

REVISED MARCH 1963

NONFERROUS ALLOYS

1. **GENERAL**
This cobalt base alloy is one of a group of naturally hard and wear resistant alloys, which also possess exceptional heat and corrosion resistance and which retain their high hardness up to high temperatures. Stellite 6 is the softest but strongest and most ductile alloy of this group of Stellites. It is available in the form of sand and investment castings and also as bare and coated welding wire for hard surfacing.

- 1.01 Commercial Designation. Stellite 6.
1.02 Alternate Designations. Haynes Stellite Alloy No. 6.
1.03 Specifications. Table 1.03.

AMS	Form	Military
5373 A	Casting, sand	
5387	Casting, prec invest	
5788	Rod, for coating welding	MIL-R-17131 A MIL-R-R CoCr A

- 1.04 Composition. Table 1.04.

Source	AMS (1X2)		AMS (3)	
	Percent		Percent	
	Min	Max	Min	Max
Nickel	-	3.00	-	3.00
Chromium	27.0	31.0	26.0	30.0
Tungsten	3.5	5.50	3.50	5.50
Iron	-	3.00	-	3.00
Carbon	0.90	1.40	0.90	1.40
Silicon	-	1.50	0.70	1.50
Manganese	-	1.00	-	0.50
Molybdenum	-	1.50	-	1.00
Cobalt	Balance		Balance	

- 1.05 Heat Treatment
1.051 Stress relief. Heat slowly to 1650 F, 2 hr minimum, furnace cool. For maximum machinability 1650 F, 4 hr, furnace cool, (4).
1.06 Hardenability. The alloy is naturally hard due to its high content of carbides and its properties are not appreciably affected by heat treating.
1.07 Forms and Conditions Available
1.071 Investment castings are available in the as cast condition.
1.072 Sand castings are available in the as cast or stress relieved condition.
1.073 Cast coated electrodes and welding wire are available in straight lengths with thicknesses from 1/8 to 3/8 in.
1.08 Melting and Casting Practice. Electric furnace air melt, combined with common sand and investment casting methods.
1.09 Special Considerations

2. **PHYSICAL AND CHEMICAL PROPERTIES**

- 2.01 Thermal Properties
2.011 Melting temperature. 2327 F approximately, (4).
2.012 Phase changes. None.
2.013 Thermal conductivity. 8.6 Btu ft per (hr sq ft F), (4).
2.014 Thermal expansion. Fig. 2.014.
2.015 Specific heat
2.02 Other Physical Properties
2.021 Density. 0.303 lb per cu in, 8.38 gr per cu cm, (4).
2.022 Electrical resistivity. 35.8 microhm in, (4).

- 2.023 Magnetic properties. Alloy is nonmagnetic. Permeability at 200 oersteds, less than 1.2, (4).
2.03 Chemical Properties
2.031 Corrosion resistance. Alloy has a high resistance to a variety of corrosive media, but it is inferior to many nickel base alloys.
2.032 Oxidation resistance. is good to about 2000 F, (4).
2.04 Nuclear Properties

	Co
28	Cr
5	W
1	C

STELLITE 6

3. **MECHANICAL PROPERTIES**

- 3.01 Specified Mechanical Properties
3.011 AMS 5373 A specifies that sand castings shall have a hardness of 40 RC minimum, (1).
3.012 AMS 5387 specifies that precision investment castings shall have a hardness of 37 RC minimum as cast, (2).
3.02 Mechanical Properties at Room Temperature
3.021 The hardness of about 40 RC is not changed by exposure up to 2000 F.
3.022 Typical mechanical properties of precision investment castings and hard surfacing deposits, Table 3.022.

Source	(4)	(5)
	Investment Castings	Hard Surfacing Deposit
F _{tu} - ksi	115	110
F _{ty} - ksi	96	-
e - percent	3	1
RA - percent	3	-
Hardness, RC	41	37* 40 to 43**
IE -ft lb Izod Smooth	4	

- * Metallic arc deposit (2 layers)
** Oxy-acetylene deposit

- 3.03 Mechanical Properties at Various Temperatures
3.031 Short time tension properties. F_{tu} of precision investment castings at 1500 F = 70 ksi, (4).
3.032 Short time properties other than tension. Effect of test temperature on compressive yield strength of sand cast test bars, Fig. 3.032.
3.033 Static stress concentration effects.
3.04 Creep and Creep Rupture Properties
3.05 Fatigue Properties
3.06 Elastic Properties
3.061 Compressive modulus of elasticity. 32,400 ksi for temperatures from 70 to 600 F, (5).
3.062 Poisson's ratio. 0.27, (5).

4. **FABRICATION**

- 4.01 Forming and Casting
4.02 Machining
4.021 General. This alloy can be machined with carbide tools. Precision investment castings should be stress relieved before machining at 1650 F, 4 hr, followed by furnace cooling, (4).
4.022 Turning tools should have a 5 degree primary clearance, 10 degree secondary clearance and a lead angle of 45 degrees, (4).
4.023 Boring and drilling requires tools with equal or greater clearances, slightly slower speeds and feeds, and lower depth of cut than those for turning and facing, (4).
4.024 Grinding. The alloy should be ground wet. If it is ground dry, it should be allowed to cool slowly to avoid surface

CODE 4304

PAGE 1

	Co
28	Cr
5	W
1	C

STELLITE 6

- checking. Grinding wheels should be slightly softer than those used to grind high speed steel. (4).
- 4.03 Welding
The alloy can be welded by oxy-acetylene, metallic-arc and inert gas shielded arc methods. Pre heating to about 1100 F is recommended in order to avoid cracking. (4).
 - 4.032 Brazing with silver solder can be used to join parts made of this alloy to other alloys. (4).
 - 4.04 Heating and Heat Treating
 - 4.05 Surface Treating

REFERENCES

- 1 AMS 5373 A. (June 1, 1951)
- 2 AMS 5387. (March 1, 1955)
- 3 AMS 5788. (June 15, 1950)
- 4 Haynes Stellite Company. "Haynes Investment-Cast Wear Resistant Alloys". (Nov. 1958)
- 5 Westinghouse Electric Corporation. "Properties of Stellite Nos. 1, 12 and 6". Bettis Plant Materials Manual. (May 1959)

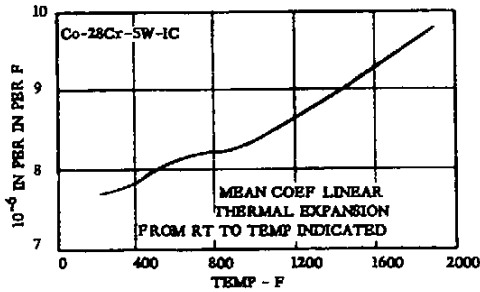


FIG. 2.014 THERMAL EXPANSION

(4)

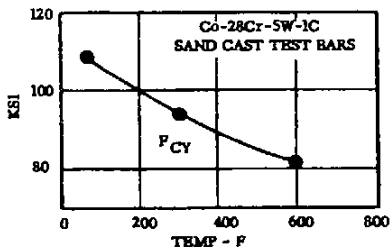


FIG. 3.032 EFFECT OF TEST TEMPERATURE ON COMPRESSIVE YIELD STRENGTH OF SAND CAST TEST BARS

(5)