PROPOSAL

to the

AVIATION PANEL

of the

ASME-ASTM JOINT COMMITTEE ON THE EFFECT OF TEMPERATURE

ON THE PROPERTIES OF METALS

FOR THE

STATISTICAL EVALUATION OF CREEP RUPTURE PROPERTIES

OF HEAT-RESISTANT ALLOYS

September 7, 1951

The proposal covers three creep-rupture tests at three temperatures on each of 10 lots of Type 347, Type 321, Inconel-X and N-155 sheet as set forth in the invitation to bid submitted by Mr. L. P. Spalding under date of July 24, 1951. The proposed testing conditions are:

ALLOY	TEMP. (°F)	DESIRED RUPTURE TIME (HRS.)		
347	1200	20	80	300
	1350	20	80	300
	1500	5	20	80
321	1200	20	80	300
	1350	20	80	300
	1500	5	20	80
Inconel "X"	1200	20	80	300
	1350	20	80	300
	1500	20	80	300
N-155	1350	20	80	300
	1500	20	80	300
	1650	5	20	80

Test materials are to be supplied by the Aviation Panel in the form of 0.040" x 27" x 36" sheet.

A time-elongation curve is to be obtained for each test. From the time-elongation data, curves of stress vs. time for deformations of 0.2, 0.5, 1.0, and 2.0% are to be established insofar as the data permit. The data obtained are to be correlated and analyzed statistically.

Room temperature tensile tests are to be used to estimate the uniformity of the material in each sheet.

PROCEDURE

Specimens will be machined in the cross-grained direction from the stock submitted. The gage lengths will be 1" wide by 2-1/4" long. The gage section will be finished by grinding under conditions demonstrated to not adversely affect the elongation at fracture.

Tensile tests will be made in duplicate at room temperature, using specimens from as widely different positions in the sheet as possible.

Tests will be conducted in individual creep-rupture machines, with the load being applied directly insofar as possible. Tests involving loads too large for direct loading will require loading by a simple beam operating through a system of knife edges. Temperature control and distribution will be within the limits of applicable ASTM Recommended Practices. Care will be exercised to keep temperature adjustment times and loading conditions constant. The Engineering Research Institute would be quite willing to adopt special features the Joint Committee might desire in the way of specimen configuration and testing conditions, providing the tests could be conducted with existing equipment.

Strain data will be obtained by a modified Marten's type extensometer system attached directly to the specimen. The sensivity of the system will be not less than 0.00001 inch per inch. Normally, extensometers are used with a sensitivity of 0.000003 inch per inch for creep work in our laboratories. Some compromise, however, will be necessary to meet the requirement of a curve out to fracture.

The client should recognize that it will be difficult to obtain the exact rupture times specified. Even for materials considered to be very uniform, exact duplication of rupture times is unusual. Sheet materials are usually non-uniform in creep properties within any one sheet so that sufficient variation from specimen to specimen to make it difficult to obtain exact rupture times would be expected. Due to the variability, the guiding principle will be the establishment of stress-rupture time curves satisfactory for interpolation of the exact desired rupture times. Every effort will be made to keep the actual rupture times within the following ranges: $5 \begin{matrix} + 3 \\ - 1 \end{matrix}$ hours, 20 ± 5 hours, 80 ± 15 hours, and 300 ± 50 hours.

Upon completion of the tests, the rupture and strain data will be analyzed statistically with a mathematician from the staff of the University of Michigan.

REPORTS

Quarterly reports will be issued to present the data obtained and analyzed to indicate the implications of the results.

A final report will be issued withon one month of the completion of the tests, setting forth the general results in both tabular and graphical form. In addition to a statistical analysis, the results will be analyzed metallurgically on the basis of the wide experience of the staff of the Engineering Research Institute with the metallurgical variables affecting the high-temperature strength of the alloys.

COSTS

On a firm fixed-price basis, the following quotation is made:

Personnel	$ 8,000.00
Materials and Maintenance	1,440.00
Specimen Preparation	4,200.00
Overhead	1,360.00
TOTAL	$15,000.00

The personnel charges include direct charges for wages and salaries for creep unit operators, metallurgical staff, and report preparation. Materials and maintenance charges include such items as electricity for creep-unit furnaces, thermocouples, and repair of furnaces, adapters and extensometers. Specimen Preparation includes the cutting of coupons from the sheets and machining the exact gage lengths for the tests. The Overhead is 10 percent. This Overhead rate is only a small fraction of the usual rate necessary for the Institute to charge for privately-sponsored research and represents a contribution on the Institute's part to a cooperative investigation sponsored by recognized technical societies.

The attention of the Joint Committee is directed to the fact that such an investigation is subject to wide variations in costs. The above quotation is intended to include all contingencies and is based on the assumption that, on an average, one retest will be needed per stress-rupture time curve. Extensive experience with

such work indicates that it would be considerable to the Joint Committee's benefit to issue a contract on the basis of actual costs but not to exceed $15,000.00. Thus, any economies which might be accomplished would be reflected in the charges.

The Engineering Research Institute would assign six creep-rupture units to the investigation, which should allow completion of the work in 12 to 15 months from the receipt of the contract and test materials; that is, between January 1 and March 31, 1953, assuming the work would be started January 1, 1952. The investigation would be supervised by A. E. White and J. W. Freeman.