

REPORT
ON
SUB-ZERO IMPACT STRENGTHS FOR UNILOY
19-9DL AND 19-9DX ALLOYS

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SUB-ZERO IMPACT STRENGTHS FOR UNILOY
19-9DL AND 19-9DX ALLOYS

Impact tests were carried out at 76°, -104°, and -323°F on three samples of 19-9DL alloy and on three samples of 19-9DX alloy. In each case the treatments used were cold drawn stress-relieved, warm worked and stress-relieved, and annealed by air cooling from 1800°F.

SUMMARY

The impact strengths decreased linearly with decrease in temperature. The annealed material averaged about 10 to 20 foot pounds higher than the cold drawn and warm worked materials. There was little difference between the 19-9DL and 19-9DX materials except for slightly higher strengths for cold drawn 19-9DX material in comparison to the warm worked condition or in comparison to the 19-9DL material cold drawn or warm worked. The annealed materials had an impact strength of about 50 foot pounds at room temperature and 26 foot pounds at -300°F. Cold drawn and warm worked material range from 21 to 35 foot pounds at room temperature and 12 to 14 at -300°F.

TEST MATERIALS

Chemical analyses of the two alloys were reported to be as follows:

Alloy Heat No.	19-9DL <u>C-6889</u>	19-9DX <u>C-6595</u>
C	.30	.31
Mn	1.23	1.28
Si	.64	.58
S	.011	.016
P	.028	.017
Cr	18.95	19.04
W	1.44	1.60
Ni	8.91	8.97
Mo	1.24	1.53
Cu	.16	.13
Cb + Ta	.28	--
Ti	.25	.56

The materials received for testing were described as follows:

<u>Grade</u>	<u>Condition</u>	<u>Bar Length (inches)</u>	<u>Bar Diameter (inches)</u>	<u>Bar Identity</u>
Uniloy 19-9DL	Annealed by air cooling from 1800°F	30	3/4	5B
	Warm worked and stress- relieved to AMS 5722	36	3/4	5A
	Cold drawn and stress- relieved to AMS 5721	36	11/16	2F
Uniloy 19-9DX	Annealed by air cooling from 1800°F	30	3/4	2D
	Warm worked and stress- relieved to AMS 5723	36	3/4	1E
	Cold drawn and stress- relieved to AMS 5724	36	11/16	1G

The following room temperature properties were reported for the annealed and warm worked materials:

<u>Alloy</u>	<u>Condition</u>	<u>Tensile Strength (psi)</u>	<u>0.2% Offset Yield Strength (psi)</u>	<u>Elongation (%)</u>	<u>Reduction of Area (%)</u>
19-9DL	Annealed by air cooling from 1800°F	109,500	50,500	36.5	52.8
19-9DL	Warm worked and stress-relieved to AMS 5722	140,500	119,500	21.0	44.0
19-9DX	Annealed by air cooling from 1800°F	105,000	47,500	34.0	53.0
19-9DX	Warm worked and stress-relieved to AMS 5723	133,000	111,400	20.5	42.6

PROCEDURE

Standard 0.394 inch square Charpy V-notch specimens were machined from the center of the stock submitted. The notch was a 45° V-notch, 0.079 inches deep, with a bottom radius of 0.010 inches. The room temperature tests were carried out at a temperature of 76°F. Tests at -104°F were carried out by immersing the specimens in acetone cooled by dry ice to that temperature. Tests of -323°F were obtained by cooling the specimens in liquid nitrogen. The actual tests were made by removing the samples from the cooling flask with pre-cooled tongs and quickly placing them in the jaws of the Charpy impact tester and breaking them immediately. The impact machine had been recently calibrated to comply with requirements set up for impact testing at low temperatures for Watertown arsenal.

RESULTS

The data obtained from the tests are given in Table 1 and shown as a function of temperature in Figure 1.

In most cases, very close checks were obtained between triplicate samples. In a few cases the spread was somewhat larger than desirable but certainly no more than might have been anticipated for the particular types of material involved.

There was really little difference between the 19-9DL and 19-9DX materials. The only exception was somewhat higher values at -100° and 76°F for the cold drawn and stress relieved 19-9DX material. Impact strengths fell off nearly linearly with temperature. The annealed material showed impact strengths of about 50 pounds at room temperature and about 26 foot pounds at -300°F , whereas the warm worked and cold drawn materials range from 21 to 35 foot pounds at room temperature to between 12 to 14 foot pounds at -300°F .

TABLE 1

CHARPY "V" NOTCH IMPACT DATA FOR 19-9DL AND 19-9DX STEELS FOR
THE TEMPERATURE RANGE OF -323°F to 76°F

<u>Condition of Material</u>	<u>Bar No.</u>	<u>Test Temp. (°F)</u>	<u>Charpy "V" -notch Impact Strength (ft.-lbs.)</u>			
			<u>Specimen Numbers</u>			<u>Average</u>
			<u>1</u>	<u>2</u>	<u>3</u>	
<u>19-9DL-Heat No. C6889</u>						
Annealed by air cooling from 1800°F	5B	76	53.0	53.0	51.0	52.5
		-104	38.5	39.0	37.0	38.0
		-323	23.0	21.5	29.5	24.5
Warm worked and stress- relieved to AMS 5722	5A	76	26.5	26.0	27.5	27.0
		-104	21.0	17.0	18.0	18.5
		-323	11.0	10.5	--	11.0
Cold drawn and stress- relieved to AMS 5721	2F	76	21.0	21.5	22.0	21.5
		-104	18.0	19.5	--	19.0
		-323	10.5	14.5	14.0	13.0
<u>19-9DX-Heat No. C6595</u>						
Annealed by air cooling from 1800°F	2D	76	49.5	50.0	52.0	50.5
		-104	40.0	39.0	37.0	38.5
		-323	24.0	24.5	24.0	24.0
Warm worked and stress- relieved to AMS 5723	1E	76	27.0	25.0	23.5	25.0
		-104	20.0	24.0	19.0	21.0
		-323	13.5	13.5	--	13.5
Cold drawn and stress- relieved to AMS 5724	1G	76	35.0	34.5	34.5	34.5
		-104	25.0	24.0	23.0	24.0
		-323	12.5	12.5	12.0	12.5

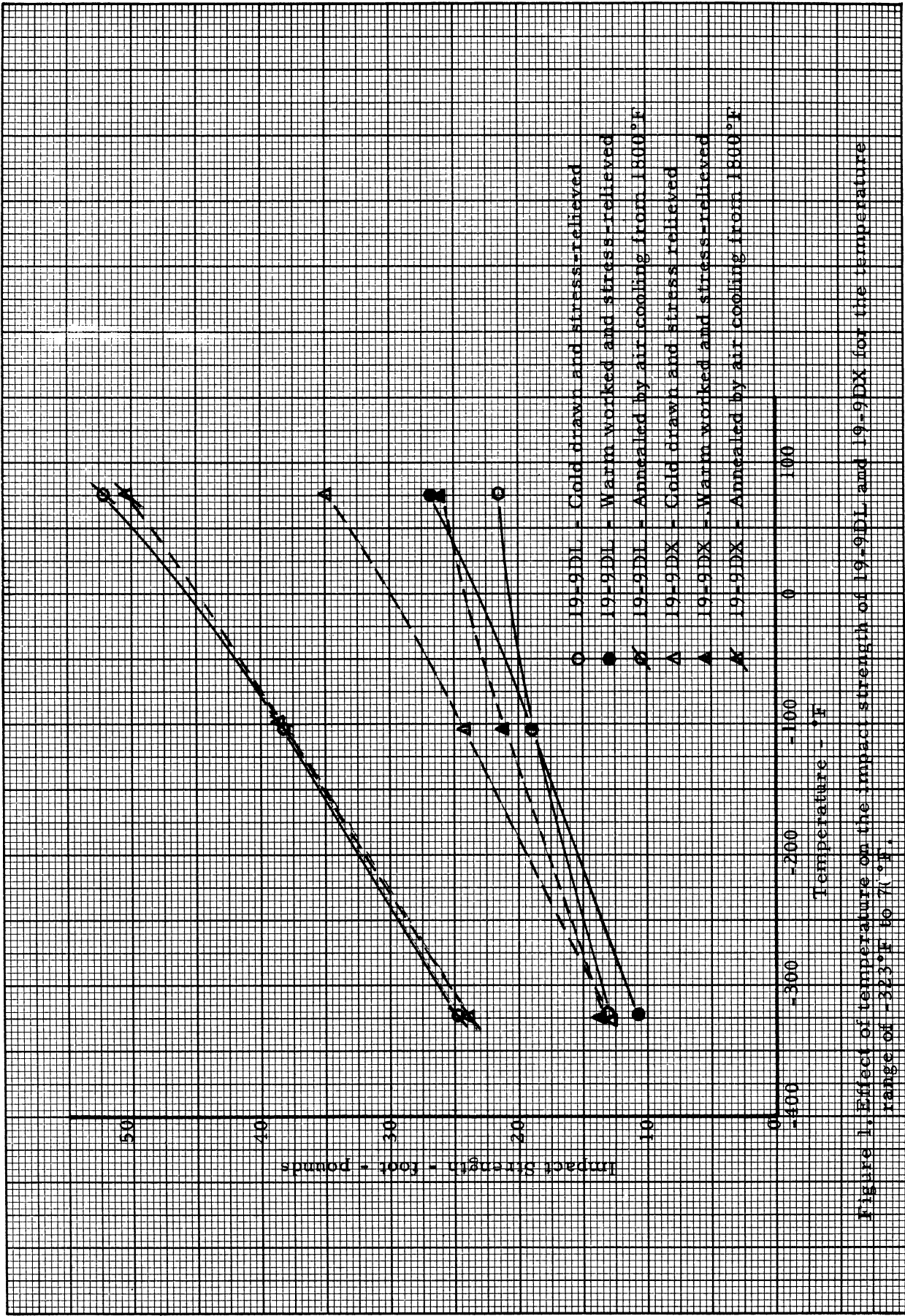


Figure 1. Effect of temperature on the impact strength of 19-9DL and 19-9DX for the temperature range of -323°F to 71°F.

