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MIL-STD-40002(AT)
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SUPERSEDING
(see 6.3)

MILITARY STANDARD
HEAT TREATMENT CODING SYSTEM, GENERAL



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F O R E W O R D

1. This military standard is approved for use by the U.S. Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. This military standard establishes a heat treatment coding system for various ferrous and nonferrous alloys based on the Unified Numbering System (UNS). This system is being universally adopted because it encompasses a method of correlating (cross indexing) numbering systems used by engineering societies, trade associations, individual users, and Government activities.

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1. SCOPE

1.1 Scope. This standard covers a variety of heat treatment procedures applicable to specific ferrous and nonferrous alloys.

1.1.1 Limitations. Magnesium alloys are excluded from reference in this document.

1.2 Purpose. This standard establishes a coding system for use in specifying heat treatment notes in drawings in abbreviated form that correlates with explicit engineering heat treatment requirements for the specified material.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-H-6088	- Heat Treatment of Aluminum Alloys.
MIL-H-6875	- Heat Treatment of Steel, Process for.
MIL-H-7199	- Heat Treatment of Wrought Copper-Beryllium Alloys, Process for.
MIL-H-81200	- Heat Treatment of Titanium and Titanium Alloys.

STANDARDS

MILITARY

MIL-STD-1876	- Nitriding, Gaseous Atmosphere Processing for.
MIL-STD-1878	- Carburizing, Gaseous Atmosphere Process for.
MIL-STD-1949	- Inspection, Magnetic Particle.
MIL-STD-6866	- Inspection, Liquid Penetrant.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Navy Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A439	- Austenitic Ductile Iron Castings, Specification for.
ASTM E10	- Brinell Hardness of Metallic Materials, Test Method for.
ASTM E18	- Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Test Methods for.

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(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS 2750	- Pyrometry.
AMS 2770	- Heat Treatment of Wrought Aluminum Alloy Parts.
AMS 5221	- Alloy Strip 49Fe - 5.3Cr - 42Ni - 2.5Ti - 0.55Al Solution Heat Treated.
AMS 5223	- Alloy Strip 49Fe - 5.3Cr - 42Ni - 2.5Ti - 0.55Al Solution Heat Treated, Cold Rolled, 10% Reduction.
AMS 5225	- Alloy Strip 49Fe - 5.3Cr - 42Ni - 2.5Ti - 0.55Al Solution Heat Treated, Cold Rolled 50% Reduction.
AMS 5598	- Alloy Sheet, Strip, and Plate, Corrosion and Heat Resistant 72Ni - 15.5Cr - 0.95(Cb+Ta) - 2.5Ti - 0.70Al - 7.0Fe Consumable Electrode or Vacuum Induction Melted Solution Heat Treated, Precipitation Hardenable
Handbook	- Unified Numbering System, Metals and Alloys.

(Application for copies should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.)

AMERICAN SOCIETY FOR METALS (ASM)

Metals Handbook Volume 4, 9th Edition "Heat Treating"

(Applications for copies should be addressed to American Society for Metals, Materials Park, OH 44073.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 Definitions. Definitions of terms relating to the heat treatment of ferrous and nonferrous alloys are amply covered in numerous documents. See 6.7 for the list of references that contain definitions pertaining to the heat treatment of these alloys.

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4. GENERAL REQUIREMENTS

4.1 Equipment.

4.1.1 Furnaces. Furnaces, high temperature for solution treatment or austenitizing and low temperature for aging or tempering, shall be of the batch or continuous design. Furnaces shall be suitable for the intended purpose, including salt bath and vacuum types, and capable of maintaining the specified temperatures in all areas of the work load zone.

4.1.1.1 Monitoring controls.

4.1.1.1.1 Atmospheres. Furnaces designed to accept atmosphere shall have monitoring devices installed to control and adjust the atmosphere introduced. This is for the protection of the product being heat treated (neutral to the base material) or for the prime purpose of case hardening (carburizing or nitriding). For detailed requirements on heat treatment furnaces, atmospheres, temperatures and controls, see military specifications MIL-H-6088, MIL-H-6875, MIL-H-7199, MIL-H-81200, MIL-STD-1876, MIL-STD-1878 and ASTM Handbook Vol 4, 9th Edition.

4.1.1.1.2 Temperatures. A sufficient number of thermocouples shall be strategically positioned in the working zone(s) to provide an accurate temperature survey of the furnace.

4.1.1.1.2.1 Instrumentation. All thermocouples used to control or indicate the temperature shall be provided with recording instrumentation (time versus temperature) in accordance with AMS 2750. The work zone tolerances shall depend upon the type of furnace and the operating temperature range. Generally, the tolerances will vary as shown below and as coded by the appropriate symbol in the instruction sheets.

Temperature tolerance (temp tol)

degrees Fahrenheit (°F) [degrees Celsius (°C)]	Symbol
± 25°F (± 14°C)	I
± 15°F (± 8°C)	II
± 10°F (± 6°C)	III
Specified temperature range	IV

4.1.2 Quench systems. Facilities required to quench parts as part of the thermal sequencing shall be integral with, or adjacent to, the furnace.

4.1.2.1 Tank size. Mass (free) quenching requires the tank containing the quenching media be of suitable size to completely immerse the parts, container, and fixturing, as applicable.

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4.1.2.2 Circulation. Quench media shall be agitated by forced circulation directed around and through the parts to provide the severity of quench necessary to meet the desired metallurgical properties, yet minimize distortion.

4.1.2.3 Temperature control. Quench media shall be temperature controlled to provide the desired metallurgical properties and minimize any dimensional changes due to distortion.

4.1.2.4 Quench media. Depending upon the material being processed and the product type, the quenching media may vary from air, water, salt, salt solutions, or oil to synthetic products, such as, the polymer types.

4.1.2.4.1 Oil quenchant. The efficiency of oil as a quenchant depends on a variety of things, mainly:

- a. Type of oil.
- b. Freedom from contaminants (water, sludge, biologicals, insolubles).
- c. Temperature.

For practical reasons, heat treatment practitioners generally operate in the range of 120 to 160°F (49 to 71°C).

4.1.2.4.2 Water quenchant. Water as a quenchant shall depend upon the material and product being processed. The specific heat treatment instruction sheet shall designate the temperature range for quenching.

4.1.2.4.3 Synthetic quenchants. Synthetic quenchants are normally used for specific material and product applications. Care shall be exercised in their use. The metallurgical results are affected by the concentration of the synthetic product in the quench solution, biological contaminants, operating temperature range, and the degree of agitation control.

4.1.3 Cold (subzero) treatment.

4.1.3.1 Subzero facility. Parts requiring subzero cooling to enhance the mechanical properties by stabilizing the microstructure (transformation of retained austenite) shall require the need for a cooling chamber or component in close proximity to the quenching system. The cooling chamber (freezer) shall be capable of maintaining a temperature in the range of -90 to -150°F (-68 to -101°C). The use of an appropriate liquid medium, such as, nitrogen (N₂) at -312°F (-191°C), to facilitate heat transfer shall be acceptable provided an adequate vessel is used for containment.

4.1.4 Safety precautions. Furnaces constructed to use atmospheres, that are either toxic and highly flammable or quench systems containing quenchants that are flammable, shall incorporate the necessary safety equipment to minimize the hazards of accidental explosions occurring in the event of utility failures.

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4.2 Materials.

4.2.1 Designations. The instruction sheets incorporate the UNS designation, where assigned and are cross indexed to commercial/industrial, SAE, or AISI designation (see table I), as applicable.

4.2.2 Product types. Product types represented in this standard and incorporated within the UNS designations cover various metal shapes, forms or processes, for example: Bar, forging, sand and investment casting, extrusion, plate, powdered metal, sheet, strip, tubing, and wire products.

4.2.3 Heat treatment coding. Coding for heat treatment is a method used to specify in engineering drawings the appropriate thermal treatment applicable for a desired requirement. Typical coding as related to the heat treatment process is shown in table II.

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5. DETAILED REQUIREMENTS

5.1 Surface preparation.

5.1.1 Cleanliness. All parts, work trays, and fixtures shall be thoroughly cleaned and free from moisture prior to being charged into a controlled atmosphere furnace. Foreign matter such as; scale, lubricants, residues from prior operations, or rust preventatives, all have either an adverse reaction on the part, furnace, equipment, or the thermochemical balance of the protective/case hardening atmosphere.

5.1.2 Surface chemistry (decarburization). Surfaces to be case hardened, either selectively or all over, shall be free from any decarburization.

5.2 Furnace loading. Parts shall be loaded into the furnace in a manner to minimize distortion (fixtures may be required), provide free access to the heating medium, and allow uniformity of the cooling media.

5.2.1 Test samples. Unless provisions are made to test parts destructively for microstructure and enriched surfaces for case depth (carburized or nitrided surfaces), test samples or test parts shall be processed concurrently with the load. Sufficient quantity of test samples from the same base material shall be distributed within the load to be representative of the processing conditions.

5.3 Dimensional control. Factors other than part shape and size that affect dimensions are:

- a. Residual stresses in the part prior to heat treatment.
- b. Stresses induced by nonuniform heat treatment.
- c. Methods of loading of fixturing parts.
- d. Growth of surfaces during case hardening.
- e. Quench media and the severity of quench.
- f. Microstructure developed.
- g. Variations in the base chemical composition of the product.

5.3.1 Cold (subzero) treatment. When specified, parts requiring subzero treatment shall be processed immediately after quenching.

5.4 Tempering. Ferrous parts requiring tempering shall be done immediately after the hardening operation. Parts subjected to cold treatment will require stabilizing at room temperature prior to tempering.

5.5 Acceptance criteria.

5.5.1 Mechanical properties. Unless otherwise specified, the primary method for accepting heat treated parts shall be based on hardness testing. If the tensile, yield and elongation requirements are necessary for certification of conformance, test bars must be provided for processing with the parts during heat treatment.

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5.5.1.1 Hardness. Hardness shall be determined using the appropriate hardness testing facility on a properly prepared surface in accordance with ASTM E10 and ASTM E18. The location on the surface to be tested shall be designated on the engineering drawing.

5.5.2 Metallurgical parameters.

5.5.2.1 Case depth. Requirements for evaluating case depth of steel components shall be performed in conformance with MIL-STD-1876 and MIL-STD-1878.

5.5.2.2 Microscopic examination. Unless otherwise specified, the microstructure of the material of the heat treated part shall not be considered part of the acceptance criteria.

5.5.3 Nondestructive testing. Unless otherwise specified, all parts susceptible to, or suspect of, cracking after heat treatment, involving a subsequent quench operation shall be inspected in accordance with MIL-STD-1949 or MIL-STD-6866, whichever is appropriate for the base material being processed.

5.5.4 Rejection, retest, rework.

5.5.4.1 Rejection. Failure of a test sample or part to meet the specified requirements shall be cause for rejection and subject to disposition for retest or rework by the acquisition agency.

5.5.4.2 Retest. Failure of any retest sample or part to meet the specified requirements shall be cause for rejection with no additional testing being permitted.

5.5.4.3 Rework. Samples or parts not complying with the specified hardness or minimum case depth shall, with acquisition agency approval, be reprocessed and subsequently reinspected.

5.5.5 Technique approval.

5.5.5.1 Process data. The instruction sheets established as part of this standard shall be maintained current and the results obtained correlated to determine consistency of processing.

5.5.5.2 Manufacturing options. Other heat treat operations may be incorporated into the manufacturing sequence to provide the most economical and practical manufacturing process providing the design requirements are maintained.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The coding system established in this standard is intended to be used in the preparation of engineering drawings to specify material and heat treatment callouts in abbreviated format.

6.2 Issue of DODISS. When this standard is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1, and 2.2).

6.3 Supersession data. This document supersedes Textron Lycoming internal specification P6000N, dated 1 March 1991.

6.4 Former standard steels. Two former standard SAE Steels (SAE 3120 and 9315) are referenced in the instruction sheets. Their use would result in a premium cost because of their limited availability.

6.5 Military application. Many of the alloys referenced in this standard are also used in the military specifications listed in table I.

6.6 Currency and comprehensive data. The ASM handbook referenced in this standard encompasses current data on all the major alloy systems. This handbook covers the properties of metals, their selection, and methods of heat treatment necessary for establishing and specifying the products materials design requirements.

6.7 References. The following references contain information on the heat treatment of ferrous and nonferrous alloys and definitions (see 3.1).

a. American Society for Metals (ASM), Metals Handbook Volume 1, 8th Edition-Properties and Selection of Metals (Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.)

b. American Society for Testing and Materials (ASTM), ASTM E44 - Heat Treatment of Metals, Definition of Terms Relating to (ASTM, 1916 Race Street, Philadelphia, PA 19103.)

c. Society of Automotive Engineers, Inc. (SAE) SAE J415 - Definitions of Heat Treating Terms, Information Report (SAE, 400 Commonwealth Drive, Warrendale, PA 15096.)

6.8 Example for specifying heat treatment notes in engineering drawings. The following example illustrates how the standard is to be used to specify the heat treatment process, in coded form, in the engineering drawing.

EXAMPLE

Material: Low carbon steel, UNS G10400 (SAE 1040).

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Heat treatment process:

- a. Anneal: Heat to 1450°F (788°C), hold at heat 60 minutes per inch of maximum cross-section, furnace cool to 850°F (454.4°C), air cool (HRC 23 max).
- b. Normalize: Heat to 1525°F (829°C) hold at heat 60 minutes per inch of maximum cross-section, cool in air.
- c. Harden: Heat to 1525°F (829°C) hold at heat 30 minutes per inch of maximum cross-section, quench in water, temper immediately.
- d. Temper: For approximate tempering temperature, refer to hardness verses tempering temperature chart for this material (pg. 92), hold for 2 hours per inch of maximum cross-section to HRC 25-30, cool in air.

Coding procedure:

- a. Locate material designation (UNS G10400) in content section of MIL-STD-4002 to identify the applicable instruction sheet number (ISN) to be used. In this example, it is ISN 50 (see note 1).
- b. Referring to ISN 50 the codes applicable to the above heat treatment process are as follows (see note 2):

L1 - Anneal, L2 - Normalize, L3 - Harden, L4A - Temper

- c. Specify the heat treatment callout in the drawing as follows:

Heat treat per MIL-STD-40002: L1234A.

NOTE:

1. Table I is a cross reference of various material designations to the UNS number.
2. Table II is a listing of the designated heat treatment codes applicable to the specific heat treatment process.

6.9 Subject term (key word) listing.

Atmospheres	Surface chemistry
Cold (subzero) treatment	Tank size
Furnace loading	Temperatures
Hardness testing	Tempering
Heat treatment	Quench systems
Metallurgical parameters	

TABLE I. Cross index of heat treat instruction with other pertinent data.

Instruction Sheet Number	Material Designation				Current MIL-SPEC/STD on Heat Treatment	Remarks
	UNS Number	Commercial/Industrial 1/	SAE 2/	AISI 3/		
1	K23015	17-22AS				
2		C-422				
3	G10220		1022	1022		
4	G10900		1090	1090		
5	J91150	CA-15				
	J91152	410 S.S. Cast				
	S41000	410 S.S.	51400	410	H-6875	
6	G86300		8630	8630	H-6875	
	J13042					
	J13050					
7	J92641					
	J92811					
	S34700	347 S.S.	30347	347	H-6875	
	S34781					
8	J94211					
	S31000	310 S.S.	30310	310	H-6875	
	S31008		30310S	310S	H-6875	
9	S32100	321 S.S.	30321	321	H-6875	
10	S66220	Discaloy				
	S66286	A286			H-6875	
11	G87400		8740	8740	H-6875	
12	G41300		4130	4130	H-6875	
	J13046					
13	G41400		4140	4140	H-6875	
	J14046					
14	G43400		4340	4340	H-6875	
15	G61500		6150	6150	H-6875	
16	G10100		1010	1010		
17	S30200	320 S.S.	30302	302	H-6875	
	S30400	304 S.S.	30304	304	H-6875	
	S30403	304L S.S.	30304L	304L	H-6875	
18	J91639	440C S.S.				
	S44004	440C S.S.	5140C	440C	H-6875	

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TABLE I. Cross index of heat treat instruction with other pertinent data - Continued.

Instruction Sheet Number	Material Designation				Current MIL-SPEC/STD on Heat Treatment	Remarks
	UNS Number	Commercial/Industrial 1/	SAE 2/	AISI 3/		
19	G93106		9310	E9310		
20	K24065	Nitraloy 135 Mod.			STD-1876	
21	N07750	Inconel X750				
22	R56400	Ti Alloy 6AL-4V			H-81200	(See sheet 47)
23	A96061	AA6061 4/	6060		H-6088	
24	G10200		1020	1020		
25	S42000	420 S.S.	51420	420	H-6875	
	S42020	420F S.S.	51420FS		H-6875	
	S42023	420FSE S.S.	51420FSE		H-6875	
26	N09979	D979				
27		Hastelloy R235				
28	S35000	AM350			H-6875	
29	N07702	Inconel 702				
30		Super Nitralloy 5 Ni - 2 Al			STD-1876	
31	T20811	H11	H11	H-687		
32	T12005	T5				Formerly Rex Supercut Hot work T-2084X
33		Ferrovac Halmo				
34	R30155	N155				
35	K52355					
36	S41623	416SE S.S.	51416SE	416SE	H-6875	
37	N04019	S Monel				
38	F43003	Ni Resist Ductile Type 3				ASTM A 439 Type D-3
39	J92170					
	J92200	17-4				
	S17400	17-4PH	17-4PH	S1740	H-6875	
40	N07041	Rene 41				
41	G52986		52100	E5210	H-6875	
42	T11350	M50				

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TABLE I. Cross index of heat treat instruction with other pertinent data - Continued.

Instruction Sheet Number	Material Designation				Current MIL-SPEC/STD on Heat Treatment	Remarks
	UNS Number	Commercial/Industrial 1/	SAE 2/	AISI 3/		
43	N06002	Hastelloy X				
44	J92001	AM355				
	S35500	AM355			H-6875	
45		X40				
46	A97178	AA7178	7178		H-6088	
47	R56400	Ti Alloy 6AL-4V			H-81200	(See Sheet 22)
48	A92024	AA2024	2024		H-6088	
49	N07001	Waspalloy				
50	G10400		1040	1040		
51			3120			Former standard SAE steel
52		CF-8M				
53	S17700	17-17PH	17-17PH	S17700	H-6875	
54		MAR-M-421				
55	N07718	Inconel 718				
56	C17200	BE-CU 5/	CA 172		H-7199	
57	C82500	BE-CU				
58	R30605	L805				
59	K92890		A538A			
60	N09902	Ni Span C902				
61	K93120		A538C			
62	S41800	Greek Ascoloy				
63		D979 Modified				
64		PM-LC-Astroloy				
65	A92024	AA2024 Alclad	2024 Alclad		H-6088	
66		C101				
67	N06625	Inconel 625				
68			9315			Former standard SAE steel

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TABLE I. Cross index of heat treat instruction with other pertinent data - Continued.

Inatruction Sheet Number	Material Designation				Current MIL-SPEC/ STD on Heat Treatment	Remarks		
	UNS Number	Commercial/ Industrial 1/	SAE 2/	AISI 3/				
69	R56260	Ti Alloy 6A1-4V			H-81200	Soln. Treated and Over Aged		
70	R56400				H-81200			
71	S15700				PH15-7Mo		S15500	H-6875
72	S15500				15-5PH			H-6875
73	S45000				C450			
74		C450						
75		Vasco Jet 2000	C103		Formerly Vasco X-2 Modified			
76								
77		Inconel 617						
78		MAR-M-247						
79		DS-C103						
80	K44220	300M		H-6875				
81	N13100	IN-100						
82		TD Nickel						
83		M40AB		M3623	AMS 6308			
84				M3633	Haynes 230			

- 1/ Commercial/industrial designations may change depending upon customer demand for the base product.
- 2/ Updated yearly by SAE.
- 3/ Updated when necessary, usually every 5-10 years, by AISI.
- 4/ Updated every 2 years by the Aluminum Association, Incorporated.
- 5/ Updated when necessary, usually every 5-10 years, by the Copper Development Association Incorporated.

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TABLE II. Typical heat treatment process coding.

Code	Process
L1	ANNEAL (A, B, etc., suffixes represent various cycles for full or partial annealing.) Industry practice is to anneal to a specified hardness range or microstructure.
L2	NORMALIZE
L3	HARDEN
L4	TEMPER (A, B, C, D, etc., suffixes represent various tempering temperatures.) Industry practice is to temper to a specified hardness range rather than a specified temperature range.
L5	STRESS RELIEVING
L6	STABILIZATION
L7S	SOLUTION TREATMENT
L7T	AGING (W, X, etc., suffixes represent thermal cycles peculiar to the material or product.)
L8	SPECIAL TREATMENT CYCLES (A, B, C, etc., suffixes represent thermal cycles to the material or product.)

NOTE: For example on how this table is used see 6.8

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INSTRUCTION SHEET 1

Material Designation: UNS K23015

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> Heat parts to 1525°F (829.4°C). a. 0.063 inch thick and under: Hold at heat for 10 minutes. b. Over 0.063 inch thick: Hold at least 30 minutes per inch of maximum cross section. Cool in air to 1300°F (704.4°C). Hold at heat for 4 hours. Cool in air (HB 248 max, or equivalent). 	I
L1A	Anneal A: <ol style="list-style-type: none"> Heat parts to 1300°F (704.4°C) in an atmosphere furnace. Hold at heat 2 hours. Cool in atmosphere. 	III
L1B	Anneal B: <ol style="list-style-type: none"> Heat parts to 1525°F (829.4°C). Hold at least 45 min/inch of max cross section. Furnace cool to 600°F (315.6°C) or lower at 100 °F (55.6°C) /hr max. Cool in air (HRB 80 max). 	I
L2	Normalize: <ol style="list-style-type: none"> Heat parts to 1725°F (940.6°C). Hold at heat for 60 minutes per inch of maximum cross section. Cool in air. <p>NOTE: Unless otherwise agreed upon in writing by the procuring activity's Materials Laboratory, air cooling shall be performed outside the furnace coding chamber.</p>	I
L3	Harden: <ol style="list-style-type: none"> Heat parts to 1650°F (898.9°C). Hold at heat for 30 minutes per inch of maximum cross section. Quench in oil. 	I

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INSTRUCTION SHEET 1 (Continued)

Material Designation: UNS K23015

Code	Operation	Temp Tol
L4A	<p>Temper:</p> <ol style="list-style-type: none"> Heat parts to 1100-1150°F (593.3-621°C). 1/ Hold at heat 6 hours. Cool in air (HRC 36-39/equivalent HB 336-363). <p>1/ The exact tempering temperature within this range shall be selected to produce the specified hardness depending on part thickness.</p>	II
L4B	<p>Temper B:</p> <ol style="list-style-type: none"> Heat parts to 1075-1125°F (579-607°C). Hold at heat for 6 hours. Cool in air (HRC 38-41/HB 352-380). 	II
L4F	<p>Temper F (Use this procedure when blueprints show no letter after L4):</p> <ol style="list-style-type: none"> Heat to 1230°F (676.7°C). Hold at heat 6 hours to HRC 24-31 (equivalent HB 248-293). Cool in air. 	I
L4H	<p>Temper H:</p> <ol style="list-style-type: none"> Heat to 1200°F (648.9°C). Hold at heat 6 hours to HRC 31-35.5 (equivalent HB 293-331). 	II
L5	<p>Stress Relief (including welded assemblies when specified):</p> <ol style="list-style-type: none"> Heat 200°F/hr max (111.2°C/hr max) to: <ol style="list-style-type: none"> 1225°F (662.8°C) if previously unheat treated. 1200°F (648.9°C) if previously tempered to L4 or L4F. 1150°F (621.1°C) if previously tempered to L4H. Hold at heat 6 hours. Cool 200°F/hr max (111.2°C/hr max) to 400°F (204.4°C) and cool in still air. 	III

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INSTRUCTION SHEET 1 (Continued)

Material Designation: UNS K23015

Code	Operation	Temp Tol
L5A	Stress Relief A: 1. Heat parts to 1110°F (598.9°C) in an atmosphere furnace. 2. Hold at heat for 2 hours. 3. Cool in atmosphere.	III
L8	Special Treatment: 1. Heat parts to 1650°F (898.9°C). 2. Hold at heat for one hour. 3. Oil quench. 4. Heat to 975°F (523.9°C). 5. Hold at heat for 8 hours. 6. Cool in air (HRC 40-45/HB 371-420).	I

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INSTRUCTION SHEET 2

Material Designation: (Commercial/Industrial) C-422

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1600°F (871.1°C). 2. Hold at heat for six (6) hours. 3. Furnace cool 50°F/hr (27.8°C/hr) to 1100°F (593.3°C). Then air cool (HRC 24 max).	I
L3	Harden: 1. Heat parts to 1900°F (1037.8°C) and hold for 30 minutes per inch of maximum cross-section. 2. Quench in oil. 3. Temper (L4) immediately after quenching.	I
L4A	Temper A: 1. Heat parts to 1125°F (607.2°C). 2. Hold at heat for three (3) hours. 3. Cool in air (HRC 32-37).	I
L4B	Temper B: 1. Heat parts to 1200°F (648.9°C). 2. Hold at heat for two (2) hours. 3. Cool in air (HRC 31-35).	I
L4C	Temper C: 1. Heat parts to 1200°F (648.9°C). 2. Hold at heat for two (2) hours. 3. Cool in air. 4. Reheat part to 1200°F (648.9°C). 5. Hold at heat for two (2) hours. 6. Cool in air (HRC 31-35).	I
L5	Stress Relief: 1. Heat parts to 1100°F (593.3°C). 2. Hold at heat for (2) hours. 3. Cool in air.	III

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INSTRUCTION SHEET 3

Material Designation: UNS G10220

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1600°F (871.1°C). 2. Hold at heat for one hours. 3. Furnace cool (HRC 23 max).	I
L5	Stress Relief: 1. Heat parts to 1100°F (593.3°C). 2. Hold at heat 2 hours. 3. Cool in air.	I

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INSTRUCTION SHEET 4

Material Designation: UNS G10900

Code	Operation	Temp Tol
L5	<p data-bbox="365 525 592 556">Stress Relief:</p> <ol data-bbox="365 588 1079 682" style="list-style-type: none">1. Heat parts to 425-250°F (218.3-232.2°C).2. Hold at heat for 4 hours.3. Cool in air.	IV

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INSTRUCTION SHEET 5

Material Designation: UNS J91150, UNS J91152, and UNS S41000

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> 1. Heat parts to 1475°F (801.7°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool to 1350°F (732.2°C) and hold 2 hours. 4. Cool in air. 	I
L1A	Anneal A: <ol style="list-style-type: none"> 1. Heat parts to 1300°F (704.4°C). 2. Hold at heat for 2 hours. 3. Cool in furnace. 	I
L2	Normalize: <ol style="list-style-type: none"> 1. Heat parts to 1925°F (1051.7°C). 2. Hold at heat for 2 hours. 3. Cool in air. 	I
L3	Harden: <ol style="list-style-type: none"> 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool in air (oil quench sections greater than 1.0 inch). 	I
L4A	Temper A: <ol style="list-style-type: none"> 1. Heat parts to 1125 - 1200°F (607.2°C - 648/9°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 18-26). 	IV
L4B	Temper B: <ol style="list-style-type: none"> 1. Heat parts to 600°F (315.6°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 36-42). 	III
L5A	Stress Relief A: <ol style="list-style-type: none"> 1. Heat parts to 1110°F (598.9°C). 2. Hold at heat for 2 hours. 3. Cool in atmosphere. 	III

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INSTRUCTION SHEET 5 (Continued)

Material Designation: UNS J91150, UNS J91152, and UNS S41000

Code	Operation	Temp Tol
L5B	<p data-bbox="370 527 626 558">Stress Relief B:</p> <ol data-bbox="370 590 935 684" style="list-style-type: none"><li data-bbox="370 590 935 621">1. Heat parts to 1110°F (598.9°C).<li data-bbox="370 621 935 653">2. Hold at heat for 6 hours.<li data-bbox="370 653 935 684">3. Cool in atmosphere.	III

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INSTRUCTION SHEET 6

Material Designation: UNS G86300, UNS J13042, and UNS J13050

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> Heat parts to 1475°F (801.1°C). Hold at heat 60 minutes per inch of maximum cross-section. Rapid cool to 1150°F (621.1°C). Hold at heat four (4) hours. Then air cool (HRC 23 max). 	I
L2	Normalize: <ol style="list-style-type: none"> Heat parts to 1650°F (898.0°C). Hold at heat 60 minutes per inch of maximum cross-section. Cool in air (HRC 26 max). 	I
L3	Harden: <ol style="list-style-type: none"> Heat parts to 1575°F (857.2°C). Hold at heat 30 minutes per inch of maximum cross-section. <ol style="list-style-type: none"> For parts under 2" max cross-section and requiring a hardness of HRC 24 or less, quench in oil. For parts under 1" max cross-section and requiring a hardness of HRC 30 or less, quench in oil. For all parts other than described in steps a and b, quench in agitated water. Temper (L4) immediately. 	I
L4A	Temper A: <ol style="list-style-type: none"> For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. Hold for 4 hours to HRC 30-34. Cool in air. 	II
L4B	Temper B: <ol style="list-style-type: none"> For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. Hold for 4 hours to HRC 26-32. Cool in air. 	II

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INSTRUCTION SHEET 6 (Continued)

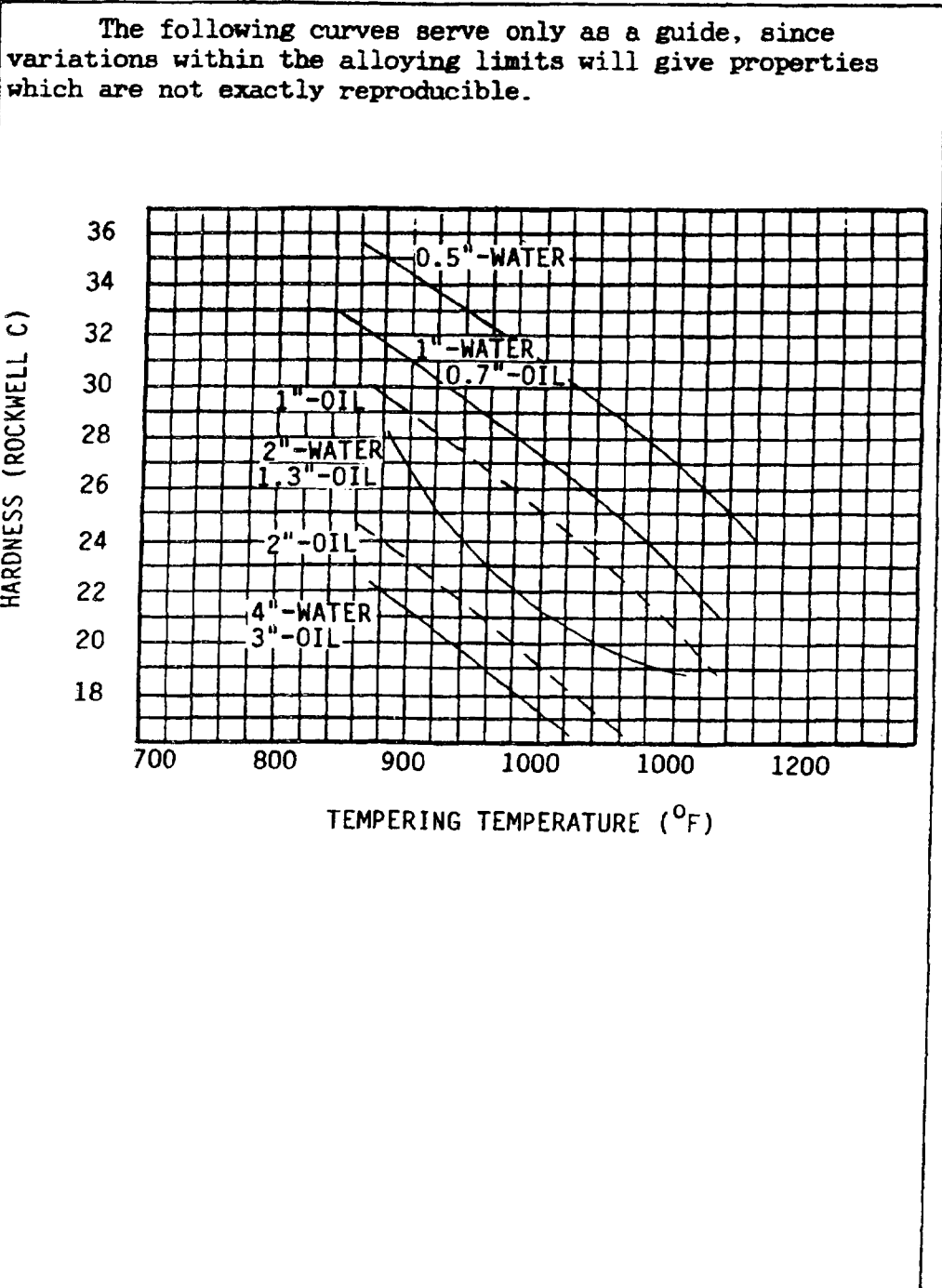
Material Designation: UNS G86300, UNS J13042, and UNS J13050

Code	Operation	Temp Tol
L4C	Temper C: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 25 max and below. 3. Cool in air.	II
L5	Stress Relief (After machining, welding, or forming, etc): 1. For hardened parts: a. Heat to 100°F (37.8°C) below tempering temperature. b. Hold at heat for 6 hours. c. Cool in still air. 2. For unhardened parts: a. Heat parts to 1125°F (607.2°C). b. Hold at heat for 2 hours. c. Cool in still air.	I

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INSTRUCTION SHEET 6 (Continued)

Material Designation: UNS G86300, UNS J13042, and UNS J13050

Code	Operation	Temp Tol
	<p>The following curves serve only as a guide, since variations within the alloying limits will give properties which are not exactly reproducible.</p> 	

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INSTRUCTION SHEET 7

Material Designation: UNS J92641, UNS J92811, UNS S34700, and UNS S34781

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1900°F (1037.8°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in water (HRB 90 max).	I
L5	Stress Relief (After forming, etc is completed): 1. Heat parts to 725°F (385°C). 2. Hold at heat 2 hours per inch of maximum cross-section. 3. Cool in air.	I
L6	Stabilization: 1. Heat parts to 1575°F (857.2°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool in air.	I

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INSTRUCTION SHEET 8

Material Designation: UNS J94211, UNS S31000, and UNS S31008

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 2000°F (1093.4°C). 2. Hold at heat 45 minutes per inch of maximum cross-section. 3. Quench in water (HRB 98 max).	I
L5	Stress Relief (After forming, etc is completed): 1. Heat parts to 625°F (329.4°C). 2. Length of time at temperature shall be determined by size of part and reason for stress relief. 3. Cool in air.	I

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INSTRUCTION SHEET 9

Material Designation: UNS S32100

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1900°F (1037.8°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool as rapidly as required (HRB 90 max).	I
L6	Stabilization: 1. Heat parts to 1525°F (829.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool in air.	I

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INSTRUCTION SHEET 10

Material Designation: UNS S66220 and UNS S66286

Code	Operation	Temp Tol
L5	Stress Relief: <ol style="list-style-type: none"> 1. Place parts in cool (500°F/260°C) furnace. 2. Heat to 600°F (316°C). 3. Hold at heat for 30 minutes. 4. Raise heat to 800°F (427°C). 5. Hold at heat for 30 minutes. 6. Raise heat to 1050°F (566°C). 7. Hold at heat 30 minutes. 8. Raise heat to 1300°F (704°C). 9. Hold at heat for 2 hours. 10. Cool to 500°F (260°C) at a rate not faster than 100°F (56°C) every 15 minutes. 	I
L7SX	Solution Treatment: <ol style="list-style-type: none"> 1. Heat parts to 1650°F (899°C). 2. Hold at heat for 3 to 5 hours. 3. Quench in oil. 4. Hardness HB 179 max. 	I
L7SY	Solution Treatment: <ol style="list-style-type: none"> 1. Heat parts to 1800°F (982°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section. 3. Quench in oil. 4. Hardness HB 165 max. 	I
L7T	Aging: <ol style="list-style-type: none"> 1. Heat parts to 1325°F (718°C). 2. Hold at heat for 16 hours. 3. Cool in air. 4. Hardness shall be as specified in L7SXT or L7SYT per the applicable solution heat treatment. 	II
L7P	Partial Aging: <ol style="list-style-type: none"> 1. Heat parts to 1200°F (649°C). 2. Hold at heat for 4 hours. 3. Cool in air. 4. Hardness HB 183-248. 	I

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INSTRUCTION SHEET 10 (Continued)

Material Designation: UNS S66220 and UNS S66286

Code	Operation	Temp Tol
L7SXT	Solution Treatment Plus Aging: 1. L7SX followed by L7T. 2. Hardness HB 277-363.	
L7SYT	Solution Treatment Plus Aging: 1. L7SY followed by L7T. 2. Hardness HB 248-341.	

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INSTRUCTION SHEET 11

Material Designation: UNS G87400

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1450°F (787.8°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Rapid cool to 1250°F (676.7°C). 4. Hold at heat for two (2) hours. Then air cool (HRC 23 max). 	I
L2	<p>Normalize:</p> <ol style="list-style-type: none"> 1. Heat parts to 1625°F (885°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in air (if hardness is above HRC 35, anneal per L1 if not to be immediately hardened). 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts to 1525°F (829.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in oil. 4. Temper (L4) immediately. 	I
L4A	<p>Temper A:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 37-42. 3. Cool in air. 	II
L4B	<p>Temper B:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 34-37. 3. Cool in air. 	II

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INSTRUCTION SHEET 11 (Continued)

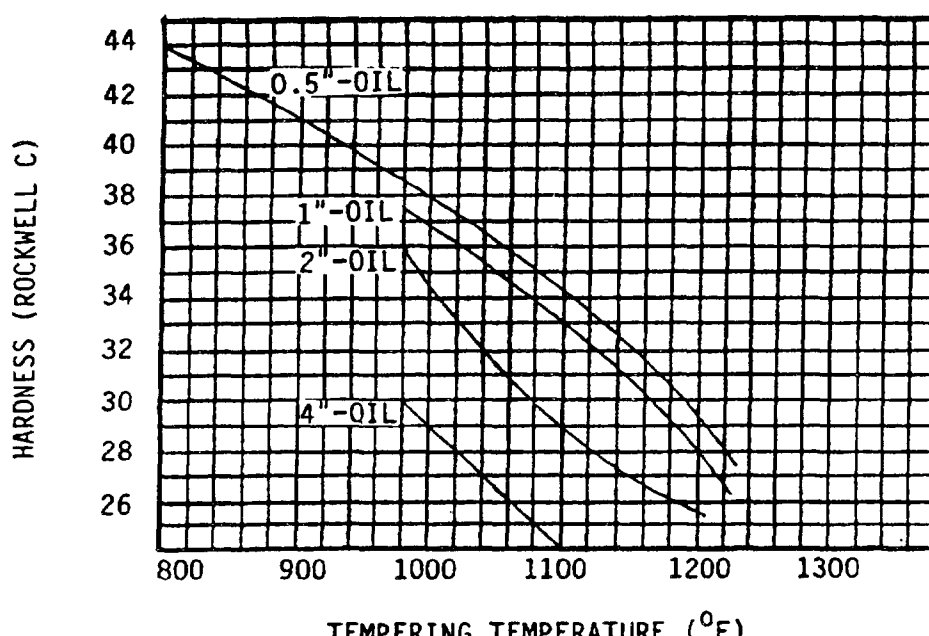
Material Designation: UNS G87400

Code	Operation	Temp Tol
L4C	Temper C: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 30-34. 3. Cool in air.	II
L4D	Temper D: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 26-32. 3. Cool in air.	II
L5	Stress Relief (After machining, welding, or forming, etc): 1. For hardened parts: a. Heat to 100°F (37.8°C) below tempering temperature. b. Hold at heat for 6 hours. c. Cool in still air. 2. For unhardened parts: a. Heat parts to 1125°F (607.2°C). b. Hold at heat for 2 hours. c. Cool in still air.	I

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INSTRUCTION SHEET 11 (Continued)

Material Designation: UNS G87400

Code	Operation	Temp Tol
	<p>The following curves serve only as a guide, since variations within the alloying limits will give properties which are not exactly reproducible.</p>  <p>0.5"-OIL</p> <p>1"-OIL</p> <p>2"-OIL</p> <p>4"-OIL</p> <p>HARDNESS (ROCKWELL C)</p> <p>TEMPERING TEMPERATURE (°F)</p>	

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INSTRUCTION SHEET 12

Material Designation: UNS G41300 and UNS J13046

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> Heat parts to 1500°F (815.5°C). Hold at heat 60 minutes per inch of maximum cross-section. Rapid cool to 1300°F (704.4°C). Hold at heat for 2 hours. Then air cool (HRC 23 max). 	I
L1A	Anneal A: <ol style="list-style-type: none"> Heat parts to 1300°F (704.4°C) in an atmosphere furnace. Hold at heat for 2 hours. Cool in atmosphere. 	I
L2	Normalize: <ol style="list-style-type: none"> Heat parts to 1650°F (898.9°C). Hold at heat 60 minutes per inch of maximum cross-section. Cool in air (HRC 26 max). 	I
L3	Harden: <ol style="list-style-type: none"> Heat parts to 1575°F (857.2°C). Hold at heat 30 minutes per inch of maximum cross-section. <ol style="list-style-type: none"> For parts under 2.0 inch max cross-section and requiring a hardness of HRC 25 or less, quench in oil. For parts under 1.0 inch max cross-section and requiring a hardness of HRC 30 or less, quench in oil. For all parts other than those described in 3.a and 3.b, quench in agitated water. However, parts 0.10 inch or less in thickness may be quenched in oil at the discretion of the heat treater, provided the hardness after tempering can be met. Temper (L4) immediately. 	I
L4A	Temper A: <ol style="list-style-type: none"> For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. Hold for 4 hours to HRC 34-37. Cool in air. 	II

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INSTRUCTION SHEET 12 (Continued)

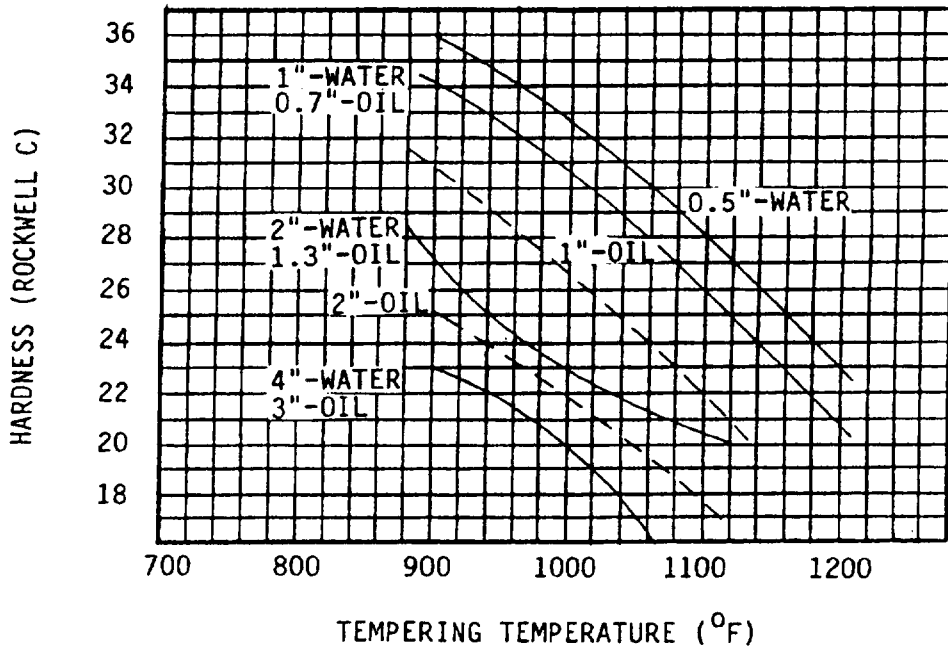
Material Designation: UNS G41300 and UNS J13046

Code	Operation	Temp Tol
L4B	Temper B: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 30-34. 3. Cool in air.	II
L4C	Temper C: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 26-32. 3. Cool in air.	II
L4D	Temper D: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 25 and below. 3. Cool in air.	II
L5	Stress Relief (After machining, welding, forming, etc): 1. For hardened parts: a. Heat to 100°F (37.8°C) below tempering temperature. b. Hold at heat for 6 hours. c. Cool in still air. 2. For unhardened parts: a. Heat parts to 1125°F (607.2°C). b. Hold at heat for 2 hours. c. Cool in still air.	I
L5A	Stress Relief A: 1. Heat parts to 1110°F (598.9°C) in an atmosphere furnace. 2. Hold at heat for 2 hours. 3. Cool in atmosphere.	I

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INSTRUCTION SHEET 12 (Continued)

Material Designation: UNS G41300 and UNS J13046

Code	Operation	Temp Tol
L8	<p>Normalize and Temper:</p> <ol style="list-style-type: none"> 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in air. 4. Heat parts to 1200°F (648.9°C). 5. Hold at heat for 2 hours minimum. 6. Cool in still air (HB 167-235). <p>The following curves serve only as guide, since variations within the alloying limits will give properties which are not exactly reproducible.</p> 	II

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INSTRUCTION SHEET 13

Material Designation: UNS G41400 and UNS J14046

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1450°F (787.8°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Rapid cool to 1275°F (690.6°C). 4. Hold at heat 2 hours. Then air cool (HRC 23 max). 	I
L2	<p>Normalize:</p> <ol style="list-style-type: none"> 1. Heat parts to 1625°F (885°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in still air (If hardness is above HRC 35, anneal per L1 if not to be immediately hardened). 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts to 1550°F (843.3°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in oil. 4. Temper (L4) immediately. 	I
L4A	<p>Temper A:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 37-42. 3. Cool in air. 	II
L4B	<p>Temper B:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 34-37. 3. Cool in air. 	II
L4C	<p>Temper C:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 30-34. 3. Cool in air. 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 13 (Continued)

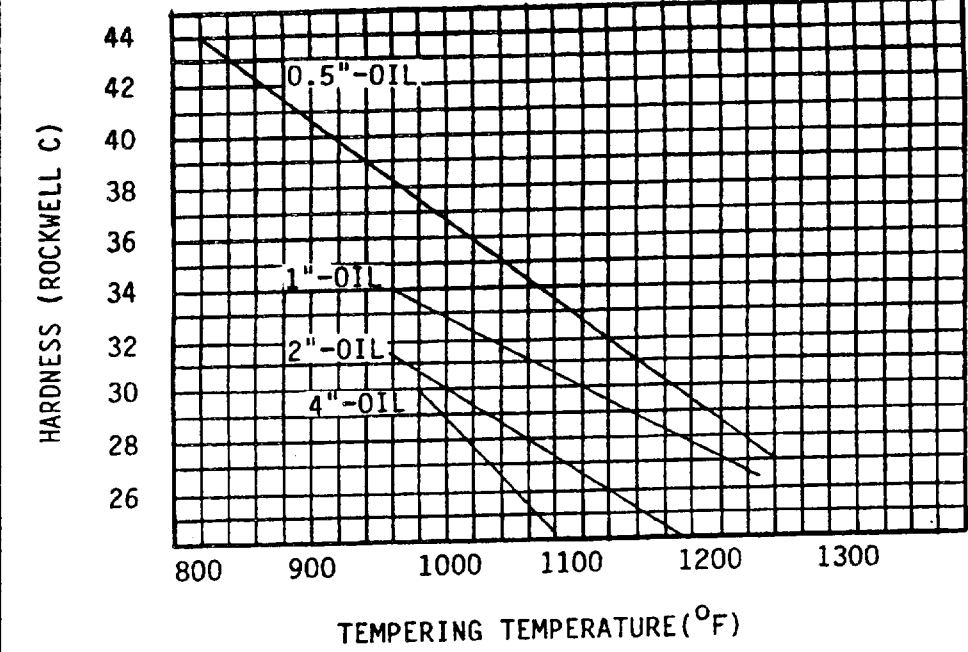
Material Designation: UNS G41400 and UNS J14048

Code	Operation	Temp Tol
L4D	Temper D: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 26-32. 3. Cool in air.	II
L5	Stress Relief (After machining, welding, or forming, etc): 1. For hardened parts: a. Heat to 100°F (37.8°C) below tempering temperature. b. Hold at heat for 6 hours. c. Cool in still air. 2. For unhardened parts: a. Heat parts to 1125°F (607.2°C). b. Hold at heat for 2 hours. c. Cool in still air.	I
L8	Normalize and Temper: 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in air. 4. Heat parts to 1200°F (648.9°C). 5. Hold at heat for 2 hours minimum. 6. Cool in still air (HB 167-235).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 13 (Continued)

Material Designation: UNS G41400 and UNS J14046

Code	Operation	Temp Tol
	<p>The following curves serve only as a guide, since variations within the alloying limits will give properties which are not exactly reproducible.</p> 	

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INSTRUCTION SHEET 14

Material Designation: UNS G43400

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1450°F (787.8°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Rapid cool to 1200°F (648.9°C). 4. Hold at heat 6 hours. Then air cool (HRC 24 max). 	I
L2	<p>Normalize:</p> <ol style="list-style-type: none"> 1. Heat parts to 1625°F (885°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in air (If hardness is above HRC 35, anneal per L1 if not to be immediately hardened). 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts to 1525°F (829.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in oil. 4. Temper (L4) immediately. 	I
L4A	<p>Temper A:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 37-42. 3. Cool in air. 	II
L4B	<p>Temper B:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 34-37. 3. Cool in air. 	II
L4C	<p>Temper C:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 30-34. 3. Cool in air. 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 14 (Continued)

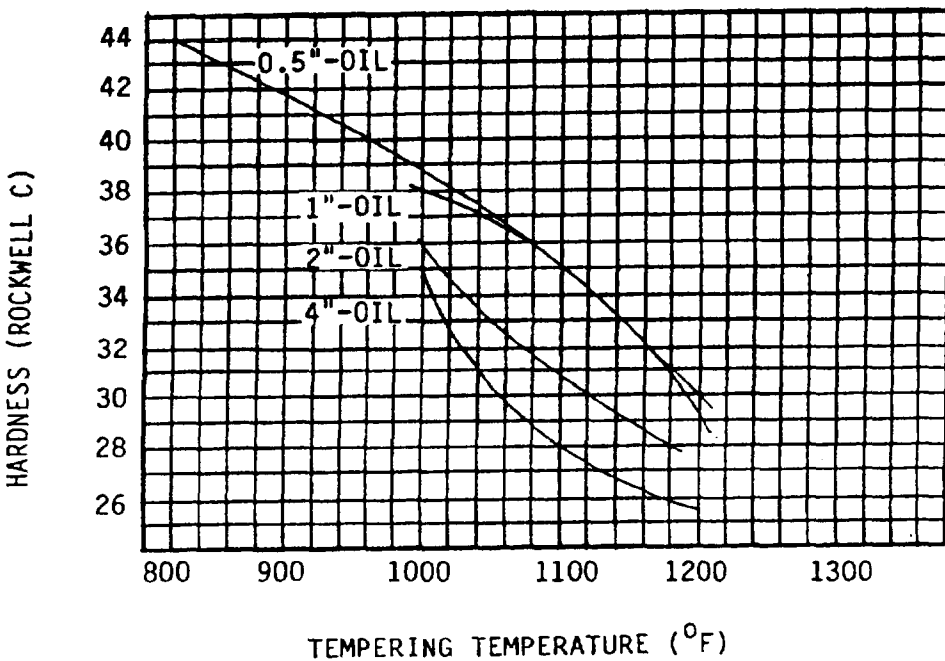
Material Designation: UNS G43400

Code	Operation	Temp Tol
L4D	Temper D: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 26-32. 3. Cool in air.	II
L4E	Temper E: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 4 hours to HRC 40-44. 3. Cool in air.	II
L5	Stress Relief (After machining, welding, or forming, etc): 1. For hardened parts: a. Heat to 100°F (37.8°C) below tempering temperature. b. Hold at heat for 6 hours. c. Cool in still air. 2. For unhardened parts: a. Heat parts to 1125°F (607.2°C). b. Hold at heat for 2 hours. c. Cool in still air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 14 (Continued)

Material Designation: UNS G43400

Code	Operation	Temp Tol																														
	<p>The following curves serve only as a guide, since variations within the alloying limits will give properties which are not exactly reproducible.</p> <div><table><caption>Approximate Hardness (Rockwell C) vs. Tempering Temperature (°F) for UNS G43400</caption><thead><tr><th>Tempering Temperature (°F)</th><th>0.5" OIL</th><th>1" OIL</th><th>2" OIL</th><th>4" OIL</th></tr></thead><tbody><tr><td>800</td><td>44</td><td></td><td></td><td></td></tr><tr><td>900</td><td>42</td><td></td><td></td><td></td></tr><tr><td>1000</td><td>40</td><td>38</td><td>36</td><td>34</td></tr><tr><td>1100</td><td>36</td><td>34</td><td>32</td><td>28</td></tr><tr><td>1200</td><td>32</td><td>30</td><td>28</td><td>26</td></tr></tbody></table></div>	Tempering Temperature (°F)	0.5" OIL	1" OIL	2" OIL	4" OIL	800	44				900	42				1000	40	38	36	34	1100	36	34	32	28	1200	32	30	28	26	
Tempering Temperature (°F)	0.5" OIL	1" OIL	2" OIL	4" OIL																												
800	44																															
900	42																															
1000	40	38	36	34																												
1100	36	34	32	28																												
1200	32	30	28	26																												

MIL-STD-40002(AT)

INSTRUCTION SHEET 15

Material Designation: UNS G61500

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1500°F (815.6°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Rapid cool to 1200°F (648.9°C). 4. Hold at heat for 1 hour. Then air cool (HRC 24 max).	I
L2	Normalize: 1. Heat parts to 1650°F (898.9°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in air. 4. If not immediately hardened (L3), anneal (L1).	I
L3	Harden: 1. Heat parts to 1575°F (857.2°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in oil. 4. Temper (L4) immediately.	I
L4A	Temper A: 1. Heat parts to 550-650°F (287.8-343.3°C). 2. Hold at heat 2 hours per inch of maximum cross-section. 3. Cool in air (HRC 48-53).	IV
L4B	Temper B: 1. Heat parts to 750-850°F (398.9-454.4°C). 2. Hold at heat 2 hours per inch of maximum cross-section. 3. Cool in air (HRC 42-47).	IV
L4C	Temper C: 1. Heat parts to 950-1050°F (510-565.6°C). 2. Hold at heat 2 hours per inch of maximum cross-section. 3. Cool in air (HRC 36-41).	IV

MIL-STD-40002(AT)

INSTRUCTION SHEET 15 (Continued)

Material Designation: UNS G81500

Code	Operation	Temp Tol
L5	<p data-bbox="384 519 607 549">Stress Relief:</p> <ol data-bbox="384 583 1215 710" style="list-style-type: none"><li data-bbox="384 583 1058 612">1. Heat parts to 475-500°F (246.1-260°C).<li data-bbox="384 614 1215 676">2. Hold at heat for 60 minutes per inch of maximum cross-section.<li data-bbox="384 678 637 708">3. Cool in air.	IV

MIL-STD-40002(AT)

INSTRUCTION SHEET 16

Material Designation: UNS G10100

Code	Operation	Temp Tol
L1	<p data-bbox="370 506 485 538">Anneal:</p> <ol data-bbox="370 570 852 666" style="list-style-type: none"><li data-bbox="370 570 835 602">1. Heat to 1200°F (648.9°C).<li data-bbox="370 602 852 634">2. Hold at heat one (1) hour.<li data-bbox="370 634 624 666">3. Cool in air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 17

Material Designation: UNS S30200, UNS S30400, and UNS S30403

Code	Operation	Temp Tol
L1	Anneal: 1. Heat to 1925°F (1051.7°C). 2. Hold at heat 30 minutes. 3. Water quench.	I
L5	Stress Relief: 1. Heat to 600°F (315.6°C). 2. Hold at heat for 2 hours per inch of maximum cross-section. 3. Cool in air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 18

Material Designation: UNS J91639 and UNS S44004

Code	Operation	Temp Tol
L1	Anneal: 1. Heat to 130°F (704.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool in air.	I
L3	Harden: 1. Heat to 1900°F (1037.8°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in oil. Parts 0.5 inch (12.7 mm) or less in cross-section may be cooled in air provided properties can be met. 4. Temper (L4) immediately.	III
L4A	Temper A: 1. Heat parts to 600°F (315.6°C). 2. Hold at heat for two (2) hours. 3. Cool in air (HRC 54-60).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 19

Material Designation: UNS G93106

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> Heat parts to 1275°F (690.6°C). Hold at heat 30 minutes per inch of maximum cross-section. Cool in air (HRC 24 max). 	I
L2	Normalize: <ol style="list-style-type: none"> Heat parts to 1750°F (954.4°C). Hold at heat 60 minutes per inch of maximum cross-section (one hour minimum). Cool in air. 	I
L2A	Normalize A: <ol style="list-style-type: none"> Heat parts to 1750°F (954.4°C). Hold at heat 60 minutes per inch of maximum cross-section (one hour minimum). Quench in oil. 	I
L3	Harden: <ol style="list-style-type: none"> Heat parts to 1475-1500°F (801.7-815.6°C). Hold at heat 30 minutes per inch of maximum cross-section. Quench in oil. 	IV
L4A	Temper A: <ol style="list-style-type: none"> Heat parts to 900-1100°F (482-629°C). Hold at heat two (2) hours. Cool in air (HRC 24-32). 	IV
L4B	Temper B: <ol style="list-style-type: none"> Heat parts to 275-300°F (135-148.9°C). 1/ Hold at heat two (2) hours. Cool in air. Case Hardness per engineering drawing. <p>1/ Parts may be heated as high as 325°F (162.8°C) provided the case hardness specified on the engineering drawing is maintained on the finish machined part.</p>	IV

MIL-STD-40002(AT)

INSTRUCTION SHEET 19 (Continued)

Material Designation: UNS G93106

Code	Operation	Temp Tol
L4C	<p data-bbox="365 510 511 541">Temper C:</p> <ol data-bbox="365 573 933 678" style="list-style-type: none"><li data-bbox="365 573 885 604">1. Heat parts to 550°F (288°C).<li data-bbox="365 604 933 636">2. Hold at heat for two (2) hours.<li data-bbox="365 636 820 667">3. Cool in air (HRC 30-38).	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 20

Material Designation: UNS K24065

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1275°F (690.6°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool in air (HRC 24 max). 	I
L2	<p>Normalize:</p> <ol style="list-style-type: none"> 1. Heat parts to 1800°F (982.2°C). 2. Hold at heat 60 minutes per inch of maximum cross-section (one hour minimum). 3. Cool in air. 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts to 1700°F (926.7°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench parts 1 inch or less of maximum cross-section in agitated oil. Quench parts greater than 1 inch of maximum cross-section in agitated water. 	I
L4A	<p>Temper A:</p> <ol style="list-style-type: none"> 1. Heat parts to 1100°F (593.3°C). 2. Hold at heat four hours. 3. Cool in air (HRC 34-40). 	II
L5	<p>Stress Relief:</p> <ol style="list-style-type: none"> 1. Heat parts to 1050°F (565.6°C). 2. Hold at heat four hours. 3. Cool in air (HRC 34-40). 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 21

Material Designation: UNS N07750

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 2100°F (1149°C) in an inert or neutral atmosphere. 2. Hold at heat for 2 hours. 3. Cool in air (HB 197 max, or equivalent).	I
L7T	Aging: (Use L7XT Aging Treatment)	
L7VT	Aging (AMS 5598 only): 1. Heat parts to 1325-1350°F (718-732°C). 2. Hold at heat for 8 hours. 3. Furnace cool to 1150°F (621°C). 4. Hold at 1150°F (621°C) for a total aging time of 18 hours. 5. Air cool (HB 285 min, or equivalent).	
L7WT	Aging: 1. Heat parts to 1200°F (649°C). 2. Hold at heat for 4 hours. 3. Cool in air (HB 371 min, or equivalent).	I
L7XT	Aging: 1. Heat parts to 1550°F (843.3°C). 2. Hold at heat for 24 hours. 3. Cool in furnace to 1300°F (704.4°C). 4. Hold parts at 1300°F (704.4°C). 5. Hold at heat for 20 hours. 6. Cool in air (HB 262-341, or equivalent).	I
L7YT	Aging: 1. Heat parts to 1500°F (815.6°C). 2. Hold at heat for 24 hours. 3. Cool in air (HB 200-277, or equivalent).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 21 (Continued)

Material Designation: UNS N07750

Code	Operation	Temp Tol
L7ZT	Aging: 1. Heat parts to 1350°F (732.2°C). 2. Hold at heat for 16 hours. 3. Cool in air (HB 326-443, or equivalent).	I
L7ST	Solution Treatment Plus Aging: (Use L7SXT Solution Treatment Plus Aging).	
L7SXT	Solution Treatment Plus Aging: 1. L7S followed by L7XT (HB 262-341, or equivalent).	
L7SYT	Solution Treatment Plus Aging: 1. L7S followed by L7YT (HB 200-277, or equivalent).	
L7SZT	Solution Treatment Plus Aging: 1. L7S followed by L7ZT (HB 326-443, or equivalent).	
L7SWT	Solution Treatment Plus Aging: 1. L7S followed by L7WT (HB 371 min, or equivalent).	

MIL-STD-40002(AT)

INSTRUCTION SHEET 22

Material Designation: UNS R56400

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1300°F (704.4°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 39 max).	I
L5	Stress Relief: 1. Heat parts to 1000°F (537.8°C) in vacuum or inert atmosphere. 2. Hold at heat for 2 hours. 3. Cool in air.	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 23

Material Designation: UNS A96061

Code	Operation	Temp Tol
L1	Anneal: (HB 40 max. or equiv.)	
L7S	Solution Treatment: (HB 55-83 or equiv.)	
L7T	Aging: (HB 83 min, or equiv.)	
L7ST	Solution Treatment Plus Aging: (HB 83 min., or equiv.) FOR THE REQUIRED TEMPERATURES AND TIMES SEE AMS 2770	

MIL-STD-40002(AT)

INSTRUCTION SHEET 24

Material Designation: UNS G10200

Code	Operation	Temp Tol
L2	Normalize: 1. Heat parts to 1700°F (926.7°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section. 3. Cool in air.	I
L5	Stress Relief: 1. Heat parts 200°F (111.2°C)/hr max to 1200°F (648°C). 2. Hold at heat 3 hours. 3. Cool 200°F (111.2°C)/hr max to 400°F (204.4°C). Then cool in still air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 25

Material Designation: UNS S42000, UNS S42020, and UNS S42023

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1425°F (773.9°C). 2. Hold at least one (1) hour per inch of <u>maximum</u> cross-section. 3. Furnace cool (HB 230 max).	
L3	Harden: 1. Preheat parts to 1425°F (773.9°C). 2. Hold at least one (1) hour per inch of <u>maximum</u> cross-section. 3. Heat parts to 1850°F (1010°C). 4. Hold at least one (1) hour per inch of <u>maximum</u> cross-section. 5. Quench in oil or air cool. 6. Temper (L4) immediately.	I
L4	Temper: 1. Heat parts to 450°F (232.2°C). 2. Hold at least for two (2) hours. 3. Cool in air (HRC 47-52).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 26

Material Designation: UNS N09979

Code	Operation	Temp Tol
L7S	Solution Treatment: 1/ 1. Heat parts to 1875°F (1025°C). 2. Hold at heat for four (4) hours. 3. Within 10 seconds of removal from furnace, rapid quench in agitated water maintained at 80°F (25°C) maximum prior to quenching parts.	III
L7T	Aging: 1/ 1. Heat parts to 1550°F (843.3°C). 2. Hold at heat 6 hours. 3. Cool in air. 4. Heat parts to 1300°F (704.4°C). 5. Hold at heat 16 hours. 6. Cool in air.	II
L7ST	Solution Treatment Plus Aging: 1. L7S followed by L7T (HB 340-418).	
L8	Solution Anneal: 2/ 1. Heat parts to 1800°F (982°C). 2. Hold at heat for four (4) hours. 3. Rapid quench in agitated water maintained at 120°F (48.9°C) maximum. 4. Hardness HB 262 maximum. 1/ Furnaces used for solution treatment and aging are to be surveyed in accordance with MIL-H-6875 at intervals not to exceed three months. 2/ The solution anneal is specifically for stress relief after inertia welding.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 27

Material Designation: (Commercial/Industrial) Hastelloy R235

Code	Operation	Temp Tol
L7S	<p data-bbox="370 533 675 567">Solution Treatment:</p> <ol data-bbox="370 596 1198 722" style="list-style-type: none"><li data-bbox="370 596 948 630">1. Heat parts to 2200°F (1204.4°C).<li data-bbox="370 630 1198 688">2. Hold at heat for 30 minutes per inch of maximum cross-section.<li data-bbox="370 688 834 722">3. Cool in air (HRC 23 max).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 28

Material Designation: UNS S35000

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1925°F (1051.7°C). 2. Hold at heat for time indicated below. Material Thickness Inch 0.090 and under over 0.090 to 0.250 Time 10 minutes 30 minutes 3. Cool rapidly in air (HRC 24 max).	I
L3	Harden: 1. Heat parts to 1710°F (932.2°C). 2. Hold at heat for one hour per inch of cross-section. 3. Sheet or composite assemblies: Cool in air to room temperature. 4. Subzero cool to at least minus 100°F (-73.3°C). 5. Hold at temperature for three hours. 6. Warm in air to room temperature.	I
L4B	Temper B (see note): 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat for three hours. 3. Cool in air (HRC 37-44).	III
L4C	Temper C: 1. Heat parts to 1075°F (579.4°C). 2. Hold at heat for three hours. 3. Cool in air (HRC 30-40). Stress Relief:	III
L5	1. Heat parts to 960°F (515.6°C). 2. Hold at heat for two hours. 3. Air cool. NOTE: This temper is mandatory for compressor blades only. Other parts may be tempered as follows: 1. Heat parts to 1015°F (546.1°C). 2. Hold at heat for three hours. 3. Cool in air (HRC 37-44).	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 28 (Continued)

Material Designation: UNS S35000

Code	Operation	Temp Tol
L8A	Equalize A: 1. Heat parts to 1425°F (773.9°C). 2. Hold at heat for three hours. 3. Cool in air to below 70°F (21.1°C). 4. When part is below 150°F (65.6°C), tap water may be used to attain temperature below 70°F (21.1°C).	I
L8B	Equalize B: 1. Heat parts to 1425°F (773.9°C). 2. Hold at heat for three hours. 3. Cool in air to room temperature. 4. Subzero cool to at least minus 100°F (-73.3°C). 5. Hold at temperature for three hours. 6. Warm in air to room temperature.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 29

Material Designation: UNS N07702

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1925°F (1051.7°C). 2. Hold at heat for 15 minutes. 3. Cool in air (HB 229 max, or equivalent).	I
L7	Aging: 1. Heat parts to 1400°F (760°C). 2. Hold at heat for 5 hours. 3. Cool in air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 30

Material Designation: (Commercial/Industrial) Super Nitralloy, 5Ni-2Al

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> 1. Heat parts to 1525°F (829.4°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Cool to 1225°F (662.8°C) and hold at heat 8 hours. 4. Furnace cool to 1150°F (621.1°C) and then air cool. 5. Hardness: HB 217 max, or equivalent. 	I III III
L2	Normalize: <ol style="list-style-type: none"> 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Cool in air. 4. Hardness: HRC 36-39, or equivalent. 	
L3	Harden: <ol style="list-style-type: none"> 1. Heat parts to 1700°F (926.7°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Oil quench. 	III
L7S	Solution Treatment: <ol style="list-style-type: none"> 1. Heat parts to 1275°F (690.6°C). 2. Hold at heat 4 hours. 3. Cool in air (oil quench sections greater than 2 inches). 4. Hardness: HRC 28-35, or equivalent. 	III
L7T	Aging: <ol style="list-style-type: none"> 1. Nitride in accordance with MIL-STD-1876. 2. Core hardness HRC 40-44. 	
L7XT	Aging (Mock Nitriding): <ol style="list-style-type: none"> 1. Heat to 1050°F (565.6°C). 2. Hold at temperature 8 hours. 3. Air cool. 4. Hardness: HRC 40-44. 	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 31

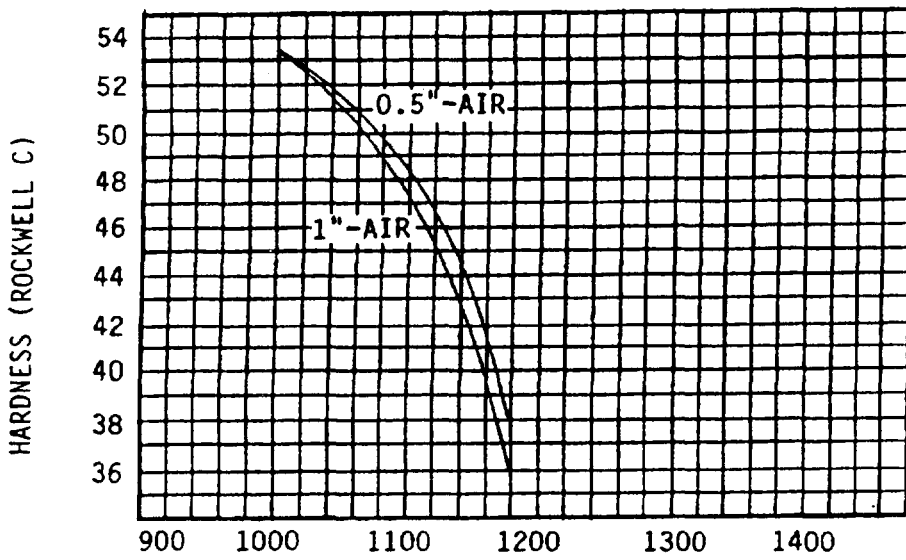
Material Designation: UNS T20811

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1525°F (829.4°C). 2. Hold at heat 2 hours. 3. Cool slowly in furnace 50°F/hr (27.8°C/hr) to 1000°F (537.8°C). 4. Remove from furnace and air cool (HB 202 max, or equivalent). 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Preheat uniformly to 1450°F (787.8°C). 2. Transfer to a furnace maintained at 1850°F (1010°C). 3. Hold at heat 30 minutes per inch of cross-section. 4. Cool in air. 	I
L4A	<p>Temper A:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 1/ 2. Hold at heat for 2 hours. 3. Cool in air. 4. Reheat in tempering temperature (2nd tempering temperature may be adjusted to achieve required hardness). 5. Hold at heat for 2 hours. 6. Cool in air (HRC 52-55). 	II
L4B	<p>Temper B:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 1/ 2. Hold at heat for 2 hours. 3. Cool in air. 4. Reheat to tempering temperature (2nd tempering temperature may be adjusted to achieve required hardness). 5. Hold at heat for 2 hours. 6. Cool in air (HRC 47-52). 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 31 (Continued)

Material Designation: UNS T20811

Code	Operation	Temp Tol
L4C	<p>Temper C:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 1/ 2. Hold at heat for 2 hours. 3. Cool in air. 4. Reheat to tempering temperature (2nd tempering temperature may be adjusted to achieve required hardness). 5. Hold at heat for 2 hours. 6. Cool in air (HRC 42-47). 	II
L4D	<p>Temper D:</p> <ol style="list-style-type: none"> 1. Heat to 1200°F (648.9°C). 2. Hold at heat for 6 hours. 3. Cool in air (HRC 30-36). <p>1/ Do not temper below 1000°F (538°C).</p> <p>The following curves serve only as a guide, since variations within the alloying limits will give properties which are not exactly reproducible.</p> 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 32

Material Designation: UNS T12005

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1650°F (898.9°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Cool in furnace to 1450°F (787.8°C). 4. Hold at temperature 4 to 6 hours. 5. Remove from furnace and air cool. 6. Hardness HB 277 maximum, or equivalent.	I
L3	Harden: 1. Heat parts uniformly in a furnace or neutral salt bath to 1525°F (829.4°C) and hold at heat 15 minutes. 2. Transfer to a neutral salt bath maintained at 2320°F (1271.3°C) and equalize. Hold at temperature 1 1/2 to 2 minutes. 3. Transfer to a natural salt bath maintained at 1075°F (579.4°C) and hold 3 to 4 minutes. 4. Cool in still air to at least 120°F (48.9°C). 5. Temper (L4) immediately.	I I III II
L4	Temper: 1. Heat parts to 1030°F (554.4°C). 2. Hold parts at heat 2 hours. 3. Cool in air. 4. Reheat parts to 1030°F (554.4°C). 5. Hold at heat 2 hours. 6. Cool in air (HRC 64-66). Tempering operations may be performed in an air furnace or a salt bath. All traces of salt must be removed after hardening if tempering is to be performed in air.	III

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INSTRUCTION SHEET 33

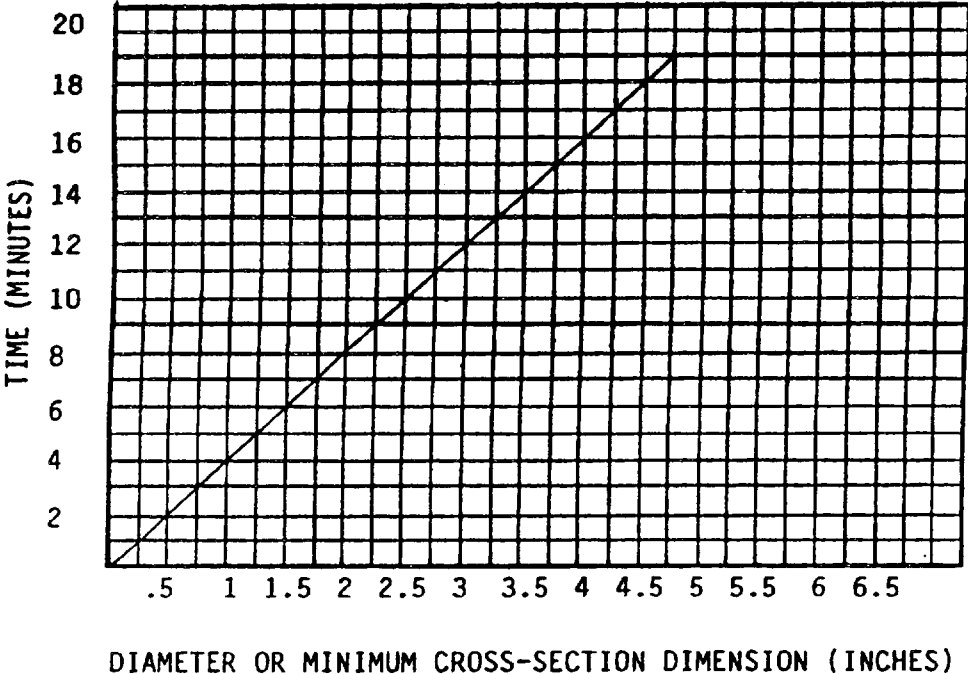
Material Designation: (Commercial/Industrial) Ferrovac Halmo

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1575°F (857.2°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Cool slowly 50°F/hr (27.8°C/hr) in furnace. 4. Hardness HB 241 maximum, or equivalent. 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts uniformly in a furnace or neutral salt bath to 1450°F (787.8°C) and hold at heat 15 minutes. 2. Transfer to a neutral salt bath maintained at 2090°F (1125.6°C) and equalize. For time at temperature refer to Time vs Cross-Section Chart for this material. 3. Transfer to a natural salt bath maintained at 1029°F (551.7°C). Hold at temperature 3 to 4 minutes. 4. Cool in still air to at least 120°F (48.9°C). 5. Temper (L4) immediately. 	I
L4	<p>Temper:</p> <ol style="list-style-type: none"> 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat 2 hours. 3. Cool in air. 4. Reheat parts to 975°F (523.9°C). 5. Hold at heat 2 hours. 6. Cool in air (HRC 63-65). <p>Tempering operations may be performed in an air furnace or a salt bath. All traces of salt must be removed after hardening if tempering is to be performed in air.</p>	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 33 (Continued)

Material Designation: (Commercial/Industrial) Ferrovac Halmo

Code	Operation	Temp Tol
	 <p data-bbox="459 1276 1304 1304">DIAMETER OR MINIMUM CROSS-SECTION DIMENSION (INCHES)</p> <p data-bbox="557 1339 1125 1367">CHART FOR TIME VERSUS CROSS-SECTION</p>	

MIL-STD-40002(AT)

INSTRUCTION SHEET 34

Material Designation: UNS R30155

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 2150°F (1176.8°C). 2. Hold at heat for 30 minutes per inch of maximum cross-section. 3. Cool in air or water quench. 4. Hardness: Sheet stock HB 157-235. Bars, forgings HB 157-217.	I
L7T	Aging: 1. Heat parts to 1500°F (815.6°C). 2. Hold at heat for 4 hours. 3. Cool in air (HB 192-241).	I
L7ST	Solution Treatment Plus Aging: 1. L7S followed by L7T (HB 192-241).	

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INSTRUCTION SHEET 35

Material Designation: UNS K52355

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> 1. Heat to 1525°F (829.4°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Cool to 1225°F (662.8°C) and hold at heat 8 hours. 4. Furnace cool to 1150°F (621.1°C) and then air cool to room temperature. 5. Hardness HB 217 max, or equivalent. 	I III III
L2	Normalize: <ol style="list-style-type: none"> 1. Heat to 1750°F (954.4°C). 2. Hold at temperature 1 hour per inch of cross-section. 3. Cool in air (HRC 34-38, or equivalent). 	III
L3	Harden: <ol style="list-style-type: none"> 1. Heat to 1650°F (898.9°C). 2. Hold at heat 1 hour per inch of cross-section. 3. Oil quench. 	III
L4	Temper: <ol style="list-style-type: none"> 1. Heat to 1225°F (662.8°C). 2. Hold at heat 4 hours. 3. Cool in air (HRC 28-32, or equivalent). 	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 36

Material Designation: UNS S41623

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> 1. Heat parts to 1575°F (857.2°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool to 1350°F (732.2°C), and hold 2 hours. 4. Cool in air. 	I
L1A	Anneal A: <ol style="list-style-type: none"> 1. Heat parts to 1300°F (704.4°C). 2. Hold at heat for 2 hours. 3. Cool in furnace. 	I
L3	Harden: <ol style="list-style-type: none"> 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool in air (oil quench sections greater than 1.0 inch). 	I
L4A	Temper A: <ol style="list-style-type: none"> 1. Heat parts to 1125°F (607.2°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 18-26). 	I
L4B	Temper B: <ol style="list-style-type: none"> 1. Heat parts to 600°F (315.6°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 36-42). 	I
L4C	Temper C: <ol style="list-style-type: none"> 1. Heat parts to 1025°F (551.7°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 26-34). 	I
L5	Stress Relief: <ol style="list-style-type: none"> 1. Heat parts to 1110°F (598.9°C). 2. Hold at heat for 2 hours. 3. Cool in atmosphere. 	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 37

Material Designation: UNS N04019

Code	Operation	Temp Tol
L1	Anneal: 1. Load parts in furnace not above 600°F (316.6°C). 2. Heat parts to 1650°F (898.9°C). 3. Hold at heat for one hour per inch of maximum cross-section (one hour minimum). 4. Furnace cool to 1200°F (648.9°C) at 200°F/hr (111.2°C/hr). 5. Quench in oil. 6. Hardness: HB 270 maximum 3000 kg load and 10 mm ball.	II
L7S	Solution Treatment: 1. Load parts in furnace not above 600°F (316.6°C). 2. Heat parts to 1650°F (898.9°C). 3. Hold at heat for one hour per inch of maximum cross-section (one hour minimum). 4. Furnace cool to 1200°F (648.9°C) at 200°F/hr (111.2°C/hr). 5. Quench in oil. 6. Hardness: HB 270 maximum 3000 kg load and 10 mm ball.	II
L7T	Aging: 1. Load parts in furnace not above 600°F (316.6°C). 2. Heat parts to 1100°F (583.3°C) and hold for five (5) hours. 3. Cool in air. 4. Hardness: HB 300 minimum , 3000 kg load and 10 mm ball.	II
L7ST	Solution Treatment Plus Aging: 1. L7S followed by L7T. 2. Hardness: HB 300 minimum , 3000 kg load and 10 mm ball. CAUTION: Do not heat in presence of sulfurous material. Do not heat in atmosphere which contain sulfur. Do not quench in oils which contain sulfur.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 38

Material Designation: UNS F43003

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> Heat parts to 1750°F (954.4°C). Hold at least 60 minutes per inch of maximum cross-section. Cool uniformly in still air. Hardness: HB 180 max, 3000 kg load and a 10 mm ball. 	II
L1A	Anneal A: <ol style="list-style-type: none"> Heat parts to 1850°F (1010°C). Hold at least 60 minutes per inch of maximum cross-section. Cool uniformly in still air. Hardness: HB 180 max, 3000 kg load and a 10 mm ball. 	II
L5	Stress Relief (After casting, machining, etc): <ol style="list-style-type: none"> Heat parts to 1175°F (635°C). Hold for 60 minutes per inch of maximum cross-section. Furnace cool to 600°F (315.6°C) or lower at 350°F (194.6°C) per hour maximum. Cool uniformly in still air. Hardness: HB 118-180, 3000 kg load and a 10 mm ball. 	II
L6	Stabilization (for dimensional stability at temperature over (900°F/482.2°C). <ol style="list-style-type: none"> Heat parts to 1600°F (871.1°C). Hold for 1 hour per inch of maximum cross-section but not less than 2 hours. Furnace cool to 1000°F (537.8°C) or lower at 350°F (194.6°C) per hour maximum. Cool uniformly in still air. Hardness: HB 180 max, 3000 kg load and a 10 mm ball. 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 39

Material Designation: UNS J92170, UNS J92200, and UNS S17400

Code	Operation	Temp Tol
L2	Normalize: 1. Heat parts to 2100°F (1149°C). 2. Hold at heat 90 minutes. 3. Air cool to below 90°F (32.2°C).	I
L7SX	Solution Treatment: 1. Hold part to 1900°F (1038°C). 2. Hold at heat 30 minutes per 1/2 inch of maximum cross-section. 3. Cool as required to below 90°F (32.2°C). 4. Hardness: HRC 36 max, or equivalent.	I
L7SY	Solution Treatment: 1. Heat parts to 1925°F (1052°C). 2. Hold at heat 30 minutes per 1/2 inch of maximum cross-section. 3. Cool as required to below 90°F (32.2°C). 4. Hardness: HRC 36 max, or equivalent.	I
L7SZ	Solution Treatment (Double Cycle): 1. Heat parts to 1925°F (1052°C). 2. Hold at heat 30 minutes per 1/2 inch of maximum cross-section. 3. Rapid air cool or oil quench to below 90°F (32.2°C). 4. Immediately repeat - steps 1, 2, and 3. 5. Hardness: HRC 36 max, or equivalent.	I
L7TA	Aging: 1. Heat parts to 925°F (496.1°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 40-48, or equivalent.	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 39 (Continued)

Material Designation: UNS J92170, UNS J92200, and UNS S17400

Code	Operation	Temp Tol
L7TB	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 34-42, or equivalent. 	III
L7TC	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1100°F (593.3°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 32-38, or equivalent. 	III
L7TD	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1150°F (621.1°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 29-35, or equivalent. 	III
L5	<p>Stress Relieve:</p> <ol style="list-style-type: none"> 1. Heat parts to 50°F (27.8°C) below the aging temperature. 2. Hold at heat for 90 minutes. 3. Air cool. 	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 40

Material Designation: UNS N07041

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1975°F (1079.4°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section (30 minutes minimum). 3. Water quench. 4. Hardness: HB 285 max, or equivalent. 	I
L7SX	<p>Solution Treatment:</p> <ol style="list-style-type: none"> 1. Heat parts to 1975°F (1079.4°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section (30 minutes minimum). 3. Water quench. 4. Hardness: HB 363 max, or equivalent for bars and forgings. HB 285 max, or equivalent for sheet. 	I
L7SY	<p>Solution Treatment:</p> <ol style="list-style-type: none"> 1. Heat parts to 2150°F (1176.8°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section (30 minutes minimum). 3. Water quench. 4. Hardness: HB 363 max, or equivalent for bars and forgings. HB 285 max, or equivalent for sheet. 	I
L7TA	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1400°F (760°C). 2. Hold at heat for 16 hours. 3. Air cool. 	II
L7TB	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1650°F (898.9°C). 2. Hold at heat for 4 hours. 3. Air cool. 	II
L7SXTA	<p>Solution Treatment Plug Aging:</p> <ol style="list-style-type: none"> 1. L7SX followed by L7TA. 2. Hardness: HB 313 min, or equivalent. 	

MIL-STD-40002(AT)

INSTRUCTION SHEET 40 (Continued)

Material Designation: UNS N07041

Code	Operation	Temp Tol
L7SYTB	<p data-bbox="375 520 862 552">Solution Treatment Plug Aging:</p> <ol data-bbox="375 583 1036 646" style="list-style-type: none"><li data-bbox="375 583 792 615">1. L7SY followed by L7TB.<li data-bbox="375 615 1036 646">2. Hardness: HB 313 min, or equivalent.	

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INSTRUCTION SHEET 41

Material Designation: UNS G52986

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1440°F (782.2°C). 2. Hold at heat 2 hours per inch of cross-section. 3. Cool slowly 15°F/hr (8.3°C/hr) to 1200°F (648.9°C). 4. Hold 6 hours. 5. Cool in air, (HB 241 max, or equivalent).	I III
L2	Normalize: 1. Heat parts to 1650°F (898.9°C). 2. Hold at heat 30 minutes per inch of cross-section. 3. Cool in air.	I
L3	Harden: 1. Heat parts to 1550°F (843.3°C). 2. Hold at heat 20 minutes per inch of cross-section. 3. Oil quench. 4. Within one hour after oil quench, sub-zero cool to at least minus 100°F (-73.3°C) for one hour. 5. Allow parts to return to room temperature and temper (L4) immediately.	I
L4	Temper: 1. Heat parts to 400°F (204.4°C). 2. Hold at heat 2 hours. 3. Air cool (HRC 58-62).	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 42

Material Designation: UNS T11350

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> 1. Heat parts to 1550°F (843.3°C). 2. Hold at heat one hour per inch of cross-section. 3. Cool slowly (50°F/27.8°C per hour) in furnace. 4. Hardness: HB 241 max, or equivalent. 	I
L3	Harden: <ol style="list-style-type: none"> 1. Heat parts uniformly in a furnace or neutral salt bath to 1550°F (843.3°C) and hold at heat 15 minutes. 2. Transfer to a neutral salt bath maintained at 2030°F (1110.0°C) and equalize. For time at temperature refer to Time vs Cross-Section Chart for this material. 3. Transfer rapidly to low temperature salt bath maintained at 1040°F (560°C). Hold at temperature 3-4 minutes. 4. Cool in still air to at least 120°F (48.9°C). Temper (L4) immediately. 	I III III
L4	Temper: 1/ <ol style="list-style-type: none"> 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat 2 hours. 3. Cool in air. 4. Sub-zero cool to minus 100°F (-73.3°C). 5. Hold at sub-zero temperature for one (1) hour. 6. Allow parts to return to room temperature. 7. Heat parts to 1000°F (537.8°C). 8. Hold at heat 2 hours. 9. Cool in air. 10. Reheat parts to 850°F (454.4°C). 11. Hold at heat 2 hours. 12. Cool in air (HRC 60-64). 2/ <p>Notes:</p> <p>1/ Tempering operations may be performed in an air furnace or a salt bath. All traces of salt must be removed after hardening if tempering is to be performed in air.</p> <p>2/ For critical applications hardness may be HRC 62-64 when specified on the engineering drawing.</p>	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 42 (Continued)

Material Designation: UNS T11350

Code	Operation	Temp Tol
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MIL-STD-40002(AT)

INSTRUCTION SHEET 43

Material Designation: UNS N06002

Code	Operation	Temp Tol
L7S	<p>Solution Treatment: 1/</p> <ol style="list-style-type: none"> 1. Parts up to 0.250 inch in thickness <ol style="list-style-type: none"> a. Heat parts to 2150°F (2276.8°C). b. Hold at heat for 15 minutes. c. Rapid air cool. d. Hardness HB 116-241, or equivalent. 2. Parts greater than 0.250 inch in thickness <ol style="list-style-type: none"> a. Heat parts to 2175°F (1190.7°C). b. Hold at heat 30 minutes. c. Water quench. d. Hardness HB 116-241, or equivalent. <p>For in-process solution treatment of M3614 only 2/</p> <ol style="list-style-type: none"> 3. Parts up to 0.250 inch in thickness <ol style="list-style-type: none"> a. Heat parts to 1975°F (1080°C). b. Hold at heat for 15 minutes. c. Rapid air cool. d. Hardness HB 116-241, or equivalent. 4. Parts greater than 0.250 inch in thickness <ol style="list-style-type: none"> a. Heat parts to 1950 to 2050°F (1094°C). b. Hold at heat 30 minutes. c. Water quench. d. Hardness HB 116-241, or equivalent. <p>1/ For identification of proper solution heat treatment in internal documents (eg: operation sheets, etc), identify as MIL-STD-40002(AT)L7S1/L7S2/L7S3/L7S4 as applicable.</p> <p>2/ Final solution treatment after all forming and welding operations are completed shall be at 2150°F (1177°C).</p>	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 44

Material Designation: UNS J92001 and UNS S35500

Code	Operation	Temp Tol								
L1	<p>Anneal:</p> <p>1. Heat parts to 1900°F (1037.8°C).</p> <p>2. Hold at heat for time indicated below.</p> <table><tr><th>Material Thickness (inches)</th><th>Time</th></tr><tr><td>0.187 and under</td><td>30 minutes</td></tr><tr><td>over 0.187 to 1.0</td><td>90 minutes</td></tr><tr><td>over 1.0</td><td>90 minutes per inch of cross- section (three hours max)</td></tr></table> <p>3. Parts under 0.187 inch, cool rapidly in air (HRC 35 max).</p> <p>Parts 0.187 inch and over, quench in water or oil (HRC 35 max).</p> <p>4. Subzero cool to at least minus 100°F (-73.3°C).</p> <p>5. Hold at temperature for three hours.</p> <p>6. Warm in air to room temperature.</p> <p>Notes: 1. Cooling rate for quench shall be 150°F per minute minimum.</p> <p>2. For in-process annealing the subzero cool may be omitted. However, for final anneals the subzero cool must be used.</p>	Material Thickness (inches)	Time	0.187 and under	30 minutes	over 0.187 to 1.0	90 minutes	over 1.0	90 minutes per inch of cross- section (three hours max)	I
Material Thickness (inches)	Time									
0.187 and under	30 minutes									
over 0.187 to 1.0	90 minutes									
over 1.0	90 minutes per inch of cross- section (three hours max)									
L3	<p>Harden:</p> <p>1. Heat parts to 1750°F (954.4°C) (Composite Assemblies containing AM 350 details shall be heated to 1710°F (932.2°C)).</p> <p>2. Hold at heat for at least 10 minutes (1 hour max).</p> <p>3. a. Plate, Bars, and Forgings: Quench in water or oil.</p> <p>b. Sheet and Composite Assemblies: Cool rapidly in air to room temperature.</p> <p>4. Subzero cool to at least minus 100°F (-73.3°C).</p> <p>5. Hold at temperature for three hours.</p> <p>6. Warm in air to room temperature.</p>	II								

MIL-STD-40002(AT)

INSTRUCTION SHEET 44 (Continued)

Material Designation: UNS J92001 and UNS S35500

Code	Operation	Temp Tol
L4B	Temper B: 1. Heat parts to 1015°F (546.1°C). 2. Hold at heat for three hours. 3. Cool in air (HRC 37-44).	II
L4C	Temper C: 1. Heat parts to 1075°F (579.4°C). 2. Hold at heat for three hours. 3. Cool in air (HRC 30-40).	II
L8A	Equalize A: 1. Heat parts to 1425°F (773.9°C). 2. Hold at heat for three hours. 3. Cool in air to below 70°F (21.1°C). 4. When part is below 150°F (65.6°C), tap water may be used to attain temperature below 70°F (21.1°C).	I
L8B	Equalize B: 1. Heat parts to 1425°F (773.9°C). 2. Hold at heat for three hours. 3. Cool in air to room temperature. 4. Subzero cool to at least minus 100°F (-73.3°C). 5. Hold at temperature for three hours. 6. Warm in air to room temperature.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 45

Material Designation: (Commercial/Industrial) X40

Code	Operation	Temp Tol
L7T	<p data-bbox="381 510 480 541">Aging:</p> <ol data-bbox="381 569 1281 695" style="list-style-type: none">1. Heat parts to 1325°F (718°C) in an inert to neutral atmosphere.2. Hold at heat for 50 hours.3. Cool in atmosphere (HRC 35-41).	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 46

Material Designation: UNS A97178

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 775°F (412.8°C). 2. Hold at heat 2 hours. 3. Furnace cool at a rate of 50°F/hr (27.8°C/hr) max to 500°F (260°C). Then air cool (HB 90 max, or equivalent).	III
L7S	Solution Treatment: 1. Heat parts to 870°F (465.6°C). 2. Hold at heat as follows: Sheet and Plate To 0.032 Thick 20 minutes 0.032 to 0.125 30 minutes 0.126 to 0.250 40 minutes 0.251 and over 60 minutes Forgings 4-6 hours 3. Quench in water (HB 90 min, or equivalent).	III
L7T	Aging: 1. Heat parts to 250°F (121.1°C). 2. Hold at heat 24 hours. 3. Cool in air.	III
L7ST	Solution Treatment Plug Aging: 1. L7S followed by L7T (HB 145 min, or equivalent).	

MIL-STD-40002(AT)

INSTRUCTION SHEET 47

Material Designation: UNS R56400

Code	Operation	Temp Tol
L1	Anneal: <ol style="list-style-type: none"> 1. Heat parts to 1300°F (70.4°C). 2. Hold at heat two (2) hours. 3. Cool in air (HRC 39 max). 	I
L7S	Solution Treatment: <ol style="list-style-type: none"> 1. Heat parts to 1750°F (954.4°C) in air atmosphere (allow furnace to run 12 hours with air atmosphere prior to loading parts in furnace). 2. Hold at heat for 1 hour. 3. Quench into violently agitated water within 10 seconds after removing from furnace. 	I
L7T	Aging: <ol style="list-style-type: none"> 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat for 8 hours. 3. Cool in air. 	II
L5	Stress Relief: <ol style="list-style-type: none"> 1. Heat parts to 900°F (482.2°C). 2. Hold at heat for 4 hours. 3. Cool in air. 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 48

Material Designation: UNS A92024

Code	Operation	Temp Tol
L1	Anneal: (HB 55 maximum, or equivalent).	
L7S	Solution Treatment: (HB 100-175 or equivalent).	
L7T	Aging: (HB 125 minimum, or equivalent).	
L7ST	Solution Treatment Plus Aging: (HB 125 minimum, or equivalent).	
	FOR THE REQUIRED TEMPERATURES AND TIMES SEE AMS 2770	

MIL-STD-40002(AT)

INSTRUCTION SHEET 49

Material Designation: UNS N07001

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 35°F (20°C) below gamma prime solvus. 2. Hold at heat for 4 hours. 3. Quench in oil.	II
L7SX	Solution Treatment: 1/ 1. Heat parts to 1825°F (995°C). 2. Hold at heat for 2 hours. 3. Air cool or faster.	I
L7T	Aging (stabilization plus precipitation): 1. Heat parts to 1550°F (843°C). 2. Hold at heat for 4 hours. 3. Cool in air to room temperature. 4. Heat parts to 1400°F (760°C). 5. Hold at heat for 16 hours. 6. Cool in air to room temperature (HB 336 to 420; for sheet and strip, hardness shall be HRC 34-44, or equivalent). 1/ Sheet strip only.	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 50

Material Designation: UNS G10400

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1450°F (788°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Furnace cool to 850°F (454.4°C). Then air cool (HRC 23 max). 	I
L2	<p>Normalize:</p> <ol style="list-style-type: none"> 1. Heat parts to 1525°F (829°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Cool in air. (If hardness is above HRC 35, anneal per L1 if not to be immediately hardened). 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts to 1525°F (829°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in water. 4. Temper (L4) immediately. 	I
L4A	<p>Temper A:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 35-40. 3. Cool in air. 	II
L4B	<p>Temper B:</p> <ol style="list-style-type: none"> 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 30-35. 3. Cool in air. 	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 50 (Continued)

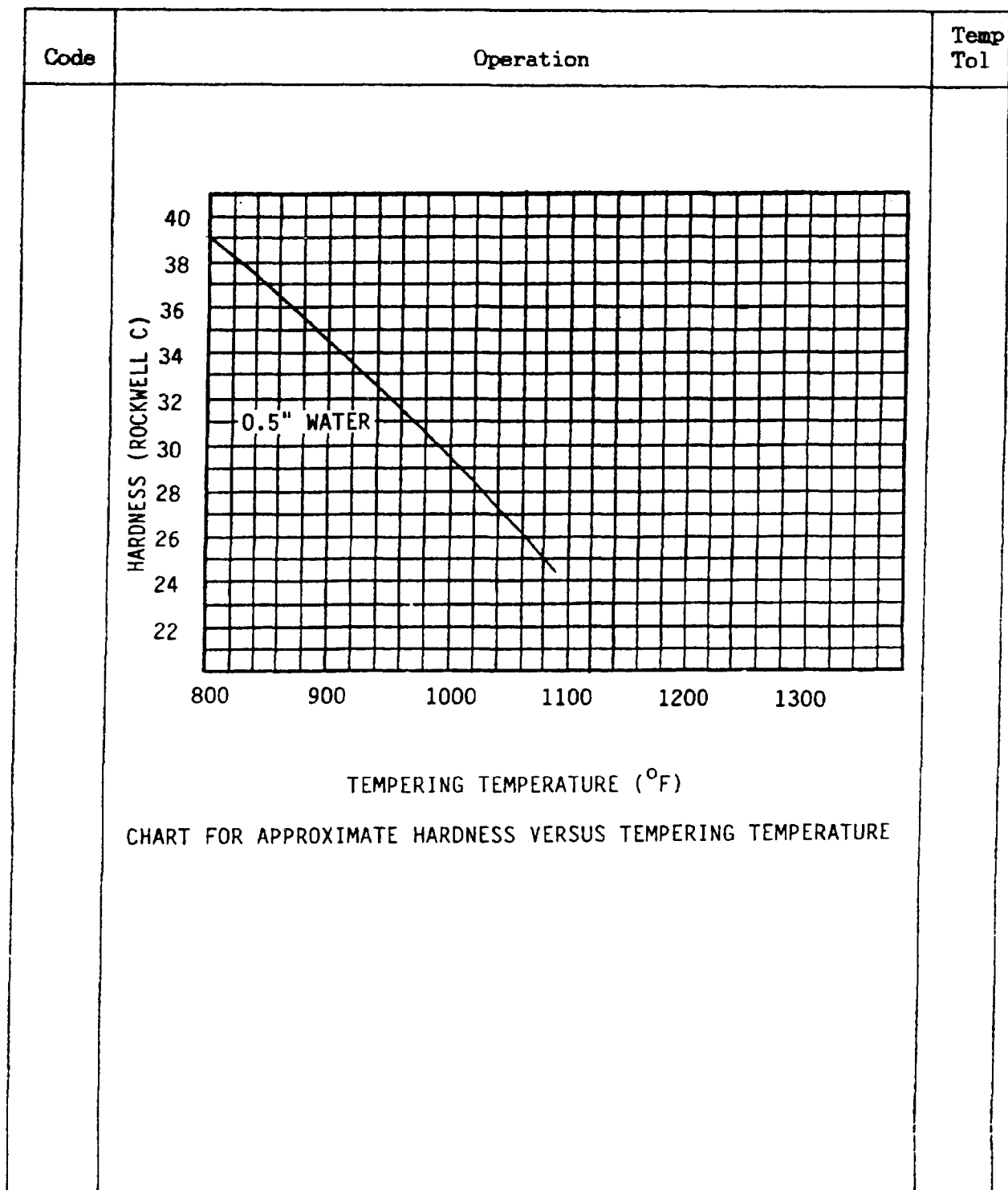
Material Designation: UNS G10400

Code	Operation	Temp Tol
L4C	Temper C: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 25-30. 3. Cool in air.	II
L4D	Temper D: 1. For approximate tempering temperature, refer to Hardness vs Tempering Temperature Chart for this material. 2. Hold for 2 hours per inch of maximum cross-section to HRC 20-24. 3. Cool in air.	II
L5	Stress Relief (After machining, welding, or forming, etc): 1. For hardened parts: a. Heat to 100°F (56°C) below tempering temperature. b. Hold at heat for 6 hours. c. Cool in still air. 2. For unhardened parts: a. Heat parts to 1125°F (607°C). b. Hold at heat for 2 hours. c. Cool in still air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 50 (Continued)

Material Designation: UNS G10400



MIL-STD-40002(AT)

INSTRUCTION SHEET 51

Material Designation: (Commercial/Industrial) SAE 3120

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1550°F (843°C). 2. Hold at heat 60 minutes per inch of maximum cross-section. 3. Furnace cool to room temperature (HB 170 max, or equivalent).	I
L2	Normalize: 1. Heat parts to 1700°F (927°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Air cool (HB 207 max, or equivalent).	I
L3	Harden: 1. Heat parts to 1450°F (788°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench in oil.	I
L4	Temper: 1. Heat parts to 300°F (149°C). 2. Hold at heat 2 hours. 3. Air cool. 4. Hardness: Carburized Case . . . HRC 60-63. Core HRC 40-50.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 52

Material Designation: (Commercial/Industrial) CF-8M

Code	Operation	Temp Tol
L1	<p data-bbox="375 516 488 548">Anneal:</p> <ol data-bbox="375 579 1138 705" style="list-style-type: none">1. Heat parts to 1950°F (1066°C).2. Hold at heat 30 minutes per inch of maximum cross-section.3. Quench in water (HRB 90 min).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 53

Material Designation: UNS S17700

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1950°F (1066°C). 2. Hold at heat for time indicated below: Material Thickness in Inches Time 0.100 and under 3 minutes over 0.100 3 minutes per 0.100 3. Cool rapidly in air (HRB 90 max).	I
L7SX	Solution Treatment (Austenite Conditioning): 1. Heat to 1400°F (760°C). 2. Hold at heat for 90 minutes. 3. Cool to 50-60°F (10.0-15.6°C) within 60 minutes. 4. Hold at temperature for 30 minutes.	I IV
L7SY	Solution Treatment (Austenite Conditioning): 1. Heat to 1750°F (954.4°C). 2. Hold at heat for 90 minutes. 3. Air cool to room temperature. 4. Cool to minus 100°F (-73.3°C). 5. Hold at temperature 8 hours. 6. Warm to room temperature.	II
L7TA	Aging: 1. Heat to 900°F (482.2°C). 2. Hold at heat for 60 minutes. 3. Air cool to room temperature. 4. Hardness: HRC 46 min, or equivalent.	III
L7TB	Aging: 1. Heat to 950°F (510°C). 2. Hold at heat for 60 minutes. 3. Air cool to room temperature. 4. Hardness: HRC 45 min, or equivalent.	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 53 (Continued)

Material Designation: UNS S17700

Code	Operation	Temp Tol
L7TC	<p data-bbox="370 520 472 552">Aging:</p> <ol data-bbox="370 583 1036 709" style="list-style-type: none">1. Heat parts to 1050°F (565.6°C).2. Hold at heat for 90 minutes.3. Air cool to room temperature.4. Hardness: HRC 38 min, or equivalent.	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 54

Material Designation: (Commercial/Industrial) MAR-M-421

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 2100°F (1149.3°C) in an inert atmosphere. 2. Hold at heat for two hours. 3. Cool in inert atmosphere to room temperature.	I
L8	Special Treatment: 1. Heat parts to 1950°F (1065.6°C) in an inert atmosphere. 2. Hold at heat for four hours. 3. Cool in inert atmosphere to room temperature. 4. Heat parts to 1400°F (760°C). 5. Hold at heat for 16 hours. 6. Cool in air.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 55

Material Designation: UNS N07718

Code	Operation	Temp Tol
L2	Normalize (homogenization): 1. Heat parts to 2000°F (1093.3°C) in an inert atmosphere. 2. Hold at heat for 1 to 2 hours. 3. Cool in inert atmosphere to below 90°F (32°C).	I
L2A	Homogenize: 1. Heat parts to 2100°F (1150°C) in an inert atmosphere. 2. Hold at heat for 10 hours. 3. Cool in an inert atmosphere to room temperature.	I
L7S	Solution Treatment: 1. Heat parts to within range of 1750 to 1800°F (955 to 980°C) in an inert atmosphere holding at selected temperature within $\pm 25^\circ\text{F}$ ($\pm 15^\circ\text{C}$). 2. Hold at heat for one hour. 3. Cool in an inert atmosphere to room temperature. (HRC 29 maximum, or equivalent.)	I
L7SZ	Solution Treatment (including normalizing): 1. Heat parts to 2075°F (1135.1°C) in an inert atmosphere. 2. Hold at heat for 10 hours. 3. Furnace cool to 1900°F (1037.8°C). 4. Hold at heat for 2 hours. 5. Cool to room temperature.	I
L7T	Aging: 1. Heat parts to 1325°F (718.3°C). 2. Hold at heat for 8 hours. 3. Furnace cool at a rate of 100°F (55.6°C) per hour to 1150°F (621.1°C). 4. Hold at 1150°F (621.1°C) heat for 8 hours. 5. Air cool to room temperature (HRC 35.5 min, or equivalent).	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 55 (Continued)

Material Designation: UNS N07718

Code	Operation	Temp Tol
L7TA	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1350°F (732.2°C). 2. Hold at heat for 10 hours. 3. Furnace cool to 1150°F (621.1°C). 4. Hold at heat for sufficient time to provide a total of 18 hours at the aging temperatures. 5. Air cool to room temperature (HRC 35.5 min, or equivalent). 	II
L7ST	<p>Solution Treatment Plus Aging:</p> <ol style="list-style-type: none"> 1. L7S followed by L7T (HRC 35.5 min, or equivalent). 	
L7SZTA	<p>Solution Treatment Plus Aging:</p> <ol style="list-style-type: none"> 1. L7SZ followed by L7TA (HRC 35.5 min, or equivalent). <p>Note: L7SZTA is to be used only for cast integral rotors.</p>	
L7TB	<p>Aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1500°F (816°C). 2. Hold at heat for 2 hours. 3. Air cool to room temperature. 1. Heat parts to 1325°F (718°C). 2. Hold at heat for 8 hours. 3. Furnace cool at a rate of 100°F (56°C) per hour to 1150°F (621°C). 4. Hold at 1150°F (621°C) heat for 8 hours. 5. Air cool to room temperature (HRC 35.5 min, equivalent). 	II
L7D	<p>Delta aging:</p> <ol style="list-style-type: none"> 1. Heat parts to 1600°F (870°C) in an inert atmosphere. 2. Hold at for 10 hours. 3. Cool in an inert atmosphere to room temperature. 	II

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INSTRUCTION SHEET 56

Material Designation: UNS C17200

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 1465°F (796.1°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section (15 minutes minimum). 3. Quench in water. 4. Hardness: HB 78-125 (500 kg load, 10 mm ball), or equivalent.	III
L7TA	Aging A: 1. Heat parts to 600-625°F (315.6-329.4°C). 2. Hold at heat for 3 hours. 3. Cool in air. 4. Hardness: HB 330-440 (3000 kg load, 10 mm ball), or equivalent.	IV
L7TB	Aging B: 1. Heat parts to 850°F (454.4°C). 2. Hold at heat for 4 hours. 3. Cool in air. 4. Hardness: HB 190 min (3000 kg load, 10 mm ball), or equivalent.	III
L7STA	Solution Treatment Plus Aging A: 1. L7S followed by L7TA. 2. Hardness: HB 330-400 (3000 kg load, mm ball), or equivalent.	
L7STB	Solution Treatment Plus Aging B: 1. L7S followed by L7TB. 2. Hardness: HB 190 min (3000 kg, 10 mm ball), or equivalent.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 57

Material Designation: UNS C82500

Code	Operation	Temp Tol
L7S	Solution Treatment: <ol style="list-style-type: none"> 1. Heat parts to 1475°F (801.7°C). 2. Hold at heat for 60 minutes per inch of maximum cross-section (15 minutes minimum). 3. Quench in water. 4. Hardness: HB 146 max (3000 kg load, 10 mm ball), or equivalent. 	III
L7TA	Aging A: <ol style="list-style-type: none"> 1. Heat parts to 650°F (343.3°C). 2. Hold at heat for 3 hours. 3. Cool in air. 4. Hardness: HB 330 min (3000 kg load, 10 mm ball), or equivalent. 	IV
L7TB	Aging B: <ol style="list-style-type: none"> 1. Heat parts to 850°F (454.4°C). 2. Hold at heat for 4 hours. 3. Cool in air. 4. Hardness: HB 190 min (3000 kg load, 10 mm ball), or equivalent. 	III
L7STA	Solution Treatment Plus Aging A: <ol style="list-style-type: none"> 1. L7S followed by L7TA. 2. Hardness: HB 330 min (3000 kg load, mm ball), or equivalent. 	
L7TB	Solution Treatment Plus Aging B: <ol style="list-style-type: none"> 1. L7S followed by L7TB. 2. Hardness: HB 190 min (3000 kg, 10 mm ball), or equivalent. 	

MIL-STD-40002(AT)

INSTRUCTION SHEET 58

Material Designation: UNS R30605

Code	Operation	Temp Tol
L7S	<p data-bbox="375 520 683 552">Solution Treatment:</p> <ol data-bbox="375 583 1284 737" style="list-style-type: none"><li data-bbox="375 583 959 615">1. Heat parts to 2100°F (1148.8°C).<li data-bbox="375 615 894 646">2. Hold at heat for 60 minutes.<li data-bbox="375 646 992 678">3. Rapid cool in air or water quench.<li data-bbox="375 678 1284 737">4. Hardness: HB 248 max (3000 kg load, 10 mm ball), or equivalent.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 59

Material Designation: UNS K92890

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 1500°F (815.6°C). 2. Hold at temperature for 1 hour per inch of maximum cross-section. 3. Air cool to room temperature. 4. Hardness: HB 326 max (3000 kg load and 10 mm ball), or equivalent.	I
L7T	Aging: 1. Heat to 900-925°F (482.2-496.1°C). 2. Hold at temperature for 3-3 1/2 hours. 3. Air cool to room temperature. 4. Hardness: HRC 48 min, or equivalent.	IV
L7ST	Solution Treatment Plug Aging: 1. L7S followed by L7T. 2. Hardness: HRC 48 min, or equivalent.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 60

Material Designation: UNS N09902

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat for 15 to 30 minutes. 3. Cool as rapid as practicable. 4. Hardness: HRB 80 max, or equivalent.	I
L7T	Aging: 1. Heat to 1250-1350°F (677-732°C). 2. Hold at heat for 3 hours. 3. Air cool. 4. Hardness: a. AMS 5221 - HRC 27-35, or equivalent. b. AMS 5223 - HRC 34-41, or equivalent. c. AMS 5225 - HRC 39-46, or equivalent.	IV
L7ST	Solution Treatment Plug Aging: 1. L7S followed by L7T. 2. Hardness: a. AMS 5221 - HRC 27-35, or equivalent. b. AMS 5223 - HRC 34-41, or equivalent. c. AMS 5225 - HRC 39-46, or equivalent.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 61

Material Designation: UNS K93120

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat to 1500°F (815.6°C). 2. Hold at temperature for 1 hour per inch of maximum cross-section. 3. Air cool to room temperature. 4. Hardness: HB 302 max (3000 kg load and 10 mm ball), or equivalent.	I
L7T	Aging: 1. Heat to 900-925°F (482.2-496.1°C). 2. Hold at temperature for 3 - 3 1/2 hours. 3. Air cool to room temperature. 4. Hardness: HRC 52 min, or equivalent.	IV
L7ST	Solution Treatment Plus Aging: 1. L7S followed by L7T. 2. Hardness: HRC 52 min, or equivalent.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 62

Material Designation: UNS S41800

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1450°F (787.8°C). 2. Hold at heat 4 hours. 3. Cool slowly in furnace (50°F/hr, 27.8°C/hr) to 800°F (426.7°C). 4. Remove from furnace and air cool. 5. Hardness: HB 311 max, or equivalent. 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Quench: Parts one inch and over in maximum cross-section shall be quenched in oil. Parts less than one inch maximum cross-section may be quenched in air or inert atmosphere. 	I
L4	<p>Temper:</p> <ol style="list-style-type: none"> 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat for 2 hours. 3. Cool in air (HRC 38-45). 	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 63

Material Designation: (Commercial/Industrial) D979 Modified

Code	Operation	Temp Tol
L7S	Solution Treatment: 1/ 1. Heat parts to 1850°F (1010°C). 2. Hold at heat for four (4) hours. 3. Rapid quench in agitated water maintained at 120°F (49°C) maximum. 4. Hardness: HB 262 maximum.	II
L7T	Aging: 1. Heat parts to 1450°F (787.8°C). 2. Hold at heat for 12 hours. 3. Cool in air. 4. Heat parts 1200°F (648.9°C). 5. Hold at heat for 12 hours. 6. Cool in air.	
L7ST	Solution Treatment Plus Aging: 1. L7S followed by L7T. 2. Hardness: HB 340-418. NOTES: 1/ Furnaces for solution heat treatment shall be capable of maintaining the temperature within the furnace work load zone within $\pm 10^\circ\text{F}$ ($\pm 4.6^\circ\text{C}$) of the temperature controller.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 64

Material Designation: (Commercial/Industrial) PM-LC-Astroloy

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat to 1975-2075°F (1079.4-1135°C). Aim 2025°F (1107°C). 2. Hold at heat for 4 hours. 3. Quench in molten salt bath to 600°F (315.6°C). 4. Air cool.	IV III
L7SZ	Solution Treatment: 1. Heat to 1975-2075°F (1079.4-1135°C). Aim 2025°F (1107°C). 2. Hold at heat for 4 hours. 3. Cool to room temperature at a rate equal to air cool.	IV
L7T	Precipitation Treatment: 1. Heat to 1600°F (871.1°C). 2. Hold at heat for 8 hours. 3. Cool to room temperature at a rate equal to air cool. 4. Heat to 1800°F (982.2°C). 5. Hold at heat for 4 hours. 6. Cool to room temperature at a rate equal to air cool. 7. Heat to 1200°F (648.9°C). 8. Hold at heat for 24 hours. 9. Air cool. 10. Heat to 1400°F (760°C). 11. Hold at heat for 8 hours. 12. Air cool. 13. Hardness: HB 313-403, or equivalent.	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 65

Material Designation: UNS A92024

Code	Operation	Temp Tol
L1	Anneal:	
L7S	Solution Treatment:	
L7T	Aging:	
L7ST	Solution Treatment Plus Aging:	
	NOTES:	
	1. FOR THE REQUIRED TEMPERATURE AND TIMES SEE AMS 2770.	
	2. THE MATERIAL SHALL NOT BE RE-HEAT TREATED MORE THAN ONCE WITHOUT THE APPROVAL OF THE PROCURING ACTIVITY'S MATERIALS LABORATORY.	

MIL-STD-40002(AT)

INSTRUCTION SHEET 66

Material Designation: (Commercial/Industrial) C101

Code	Operation	Temp Tol
L8	<p>Special Heat Treatment:</p> <ol style="list-style-type: none"> 1. Heat parts to 2050°F (1120°C) in an inert atmosphere. 2. Hold at heat for 2 hours. 3. Cool to 1400°F (760°C) in an inert or air atmosphere at a rate of 130°F (70°C) per minute minimum and then air cool to room temperature. 4. Heat parts to 1550°F (840°C) in an inert or air atmosphere. 5. Hold at heat for 4 hours. 6. Cool in air. 7. Heat parts to 1400°F (760°C) in an inert or air atmosphere. 8. Hold at heat for 16 hours. 9. Cool in air. <p>NOTE: Exact heat treating process for turbine rotor castings shall be approved by the procuring activity's materials laboratory prior to use.</p>	I
L8A	<p>Special Heat Treatment A:</p> <ol style="list-style-type: none"> 1. Heat parts to 2050°F (1120°C) in an inert or air atmosphere. 2. Hold at heat for 2 hours. 3. Cool in air or inert atmosphere at a rate equivalent to air cool. 	I
L8B	<p>Special Heat Treatment B:</p> <ol style="list-style-type: none"> 1. Heat parts to 1550°F (840°C) in an inert or air atmosphere. 2. Hold at heat for 4 hours. 3. Cool in air. 4. Heat parts to 1400°F (760°C) in an inert or air atmosphere. 5. Hold at heat for 16 hours. 6. Cool in air. 	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 66 (Continued)

Material Designation: (Commercial/Industrial) C101

Code	Operation	Temp Tol
L8C	<p data-bbox="365 514 755 546">Post HIP Heat Treatment:</p> <ol data-bbox="365 577 1323 735" style="list-style-type: none"><li data-bbox="365 577 1291 609">1. Heat parts to 2200°F (1205°C) in an inert atmosphere.<li data-bbox="365 609 836 640">2. Hold at heat for 2 hours.<li data-bbox="365 640 1323 735">3. Cool to 1800°F (980°C) in an inert or air atmosphere at a rate of 100 to 200°F (55 to 110°C) per minute, then rapidly air cool to room temperature.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 67

Material Designation: UNS N06625

Code	Operation	Temp Tol
L1	<p data-bbox="407 520 521 548">Anneal:</p> <ol data-bbox="407 583 1203 709" style="list-style-type: none">1. Heat parts to 2050°F (1020°C) in a vacuum.2. Hold at heat for one half to one hour.3. Very rapid furnace cool with nitrogen to room temperature.	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 68

Material Designation: (Commercial/Industrial) SAE 9315

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1275°F (690.6°C). 2. Hold at heat 30 minutes per inch of <u>maximum</u> cross-section. 3. Cool in air (HRC 24 max).	I
L2	Normalize: 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 60 minutes per inch of <u>maximum</u> cross-section (one hour minimum). 3. Cool in air.	I
L2A	Normalize A: 1. Heat parts to 1750°F (954.4°C). 2. Hold at heat 60 minutes per inch of <u>maximum</u> cross-section (one hour minimum). 3. Quench in oil.	I
L3	Harden: 1. Heat parts to 1475-1500°F (801.7-815.6°C). 2. Hold at heat 30 minutes per inch of <u>maximum</u> cross-section. 3. Quench in oil.	IV
L4A	Temper A: 1. Heat parts to 1000°F (537.8°C). 2. Hold at heat two (2) hours. 3. Cool in air (HRC 24-32).	I
L4B	Temper B: 1. Heat parts to 275-300°F (135-148.9°C). 1/ 2. Hold at heat two (2) hours. 3. Cool in air. 4. Case Hardness per engineering drawing. Core hardness HRA 68-72 (HRC 35-43). 1/ Parts may be heated as high as 325°F (162.8°C) provided the case hardness specified on the engineering drawing is maintained on the finish machined part.	IV

MIL-STD-40002(AT)

INSTRUCTION SHEET 69

Material Designation: UNS R56260

Code	Operation	Temp Tol
L7S	<p>Solution Treatment:</p> <ol style="list-style-type: none">1. Heat parts to 1650°F (898.9°C) in a suitable protective atmosphere.2. Hold at heat for one hour.3. Cool at a rate equivalent to air cooling.	I
L7T	<p>Aging:</p> <ol style="list-style-type: none">1. Heat parts to 1100°F (593.3°C).2. Hold at heat for 4 to 8 hours.3. Air cool (HRC 33-45).	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 70

Material Designation: UNS R56400

Code	Operation	Temp Tol
L5	Stress Relief: 1. Heat parts to 900°F (482.2°C). 2. Hold at heat for 4 hours. 3. Cool in air.	II
L7S	Solution Treatment: 1. Heat parts to 1750°F (954.4°C) in air atmosphere. 2. Hold at heat for 1 hours. 3. Quench in agitated water within 10 seconds after removal from furnace.	I
L7T	Aging (overaging): 1. Heat parts to 1300°F (704.4°C). 2. Hold at heat for 2 hours minimum. 3. Cool in air to room temperature (HRC 39 max).	I

MIL-STD-40002(AT)

INSTRUCTION SHEET 71

Material Designation: UNS S15700

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1950°F (1066°C). 2. Hold at heat for time indicated below: Material Thickness in Inches Time 0.100 and under 3 minutes over 0.100 3 minutes per 0.100 3. Cool rapidly in air (HRB 100 max).	I
L7SX	Solution Treatment (Transformation Conditioning): 1. Heat to 1400°F (760°C). 2. Hold at heat for 90 minutes. 3. Cool to 50-60°F (10.0-15.6°C) within 60 minutes. 4. Hold at temperature for 30 minutes.	I IV
L7SY	Solution Treatment (Austenite Conditioning): 1. Heat to 1750°F (954.4°C). 2. Hold at heat for 90 minutes. 3. Air cool to room temperature. 4. Cool to minus 100°F (-73.3°C). 5. Hold at temperature 8 hours. 6. Warm to room temperature.	II
L7TA	Aging: 1. Heat to 950°F (510°C). 2. Hold at heat for 60 minutes. 3. Air cool to room temperature. 4. Hardness: HRC 46 min, or equivalent.	III
L7TB	Aging: 1. Heat to 1050°F (565.6°C). 2. Hold at heat for 90 minutes. 3. Air cool to room temperature. 4. Hardness: HRC 40 min, or equivalent.	III

MIL-STD-40002(AT)

INSTRUCTION SHEET 72

Material Designation: UNS S15500

Code	Operation	Temp Tol
L7S	Solution Treatment: <ol style="list-style-type: none"> 1. Heat parts to 1900°F (1037.8°C). 2. Hold at heat 30 minutes per 1/2 inch of maximum cross-section. 3. Oil quench or air cool. 4. Hardness: HRC 39 max, or equivalent. 	I
L7TA	Aging: <ol style="list-style-type: none"> 1. Heat parts to 1025°F (551.7°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 35-42, or equivalent. 	III
L7TB	Aging: <ol style="list-style-type: none"> 1. Heat parts to 1075°F (579.4°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 31-39, or equivalent. 	III
L7TC	Aging: <ol style="list-style-type: none"> 1. Heat parts to 1100°F (593.3°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 32-38, or equivalent. 	III
L7TD	Aging: <ol style="list-style-type: none"> 1. Heat to 1150°F (621.1°C). 2. Hold at heat for 4 hours. 3. Air cool. 4. Hardness: HRC 28-37, or equivalent. 	III
L7STD	Example: Solution Treatment Plus Aging: <ol style="list-style-type: none"> 1. Solution treat per L7S. 2. Age per L7TD. 3. Hardness: HRC 28-37, or equivalent. 	

MIL-STD-40002(AT)

INSTRUCTION SHEET 73

Material Designation: UNS S45000

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 1900°F (1037.8°C). 2. Hold at heat 60 ± 10 minutes. 3. a. Plate, bar, and forgings: Quench in water or oil. b. Sheet and composite assemblies: Cool rapidly in air. 4. Hardness HRC 33 maximum.	I
L7TA	Aging: 1. Heat parts to 950°F (510°C). 2. Hold at heat for 4 hours. 3. Cool in air. 4. Hardness HRC 37 to 44.	II
L7TB	Aging: 1. Heat parts to 1050°F (565.6°C). 2. Hold at heat for 4 hours. 3. Cool in air. 4. Hardness HRC 34 to 41.	II
L7TC	Overage: 1. Heat parts to 1150°F (621°C). 2. Hold at heat for 4 hours. 3. Cool in air. 4. No hardness requirement.	II

MIL-STD-40002(AT)

INSTRUCTION SHEET 74

Material Designation: (Commercial/Industrial) C450

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat parts to 1904°F (1040°C) in an inert atmosphere or vacuum. 2. Hold at heat for one hour minimum. 3. Cool to 200°F (93.3°C) or lower part temperature within 1 1/2 hours, then remove parts and immerse in water maintained at 70°F (21.2°C) or lower, holding in water for 30 minutes minimum.	I
L7TA	Aging: Obsolete.	
L7TB	Aging: 1. Heat parts to a temperature which will provide a hardness of HRC 33 to 37. 1/ 2. Hold at heat for 4 hours. 3. Cool in air. 4. Hardness HRC 33 to 37. 1/ In no case shall a temperature setting greater than 1058°F (570°C) be used without prior written permission of the procuring activity's materials laboratory.	II

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INSTRUCTION SHEET 75

Material Designation: (Commercial/Industrial) Vasco Jet 2000

Code	Operation	Temp Tol
L1	<p>Anneal:</p> <ol style="list-style-type: none"> 1. Heat parts to 1625°F (884.4°C). 2. Hold at heat 30 minutes per inch of maximum cross-section. 3. Cool to 800°F (427°C) at 50°F (27.8°C) per hour. 4. Cool in air. 	I
L3	<p>Harden:</p> <ol style="list-style-type: none"> 1. Preheat parts to 1450 to 1500°F (788 to 815°C). 2. Hold at heat for 1 hour. 3. Heat parts to 1850°F (1010°C). 4. Holding time shall be as specified on the engineering drawing. 5. Quench in oil. 6. Deep freeze at minus 100 to minus 120°F (-75 to -85°C). 7. Hold at temperature for 3 hours minimum. <p>NOTE: Time between quench and deep freeze shall not exceed 30 minutes.</p>	II
L4	<p>Temperature:</p> <ol style="list-style-type: none"> 1. Heat parts to 600°F (315°C). 2. Hold at heat for 2 hours. 3. Air cool to room temperature. 4. Heat parts to 600°F (315°C). 5. Hold at heat for 2 hours. 6. Air cool. 	II
L8	<p>Stabilization:</p> <ol style="list-style-type: none"> 1. Heat parts to 1850°F (1010°C). 2. Hold at heat for 2 hours. 3. Quench in oil. 4. Heat to 1250°F (675°C). 5. Hold at heat for 1 hour. 6. Air cool. 7. Heat to 1350°F (730°C). 8. Hold at heat for 1 hour. 9. Air cool (HRC 36 max). 	I

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INSTRUCTION SHEET 76

Material Designation: SAE C103

Code	Operation	Temp Tol
L8	<p data-bbox="380 512 751 543">Special Heat Treatment:</p> <ol data-bbox="380 575 1328 919" style="list-style-type: none">1. Heat parts to 2150°F (1176.8°C) in an inert atmosphere.2. Hold at heat for 2 hours.3. Cool in an inert atmosphere to room temperature.4. Heat to parts to 1550°F (843.3°C) in an inert or air atmosphere.5. Hold at heat for 4 hours.6. Cool in air.7. Heat parts to 1400°F (760°C) in an inert or air atmosphere.8. Hold at heat for 16 hours.9. Cool in air.	I

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INSTRUCTION SHEET 77

Material Designation: (Commercial/Industrial) Inconel 617

Code	Operation	Temp Tol
L7S	<p data-bbox="378 531 683 562">Solution Treatment:</p> <ol data-bbox="378 594 1117 688" style="list-style-type: none">1. Heat parts to 2150°F (1177°C) in a vacuum.2. Hold at heat for 10 minutes.3. Furnace cool as rapidly as possible.	I

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INSTRUCTION SHEET 78

Material Designation: (Commercial/Industrial) MAR-M-247

Code	Operation	Temp Tol
L8A	Special Heat Treatment: 1. Heat parts to 2240°F (1225°C) in argon or vacuum. 2. Hold at heat for 2 hours. 3. Cool in argon to 1000°F (538°C) then air cool to room temperature.	II
L8B	Special Heat Treatment: 1. Heat to 1800°F (980°C) in argon or vacuum. 2. Hold at heat for 5 hours. 3. Cool in argon to 1000°F (538°C) then cool in air to room temperature. 4. Heat to 1600°F (870°C). 5. Hold at heat for 20 hours. 6. Air cool.	II
L8C	Special Heat Treatment: 1/ 1. Heat to 1600°F (870°C). 2. Hold at heat for 20 hours. 3. Air cool. 1/ This heat treatment is only to be used for coated parts.	II

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INSTRUCTION SHEET 79

Material Designation: (Commercial/Industrial) DS-C103

Code	Operation	Temp Tol
L8A	Special Heat Treatment: 1. Heat parts to 2200°F (1204°C) in argon or vacuum. 2. Hold at heat for 4 hours minimum. 3. Increase heat to 2245°F (1228°C) in argon or vacuum. 4. Hold at heat for 2 hours minimum. 5. Cool in argon to 1000°F (537.8°C) then air cool to room temperature.	II
L8B	Special Heat Treatment: 1. Heat to 1975°F (1079.4°C) in argon or vacuum. 2. Hold at heat for 4 hours. 3. Cool in argon to 1000°F (537.8°C) then cool in air to room temperature. 4. Heat to 1600°F (871.1°C). 5. Hold at heat for 20 hours. 6. Air cool.	II

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INSTRUCTION SHEET 80

Material Designation: UNS K44220

Code	Operation	Temp Tol
L2	Normalize: 1. Heat to 1700°F (927°C). 2. Hold at heat for 60 minutes. 3. Cool in air.	I
L3	Harden: 1. Heat to 1600°F (870°C). 2. Hold at heat for 60 minutes. 3. Quench in oil.	I
L4	Temper: 1. Heat to 575°F (302°C). 2. Hold at heat for 2 hours. 3. Cool in air. 4. Heat to 575°F (302°C). 5. Hold at heat for 2 hours. 6. Cool in air. 7. Hardness: HRC 53 min.	III

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INSTRUCTION SHEET 81

Material Designation: UNS N13100

Code	Operation	Temp Tol
L7S	Solution Treatment: 1. Heat to 2125°F (1165°C). 2. Hold at heat for 2 hours. 3. Oil quench.	II
L7T	Precipitation Treatment: 1. Heat to 1200°F (650°C). 2. Hold at heat for 2 hours. 3. Air cool to below 700°F (370°C). 4. Heat to 1400°F (760°C). 5. Hold at heat for 16 hours. 6. Air cool.	II
L7ST	Solution treatment plus precipitation treatment L7S plus L7T.	II

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INSTRUCTION SHEET 82

Material Designation: (Commercial/Industrial) Thoria Dispersed (TD) Nickel

Code	Operation	Temp Tol
L1	<p data-bbox="370 520 690 556">Anneal (In-process):</p> <ol data-bbox="370 583 1323 682" style="list-style-type: none"><li data-bbox="370 583 1323 619">1. Heat to 1800°F (980°C) in a vacuum or inert atmosphere.<li data-bbox="370 619 1323 655">2. Hold at heat for 10 minutes.<li data-bbox="370 655 1323 682">3. Furnace fan cool.	I

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INSTRUCTION SHEET 83

Material Designation: (Applicable Material Specification) M40AB, AMS 6308

Code	Operation	Temp Tol
L1	Anneal: 1. Heat parts to 1300°F (705°C). 2. Hold at heat for 4 to 8 hours. 3. Slow furnace cool (HBN 248 max).	II
L2	Stabilize: 1. Heat parts to 1725°F (955°C). 2. Hold at heat for 1 hour minimum. 3. Oil quench. 4. Heat parts to 1150°F (620°C). 5. Hold at heat for 2 hours. 6. Cool in air.	I
L3	Harden: 1. Heat parts to 1675°F (915°C). 2. Hold at heat for 20 to 40 minutes. 3. Oil quench. 4. Cool to minus 100°F (-73°C) or colder. 5. Hold at temperature for 2 hours minimum. 6. Warm to room temperature.	II
L4	Temper: 1. Heat parts to 450°F (230°C). 2. Hold at heat for 2 hours. 3. Cool to room temperature. 4. Heat parts to 450°F (230°C). 5. Hold at heat for 2 hours. 6. Cool to room temperature.	III

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INSTRUCTION SHEET 84

Material Designation: (Applicable Material Specification) M3632,
M3633 (Haynes 230)

Code	Operation	Temp Tol
L7S	<p data-bbox="367 552 672 583">Solution Treatment:</p> <ol data-bbox="367 615 1287 804" style="list-style-type: none"><li data-bbox="367 615 1073 646">1. Heat to 2150 to 2275°F (1176 to 1246°C).<li data-bbox="367 646 1287 741">2. Hold at the selected temperature within $\pm 25^\circ\text{F}$ ($\pm 15^\circ\text{C}$) for a length of time appropriate for the thickness of the material section, and not to exceed 30 minutes.<li data-bbox="367 741 1252 804">3. Cool in inert gas at a rate equivalent to rapid air cooling.	I

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APPENDIX

CROSS INDEX OF MATERIAL DESIGNATION TO UNS/ISN NUMBER

10. GENERAL

10.1 Scope. This appendix contains a listing of heat treatment specifications from two sources (SAE and commercial) and are cross indexed to the UNS and ISN numbers used in this standard. Although this appendix is not a mandatory part of this standard, the information contained herein should be useful in interpreting engineering drawings with coded heat treatment notes prepared in accordance with P6000 (see 6.3).

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. GENERAL REQUIREMENTS

30.1 Tables used in appendix. The two tables in this appendix consist of listings of industry and commercial material designations cross indexed to the UNS and ISN numbers used in this standard.

TABLE-APP I. Cross index of SAE material designation to UNS number and ISN number.

SAE Material designation	UNS number	ISN number	SAE Material designation	UNS number	ISN number
AMD 55DG	—	92	AMS 5050	G10100	16
AMS 4025	A96061	23	AMS 5070	G10220	3
AMS 4026	A96061	23	AMS 5112	G10900	4
AMS 4027	A96061	23	AMS 5221	N09902	60
AMS 4035	A92024	48	AMS 5223	N09902	60
AMS 4040	A92024	65	AMS 5225	N09902	60
AMS 4080	A96061	23	AMS 5334	J13042	6
AMS 4082	A96061	23	AMS 5335	J13050	6
AMS 4087	A92024	48	AMS 5336	J13046	12
AMS 4115	A96061	23	AMS 5338	J14046	13
AMS 4117	A96061	23	AMS 5342	J92200	39
AMS 4120	A92024	48	AMS 5343	J92200	39
AMS 4127	A96061	23	AMS 5344	J92200	39
AMS 4150	A96061	23	AMS 5350	J91152	5
AMS 4152	A92024	48	AMS 5351	J91150	5
AMS 4530	C17200	56	AMS 5352	J91639	18
AMS 4532	C17200	56	AMS 5355	J92200	39
AMS 4890	C82500	57	AMS 5362	J92811	7
AMS 4892	N04019	37	AMS 5363	J92641	7
AMS 4893	N04019	37	AMS 5365	J94211	8
AMS 4928	R56400	22	AMS 5366	J94211	8
AMS 4981	R56260	69	AMS 5368	J92001	44
AMS 5040	G10100	16	AMS 5376	R30155	34
AMS 5042	G10100	16	AMS 5383	N07718	55

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TABLE-APP I. Cross index of SAE material designation to
UNS number and ISN number - Continued.

SAE Material designation	UNS number	ISN number	SAE Material designation	UNS number	ISN number
AMS 5390	N06002	43	AMS 5621	S42000	25
AMS 5398	J92200	39	AMS 5630	S44004	18
AMS 5504	S41000	5	AMS 5643	S17400	39
AMS 5506	S42000	25	AMS 5644	S17700	53
AMS 5510	S32100	9	AMS 5645	S32100	9
AMS 5511	S30403	17	AMS 5646	S34700	7
AMS 5512	S34700	7	AMS 5651	S31008	8
AMS 5513	S30400	17	AMS 5659	S15500	72
AMS 5515	S30200	17	AMS 5662	N07718	55
AMS 5520	S15700	71	AMS 5663	N07718	55
AMS 5521	S31008	8	AMS 5664	N07718	55
AMS 5525	S66286	10	AMS 5667	N07750	21
AMS 5528	S17700	53	AMS 5668	N07750	21
AMS 5529	S17700	53	AMS 5678	S17700	21
AMS 5532	R30155	34	AMS 5680	S34781	7
AMS 5536	N06002	43	AMS 5689	S32100	9
AMS 5537	R30805	58	AMS 5694	S31080	—
AMS 5542	N07750	21	AMS 5698	N07750	21
AMS 5545	N07041	40	AMS 5699	N07750	21
AMS 5547	S35500	44	AMS 5706	N07001	49
AMS 5548	S35000	28	AMS 5712	N07041	40
AMS 5549	S35500	44	AMS 5713	N07041	40
AMS 5554	S35000	28	AMS 5731	S66286	10
AMS 5556	S34700	7	AMS 5732	S66286	10
AMS 5557	S32100	9	AMS 5734	S66286	10
AMS 5570	S32100	9	AMS 5737	S66286	10
AMS 5571	S34700	7	AMS 5743	S35500	44
AMS 5572	S31008	8	AMS 5745	S35000	28
AMS 5575	S34700	7	AMS 5754	N06002	43
AMS 5576	S32100	9	AMS 5759	R30605	58
AMS 5577	S31008	8	AMS 5763	S45000	73
AMS 5581	N06625	67	AMS 5768	R30155	34
AMS 5589	N07718	55	AMS 5769	R30155	34
AMS 5591	S41000	5	AMS 5773	S45000	73
AMS 5596	N07718	55	AMS 5798	N06002	43
AMS 5597	N07718	55	AMS 5852	—	64
AMS 5599	N06625	67	AMS 5862	S15500	72
AMS 5604	S17400	39	AMS 5863	S45000	73
AMS 5610	S41623	36	AMS 5865	—	82
AMS 5613	S41000	5	AMS 6260	G93106	19
AMS 5616	S41800	62	AMS 6263	—	68
	S42020		AMS 6265	G93106	19
AMS 5620	(Type II)		AMS 6267	G93106	19
	S42023	25	AMS 6280	G86300	6
	(Type I)		AMS 6281	G86300	6

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TABLE-APP I. Cross index of SAR material designation to
UNS number and ISN number - Continued.

SAR Material designation	UNS number	ISN number
AMS 6302	K23015	1
AMS 6322	G87400	11
AMS 6323	G87400	11
AMS 6350	G41300	12
AMS 6351	G41300	12
AMS 6355	G86300	6
AMS 6358	G87400	11
AMS 6330	G41300	12
AMS 6370	G41300	12
AMS 6371	G41300	12
AMS 6381	G41400	13
AMS 6382	G41400	13
AMS 6395	G41400	13
AMS 6414	G43400	14
AMS 6415	G43400	14
AMS 6416	K44220	80
AMS 6440	G52986	41
AMS 6448	G61500	15
AMS 6450	G61500	15
AMS 6455	G61500	15
AMS 6470	K24065	20
AMS 6471	K24065	20
AMS 6475	K52355	35
AMS 6487	T20811	31
AMS 6490	T11350	42
AMS 6512	K92890	59
AMS 6514	K93120	61
AMS 6530	G86300	6
AMS 6550	G86300	6

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APPENDIX

TABLE-APP II. Cross reference of Commercial material designation to UNS number and ISN number.

Commercial material designation	UNS number	ISN number	Commercial material designation	UNS number	ISN number
M 3301	A97178	46	M 3705	S35000	28
M 3302	A97178	46	M 3706	K92890	59
M 34AC	R56260	69	M 3707	—	52
M 3400	R56400	22	M 3709	S35000	28
M 3403	R56400	47	M 3710	—	44
M 3408	R56400	70	M 3712	—	74
M 3502	—	45	M 4000	G10200	24
M 3504	R30805	58	M 4001	G52986	41
M 36BB	—	78	M 4002	K24065	20
M 36BE	—	79	M 4003	G43400	14
M 36BP	N13100	81	M 4004	G93108	19
M 3603	N09979	26	M 4005	—	30
M 3604	N07702	29	M 4006	T20811	31
M 3606	N07718	55	M 4007	T12005	32
M 3611	N07041	40	M 4008	—	33
M 3612	—	54	M 4010	T11350	42
M 3613	—	64	M 4016	G10400	50
M 3614	N06002	43	M 4019	—	75
M 3615	—	63	M 4025	—	12
M 3617	—	66	M 4026	—	13
M 3621	—	76	M 4028	—	51
M 3625	—	77	M 4050	F43003	38
M 3628	—	78	M 4100	K23015	1
M 3629	—	79	M 4140	K23015	1
M 3630	N13100	81	M 4340	—	2
M 3702	—	10	M 4341	—	5
M 3703	—	44	R 235	—	27
M 3704	K93120	61	(Hastalloy)		

NOTE: Table II contains material designations used in P6000N (see 6.3, Supersession data).

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