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MECHANICAL PROPERTIES OF URANIUM-BASE
NIOBIUM ALLOYS

Ross J. Jackson and Joseph F. Boland



THE DOW CHEMICAL COMPANY
ROCKY FLATS DIVISION
P. O. BOX 888
GOLDEN, COLORADO 80401

U. S. ATOMIC ENERGY COMMISSION
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MECHANICAL PROPERTIES OF URANIUM-BASE NIOBIUM ALLOYS

Ross J. Jackson and Joseph F. Boland

Abstract. Tensile properties of gamma-quenched and aged binary U-2, U-4, U-5, U-6, and U-8 wt% Nb alloys, and the ternary U-7.5 wt% - 2.5 wt% Zr alloy are presented. Two hundred sixty-four different combinations of composition-time-temperature representing 527 tests are included. Impact properties of gamma-quenched and aged binary U-4 and U-6 wt% Nb alloys, and the ternary U-7.5 Nb - 2.5 Zr alloy are presented. Thirty-six different combinations of composition-time-temperature representing 106 tests are included.

INTRODUCTION

This report summarizes mechanical property data generated at the Rocky Flats Plant on uranium-base niobium alloys and is current to April 1, 1971. Two other Rocky Flats reports have dealt with mechanical properties of these alloys. Jackson and Miley¹ discussed tensile properties of the quenched and aged U-4, U-6, and U-8 wt% Nb alloys from a fundamental mechanistic point of view. From a similar point of view, Jackson and Boland² discussed mechanical properties of the U-7.5 wt% Nb-2.5 wt% Zr alloy. For a discussion of the structures and strengthening mechanism involved with uranium-base niobium alloys the reader should consult the two above mentioned reports, since these subjects are not covered in this report.

Other reports dealing with mechanical properties of uranium-base niobium alloys are as follows. Zukas³ discussed the transformation kinetics and mechanical properties of the U-0.5 wt% Nb-0.5 wt% Mo alloy. Peterson and others^{4, 5, 6} studied physical and mechanical properties of numerous uranium alloy compositions, but prime interest was centered on the U-7.5 wt% Nb-2.5 wt% Zr alloy. Hoge⁷ investigated the effects of dynamic tension loading on the mechanical properties of the U-7.5 wt% Nb-2.5 wt% Ar alloy. Hoge found that tensile strength increased moderately with increasing strain rates (10^{-3} to 160 in./in.-sec.), but more important was the fact that dynamic loading caused only a slight decrease in ductility.

TENSILE PROPERTIES

Both cylindrical and flat tensile bars were used, and the dimensional specifications are listed in Figure 1. The

type of bar used in a given test is specified in the figure caption. Spot checks for several fixed compositions and heat treatments using sister cylindrical and flat specimens or different size bars yielded near identical values for the measured tensile properties. Therefore, specimen geometry, within the limits of Figure 1, does not appear to alter measured tensile values.

Other test data such as composition, date of test, thermal and mechanical history, test temperature, strain rate, bars per datum point, etc., are also listed in the individual figure captions.

Tensile Properties of U-2.4 wt% Nb:

Tensile test data for gamma-quenched U-2.4 wt% Nb alloy aged 24 hours at various temperatures appear in Figure 2.

Tensile Properties of U-4.2wt% Nb:

Figure 3 shows room temperature tensile test data for gamma-quenched and 80-hour aged U-4.2 wt% Nb alloys. Figure 4 lists transverse and longitudinal room temperature tensile test data for gamma-quenched U-4.2 wt% Nb alloys aged for 24 hours at various times. Figure 5 shows room temperature tensile test for gamma-quenched U-4.2 wt% Nb alloys aged at 260°C for various times. Figure 6 lists comparative room temperature tensile data for gamma-quenched U-4.2 wt% Nb alloys aged at 260°C and 270°C for various times. There is no duplication of data in the four figures.

Tensile test bars longitudinal to the working direction (the alloy is worked prior to the 800°C heat treatment) show slightly different tensile properties than bars transverse (long transverse direction) to the working direction. This difference is shown in Figures 7 and 8 for two separate groups of hot forged gamma-quenched and 260°C and 270°C 80-hour aged U-4.2 Nb alloys, respectively. The difference in longitudinal and transverse tensile values for two separate groups of U-4.2 wt% Nb alloys aged 24 hours at 245°C is shown in Figure 9. The difference in the two groups is believed caused by the anneal time at 800°C or to hydrogen content.

Tensile Properties of U-4.5 wt% Nb:

Figure 10 shows room temperature tensile-test data for gamma-quenched U-4.5 wt% niobium alloy aged one hour at various times. Figures 11a and 11b show comparative room temperature tensile test data for gamma-quenched U-4.5 wt% Nb alloys aged at 250, 260, 270, and 280°C for various times. The tensile data for the 250° and 260°C age shown in Figures 11a and 11b are plotted on a log time scale in Figure 12. Tensile test data for virgin arc-cast U-4.5 wt% Nb aged 24 hours at various temperatures are shown in Figure 13.

Tensile Properties of U-5.0 wt% Nb:

The 0.2% offset yield strength as a function of composition (U-4.5 to U-5.1 wt%Nb) is shown in Figure 14.

Tensile Properties of U-6.3 wt% Nb:

Figure 15 shows tensile test data for a U-6.3 wt% Nb alloy aged one hour at various temperatures. Tensile test data for gamma-quenched U-6.3 wt% Nb alloy aged at 150°C for various times appears in Figure 16. Hot tensile strength data for the U-6.3 wt% Nb alloy aged two hours at a given temperature and then tested hot is shown in Figure 17.

Tensile Properties of U-8.5 wt% Nb:

Tensile test data for gamma-quenched U-8.5 wt% Nb aged one hour at various temperatures is shown in Figure 18.

Tensile Properties of U-7.3 wt% Nb-2.5 wt% Zr:

Figure 19 shows tensile test data for gamma-quenched U-7.3 Nb-2.5 Zr aged 80 hours at various temperatures. Figures 20a and 20b show similar data for the U-7.3 Nb-2.5 Zr alloy aged 6 and 30 hours at various temperatures. Tensile test data for gamma-quenched U-7.3 Nb-2.5 Zr alloys aged at 200°C for various times is shown in Figure 21.

COMPRESSIVE PROPERTIES

Compressive data on uranium-base niobium alloys are in short supply.

Compressive Properties of U-4.2 wt% Nb:

Comparative compressive and tensile 0.2% offset yield strengths for the 800°C water quenched and aged U-4.2 wt% Nb alloy are listed in Table 1. These alloys show a higher 0.2% offset yield strength in compression than in tension.

Table 1. Comparative Compressive and Tensile 0.2% Offset Yield Strengths.

Composition:	U-4.2 wt% Nb . . . Bar Type: 3:1, L:D
Date:	4/70; 11/70
Material:	Induction-cast recycle, homogenized 2 hr at 1100 °C, hot forged 800°C, water quenched, compressive blanks machined.
History:	Gammaized 30 min. at 800°C, water quenched, aged 80 hr at 260°C or 270°C, air cooled, tested 24°C.
Strain Gage:	SR-4.

Composition	Heat Treatment	Compressive		Tensile	
		0.2% Y.S. (10 ³ psi)	No. of Bars	0.2% Y.S. (10 ³ psi)	No. of Bars
U-4.2 wt% Nb	Aged 80 hr at 260°C	176	4	163	3
U-4.2 wt% Nb	Aged 80 hr at 270°C	189	4	174	32

IMPACT PROPERTIES

Standard V-notch Charpy impact specimens were used. Test data such as composition, date of test, thermal and mechanical history, test temperature, bars per datum point, etc., are listed in the individual figure captions.

Impact Properties of U-4.2 wt% Nb:

Charpy V-notch impact strengths for gamma-quenched U-4.2 wt% Nb aged 80 hours at 270°C and then tested at temperature are shown in Figure 22.

Impact Properties of U-4.5 wt% Nb:

Room temperature, Charpy V-notch impact strengths for gamma-quenched U-4.5 wt% Nb alloys aged one hour at various temperatures appear in Figure 23.

Impact Properties of U-6.3 wt% Nb:

Room temperature, Charpy V-notch impact strengths for gamma-quenched (both water and air quenched) are shown in Figure 24. Impact strengths as a function of density (niobium content) appear in Figure 25.

Impact Properties of U-7.3 wt% Nb-2.5 wt% Zr:

Impact test data (Charpy V-notch) for gamma-quenched U-7.3 wt% Nb-2.5 wt% Zr aged 30 hours at various temperatures appear in Figure 26. Impact test data (Charpy V-notch) for gamma-quenched U-7.3 Nb-2.5 Zr aged at 200°C for various times is shown in Figure 27.

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7. K. G. Hoge, "Mechanical Properties of Gamma Phase Uranium-7.5 wt% Niobium-2.5 wt% Zirconium Alloy Under Dynamic Loading," USAEC Report UCRL-14805 (Lawrence Radiation Laboratory, Livermore, California), 1966.

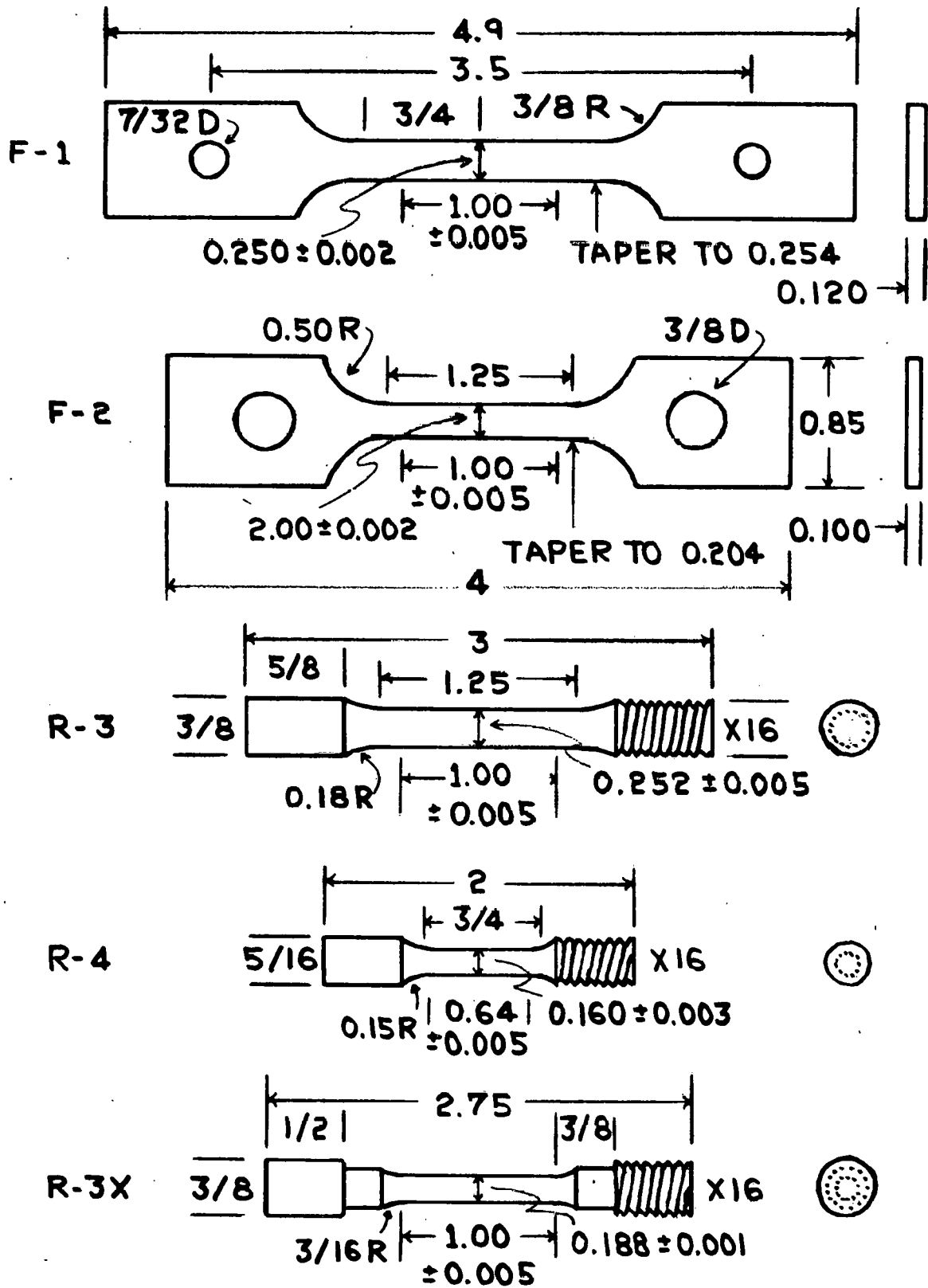


Figure 1. Design and Specification of Tensile Bars Used In This Study.

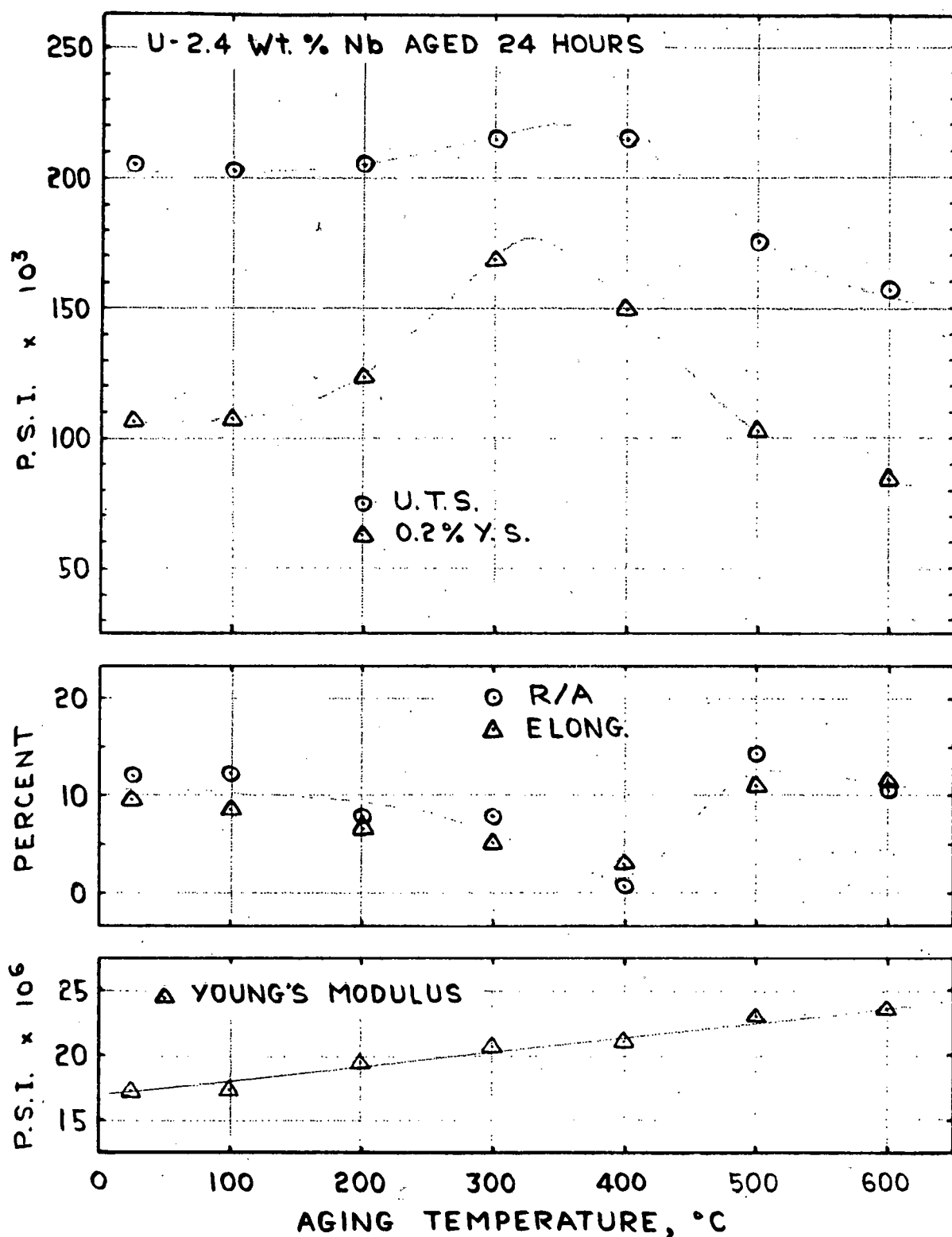


Figure 2. Tensile Test Data for 24 Hour Aged U-2.4 Nb Alloy.

Composition: U-2.4 wt% Nb. . . Bar Type: R-4. . . Date: 2/71.

Material: Single-arc-cast virgin, hot forged 820°C, homogenized 2 hr at 1050°C, hot rolled 620°C, rough tensile blanks machined.

History: Gammaized 20 min. at 820°C, water quenched, aged 24 hr at temperature, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 2.

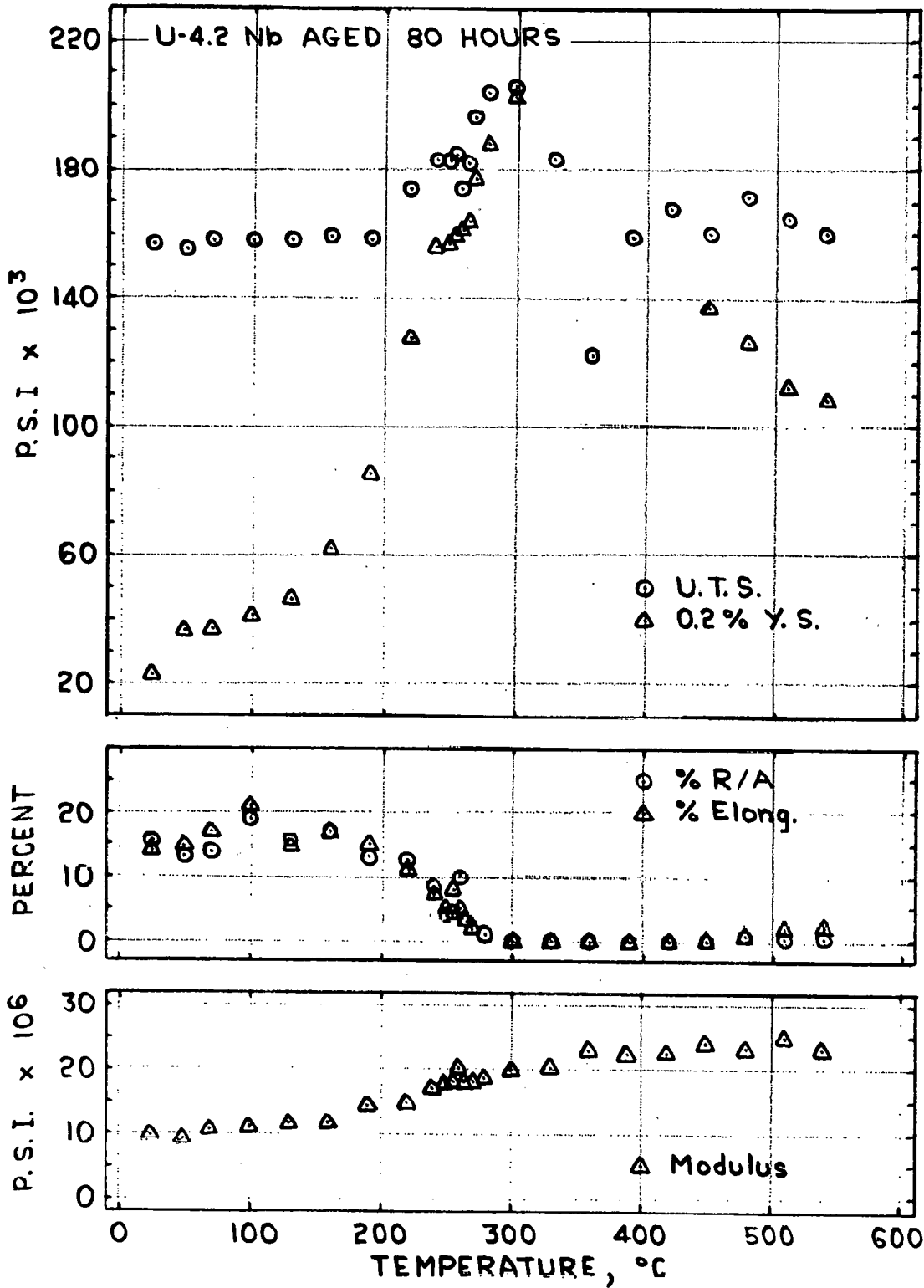


Figure 3. Tensile Test Data for 80 Hour Aged U-4.2 Nb Alloy.
 Composition: U-4.2 wt% Nb. . . Bar Type: R-3. . . Date: 3/70.
 Material: Induction-cast recycle, homogenized 4 hr at 1100°C, hot forged 800°C, water quenched, tensile blanks machined.
 History: Gammaized 30 min. 800°C, water quenched, aged 80 hr at temperature, air cooled, machined, tested 24°C.
 Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1.

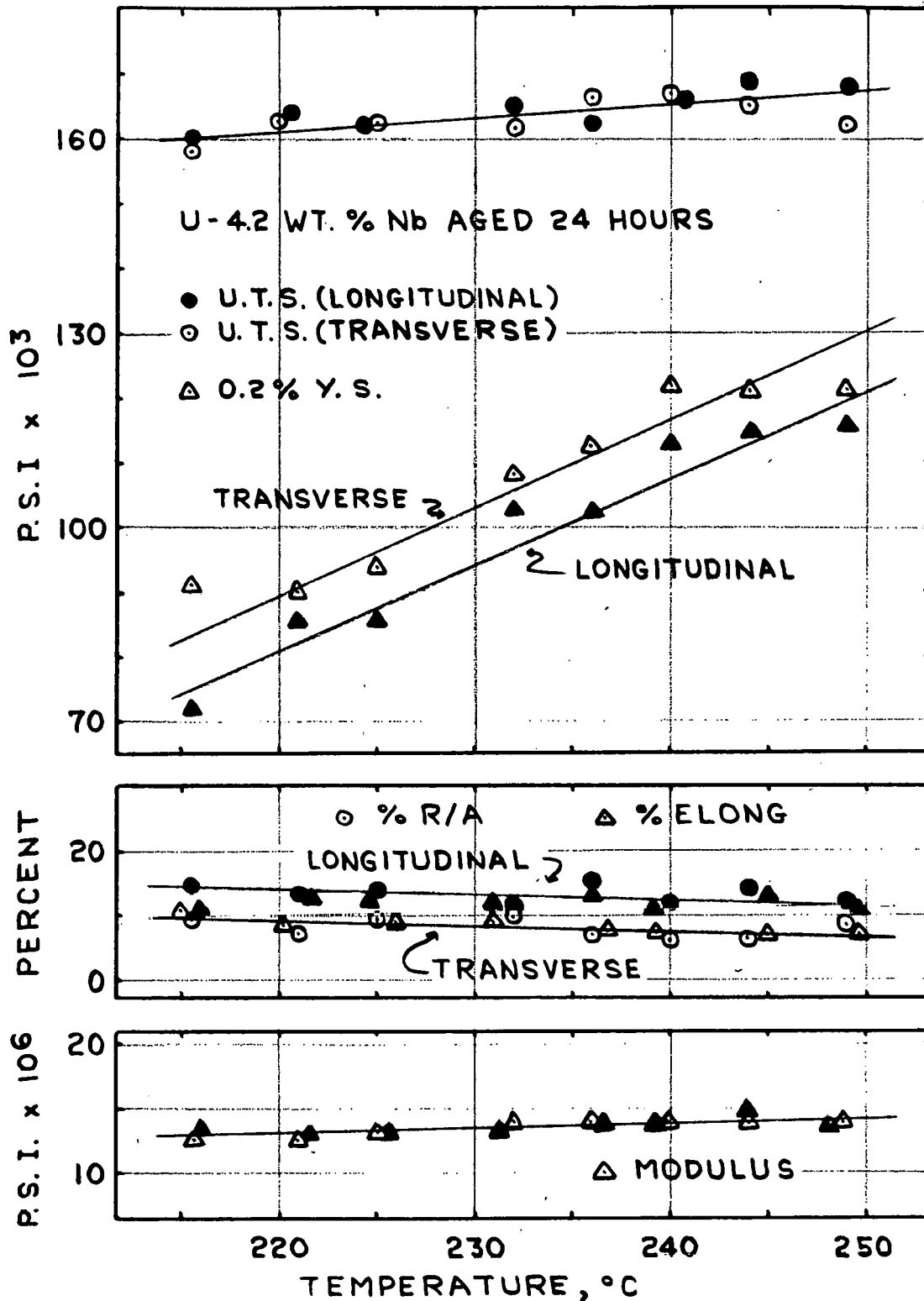


Figure 4. Longitudinal and Transverse Tensile Data for U-4.2 Nb Aged 24 Hours.

Composition: U-4.2 wt% Nb. . . Bar Type: R-4. . . Date: 1/71.

Material: Induction-cast recycle, homogenized 4 hr at 1100°C, hot extruded 800°C, water quenched, tensile blanks machined transverse and longitudinal to extrusion direction.

History: Gammaized 30 min. 800°C, water quenched, aged 24 hr at various temperatures, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 2.

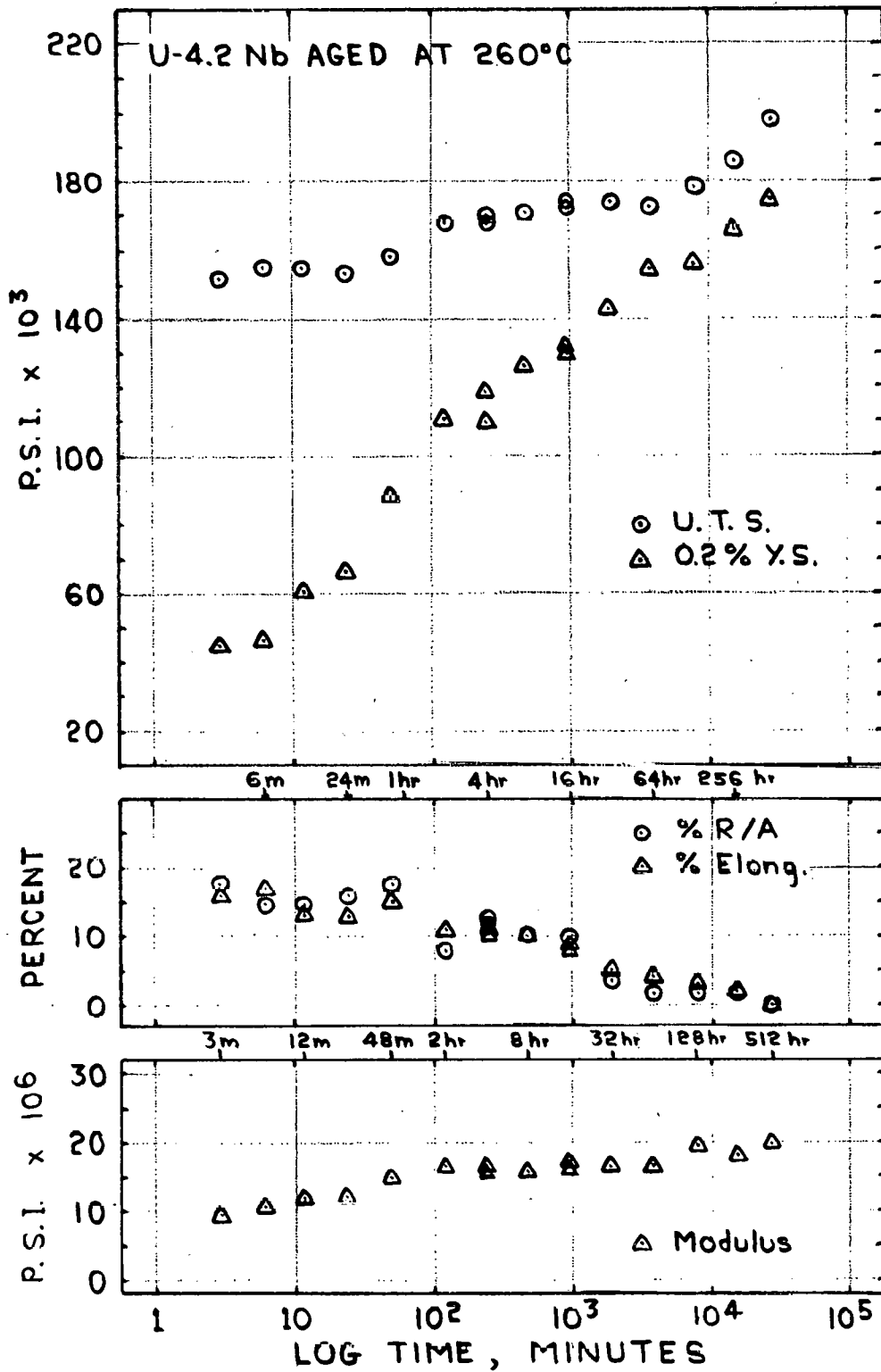


Figure 5. Tensile Test Data for 260°C Aged U-4.2 Nb Alloy.
 Composition: U-4.2 wt% Nb. . . . Bar Type: R-3. . . . Date: 3/70.
 Material: Induction-cast recycle, homogenized 4 hr at 1100°C, hot extruded 800°C, water quenched, tensile blanks machined.
 History: Gammaized 30 min. 800°C, water quenched, aged 260°C for various times, air cooled, machined, tested 24°C.
 Strain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1.

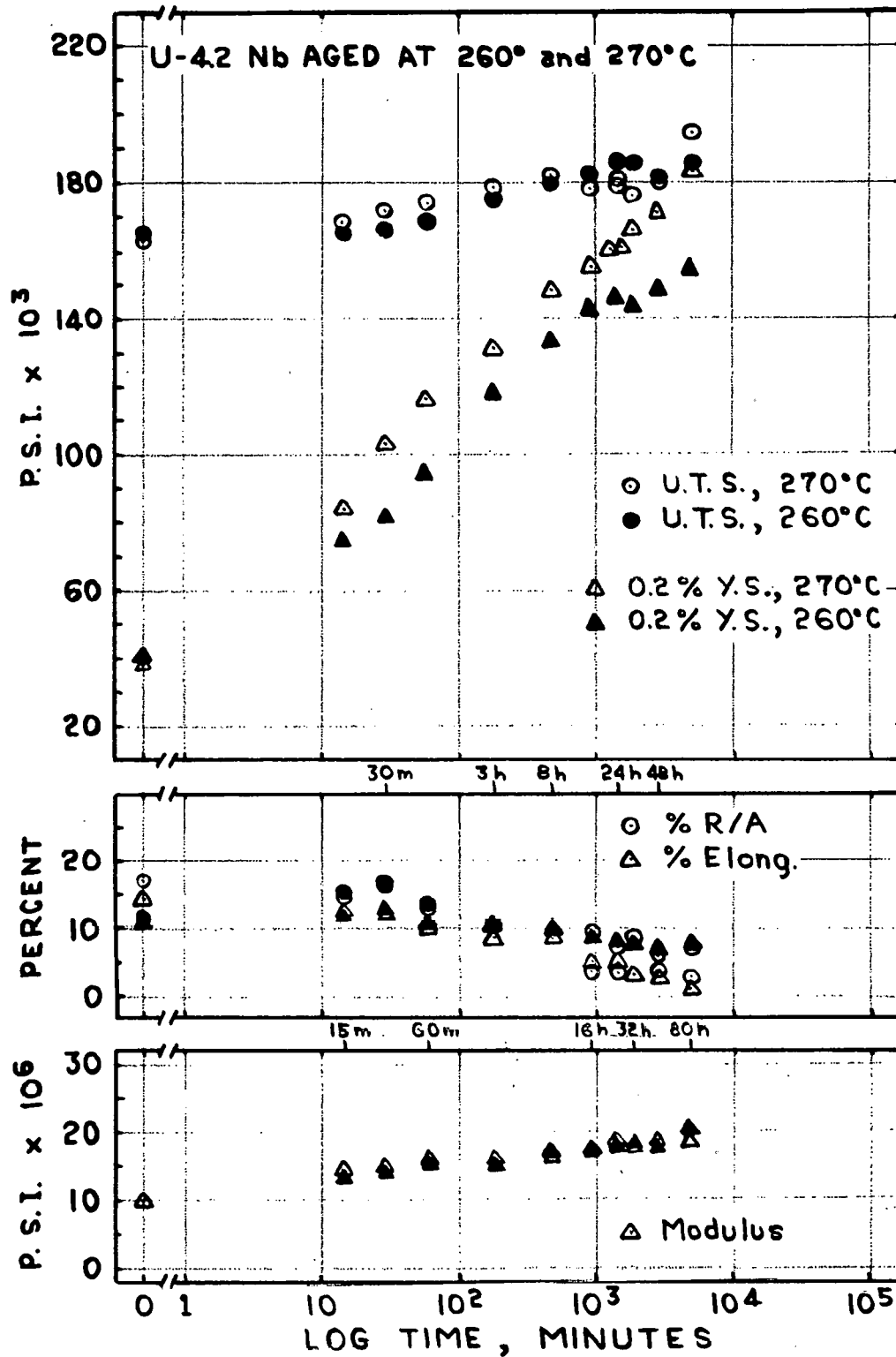


Figure 6. Tensile Test Data for 260° and 270°C Aged U-4.2 Nb Alloy.

Composition: U-4.2 wt% Nb. . . Bar Type: R-3. . . Date: 9/68.

Material: Induction-cast recycle, homogenized 2 hr at 1100°C, hot extruded 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. 800°C, water quenched, aged 260°C or 270°C for various times, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1.

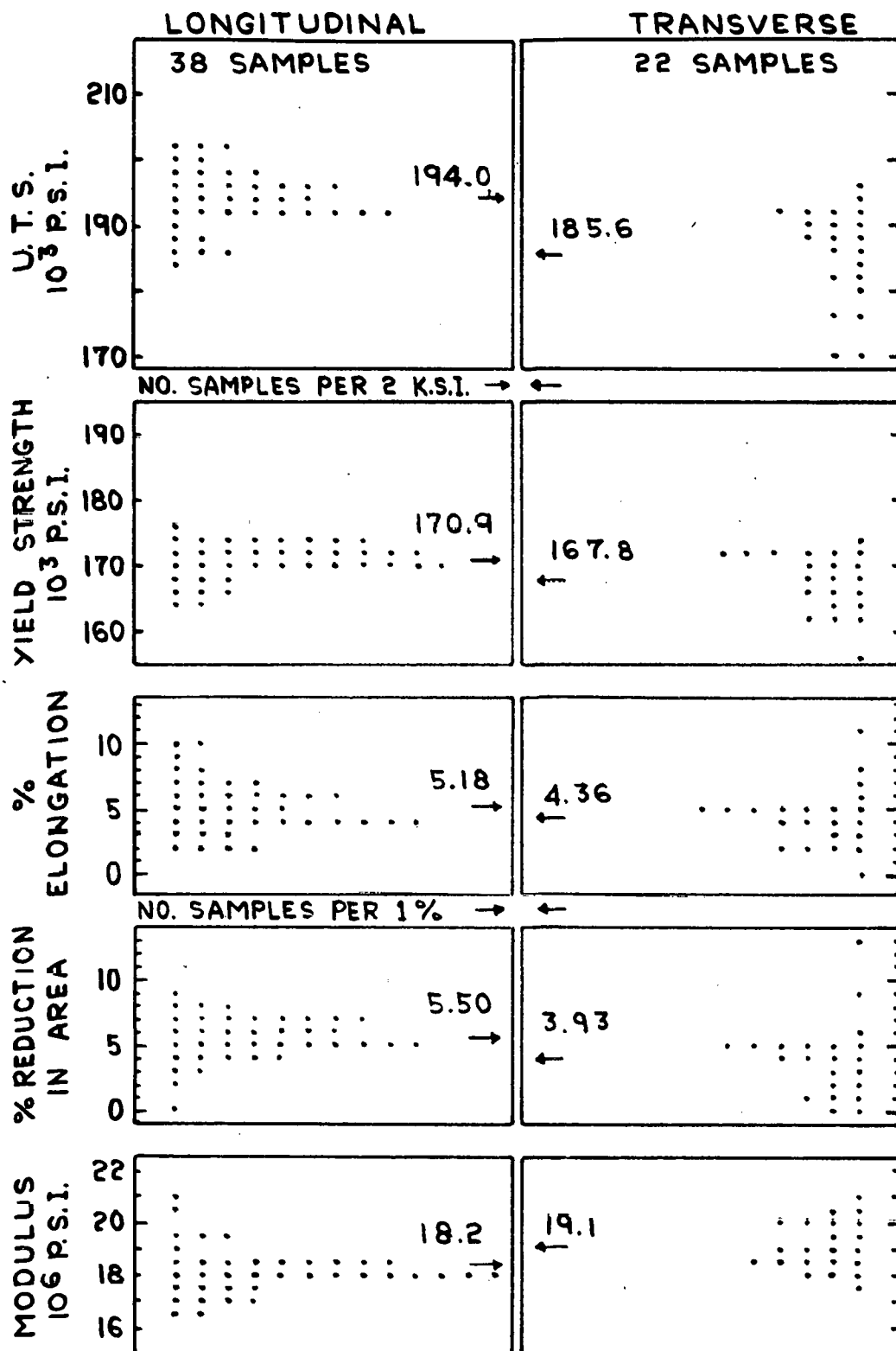


Figure 7. Longitudinal and Transverse Tensile Data for U-4.2 Nb Aged 80 Hours at 260°C.

Composition: U-4.2 wt% Nb. . . Bar Type: R-4. . . Date: 7/69.

Material: Induction-cast recycle, homogenized 4 hr at 1100°C, hot-forged 800°C, water quenched, tensile blanks machined transverse and longitudinal to working direction.

History: Gammaized 20-60 min. 800°C, water quenched, aged 80 hr at 260°C, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1.

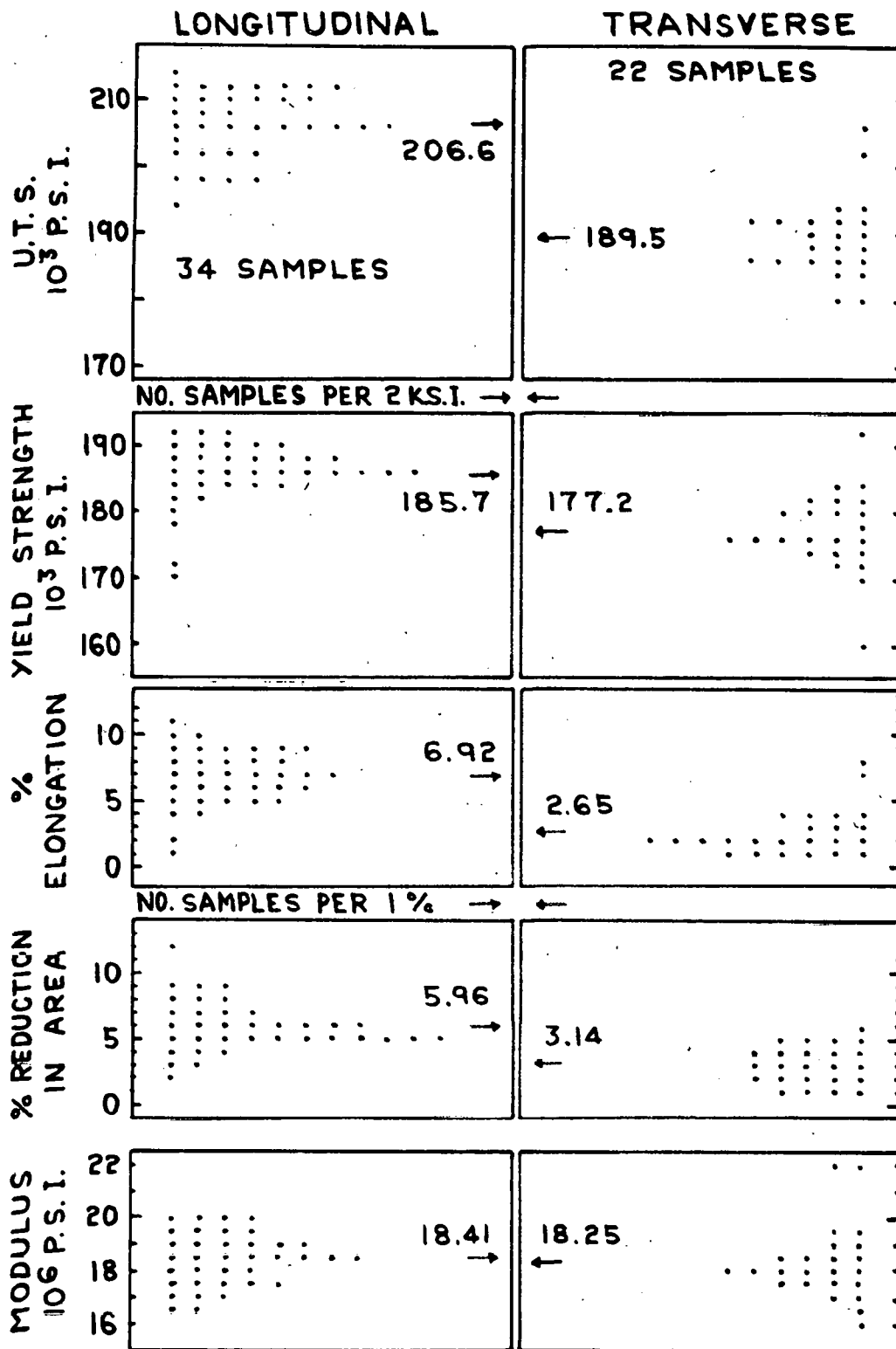


Figure 8. Longitudinal and Transverse Tensile Data for U-4.2 Nb Aged 80 Hours at 260°C.

Composition: U-4.2 wt% Nb. . . . Bar Type: R-4. . . . Date: 7/69.

Material: Induction-cast recycle, homogenized 4 hr at 1100°C, hot-forged 800°C, water quenched, tensile blanks machined transverse and longitudinal to working direction.

History: Gammaized 20-60 min. 800°C, water quenched, aged 80 hr at 270°C, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1.

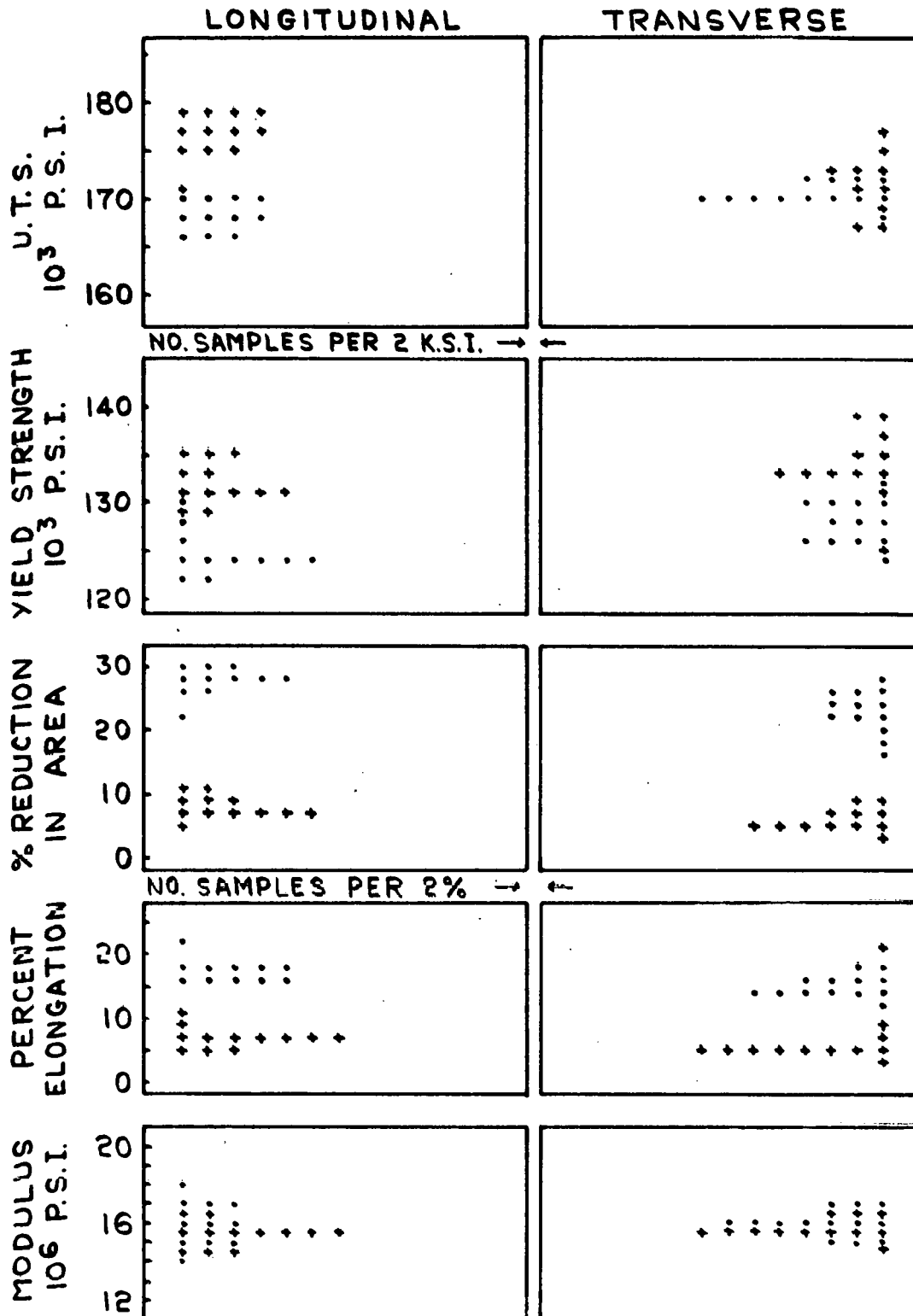


Figure 9. Longitudinal and Transverse Tensile Data for U-4.2 Nb Aged 24 Hours at 245°C.

Composition: U-4.2 wt% Nb. . . . Bar Type: R-4. . . . Date: 1/71, 3/71.

Material: Induction-cast recycle, homogenized 2 hr at 1100°C, hot extruded 800°C, water quenched, tensile blanks machined transverse and longitudinal to extrusion direction.

History: Gammaized 15 or 45 min. 800°C, water quenched, aged 24 hr at various temperatures, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1.

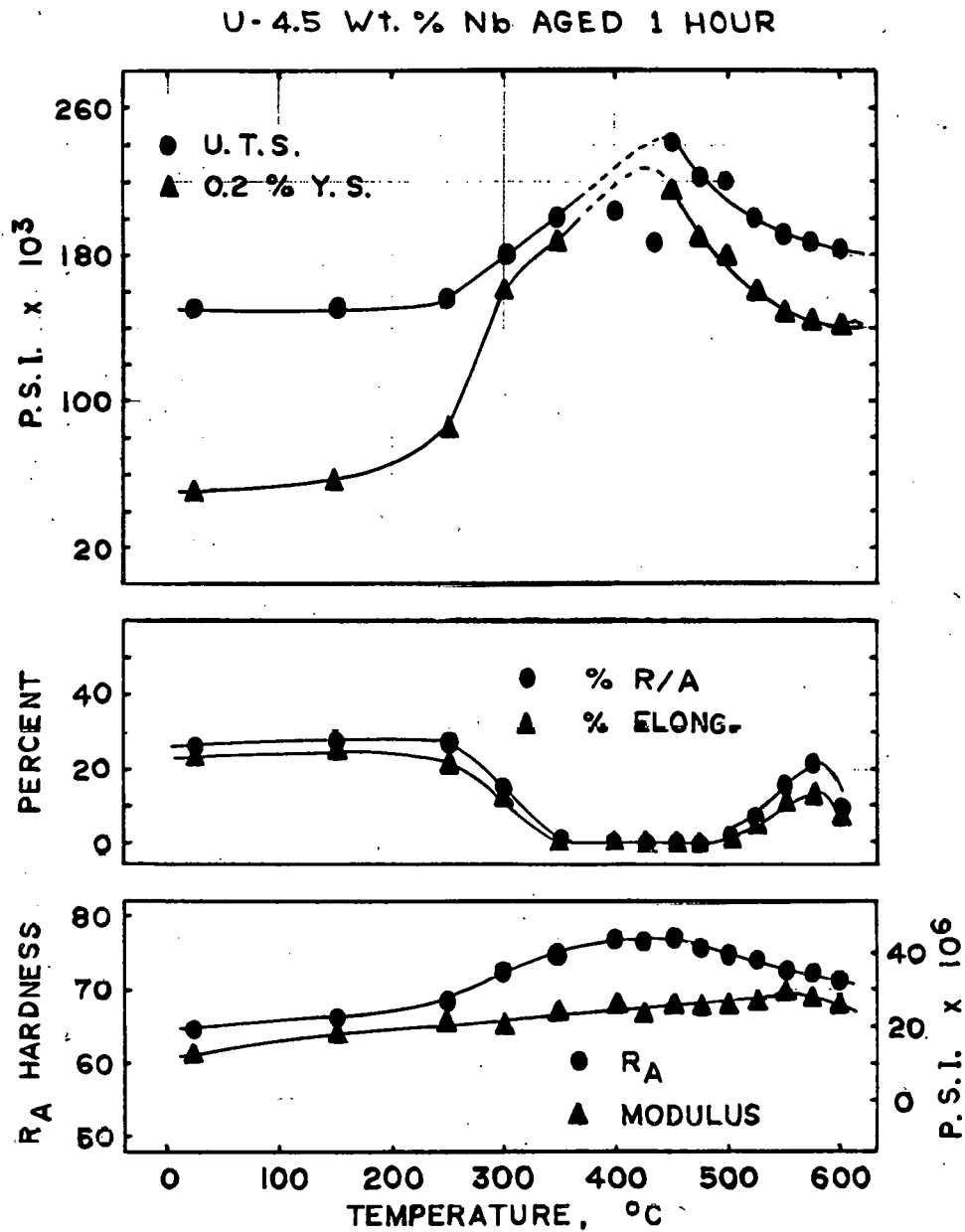


Figure 10. Tensile Test Data for 1 Hour Aged U-4.5 Nb Alloy.

Composition: U-4.5 wt% Nb. . . . Bar Type: F-1. . . . Date: 10/66.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 800°C, water quenched, aged 1 hr at various temperatures, air cooled, machined, tested 24°C.

Strain Rate: 0.002 in./in.-min. . . . Bars per datum point: 3.

U - 11 at. % Nb

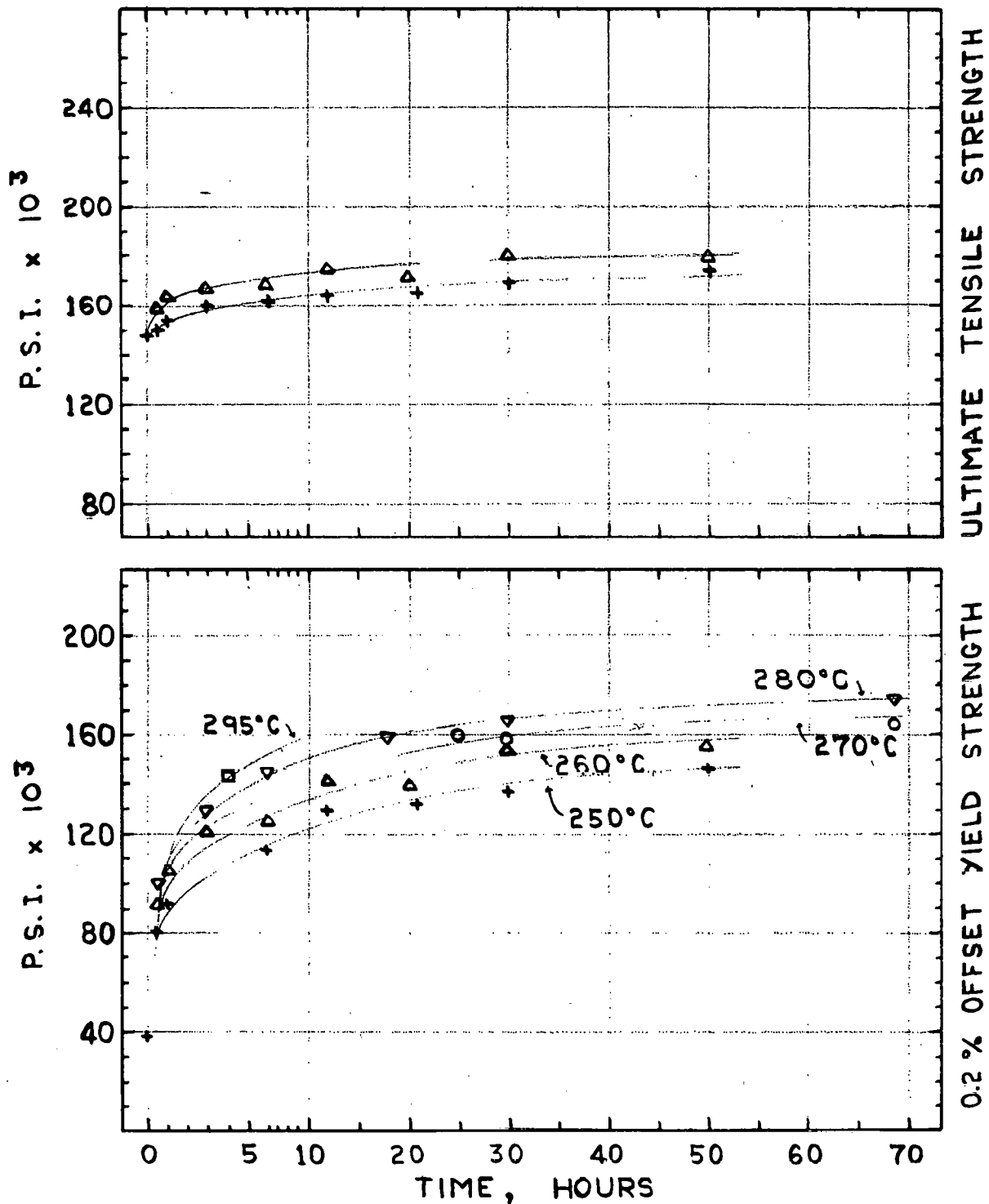


Figure 11a. Tensile Test Data for 250, 260, 270, 280, and 295°C Aged U-4.5 Nb Alloy.

Composition: U-4.5 wt% Nb. . . Bar Type: R-3. . . Date: 4/68.

Material: Induction-cast recycle, homogenized 2 hr at 1100°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. 800°C, water quenched, aged 250, 260, 270, 280, and 295°C for various times, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1.

U-11 at. % Nb

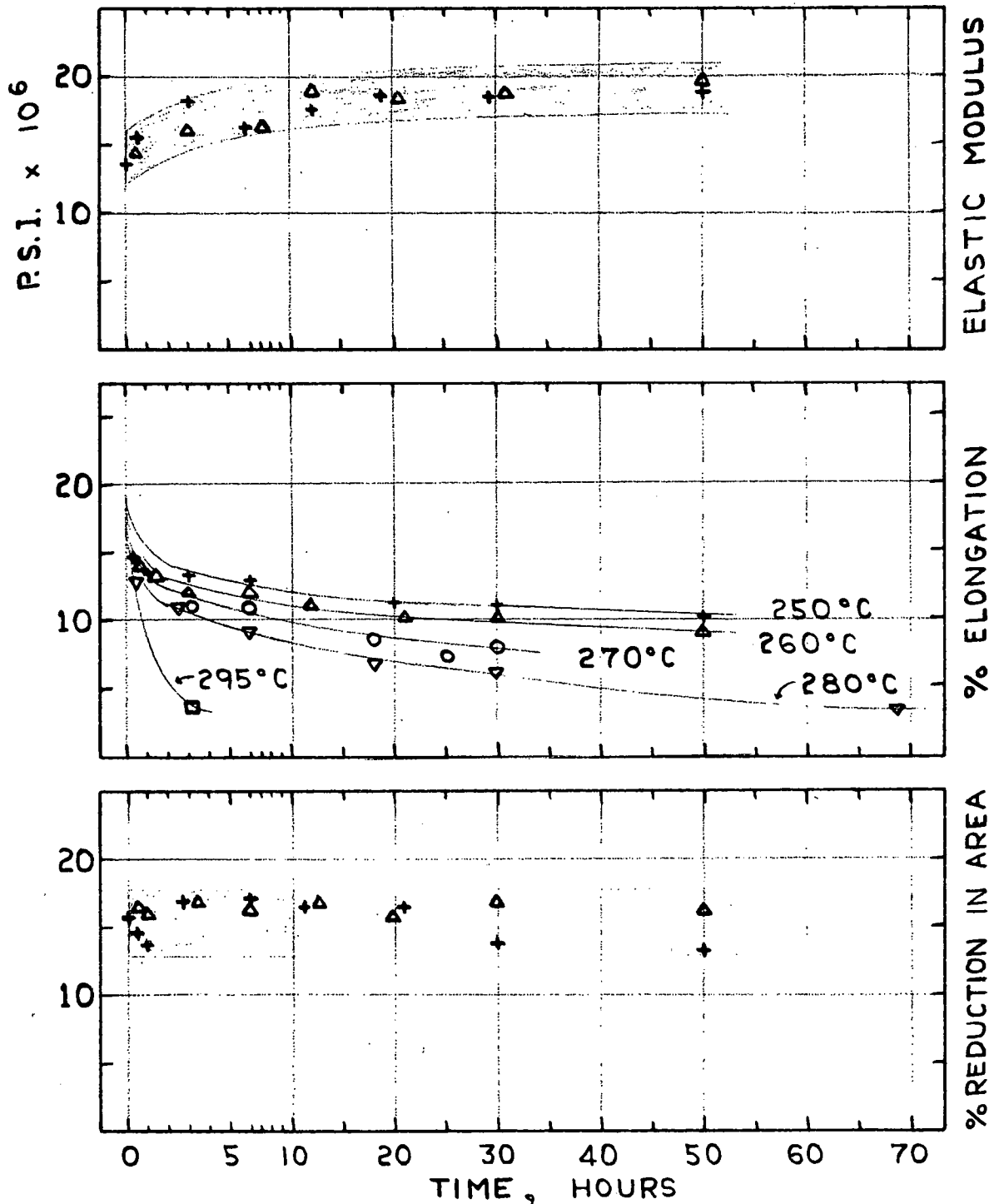


Figure 11b. Tensile Test Data for 250, 260, 270, 280, and 295°C Aged U-4.5 Nb Alloy.

Composition: U-4.5 wt% Nb. . . . Bar Type: R-3. . . . Date: 4/68.

Material: Induction-cast recycle, homogenized 2 hr at 1100°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. 800°C, water quenched, aged 250, 260, 270, 280, and 295°C for various times, air cooled, machined, tested 24°C

Estrain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1.

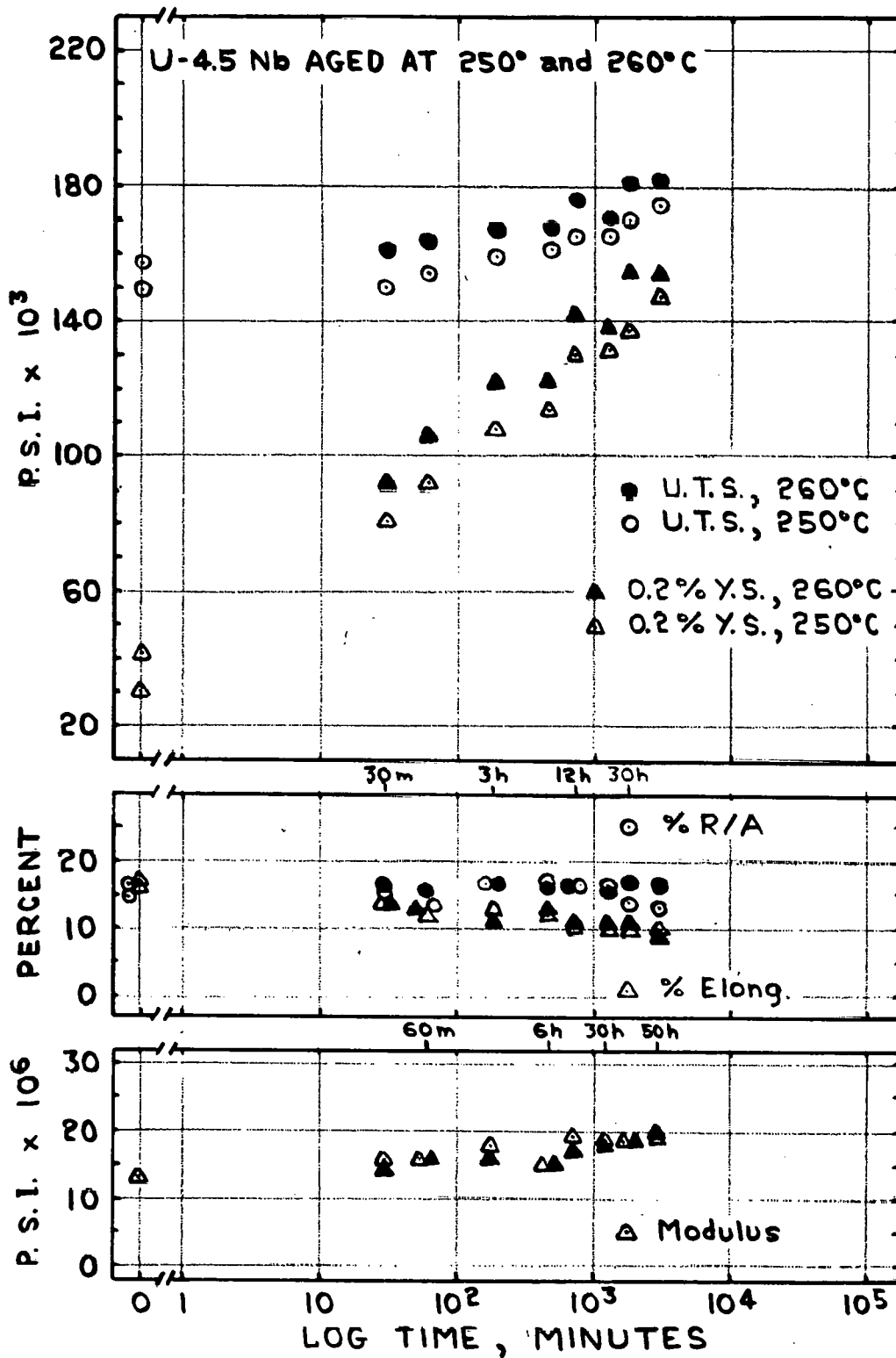


Figure 12. Tensile Data for 250°C and 260°C Aged U-4.5 Nb Alloy.

Composition: U-4.5 wt% Nb. . . Bar Type: R-3: . . . Date: 4/68.

Material: Induction-cast recycle, homogenized 2 hr at 1100°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. 800°C, water quenched, aged 250 and 260°C for various times, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1.

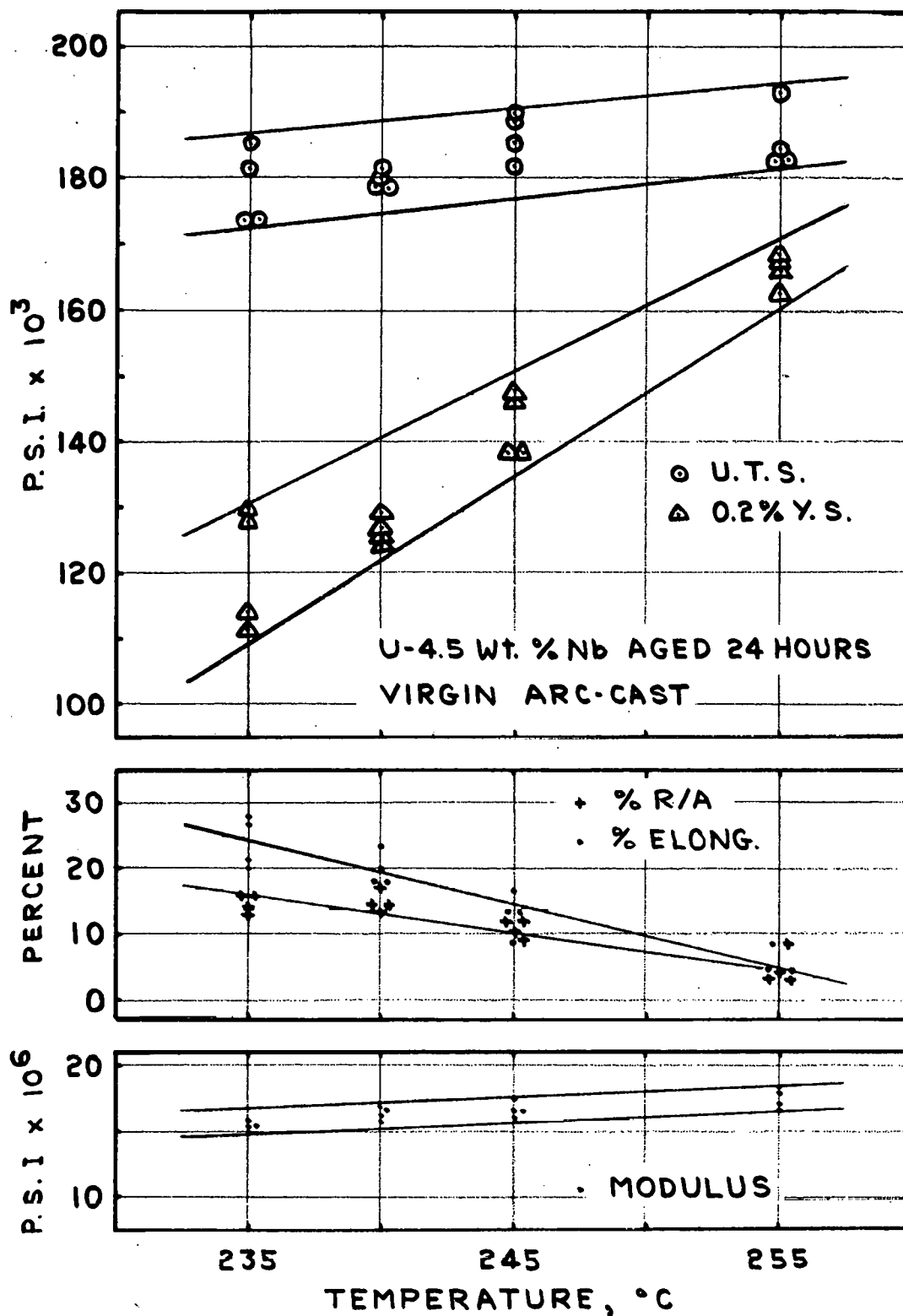


Figure 13. Tensile Test Data for Virgin, Arc-cast U-4.5 Nb Aged 24 Hours.

Composition: U-4.5 wt% Nb. . . . Bar Type: R-4. . . . Date: 1/71.

Material: Double arc-cast virgin, homogenized 4 hr at 1100°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 800°C, water quenched, aged 34 hr at various temperatures, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1.

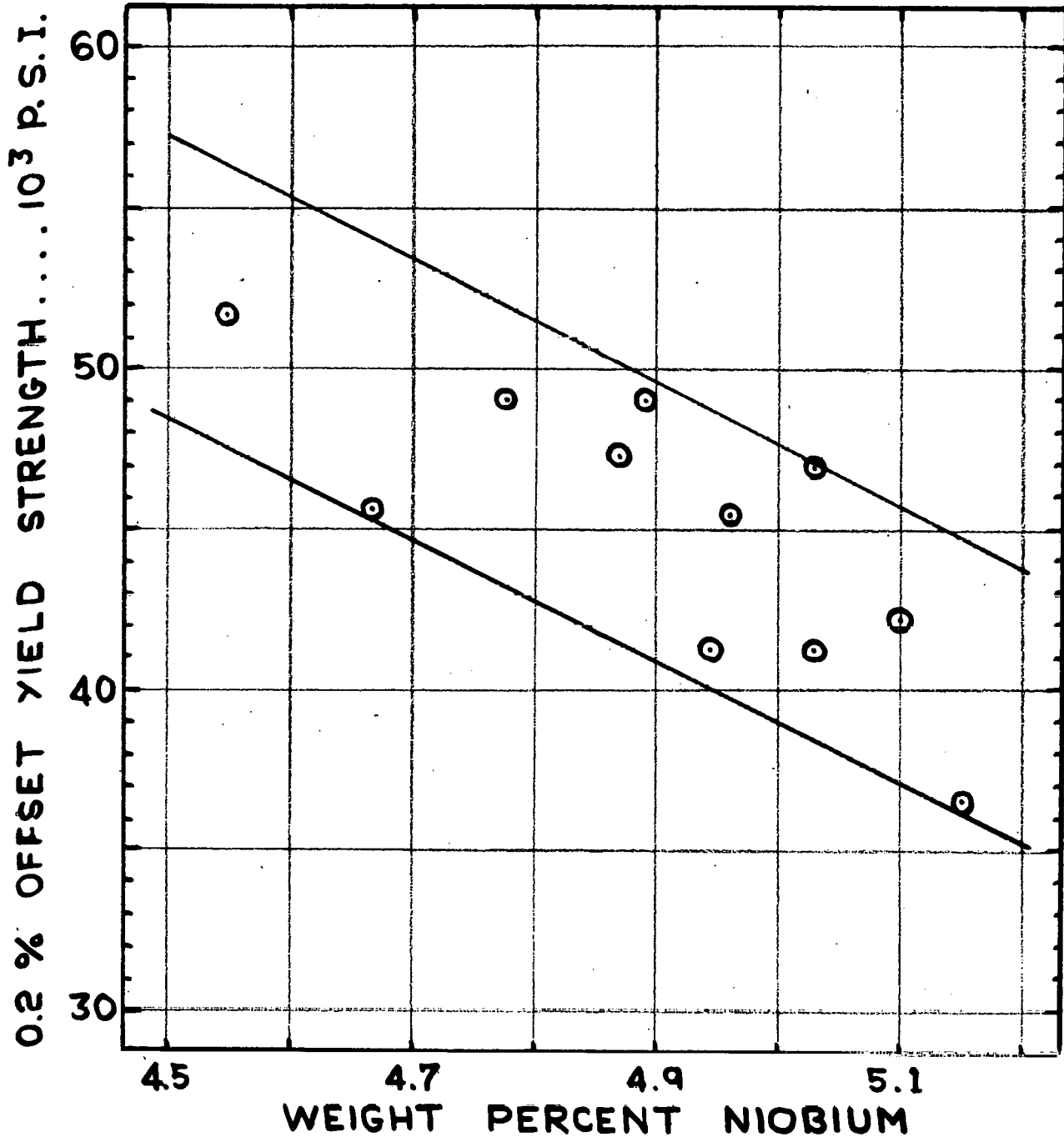


Figure 14. Yield Strength as Function of Composition.

Composition: U-4.5 to U-5.1 wt% Nb. . . . Bar Type: R-3.

Material: Induction cast recycle, homogenized 2 hr 1100°C, hot rolled 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. 800°C, water quenched, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1.

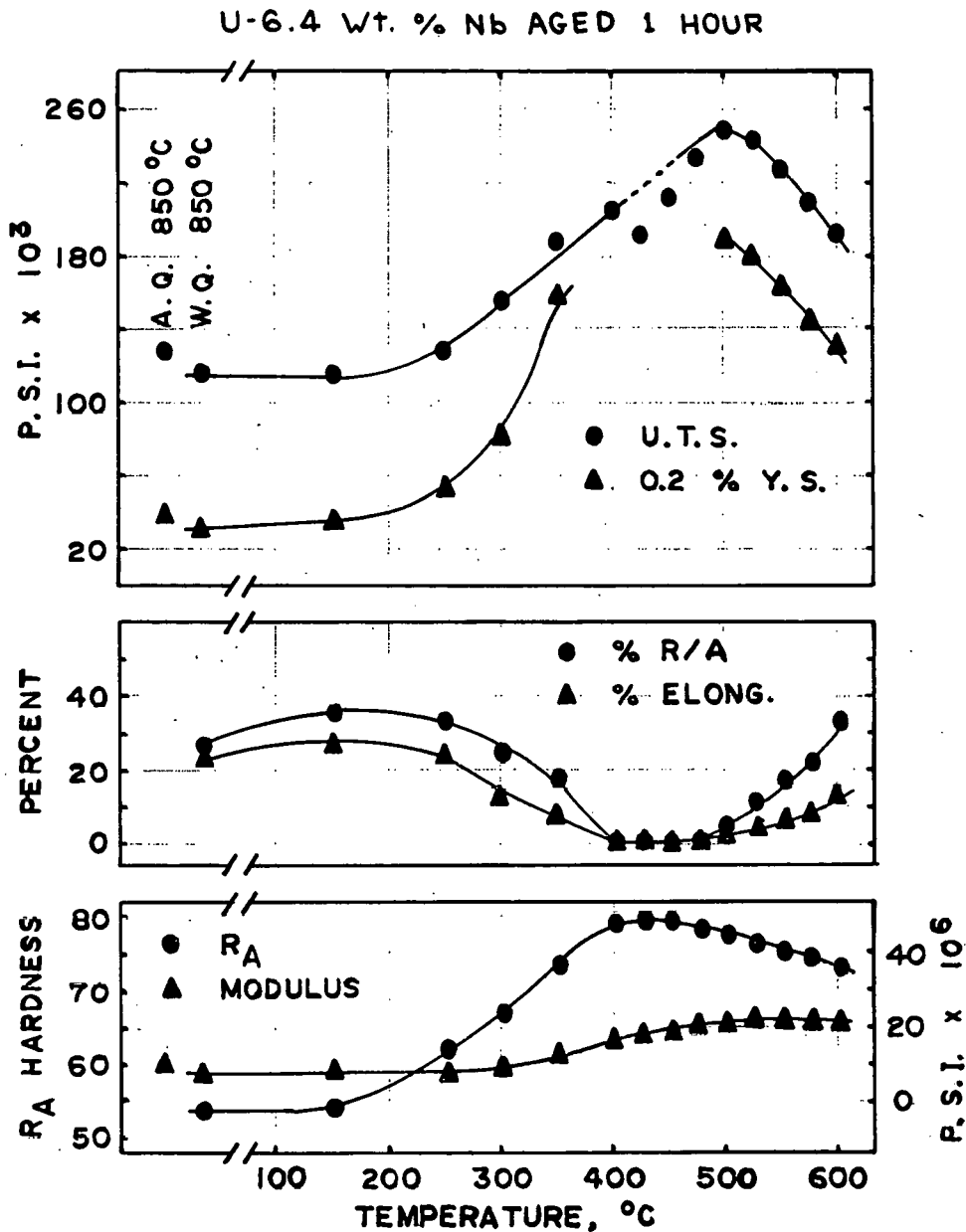


Figure 15. Tensile Test Data for One Hour Aged U-6.3 Nb Alloy.

Composition: U-6.3 wt% Nb. . . Bar Type: F-1. . . Date 8/66.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 850°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. 850°C, water quenched (6 bars air quenched), aged 1 hr at temperature, air cooled, machined, tested 24°C.

Strain Rate: 0.002 in./in.-min. . . Bars per datum point: 3.

U-6.4 Wt. % Nb AGED AT 150°C

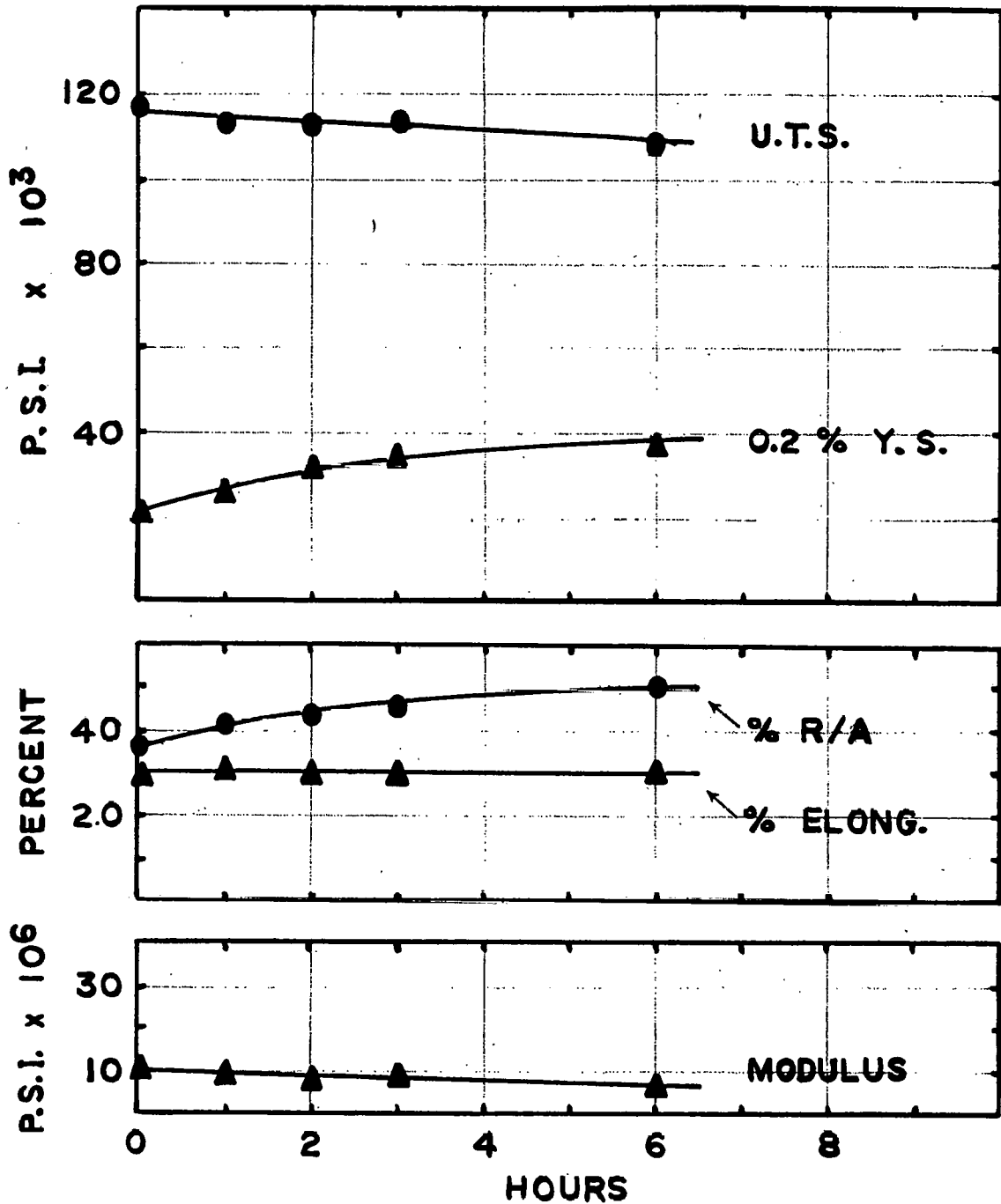


Figure 16. Tensile Test Data for 150° C Aged U-6.3 Nb Alloy.

Composition: U-6.3 wt% Nb. . . Bar Type: F-2. . . Date: 8/67.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 850°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 850°C, water quenched, aged in oil at 150°C, air cooled, tested 24°C.

Strain Rate: 0.002 in./in.-min. . . Bars per datum point: 3.

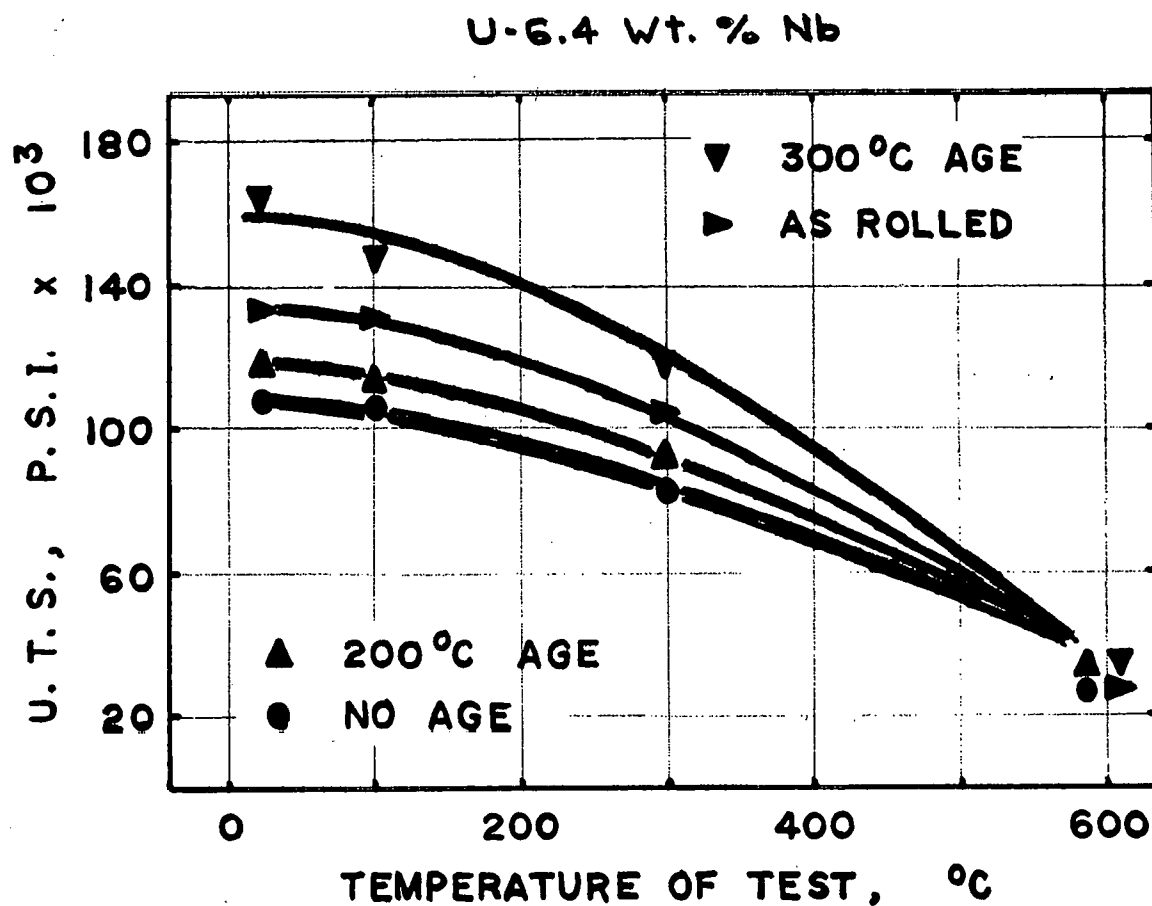


Figure 17. Hot Tensile Test Data for U-6.3 Nb Alloy.

Composition: U-6.3 wt% Nb. . . Bar Type: F-1. . . Date: 9/65.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 850°C-550°C, water quenched, tensile blanks machined, (one set of bars were tested in the as-rolled condition).

History: Gammaized 30 min. at 850°C, water quenched, aged 2 hr at indicated temperature, air cooled, machined, tested hot at 100, 300, or 600°C.

Strain Rate: 0.002 in./in.-min. . . Bars per datum point: 1.

U-8.4 Wt. % Nb AGED 1 HOUR

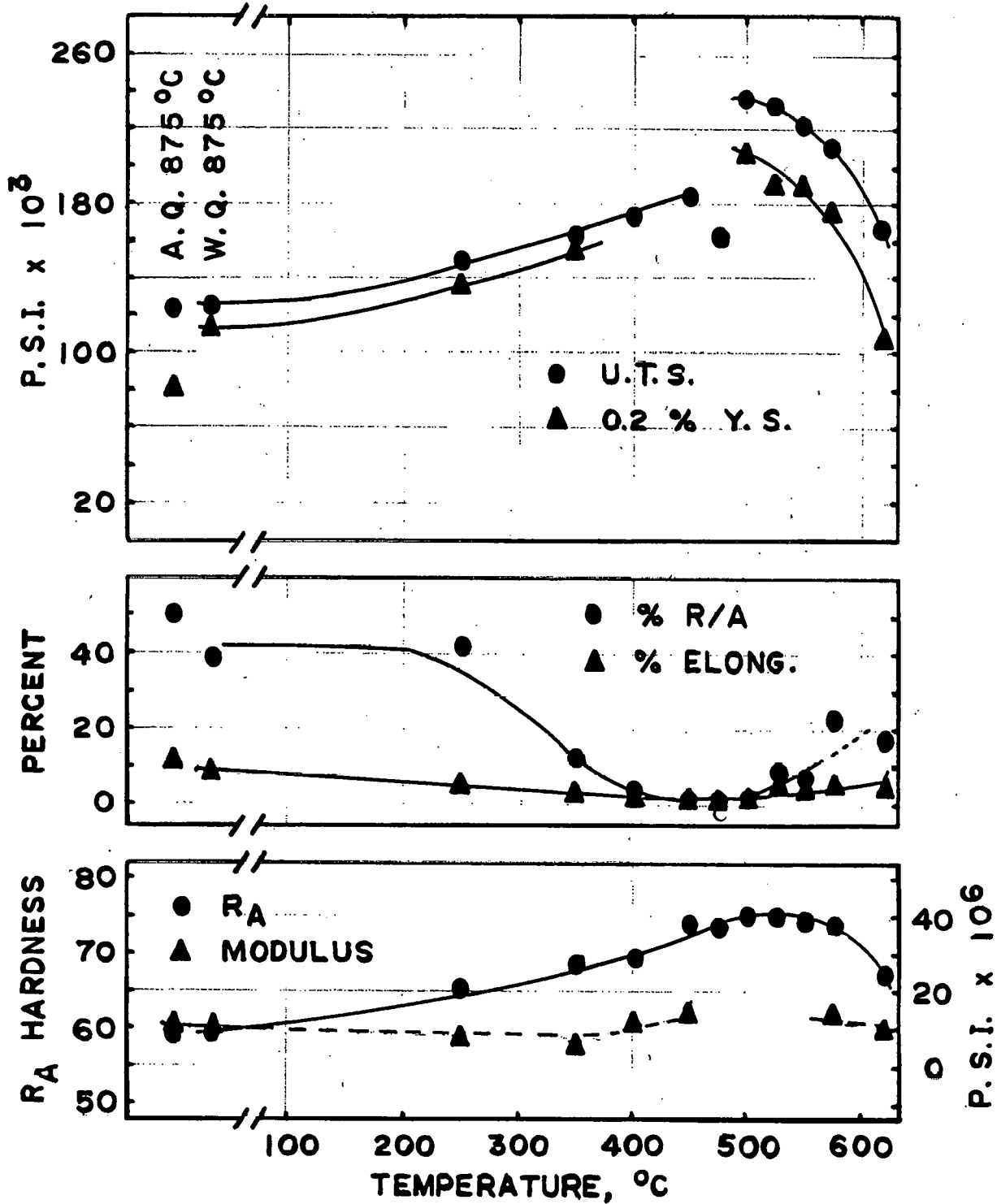


Figure 18. Tensile Test Data for U-8.5 Nb Aged One Hour.

Composition: U-8.4 wt% Nb. . . Bar Type: F-1. . . Date: 1/67.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 850°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 875°C, water quenched (6 bars air quenched), aged 1 hr at temperature, air cooled, machined, tested 24°C.

Strain Rate: 0.002 in./in.-min. . . Bars per datum point: 3.

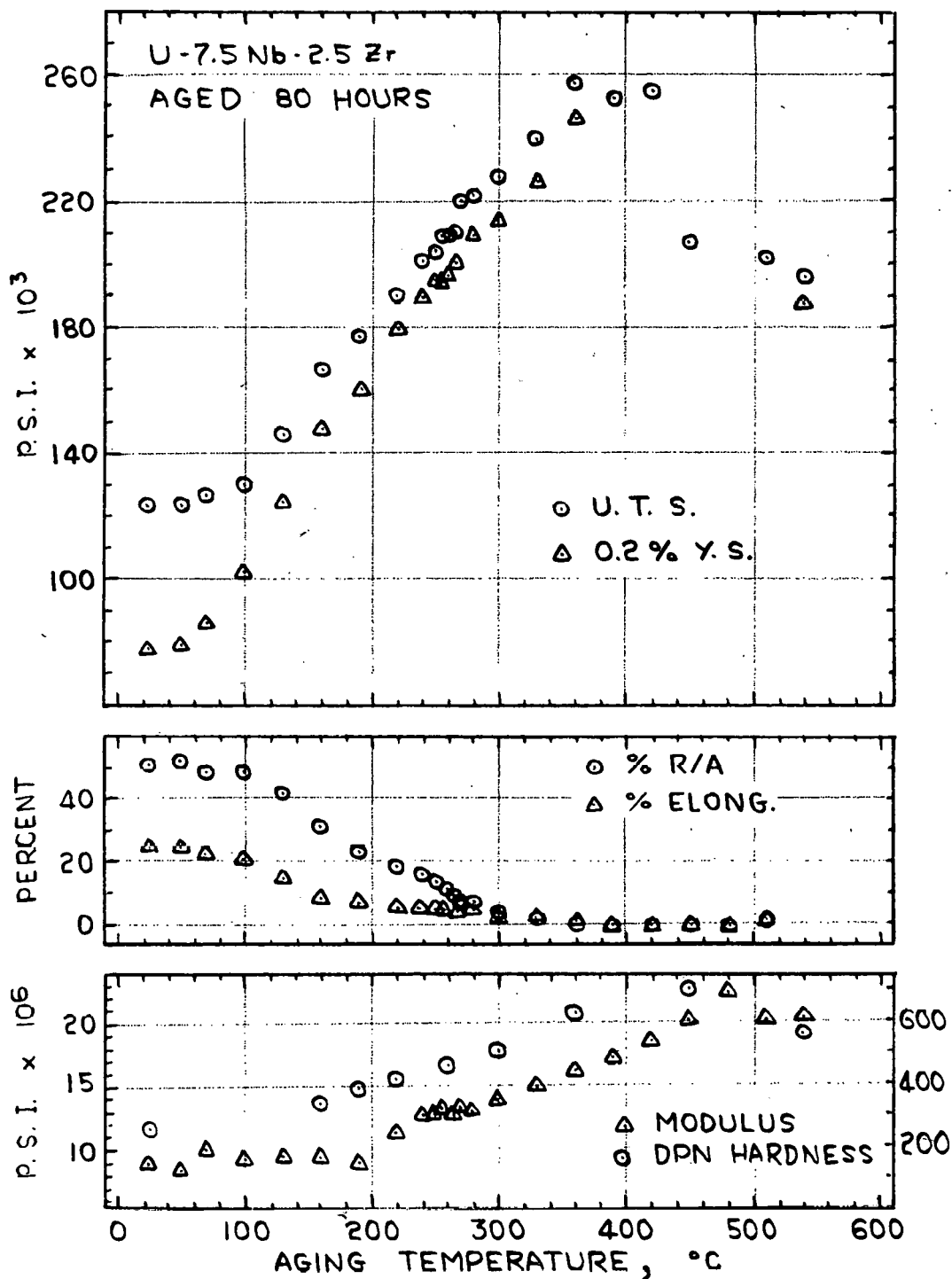


Figure 19. Tensile Test Data for 80 Hour Aged U-7.3 Nb-2.5 Zr Alloy.

Composition: U-7.3 wt% Nb-2.5 wt% Zr. . . Bar Type: R-3. . . Date: 3/70.

Material: Induction cast, homogenized 4 hr at 1150°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 900°C, water quenched, aged 80 hr at temperature, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1.

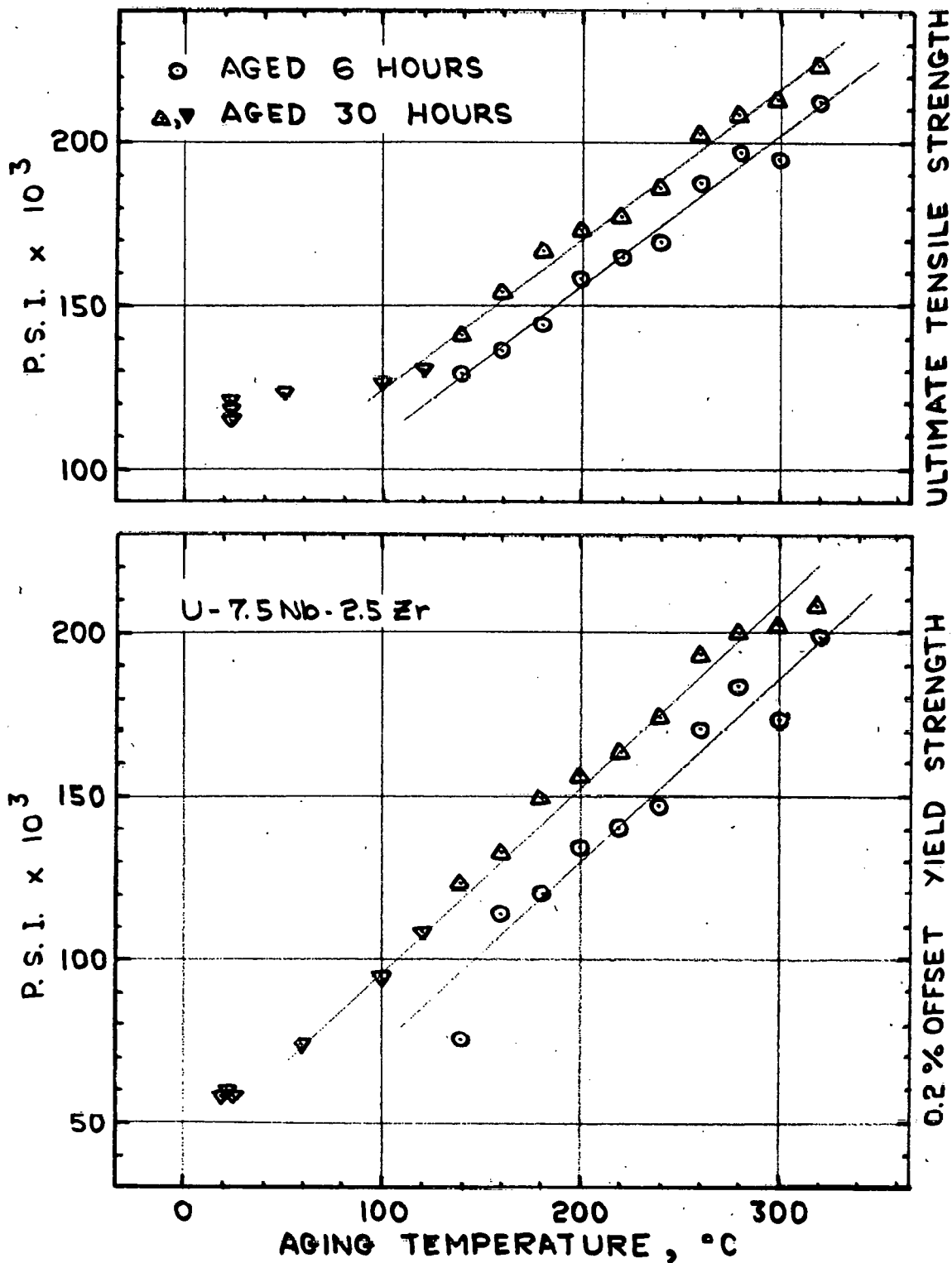


Figure 20a. Tensile Test Data for 6 and 30 Hour Aged U-7.3 Nb-2.5 Zr Alloy.

Composition: U-7.3 wt% Nb-2.5 wt% Zr. . . Bar Type: R-3. . . Date: 6/68; 1/69

Material: Induction cast, homogenized 4 hr at 1150°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 900°C, water quenched, aged 6 or 30 hr at temperature, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . Bars per datum point: 1 for 6 hr, 2 for 30 hr.

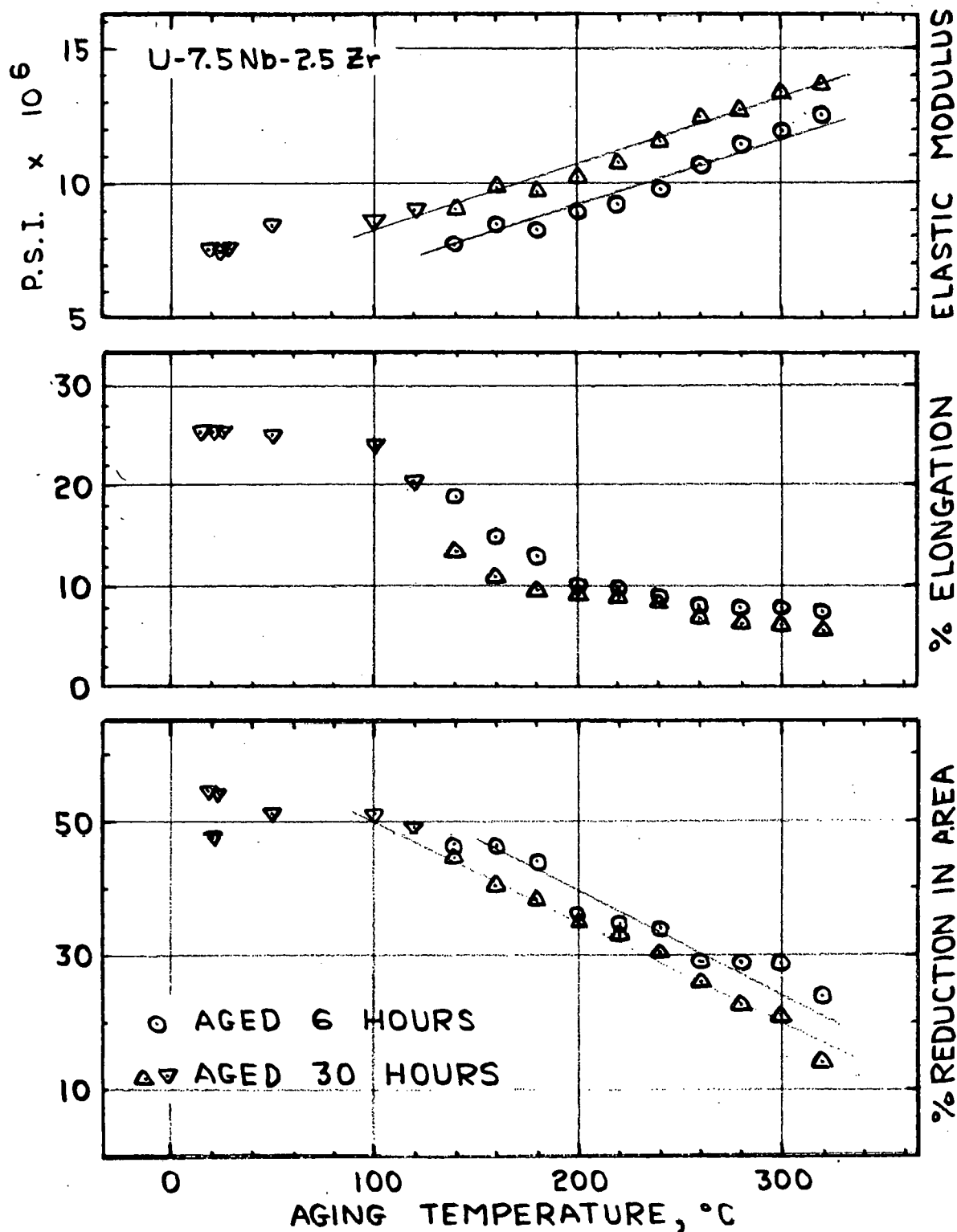


Figure 20b. Tensile Test Data for 6 and 30 Hour Aged U-7.3 Nb-2.5 Zr Alloy.

Composition: U-7.3 wt% Nb-2.5 wt% Zr. . . . Bar Type: R-3. . . . Date: 6/68; 1/69.

Material: Induction cast, homogenized 4 hr at 1150°C, hot forged 800°C, water quenched, tensile blanks machined.

History: Gammaized 30 min. at 900°C, water quonohod, aged 6 or 30 hr at temperature, air cooled, machined, tested 24°C.

Strain Rate: 0.005 in./in.-min. . . . Bars per datum point: 1 for 6 hr, 2 for 30 hr.

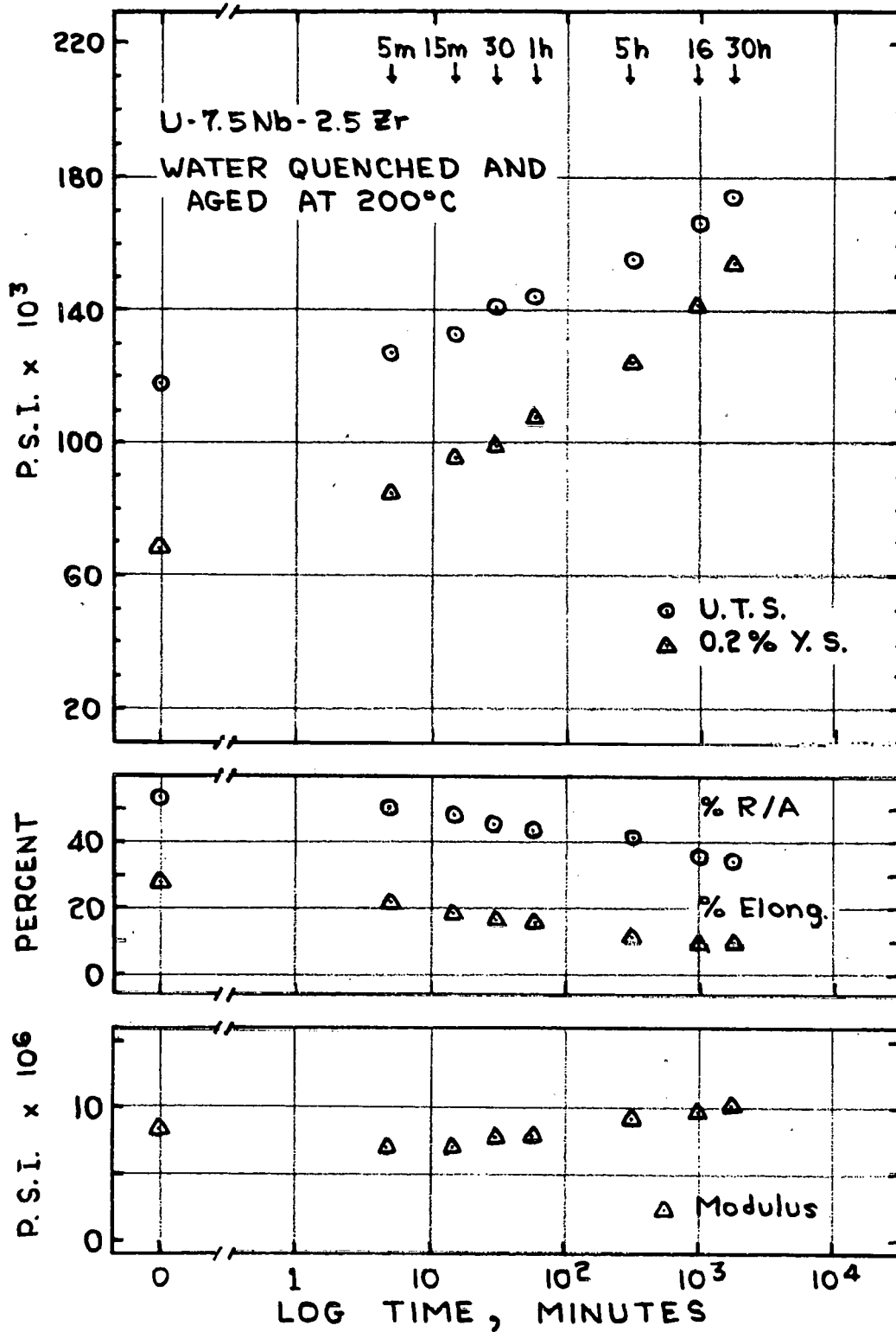


Figure 21. Tensile Test Data for 200°C Aged U-7.3 Nb-2.5 Zr Alloy.
 Composition: U-7.3 wt% Nb-2.5 wt% Zr. . . Bar Type: R-3. . . Date: 1/69.
 Material: Induction cast, homogenized 4 hr at 1150°C, hot forged 800°C, water quenched, tensile blanks machined.
 History: Gammaized 30 min. at 900°C, water quenched, aged 200°C in oil, air cooled, machined, tested 24°C.
 Strain Rate: 0.003 in./in.-min. . . Bars per datum point: 1.

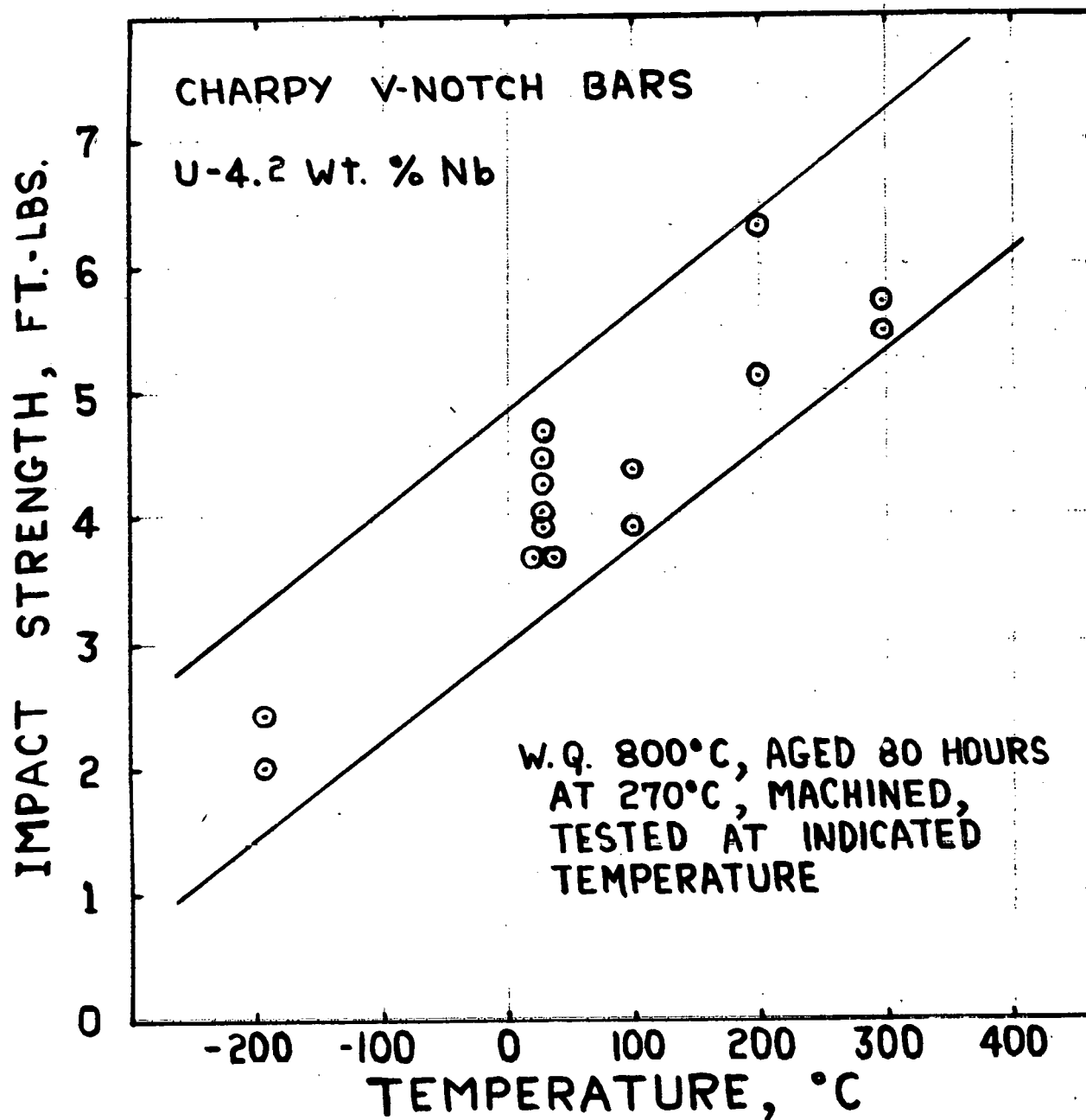


Figure 22. Hot Impact Test Data of 80 Hour Aged U-4.2 Nb Alloy.

Composition: U-4.2 wt% Nb. . . Bar Type: Std. V-Notch Charpy. . . Date: 10/70.

Material: Induction-cast recycle, homogenized 4 hr at 1100°C, hot forged 800°C, water quenched, impact blanks machined.

History: Gammaized 30 min. at 800°C, water quenched, aged 80 hr at 270°C, machined, tested at indicated temperature.

Bars per datum point: 1.

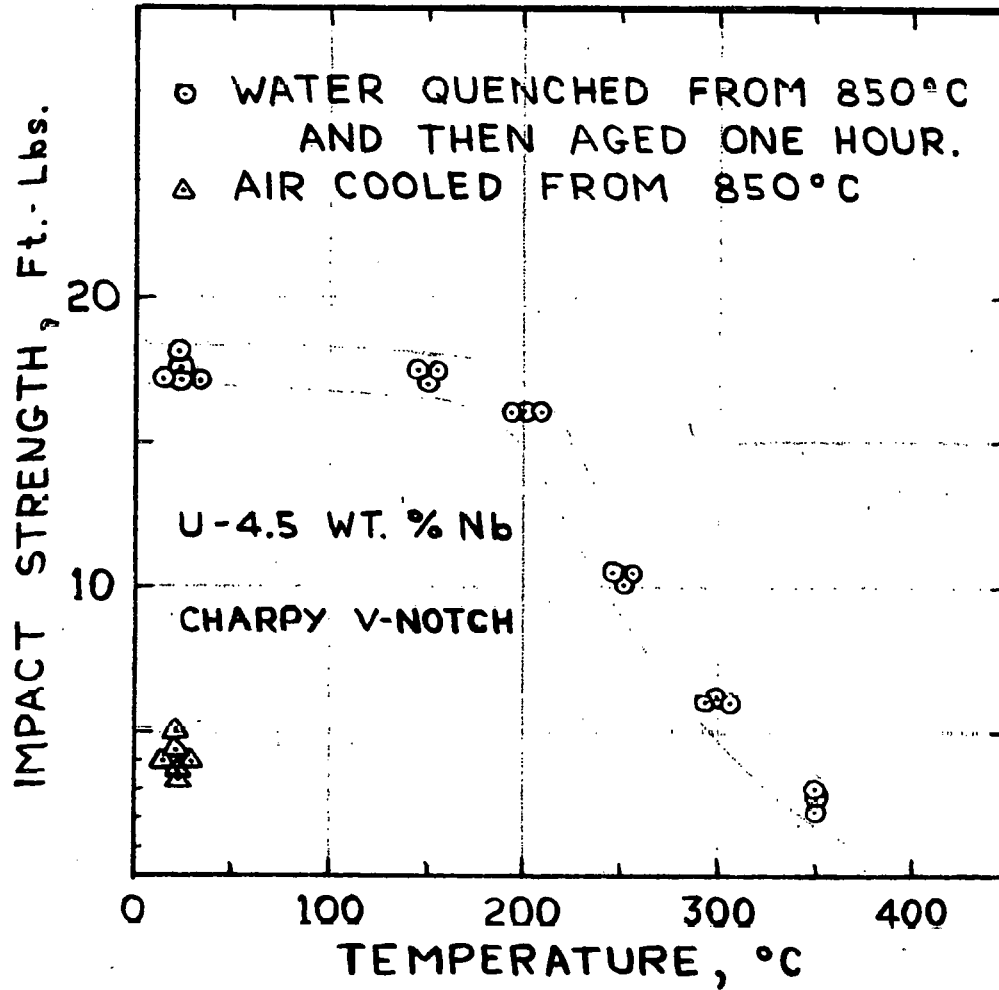


Figure 23. Impact Test Data for One Hour Aged U-4.5 Nb Alloy.

Composition: U-4.5 wt% Nb. . . . Bar Type: Std. V-Notch Charpy. . . . Date: 1/68.

Material: Induction-cast recycle, homogenized 2 hr at 1100°C, hot forged 800°C, water quenched, impact blanks machined.

History: Gammaized 30 min. at 800°C, water quenched (6 bars air cooled), aged 1 hr at temperature, air cooled, tested 24°C.

Bars per datum point: 1.

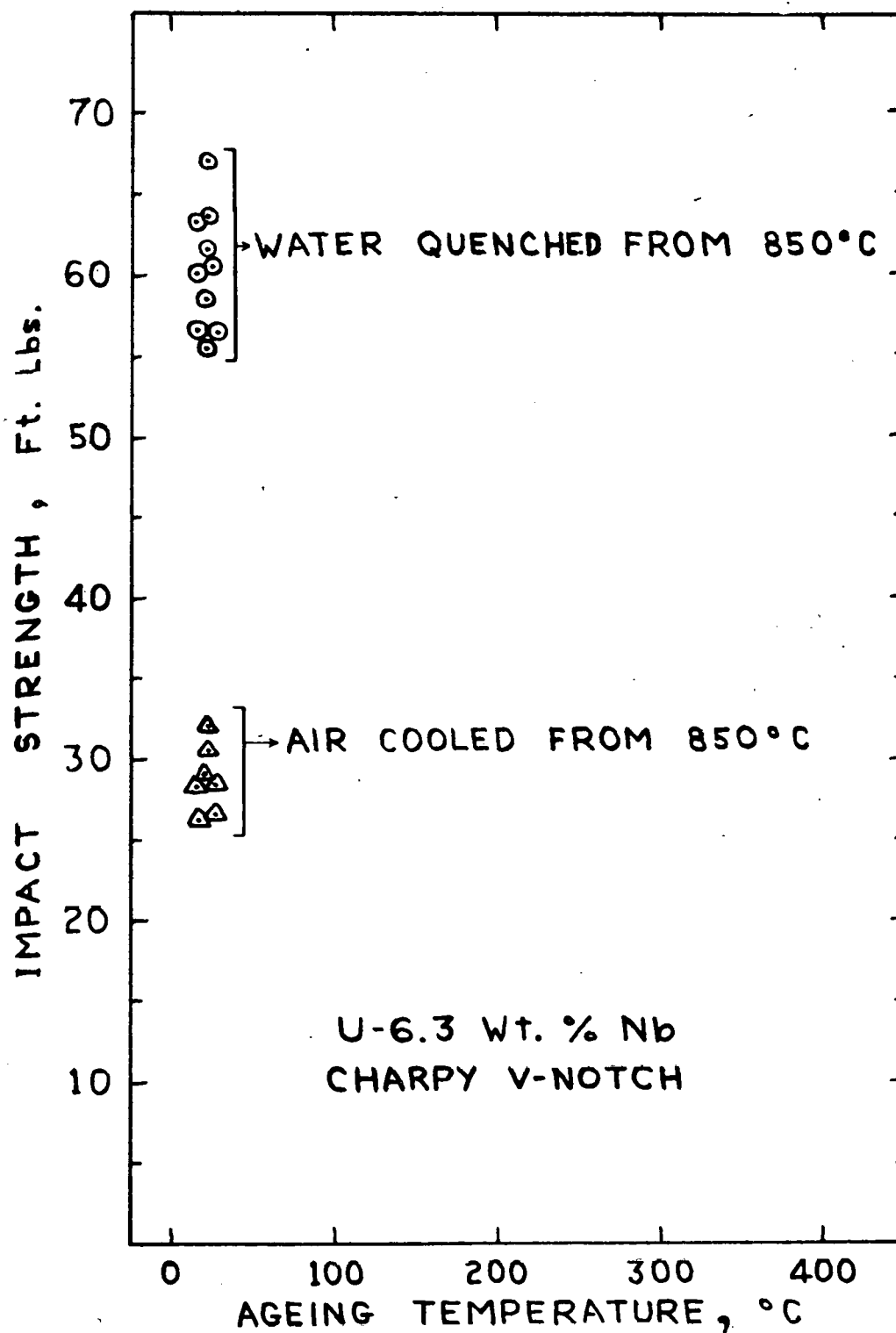


Figure 24. Impact Test Data for U-6.3 Nb Alloy.

Composition: U-6 wt% Nb. . . Bar Type: Std. V-notch Charpy. . . Date: 9/67, 1/68.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 850°C, water quenched, impact blanks machined.

History: Gammaized 30 min. at 850°C, water or air quenched, machined, tested 24°C.

Bars per datum point: 1.

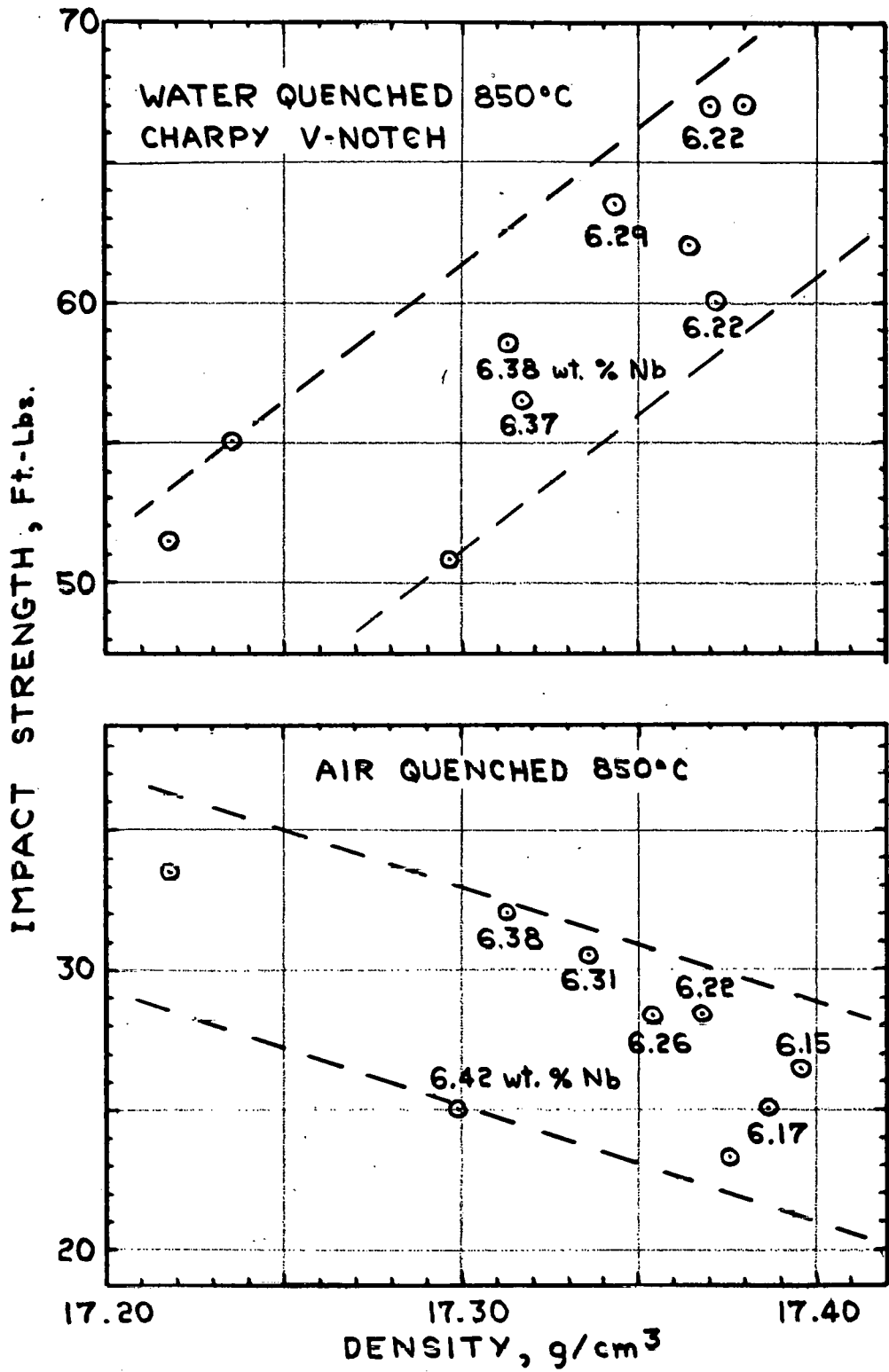


Figure 25. Impact Test Data as Function of Density (Composition).

Composition: About U-6.3 wt% Nb. . . . Bar Type: V-notch Charpy. . . . Date: 9/67, 1/68.

Material: Double arc-cast virgin, homogenized 2 hr at 1100°C, hot rolled 850°C, water quenched, impact blanks machined.

History: Gammaized 30 min. at 850°C, water or air quenched, machined, tested 24°C.

Bars per datum point: 1.

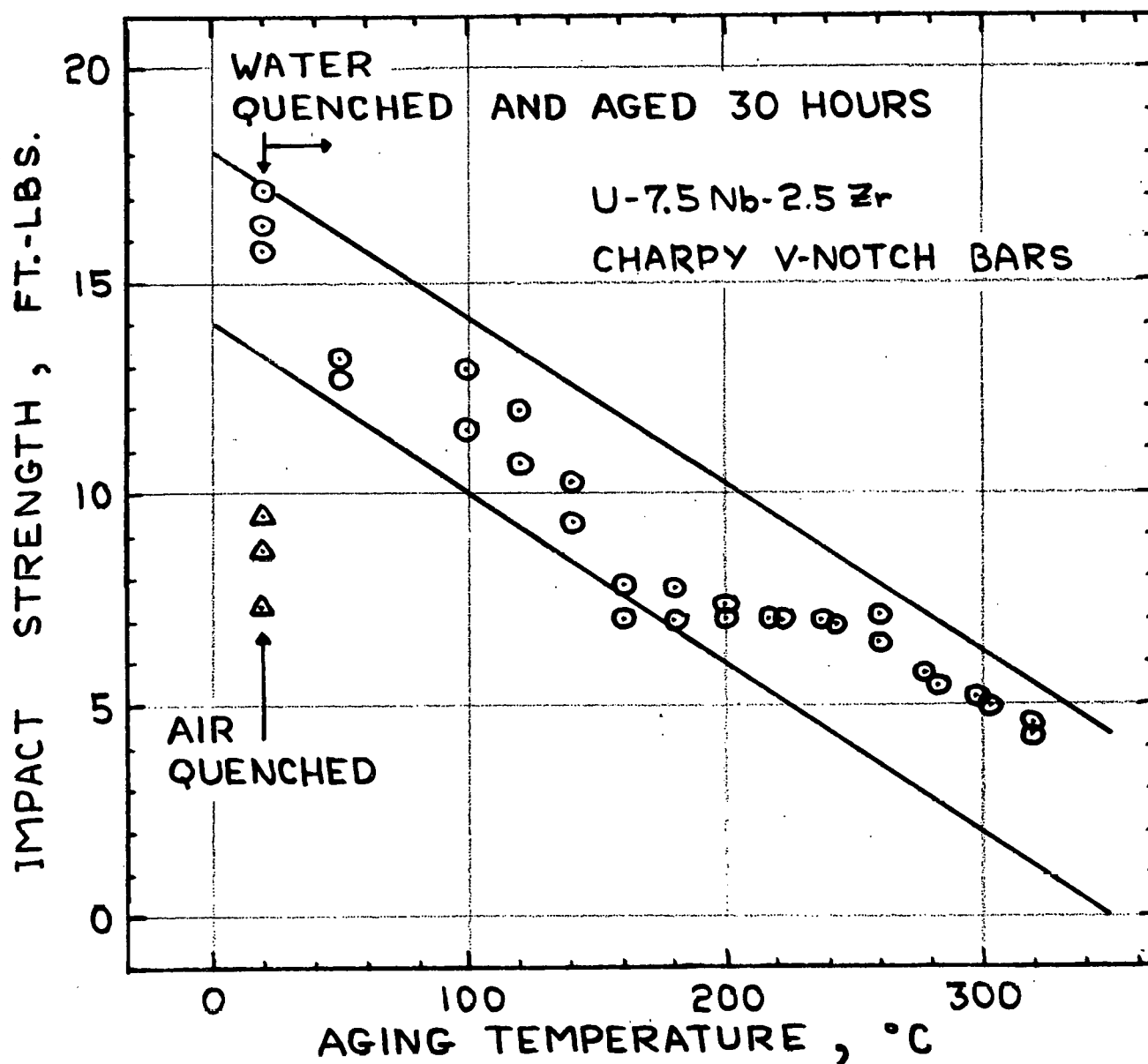


Figure 26. Impact Test Data for 30 Hour Aged U-7.3 Nb-2.5 Zr Alloy.

Composition: U-7.3 wt% Nb-2.5 wt% Zr. . . Bar Type: Std. V-notch Charpy. . . Date: 1/69.

Material: Induction cast, homogenized 4 hr at 1150°C, hot forged 800°C, water quenched, impact blanks machined.

History: Gammaized 30 min. at 900°C, water quenched (3 air cooled), aged 30 hr at temperature, air cooled, machined, tested 24°C.

Bars per datum point: 1.

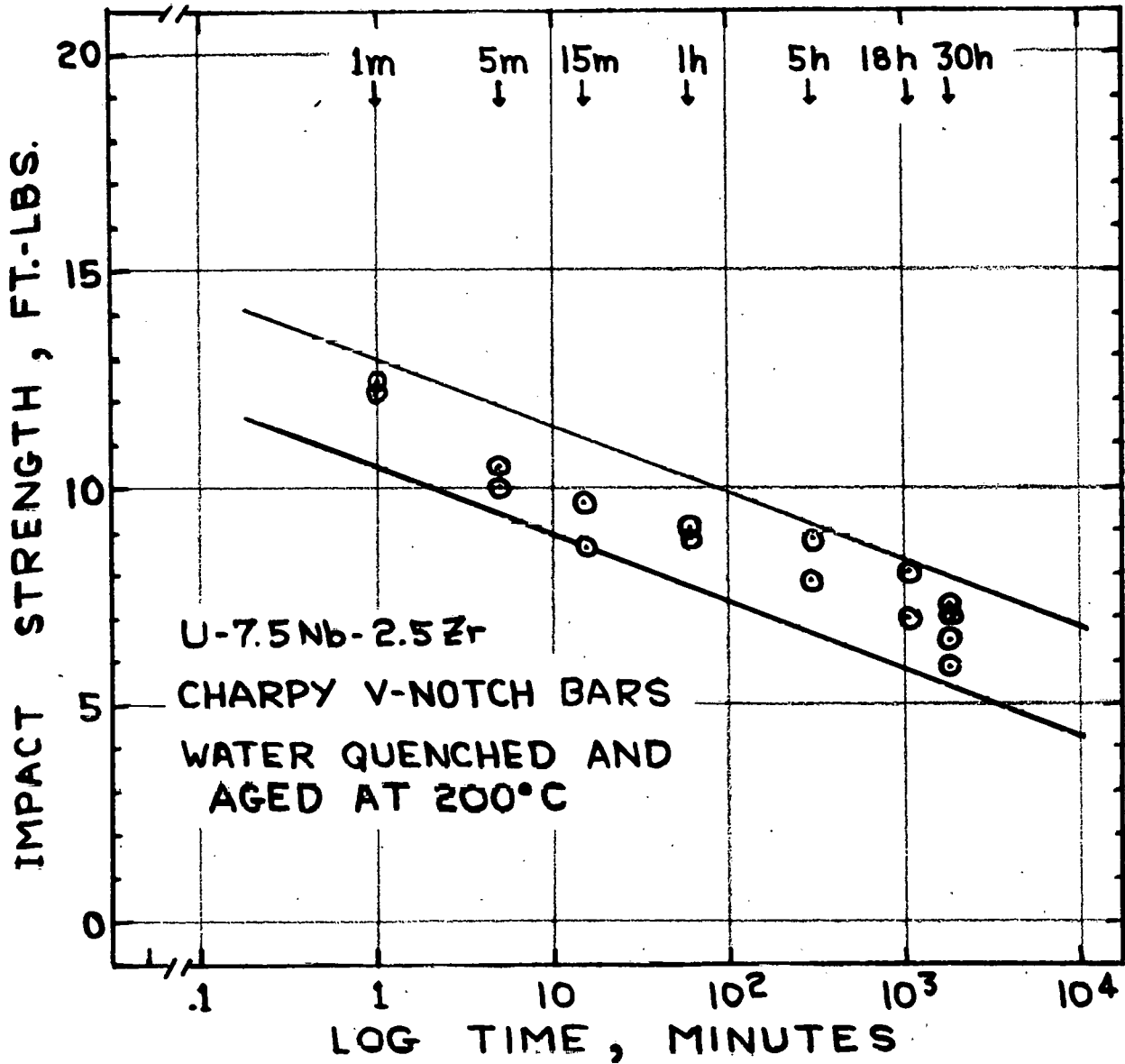


Figure 27. Impact Test Data for 200°C Aged U-7.3 Nb-2.5 Zr Alloy.

Composition: U-7.3 wt% Nb-2.5 wt% Zr. . . . Bar Type: Std. V-notch Charpy. . . . Date: 1/69.

Material: Induction cast, homogenized 4 hr at 1150°C, hot forged 800°C, water quenched, impact blanks machined.

History: Gammaized 30 min. at 900°C, water quenched, aged 200°C in oil, air cooled, machined, tested 24°C.

Bars per datum point: 1.