rejected material shall be preserved for three weeks from the date of the test report. In case of dissatisfaction with the results of the test, the seller may make claim for a rehearing within that time.

16. Packaging, Loading, and Package Marking

16.1 *Packaging and Loading*:

16.1.1 Unless otherwise specified, shipments shall be packaged and loaded in accordance with Practices A 700.

16.1.2 When specified in the contract or order, and for direct procurement by or direct shipment to the government, when Level A is specified, preservation, packaging, and loading shall be in accordance with the Level A requirements of MIL-STD-163.

16.2 *Package Marking*:

16.2.1 Shipments shall be properly marked with the name or brand of manufacturer, purchaser's name and order number, specification number (ASTM A 600), heat number, grade or type, and where appropriate, the size, length, and weight. Unless otherwise specified, method of marking is at the option of the manufacturer.

16.2.2 When specified in the contract or order, and for direct procurement by or direct shipment to the government, marking for shipment, in addition to any requirements specified in the contract or order, shall be in accordance with MIL-STD-163 for military agencies, and in accordance with Fed. Std. No. 123 for civil agencies.

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

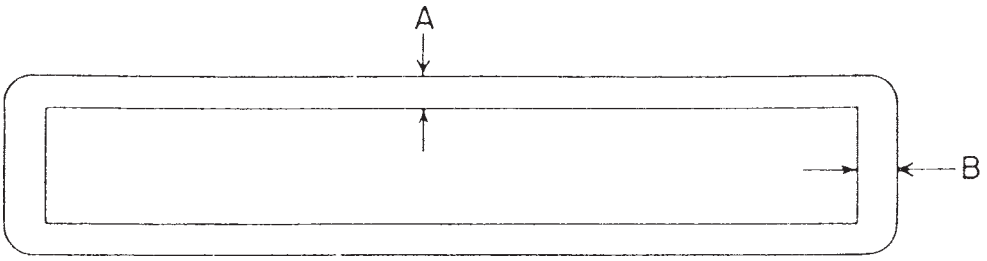
17. Keywords

17.1 high speed; tool steel

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TABLE 7 Maximum Decarburization Limits
Forged Square and Flat Bars
Maximum Limit Per Side

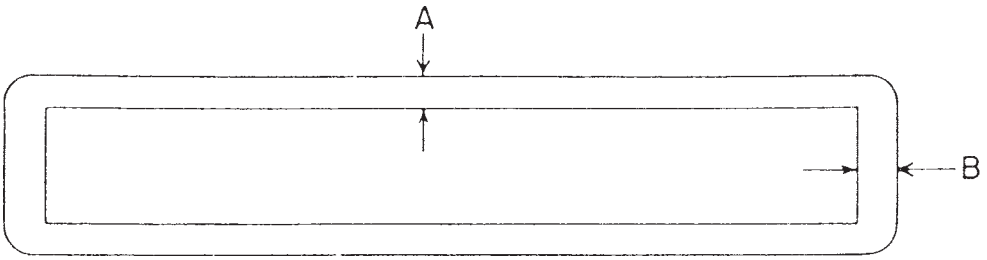
NOTE—The recommended minimum allowance for machining prior to heat treatment is 25 % greater than the maximum decarburization allowed.



Specified Thickness, in. (mm)		Specified Width, Inches (mm)								
		Over 1 to 2 (25.4 to 50.8), incl	Over 2 to 3 (50.8 to 76), incl	Over 3 to 4 (76 to 102), incl	Over 4 to 5 (102 to 127), incl	Over 5 to 6 (127 to 152), incl	Over 6 to 7 (152 to 178), incl	Over 7 to 8 (178 to 203), incl	Over 8 to 9 (203 to 229), incl	Over 9 to 12 (229 to 305), incl
Over ½ to 1, (12.7 to 25.4), incl	A	0.038 (0.97)	0.042 (1.07)	0.048 (1.22)	0.052 (1.32)	0.056 (1.42)	0.062 (1.57)	0.066 (1.68)	0.072 (1.83)	0.080 (2.03)
	B	0.048 (1.22)	0.056 (1.42)	0.070 (1.78)	0.080 (2.03)	0.094 (2.39)	0.110 (2.79)	0.132 (3.35)	0.132 (3.35)	0.132 (3.35)
Over 1 to 2, (25.4 to 50.8), incl	A	0.058 (1.47)	0.062 (1.57)	0.066 (1.68)	0.070 (1.78)	0.074 (1.88)	0.080 (2.03)	0.084 (2.13)	0.094 (2.39)	0.106 (2.69)
	B	0.058 (1.47)	0.066 (1.68)	0.078 (1.98)	0.086 (2.18)	0.100 (2.54)	0.114 (2.90)	0.132 (3.35)	0.132 (3.35)	0.132 (3.35)
Over 2 to 3 (50.8 to 76), incl	A	...	0.080 (2.03)	0.084 (2.13)	0.088 (2.24)	0.092 (2.34)	0.098 (2.49)	0.106 (2.69)	0.114 (2.90)	0.126 (3.20)
	B	...	0.080 (2.03)	0.092 (2.34)	0.098 (2.49)	0.106 (2.69)	0.118 (3.00)	0.136 (3.45)	0.136 (3.45)	0.136 (3.45)
Over 3 to 4 (76 to 102), incl	A	...	...	0.102 (2.59)	0.106 (2.69)	0.112 (2.84)	0.120 (3.05)	0.132 (3.35)	0.140 (3.56)	0.158 (4.01)
	B	...	...	0.102 (2.59)	0.106 (2.69)	0.112 (2.84)	0.120 (3.05)	0.132 (3.35)	0.140 (3.56)	0.158 (4.01)
Over 4 to 5 (102 to 127), incl	B	...	...	...	0.126 (3.20)	0.130 (3.30)	0.138 (3.51)	0.146 (3.71)	0.156 (3.96)	0.170 (4.32)
Over 5 to 6 (127 to 152), incl	A	...	...	...	...	0.150 (3.81)	0.158 (4.01)	0.166 (4.22)	0.176 (4.47)	0.188 (4.78)
	B	...	...	...	...	0.150 (3.81)	0.158 (4.01)	0.166 (4.22)	0.176 (4.47)	0.188 (4.78)
Over 6 to 7 (152 to 178), incl	A	...	...	...	...	...	0.176 (4.47)	0.186 (4.72)	0.186 (4.72)	0.198 (5.03)
	B	...	...	...	...	...	0.176 (4.47)	0.186 (4.72)	0.186 (4.72)	0.198 (5.03)

TABLE 8 Maximum Decarburization Limits
Cold Drawn Square and Flat Bars
Maximum Limits Per Side

NOTE—The recommended minimum allowance for machining prior to heat treatment is 25 % greater than the maximum decarburization allowed.



Specified Thickness, in. (mm)		Specified Width, in. (mm)					
		0 to ½ (0 to 12.7), incl	Over ½ to 1 (12.7 to 25.4), incl	Over 1 to 2 (25.4 to 50.8), incl	Over 2 to 3 (50.8 to 76), incl	Over 3 to 4 (76 to 102), incl	Over 4 to 5 (102 to 127), incl
0 to ½ (0 to 12.7), incl	A	0.020 (0.51)	0.020 (0.51)	0.024 (0.61)	0.028 (0.71)	0.032 (0.81)	0.036 (0.91)
	B	0.020 (0.51)	0.026 (0.66)	0.032 (0.81)	0.038 (0.97)	0.044 (1.12)	0.054 (1.37)
Over ½ to 1 (12.7 to 25.4), incl	A	...	0.036 (0.91)	0.036 (0.91)	0.036 (0.91)	0.040 (1.02)	0.044 (1.12)
	B	...	0.036 (0.91)	0.042 (1.07)	0.046 (1.17)	0.056 (1.42)	0.064 (1.63)
Over 1 to 2 (25.4 to 50.8), incl	A	...	...	0.052 (1.32)	0.052 (1.32)	0.056 (1.42)	...
	B	...	...	0.052 (1.32)	0.056 (1.42)	0.060 (1.52)	...

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TABLE 9 Size Tolerances for Hot-Rolled Bars
Rounds,[A] Squares, Octagons, Quarter Octagons, Hexagons
Size Tolerances

NOTE—Out-of-round or square to be ¾ of total tolerance maximum.

Specified Sizes, in. (mm)	Size Tolerances, in. (mm)	
	Minus	Plus
To ½ (12.7), incl	0.005 (0.13)	0.012 (0.30)
Over ½ to 1 (12.7 to 25.4), incl	0.005 (0.13)	0.016 (0.41)
Over 1 to 1½ (25.4 to 38.1), incl	0.006 (0.15)	0.020 (0.51)
Over 1½ to 2 (38.1 to 50.8), incl	0.008 (0.20)	0.025 (0.64)
Over 2 to 2½ (50.8 to 63.5), incl	0.010 (0.25)	0.030 (0.76)
Over 2½ to 3 (63.5 to 76.2), incl	0.010 (0.25)	0.040 (1.02)
Over 3 to 4 (76.2 to 101.6), incl	0.012 (0.30)	0.050 (1.27)
Over 4 to 5½ (101.6 to 139.7), incl	0.015 (0.38)	0.060† (1.52)
Over 5½ to 6½ (139.7 to 165.1), incl	0.018 (0.46)	0.100 (2.54)
Over 6½ to 8 (165.1 to 203.2), incl	0.020 (0.51)	0.150 (3.81)

[A] For high-speed steel rounds free of scale and decarburization, see Table 10.
† Editorially corrected.

TABLE 10 Diameter Tolerances for Round Bars, High-Speed Steels (Free of Scale and Decarburization)

NOTE—Out-of-round to be ½ of total tolerance maximum.

Specified Diameter, in. (mm)	Diameter Tolerances, in. (mm)	
	Under	Over
¼ to ⅝ (6.4 to 15.8), excl	0.0015 (0.038)	0.0015 (0.038)
⅝ to 3 1⁄16 (15.8 to 77.6), excl	0.000	0.004 (0.10)
3 1⁄16 to 4 1⁄16 (77.6 to 103), excl	0.000	0.006 (0.15)
4 1⁄16 to 7⅛ (103 to 181), excl	0.000	0.031 (0.78)
7⅛ to 8⅛ (181 to 206.2), excl	0.000	0.062 (1.6)
8⅛ to 10⅛ (206.2 to 257), excl	0.000	0.093 (2.4)
10⅛ to 12⅛ (257 to 307.7), excl	0.000	0.125 (3.2)
12⅛ and over (307.7 and over), excl	0.000	0.187 (4.7)

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TABLE 11 Hot-Rolled Flat Bars
Width and Thickness Tolerances
Width Tolerances[A]

Specified Widths, in. (mm)	Width Tolerances, in. (mm)	
	Under	Over
To 1 (25.4), incl	0.016 (0.41)	0.031 (0.79)
Over 1 to 3 (25.4 to 76), incl	0.031 (0.79)	0.047 (1.19)
Over 3 to 5 (76 to 127), incl	0.047 (1.19)	0.063 (1.60)
Over 5 to 6 (127 to 152), incl	0.063 (1.60)	0.094 (2.39)
Over 7 to 10 (178 to 254), incl	0.078 (1.98)	0.125 (3.18)
Over 10 to 12 (254 to 305), incl	0.094 (2.39)	0.156 (3.96)

Thickness Tolerances

Specified Widths, in. (mm)	Thickness Tolerances for Specified Thicknesses, in. (mm)											
	To ¼ (6.4), incl		Over ¼ to ½ (6.4 to 12.7), incl		Over ½ to 1 (12.7 to 25.4), incl		Over 1 to 2 (25.4 to 50.8), incl		Over 2 to 3 (50.8 to 76), incl		Over 3 to 4 (76 to 102), incl	
	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over
To 1 (25.4), incl	0.006(0.15)	0.010(0.25)	0.008(0.20)	0.012(0.30)	0.010(0.25)	0.016(0.41)	...	...	...	...	...	...
Over 1 to 2 (25.4 to 50.8), incl	0.006(0.15)	0.014(0.36)	0.008(0.20)	0.016(0.41)	0.010(0.25)	0.020(0.51)	0.020(0.51)	0.024(0.61)	...	...	...	...
Over 2 to 3 (50.8 to 76), incl	0.006(0.15)	0.018(0.46)	0.008(0.20)	0.020(0.51)	0.010(0.25)	0.024(0.61)	0.020(0.51)	0.027(0.69)	0.026(0.66)	0.034(0.86)	...	...
Over 3 to 4 (76 to 102), incl	0.008(0.20)	0.020(0.51)	0.010(0.25)	0.022(0.56)	0.013(0.33)	0.024(0.61)	0.024(0.61)	0.030(0.76)	0.032(0.81)	0.042(1.07)	0.040(1.02)	0.048(1.22)
Over 4 to 5 (102 to 127), incl	0.010(0.25)	0.020(0.51)	0.012(0.30)	0.024(0.61)	0.015(0.38)	0.030(0.76)	0.027(0.69)	0.035(0.89)	0.032(0.81)	0.042(1.07)	0.042(1.07)	0.050(1.27)
Over 5 to 6 (127 to 152), incl	0.012(0.30)	0.020(0.51)	0.014(0.36)	0.030(0.76)	0.018(0.46)	0.030(0.76)	0.030(0.76)	0.035(0.89)	0.036(0.91)	0.046(1.17)	0.044(1.12)	0.054(1.37)
Over 6 to 7 (152 to 178), incl	0.014(0.36)	0.027(0.69)	0.016(0.41)	0.032(0.81)	0.018(0.46)	0.035(0.89)	0.030(0.76)	0.040(1.02)	0.036(0.91)	0.048(1.22)	0.046(1.17)	0.056(1.42)
Over 7 to 10 (178 to 254), incl	0.018(0.46)	0.030(0.76)	0.020(0.51)	0.035(0.89)	0.024(0.61)	0.040(1.02)	0.035(0.89)	0.045(1.14)	0.040(1.02)	0.054(1.37)	0.052(1.32)	0.064(1.62)
Over 10 to 12 (254 to 305), incl	0.020(0.51)	0.035(0.89)	0.025(0.64)	0.040(1.02)	0.030(0.76)	0.045(1.14)	0.040(1.02)	0.050(1.27)	0.046(1.17)	0.060(1.52)	0.056(1.42)	0.072(1.83)

[A] Out-of-square to be ¾ of total width tolerance maximum.

TABLE 12 Forged Bars
Rounds,[A] Squares, Octagons, Hexagons
Size Tolerances

NOTE—Out-of-round or square to be ¾ of total tolerance maximum.

Specified Sizes, in. (mm)	Size Tolerances, in. (mm)	
	Minus	Plus
Over 1 to 2 (25.4 to 50.8), incl	0.030 (0.76)	0.060 (1.52)
Over 2 to 3 (50.8 to 76), incl	0.030 (0.76)	0.080 (2.03)
Over 3 to 5 (76 to 127), incl	0.060 (1.52)	0.125 (3.18)
Over 5 to 7 (127 to 177.8), incl	0.125 (3.18)	0.187 (4.75)
Over 7 to 9 (178 to 229), incl	0.187 (4.75)	0.312 (7.92)

[A] Refer to Table 10 for diameter tolerances on rounds of high-speed steels free of scale and decarburization.

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TABLE 13 Forged Flat Bars

Width Tolerances

Specified Widths, in. (mm)	Width Tolerances, in. (mm)[A]	
	Minus	Plus
Over 1 to 3 (25.4 to 76), incl	0.031 (0.79)	0.078 (1.98)
Over 3 to 5 (76 to 127), incl	0.062 (1.57)	0.125 (3.18)
Over 5 to 7 (127 to 178), incl	0.125 (3.18)	0.187 (4.75)
Over 7 to 9 (178 to 229), incl	0.187 (4.75)	0.312 (7.92)

Thickness Tolerances

Specified Widths, in. (mm)	Thickness Tolerances for Specified Thicknesses, in. (mm)									
	To 1 (25.4), incl		Over 1 to 3 (25.4 to 76), incl		Over 3 to 5 (76 to 127), incl		Over 5 to 7 (127 to 178), incl		Over 7 to 9 (178 to 229), incl	
	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus
Over 1 to 3 (25.4 to 76), incl	0.016 (0.41)	0.031 (0.79)	0.031 (0.79)	0.078 (1.98)	. . .	. . .	. . .	. . .	. . .	. . .
Over 3 to 5 (76 to 127), incl	0.031 (0.79)	0.062 (1.57)	0.047 (1.19)	0.094 (2.39)	0.062 (1.57)	0.125 (3.18)	. . .	. . .	. . .	. . .
Over 5 to 7 (127 to 178), incl	0.047 (1.19)	0.094 (2.39)	0.062 (1.57)	0.125 (3.18)	0.078 (1.98)	0.156 (3.96)	0.125 (3.18)	0.187 (4.75)	. . .	. . .
Over 7 to 9 (178 to 229), incl	0.062 (1.57)	0.125 (3.18)	0.078 (1.98)	0.156 (3.96)	0.094 (2.39)	0.187 (4.75)	0.156 (3.96)	0.219 (5.56)	0.187 (4.75)	0.312 (7.92)

[A] Out-of-square to be ¾ of total width tolerance maximum.

TABLE 14 Straightened Hot Rolled Annealed Bars or Cold Finished Bars

Straightness Tolerances

This table does not apply to flat bars having a width to thickness ratio of 6 to 1 or greater. Measurement is taken on the concave side of the bar with a straightedge. Bars are furnished to the following straightedge tolerances: Hot rolled bars:

⅛ in. in any 5 ft, but may not exceed 1/8 in. × (no. of ft in length/5)

The foregoing formula applies also to bars under 5 ft in length, (3.2 mm in any 1.54 m, but may not exceed 3.2 mm × (no. of m in length/1.54). The foregoing formula applies also to bars under 1.54 m in length.)

1/16 in. in any 5 ft, but may not exceed 1/16 in. × (no. of ft in length/5)

The foregoing formula applies also to bars under 5 ft in length, (1.6 mm in any 1.54 m, but may not exceed 1.6 mm × (no. of m in length/1.54). The foregoing formula applies also to bars under 1.54 m in length.)

TABLE 15 Hot Rolled or Forged Bars and Billets

Tolerances for Machine Cut Lengths

Specified Sizes Apply to Rounds, Squares, Hexagons, Octagons, and Width of Flats, in. (mm)	Tolerances for Specified Lengths, 14 ft (4.27 m) max, in. (mm)	
	Minus	Plus
To 9 (229), incl	0	⅜ (9.5)
Over 9 to 12 (229 to 305), incl	0	½ (12.7)
Over 12 to 18 (305 to 457), incl	0	¾ (19.1)
Over 18 (457)	0	1 (25.4)

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TABLE 16 Drill Rod, Rounds, Polished or Ground
Size Tolerances

NOTE—Out-of-round to be ½ of total tolerance maximum.

Specified Size, in. (mm)	Standard Manufacturing Tolerance, in. (mm), plus and minus	Precision Tolerance, in. (mm), plus and minus
Up to 0.124 (3.15), incl	0.0003 (0.008)	0.0002 (0.005)
0.125 to 0.499 (3.18 to 12.7), incl	0.0005 (0.013)	0.00025 (0.006)
0.500 to 1.500 (12.7 to 38.1), incl	0.001 (0.025)	0.0005 (0.013)

TABLE 17 Drill Rod, Shapes Other than Rounds, Cold Drawn
Size Tolerances

Specified Size, in. (mm)	Tolerances, in. (mm), plus and minus
Up to ¼ (6.4), excl	0.0005 (0.013)
¼ to ¾ (6.4 to 19.0), excl	0.001 (0.025)
¾ to 1 (19.0 to 25.4), incl	0.0015 (0.038)

TABLE 18 Cold Drawn Bars
Rounds, Octagons, Quarter Octagons and Hexagons
Size Tolerances

NOTE—Out-of-round to be ½ of total tolerance maximum.

Specified Size, in. (mm)	Tolerance, in. (mm), plus and minus
¼ to ½ (6.4 to 12.7), excl	0.002 (0.05)
½ to 1 (12.7 to 25.4), excl	0.0025 (0.06)
1 to 2¾ (25.4 to 69.8), incl	0.003 (0.08)

TABLE 19 Cold Drawn Square and Flat Bars
Size Tolerances

NOTE—Out-of-square to be ½ of total tolerance maximum.

Specified Size, in. (mm)	Tolerance, in. (mm), plus and minus
¼ to ¾ (6.4 to 19.1), incl	0.002 (0.05)
Over ¾ to 1½ (19.1 to 38.1), incl	0.003 (0.08)
Over 1½ (38.1)	0.004 (0.10)

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TABLE 20 Forgings, Disks, Rings and Rectangular Blocks

NOTE 1— Unmachined tool steel forgings are furnished to size and surface allowances for machining and tolerances over allowances. Experience indicates that the allowances and tolerances in the tabulation below are satisfactory for many applications. When width and thickness differ, each dimension carries its individual allowance and tolerance in accordance with the tabulation: also, the ID and OD take their respective allowances and tolerances.

NOTE 2—When forgings are ordered, the purchaser should state whether the sizes are the forged or the finished sizes. The minimum sizes ordered for forgings should be the finished sizes plus allowances for machining; and the ordered forged sizes are subject to applicable tolerances.

Finish Size, Diameter or Distance Between Parallel Faces or Both, in. (mm)	Allowances for Machining Over Finished Size[A], in. (mm)	Tolerances Over the Allowance[A], in. (mm)	
		Minus	Plus
Up to 3 (76), incl	⅛ (3.2)	0	⅛ (3.2)
Over 3 to 5 (76 to 127), incl	3⁄16 (4.8)	0	3⁄16 (4.8)
Over 5 to 7 (127 to 178), incl	5⁄16 (7.9)	0	5⁄16 (7.9)
Over 7 to 12 (178 to 305), incl	⅜ (9.5)	0	⅜ (9.5)
Over 12 to 17 (305 to 432), incl	½ (12.7)	0	½ (12.7)

[A] Ring forgings: For the outside diameter, use the same allowances and tolerances shown in the above tabulation; for the inside diameter, double the tolerances shown in the above tabulation.

TABLE 21 Hot Rolled Plates and Sheets
Tolerances for Width and Thickness

Specified Thickness, in. (mm)	Specified Width, in. (mm)			
	Up to 15 (381)		Over 15 (381)	
	All tolerances, over specified width and specified thickness, in. (mm), all plus			
	Width	Thickness	Width	Thickness
Up to 0.025, (0.64), incl	⅛ (3.2)	0.006 (0.15)	3⁄16 (4.8)	0.006 (0.15)
Over 0.025 to 0.065, (0.64 to 1.65), incl	⅛ (3.2)	0.008 (0.20)	3⁄16 (4.8)	0.008 (0.20)
Over 0.065 to 0.120, (1.65 to 3.05), incl	⅛ (3.2)	0.010 (0.25)	3⁄16 (4.8)	0.010 (0.25)
Over 0.120 to 0.1875, (3.05 to 4.76), incl	3⁄16 (4.8)	0.016 (0.41)	¼ (6.4)	0.016 (0.41)
Over 0.1875 to 0.250, (4.76 to 6.35), incl	3⁄16 (4.8)	0.018 (0.46)	¼ (6.4)	0.018 (0.46)

Specified Thickness, in. (mm)	Specified Width, in. (mm)	
	Over 12 (305)	
	All tolerances, over specified width and specified thickness, in. (mm), all plus	
	Width	Thickness
¼ to ½ (6.4 to 12.7), incl	¼ (6.4)	1⁄16 (1.6)
Over ½ to 2 (12.7 to 50.8), incl	¼ (6.4)	⅛ (3.2)
Over 2 (50.8)	¼ (6.4)	¼ (6.4)

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TABLE 22 Machined Square and Flat Bars
Size, Straightness and Squareness Tolerances

NOTE—For closer tolerances and improved surface finish, bars with machined surfaces in standard bar lengths may be available. The bars are free of surface imperfections and decarburization. Surface finish in 125 μin. (3.18 μm) rms maximum. These bars are furnished oversize to allow for finishing after heat treating.

Size Tolerances			
Dimension	Oversize, in. (mm)	Tolerance on Oversized Dimension, in. (mm)	
		Minus	Plus
Thickness	0.015 (0.38)	0	0.020 (0.51)
Width	0.015 (0.38)	0	0.020 (0.51)

Straightness Tolerances

⅛ in. in any 5 ft, but may not exceed 1/6 in. × (no. of ft in length/5)

The foregoing formula applies also to bars under 5 ft in length, (1.6 mm in any 1.54 m, but may not exceed 1.6 mm × (no. of m in length/1.54). The foregoing formula applies also to bars under 1.54 m in length.)

Squareness Tolerances

The width and thickness dimensions specified must be attainable when surfaces are subsequently made to be parallel and square. Closer limits of squareness may be agreed upon between seller and purchaser.

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, and order. Details of these supplementary requirements shall be agreed upon by the seller and the purchaser.

S1. Ultrasonic Quality

S1.1 Material shall be ultrasonically tested at appropriate stages of the manufacture to ensure the quality, when and as agreed upon between seller and purchaser. When required, it shall be performed in accordance with the latest issue of Practice A 388/A 388M.

S2. Cleanliness

S2.1 In special situations, such as where the surface finish of the part requires optimum polishing characteristics, the cleanliness of the steel shall be ascertained in accordance with the latest issue of Practice E 45. The permissible limits shall be agreed upon between seller and purchaser.

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ANNEX

(Mandatory Information)

A1. MINIMUM REQUIREMENTS FOR HIGH-SPEED STEELS

A1.1 General

A1.1.1 High-speed steels are so named primarily because of their ability to machine materials at high cutting speeds. They are complex iron base alloys of carbon, chromium, vanadium, molybdenum or tungsten, or combinations thereof and in some cases substantial amounts of cobalt. The carbon and alloy contents are balanced at levels to give high attainable hardening response, high wear resistance, high resistance to the softening effect of heat, and good toughness for effective use in industrial cutting operations. Commercial practice has developed two groups of cutting materials: the recognized standard high-speed steel which serves almost all applications under mild to severe metal cutting conditions, and a smaller group of intermediate steels which are satisfactory for limited applications under mild to moderate metal-cutting conditions.

A1.2 Requirements

A1.2.1 The minimum requirements that must be met to be classed as a standard high-speed steel, and those for an intermediate high-speed steel, are listed in Table A1.1. To be acceptable for either group, an alloy must meet all of the requirements shown for that group.

TABLE A1.1 Requirements for High-Speed Steels

	Standard	Intermediate
Chemical Requirements:		
Minimum alloy content by major elements:		
Carbon	0.65	0.70
Chromium	3.50	3.25
Vanadium	0.80	0.80
Tungsten + 1.8 molybdenum	11.75	6.50
Minimum total alloy content based on tungsten equivalents (1/3 Cr + 6.2 V + W + 1.8 Mo):		
Grades containing less than 5 % cobalt	22.50	13.00
Grades containing 5 % or more cobalt	21.00	12.00
Hardening Response Requirements:		
Ability to be austenitized, and tempered at a temperature not less than 950°F with a fine grain structure (Snyder-Graff grain size 8 minimum) to	63 HRC	61 HRC

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