

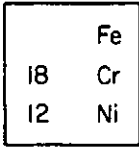
REVISED: MARCH 1972  
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## FERROUS ALLOYS

1. GENERAL  
Type 305 austenitic stainless steel is the member of the 18Cr-8Ni steel family having the highest nickel content considered to be within this classification. It is, therefore, the austenitic stainless steel with the lowest rate of strain hardening. It is used in sheet, strip and plate form for difficult drawing, spinning and other forming operations and in wire form for severe upsetting. It also becomes less magnetic on cold work than other 18-8 steels, particularly Type 301. This steel has a higher carbon content than Type 304 and, therefore, a greater susceptibility to intergranular corrosion after exposure at 800 to 1500F. The properties of this alloy are otherwise nearly identical to those of Type 304.
- 1.01 Commercial Designation  
Type 305
- 1.02 Alternate Designations  
AISI Type 305 austenitic stainless steel, 18-8 FS stainless steel, 18-12 steel, 30305.
- 1.03 Specifications  
Table 1.03.
- 1.04 Composition  
AMS specified chemical composition, Table 1.041.  
1.042 ASTM specified chemical compositions, Table 1.042.
- 1.05 Heat Treatment  
1.051 Anneal or solution heat treat. 1850 to 2000F, 1/2 to 1 hr per in thickness, 2 hr minimum for plate, air cool or quench, depending on section size. Cooling to 800F maximum should be within 3 minutes.
- 1.06 Hardness  
This steel can be hardened only by cold working, and this to a lesser degree than the other steels of the 18-8 family.  
1.061 Typical hardness for annealed and soft temper conditions. 78 to 82 Rockwell B, (94 maximum) (14).  
1.062 Effect of cold rolling on hardness of various 18-8 stainless steel sheets, Figure 1.062.
- 1.07 Forms and Conditions Available  
This steel is available in plate, sheet, strip, bar, shapes billet, forging and wires. Plate, sheet, strip, bar, shapes and wires may be obtained in hot finished and annealed, cold finished and annealed and cold worked conditions.
- 1.08 Melting and Casting Practice  
Electric arc, electric induction, or other suitable commercial processes.
- 1.09 Special Considerations  
When chromium-nickel steels containing more than about 0.04C are subjected to annealing at temperatures of 1850 to 2050F and are then reheated to or held at temperatures of approximately 800 to 1600F, chromium carbides will precipitate at the austenite boundaries (16, p. 24). This intergranular precipitation or sensitization promotes intergranular corrosion cracking and reduces corrosion resistance of these steels. Heat treatment and welding conditions should be chosen to avoid carbide formation. Additions of columbium and titanium are used to stabilize these alloys and reduce intergranular corrosion sensitivity.
2. PHYSICAL AND CHEMICAL PROPERTIES
- 2.01 Thermal Properties  
2.011 Melting range. 2550 to 2650F.  
2.012 Phase changes. Some transformation from austenite to ferrite (martensite) occurs when alloy is severely cold worked.  
2.0121 Time-temperature-transformation diagrams.
- 2.013 Thermal conductivity. Typical values (16):  
At 212F 9.4 Btu per (hr sq ft)(F per ft)  
At 932F 12.4 Btu per (hr sq ft)(F per ft).  
2.014 Thermal expansion, Table 2.014.  
2.015 Specific heat. 0.12 Btu (lb ft) for 32-212F (16).  
2.016 Thermal diffusivity.
- 2.02 Other Physical Properties  
2.021 Density. 0.29 lb per cu in (16).  
2.022 Electrical properties.  
2.0221 Electrical resistivity. 72.0 microhm - cm at 70F (16).  
2.023 Magnetic properties. This steel is non-magnetic in the annealed condition. It becomes slightly magnetic when severely cold worked as a result of transformation of austenite to ferrite (martensite)(this effect is less pronounced than for the other 18-8 grades).  
2.0231 Effect of cold reduction on permeability at various temperatures at H=200 oersteds, Table 2.0231.  
2.0232 Effect of cold reduction on permeability of cold rolled strip, Figure 2.0232.  
2.024 Emittance.  
2.025 Damping capacity.
- 2.03 Chemical Properties  
2.031 General corrosion resistance of this steel is similar to that of Type 304.  
2.032 This steel is only slightly embrittled by high pressure (10,000 psi) gaseous hydrogen environment, Table 2.032.
- 2.04 Nuclear Properties  
2.041 Effect of neutron irradiation on room temperature tensile properties of annealed bar, Table 2.041.
3. MECHANICAL PROPERTIES
- 3.01 Specified Mechanical Properties  
3.011 AMS specified mechanical properties.  
3.0111 AMS specified mechanical properties for plate, sheet, and strip, Table 3.0111.  
3.0112 AMS specified mechanical properties for wire, Table 3.0112.  
3.012 ASTM specified mechanical properties.  
3.0121 ASTM specified mechanical properties for plate, sheet, and strip, Table 3.0121.  
3.0122 ASTM specified mechanical properties for bar and shapes, Table 3.0122.  
3.0123 ASTM specified mechanical properties of bar for cold heading and cold forging, Table 3.0123.  
3.0124 ASTM specified mechanical properties for tube, Table 3.0124.  
3.0125 ASTM specified mechanical properties for forging, Table 3.0125.  
3.0126 ASTM specified mechanical properties of wire for cold heading and cold forging, Table 3.0126.  
3.0127 ASTM specified mechanical properties of rope wire, Table 3.0127.
- 3.02 Mechanical Properties at Room Temperature  
3.021 Tension.  
3.0211 Stress-strain diagrams.  
3.0212 Typical tensile properties, Table 3.0212.  
3.0213 Effect of cold work on tensile properties.  
3.02131 Range of tensile properties and hardness for various tempers and diameters of cold draw wire, Table 3.02131.  
3.02132 Effect of cold rolling on tensile properties of strip, Figure 3.02132  
3.02133 Effect of cold drawing on tensile properties of bar, Figure 3.02133.  
3.02134 Effect of cold drawing on tensile properties of coiled bar, Figure 3.02134.  
3.022 Compression.  
3.0221 Stress-strain diagrams.  
3.023 Impact.  
3.024 Bending.  
3.025 Torsion and shear.  
3.026 Bearing.  
3.027 Stress concentration.

	Fe
18	Cr
12	Ni

TYPE 305



TYPE 305

- 3.0271 Notch properties.
- 3.0272 Fracture toughness.
- 3.028 Combined properties.
- 3.03 Mechanical Properties at Various Temperatures
- 3.031 Tension.
- 3.0311 Stress-strain diagrams.
- 3.032 Compression.
- 3.0321 Stress-strain diagrams.
- 3.033 Impact.
- 3.034 Bending.
- 3.035 Torsion and shear.
- 3.036 Bearing.
- 3.037 Stress concentration.
- 3.0371 Notch properties.
- 3.0372 Fracture toughness.
- 3.038 Combined properties.
- 3.04 Creep and Creep Rupture Properties
- 3.05 Fatigue Properties
- 3.051 Fatigue crack growth in annealed sheet, (longitudinal or RW orientation), Figure 3.051.
- 3.052 Fatigue crack growth in annealed sheet (transverse or WR orientation), Figure 3.052.
- 3.053 Fatigue crack growth in cold rolled sheet (longitudinal or RW orientation), Figure 3.053.
- 3.054 Fatigue crack growth in cold rolled sheet (transverse or WR orientation), Figure 3.054.
- 3.06 Elastic Properties
- 3.061 Poisson's ratio.
- 3.062 Modulus of elasticity.  $28 \times 10^6$  psi, typical.
- 3.063 Modulus of rigidity.

4. FABRICATION

- 4.01 Formability
- 4.011 General. Forming of this steel differs in various respects from that of Types 301 and 302, but it is similar to that of Type 304. Because of its lower strain hardening, Type 305 requires less power and requires fewer intermediate anneals in multi-stage forming. Its stretch forming ability, however, is lower than that of Types 301 and 302, because of its lower elongation.
- 4.012 Deep drawing of this steel is usually performed with the same or less reduction in the first draw than that of Types 301 and 302, but without intermediate anneals before the second, and possibly further draws. The reductions in these draws should be considerably lower than those possible for Type 301 which needs annealing after each draw. Type 305 also has a greater tendency to become thin at sharp radii than Types 301 and 302. Annealing is necessary if the hardness exceeds 35 to 40  $R_C$ .
- 4.013 Type 305 is preferred for spinning applications because of its lower strain hardening. The surface should be kept clean and free from foreign particles during spinning.
- 4.02 Machining and Grinding
- All 300 series austenitic stainless steels can be machined. Use of high speed or carbide tools, positive feed, and abundant flow of coolant or lubricant is recommended.
- 4.03 Welding
- Thermal properties of this steel should be considered in the design of welded equipment and welding fixtures to minimize warpage or distortion at the weld. Welding rods of similar chemical analysis, or with slightly higher chromium-nickel content, as the base metal should be used. The use of fluxes, coated rods and inert gas shields is recommended.
- 4.04 Surface Treatment
- See ASTM A380-57 "Recommended Practice for Descaling and Cleaning Stainless Steel Surfaces."

TABLE 1.03

Form	AMS	ASTM
Sheet, strip and plate	5514A	A-167, A-240
Bar and billet		A-276, A-314
Tube		A-249
Forging		A-473
Wire; rope and safety	5685D	A-492
Wire, riveting and cold heading	5686A	A-493
Wire, cold finished or cold drawn rounds and shapes		A-580
Wire, weaving		A-478

TABLE 1.041

Source	AMS (1)		AMS (2)		AMS (3)	
Alloy	Fe-18Cr-12Ni (Type 305)					
Form	Plate, sheet, strip		Wire, safety		Wire, riveting	
	Percent		Percent		Percent	
	min	max	min	max	min	max
Carbon	-	0.12	-	0.08	-	0.08
Manganese	-	2.00	-	2.00	-	2.00
Phosphorous	-	0.040	-	0.040	-	0.040
Sulfur	-	0.030	-	0.030	-	0.030
Silicon	-	1.00	-	1.00	-	1.00
Chromium	17.00	19.00	17.00	19.00	17.00	19.00
Nickel	10.00	13.00	10.00	13.00	10.00	13.00
Copper	-	0.50	-	0.50	-	0.50
Molybdenum	-	0.50	-	0.50	-	-
Iron	Balance		Balance		Balance	

TABLE 1.042

Source	ASTM (4)(5)(6)(7)(8)(9)(10)(11)(12)(13)			
Alloy	Fe-18Cr-12Ni (Type 305)			
Form	Sheet, strip and plate; bar and billet; tube; forging; and wire		Bar and wire for cold heading and cold forging	
	Percent		Percent	
	minimum	maximum	minimum	maximum
Carbon	-	0.12	-	0.12
Manganese	-	2.00	-	2.00
Phosphorous	-	0.045	-	0.045
Sulfur	-	0.030	-	0.030
Silicon	-	1.00	-	1.00
Chromium	17.00	19.00	17.00	19.00
Nickel	10.00	13.00	11.00	13.00
Iron	Balance		Balance	

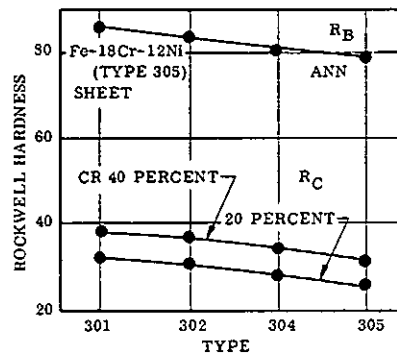


FIG. 1.062 EFFECT OF COLD ROLLING ON HARDNESS OF VARIOUS 18-8 STAINLESS STEEL SHEETS. (19)

TABLE 2.014

Source (16)	
Alloy	Fe-18Cr-12Ni (Type 305)
Temperature Range F	Mean Coefficient of Thermal Expansion 10 <sup>-6</sup> in/in/F
32-212	9.6
32-600	9.9
32-1000	10.2
32-1200	10.4

TABLE 2.032

Source (17)	
Alloy	Fe-18Cr-12Ni (Type 305)
Condition	Anneal + Cold Drawn
Environment	10,000 psi He*      10,000 psi H <sub>2</sub>
F <sub>TU</sub> - ksi	90*      87
F <sub>TY</sub> - ksi	51      -
e(1.25 in) - percent	63      65
RA - percent	78      75
Notch Strength - ksi (K <sub>t</sub> 8.6)	165*      147
RA (Notched Bar) - percent	19      17

\* He was contaminated with H<sub>2</sub>. Strength reported are those for tests in ambient air minus 10 ksi to compensate for effect of 10,000 psi pressure.

Fe
18 Cr
12 Ni
TYPE 305

TABLE 2.0231

Source (15)		
Alloy	Fe-18Cr-12Ni (Type 305)*	
Condition	Anneal + Cold Reduced	
Percent Cold Reduction	Temperature Range - F	Permeability at H = 200 oersteds
0	20-100	1.003
25	20-300	1.005
50	20-871	1.025

C 1.069, Mn 0.94, P 0.021, S 0.013, Si 0.52, Cr 17.19, Ni 11.65

TABLE 2.041

Source (18)		
Alloy	Fe-18Cr-12Ni (Type 305)	
Form	Bar	
Condition	Annealed	
	Unirradiated	Irradiated*
F <sub>TU</sub> - ksi	98.0	103.6
F <sub>TY</sub> - ksi	32.1	71.4

\* Irradiation - 3.9 x 10<sup>19</sup> n/cm<sup>2</sup> at 80C

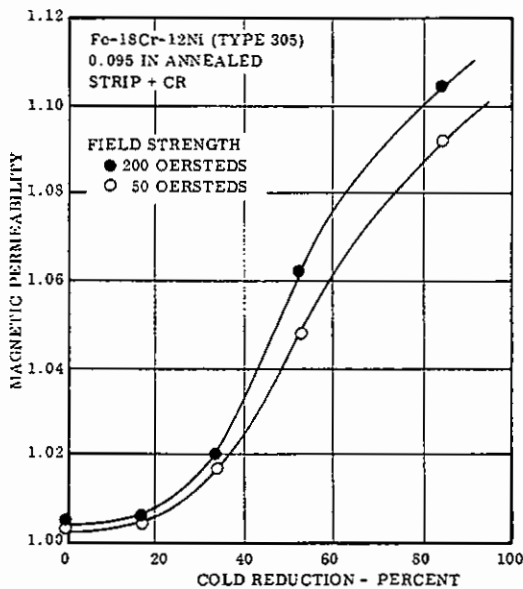


FIG. 2.0232 EFFECT OF COLD REDUCTION ON PERMEABILITY OF COLD ROLLED STRIP. (24)

TABLE 3.0111

Source AMS (1)	
Alloy	Fe-18Cr-12Ni (Type 305)
Form	Plate, sheet, strip
Condition	CR + Sol Treat (sheet, strip) HR + Sol Treat (Plate)
Thickness - inch	< 0.025      ≥ 0.025
F <sub>TU</sub> - maximum* - ksi	100      100
e(2 in) - minimum* percent	45      50

\* L specimens for width < 9 in, T specimens for width ≥ 9 in.

TABLE 3.0112

Source AMS (2)			AMS (3)
Alloy	Fe-18Cr-12Ni (Type 305)		
Form	Wire, safety		Wire, riveting
	coiled	straight	
Condition	Solution treat + cold finish		Solution treat
F <sub>TU</sub> - max - ksi	110	120	110

Fe  
18 Cr  
12 Ni

TYPE 305

TABLE 3.0121

Source	ASTM (4)(5)
Alloy	Fe-18Cr-12Ni (Type 305)
Form	Plate, sheet, strip
Condition	Soft
F <sub>tu</sub> - minimum - ksi	70
F <sub>ty</sub> - minimum - ksi	25
e(2 in) - minimum - percent	40.0
Hardness	
Rockwell B - maximum	94
Brinell - maximum	202

TABLE 3.0125

Source	ASTM (8)
Alloy	Fe-18Cr-12Ni (Type 305)
Form	Forging
Condition	1900F min + WQ or Rapid AC
F <sub>tu</sub> - minimum - ksi	75
F <sub>ty</sub> - minimum - ksi	30
e(2 in) - minimum - percent	40
RA - minimum - percent	50

TABLE 3.0122

Source	ASTM (6)		
Alloy	Fe-18Cr-12Ni (Type 305)		
Form	Bar and Shapes		
Condition	Hot Finish and Annealed	Cold Finish and Annealed	
Size (Dia or Thickness)	all	<1/2 in	>1/2 in
F <sub>tu</sub> - minimum - ksi	75(70)*	90	75(70)*
F <sub>ty</sub> - minimum - ksi	30(25)*	45	30(25)*
e(2 in) - min - percent	40	35	35
RA - minimum - percent	50	45	50

\* extrusions

TABLE 3.0126

Source	(12)			
Alloy	Fe-18Cr-12Ni (Type 305)			
Form	Wire, Cold Heading and Forging			
Diameter	< 0.156 inch		> 0.156 inch	
Condition	Lightly Drafted	Annealed	Lightly Drafted	Annealed
F <sub>tu</sub> - ksi	80-110	75-105	80-100	75-95

TABLE 3.0123

Source	(12)	
Alloy	Fe-18Cr-12Ni (Type 305)	
Form and Size	Bar >1/2 in diameter	
Condition	Lightly Drafted	Annealed
F <sub>tu</sub> - ksi	75-95	70-90

TABLE 3.0127

Source	(11)							
Alloy	Fe-18Cr-12Ni (Type 305)							
Form	Rope Wire							
Condition	Cold Drawn							
Diameter - inch	less than 0.010	0.011 to 0.019	0.020 to 0.040	0.041 to 0.050	0.051 to 0.060	0.061 to 0.070	0.071 to 0.090	0.091 to 0.100
F <sub>tu</sub> - ksi	245	240	235	230	225	220	210	205

TABLE 3.0124

Source	ASTM (9)
Alloy	Fe-18Cr-12Ni (Type 305)
Form and Size	Tube 1/2 to 5 in OD ; 0.035 to 0.32 in wall thickness
Condition	1900F min + WQ or rapid cool
F <sub>tu</sub> - min - ksi	75
F <sub>ty</sub> - min - ksi	30
e(2 in) - min - percent	35*
* For longitudinal strip tests the width of the gage section shall be 1 inch and the basic minimum elongation shall be reduced by 1.75 percent** for each 1/32 inch decrease in wall thickness below 5/16 inch.	
** Not applicable to tubes less than 1/8 inch OD or having wall thickness below 0.015 inch or both.	

TABLE 3.0212

Source	AISI (20)			
Alloy	Fe-18Cr-12Ni (Type 305)			
Form	Plate	Sheet, Strip	Wire	
Condition	Annealed			Soft Temper
F <sub>tu</sub> -typical-ksi	85	85	85	100
F <sub>ty</sub> -typical-ksi	35	38	47	54
e(2 in)-typ-percent	55	50	60	58
RA-typical-percent	-	-	77	74
Hardness - R <sub>B</sub> -typical	-	80	78	82

TABLE 3.02131

Source	(25, p. 6)											
Alloy	Fe-18Cr-12Ni (Type 305)											
Form	Wire											
Condition	Cold Drawn											
Temper	1/4 Hard			1/2 Hard			3/4 Hard			Full Hard		
Diameter - in(a)	A	B	C	A	B	C	A	B	C	A	B	C
$F_{TU}$ - ksi	130 to 165	130 to 160	110 to 130	165 to 200	150 to 190	140 to 160	200 to 250	180 to 230	160 to 190	230 to 300	210 to 260	190 to 220
$F_{TY}$ - ksi	100 to 140	95 to 125	90 to 110	150 to 180	120 to 165	110 to 130	180 to 210	150 to 200	130 to 160	210 to 260	180 to 240	160 to 190
$e(2 \text{ in})$ -percent	20 to 30	15 to 25	20 to 30	12 to 19	11 to 18	12 to 20	7 to 12	6 to 12	8 to 12	1 to 2	2 to 5	3 to 6
Hardness $R_C$	-	-	23 to 28	-	-	29 to 32	-	-	33 to 37	-	-	38 to 43

(a) A - 0.002 to 0.020 inch  
 B - 0.021 to 0.125 inch  
 C - 0.125 to 0.375 inch

Fe
18 Cr
12 Ni

TYPE 305

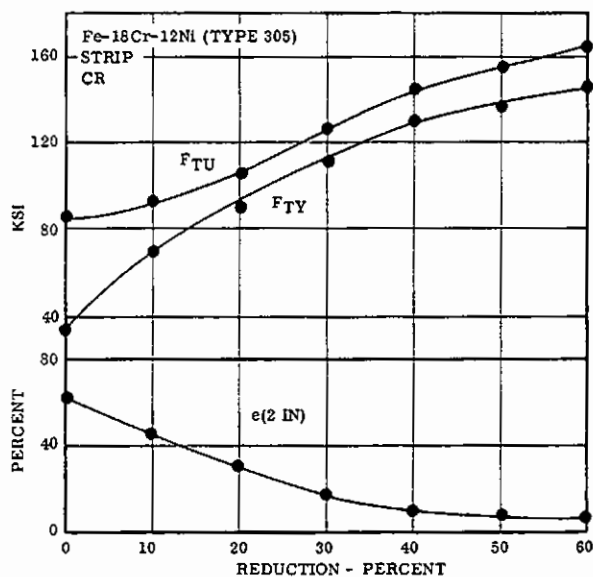


FIG. 3.02132 EFFECT OF COLD ROLLING ON TENSILE PROPERTIES OF STRIP. (21, p. 7)

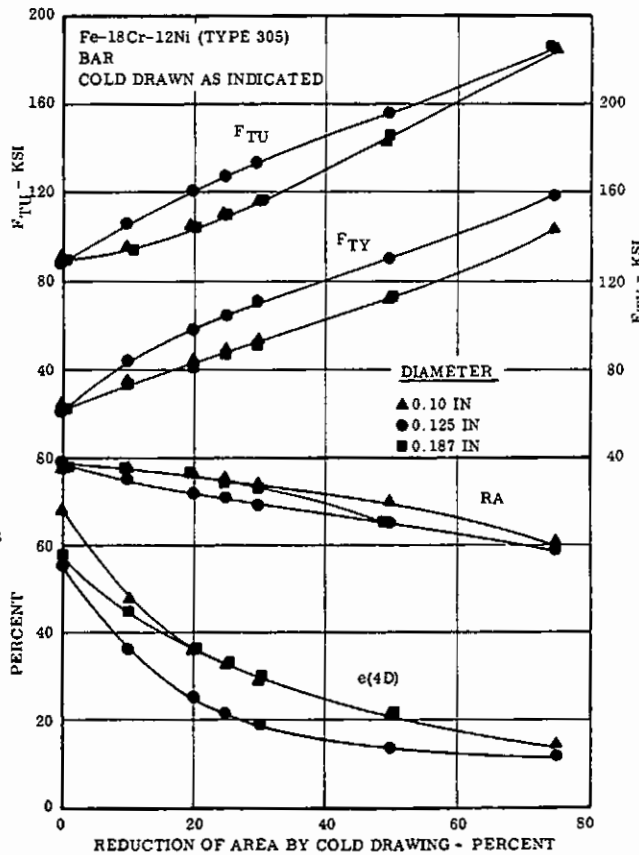


FIG. 3.02133 EFFECT OF COLD DRAWING ON TENSILE PROPERTIES OF BAR. (22)

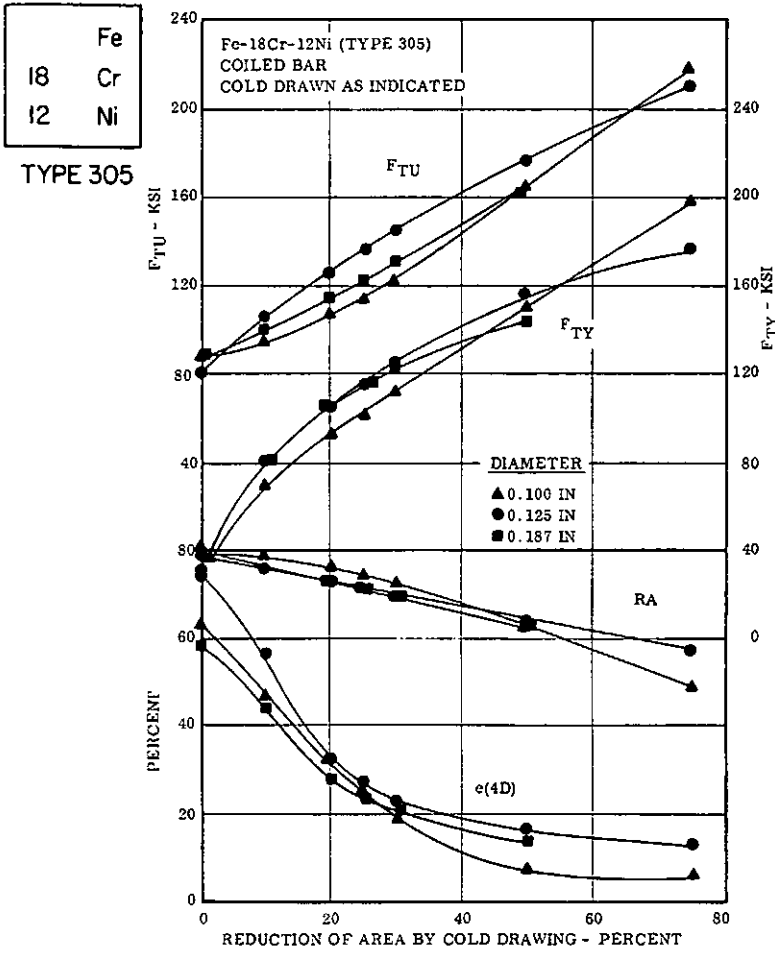


FIG. 3.02134 EFFECT OF COLD DRAWING ON TENSILE PROPERTIES OF COILED BAR. (22)

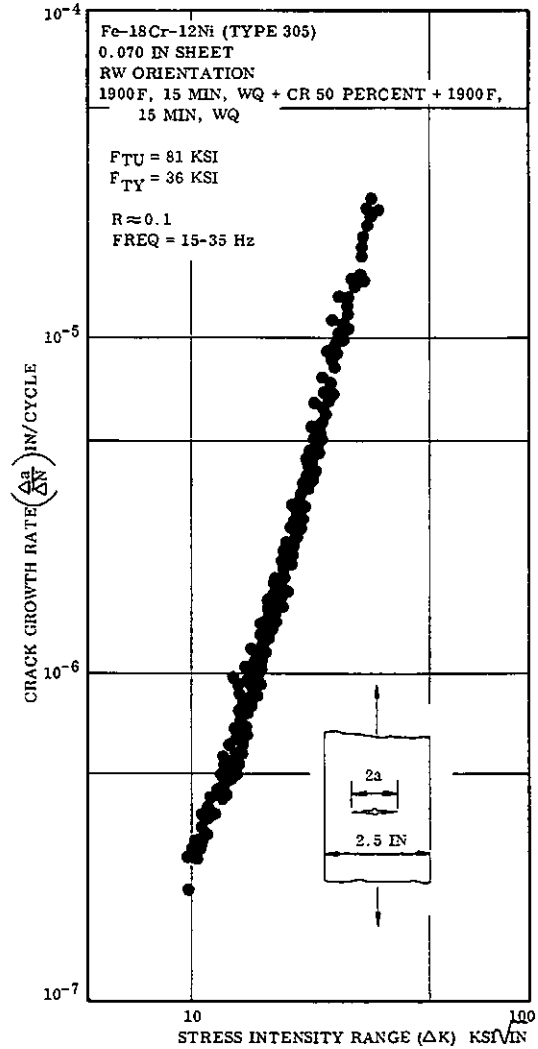


FIG. 3.051 FATIGUE CRACK GROWTH IN ANNEALED SHEET (LONGITUDINAL OR RW ORIENTATION). (23)

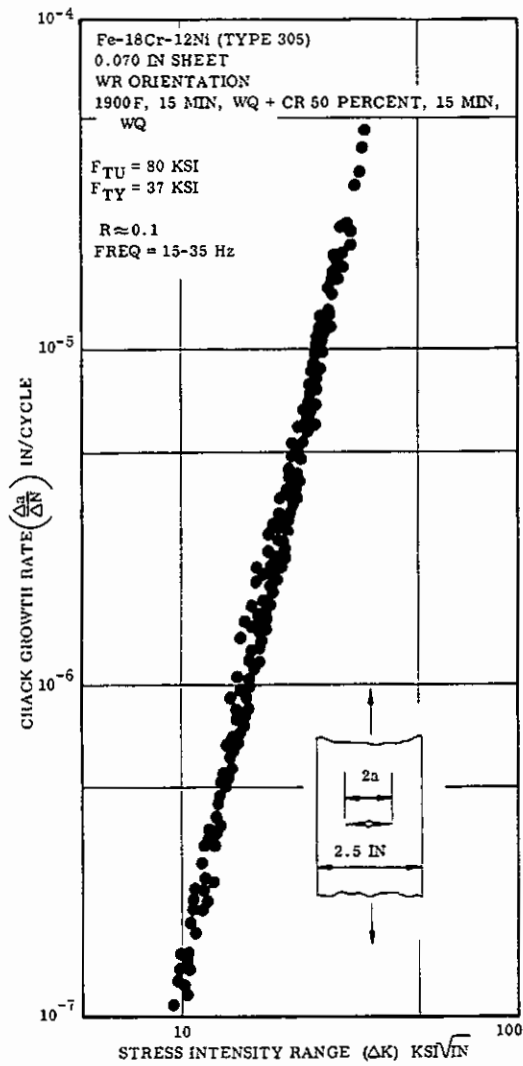


FIG. 3.052 FATIGUE CRACK GROWTH IN ANNEALED SHEET (TRANSVERSE OF WR ORIENTATION). (23)

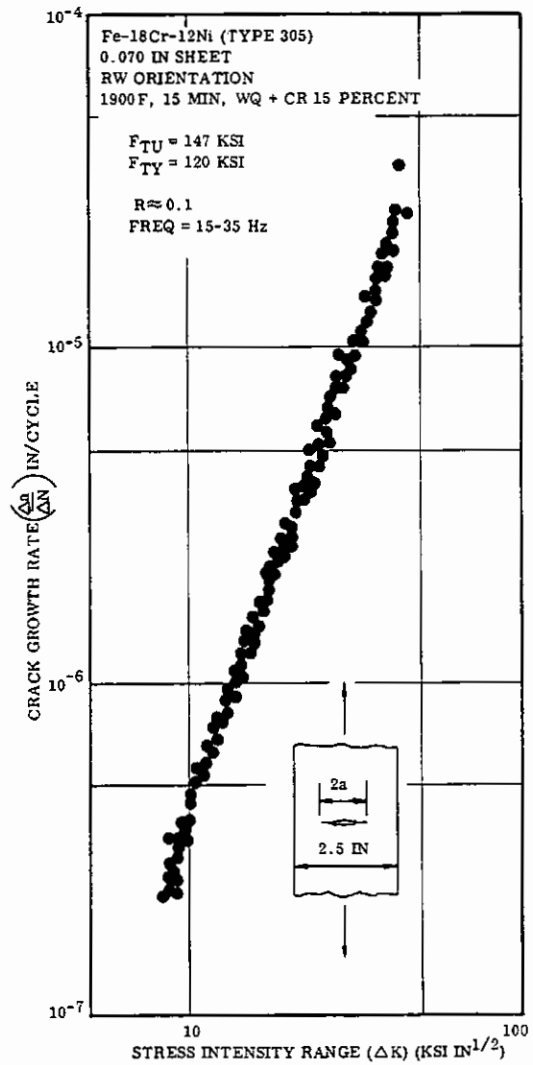


FIG. 3.053 FATIGUE CRACK GROWTH IN COLD ROLLED SHEET (LONGITUDINAL OR RW ORIENTATION). (23)

	Fe
18	Cr
12	Ni

TYPE 305

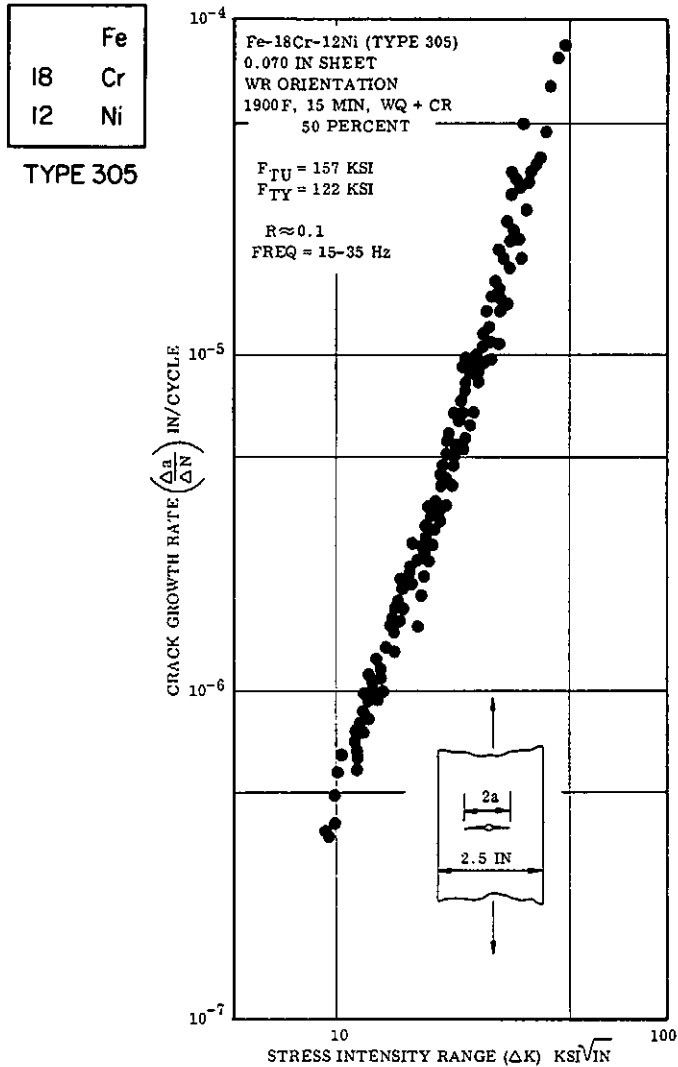


FIG. 3.054 FATIGUE CRACK GROWTH IN COLD ROLLED SHEET (TRANSVERSE OR WR ORIENTATION). (23)

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