Technical Data Sheet

ATI 15-7™

Semi-Austenitic Stainless Steel

(UNS S15700)

INTRODUCTION

ATI 15-7™ Precipitation Hardening Alloy (S15700, AISI Type 632) is a chromium-nickel-molybdenum-aluminum semi-austenitic precipitation hardening stainless steel used for applications requiring high strength and a moderate level of corrosion resistance.

The S15700 alloy is similar to ATI 17-7 Precipitation Hardening Alloy (S17700). The S15700 alloy is designed with substitution of approximately 2.0 percent molybdenum for 2.0 percent chromium in the S17700 alloy. This results in somewhat higher room and elevated temperature strength for the S15700 alloy. The S15700 alloy has been available for a number of years and has found application in aerospace and many spring type applications requiring high strength.

The ATI 15-7 precipitation hardening alloy may be formed in a soft austenitic condition and hardened to a high strength level by low temperature heat treatments. The low temperature heat treatment required for developing high strength allows minimum distortion compared to conventional quench and temper hardening processes. In addition to material produced by the standard refining procedures, material which has been vacuum arc or electroslag re-melted is available for further increase in resistance to fatigue, for those applications subject to cyclic stresses.

SPECIFICATIONS & CERTIFICATES

The ATI 15-7 Precipitation Hardening Alloy is covered by the following specifications

Specification	Product Form
AMS 5520	Sheet, Strip and Plate
AMS 5657	Bars and forgings
AMS 5812	Weld Wire
AMS 5813	Weld Wire
ASTM A 461	Bars, Forgings and Forging Stock
ASTM A 564	Bars, Wire and Shapes
ASTM A 579	Forgings
ASTM A 693	Plate, Sheet and Strip
ASME A 705	Forgings
MIL S-8955	Plate, Sheet and Strip

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Chemical in Weight Percent per AMS 5520	
Carbon	0.09
Manganese	1.00
Phosphorus	0.040
Sulfur	0.030
Silicon	1.00
Chromium	14.00-16.00
Nickel	6.50-7.75
Molybdenum	2.00-3.00
Aluminum	0.75-1.5
Iron	Balance

PRODUCT FORMS

The ATI 15-7 precipitation hardening alloy is furnished as plate, sheet and strip from ATI. In all forms, the material is furnished in the annealed condition. In strip forms, the material may be provided in a cold rolled condition suitable for direct precipitation hardening heat treatment.

PHYSICAL PROPERTIES

	Condition A	Condition RH 950	Condition TH 1050
Density lb/in^3 g/cm^3	0.282 7.80	0.277 7.67	0.277 7.67
Linear Coefficient of Thermal Expansion Units of 10^{-6}/°F (10^{-6}/°C)			
Temperature Range			
70 - 200°F (21 - 93°C)	8.0 (14.4)	5.0 (9.0)	6.1 (11.0)
70 - 400°F (21 - 204°C)	8.0 (14.4)	5.4 (9.7)	6.1 (11.0)
70 - 600°F (21 - 316°C)	8.5 (15.3)	5.6 (10.1)	6.1 (11.0)
Magnetic Permeability	Weakly Ferromagnetic	Strongly Ferromagnetic	Strongly Ferromagnetic
Strongly Ferromagnetic in Conditions R and T			
Thermal Conductivity	Btu-ft/h-ft^2-°F (W/m-K)		

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70°F 200°F 400°F	(21°C) (93°C) (204°C)	- - -	8.7 9.3 10.2	(15.1) (16.2) (17.7)	8.7 9.3 10.3	(15.1) (16.2) (17.9)
Electrical Resistivity	approximately 82 microhm-cm in annealed or hardened conditions					

MECHANICAL PROPERTIES

Elastic Modulus (Typical Values)

	Condition A	Condition RH 950	Condition TH 1050
Modulus of Elasticity Units of 106 psi	28 (195)	28 (195)	28 (195)

Room Temperature Properties (Typical Values) Sheet and Strip

	Condition A	Condition RH 950	Condition TH 1050
0.2% Yield Strength, psi (MPa)	55,000 (380)	220,000 (1515)	200,000 (1380)
Ultimate Tensile Strength, psi (MPa)	125,000 (860)	245,000 (1690)	210,000 (1450)
Elongation (%)	30	6	6
Hardness, Rockwell	88 B	48 C	43 C

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Elevated Temperature Properties

The following are short time elevated temperature tensile property comparisons of the S15700 and S17700 alloys.

Property and Temperature	Condition RH 950		Condition TH 1050	
	S15700	S17700	S15700	S17700
70°F (21°C)				
0.2% offset Yield Strength psi, (MPa)	220,000 (1515)	200,000 (1380)	200,000 (1380)	175,000 (1205)
Ultimate Tensile Strength psi (MPa)	245,000 (1690)	225,000 (1550)	210,000 (1450)	195,000 (1345)
Elongation % in 2"	6	7	6	8
300°F (149°C)				
0.2% offset Yield Strength psi, (MPa)	205,000 (1415)	192,000 (1325)	190,000 (1310)	170,000 (1170)
Ultimate Tensile Strength psi (MPa)	228,000 (1570)	208,000 (1435)	198,000 (1365)	179,000 (1235)
Elongation % in 2"	4	5	5	8
600°F (316°C)				
0.2% offset Yield Strength psi, (MPa)	178,000 (1225)	169,000 (1165)	172,000 (1185)	155,000 (1070)
Ultimate Tensile Strength psi (MPa)	205,000 (1415)	189,000 (1305)	180,000 (1240)	162,000 (1115)
Elongation % in 2"	5	5	5	4

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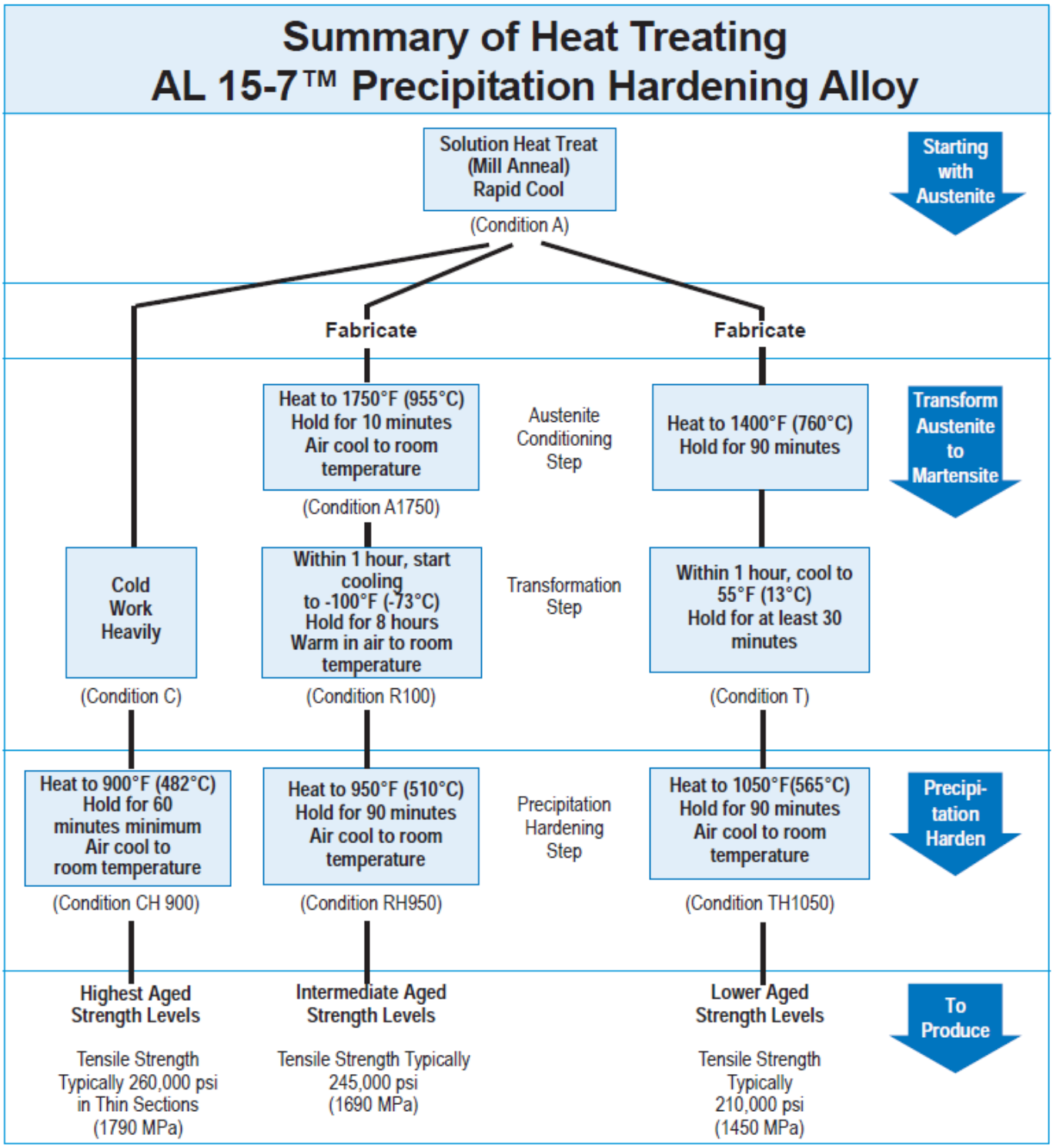
Summary of Heat Treating AL 15-7™ Precipitation Hardening Alloy



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CORROSION RESISTANCE

Tests show that the corrosion resistance of ATI 15-7 alloy approaches that of Type 304 stainless steel in most media. In general, the corrosion resistance of ATI 15-7 Precipitation Hardening alloy is superior to that of the hardenable 400 series stainless steels.

WELDABILITY

The ATI 15-7 precipitation hardening alloy is weldable by conventional inert gas welding methods. Welding behavior is similar to ATI 17-7 Precipitation Hardening Alloy (S17700). The precipitation hardening reaction in the alloy is dependent on the presence of aluminum, a reactive element. For this reason, inert gas methods are used to protect against the loss of aluminum.

One effect of the molybdenum addition to the ATI 15-7 alloy is an increased amount of ferrite in the weld deposit in comparison to the ATI 17-7 alloy.

One of the desirable features of the ATI 15-7 alloy is the elimination of the need for preheating and postweld annealing procedures needed for conventional hardenable stainless steel materials.

HEAT TREATMENT

The ATI 15-7 alloy is furnished in the annealed condition referred to as Condition A. In this condition, the material contains a metallurgical structure which is primarily austenite. As an austenitic material, the ATI 15-7 alloy possesses a relatively low strength. This is the condition in which formability is easiest.

To develop the high precipitation hardened strength of the material, material in Condition A is further heat treated to accomplish two necessary steps. The first is a heat treatment which allows the relatively stable austenite of Condition A to transform to martensite (Austenite Conditioning and Transformation). The second is a precipitation hardening heat treatment to further strengthen the material.

The austenite is easier to transform to martensite using a lower temperature heat treatment than the 1950°F of Condition A. For this reason, Condition TH 1050 uses a 1400°F (760°C) heat treatment to produce a martensite transformation around room temperature, and this is followed by a precipitation hardening heat treatment at 1050°F (565°C).

If Condition RH 950 is desired, the austenite conditioning heat treatment is conducted at 1750°F (955°C). In this case, the martensite transformation is not complete until the material is held for some time at -100°F (- 73°C). When the transformation is complete, the material is precipitation hardened at 950°F (510°C) to Condition RH 950.

Because the precipitation hardened reaction can be driven past peak strength by high temperature or excessive time at the aging temperature, higher temperature or longer time precipitation hardening heat treatments than the standard heat treatments may produce lower strength levels.

When ATI 15-7 alloy in Condition A is cold worked with substantial deformation, a transformation to martensitic structure is produced by the deformation. In this condition, Condition C, the material may be precipitation hardened directly by heat treatment at 900°F (482°C) to condition CH 900. This is the highest strength condition of material, but the strength is achieved at a cost of low tensile ductility.

The heat treatments used for the ATI 15-7 Precipitation Hardening Alloy are summarized on page 5.

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