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MARAGING
DATA SHEET

HIGH STRENGTH MARAGING STEEL

CHEMISTRY

Nominal Analysis	C	SI	MN	NI	CO	MO	TI	AL	FE
C250	.03max	.10max	.10max	18.50	7.50	4.80	.40	.10	Bal
C300	.03max	.10max	.10max	18.50	9.0	4.80	.60	.10	Bal
C350	.03max	.10max	.10max	18.50	12.0	4.80	1.40	.10	Bal

GENERAL CHARACTERISTICS

Maraging is a 18% nickel, cobalt strengthened steel (C-type) with excellent properties, workability and heat treatment characteristics. Maraging is double vacuum melted by VIM (Vacuum Induction Melt) followed by VAR (Vacuum Arc Remelt). Maraging material is supplied in the annealed and descaled condition. The alloy is very tough, relatively soft (RC 30/35), readily machined or formed. Maraging provides a high value for critical parts in aerospace, structural, component and tooling applications.

MARAGING

***MAR**tensitic - a very hard form of steel crystalline structure
*Subsequent **AGING** (precipitation hardening -approx 3-6 hours @ 900ºF yields optimum material characteristics)

***SPECIFICATIONS:**

AMS 6512 = C250 maraging
AMS 6514 = C300 maraging
AMS 6515 = C350 maraging
Mil-S-46850 (applies to all grades) – **FRACTURE TOUGHNESS APPLIES**

MACHINING

Machinability of annealed maraging steels is comparable to steels such as 4340 at the same hardness level (Rc30/35). However, when the material is aged (heat treated), the choice of cutting tools and machining conditions become very important. Rigid equipment, very sharp tools, and an abundance of coolant are essential.

PHYSICAL PROPERTIES	C250	C300	C350
Density	.289 lbs./cu.in.	.289 lbs./cu.in.	.292 lbs./cu.in.
Average Coefficient of Thermal Expansion	5.6×10^{-6} in./ in./ ºF	5.6×10^{-6} in./ in./ ºF	6.3×10^{-6} in./ in./ ºF
Modulus of Elasticity	27.0×10^{-6} psi	27.5×10^{-6} psi	29.0×10^{-6} psi

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HEAT TREATMENT

Maraging alloys are essentially carbon-free, a protective atmosphere is not required during annealing or aging. Material is supplied in the solution annealed condition with a hardness of 30/35 Rc. Typical heat treat time/temperature are listed below. Large cross sections should be aged for longer periods.

AGING (heat treatment)

	*AGING TEMP	*AGING TIME	*RESULTING HARDNESS
Maraging 250	900/925 ºF	6 hrs.	48/52 Rc
Maraging 300	900/925 ºF	6 hrs.	50/55 Rc
Maraging 350	900/925 ºF	6 hrs.	55/60 Rc
	Or 950 ºF	3 hrs.	56/60 Rc

Typical - Round Bar Minimum Properties After Aging (Longitudinal Direction)	Rc	Tensile Strength ksi	0.2% Yield Strength ksi	Elongation in 4.5√A %	Reduction of Area %
250	50	254	248	11.0	53
300	54	293	286	10.0	46
350	57	342	336	6.2	28

NOTE: A modified aging cycle is suggested for die casting applications for increased die life. The following thermal treatments have been used to obtain desirable characteristics for die casters. Following the rough machining of the die, anneal at 1500-1525 ºF for 1 hour per inch of thickness is typical. After finish machining, an aging heat treatment of 980-1000 ºF for 6 hours is typical.

AVAILABILITY

Maraging is available as billet, bar, rod, plate, sheet and customized forgings.

ADVANTAGES OF MARAGING

EXCELLENT MECHANICAL PROPERTIES

*high yield and ultimate tensile strengths
*high fatigue strength
*high toughness, ductility and impact strengths
*high compressive strength
*hardness and wear resistance sufficient for many tooling applications

EXCELLENT WORKABILITY

*high resistance to crack propagation
*good weldability w/o preheating or post heating
*readily formed – cold, warm, hot (w/o in process anneals)
*excellent polishability

EXCELLENT HEAT TREATMENT CHARACTERISTICS

*low furnace temps required
*uniform, predictable shrinkage during heat treatment
*through hardening w/o quenching
*minimal distortion during heat treatment (.0009 in/in C250 // .001 in/in C300)
*precipitation hardening, aging heat treatment
*freedom from carburization or decarburization

ADVANTAGES DURING APPLICATION

*low coefficient of expansion minimizes heat checking
*good repair weldability
*easily reworked and retreated for secondary tool life
*pitting and corrosion resistance superior to common tool steel
*excellent mechanical properties have led to longer tool life

The technical information, presented in this department are representative only, and are **not** guaranteed values.