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ROOM TEMPERATURE TENSILE TESTS OF 15CDV6 (VASCOJET 90) STEEL SHEET MATERIAL

by

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PHYSICAL METALLURGY DIVISION

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Mines Branch Investigation Report IR 66-47

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SUMMARY OF RESULTS

This report presents the results obtained by the Physical Metallurgy Division, (D.M.)**in the round-robin testing of 15CDV6 (Vascojet 90) steel sheet material.

This work is part of an international testing program sponsored and organized by the Structures and Materials Panel of AGARD (NATO). The program is intended to contribute to the standardization of high temperature testing procedures for alloys of the Refractory metals.

The tensile tests reported herein were conducted at room temperature, under conventional conditions and also under the conditions used for the elevated temperature tests of TZM Molybdenum Alloy Sheet Material reported in Mines Branch Investigation Report IR 65-85.

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** D.M. - Signifies Department of Mines & Technical Surveys.

INTRODUCTION

A meeting of the Working Group on Refractory Metal Testing, Structures and Materials Panel, AGARD, was held on the 2nd July 1965, in Paris, France.

As a result of this meeting, it was decided that a quantity of steel sheet would be made available by France, to the laboratories participating in the round-robin refractory metal testing program, for use in an exercise to "check-out" its equipment.

In November 1965, a Progress Report No. 1, was prepared by Mr. Coutsouradis, AGARD Coordinator, outlining the results obtained in the frame of the Materials Group cooperative program on mechanical testing of TZM molybdenum sheet material.

Subsequently, a test program (Supplement No. 1, February 1966), limited to the steel sheet material identified as 15CDV6 (Vascojet 90), was drawn up.

The purpose of this program was stated to be as follows:

(a) to evaluate the dispersion of the results occurring during the determination of room temperature tensile test data under usual conditions.

(b) to evaluate the dispersion of the results occurring during the determination of room temperature tensile test data under the conditions used for tests at elevated temperatures.

This report presents the results obtained by the Physical Metallurgy Division (D.M.) in the round-robin testing of the 15CDV6 (Vascojet 90) material.

TEST MATERIAL

The material used in this program was made available by Sud-Aviation, France. It was identified as 15CDV6 (Vascojet 90) and reported as having a tensile strength similar to that of the TZM molybdenum alloy at a temperature of 1050°C. The material was carefully selected to ensure homogeneity of the samples offered to the Materials Group.

Each participating laboratory received one sheet with dimensions 500 x 150 x 1.5 mm. The sheet received by the Physical Metallurgy Division (D.M.) was identified as No. 5, as shown in Figure 1.

Preliminary tensile tests had been carried out by the Sud-Aviation laboratories. These results are recorded in Table 1.

TEST SPECIMENS

The tensile specimens used were machined according to the recommendations of Appendix 1 of the document relative to the testing program on TZM alloy sheet. The specimen dimensions, as shown in Figure 2, are the same as those used for the TZM material.

TEST CONDITIONS

A) Conventional Tensile Tests at Room Temperature Outside the Vacuum Chamber

For these tensile tests, the furnace and vacuum diffusion pump were swung away from the Instron testing machine. The specimens were secured with pins in the slotted loading adaptors. The top adaptor was attached to the load cell through a universal joint, while the bottom adaptor was provided with a ball and socket connector to ensure axial alignment.

The temperature of the room during all tests was approximately 78°F.

A cross head speed of 0.005 inches per minute was maintained up to an offset of 0.5%. Thereafter, the speed was increased to 0.05 inches per minute until fracture occurred.

In all tests, the percentage elongation was determined over a one inch gauge length, lightly scribed on each specimen.

The ten (10) specimens were tested according to the predetermined scheme of random distribution as shown in Figure 3.

B) Tensile Tests at Room Temperature
Under Elevated Temperature Conditions

The same procedure was followed for this group of tests as had been carried out in part A, with the exception that each specimen was placed in the test chamber under a vacuum of approximately 4×10^{-5} mm Hg.

Ten (10) specimens were tested under these conditions in the order outlined in Figure 3.

C) Tensile Tests at Room Temperature
Inside the Vacuum Chamber
Open to Atmosphere

Since there were a number of extra specimens available, ten (10) specimens were chosen at random and tested inside the vacuum chamber with the chamber door opened.

TEST RESULTS

The yield strengths for 0.2% offset, ultimate tensile strengths, and elongations for specimens tested under the three conditions described in this report are recorded in Table 2.

DISCUSSION OF RESULTS

Analysis of variance of "A" vs "B" vs "C" indicated that the three groups of tensile test results were not significantly different from one another at the 5% level of significance. However, the analysis of variance showed that the testing conditions affected the yield strength at the 10% level of significance. In the case of tests performed in vacuum, the yield strengths were less than those in air (inside and outside the vacuum chamber).

The remarks concerning yield strength apply to a lesser degree to the ultimate tensile strength.

The significance level of variation of percentage elongation was very low.

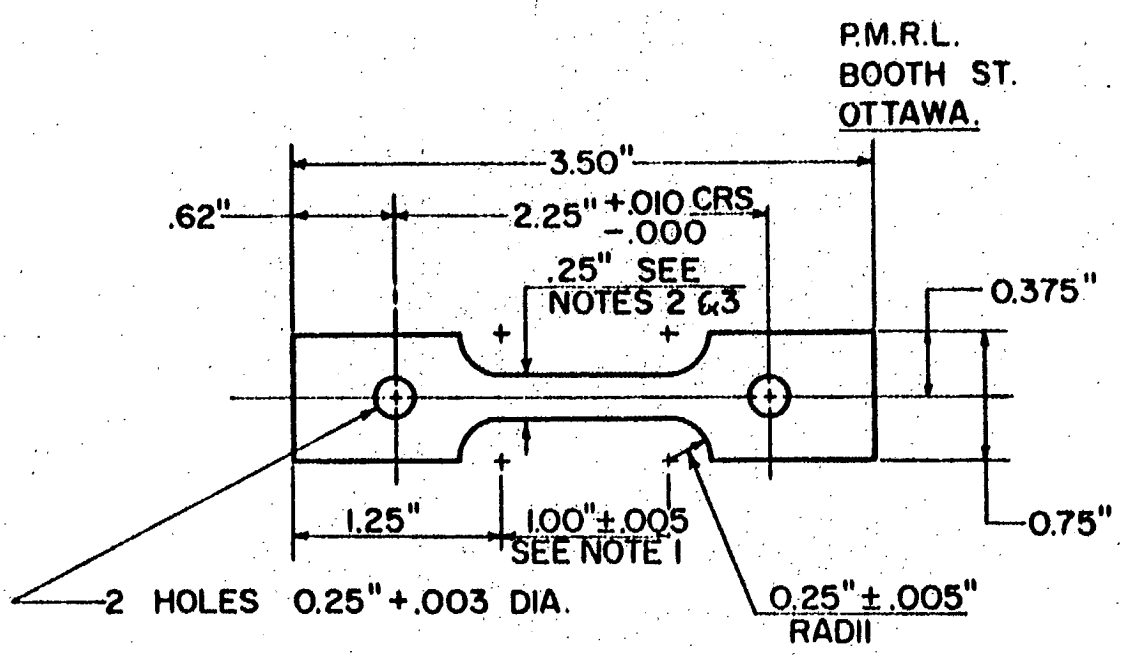
ACKNOWLEDGMENT

The statistical analysis was performed by Mr. D. K. Faurschou of the Physical Metallurgy Division (D.M.)

JH/sg

1. C.E.N	2. T.H.A	3. Sud Aviation
4. C.N.R.M	5. D.M ✔	6. W.P.A.F.B
7. Réserve	8. G.D	9. N.E.L
10. N.A.E.C	11. Pechiney	12. I.M.I

Figure 1. Test Pieces Relative to Original Sheet.



NOTES:

1 - THE POSITIONS OF THE POINTS OF TANGENCY ON THE OPPOSITE EDGES OF THE GAUGE LENGTH MUST BE WITHIN .005" MAX. OF EACH OTHER.

2 - THERE MUST BE NO UNDERCUT OF SHOULDER RADIUS AT POINT OF TANGENCY.(.001" MAX UNDERCUT PERMITTED.)

3 - CENTRE LINE OF GAUGE LENGTH MUST BE WITHIN .002" OF THE CENTRE LINE THROUGH THE HOLES.

4 - SPECIMEN THICKNESS TO BE THE SAME AS THE THICKNESS OF SHEET FROM WHICH IT IS CUT.

Figure 2. Hot Tensile Test Sheet Specimen.

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35

Prélèvement d'éprouvettes sur tôle de 150 x 500 x 1,5 mm

Echantillons :
9-12-16-18-19-26-29-30-31-34
1 ier groupe d'essais

Echantillons :
1-2-3-13-15-20-21-27-32-33
2 e groupe d'essais

Sampling of test-pieces on Sheet 150 x 500 x 1,5 mm

Test-pieces :
9-12-16-18-19-26-29-30-31-34
1st group of Tests

Test-pieces :
1-2-3-13-15-20-21-27-32-33
2nd group of Tests

Figure 3. Sampling Scheme.

TABLE 1

Data on Original Sheet as Determined by Sud-Aviation

Sheet n°	0.2 Y.S. kg/mm^2	U.T.S. kg/mm^2	Elongation %
1	48.7 51	63.7 63.2	24 24
2	47.8 50.3	61.2 65.3	22 20.5
4	46 49.2	59.5 63	24 24
5	50.2 51.1	65.3 66.4	22 20.5
6	48.8 48.8	63.3 63.2	22 22
8	50 50.7	65 66	22 22
9	49.3 49.8	64.7 63.4	24 22
10	51.2 50.8	66.8 66.4	20.5 22
11	52.7 49.6	68.4 65.4	26 24
12	48.9 50.2	63 65	24 24
Average	49.25	64.3	22.8

TABLE 2

A) Conventional Conditions - Outside Vacuum Chamber

Specimen No.	Yield Strength 0.2% Offset ksi	Ultimate Tensile Strength ksi	Elongation %
9	73.3	93.5	18.0
12	72.6	94.4	21.0
16	72.6	94.9	20.0
18	73.3	95.2	19.0
19	70.8	93.0	16.0
26	72.0	94.3	19.0
29	70.3	92.8	19.0
30	72.1	94.2	19.0
31	71.0	94.3	18.0
34	72.5	95.6	17.0
$\frac{n}{\bar{x}}$	10 72.05 (50.6 kg/mm^2)	10 94.22 (66.2 kg/mm^2)	10 18.6

B) Elevated Temperature Conditions - Vacuum

1	68.4	89.4	18.0
2	69.8	90.2	21.0
3	71.2	92.8	19.0
13	69.6	92.9	20.0
15	71.9	93.1	19.0
20	70.3	93.2	20.0
21	71.6	94.2	19.0
27	70.1	93.2	19.0
32	72.0	94.6	18.0
33	73.1	95.2	16.0
$\frac{n}{\bar{x}}$	10 70.8 (49.8 kg/mm^2)	10 92.88 (65.3 kg/mm^2)	10 18.9

Cont'd.

TABLE 2 Concl'd.

C) In Vacuum Chamber - Open to Atmosphere

4 5 7 8 11 14 17 22 24 35	71.7 70.6 70.2 70.2 72.1 70.4 69.8 72.0 72.8 73.5	92.3 91.8 92.0 91.2 93.5 92.6 93.3 93.3 95.2 96.0	18.0 20.0 20.0 18.0 19.0 19.0 19.0 19.0 19.0 21.0
n $\bar{x}$	10 71.33 (50.2 kg/mm^2)	10 93.12 (65.5 kg/mm^2)	10 19.2
Overall Average	71.38 (50.2 kg/mm^2)	93.41 (65.7 kg/mm^2)	18.9
Stand. Deviation n = 30	1.26	1.58	1.26