

## Nickel Iron Alloy Comparison Chart

(For reference only)

CHEMICAL COMPOSITION %							
Chemical Element	Percentage	ASTM F15 Alloy					36 Alloy (Invar)
		(Kovar)	52 Alloy	48 Alloy	46 Alloy	42 Alloy	
Iron	Nominal	Bal	Bal	Bal	Bal	Bal	Bal
Nickel	Nominal	29	50.5	48	46	41	35
Cobalt	Nominal	17					0.50
Manganese	Max.	0.50	0.60	0.80	0.80	0.80	0.60
Silicon	Max.	0.20	0.30	0.30	0.30	0.30	0.40
Carbon	Max.	0.04	0.05	0.05	0.05	0.05	0.05
Aluminum	Max.	0.10	0.10	0.10	0.10	0.10	0.10
Magnesium	Max.	0.10					0.10
Zirconium	Max.	0.10					0.10
Titanium	Max.	0.10					0.10
Copper	Max.	0.20					
Chromium	Max.	0.20	0.25	0.25	0.25	0.25	0.25
Molybdenum	Max.	0.20					
Phosphorus	Max.		0.025	0.025	0.025	0.025	0.015
Sulfur	Max.		0.025	0.025	0.025	0.025	0.015

PHYSICAL PROPERTIES							
Property	Unit	ASTM F15 Alloy					36 Alloy (Invar)
		(Kovar)	52 Alloy	48 Alloy	46 Alloy	42 Alloy	
Density	Lbs/in <sup>2</sup>	0.302	0.300	0.298	0.295	0.293	0.291
Specific Gravity		8.36	8.30	8.25	8.17	8.12	8.05
Specific Heat				0.12	0.12	0.12	0.123
Curie Temperature	°F	815	986	880	860	716	535
Melting Point	°F	2640	2600	2600	2600	2600	2600
Electrical Resistivity	Ohm-cir mil/ft	294	260	290	277	430	495
Thermal Conductivity	BTU/in/ft <sup>2</sup> /hr/°F	120	97	90	79.2	74.5	72.6

Temp. range - °C	Linear coefficient of thermal expansion cm. per cm. per °C x 10 <sup>-6</sup>						
	Kovar - 1	52 Alloy - 2	48 Alloy - 3	46 Alloy - 4	42 Alloy - 5	42-6 Alloy - 6	Invar - 7
30-150	—	—	—	—	—	—	1.2 - 2.7
30-200	—	—	—	—	—	—	—
30-300	—	—	—	—	4.0 - 4.7	—	—
30-350	—	—	—	7.1 - 7.8	—	8.5 - 9.2	—
30-400	4.6 - 5.2	—	8.2 - 9.2	—	—	—	—
30-425	—	—	—	—	—	9.7 - 10.4	—
30-450	5.1 - 5.5	9.6 - 10.1	—	—	6.7 - 7.4	—	—
30-500	—	—	—	8.2 - 8.9	—	—	—
30-550	—	10.2 - 10.7	9.6 - 10.3	—	—	—	—

MECHANICAL PROPERTIES (As Annealed)							
Tensile Strength	PSI x 1000	75	80	79	80	82	65
Yield Strength	PSI x 1000	50	40	36	35	40	40
Elongation	% in 2"	30	35	30	30	30	35
Hardness	Rockwell B	80	80	80	80	80	80
Elastic Modulus	psi x 10(-6)			24	21	21.5	20.5