GENERAL DYNAMICS | CONVAIR

Report No. 8926-171

Material - Nickel Base Alloy - Hastelloy R-235 (Haynes Stellite Co.)

Fusion Weld Strengths

(An Abstract Report)

C. W. Alesch

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Abstract:

Hastelloy R-235 nickel base alloy sheet in the thicknesses and conditions listed below was tungsten inert gas fusion but welded and tested with the following results.

	Weld Strength KSI	Joint Efficiency Percent
0.016", 10% cold worked, welded	117.6	89
0.040", solution heat treated,* welded	128.3	98
0.020", solution heat treated, aged,** welded	137.9	86
0.040", solution heat treated, welded, aged	132.0	94

* 1975°F, water quench
** 1500°F, 2 hours, air cool

Reference: Alesch, C. W., "Material - Nickel Base Alloy - Hastelloy R-235 (Haynes Stellite Co.). Fusion Weld Strengths (An Abstract Report)," General Dynamics/Convair Report 8926-171, San Diego, California, 19 April 1963. (Reference attached).

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Reference: Vermilyea, E. J., Green, E. D., Carr, W. L., Margitan, E., "Fabricability of Materials R-235, L-605, Rene 41, M-252 and J-1650 as Pertaining to Part No. 8-26054," General Dynamics/Convair Report AMR-PR 889, San Diego, California, April 1961.

Haynes Stellite Co. Hastelloy Alloy R-235 in the thicknesses, conditions and strength conditions listed in Table 1 was fusion butt welded by the tungsten inert gas method. The fusion welding schedules employed are given in Tables 2 and 3. The strengths of the welds are given in Table 4. "Five radiographs of fusion welded coupons were studied for porosity and weld continuity. No porosity in or around weldments could be detected on any of the weld specimens, and all welds exhibited good thickness continuity." The efficiencies of the fusion welded R-235 joints were found to be:

1. Ten per cent cold work then welded, - 89%
2. Solution heat treated then welded, - 98%
3. Solution heat treated, aged then welded, - 86%
4. Solution heat treated, welded then aged, - 94%

The solution heat treatment was done at the mill, and consisted of heating at 1975°F and quenching in water. Aging consisted of heating at 1500°F for 2 hours, and air cooling.

Prepared by C. W. Alesch
19 April 1963

Table 1

Mechanical Properties of R-235

Gage (in.)	Cond.	Yield Strength (.2%)	Ultimate Strength (lb)	Elong. %	Average Yield Strength (lb)	Average Ultimate Strength (lb)	Average Elong. %
0.016	C.W.	89,700	129,200	27.0	97,000	131,900	25.7
"	"	90,100	131,600	26.9			
"	"	92,200	134,800	23.2			
0.020	A	108,600	152,400	14.5	107,100	146,500	12.8
"	A	107,400	145,100	13.0			
"	A	105,200	141,000	11.0			
0.040	A	101,100	153,400	16.4	101,000	153,100	15.8
"	A	99,400	151,200	15.8			
"	A	104,000	154,600	15.1			
0.040	S.H.T.	77,400	132,100	38.0	77,700	130,000	39.0
"	"	79,600	126,200	42.0			
"	"	76,100	131,600	37.0			

C.W. - 10% Cold Worked Material
A - Aged Material
S.H.T. - Solution Heat Treated Material

Table 2

Schedule for Welding 0.020 inch to 0.020 inch Annealed
R-235

Current:	DCSP 30 amperes
Voltage:	10 volts
Torch Speed:	15 inches/min.
Electrode:	0.040" diam. 2% thoriated tungsten
Cup Size:	#8
Back-up Gas:	argon
Flow Rate:	16 cu ft/hr
Torch Gas:	argon
Flow Rate:	16 cu ft/hr
Clamp Spacing:	0.125"
Clamp Pressure:	55 lb
Back-up Bar Material:	0.010" copper insert

Table 3

Schedule for Welding 0.040 inch to 0.040 inch Annealed
R-235

Current:	DCSP 50 amperes
Voltage:	10 volts
Torch Speed:	30 inches/min.
Electrode:	1/16" diam. 2% thoriated tungsten
Cup Size:	#8
Back-up Gas:	argon
Flow Rate:	20 cu ft/hr
Torch Gas:	17% argon - 83% Helium
Flow Rate:	50 cu ft/hr'
Clamp Spacing:	5/32"
Clamp Pressure:	80 lb
Back-up Bar Material:	0.010" copper insert

Table 4

Mechanical Properties of Fusion Welded R-235

Gage in.	Cond.	Yield Strength (.2%) (lb)	Ultimate Strength (lb)	Elong. %	Average Yield Strength (lb)	Average Ultimate Strength (lb)	Average Elong. %	Failure
0.016	1	91,100	120,000	6.5	88,900	117,600	5.9	Weld
"	"	86,200	120,100	7.0				"
"	"	87,900	111,900	3.5				"
"	"	90,400	118,400	6.5				"
0.040	2	82,000	131,700	31.0	78,300	128,300	27.5	Adj. Weld
"	"	76,400	126.000	30.0				*P.M.
"	"	77,700	124,300	21.5				Weld
"	"	77,100	131,100	27.5				Adj. Weld
0.020	4	99,400	138,100	10.4	97,900	137,900	9.9	Adj. Weld
"	"	101,000	142,700	9.9				P.M.
"	"	93,400	137,300	11.2				P.M.
"	"	97,700	133,600	8.1				Weld
0.040	3	91,400	134,200	18.0	86,100	132.000	13.7	Weld
"	"	78,800	127,400	13.7				Weld
"	"	90,100	130,800	10.4				Weld
"	"	84,000	135,700	12.6				Adj. Weld

1. 10% cold worked then weld
2. Solution heat treat then weld
3. Solution heat treat, age then weld
4. Solution heat treat, weld then age

*P.M. = parent metal