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FRACTURE TOUGHNESS, FATIGUE AND CORROSION CHARACTERISTICS OF X7080-T7E41 AND 7178-T651 PLATE AND 7075-T6510, 7075-T73510, X7080-T7E42, AND 7178-T6510 EXTRUDED SHAPES

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FOREWORD

This investigation was conducted by the Alcoa Research Laboratories, Aluminum Company of America, New Kensington, Pennsylvania, under USAF Contract Number F33615-67-C-1521, Project 7381, "Materials Applications," Task No. 738106, "Engineering and Design Data." This work was under the direction of the Air Force Materials Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio, with Mr. S. O. Davis and Mr. A. W. Gunderson as project engineers.

This report covers work done from March, 1967, to July, 1969.

The investigation was carried out under the supervision of Mr. J. G. Kaufman. Mr. P. E. Schilling co-ordinated the preparation of the reports, and served as project leader for the axial-stress fatigue and fracture toughness phases of the program. Messrs. G. E. Nordmark and B. W. Lifka were project leaders for the fatigue crack propagation and corrosion projects, respectively. Mr. J. W. Coursen investigated the evaluation of stress-corrosion resistance by a fracture mechanics approach.

The manuscript was released by the authors in September for publication as a technical report.

This technical report has been reviewed and is approved.

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ABSTRACT

The tensile properties, plane-strain fracture toughness (K_{Ic}), axial-stress fatigue properties and fatigue-crack propagation rates, and the resistance to exfoliation and stress-corrosion cracking, have been determined for several aluminum alloys. Two thicknesses of X7080-T7E41(T751) and 7178-T651 plate, and two thicknesses of 7075-T6510, 7075-T73510, X7080-T7E42(T7510) and 7178-T6510 extruded shapes, have been evaluated. The results are summarized as follows:

	7075-T6-Type		7075-T73-Type		X7080-T7-Type		7178-T6-Type	
	Plate	Extruded Shapes	Plate	Extruded Shapes	Plate	Extruded Shapes	Plate	Extruded Shapes
TS, ksi (1)	87	87	72	74	68	72	91	92
TYS, ksi (1)	78	79	61	64	60	64	84	82
K_{Ic}, ksi$\sqrt{in.}$ (1)	26 *	29	30*	34	36	38	23	24
Properties (2)	Least Uniform		Uniform		Most Uniform		Least Uniform	
Relative Fatigue (3)	Low		High		High		Low	
Exfoliation (4)	Low		Very High		High		Low	
SCC (5)	Low		Very High		High		Low	

NOTES: (1) Longitudinal direction.
(2) Uniformity of properties within large cross-section.
(3) Relative resistance to fatigue crack growth.
(4) Relative resistance to exfoliation attack.
(5) Relative resistance to stress-corrosion cracking.

* From previous programs.

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SECTION I

INTRODUCTION

Fracture toughness, fatigue and corrosion characteristics are among the most important properties in determining the suitability of materials for many aerospace applications. A concerted effort has been made in recent years to develop fracture-toughness, fatigue and corrosion-resistance information for a number of aluminum alloys, tempers and products. Plate of seven alloys and tempers, including 2020-T651, 2024-T851, 2219-T851, 7001-T75, 7075-T651, 7075-T7351 and 7079-T651, were initially evaluated[1,2] and some effort in the fracture toughness field was extended to extruded shapes[3]. Another program is underway to evaluate stress-relieved hand forgings[4].

The effort described in this report was a comprehensive evaluation of 7178-T651 and X7080-T7E41(T751) plate, and extruded shapes of 7075-T6510, 7075-T73510, X7080-T7E42(T7510), and 7178-T6510. The procedures which were used in this new program were generally similar to those which were used in the previous investigations and, where possible, direct comparisons have been made with data which were developed previously[1,2]. The data reported are not design or expected-minimum values of the properties involved, but rather the results of tests of representative lots of material; thus they must be interpreted as representative values rather than statistically reliable average or minimum values of the properties involved.

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SECTION II

MATERIAL

The materials which were used in this program included two thicknesses each of X7080-T7E41 (experimental equivalent of T751 temper; see below) and 7178-T651 plate, and two sizes of 7075-T6510, 7075-T73510, X7080-T7E42 (experimental equivalent of T7510 temper; see below) and 7178-T6510 extruded shapes. All three alloys are of the Al-Zn-Mg-Cu series, 7075 and 7178 being older alloys and X7080 a relatively new alloy (still experimental as indicated by the "X" prefix to the designation); this new alloy is available only in T7-type tempers. The two plate thicknesses were 1/2 and 1-3/8 in. The extruded shapes were an 11/16-in. thick by 16-in. wide integrally stiffened panel (Fig. 1), and a 3-1/2-in. thick by 7-1/2-in. wide solid rectangular bar (Fig. 2). These thicknesses and shapes were selected to provide information on the influences of specimen direction and location, and grain flow pattern on the properties.

The two thicknesses of each alloy and temper and product were fabricated especially for this program from the same cast of metal, to insure that chemical composition was not an uncontrolled variable. Commercial production and inspection practices were used in the fabricating plants. All samples were 100-per cent ultrasonically inspected to meet Class A standards[5]. Except as noted below, the plate samples were fabricated to the final temper at Alcoa's Davenport, Iowa, Works, and the extruded samples were fabricated to the final temper at Alcoa's Lafayette, Indiana, Works.

Since alloy X7080 was developed as a forging alloy, and prior to this program had not been produced as plate or extruded shapes, some additional development* was necessary to arrive at suitable procedures for the fabrication of X7080 plate and extrusions. The X7080 plate and extruded shapes were fabricated to the W51 (plate) or W510 (extrusion) temper at the plants, and supplied to the Alcoa Research Laboratories (ARL) in those tempers. (The W51 and W510 tempers indicate that the material was solution heat-treated and stress-relieved by stretching.) Exploratory work was carried out at ARL to establish thermal treatments which would provide the same combination of properties for these products as for X7080-T7 forgings. The test samples were given the final aging treatments at ARL, and they were designated as the T7E41 (plate) and T7E42 (extrusions) tempers. These experimental temper designations have been used throughout this report, because there are no officially assigned Aluminum Association-approved tempers for the X7080 products. The experimental temper designations serve to emphasize the developmental nature of the X7080 samples.

* At Contractor's expense.

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SECTION III

CONTROL TESTS

Four types of control tests were performed on each lot of material, to establish that the samples were suitable for use in this project.

A. Chemical Analyses

The chemical composition of each lot of material was determined by quantometric analysis, with backup by the atomic-absorption method for copper, magnesium and zinc.

The composition of each of the samples, shown in Table I, was within accepted limits except that the chromium content of the analyzed pieces from the 1-3/8-in. 7178-T651 plate was 0.01 per cent below the specified minimum value. Both the 1/2-in. and 1-3/8-in. samples were fabricated from the same ingot, and both the melt from which the ingot was cast and the 1/2-in. plate were within chemical composition limits. Therefore, the slightly lower chromium content of the thicker plate was considered to be representative of the point to point variation in composition which is to be expected in fabricated products. Such minor differences have no significant effect on the overall properties of the products.

B. Tensile Tests

The tensile properties of each lot of material were determined in accordance with ASTM Methods E8, "Tension Testing of Metallic Materials"[6]; yield strengths were determined from autographically recorded load-strain diagrams. Longitudinal and long-transverse specimens were taken from the 1/2-in. plate and 11/16-in. extruded shape, and longitudinal, long-transverse and short-transverse specimens were taken from the 1-3/8-in. plate and 3-1/2-in. extruded shape.

The results of the tests are shown in Table II, along with the applicable specified minimum values (not established for X7080 nor for the thicker extruded shapes of some alloys and tempers). The tensile properties of the 7075 and 7178 plate and extruded shapes exceed the corresponding specified minimum values[7,8,9]. Though no specified minimum properties are available for comparison, the tensile properties of the X7080 plate and extruded shapes appear typical of the expected level for these products.

C. Corrosion Tests

The resistance of each sample to intergranular attack

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in a sodium chloride-hydrogen peroxide solution was determined as per MIL-H-6088D[10]. Each of the lots exhibited a type and extent of attack, shown in Table III, which was typical of that expected of the respective alloy, temper and product.

D. Electrical Conductivity Tests

The electrical conductivity of each sample was determined with a type FM-103 Magnatest Conductivity Meter in accordance with ASTM Method B342-63[11]. Each lot exhibited a conductivity, shown in Table IV, that was representative of the respective alloy, temper and product.

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SECTION IV

PROCEDURE

The tensile properties, fracture toughness, axial-stress fatigue, fatigue crack growth and corrosion characteristics of each item were determined. The detailed test program is shown in Table V.

A. Tensile Properties

Scope. The tensile properties of each of the samples were determined in the longitudinal, long-transverse and short-transverse (where practical) directions. In addition, the variation in properties throughout the cross section, and the effect of removing the fabricated (i.e., as-rolled or as-extruded) surfaces were determined for individual samples.

Specimens. Full-thickness sheet-type specimens (ASTM E8[6], Fig. 6) were taken from the 1/2-in. plate and from the stiffeners on the extruded panels, while 3/8 or 1/2-in. diameter tensile specimens (ASTM E8[6], Fig. 8) were taken from the base of the extruded panels and the thicker plate.

In general, the specimens were taken from each sample at locations corresponding to the specification test locations, but in addition, specimens were taken at several locations from the extruded shapes (Figs. 1 and 2) to determine the variations in tensile properties throughout the cross sections. In addition, tests were made of specimens from the 1/2-in. plate and the stiffeners of the 11/16-in. shape with 0.020 in. machined from the surfaces, to determine the effect of removal of the fabricated surface on the tensile properties.

Procedure. The ultimate tensile strengths, tensile yield strengths and elongations were determined in accordance with ASTM Methods E8, "Tension Testing of Metallic Materials"[6]. Yield strengths were determined from autographic load-strain diagrams, using a 0.2-per cent offset. All tests were made in testing machines which meet ASTM[12] and U.S. Government requirements for accuracy.

B. Fracture Toughness

Scope. Plane-strain fracture-toughness tests to determine K_{Ic} were made of each of the samples in the longitudinal, long-transverse and (where possible) short-transverse directions. As in the case of the tensile tests, fracture-toughness tests were made of specimens from several locations

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in the extruded shapes to determine the variation in toughness throughout the cross-section, and also of specimens with light surface cuts (0.020 in.) to determine the effect of removal of the fabricated surface on the toughness.

Specimens. The fracture-toughness tests were made with fatigue-cracked notch-bend and compact tension specimens from locations corresponding to those used in the tensile tests (Figs. 3 and 4 for the extruded shapes). The original program called for the use of notch-bend specimens only. The compact tension specimens were tested to obtain more meaningful data in some cases. The dimensions of the specimens are shown in Figs. 5 and 6 and are consistent with the ASTM Method for Plane Strain Fracture Toughness Testing of Metallic Materials[13].

Procedure. The fatigue cracking and the test procedures were generally in accordance with the ASTM Method for Plane Strain Fracture Toughness Testing of Metallic Materials[13] or with the earlier version[14] which was current at the time the test program was carried out. The notch-bend specimens (Fig. 5) were fatigue-cracked by cantilever bending (R = -1.0) in a Sonntag SF-4 machine at 3650 cpm. The compact tension specimens (Fig. 6) were fatigue-cracked by axial loading (R = +0.1) in Krouse machines at 1750 cpm. The maximum stress intensities for fatigue-cracking varied from about 5000 to 12,000 psi$\sqrt{\text{in.}}$, depending upon the alloy and temper.

Typical K_{Ic} test setups for the notch-bend and compact tension tests are shown in Figs. 7 and 8, respectively. The tests were conducted in an Olson 30,000-lb screw-driven machine, and load-versus-crack-opening-displacement (COD) curves were plotted autographically. For each test, a candidate value of the critical plane-strain stress-intensity factor, K_Q, was calculated with the load, taken from the autographic load-displacement curve, which caused a crack extension of about 2 per cent of the original crack length. This was determined by applying the appropriate secant offset (5 per cent for the notch-bend tests, 4 per cent for the compact tension tests) to the autographic load displacement curves. The K_Q values were calculated by the following expressions[13]:

Notch Bend:

$$K_Q = \frac{P_Q(a)^{1/2}S}{BW^2}\left[2.9 - 4.6\left(\frac{a}{W}\right) + 21.8\left(\frac{a}{W}\right)^2 - 37.6\left(\frac{a}{W}\right)^3 + 38.7\left(\frac{a}{W}\right)^4\right] \quad (1)$$

Compact Tension:

$$K_Q = \frac{P_Q(a)^{1/2}}{BW}\left[29.6 - 185.5\left(\frac{a}{W}\right) + 655.7\left(\frac{a}{W}\right)^2 - 1017.0\left(\frac{a}{W}\right)^3 + 638.9\left(\frac{a}{W}\right)^4\right] \quad (2)$$

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Where P_Q = Load causing two per cent crack extension, lb.

B = Specimen thickness, in.

W = Specimen width, in.

a = Fatigue crack length, in.

S = Span length, in.

Analysis. The K_Q value was considered to be equal to (i.e., a valid value of) the critical plane-strain stress-intensity factor of the material, K_{Ic}, if the following criteria were met[13,14]:

a. The thickness and crack length of the specimen were large with respect to the size of the plastic zone at the crack tip. This requirement was considered to have been met if the thickness and crack length of the test specimen were equal to or greater than 2.5 times the ratio $(K_Q/\sigma_{YS})^2$.

b. The majority of the deviation from linearity in the load-displacement curve prior to the secant intersection was caused by crack extension, rather than plastic deformation of the specimen. This requirement was considered to have been met if the offset at a load equal to 80 per cent of the load at the secant intercept was not more than 1/4 of the offset at the secant intercept.

c. The fatigue-crack front was sufficiently extended from the machined notch, and was not excessively curved or out of plane.

d. The specimen was fatigue cracked at a stress intensity which was less than one-half of the calculated K_Q value, or 0.0012 times Young's modulus for the material, whichever was smaller.

In some instances, K_Q values were interpreted to be meaningful values of K_{Ic} if criteria c and d were exceeded by only a slight margin, as noted with the data.

C. Axial-Stress Fatigue Properties

Scope. The axial-stress fatigue properties of each of the samples were determined, and modified Goodman Diagrams were prepared. The effects of specimen direction, stress ratio and stress concentration factor were evaluated for some individual samples.

Specimens. The specimens were of the general designs in Figs. 9 and 10. The 1/4-in. diameter smooth specimens were used for all tests of the 1/2-in. plate samples, and for the tests at nominal maximum stresses above 70,000 psi for all samples.

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Longitudinal specimens were taken from the 1/2-in. plate and 11/16-in. extruded panel, longitudinal and long-transverse specimens were taken from the 1-3/8-in. plate, and longitudinal, long-transverse and short-transverse specimens were taken from the 3-1/2-in. extruded bar. In general, axial-stress fatigue specimens were taken from locations near the center of the cross-section where any variations in fatigue properties relatable to the location should be at a minimum. For the 3-1/2-in. bar, however, specimens were taken from several locations to check the effect of location on the fatigue properties.

Procedure. The axial-stress fatigue properties of each of the samples were determined with smooth (Fig. 9) specimens at three stress ratios*, R = +0.5, 0.0, and -1.0. For the 1-3/8-in. plate and 3-1/2-in. extruded bar, tests were also made with two designs of notched specimens (Fig. 10) with theoretical stress concentration factors (K_t)[15] of 3.0 and =12.

The specimens were tested in Tatnall-Krouse double-unit direct-stress fatigue testing machines, having a 5000-lb. capacity and 1/8-in. maximum throw and operating at 1500 or 1725 cpm. The loading cycle was sinusoidal.

Analysis. Modified Goodman diagrams were prepared from the S-N data for all three test directions and all three stress concentration factors, for fatigue lives to ten million cycles. The particular stress ratios used were selected to provide the maximum amount of information for preparing such diagrams. Approximately ten specimens were used to develop S-N curves for each direction, stress ratio, and theoretical stress-concentration factor.

D. Fatigue-Crack Propagation Rate

Scope. The rate of propagation of fatigue cracks was determined for each sample in the longitudinal direction. For individual samples, the effects of specimen direction, specimen location and removal of fabricated surface were determined.

Specimens. The fatigue-crack propagation rates were determined with specimens of the design in Fig. 11. The notch design was severe enough to hasten the initiation of fatigue cracks, but was mild enough that the numbers of cycles to crack initiation and complete failure have some significance. The theoretical stress concentration factor (determined at AFML) was 5.43.

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* $\text{Stress Ratio } R = \frac{\text{Minimum Stress in the Cycle}}{\text{Maximum Stress in the Cycle}}$

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Longitudinal specimens were taken from the 1/2-in. plate and 3-1/2-in. extruded bar, and both longitudinal and long-transverse specimens were taken from the 1-3/8-in. plate and 11/16-in. extruded panel (the transverse specimens from the extruded panel were fore-shortened in the grip ends and the reduced sections). The specimens from the 1-3/8-in. plate and 3-1/2-in. extruded bar were 3/4-in. thick, while most of those from the 1/2-in. plate and 11/16-in. extruded panel were of the full thickness. A few specimens from the thinner samples were also tested with 0.020 in. removed from the fabricated surface by machining.

Procedure. The fatigue crack propagation rates were determined by constant-maximum-load tests in 50,000-lb capacity structural fatigue machines (310 cpm) of the type shown in Fig. 12. The tests were made at a stress ratio of +0.33, at a maximum nominal stress of 9900 psi on the net section. This provided crack-propagation data for lives in the range of 10^4 to 10^7 cycles, which are of principal interest in design.

The initiation of fatigue cracks was detected by both visual inspection and an electrical crack-detection system. The latter consisted of bare 0.0015-in. diameter Advance wires bonded on one face of the specimen about 1/16-in. from the root of the notch, which when broken by an advancing fatigue crack resulted in the machine being shut off. Crack lengths were measured with a scale graduated to hundredths of an inch and a magnifying glass. Because the fatigue cracks usually advance on a convex front through the thickness of the specimen, the measurement of crack lengths to greater accuracies is not justified.

Analysis. Curves of crack length (expressed as a percentage of the width of the specimen, i.e., 2a/w, %) versus number of cycles were plotted, and rates of fatigue crack growth, da/dN, were obtained from the slopes of these curves by a procedure described in detail under Section V, Discussion of Results, Part D[16,17]. Values of ΔK, the stress-intensity range, were calculated from the instantaneous crack length measurements and plots of crack growth rates versus ΔK were developed. The relationship used to calculate the stress intensity for these specimens was as follows:

$$K_I = \frac{P}{Wt}\sqrt{a}\,[1.77 + 0.227(\frac{2a}{W}) - 0.510(\frac{2a}{W})^2 + 2.7(\frac{2a}{W})^3]$$

Where $$a = a_o + \frac{K_I^{\,2}}{6\pi\sigma_{YS}^{\,2}}$$

K_I = Stress intensity factor, psi$\sqrt{\text{in.}}$

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P = Load, lb.

w = Specimen width, in.

t = Specimen thickness, in.

a_o = Half of measured crack length, in.

σ_{YS} = Yield strength of the material, psi

E. Exfoliation

Scope. Panels were exposed at 45 degrees to the horizontal to acidified salt spray, seacoast atmosphere, and inland industrial atmosphere, to determine their resistance to exfoliation attack. All materials included in the program were tested in this manner.

Specimens. The panels exposed to salt-spray were 4x5 in. in size, and those exposed in the atmospheres were 4x9 in. in size. Because the surfaces of some products are extensively machined, and because the tendency for susceptible aluminum alloy-tempers to exfoliate generally increases from the surface to the center of the product, various planes in each product were exposed, as listed below:

(1) 1/2-in. plate - rolled surface and T/4 plane.

(2) 1-3/8-in. plate - near surface (3/16 in. removed) and T/2 plane.

(3) 11/16x16-in. extruded panel - extruded surface and T/4 plane.

(4) 3-1/2x7-1/2-in. extruded bar - extruded surface, T/10, T/4 and T/2 planes.

Procedure. The salt-spray tests were carried out in cabinets designed to meet the requirements for ASTM Method 287, "Acetic Acid-Salt Spray Testing"[18]. The length of exposure was two weeks, and the panels were inspected daily for extent of attack. Test conditions were the same as those required by ASTM B287 with the exception that the following variations were introduced:

(1) Operating Temperature was 120 F, rather than 95 F.

(2) Specimens were intermittently sprayed in 6-hour repetitive exposure cycles, consisting of 3/4-hour salt-spray time (operating per ASTM B287), 2 hours of dry-air purge, plus 3-1/4 hours at 100 per cent relative humidity (no salt).

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It has been found that the salt spray test conducted by Alcoa is more conducive to the development of exfoliation attack than are the ASTM B287 salt-spray tests[19].

For the tests in seacoast atmosphere, panels were exposed at Point Judith, Alcoa's seacoast exposure station in Rhode Island. The station is located about 300 ft from the water's edge with the accompanying elements of considerable salt mist, persistent fog, and prevailing off-shore winds. Corrosive conditions are severe and compare favorably with those at the ASTM seacoast exposure station at La Jolla, California. Data obtained at Point Judith may be used to indicate the expected performance of aluminum alloys in most seacoast environments.

For the tests in inland industrial atmosphere, panels were exposed on the roof of the Alcoa Research Laboratories in New Kensington, Pennsylvania. The corrosivity of the atmosphere in New Kensington is about as severe as those at ASTM exposure stations in Altoona, Pennsylvania, New York City, and Pittsburgh, Pennsylvania (before smoke control), and generally is more severe than at other inland areas. Data obtained at New Kensington may be used to indicate the resistance of aluminum alloys to the atmosphere in most industrial areas.

The panels exposed to the seacoast and inland industrial atmospheres were examined quarterly over a one-year exposure period. These exposures are continuing for at least a four-year exposure period.

Analysis. After exposure, the panels which underwent the salt-spray test were analyzed by visual inspection and microscopic examination for type and extent of attack.

F. Stress-Corrosion Cracking

1. Conventional Approach

Scope. Three types of specimens, 0.437 and 0.125-in. diameter tensile specimens and 0.750-in. O.D. C-rings, were exposed under stress to three environments to determine the resistance of the materials to stress-corrosion cracking. The environments included (1) 3-1/2 per cent NaCl alternate immersion for 12 or more weeks, (2) Point Judith seacoast atmosphere for one year or more, and (3) New Kensington inland industrial atmosphere for one year or more. Tests were made of the 3-1/2x7-1/2-in. extruded bars and 1-3/8-in. thick plate, in all three directions, with emphasis on the critical short-transverse direction, while tests of the 11/16x16-in. extruded panels and the 1/2-in. thick plate were made only in the long-transverse direction.

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Specimens. All test specimens were centered in the product thickness. Tensile specimens, 0.437-in. diameter (Fig. 13), were taken in the longitudinal direction from the 1-3/8-in. plate and 3-1/2x7-1/2-in. extruded bars, and in the long-transverse direction from all items. In addition, some supplemental* 0.125-in. diameter tensile specimens (Fig. 14) were taken in the long-transverse direction from the 11/16x16-in. extruded panels, to provide a comparison of the resistance of specimens located directly under an outstanding rib with that of specimens positioned between the ribs. For the short-transverse direction, 0.125-in. diameter tensile specimens were taken from the 3-1/2x7-1/2-in. extruded bars, and 0.750-in. O.D. C-rings (Fig. 15) from the 1-3/8-in. plate.

Procedure. All of the 0.125 and 0.437-in. tensile specimens were stressed in fixtures of the type shown in Fig. 16. The specimens were stressed by applying inward motion to the wedge-like side pieces, thus developing direct tensile stresses in the specimens. The stresses were controlled by measuring the corresponding strain in the specimen during loading with Huggenberger Tensometers. Prior to exposure, the fixtures were protected by means of an appropriate coating so that only the test section of the specimen itself was exposed.

The C-ring specimens were stressed in bending by tightening the bolt unit assembly to a predetermined deflection.

For longitudinal and long-transverse specimens, stresses equal to 75 per cent of the tensile yield strength were used. For short-transverse specimens, stresses equal to the following percentages of the corresponding tensile yield strength were used:

(1) 7075-T73510 extrusions, 75 and 50 per cent.

(2) X7080-T7E41 plate and X7080-T7E42 extrusions, 75, 50, 42, 34, 25 and 15 per cent.

(3) 7178-T651 plate, and 7075-T6510 and 7178-T6510 extrusions, 50, 25 and 15 per cent.

Unstressed specimens were also exposed to each environment.

The three types of specimen were exposed to each of the environments listed in the Scope.

The 3-1/2-per cent NaCl alternate-immersion test, as conducted by Alcoa Research Laboratories, employs 3-1/2 per cent by weight NaCl solution in tap water in tanks such as those shown in Fig. 17. The solution is changed every four

* Not called for in the original program.

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weeks, at which time the racks and specimens are cleaned by spraying with tap water. Loss of water by evaporation is compensated for by additions of tap water. The alternate-immersion cycle included total immersion for ten minutes per hour and aeration above the solution for the remaining 50 minutes per hour. The seacoast and industrial atmospheres were described previously (page 11).

Analysis. All fractured specimens were subjected to visual and microscopic examination to determine the nature of the failure. In addition, the tensile specimens which did not fracture during exposure were tested statically to determine the change in tensile strength resulting from the exposure under stress. For comparison, the control specimens that had been exposed to the same environments, but without stress, were also tested.

2. Fracture Mechanics Approach

Scope. Short-transverse precracked compact-tension specimens from the 3-1/2x7-1/2-in. extruded bar of each alloy and temper were exposed to 3-1/2 per cent salt (NaCl) water solution. Different methods of precracking and loading were studied. The results of these tests were correlated with those obtained in conventional stress-corrosion tests of smooth tensile specimens.

Specimens. Short-transverse compact tension specimens (1.0 in. thick), of the type shown in Fig. 6, were machined from each of the 3-1/2x7-1/2-in. extruded bars. The dimensions of the specimens were chosen in accordance with the guidelines in Ref. 13 to ensure that plane-strain conditions would prevail during the tests.

Procedure. Most of the specimens for environmental tests were precracked in fatigue, at stress intensities ranging from 5000 to 12,000 psi$\sqrt{in}$. Some of the specimens which were bolt loaded were precracked in tension, simply by turning the bolt until the desired crack length was developed. In both cases, the crack lengths were measured on the surfaces of the specimens. Various stress intensity levels equal to or less than K_{Ic}, as determined in the fracture toughness tests, were applied to the specimens using the ring- or bolt-type loadings shown in Figs. 18 and 19, respectively. The applied stress intensity levels (referred to as K_I) were selected in an effort to determine whether or not there was a stress intensity level below which stress corrosion cracking would not take place; this lower "threshold" level has been called K_{Iscc}[20,21], and this terminology is used in this report with the qualifications noted in the Discussion of Results. The specimens were exposed to either constant or alternate immersion in 3-1/2 per cent salt (NaCl) water solution. For the bolt-loaded specimens, the alternate immersion cycle was continuous and the same as for

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smooth specimens: total immersion for 10 minutes per hour and aeration above the solution for 50 minutes per hour. For the ring-loaded specimens, the cycle was carried out manually and was irregular; overnight and weekends, the specimen was completely immersed.

Analysis. Equation 2 (page 6) was used to determine the stress-intensity factors.

For specimens loaded in rings of the size used in this investigation, the applied stress intensity increases with crack growth; thus, if crack growth occurs, the test terminates in fracture of the specimen. Strain gages were applied to the load rings and clip gages were attached to the specimens, so that the load (P) and crack opening displacement (v) could be monitored throughout each test. The crack length at any given time can be determined using the compliance calibration data shown in Fig. 20, and represented by the equation:

$$\left(\frac{a}{W}\right)^2 = -3.065\times10^{-2} + 6.713\times10^{-3}\left(\frac{v}{P} BE\right) - 3.063\times10^{-5}\left(\frac{v}{P} BE\right)^2 + 5.545\times10^{-8}\left(\frac{v}{P} BE\right)^3 \quad (3)$$

where E = Modulus of elasticity in tension, psi

v = Crack opening displacement, and other symbols are as defined on page 7.

For bolt-loaded specimens, the applied stress intensity decreases with crack growth and eventually, the crack would be expected to "arrest" as K_I approaches a lower "threshold" value below which stress corrosion cracking would not take place, i.e., K_{Iscc}. The crack opening displacements required to produce the desired loads (i.e., stress intensities) in fatigue-precracked specimens were calculated with the equation:

$$\frac{v}{P} BE = +127.71 - 1453.6\left(\frac{a}{W}\right)^2 + 7924.9\left(\frac{a}{W}\right)^4 - 16708.\left(\frac{a}{W}\right)^6 + 14052.\left(\frac{a}{W}\right)^8 \quad (4)$$

The specimens were held in a vise and the bolts were tightened until the appropriate crack opening displacement, as measured with a clip gage, was obtained. In the case of the tension-cracked specimens, no measurements were made during precracking; the bolts were simply tightened until the desired crack length

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was obtained. This represented an arrest value of K_I, which was assumed because of the small crack growth involved to be essentially equal to K_{Ic}. The crack lengths on the surfaces of the specimens were measured periodically during exposure. When the tests were terminated, the crack-opening displacements were measured as the bolts were removed; the terminal crack-opening displacements were then reapplied with a testing machine to determine the residual loads and stress intensities.

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Section V

DISCUSSION OF RESULTS

A. Tensile Properties

Plate. The tensile properties of the 1/2-in. and 1-3/8-in. plate are shown in Table VI. The longitudinal properties were generally higher than the long-transverse properties, which were, for the 1-3/8-in. plate, higher than the short-transverse properties. The only exception to this general rule was that the longitudinal tensile strength of the 1-3/8-in. X7080-T7E41 plate was slightly below the long-transverse value. The variation of properties with direction was smaller for the X7080-T7E41 plate than for the 7178-T651 plate.

Also shown in Table VI are data for specimens from the 1/2-in. plate with 0.020 in. machined from each surface. These data were obtained to determine the effect of machining away the rolled surface on the tensile properties. There was no significant difference in properties with and without the rolled surface for the X7080-T7E41 plate. For the 7178-T651 plate, the strengths of the specimens with machined surfaces were about one per cent lower, which is not considered significant. Overall, it is concluded that there is no significant effect of the removal of the as-rolled surfaces from plate.

Extruded Integrally-Stiffened Panels. The tensile properties at various locations within the 11/16x16-in. extruded integrally-stiffened panels are shown in Table VII. The ratios of the tensile properties at various locations, and in the two directions, to the tensile properties at the specification (quarter-width, W/4) location in the base, are shown in Table VIII. The specimen locations are illustrated in Fig. 1. The longitudinal tensile properties of the stiffeners (ribs) are also listed in Table IX, to more clearly demonstrate the effects of location in the width and of removal of the extruded surfaces. Ratios illustrating the influence of surface removal are shown in Table X.

Several significant observations may be made from Tables VIII and X. The properties were quite uniform within the cross-section (Table VIII). The largest variation resulting from differences in location and direction was only about ten per cent, and in most cases the variations were less than five per cent. In general, the strengths of the stiffeners were from two to four per cent lower than those of the base. The long-transverse properties averaged about three per cent lower than the corresponding longitudinal properties. It appears that the T7-type samples (7075-T73510 and X7080-T7E42) have smaller differences between the longitudinal and long-transverse properties than do the T6-type samples (7075-T6510 and 7178-T6510).

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The removal of the extruded surfaces (Table X) resulted in slightly but consistently higher longitudinal tensile properties for the stiffeners; the difference averaged only one per cent. The reason for the higher strengths is undoubtedly the removal of the low-strength recrystallized surface layer which is common to most aluminum alloy extrusions.

Extruded Bar. The tensile properties at various locations in the 3-1/2x7-1/2 in. extruded bars are shown in Figs. 21, 23, 25 and 27. The average properties at the specification locations are listed in Table II. The ratios of the tensile strength and tensile yield strength from each test, to the average properties in the longitudinal direction at the specification locations (quarter-width, quarter-thickness; W/4, t/4), are shown in Figs. 22, 24, 26 and 28.

The tensile strengths and tensile yield strengths were generally highest at the surfaces of the bars, and lowest at the centers. In the longitudinal direction, yield strengths varied by as much as 15 per cent from the corners to the centers. In the short-transverse direction, yield strengths varied by as much as 21 per cent from edge to center. For all four samples, variations in the tensile strengths were smaller than those in yield strengths. The X7080-T7E42 bar (Figs. 25 and 26) had less variation in properties with location and direction, than the other three bars. The four extruded bars can be arranged in the following order with respect to uniformity of properties: X7080-T7E42 was most uniform, followed by 7075-T73510 and 7075-T6510; 7178-T6510 was least uniform.

For all four materials the longitudinal properties were highest, and the short-transverse properties were lowest.

Comparisons of Alloys and Products. For the two alloy-temper combinations of plate which were tested in this program, the 7178-T651 samples had much higher tensile properties than the X7080-T7E42 samples. The tensile and yield strengths of the 7178-T651 plate were also higher than those of the other alloys and tempers tested as 1-3/8 in. plate in previous programs[1,2], as shown by the average properties summarized in Table XI. The strength of the X7080-T7E41 plate places it at a level slightly below the 7075-T7351 plate, but well above the 2219-T851 plate which had the lowest strengths of the entire group.

The four alloy-temper combinations of extruded shapes tested in this investigation can be arranged in the following general order (highest to lowest) with respect to tensile properties.

7178-T6510
7075-T6510
7075-T73510
X7080-T7E42

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For the 3-1/2x7-1/2-in. extruded bars, the longitudinal tensile properties of the X7080-T7E42 sample were only slightly lower than those of the 7075-T73510 sample, while the long and short-transverse properties were somewhat higher.

The extruded samples of all four alloys generally had higher strengths and lower elongations than the plate samples of the same alloys (from the current and previous programs), but there were many exceptions. The exceptions were generally associated with the 3-1/2x7-1/2-in. extruded bar which, because of its thickness and the quench sensitivity of some alloys, would be expected to have lower strength than thinner plate and extruded shapes. There are insufficient data to make any firm conclusions about the comparison of products or the effect of product thickness.

B. Fracture Toughness

Notation. Because of the variety of directions and orientations from which fracture-toughness specimens can be taken, it is desirable to use a supplemental system along with the conventional longitudinal—long-transverse—short-transverse designation for describing the specimens. A convenient notation for describing planar cracks uses two letters, the first to indicate the direction perpendicular to the crack plane, and the second to indicate the direction of crack growth. (This is similar to a convention for describing stress components in solid mechanics.) This type of notation has been used in the past for describing specimens from plate, with the RWT identification: Rolling direction, Width direction, and Thickness direction. Because the R is not readily associated with products other than plate (extruded shapes and forgings, for example), a modification of that notation which is meaningful for most metal products is used in this report, and is recommended for general use.

As before, the first letter indicates the direction perpendicular to the crack plane, and the second indicates the direction of crack growth. The letters LWT are used instead of RWT, with the L indicating the Longitudinal, Length or Long grain direction. The meanings of the other two letters are unchanged. The six principal combinations of crack plane and direction of crack growth are as follows:

Direction Perpendicular to the Crack Plane	Direction of Crack Growth	Specimen Designation
Longitudinal (Length or Long Grain)	Width	L-W*
	Thickness	L-T
Width (Long-Transverse)	Longitudinal	W-L*
	Thickness	W-T
Thickness (Short-Transverse)	Longitudinal	T-L*
	Width	T-W

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The starred orientations are the usual ones for determining fracture properties; they correspond with what would normally be called the longitudinal, long-transverse and short-transverse directions.

Test Results. The fracture-toughness test results are presented in Tables XII, XIII and XV for plate, extruded ribbed panels and extruded bars, respectively,* The meaningful data for the extruded panels and bars are summarized in Tables XIV and XVI, respectively. The meaningful results of the fracture-toughness tests of all of the contract materials, with some additional data for comparison, are summarized in Table XVII.

Tables XII, XIII, and XV contain (a) K_Q values, (b) indications of whether the K_Q values are meaningful (i.e., valid or acceptable) K_{Ic} values, and (c) values of the factor $2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$ (σ_{YS} is the 0.2 per cent offset yield strength of the material).† This factor is equal to the minimum specimen thickness which can be used to obtain a meaningful K_{Ic} value for the material, since it approximates the minimum section thickness in which fractures are likely to propagate in the plane-strain mode.[13] It is also an indication of the relative fracture efficiency of the material, since the critical crack size is proportional to K_{Ic}^2/σ_{YS}^2. A higher value for one material than another, indicates that the former material will tolerate a larger crack at stresses as high as the yield strength without unstable fracture, or that it may be stressed nearer the yield strength before a crack of any given size will trigger unstable fracture.

It should be noted that a number of the fracture-toughness values obtained in this project were not valid by the several criteria of the ASTM Test Methods[13,14]. For example, for some of the 1/2-in. plate and 11/16-in. extruded panels, it was simply not possible to take specimens of sufficient thickness to insure plane-strain conditions, and thus to obtain valid K_{Ic} values. In such cases, test invalidity might be considered to be an indication that the material is so tough that elastic plane-strain fracture would not be a problem in these products. In other cases, the relatively small size of the bend specimens which could be made from available material prevented good control of the length and straightness of the fatigue cracks. Compact-tension specimens were used in some cases where meaningful values were not obtained with the bend specimens.

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* The detailed results of the fracture-toughness tests are reported in Appendix I.

† The values indicated as not meaningful should not be extracted from this report without being so indicated; such values may be of no engineering significance even to merit rating purposes.

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If a test result is not meaningful, there is usually no sure indication whether it is above, equal to, or below the actual K_{Ic} value for the material, or, if higher or lower, how far different it is from the K_{Ic} value.

Plate. The X7080-T7E41 plate had consistently greater fracture toughness than the 7178-T651 plate. Meaningful values of K_{Ic} could not be obtained for the 1/2-in. X7080-T7E41 plate because the specimen thickness was not great enough to insure plane-strain conditions and the plastic deformations at the secant intercept were greater than allowed by the criteria for acceptability.

The data in Table XII show clearly that the plane-strain fracture toughness was greater in the longitudinal (L-W) direction than in the long-transverse (W-L) direction. Little can be said about the effect of removal of the rolled surface. Although the data for X7080-T7E41 suggested that the effect might be significant, the values were invalid. For 7178-T651, the differences varied with direction, but some of these data were also invalid.

The effect of plate thickness on fracture toughness could not be established for X7080-T7E41. For 7178-T651, K_{Ic} values for the 1/2-in. plate were lower than those of the 1-3/8-in. plate, but the difference was not significant.

Extruded Integrally-Stiffened Panels. As shown in Table XIII, most of the K_Q values obtained for the 7075-T73510 and X7080-T7E42 extruded ribbed panels were invalid because the specimen thickness was too small. The fracture toughness is thereby indicated to be appreciably higher for these two alloys, than for 7075-T6510 and 7178-T6510.

The data in Table XIV show that the plane-strain fracture toughness of the extruded ribbed panels was generally greater in the longitudinal (L-W) than in the long-transverse (W-L) direction. Removal of the extruded surface did not have any consistent effect on the test results. From Table XIV, in the longitudinal direction, the fracture toughness at the edges of the panels was generally below that obtained at the quarter-width locations. There did not appear to be any consistent variation from the center to the quarter-width locations, in either the longitudinal or long-transverse directions.

Extruded Bars. The data in Tables XV and XVI confirm indications from tests of the thinner specimens that the toughness of the X7080-T7E42 and 7075-T73510 are greater than those of 7075-T6510 and 7178-T6510. Data for 7075-T6510 indicate that the toughness in the longitudinal direction is greater if the specimens are oriented so that the cracks propagate through the thickness (L-T) rather than across the width (L-W). The longitudinal (L-T and

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L-W) fracture toughness was higher than the long-transverse (W-L) and short-transverse (T-L) fracture toughness. The differences between the long-transverse and short-transverse values were generally less than the differences between the longitudinal and long-transverse values.

There were no clear trends in the differences in toughness among the various locations in any of the three directions tested.

Comparison of Alloys and Products. The data in Table XVII are useful in making some generalizations about the fracture toughness of the different materials. The values reported are the ones obtained from locations corresponding closely to the specification locations for tensile specimens. Overall average values of K_{Ic} (ksi$\sqrt{in.}$) for the various products are as follows, with the alloy-temper combinations arranged in the order of decreasing fracture toughness:

	L (L-W)	LT (W-L)	ST (T-L)
X7080-T7-type	36	27	23
7075-T73-type	32	27	20
7075-T6-type	29	23	19
7178-T6-type	23	19	14

The alloys and tempers are rated in the same order for each product. It should be noted that these represent tests of only a few lots of material and have no statistical reliability associated with them.

In every case, the longitudinal (L-W or L-T) fracture toughness values were greater than the long-transverse (W-L) values, and, where determined, the short-transverse (T-L) values were always lowest. There is no clear indication as to whether the plate or extruded products were tougher, nor as to whether the extruded panels were tougher than the extruded bars. The differences from lot to lot of any one product would probably be as great as those from product to product, and would differ with the strength level of the individual sample. It should be noted that only one sample of each alloy-temper combination of each product has been tested in this program.

Comparison of these results with the data from previous programs[1,2] suggests the following overall ratings of the alloys and tempers in the form of plate, in order of decreasing fracture toughness:

2219-T851
X7080-T7E41
7075-T7351
7075-T651
7079-T651

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2024-T851
7001-T75
7178-T651
2020-T651

It is expected that the order of ranking for other products would be essentially, if not exactly the same.

C. Axial-Stress Fatigue

Results. The S-N diagrams and modified Goodman diagrams are shown in Figs. 29 through 128. The S-N diagrams are numbered as follows, and face the corresponding modified Goodman diagrams:

				S-N Diagrams								
				Smooth Specimens			K_t = 3			K_t = 12		
Product	Alloy and Temper	Thickness, in.	Location	L	LT	ST	L	LT	ST	L	LT	ST
Plate	X7080-T7E41	1/2	Center	29	--	--	--	---	---	---	---	---
		1-3/8	Center	33	33	--	37	37	---	41	41	---
	7178-T6510	1/2	Center	31	--	--	--	---	---	---	---	---
		1-3/8	Center	35	35	--	39	39	---	43	43	---
Extruded Shapes	7075-T73510	11/16	Center	45	--	--	--	---	---	---	---	---
		3-1/2	Midway	53	55	57	81	83	85	105	107	109
			Surface	77	--	77	--	---	---	---	---	---
	7075-T73510	11/16	Center	47	--	--	--	---	---	---	---	---
		3-1/2	Midway	59	61	63	87	89	91	111	113	115
			Surface	78	--	78	--	---	---	---	---	---
	X7080-T7E42	11/16	Center	49	--	--	--	---	---	---	---	---
		3-1/2	Midway	65	67	69	93	95	97	117	119	121
			Surface	79	--	79	--	---	---	---	---	---
	7178-T651	11/16	Center	51	--	--	--	---	---	---	---	---
		3-1/2	Midway	71	73	75	99	101	103	123	125	127
			Surface	80	--	80	--	---	---	---	---	---

The detailed results of the fatigue tests are reported in Appendix II.

Because of the variety of alloys, tempers, products, product sizes, specimen directions and specimen locations which were tested, it is impractical to comment on each of the potential combinations. Rather, the data have been analyzed to establish what appear to be general patterns, as reflected by the discussion below. In considering these, it is well to keep in mind that only one lot of each alloy, temper and product was tested, and although some 1700 tests were conducted, it is not reasonable to attach any statistical reliability to the results. The differences which are discussed below must be regarded only as indications of trends, rather than conclusive differences.

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Comparison of Alloys and Tempers. At relatively short fatigue lives, there were in many instances relatively large differences in fatigue strengths indicated among the various alloys and tempers. As expected, the differences were usually related to the differences in static tensile strengths at short lives, and diminished or disappeared as fatigue lives increased. At 10^7 cycles, there were no consistent differences among the alloys and tempers, although in individual instances certain alloys or tempers appeared to have some advantage. Overall ratings might place the alloys in the following order of decreasing fatigue strength at 10^7 cycles with smooth (K_t = 1.0) specimens:

7075-T651X
7178-T651X
7075-T7351X
X7080-T7E4X

With notched specimens, the fatigue strengths at 10^7 cycles of the X7080-T7E4X products are as high or higher than those of the other alloys and tempers, thus the fatigue-strength-reduction factors* for the former would be lower.

Comparison of Products. There were no consistent differences with product discernible from these data.

Comparison of Product Thicknesses. There were no consistent differences related to product thickness discernible from these data.

Comparison of Directions. There was a very definite fatigue strength variation associated with specimen direction for the 3-1/2x7-1/2-in. extruded bar. The fatigue strengths in the longitudinal direction were higher than in the long-transverse direction, which were in turn higher than in the short-transverse direction. The differences were generally largest with the higher stress ratio (+0.5), with notched specimens as well as smooth specimens, and least (sometimes nonexistent) with the lowest stress ratio (-1.0). The differences between the longitudinal and long-transverse directions were much more pronounced with the 3-1/2-in. extruded bar than with the 1-3/8-in. plate.

Comparison of Specimen Locations. For the 3-1/2-in. extruded bar (the only product for which specimen location was a variable), there was no consistent difference in the fatigue strengths of longitudinal specimens from the center region and from near the surface. For short-transverse specimens, however, those taken near the edges had higher strengths than those from the center-to-midway locations.

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* $K_f = \frac{\text{Fatigue Strength of Smooth Specimens}}{\text{Fatigue Strength of NOtched Specimens}}$

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Comparison of Theoretical Stress Concentration Factors. Specimens notched to a theoretical stress concentration of 3.0 developed fatigue strengths near 10^7 cycles which were about 1/3 of the smooth specimen strength, as theoretical expectations would indicate. Fatigue strength reduction factors ranged from about 2.1 to 4.8, with X7080-T7E4X generally having the lowest factors and 7075-T7351 and 7178-T651X generally having the highest.

Specimens notched to a theoretical stress concentration in excess of 12 developed still lower fatigue strengths, but not nearly as low as suggested by the theoretical value. This is to be expected because the theoretical stress concentration factor has little meaning when so little of the fatigue process zone in the specimen was stressed in the range of elastic action. Fatigue strength reduction factors ranged from about 2.9 to 6.0, with little consistent variation from alloy to alloy.

D. Fatigue Crack Propagation

Results. The numbers of cycles to initiate visible fatigue cracks are listed in Table XVIII; the crack propagation data are plotted in Figs. 129 through 141; the crack growth rates, da/dN are plotted in Figs. 142 through 155 as a function of the stress-intensity range, ΔK. The detailed initiation and propagation data are presented in Appendix III.

Crack Initiation (Table XVIII). The number of cycles to initiate cracks was greater for specimens from the 7178-T651 plate than for specimens from the X7080-T7E41 plate or the extruded shapes. Because of a minor machining error, the central holes for the notches of a number of the 1/2-in. thick 7178-T651 plate specimens were drilled to a diameter about 1/32-in. oversize. This resulted in a slightly lower stress concentration and appears to have further increased the lives to initial cracking for the indicated specimens of this product.

Fewer cycles were required to initiate cracks in the long-transverse specimens than in the longitudinal specimens of the X7080-T7E42 extruded panel. The other materials did not exhibit any significant directional difference. Machining the surfaces of the extruded shapes did not appear to affect crack initiation.

Scatter in Crack Propagation Data. Considerable scatter was observed in the crack propagation data from replicate tests of some alloys. This scatter may be attributed to several factors: (1) the procedure for establishing initiation of the crack, as described in the Procedure, (2) the initiation of cracks on one side of the notch before the other, and (3) variations in humidity.

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On the first point, the length of the crack when first observed in each specimen was generally short, but the lengths varied substantially from specimen to specimen. To obtain a common reference for crack growth analysis, each set of data was extrapolated linearly to a zero crack length (notch = 16.7 per cent of gross width) using the first three data points. The crack propagation data were referred to this calculated initial number of cycles. Appendix III gives those calculated values rather than the number of cycles to visible cracking, shown in Table XVIII.

The data for specimens L2 and T2 in Fig. 133 (11/16x16-in. 7075-T6510 extruded panel) illustrate the second point, that cracking on only one side of the original machined notch can significantly affect the propagation rate. The crack growth was much slower when there was propagation on only one side of the notch. In the latter stages of cracking, however, the eccentricity generally caused faster growth, and fracture occurred at a shorter total crack length.

On the third point, investigations such as that of Ref. 22 have shown that water vapor in the atmosphere can affect the rate of crack propagation. For this reason, the range of relative humidity which was measured during the crack propagation tests of each specimen is included with the data. For specimens where there was a significant variation between the humidities for replicate test specimens, such as specimens T1 and T2 of Fig. 130 (1-3/8-in. X7080-T7E41 plate), it was observed that crack propagation was somewhat faster at the higher humidities.

Determination of Crack Growth Rates. In Fig. 141, the data for one of the 7075-T7351 specimens from Fig. 136 are replotted using an expanded scale for the cycles. As is illustrated, substantial portions of the data can be represented by straight lines. Accordingly, to determine the rates of crack propagation, a computer program was written to determine the slope of the straight line which best fits the crack length (i.e., area cracked, plotted logarithmically) versus the number of cycles (plotted linearly). To obtain the rate of crack propagation for a specific total crack length (crack length plus machined notch), a straight line was fit by the least squares method to the data for those points which were within 0.30 in. (10 per cent of the gross width) of that total crack length. For example, for a total notch plus crack length of 0.90 in. (30 per cent of the gross width), a straight line was fit to the data for total crack lengths from 0.60 in. to 1.20 in. (20 to 40 per cent of gross width).

The crack propagation rates in Figs. 142 through 155 are given in terms of da/dN, where a is one-half the total crack length, and N is the number of cycles. The rates shown in the figures were determined by averaging the rates obtained

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for the replicate specimens of each sample, direction and surface condition. The data for the eccentrically cracked specimens were not included in the average if cracks were not visible at all four "corners" of the notch by the time the total crack length equaled 1.0 in. (33-1/3 per cent of the gross area cracked).

In Figs. 142 through 155, curves have been drawn to fit the crack propagation data. For plots such as Fig. 142, a straight line relationship (proposed by Paris and Erdogan[17] and others) provides a good fit. Anderson[17] suggested that there might be a tailing off of the crack propagation curves at both the very low and very high rates. The data for 7178-T6510 extrusions, Figs. 153 and 154, indicate such a relationship.

Plate. For the 1/2-in. X7080-T7E41 plate, Fig. 142, neither specimen direction, nor light machining to remove the rolled surface, affected the crack propagation behavior. Also, as seen in Fig. 143, nearly equal rates were obtained for transverse specimens from the center of thickness of the 1-3/8-in. thick plate. At the lower stress intensities, the fatigue crack growth rates for the longitudinal specimens from the 1-3/8-in. plate are lower than those of the 1/2-in. thick plate.

The 7178-T651 plate (Figs. 144 and 145), especially the 1/2-in. thick sample, was plagued with eccentric cracking. In several cases only one specimen of three had cracks visible at all four corners of the notch by the time the total crack length reached 1.0 in. The eccentricity is probably related to the large number of cycles to initial cracking for this alloy; the scatter in these numbers may result from significant differences between the number of cycles to initiate cracks at the two edges of the notch. For this alloy, machining to remove the rolled surface appeared to decrease the resistance to crack propagation. In view of the crack eccentricities, the data are not adequate to determine whether or not there is a difference with direction for either plate thickness.

Extruded Shapes. For the extruded shapes, Figs. 146 through 153, the rate of crack propagation was generally faster for transverse specimens than for longitudinal specimens except for alloy 7178-T6510.

For three of the four materials, the presence of an extruded surface on the specimens from the 11/16-in. panel does not appear to have affected the rate of crack propagation. For 7075-T6510 (Fig. 146), however, removing the surface material resulted in faster propagation. For the 3-1/2-in. bar, the specimens from midthickness tended to have slightly lower crack propagation rates than the specimens from the surface.

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For 7075-T6510 and 7075-T73510, there is excellent agreement among the growth rate curves for the 1-3/8-in. thick plate[1], the 11/16-in. thick panel and the 3-1/2-in. thick bar (Figs. 146 through 150). For 7178-T6510, the correlation between the S-shaped curves for the three products was almost as good (Fig. 154). At the lower stress intensities, crack propagation was slower for the 1-3/8-in. X7080-T7E41 plate than for the extruded shapes (Fig. 151), while the data for the 1/2-in. thick plate (Fig. 142) more closely approximate the pattern for the extruded shapes.

Comparison of Alloys and Products. In Fig. 154, the crack propagation curves for the longitudinal specimens from 1-3/8-in. plate are compared with curves previously reported[1] for 1-3/8-in. 7075-T7351 and 7075-T651 plate; data for these two alloys roughly bracket, and thus define a band for, data obtained previously for 2020-T651, 2024-T851, 2219-T851, 7001-T75 and 7079-T651. The crack propagation rates for 7075-T7351 and X7080-T7E41 plate are consistently lower than those for 7075-T651 and 7178-T651 plate. At medium stress-intensity ranges, the 7075-T651 plate has some advantage over the 7178-T651 plate.

The crack propagation rates for longitudinal specimens from the 3-1/2-in. thick extrusions are compared in Fig. 155. The ranking of the alloys and tempers with respect to rate of fatigue crack propagation is generally the same as for plate: 7075-T73510 has the lowest rate, X7080-T7E42 is next, followed by 7075-T6510 and 7178-T651. The advantage of 7075-T73510 over X7080-T7E42 in the form of extruded bar is somewhat greater than that which is shown in Fig. 154 for the corresponding plate samples.

As was true for the plate specimens, the data for 7178-T6510 suggest an S-shape curve. However, the data for the other alloys can be closely represented by straight lines on a log-log plot; thus, the relationship between stress intensity range (ΔK) and crack growth rate (da/dN) can be characterized by the expression $\frac{da}{dN} = C(\Delta K)^n$. The exponent n for the 7178-T6510 curve is about 3.5, whereas the average slope for the other three alloys is about 2.7. This latter value approximates the value (3.0) predicted by Head's theory[23]. Using data from several sources which included higher and lower crack growth rates, Paris and Erdogan[17] proposed a slope of 4 for 2024-T3 sheet.

E. Exfoliation

All of the various exfoliation specimens have completed or exceeded the exposure periods specified in the original program. However, a one-year period in atmospheric environments

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does not produce conclusive results. Continuation of these exposure tests requires only routine, periodic inspection; therefore, all atmospheric tests will be continued until they complete at least four years of exposure.

Acidified Salt-Spray. The results of the accelerated exfoliation tests in the acidified salt-spray environment are listed in Table XIX and representative specimens are illustrated in Figs. 156 and 157 (plate) and 158 through 162 (extrusions).

None of the 7075-T73510 specimens developed any exfoliation and the X7080-T7E41 plate specimens and X7080-T7E42 extrusion specimens incurred very slight exfoliation only on interior planes. This confirms the high degree of resistance to exfoliation which is expected of the T7-type tempers.

In contrast, the 1-3/8-in. 7178-T651 plate and the 7075-T6510 and 7178-T6510 extrusions incurred severe exfoliation on interior planes and these specimens were removed from test after only one week of exposure. A high degree of susceptibility to exfoliation is frequently encountered in these alloy-tempers and products, and these results were in line with the expected performance.

The low susceptibility to exfoliation exhibited by the 1/2-in. 7178-T651 plate in the contract has occasionally been found in other lots of 7178-T651 plate tested at ARL. The usual performance, however, has been the greater susceptibility exhibited by the 1-3/8-in. plate in the contract.

None of the extruded samples exfoliated when the extruded surface was exposed. This is the result of a thick recrystallized surface layer which is not prone to exfoliate. It is to be expected, however, that if the exposure were continued, corrosion would eventually undermine this layer, and cause exfoliation of the subsurface metal of susceptible materials, i.e., 7075 and 7178 in T6-type tempers.

Seacoast Atmosphere. The panels from the plate and extruded products which were exposed at Point Judith, Rhode Island, have now accrued 13 to 15 months of exposure. Scattered small sites of incipient exfoliation have developed on subsurface planes of the T6-type products of 7075 and 7178. This length of exposure, however, is not sufficient to indicate the performance to be expected with continued exposure.

Industrial Atmosphere. The panels from the plate and extruded products which were exposed at New Kensington, Pennsylvania, have accrued over 14 months of exposure. No exfoliation has developed, but the period of exposure is of insufficient duration to be significant.

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F. Stress Corrosion Tests

1. Conventional Approach

All of the various stress-corrosion specimens have completed or exceeded the 12-month exposures specified in the program. The supplemental atmospheric tests of 0.125-in. diameter, long-transverse tensile specimens from the 11/16x16-in. extruded panels have completed 6 months of exposure to the seacoast atmosphere, and 8 months of exposure to the industrial atmosphere. However, a one-year period does not produce conclusive results for atmospheric environments. Continuation of these exposure tests requires only routine, periodic inspection; therefore, all atmospheric tests will continue until they complete at least four years of exposure.

Results. The results of the stress-corrosion tests are listed in Tables XX (longitudinal direction), XXI (long-transverse direction), XXII and XXIII (short-transverse direction of plate and extruded samples). The reductions in tensile strength, caused by corrosion, of specimens which completed the 3.5 per cent NaCl alternate immersion test are given in Table XXIV for longitudinal and long-transverse specimens and in Table XXV for short-transverse specimens.

Longitudinal Direction. No longitudinal specimen has failed (Table XX). This illustrates the high resistance to stress-corrosion cracking in this direction which is expected of all aluminum alloys and tempers.[24]

The per cent reduction in tensile strength after 182 days exposure to alternate immersion (Table XXIV) indicates the relative resistance to general corrosive attack. Alloy X7080-T7-type was the least affected, followed by 7075-T73510, 7075-T6510 and then 7178-T6-type. This general order is in agreement with test results of other samples of these alloys and tempers[24]. The reductions in strength of the unstressed and the stressed specimens were generally similar. The most divergent case was 7178-T6-type, for which the stressed specimens showed twice the loss in strength of the unstressed specimens. This degree of difference for 7178-T6-type, however, is not unusual.

Long-Transverse Direction. In interpreting the results of the stress-corrosion tests listed in Table XXI, it must be remembered that, while all the specimens were taken across the principal direction of working (that is, in the long-transverse direction as regards the physical dimensions of the product), the only specimens with a true long-transverse grain structure (more elongated grain shape parallel to the axis than normal to the axis of the specimen) were those from the 1/2 and 1-3/8-in. plates and the 0.125-in. diameter specimens centered between the ribs of the 11/16x16-in. extruded panels.

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Specimens centered directly under upstanding ribs of the extruded panels contained a grain structure which was on an angle to the specimen axis, rather than parallel to it, because of the metal flow in those regions during the extrusion process. Consequently the applied stress acted on a bias to the grain structure, and had a short-transverse, as well as a long-transverse component.

In the case of the 3-1/2x7-1/2-in. extruded bars, metallographic examination revealed that the grain had a nearly equi-axed cross section, which would more correctly be described as simply transverse (similar to the grain structure in round or square shapes), than as long-transverse. For susceptible alloys and tempers, it is known that this type of grain structure has a lower resistance to stress-corrosion cracking than a true long-transverse structure, and is actually more comparable to a short-transverse structure.

No truly long-transverse specimen failed in the atmosphere, and failure in alternate immersion was limited to the 7178-T651 plate and 7178-T6510 extruded panel after 56 or more days exposure. Representative failures were examined microscopically and stress-corrosion cracking was confirmed to be the mechanism of failure. An example of the evidence on which this is based is shown in Fig. 163. All of the alloys and tempers evaluated exhibited a high degree of resistance to stress-corrosion cracking, when stressed in the truly long-transverse direction, although some stress-corrosion hazard exists when 7178-T6-type material is highly stressed.

The remaining data presented in Table XXI must be analyzed with regard to the specimen position in the particular types of extruded shapes which were tested, and should not be directly compared with general summaries of data for the long-transverse direction. The data for the 7075 and 7178-T6510 shapes show a lower resistance than is generally expected of this temper in the long-transverse direction. The specimens taken under the rib of the 11/16-in. panel illustrate the stress-corrosion hazard that is occasionally encountered as a result of extensive machining of complex shapes and exposure of grain ends. These data also illustrate the superiority of the T7-type tempers which were still resistant despite the less favorable grain structure.

Comparison of the data from the 0.125 and 0.437-in. diameter specimens taken from the 11/16-in. panel (Table XXI) clearly shows that resistance to stress-corrosion cracking is primarily a function of grain orientation and temper and is not dependent on the size of specimen tested.

The results of the atmospheric tests, although of a preliminary nature, are in agreement with the performance which is generally obtained for Al-Zn-Mg-Cu alloys. Results of seacoast atmosphere tests generally agree well with alternate-immersion data in rating the alloys even though somewhat longer

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exposure times are required for meaningful data. On the other hand, the alternate-immersion test is usually a conservative indicator of the performance to be expected in an industrial atmosphere, as is evidenced by the fact that no failure occurred in the industrial atmosphere.

In general, the reduction in tensile strength of long-transverse specimens by corrosion (Table XXIV) showed the same trend noted above for longitudinal specimens, X7080-T7-type being least affected, followed by 7075-T73510, 7075-T6510 and then 7178-T6-type. The only exception was the relatively high loss for the stressed X7080-T7E42 specimen from the 3-1/2-in. bar (12 per cent), compared with that for the corresponding unstressed specimens (3 per cent). Metallographic examination of these specimens established that the high loss for the stressed specimens resulted from the presence of incipient stress-corrosion cracks. This indicates that for this extruded shape, X7080-T7E42 has a resistance which is just slightly less than that of 7075-T73510.

<u>Short-Transverse-Direction of 1-3/8-in. Plate.</u> Short-transverse specimens from both plate samples failed when exposed to alternate immersion (Table XXII), but two distinct levels of resistance were indicated.

Most of the 7178-T651 specimens failed quickly (6 to 9 days). Cracking was readily visible to the unaided eye even at the lowest stress level, 15 per cent of the yield strength (10,000 psi). In contrast, the X7080-T7E41 specimens endured longer exposures; the cracking present after 84 days was incipient, originating from the base of corrosion pits and could only be detected microscopically (see Fig. 164). Cracking in the X7080-T7E41 specimens occurred at stresses as low as 34 per cent of the yield strength (19,000 psi).

A few X7080-T7E41 specimens were also tested in a boiling 6 per cent NaCl solution by total immersion. This was not part of the original program, but was carried out as an experiment to try to predict the performance in the industrial atmosphere. The boiling 6 per cent NaCl does not cause any appreciable surface corrosion, so that the cracks could be detected visually. The results confirmed the alternate-immersion tests, with failures occurring at 75 and 50 per cent of the yield strength, but not at 25 per cent.

These results are in good agreement with general experience with these alloys and tempers[24]. They show that 7178-T651 plate has relatively low stress-corrosion resistance in the short-transverse direction and that substantially better performance is to be expected of X7080-T7E41 plate.

The atmospheric tests (Table XXII) are still underway, but the results tend to parallel those obtained in alternate immersion tests, showing a marked susceptibility for 7178-T651 and only a slight susceptibility for X7080-T7E41. The only

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X7080-T7E41 failures have been in specimens stressed to 75 per cent of the yield strength and exposed to the industrial atmosphere. The earlier occurrence of stress-corrosion failures for alloy X7080-T7E41 in the industrail atmosphere than in the seacoast atmosphere is not unique and has been noted for other alloys[25]. Moreover, previous Alcoa experience with X7080-T7 forgings has shown that the stress-corrosion threshold determined in an industrial atmosphere was lower than that indicated by the 3.5% NaCl alternate-immersion test.

Short-Transverse Direction of 3-1/2-in. Extruded Bar. In general, the performance of the short-transverse specimens from the extruded bars (Table XXIII) was as expected for the alloys and tempers involved. Relatively low resistance to stress-corrosion cracking is indicated for the 7075-T6510 and 7178-T6510 extrusions by failure even at stress levels of 15 per cent of the yield strength in the alternate immersion and seacoast environments (Table XXIII).

Neither of the other alloy-tempers has yet produced failures in the atmospheric environments. The only other failures in alternate immersion were specimens of alloy X7080-T7E42 and, even here, failures were limited to the highest stress level (75 per cent of the yield strength) and occurred after comparatively long exposures. Excellent resistance is to be expected of all 7075-T73510 extruded shapes, but this is not the general case for X7080-T7-type products. The better-than-average performance of the X7080-T7E42 bar is attributed to the more-nearly equi-axed grain structure, which is less prone to stress-corrosion cracking than are the more directional grain structures present in extrusions with greater width to thickness ratios.

The per cent reductions in tensile strength for specimens which survived the alternate immersion tests are listed in Table XXV. The loss in strength for all of the stressed X7080-T7E42 specimens and for the 7075-T73510 specimens stressed to 50 per cent of the yield strength (22,000 psi) was essentially the same as for the corresponding unstressed specimens. This confirms that no appreciable incipient cracking was present. However, for the 7075-T73510 specimens stressed to 75 per cent of the yield strength (41,000 psi) and the 7075 and 7178-T6510 specimens stressed to 15 per cent of the yield strength (9000 psi for both), the losses were roughly twice those of the unstressed specimens. These specimens were examined microscopically to determine whether the high loss of strength in the stressed specimens was the result of deep pitting corrosion, or of incipient stress-corrosion cracking. Examination of the 7075-T73510 specimens which had been stressed to 75 per cent of the yield strength showed no evidence of incipient stress-corrosion cracking and verified that these specimens were resistant to stress-corrosion cracking. On the other hand, intergranular cracks were found in both the 7075-T6510 and 7178-T6510 specimens which had been stressed to 15 per cent of the yield stress, confirming the susceptibility to stress-corrosion cracking that had already been shown by the early failure of one specimen from each of these two samples.

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Comparison of Alloys and Products. The alloys and tempers tested in this program are listed below in order of decreasing resistance to stress-corrosion cracking:

Product	Long-Transverse Direction		Short-Transverse Direction	
Plate	X7080-T7E41	(very high)	X7080-T7E41	(high)
	7178-T651	(medium)	7178-T651	(low)
11/16-in. Panel	7075-T73510	(very high)	---	
	X7080-T7E42	(very high)	---	
	7075-T651	(high)	---	
	7178-T6510	(medium)	---	
3-1/2-in. Bar	7075-T73510	(very high)	7075-T7351	(very high)
	X7080-T7E42	(very high)	X7080-T7E42	(high)
	7075-T6510	(low)	7075-T6510	(very low)
	7178-T6510	(low)	7178-T6510	(very low)

These ratings agree with previous experience with these alloys, tempers and products[1,2,24].

2. Fracture-Mechnics Approach

Background. It has been suggested that the stress-corrosion characteristics of metals are more closely related to applied stress intensity (K_I) than to applied stress[20,21]. If this is true, then the use of a fracture-mechanics approach involving a precracked specimen should provide a more meaningful evaluation of stress-corrosion resistance than conventional methods employing smooth specimens, and a threshold stress intensity level could be determined, at or below which stress-corrosion cracking will not occur. Such a threshold has been referred to as K_{Iscc}. It has also been suggested that an advantage of the fracture-mechanics approach is that the use of a precracked specimen would eliminate the incubation period required to develop a crack initiation site in smooth specimens. Therefore, the tests should be more rapid and the results less difficult to interpret.

Results. A fracture-mechanics approach was used to evaluate the stress-corrosion resistance of the 3-1/2x7-1/2-in. extruded bars in the short-transverse (T-L) direction. The short-transverse critical plane-strain stress intensity factors, K_{Ic}, determined with compact tension specimens are shown in Table XV along with other fracture toughness data for the extruded bars. The results of the tests of ring-loaded pre-cracked specimens are summarized in Table XXVI, and the increase in crack length and stress intensity with time for the 7075-T6510 and 7178-T6510 samples is shown in Figs. 165 and 166. The results of the tests of bolt-loaded specimens are shown in Table XXVII, and the crack growth data are plotted in Figs. 167 through 170.

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Ring-Loaded Specimens. In the ring-loaded specimens, there was considerable stress-corrosion crack growth, and complete fracture occurred with specimens of 7075-T6510 (Fig. 165) and 7178-T6510 (Fig. 166) under initial stress intensities (K_{Ii}) of only 12,900 and 10,000 psi$\sqrt{in.}$, respectively; for both materials, this was about 70 per cent of K_{Ic}. The actual stress intensities at fracture were approximately the same as K_{Ic} (sometimes higher, sometimes lower), indicating that the stress intensity at fracture is not influenced markedly by environment or type of crack (stress-corrosion versus fatigue). For specimens of X7080-T7E42, some crack growth occurred with a K_{Ii} of 20,800 psi$\sqrt{in.}$, or 90 per cent of K_{Ic}, and the specimens failed after about 1000 hours exposure. Specimens of 7075-T73510 showed little evidence of crack growth, and under a stress intensity of 19,600 psi$\sqrt{in.}$, or 97 per cent of K_{Ic}, one specimen did not fracture in 1000 hours.

The times to failure, particularly for the two susceptible samples, were much longer than expected. Specimens of 7075-T6510 and 7178-T6510 fractured after 100 to 300 hours at K_{Ii} levels equal to or greater than 90 per cent of K_{Ic}, whereas smooth tensile specimens from these same samples failed within 4 days (96 hours) under a stress of only 25 per cent of the yield strength. Various procedures were used in attempts to accelerate the tests. A saw cut was made in one specimen of 7075-T651 in order to expose more grain boundaries at the root of the notch. Although this may have accelerated failure to some extent, the effect was not significant. A flexible ring (ring No. 2) which more closely approximates a dead weight loading was used in some of these tests. This did not seem to accelerate failures significantly, although more testing might indicate a difference in failure times associated with the relative flexibilities of the rings.

The most significant decrease in time to failure was produced by alternate immersion. Alternate-immersion cycles were accomplished manually during normal working hours and the specimens remained immersed overnight and on weekends. One specimen of 7075-T6510 in alternate immersion failed in about the same time as two other specimens in constant immersion with higher K_{Ii} values, and one specimen of 7178-T6510 in alternate immersion failed in about one-third the time of a duplicate specimen (same K_{Ii}) in constant immersion.

Bolt-Loaded Specimens. In tests of bolt-loaded specimens, in Table XXVII, at least one specimen from each sample was precracked in direct tension, rather than by fatigue; and since the load was not removed after precracking, the initial K_{Ii} values, actually arrest values, were considered to be reasonably close to K_{Ic}. The initial crack length was measured on the surfaces of the specimen. Since the crack front through the thickness of each specimen was not perfectly straight, the initial crack length, load, and K_{Ii} value for each fatigue-cracked specimen is an estimated value.

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As shown in Figs. 167 through 170, bolt-loaded specimens from alloys 7075 and 7178 in the T6510 temper experienced considerable crack growth; specimens from X7080-T7E42 experienced moderate crack growth and specimens from 7075-T73510 experienced negligible crack growth. For alloy-temper combinations in which cracks grew, the specimens bolt-loaded to 100 per cent K_{Ic} experienced more crack growth than those with lower applied K_{Ii} values.

Initial crack growth in bolt-loaded specimens of the two susceptible alloys (Figs. 167 and 170) seems to have been more rapid in alternate immersion tests than in constant immersion tests. After 2500 hours exposure, however, the residual stress intensity factors K_{If} for the susceptible alloys (see Table XXVII) approached the same level regardless of the type of test (alternate or constant immersion), type of precrack (tensile or fatigue), or applied stress intensity (K_{Ii}). Except for one specimen, the residual stress intensities after 2500 hours for 7075-T6510 ranged from 13,000 to 13,500 psi$\sqrt{\text{in.}}$, or about 69 per cent of K_{Ic}, and the residual stress intensities for 7178-T6510 ranged from 8600 to 10,800 psi$\sqrt{\text{in.}}$, or about 67 per cent of K_{Ic}. For both samples, there was little difference between the residual stress intensities after 800 and 2500 hours in the alternate immersion tests, even though the cracks continued to grow (Figs. 167 and 170) at a slow rate. However, the true threshold stress intensities (K_{Iscc}), if they exist, would apparently be at least slightly lower than these values, since the shape of the crack length-time plots suggest that complete crack arrest (as would be indicated by horizontal asymptotes) had not been reached when the tests were discontinued.

Specimens from the sample of 7075-T73510 experienced negligible crack growth. One must therefore conclude that this alloy is not susceptible to stress-corrosion cracking, even though the residual stress intensities were lower than the estimated initial values. This apparent decay in stress intensity could be due to (a) crack blunting by corrosion, (b) creep or stress relaxation in the screw threads or highly stressed regions in the specimen, or (c) lower actual initial stress intensities than the estimated values.

Specimens from the X7080-T7E42 sample experienced some crack growth, but some of the apparent decay in stress intensity may be due to the reasons mentioned above for the 7075-T73510 specimens. In any event, there was considerable variability in residual stress intensity values.

Metallographic Analysis. Metallographic examinations of several bolt-loaded specimens support the conclusions drawn from the test data concerning the relative degree of stress corrosion cracking which developed in these specimens. Low magnification photomicrographs of the overall crack and high magnification photomicrographs of the crack tip in specimens from each sample are shown in Figs. 171 through 178. The

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initial portion of the crack in each specimen was broadened by general corrosion, which seemed to be somewhat more severe in the constant immersion tests. Considerable intergranular stress-corrosion crack growth occurred in specimens of 7075-T6510 (Figs. 171 and 172) and 7178-T6510 (Figs. 177 and 178), whether subjected to alternate or constant immersion. Longer stress-corrosion cracks developed in the specimens with higher K_{Ii} values. The specimen of X7080-T7E42 (Figs. 175 and 176) loaded to 100 per cent K_{Ic} and subjected to alternate immersion showed considerable evidence of intergranular crack growth. The cracks in specimens of 7075-T7351 (Figs. 173 and 174) were broadened somewhat by general corrosion but there was no evidence of intergranular crack growth.

Comparison of Ring and Bolt Loading. All of the stress intensity versus time data for alloys 7075-T6510 and 7178-T6510 are shown in Fig. 179. The initial stress intensity values (K_{Ii}) are plotted for the ring-loaded specimens and the residual stress intensity values (K_{If}) are plotted for the bolt-loaded specimens. In the latter case, some data are shown with arrows, since the crack growth data in Figs. 167 through 170 suggest that complete crack arrest had not yet occurred. Some general conclusions can be drawn by considering all of these data. It appears that, at shorter lives, the stress intensity level K_I drops more rapidly with ring loading than with bolt loading, but this is based on few data. One might expect an even greater difference associated with loading since, as crack growth develops, K_I increases with the ring loading and decreases with the bolt loading.

It is appropriate at this point to indicate some of the advantages and disadvantages of these two types of loading. In favor of the ring load, the stress intensity level can be monitored throughout the test, and if crack growth occurs, the test is terminated by fracture of the specimen. However, several specimens must be loaded to various stress intensities in order to determine the lowest stress intensity at which stress corrosion will take place, i.e., K_{Iscc}. A disadvantage of bolt-loaded specimens is the fact that the time required to obtain crack arrest is quite long and indefinite. On the other hand, the specimens are self-contained, easy to handle, and K_{Iscc} can be determined with tests on only one or two specimens.

Regardless of the procedure, most of the decrease in K_I for the susceptible samples (Fig. 179) occurs within 1000 hours, although it may take 2000 hours or more to establish a true K_{Iscc}, if it exists. The K_{Iscc} values for these samples of 7075-T6510 and 7178-T6510 appear to be equal to or less than about 12,000 and 8500 psi$\sqrt{\text{in.}}$, respectively, both of which are approximately 60 per cent of the respective K_{Ic} values. The value for 7075-T6510 bar is appreciably higher than that reported by Mulherin[28] for 7075-T651 plate, further indication that complete crack arrest may not have occurred.

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The data for specimens of 7075-T73510 and X7080-T7E42 are more difficult to analyze because of creep and/or relaxation which may have occurred during exposure. Tests of ring- and bolt-loaded specimens and metallographic examinations agree that some stress-corrosion crack growth occurred in specimens of X7080-T7E42 at high K_I levels, and that no appreciable crack growth occurred in specimens of 7075-T73510. Considering the long time to failure in ring-type tests of X7080-T7E42, it is probably safe to say the K_{Iscc} for this sample is about 20,000 psi$\sqrt{in.}$, or about 85 per cent of K_{Ic}.

There does not appear to be a meaningful value of K_{Iscc} for 7075-T73510. The sample of this alloy and temper which was tested did not exhibit stress-corrosion cracking under any test condition, which included stress intensities very close to K_{Ic}. It does not appear to be appropriate to state that K_{Iscc} is equal to K_{Ic}, since there is no indication from these tests of whether or not stress-corrosion cracking will occur at stress intensities above K_{Ic}. For purposes of presenting the data, K_{Iscc} for this material will be shown simply as $\gtrsim K_{Ic}$, recognizing the vagueness of this term.

<u>Comparison of Alloys and Tempers</u>. The K_{Ic} and approximate K_{Iscc} values for these samples are shown in Fig. 180. The per cent difference between these values is also shown in order to illustrate a possible pitfall in interpreting such data. For instance, the K_{Iscc} values for 7075-T73510 and X7080-T7E42 might be considered nearly equal, but X7080-T7E42 has been shown to be susceptible to stress-corrosion cracking while 7075-T73510 seems practically immune. It should be emphasized that these data should not be interpreted to indicate that 7075-T73510 would be susceptible to stress-corrosion cracking at stress intensities above K_{Ic}, where plane strain conditions do not exist; no tests were made to determine this. Also, K_{Iscc} for 7075-T6510 is 3500 psi$\sqrt{in.}$ higher than K_{Iscc} for 7178-T6510, but the percentage decrease from their respective K_{Ic} values is about the same for both alloys.

The relative ratings of these four samples with respect to stress corrosion resistance and their approximate K_{Iscc} levels are as follows:

	Alloy and Temper	Resistance	Approximate K_{Iscc}, psi$\sqrt{in.}$
1.	7075-T73510	(very high)	$\gtrsim$20 500 (K_{Ic})
2.	X7080-T7E42	(high)	$\approx$20 000
3.	7075-T6510	(very low)	$\lesssim$12 000
4.	7178-T6510	(very low)	$\lesssim$ 8 500

<u>Comparison of Conventional and Fracture-Mechanics Approaches to Stress-Corrosion Cracking</u>. The ratings of the alloys and tempers with respect to stress-corrosion resistance which were obtained with the fracture-mechanics approach are the same as those obtained with the conventional approach.

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The times required to determine K_{Iscc} and threshold stress levels were about the same for the two types of test, but the times to failure of ring-loaded compact tension specimens with high K_{Ii} values were appreciably longer than those for smooth tensile specimens under high stress. A reason might be that the per cent difference between K_{Ic} and K_{Iscc} is not as great as the per cent difference between yield strengths and stress-corrosion threshold stress levels.

In the past, there has not been any clear way to relate stress-corrosion data obtained by conventional methods (smooth specimens) and those obtained with a fracture-mechanics (precracked specimens) approach. In fact, proponents of each of the two approaches have been generally antagonistic toward the other approach or toward the view that the two might be compatible. The reasons for this view are clear enough. The fracture mechanics relationship between flaw size and stress via stress intensity factor would seem to indicate that this sample of 7075-T6510, with a K_{Iscc} of about 12,000 psi$\sqrt{\text{in.}}$, could sustain relatively high stresses in the short-transverse direction in the presence of very small cracks. For example, it could sustain a stress of 30,000 psi with a 0.18-in. crack in 3.5% NaCl. But in tests of smooth specimens containing no initial macroscopic flaws, failures occurred within four days, at stresses of only 9000 psi. A means of merging the two types of data is to use the threshold stresses for stress-corrosion cracking of smooth specimens as a "cut off" or upper limit for stresses derived from the K_{Iscc} value. This is as illustrated graphically in Fig. 181 for 7075-T6510, using the approximate value developed for K_{Iscc} and a generalized equation relating stress intensity (K_I), stress (σ) and flaw size (2a). The implications of such a plot are that (a) to avoid stress-corrosion cracking the material should not be stressed at levels above the cut off, even when there are no detectable flaws in the material; (b) when relatively large flaws are present, the material should not be stressed at levels above that defined by the stress intensity relationship. Diagrams similar to Fig. 181 are shown for X7080-T7E42 and 7178-T6510 in Figs. 182 and 183. None is shown for 7075-T73510, since no stress-corrosion cracking was observed for this alloy and temper in either smooth or precracked specimens.

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Section VI

SUMMARY AND CONCLUSIONS

The tensile properties, plane-strain fracture toughness (K_{Ic}), axial-stresss fatigue properties, fatigue crack propagation rates, and resistance to exfoliation and stress-corrosion cracking have been determined for four materials. One lot each of 1/2-in. and 1-3/8-in. thick X7080-T7E41 and 7178-T651 plate and of 11/16-in. and 3-1/2-in. thick 7075-T6510, 7075-T73510, X7080-T7E42 and 7178-T6510 extruded shapes were tested. The results may be summarized as follows:

A. Tensile Properties

A1. The longitudinal tensile properties were generally higher than the long-transverse properties, and, for the 1-3/8-in. plate and 3-1/2x7-1/2-in. extruded bar, the short-transverse tensile properties were lowest. The differences were much larger in the extruded shapes than in the plate.

A2. Removal of the fabricated (i.e., as-rolled or as-extruded) surface had no significant effect on the tensile properties of the 1/2-in. plate samples. Removal of the fabricated surface from the stiffeners of the 11/16x16-in. extruded panels raised their tensile properties about one per cent.

A3. The alloy-temper combinations can be ranked in the following order with respect to uniformity of the tensile properties at different locations and in different directions.

X7080-T7-type (most uniform)
7075-T73-type
7075-T6-type
7178-T6-type (least uniform)

A4. The alloy-temper combinations can be ranked in the following order with respect to tensile and tensile yield strength:

7178-T6-type (highest)
7075-T6-type
7075-T73-type
X7080-T7-type (lowest)

B. Fracture Toughness

B1. The fracture toughness varied with direction in the same order as the tensile properties: values of K_{Ic} in the longitudinal (L-T and L-W) direction were higher than those in the long-transverse (W-L) direction, and those in the short-transverse (T-L) direction were lowest.

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B2. Removal of the fabricated surface had no significant effect on the fracture toughness of either the 1/2-in. plate or the 11/16x16-in. extruded panels.

B3. The fracture properties of the T7-type products were more uniform with respect to specimen location and direction than those of the T6-type products.

B4. The samples can generally be ranked in the following order with respect to plane-strain fracture toughness, K_{Ic}:

X7080-T7-type (highest)
7075-T73-type
7075-T6-type
7178-T6-type (lowest)

C. Axial-Stress Fatigue

C1. Based upon tests at three stress ratios (R = +0.5, 0.0, and -1.0) modified Goodman diagrams were developed for smooth longitudinal specimens from each alloy, temper and product, and for certain samples, also for long-transverse and short-transverse specimens, for specimens from surface and center locations and for specimens with three different stress concentration factors, K_t = 1 (smooth specimens), K_t = 3, and $K_t \geq 12$.

C2. The fatigue properties of the 1-3/8-in. plate did not vary with specimen direction. However, for the 3-1/2x7-1/2-in. extruded bars, the longitudinal fatigue properties were higher than the long-transverse fatigue properties, which were in turn higher than the short-transverse fatigue properties.

C3. For each alloy-temper combination, the 1/2-in. and 1-3/8-in. plate and the extruded panel had very similar fatigue properties in the longitudinal direction.

C4. Specimen location in the extruded bars had no significant effect on the fatigue properties in the longitudinal direction. For the short-transverse direction, specimens located adjacent to the extruded surface had higher fatigue strengths than specimens from the center two-thirds of the cross-section.

C5. The four alloy-temper combinations are ranked in the following order with respect to overall fatigue strengths:

7075-T6-type (highest)
7178-T6-type
7075-T73-type
X7080-T7-type (lowest)

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The many test variables which were included in this program produced a wide variety of results and, for some of these variables, the test results would rank the four materials in a completely reversed order.

D. Fatigue Crack Propagation

D1. For both plate and extruded shapes, crack propagation was usually faster for transverse specimens than for longitudinal specimens.

D2. Neither machining to remove the rolled or extruded surfaces, nor taking specimens from various locations in the thicker extruded shape, consistently affected the crack propagation rates.

D3. In most cases, similar crack propagation rates were obtained for the plate and extruded shapes, as well as for the two thicknesses of these products.

D4. Except with relatively short cracks (low ranges of stress intensities) the alloys and tempers would rate in the following order with respect to fatigue crack propagation:

7075-T73-type (highest)
X7080-T7-type
7075-T6-type
7178-T6-type (lowest)

D5. Plots of crack growth rate $\frac{da}{dN}$ versus range of stress intensity factor, ΔK, were developed.

D6. The relations between log ΔK, the range of stress intensity, and log da/dN, the rate of crack propagation, were determined and found to be nearly linear for all except the 7178-T6-type samples. The average slopes for the data, equivalent to the exponent n in Paris' relationship[17] $\frac{da}{dN} = \frac{(\Delta K)^n}{C}$, were generally about 2.7.

E. Exfoliation Resistance

The greatest resistance to exfoliation attack was exhibited by the 7075-T73-type samples, closely followed by the X7080-T7-type samples. In contrast, the 7075-T6-type and 7178-T6-type exhibited low resistance to exfoliation, particularly on interior planes through the product thickness.

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F. Stress Corrosion Resistance

F1. In the longitudinal direction, all alloys and tempers were highly resistant to stress-corrosion cracking, and no failure occurred at stresses as high as 75 per cent of the respective yield strength.

F2. In the long-transverse direction, the 7075-T73-type and X7080-T7-type samples were highly resistant to stress-corrosion cracking and no failures occurred at stresses as high as 75 per cent of the respective yield strength. Certain of the 7075-T6-type and 7178-T6-type samples, notably the 3-1/2x7-1/2-in. extruded bars, showed some susceptibility to stress-corrosion cracking at this high stress level. The greater susceptibility of the 3-1/2x7-1/2-in. extruded bars was related to their equi-axed grain structure.

F3. In the short-transverse direction, the alloys and tempers rate in the following order with regard to resistance to stress-corrosion cracking:

Alloy and Temper	Resistance	Failures at This Percentage of Yield Strength*	No Failures at This Percentage of Yield Strength*	Approximate K_{Iscc},† psi$\sqrt{in}$.
7075-T73510	Very High	--	75	≈20 500 (K_{Ic})
X7080-T7E42	High	75	50	≈20 000
X7080-T7E41	Medium	34	25	--
7075-T6510	Low	15	--	≈12 000
7178-T651, T6510	Low	15	--	≈ 8 500*

* 3-1/2% NaCl, alternate immersion

† 3-1/2% salt (NaCl) water solution

** T6510 only

F4. Comparisons between the results of stress-corrosion tests obtained with conventional (smooth specimens) and fracture mechanics (precracked specimens) techniques are tentative, but suggest the following:

a. Tests of precracked specimens using a fracture mechanics approach and tests of smooth tensile specimens rated the alloys and tempers in the same order with regard to stress-corrosion resistance.

b. For the alloys which were susceptible to stress-corrosion cracking, initial results are obtained more rapidly with a conventional approach (smooth specimens) than with a fracture mechanics approach (precracked

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specimens). However, the times required to determine K_{Iscc} and threshold stress levels appear to be about the same.

c. A method is proposed for relating stress corrosion threshold stresses determined by conventional methods are K_{Iscc} values, for design purposes.

F5. Certain aspects of conducting fracture-mechanics stress-corrosion tests were studied, with the following tentative indications:

a. Ring loading has the advantage that stress intensity level can be monitored more readily throughout the test and, if crack growth occurs, the test is normally terminated by fracture of the specimen. Bolt loading has the advantages that the test assembly is self contained, easy to handle, and it should be possible to determine K_{Iscc} with only one or a few specimens.

b. The applied K_I drops more rapidly in alternate immersion than in constant immersion and more rapidly with a ring loading than with a bolt loading, but in each case, 2000 hours or more are required to approximate K_{Iscc}.

c. In bolt-loaded specimens, the residual stress intensity for susceptible materials approached the same level regardless of type of precrack (tension or fatigue).

d. The actual K_I at fracture in sustained-load tests of precracked specimens in 3-1/2 per cent salt water solution is in the same range as K_{Ic} in air, indicating that K_{Ic} is unaffected by this environment, and the type of crack in the specimen (stress corrosion crack or fatigue crack).

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Section VII

RECOMMENDATIONS

A. Fracture Toughness Specimens

Notch-bend fracture-toughness specimens were tested to determine K_{Ic} values in this project. The results of several tests of compact-tension fracture-toughness specimens have been reported here, to supplement the notch-bend results. For the same capacity to measure plane-strain fracture toughness, the compact tension specimen is significantly smaller than the notch-bend specimen. The compact tension specimens are easier to fatigue-crack and to test, and produce a higher proportion of valid test results than the notch-bend specimens. The K_{Ic} values which are obtained with the two types of specimens are the same.

It is recommended that in future projects which include fracture toughness tests, compact tension specimens be used.

B. Fatigue Testing

In this project, complete S-N curves and modified Goodman diagrams have been determined for single samples of each alloy-temper combination for each product. A great number of fatigue tests was required to obtain complete sets of curves. Since each set represents only a single sample, however, the statistical reliability is very low. The same total number of fatigue tests, with the specimens taken from several different lots of material, would produce as much useful data and more reliably represent the alloy and temper.

It is recommended that in future projects which include S-N curves and modified Goodman diagrams, several lots of each material be tested, in order to increase the reliability of the curves and diagrams.

C. Fatigue Data Analysis

Given a series of fatigue test results, different investigators may construct the S-N curves differently. S-N curves for several stress ratios, and modified Goodman diagrams, must fit into a consistent family of lines, and this serves as a restraint on the placing of the lines. An objective method of analyzing the fatigue data, using automated data processing and plotting equipment, is needed.

It is recommended that work be undertaken to develop objective and automated methods for analyzing fatigue test data, to obtain S-N curves and modified Goodman diagrams.

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D. Fatigue Crack Propagation

A number of the specimens used in developing fatigue crack propagation data cracked eccentrically, with the resultant reduction in the usefulness of the data. This apparently results from the crack starters being not sharp enough, and it is recommended that a sharper notch be used in future tests.

E. Stress-Corrosion Testing

The tests described herein provided some general indications of the problems in evaluating stress-corrosion cracking by a fracture mechanics approach. This work should be continued to determine "K_{Iscc}" more precisely and to determine more conclusively the relationship between K_{Iscc} and the stress-corrosion cracking threshold stress from tests of smooth specimens. Other environments, types of specimen, loading conditions and methods of analysis of data should also be investigated. Some effort along this line is already underway[27].

F. T76-Type Temper

Alloys 7075 and 7178 are now available in T76-type tempers. Products in the T76-type tempers have slightly lower strength and higher toughness than the corresponding T6 products, immunity to exfoliation attack, and a higher resistance to stress-corrosion cracking than the T6-type products.

It is recommended that work be undertaken to evaluate the fracture toughness, fatigue and corrosion characteristics, and to obtain statistically reliable design mechanical properties, of 7075 and 7178-T76-type plate and extruded products.

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3. D. J. Brownhill, R. E. Davies and D. O. Sprowls, "Mechanical Properties, Including Fracture Toughness and Fatigue, and Resistance to Stress Corrosion Cracking, of Stress-Relieved Stretched Aluminum Alloy Extrusions". Technical Report AFML-TR-68-34, February, 1968.

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TABLES AND FIGURES

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TABLE I

CHEMICAL COMPOSITIONS OF ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Alloy	Product	Temper	Thickness, or Size and Shape, in.	ARL Sample Number	Element, Per Cent Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti
7075	Extrusion	T6510	11/16x16 panel	340637	0.10	0.15	1.61	0.01	2.45	0.20	0.00	5.82	0.02
			3-1/2x7-1/2 bar	340619	0.09	0.17	1.57	0.02	2.44	0.21	0.00	5.66	0.02
		T73510	11/16x16 panel	340639	0.10	0.15	1.61	0.01	2.43	0.20	0.00	5.86	0.02
			3-1/2x7-1/2 bar	340620	0.09	0.17	1.57	0.02	2.46	0.21	0.00	5.68	0.02
	Nominal*				--	--	1.6	--	2.5	0.30	--	5.6	--
	Limits†				0.50	0.7	1.2-2.0	0.30	2.1-2.9	0.18-0.40	--	5.1-6.1	0.20
X7080	Plate	T7E41	1/2	343260	0.14	0.20	0.92	0.32	2.01	0.00	0.00	6.22	0.03
			1-3/8	343259	0.14	0.19	0.92	0.32	2.01	0.00	0.00	6.25	0.03
	Extrusion	T7E42	11/16x16 panel	340730	0.04	0.14	1.10	0.39	2.02	0.00	0.00	6.10	0.03
			3-1/2x7-1/2 bar	340732	0.04	0.14	1.12	0.39	2.04	0.00	0.00	6.08	0.03
	Nominal*				--	--	1.0	0.35	2.25	--	--	6.0	--
	Limits‡				0.30	0.40	0.50-1.5	0.10-0.7	1.5-3.0	0.12	--	5.0-7.0	0.20
7178	Plate	T651	1/2	340457	0.11	0.23	1.88	0.04	2.60	0.18	0.01	6.89	0.03
			1-3/8	340450	0.10	0.22	1.95	0.04	2.54	0.17	0.01	6.61	0.03
	Extrusion	T6510	11/16x16 panel	340616	0.11	0.17	1.99	0.02	2.60	0.20	0.00	6.72	0.03
			3-1/2x7-1/2 bar	340635	0.15	0.18	2.16	0.03	2.82	0.19	0.00	6.53	0.02
	Nominal*				--	--	2.0	--	2.7	0.30	--	6.8	--
	Limits†				0.50	0.7	1.6-2.4	0.30	2.4-3.1	0.18-0.40	--	6.3-7.3	0.20

* Kent R. Van Horn (Editor): Aluminum, "Properties, Physical Metallurgy and Phase Diagrams," Vol. I, p. 306, ASM, Metals Park, 1967.

† ASTM Standard Specifications B209-68 and B221-68; ASTM Standards, Part 6, October, 1968. } maximum unless a range is shown.

‡ Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Wrought Aluminum Alloys. New York, March 15, 1968. } maximum unless a range is shown.

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TABLE II

TENSILE PROPERTIES† OF ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Product	Alloy and Temper	Thickness, or Size and Shape, in.	Sample Number	Longitudinal Tensile Strength, psi	Longitudinal Yield Strength,** psi	Longitudinal Elongation in 4D, %	Long-Transverse Tensile Strength, psi	Long-Transverse Yield Strength,** psi	Long-Transverse Elongation in 4D, %	Short-Transverse Tensile Strength, psi	Short-Transverse Yield Strength,** psi	Short-Transverse Elongation in 4D, %
Plate	X7080-T7E41	1/2	343260	68 200	58 900	16.5	67 600	56 800	15.0	--	--	--
		1-3/8	343259	67 900	60 200	14.5	68 300	59 600	12.5	67 100	56 300	7.0
		Minimum‡				NOT ESTABLISHED	FOR	THIS PRODUCT				
	7178-T651	1/2	340457	88 800	83 400	14.5	88 500	78 800	11.0	--	--	--
		Minimum*		--	--	--	84 000	73 000	6	--	--	--
		1-3/8	340450	92 500	81 900	9.0	87 800	77 800	9.0	80 200	68 100	2.2
		Minimum*		--	--	--	84 000	73 000	4	--	--	--
Extrusion	7075-T6510	11/16x16 panel	340637	90 400	82 400	12.5	87 000	78 700	13.6	--	--	--
		Minimum*		81 000	72 000	7	--	--	--	--	--	--
		3-1/2x7-1/2 bar	340619	85 400	75 700	10.9	77 300	66 700	10.5	75 500	61 400	7.9
		Minimum*		78 000	70 000	6	--	--	--	--	--	--
	7075-T73510	11/16x16 panel	340639	75 700	65 000	12.9	73 100	62 400	10.0	--	--	--
		Minimum*		70 000	61 000	7	--	--	--	--	--	--
		3-1/2x7-1/2 bar	340620	73 700	63 800	12.6	67 400	56 800	9.5	66 200	54 100	7.1
		Minimum‡				NOT ESTABLISHED	FOR	THIS THICKNESS				
	X7080-T7E42	11/16x16 panel	340730	72 400	63 800	14.6	72 200	61 800	11.4	--	--	--
		3-1/2x7-1/2 bar	340732	72 000	64 000	13.0	68 000	59 100	11.5	68 100	56 200	8.6
		Minimum‡				NOT ESTABLISHED	FOR	THIS PRODUCT				
	7178-T6510	11/16x16 panel	340616	94 400	87 200	11.0	91 100	82 900	10.7	--	--	--
		Minimum*		87 000	78 000	5	--	--	--	--	--	--
		3-1/2x7-1/2 bar	340635	89 000	80 700	9.2	77 000	67 900	4.5	71 300	62 300	2.0
		Minimum‡				NOT ESTABLISHED	FOR	THIS THICKNESS				

† At locations corresponding to specification test locations: Plate - t/2, Extruded panel - t/2, W/4 (L); t/2, W/2 (LT)
Extruded bar - t/4, W/4 (L); t/2, W/2 (LT, ST)
t - thickness, W - width.

‡ Not established at this time.

* Aluminum Standards and Data, First Edition, Aluminum Association, New York, April, 1968.

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** 0.2 per cent offset.

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TABLE III

RESULTS OF INTERGRANULAR CORROSION TESTS(1) OF ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Product	Alloy and Temper	Thickness, in.	Sample Number	Type of Attack in $NaCl-H_2O_2$ Solution(2)	
				T/4 Plane	T/2 Plane
Plate	X7080-T7E41	1/2	343260	P	-
		1-3/8	343259	-	P
	7178-T651	1/2	340457	P + SI	-
		1-3/8	340450	-	P + I
Extruded Shape	7075-T6510	11/16	340637	P + SI	-
		3-1/2	340619	-	I
	-T73510	11/16	340639	P	-
		3-1/2	340620	-	P
	X7080=T7E42	11/16	340730	P	-
		3-1/2	340732	-	P
	7178-T6510	11/16	340616	I	-
		3-1/2	340635	-	I

NOTES: (1) Conducted as per paragraph 4.4.3 of MIL-H-6088D.

(2) P - Pitting attack.

P + SI - Pitting with some slight associated intergranular attack at the same sites.

P + I - Predominantly pitting attack with some discrete sites of intergranular attack.

I - Intergranular attack.

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TABLE IV

RESULTS OF ELECTRICAL CONDUCTIVITY MEASUREMENTS(1) OF ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Product	Alloy and Temper	Thickness, in.	Sample Number	Conductivity - % IACS Surface	Near Surface(2)	T/4 Plane	T/2 Plane
Plate	X7080-T7E41	1/2	343260	39.0	--	38.3	--
		1-3/8	343259	--	38.4	--	38.7
	7178-T651	1/2	340457	32.2	--	31.9	--
		1-3/8	340450	--	33.0	--	32.6
Extruded Shape	7075-T6510	11/16	340637	34.0	--	32.6	--
		3-1/2	340619	34.6	34.2	34.7	34.9
	-T73510	11/16	340639	41.9	--	40.6	--
		3-1/2	340620	41.8	41.3	41.7	41.7
	X7080-T7E42	11/16	340730	39.0	--	38.4	--
		3-1/2	340732	38.6	38.3	38.4	38.3
	7178-T6510	11/16	340616	32.2	--	31.9	--
		3-1/2	340635	33.6	32.7	33.1	33.5

NOTES: (1) Determined with a type FM-103 Magnatest Conductivity Meter, in accordance with ASTM Method B342-63, "Standard Method of Test for Electrical Conductivity by Use of Eddy Currents," 1968 Book of ASTM Standards, Part 6.

(2) 3/16 in. machined off 1-3/8 in. plate and 3/8 in. machined off 3-1/2 in. extrusions.

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TABLE V

TEST PROGRAM FOR ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Product	Thickness, in.	Type of Test	Kind of Specimen	Direction*	Location**	Total Tests Per Alloy and Temper
Plate	1/2	Tension (ASTM E8)	1/2-in. Wide Sheet-Type			
			fabricated surface	L, LT	a	2
			fabricated surface removed	L	a	1
		Fracture Toughness (ASTM Method)	Notch Bend (Fig. 5)			
			fabricated surface	L, LT	a	4
			fabricated surface removed	L, LT	a	4
		Axial-Stress Fatigue, R = -1.0, 0.0, +0.5	K_t = 1.0 (Fig. 9)	L	a	30
		Fatigue-Crack Propagation, R = +0.33	Center-notched (Fig. 11)			
			fabricated surface	L, LT	a	6
			fabricated surface removed	L	a	2
		Corrosion				
		MIL-H-6088D	Blank	-	a	1
		Exfoliation (ASTM B287)	4x9-in. Panel[b]	L	a	6[c]
		Conductivity	4x9-in. Panel[d]	L	a	6[d]
		Stress Corrosion	Tensile (Fig. 13) 0.437-in. diameter	LT	a	15[e]
	1-3/8	Tension (ASTM E8)	1/2-in. diameter	L, LT	a	2
			1/8-in. diameter	ST	a	1
		Fracture Toughness (ASTM Method)	Notch Bend (Fig. 5) 1-in. thick	L, LT	a	4
		Axial-Stress Fatigue, R = -1.0, 0.0, +0.5	K_t = 1.0 (Fig. 9)	L, LT	a	60
			K_t = 3.0 (Fig. 10)	L, LT	a	60
			K_t ≥ 12 (Fig. 10)	L, LT	a	60
		Fatigue-Crack Propagation, R = +0.33	Center-notched (Fig. 11)	L, LT	a	6
		Corrosion				
		MIL-H-6088D	Blank	-	a	1
		Exfoliation (ASTM B287)	4x9-in. Panel[b]	LT	a	6[c]
		Conductivity	4x9-in. Panel[d]	LT	a	2
		Stress Corrosion	Tensile (Fig. 13) 0.437-in. diameter	L, LT	a	30[e]
			C-rings (Fig. 15)	ST	a	f
Extruded Panel	11/16	Tension (ASTM E8)	1/2-in. Wide Sheet-Type (stiffeners)			
			fabricated surface	L	C, M(2), E(2)[g]	5
			fabricated surface removed	L	C, M(2), E(2)[g]	5
			3/8-in. Diameter (base)	L	C, M(2), E(2)[g]	5
				LT	C, M(2)	3
		Fracture Toughness (ASTM Method)	Notch Bend (Fig. 5)			
			fabricated surface	L	C, M(2), E(2)[h]	5
				LT	C(2), M(2)[h]	4
			fabricated surface removed	L	C, M, E[h]	3
				LT	C, M[h]	2
		Axial-Stress Fatigue, R = -1.0, 0.0, +0.5	K_t = 1.0 (smooth; Fig. 9)	L	M	30
		Fatigue-Crack Propagation R = +0.33	Center-notched (Fig. 11)			
			fabricated surface	L	M	3
				LT	M	3
			fabricated surface removed	L	M	2
		Corrosion				
		MIL-H-6088D	Blank	-	M	1
		Exfoliation (ASTM B287)	4x9-in. Panel[b]	L	M	6[c]
		Conductivity	4x9-in. Panel[d]	L	M	2
		Stress Corrosion	Tensile (Fig. 13) 0.437-in. diameter	LT	C	15[e]
			(Fig. 14) 0.125-in. diameter	LT	C	5[e]
			(Fig. 14) 0.125-in. diameter	LT	M	15[e]
Extruded Bar	3-1/2	Tension (ASTM E8)	1/2-in. diameter	L	C, M(8), S(8)[i]	17
				LT	C, M(2), S(2)[i]	5
			3/8-in. diameter	ST	C, M(2), S(2)[i]	5
		Fracture Toughness (ASTM Method)	Notch Bend (Fig. 5) 1-in. thick	L	C(2), M(2), S(2)[j]	6
			1/2-in. thick	LT	C, M(2), S(2)[j]	5
			1/4-in. thick	ST	C, M(2), S(2)[j]	5
		Axial-Stress Fatigue, R = -1.0, 0.0, +0.5	K_t = 1.0 (Fig. 9)	L, LT, ST	C-M	90
			K_t = 3.0 (Fig. 10)	L, LT, ST	C-M	90
			K_t ≥ 12 (Fig. 10)	L, LT, ST	C-M	90
			K_t = 1.0 (Fig. 9)	L, ST	S	20
		Fatigue-Crack Propagation R = +0.33	Center-notched (Fig. 11)	L	M, S(2)	3
		Corrosion				
		MIL-R-6088D	Blank	-	C	1
		Exfoliation (ASTM B287)	4x9-in. Panel	L	k	15
		Conductivity	4x9-in. Panel[d]	L	k	4
		Stress Corrosion	Tensile (Fig. 13) 0.437-in. diameter	L, LT	C	30[e]
			(Fig. 14) 0.125-in. diameter	ST	C	m
		Fracture Approach	Compact Tension (Fig. 6)	ST	C-M	9

NOTES:

a Location in width not controlled; specimens machined from center of thickness of plate unless specified otherwise.

b One surface as-fabricated; other surface machined to T/4 (1/2-in. plate and 11/16-in. extruded panel) or T/2 (1-3/8-in. plate) plane.

c Two at 45° (one facing upward, one downward) in each of three environments: salt spray, seacoast and industrial atmosphere

d The 4x9-in. panels were tested to determine electrical conductivity before exposure for exfoliation testing.

e Three stressed (75% YS) plus two unstressed in each of three environments; 3-1/2% NaCl, seacoast and industrial atmosphere.

f Three stressed at each of three or six stress levels in each of three environments, as follows:

	Per Cent of Tensile Yield Strength 15	25	34	42	50	75
X7080-T7E41	X	X	X	X	X	X
7178-T651	X	X	-	-	X	-

g For locations of specimens, see Fig. 1.

h For locations of specimens, see Fig. 3.

i For locations of specimens, see Fig. 2.

j For locations of specimens, see Fig. 4.

k Surface and near surface, quarter plane, and center plane, each represented by two longitudinal sections, at 45° (one facing upward, one downward), in seacoast and industrial atmospheres. Surface and near surface, quarter plane, and center plane, each represented by a longitudinal section, in salt spray environment.

m Three stressed at each of two, three or six stress levels, and two unstressed, in each of three environments; stresses varied with alloy and temper as follows:

	Per Cent of Tensile Yield Strength 15	25	34	42	50	75
7075-T651	X	X	-	-	X	-
7075-T7351	-	-	-	-	X	X
X7080-T7E42	X	X	X	X	X	X
7178-T651	X	X	-	-	X	-

* L - Longitudinal; LT - Long-Transverse; ST - Short-Transverse

** C - Center of thickness of cross section.
M - Midway center to edge (panel) or surface (3-1/2-in. bar).
E - Edge (of integrally stiffened panel).
S - Surface (of 3-1/2-in. bar).
C-M - Central 2/3 of cross-section (3-1/2-in. bar).

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TABLE VI

TENSILE PROPERTIES OF 1/2 AND 1-3/8-IN. ALUMINUM ALLOY PLATE(1)

F33615-67-C-1521

Alloy and Temper	ARL Sample Number	Thickness, in.	Longitudinal Tensile Strength, psi	Longitudinal Tensile Yield Strength,* psi	Longitudinal Elongation in 2 in. or 4D, %	Long-Transverse Tensile Strength, psi	Long-Transverse Tensile Yield Strength,* psi	Long-Transverse Elongation in 2 in. or 4D, %	Short-Transverse Tensile Strength, psi	Short-Transverse Tensile Yield Strength,* psi	Short-Transverse Elongation in 2 in. or 4D, %
X7080-T7E41 (T751)	343260	1/2									
		As-Rolled Surfaces	68 200	58 900	16.5	67 600	56 800	15.0	--	--	---
		Machined Surfaces†	68 300	59 100	16.0	--	--	--	--	--	---
	343259	1-3/8	67 900	60 200	14.5	68 300	59 600	12.5	67 100	56 300	7.0
7178-T651	340457	1/2									
		As-Rolled Surfaces	88 800	83 400	14.5	88 500	78 800	11.0	—	--	---
		Machined Surfaces†	88 100	82 400	13.0	--	--	—	--	--	---
	340450	1-3/8	92 500	81 900	9.0	87 800	77 800	9.0	80 200	68 100	2.2

NOTE: (1) Tensile properties were determined with 1/2-in. wide sheet-type specimens for the 1/2-in. plate, and 1/2-in. (longitudinal and long-transverse) and 1/8-in. (short-transverse) round specimens from the 1-3/8-in. plate, duplicate specimens.

* 0.2 per cent offset.

† 0.020 in. machined from each surface.

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TABLE VII

TENSILE PROPERTIES† AT VARIOUS LOCATIONS†† IN CROSS-SECTION OF EXTRUDED 11/16x16-IN. INTEGRALLY STIFFENED ALUMINUM ALLOY PANELS

F33615-67-C-1521

Alloy and Temper	Location	ARL Sample Number	Longitudinal – Edge: Tensile Strength, psi	Longitudinal – Edge: Tensile Yield Strength,* psi	Longitudinal – Edge: Elongation in 2" or 4D, %	Longitudinal – W/4: Tensile Strength, psi	Longitudinal – W/4: Tensile Yield Strength,* psi	Longitudinal – W/4: Elongation in 2" or 4D, %	Longitudinal – W/2: Tensile Strength, psi	Longitudinal – W/2: Tensile Yield Strength,* psi	Longitudinal – W/2: Elongation in 2" or 4D, %	Long-Transverse – W/4: Tensile Strength, psi	Long-Transverse – W/4: Tensile Yield Strength,* psi	Long-Transverse – W/4: Elongation in 2" or 4D, %	Long-Transverse – W/2: Tensile Strength, psi	Long-Transverse – W/2: Tensile Yield Strength,* psi	Long-Transverse – W/2: Elongation in 2" or 4D, %
7075-T6510	Base	340637	92 ?00	85 400	10.?	90 400	82 500	12.9	89 700	81 800	12.9	87 200	78 400	12.9	87 000	[illegible]	13.6
			94 000	8? 400	[illegible]	90 30?	82 200	12.?	--	--	--	[illegible]	78 800	12.1	--	--	--
		Avg.	93 300	86 400	11.0	90 400	82 400	12.5	89 700	81 800	12.9	[illegible]	78 400	12.5	87 000	[illegible]	[illegible]
	Ribs - As-Extruded Surfaces		88 200	80 600	13.0	89 200	80 500	12.0	90 500	81 700	12.0	--	--	--	--	--	--
			86 200	80 100	12.0	90 100	81 100	13.0	--	--	--	--	--	--	--	--	--
		Avg.	[illegible]	80 400	12.5	[illegible]	80 800	12.5	90 500	81 700	12.0	--	--	--	--	--	--
	Ribs - Machined Surfaces**		88 400	[illegible]	12.5	[illegible]	81 ?00	11.?	8? 400	82 ?00	1?.0	--	--	--	--	--	--
			8? 700	[illegible]	12.?	[illegible]	82 ?00	[illegible]	--	--	--	--	--	--	--	--	--
		Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13.0	--	--	--	--	--	--
7075-T73510	Base	340635	[illegible]	[illegible] 600	12.9	[illegible]	[illegible]	12.?	75 300	64 ?00	10.9	[illegible]	63 500	10.0	[illegible] 100	[illegible]	[illegible]
			[illegible] 300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	[illegible]	[illegible]	[illegible]	--	--	--
		Avg.	[illegible]	65 500	13.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 600	10.4	[illegible]	[illegible]	[illegible]
	Ribs - As-Extruded Surfaces		[illegible]	[illegible]	14.5	72 ?00	[illegible]	[illegible]	[illegible]	62 100	[illegible]	--	--	--	--	--	--
			[illegible]	[illegible]	15.0	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--	--	--	--
		Avg.	[illegible]	[illegible]	14.?	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--
	Ribs - Machine Surfaces**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--	--	--	--
		Avg.	[illegible]	[illegible]	14.5	[illegible] 500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--
X7080-T7E42	Base	340730	[illegible]	58 ?00	[illegible]	72 ?00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71 ?00	[illegible]	[illegible]	[illegible]	61 ?00	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	[illegible]	[illegible]	[illegible]	--	--	--
		Avg.	[illegible]	[illegible]	15.4	[illegible]	[illegible]	[illegible]	[illegible] 400	[illegible]	[illegible]	[illegible] 400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Ribs - As-Extruded Surfaces		[illegible]	[illegible]	16.0	[illegible]	[illegible]	[illegible]	68 500	[illegible]	17.0	--	--	--	--	--	--
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.5	--	--	--	--	--	--	--	--	--
		Avg.	58 400	[illegible]	15.8	[illegible]	[illegible]	[illegible]	68 500	[illegible]	[illegible]						
	Ribs - Machined Surfaces**		[illegible] 900	61 900	[illegible]	59 700	[illegible]	15.0	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--	--	--	--	--	--	--	--	--
		Avg.	[illegible]	[illegible] 300	15.?	[illegible]	61 ?00	15.?	[illegible]	[illegible] 300	[illegible]	--	--	--	--	--	--
7178-T?510	Base	340516	94 ?00	[illegible]	[illegible]	94 ?00	87 400	10.?	94 200	86 ?00	[illegible]	91 ?00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.4	--	--	--	[illegible]	[illegible]	[illegible]	--	--	--
		Avg.	94 ?00	[illegible]	11.?	94 ?00	[illegible] 300	11.0	94 200	86 ?00	[illegible]	91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Ribs - As-Extruded Surfaces		[illegible]	[illegible]	10.0	93 300	[illegible]	11.0	9? 900	85 800	1?.0	--	--	--	--	--	--
			86 ?00	[illegible] 400	10.5	90 ?00	8? 200	11.5	--	--	--	--	--	--	--	--	--
		Avg.	[illegible]	[illegible]	10.?	92 000	84 300	11.?	92 ?00	85 800	12.?	--	--	--	--	--	--
	Ribs - Machined Surfaces**		92 ?00	8? 100	11.5	[illegible]	[illegible]	1?.?	[illegible]	[illegible] 400	10.?	--	--	--	--	--	--
			[illegible]	8? 400	11.5	9? ?00	84 000	12.0	--	--	--	--	--	--	--	--	--
		Avg.	[illegible] 400	[illegible]	11.5	94 ?00	[illegible]	[illegible]	[illegible]	[illegible]	10.?	--	--	--	--	--	--

† 3/8-in. diameter specimens from base. 1/2-in. wide sheet-type specimens from ribs.

†† Locations as shown in Fig. 1; duplicate specimens shown for edge and W/4 locations were from opposite sides at center (see Table IV).

* 0.2 per cent offset.

** 0.020 in. removed from each surface by machining.

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TABLE VIII

RELATIONSHIPS AMONG THE TENSILE PROPERTIES AT VARIOUS LOCATIONS* WITHIN EXTRUDED INTEGRALLY-STIFFENED ALUMINUM ALLOY PANELS

F33615-67-C-1521

Alloy and Temper	Sample Number	Location	Longitudinal						Long-Transverse/Longitudinal			
			TS (E)/TS (W/4)	TYS (E)/TYS (W/4)	TS (W/4)/TS (W/4)	TYS (W/4)/TYS (W/4)	TS (W/2)/TS (W/4)	TYS (W/2)/TYS (W/4)	TS (W/4)/TS (W/4)	TYS (W/4)/TYS (W/4)	TS (W/2)/TS (W/4)	TYS (W/2)/TYS (W/4)
7075-T6510	340637	Base	1.03	1.05	1.00	1.00	0.99	0.99	0.96	0.96	0.96	0.96
		Ribs	0.97	0.98	0.98	0.98	1.01	0.99	--	--	--	--
7075-T73510	340639	Base	1.00	1.01	1.00	1.00	0.99	0.99	0.98	0.98	0.97	0.96
		Ribs	0.96	0.96	0.96	0.96	0.96	0.96	--	--	--	--
X7080-T7E42	340730	Base	0.94	0.92	1.00	1.00	1.00	1.00	0.99	0.97	1.00	0.97
		Ribs	0.94	0.94	0.95	0.95	0.95	0.96	--	--	--	--
7178-T6510	340616	Base	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.96	0.96	0.95
		Ribs	0.95	0.93	0.97	0.97	0.98	0.98	--	--	--	--

NOTE: Ratios are based on properties at the W/4 location in the base of each panel.

W - Width of extruded panel.
TS - Tensile strength.
TYS - Tensile yield strength.

* Locations as shown in Fig. 1.

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TABLE IX

TENSILE PROPERTIES OF STIFFENERS IN EXTRUDED 11/16x16-IN. INTEGRALLY STIFFENED ALUMINUM ALLOY PANELS: EFFECTS OF LOCATION# IN WIDTH AND SURFACE REMOVAL ON LONGITUDINAL TENSILE PROPERTIES OF THE STIFFENERS

F33615-67-C-1521

Alloy and Temper	Sample Number	Surface Condition		Edge	W/4	W/2	W/4	Edge
7075-T6510	340637	As-Extruded	Tensile Strength, ksi	88.2	88.2	90.9	89.1	88.0
			Tensile Yield Strength, ksi*	80.6	80.5	81.7	81.1	80.1
			Elongation in 2 in., %	13.0	12.0	12.0	13.0	12.0
		Machined**	Tensile Strength, ksi	88.4	88.4	89.4	89.2	88.7
			Tensile Yield Strength, ksi*	81.0	81.0	82.5	82.1	81.0
			Elongation in 2 in., %	12.5	11.5	13.0	11.5	12.5
7075-T73510	340639	As-Extruded	Tensile Strength, ksi	73.3	72.8	72.5	72.2	72.8
			Tensile Yield Strength, ksi*	63.0	62.8	62.1	62.8	62.1
			Elongation in 2 in., %	14.5	14.0	13.5	14.5	15.0
		Machined**	Tensile Strength, ksi	74.5	73.7	73.3	73.8	73.8
			Tensile Yield Strength, ksi*	64.3	63.2	63.0	63.7	63.1
			Elongation in 2 in., %	14.5	13.5	13.5	13.5	14.5
X7080-T7E42	340730	As-Extruded	Tensile Strength, ksi	69.2	68.7	68.5	68.6	67.7
			Tensile Yield Strength, ksi*	60.9	60.5	61.0	60.2	59.2
			Elongation in 2 in., %	16.0	15.5	17.0	17.0	15.5
		Machined**	Tensile Strength, ksi	69.9	69.7	70.0	69.7	69.6
			Tensile Yield Strength, ksi*	61.9	61.7	62.2	61.5	61.6
			Elongation in 2 in., %	14.5	15.0	15.0	15.0	15.5
7178-T6510	340616	As-Extruded	Tensile Strength, ksi	91.2	93.3	92.9	90.6	88.0
			Tensile Yield Strength, ksi*	83.3	86.4	85.8	82.2	79.4
			Elongation in 2 in., %	10.0	11.0	12.0	11.5	10.5
		Machined**	Tensile Strength, ksi	92.1	97.6	93.4	91.8	88.7
			Tensile Yield Strength, ksi*	85.1	87.9	86.4	84.0	80.4
			Elongation in 2 in., %	11.5	10.0	10.0	12.0	11.5

NOTE: Tensile properties determined with 1/2-in. wide sheet-type specimens.

Location as shown in Fig. 1

* 0.2 per cent offset.

** 0.020 in. removed from each surface by machining.

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TABLE X

RATIOS AMONG THE TENSILE PROPERTIES OF THE STIFFENERS IN EXTRUDED 11/16x16-IN. INTEGRALLY STIFFENED ALUMINUM ALLOY PANELS - EFFECT OF SURFACE REMOVAL*

F33615-67-C-1521

Alloy and Temper	Sample Number	Ratio: Strength With Surface Removed By Machining / Strength With As-Extruded Surface									
		Edge		W/4		W/2		W/4		Edge	
		TS	TYS	TS	TYS	TS	TYS	TS	TYS	TS	TYS
7075-T6510	340637	1.00	1.00	1.00	1.01	0.98	1.01	1.00	1.01	1.01	1.01
7075-T73510	340639	1.02	1.02	1.01	1.01	1.01	1.01	1.02	1.01	1.01	1.02
X7080-T7E42	340730	1.01	1.02	1.01	1.02	1.02	1.02	1.02	1.02	1.03	1.04
7178-T6510	340616	1.01	1.02	1.05	1.02	1.01	1.01	1.01	1.02	1.01	1.01
	Avg.	1.01	1.02	1.02	1.02	1.00	1.01	1.01	1.02	1.02	1.02
	Overall Avg.	1.01									

* 0.020 in. removed from each surface by machining.

W - Width of extruded panel.
TS - Tensile strength.
TYS - Tensile yield strength.

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TABLE XI

SUMMARY OF TENSILE PROPERTIES OF 1-3/8-IN. ALUMINUM ALLOY PLATE[1]

F33615-67-C-1521

Alloy and Temper	Ref.	Longitudinal(2)			Long-Transverse(2)			Short-Transverse(3)		
		Tensile Strength, psi	Yield Strength, psi	Elongation in 4D %	Tensile Strength, psi	Yield Strength, psi	Elongation in 4D %	Tensile Strength, psi	Yield Strength, psi	Elongation in 4D %
2020-T651	2	82 200	76 600	6.0	82 300	77 800	2.3	76 600	74 000	0.8
2024-T851	2	71 900	65 800	8.1	71 000	65 000	7.1	67 700	63 200	2.0
2219-T851	2	66 600	51 200	10.5	65 800	50 400	10.4	66 700	51 500	6.1
7001-T75	2	81 000	71 100	9.5	80 400	70 500	8.8	73 000	66 300	1.9
7075-T651	1	86 700	78 400	11.2	85 100	76 100	11.3	80 500	67 200	3.4
7075-T7351	1	72 400	61 200	12.3	71 100	60 000	11.1	69 200	58 300	5.2
7079-T651	1	83 000	76 300	11.2	82 800	73 200	11.2	78 400	68 000	4.6
X7080-T7E41	-	67 900	60 200	14.5	68 300	59 600	12.5	67 100	56 300	7.0
7178-T651	-	92 500	81 900	9.0	87 800	77 800	9.0	80 200	68 100	2.2

NOTES: (1) One lot each of X7080-T7E41 and 7178-T651; three lots of all others.

(2) 1/2-in. diameter specimens.

(3) 1/8-in. diameter specimens.

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TABLE XII

RESULTS OF PLANE-STRAIN FRACTURE TOUGHNESS TESTS OF 1/2 AND 1-3/8-IN. ALUMINUM ALLOY PLATE

F33615-67-C-1521

Alloy and Temper	Thickness, in.	ARL Sample Number	Specimen Thickness, in.	Surface Condition	Longitudinal (L-W) K_Q, psi $\sqrt{in.}$	Longitudinal (L-W) Meaningful K_{Ic} (1)	Longitudinal (L-W) $2.5 (\frac{K_Q}{\sigma_{YS}})^2$, in.	Long-Transverse (W-L) K_Q, psi $\sqrt{in.}$	Long-Transverse (W-L) Meaningful K_{Ic} (1)	Long-Transverse (W-L) $2.5 (\frac{K_Q}{\sigma_{YS}})^2$, in.
X7080-T7E41	1/2	343260	1/2	As Rolled	27 600	No (a,b)	0.550	28 300	No (a,b)	0.622
					34 000	No (a,b)	0.832	26 000	No (a,b)	0.522
				Average	--			--		
				Rolled Surface Removed (2)	31 900	No (a,b)	0.727	30 100	No (a,b)	0.701
					31 600	No (a,b)	0.712	31 500	No (a,b)	0.770
				Average	--			--		
	1-3/8	343259	1	Rolled Surface Removed (3)	35 000	Yes	0.845	28 700	Yes	0.579
					37 500	Yes	0.971	30 000	Yes	0.631
					34 800(4)	Yes	0.835	28 600(4)	Yes	0.575
					36 500(4)	Yes	0.921	28 000(4)	Yes	0.553
					34 100(4)	Yes	0.802	27 800(4)	Yes	0.544
				Average	35 500			28 500		
7178-T651	1/2	340457	1/2	As Rolled	22 000	Yes	0.179	20 700	Yes	0.173
					19 300	No (c-22)	0.138	20 100	No (c-14)	0.163
				Average	22 000			20 700		
				Rolled Surface Removed (2)	21 200	No (c-17)	0.161	16 800	No (c-21)	0.114
					24 600	No (c-29)	0.218	18 600	Yes	0.139
				Average	--			18 600		
	1-3/8	340450	1	Rolled Surface Removed (3)	23 200	No (c-14)	0.200	18 900	No (c-16)	0.148
					23 100	No (c-14)	0.199	18 900	No (c-18)	0.148
					22 800	No (c-11)	0.194	19 800	Yes	0.162
					23 000(4)	Yes	0.197	20 800(4)	Yes	0.179
					23 500(4)	Yes	0.206	20 600(4)	Yes	0.175
					23 400(4)	Yes	0.204	19 900(4)	Yes	0.163
				Average	23 300			20 300		

NOTES: (1) Indicated not meaningful if (a) the specimen was not thick enough, (b) plastic deformation was excessive, or (c) the fatigue crack front deviated from straightness by the per cent indicated, which was excessive.

(2) 0.020 in. machined from each surface.

(3) 3/16 in. machined from each surface.

(4) These values were obtained with 1-in. thick compact tension specimens. Others were determined with notched bend specimens.

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TABLE XIII

RESULTS OF PLANE-STRAIN FRACTURE TOUGHNESS TESTS OF EXTRUDED 11/16x16-IN. INTEGRALLY STIFFENED ALUMINUM ALLOY PANELS[1]

F33615-67-C-1521

Alloy and Temper	ARL Sample Number	Location in Width	Longitudinal (L-W)						Long-Transverse (W-L)					
			K_Q, psi $\sqrt{in.}$	Meaningful K_{Ic} (2)	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.	K_Q, psi $\sqrt{in.}$	Meaningful K_{Ic} (2)	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.	K_Q, psi $\sqrt{in.}$	Meaningful K_{Ic} (2)	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.	K_Q, psi $\sqrt{in.}$	Meaningful K_{Ic} (2)	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.
			As-Extruded Surface			Machined Surfaces (3)			As-Extruded Surfaces			Machined Surfaces (3)		
7075-T6510	340637	W/2	26 600	Yes	0.264	27 900	No (c-14)	0.291	23 900	Yes	0.232	23 800	Yes	0.230
			--	--	--	--	--	--	25 000	No (c-12)	0.253	--	--	--
		W/4	28 400	No (c-12)	0.296	27 700	No (c-23)	0.282	24 700	Yes	0.246	24 100	No (d)	0.234
			27 600	Yes	0.280	--	--	--	23 200	Yes	0.216	--	--	--
		Edge	25 600	Yes	0.219	26 500	Yes	0.235	--	--	--	--	--	--
			25 700	Yes	0.222	--	--	--	--	--	--	--	--	--
7075-T73510	340639	W/2	35 000	No (a)	0.732	31 900	No (b)	0.609	29 200	No (b)	0.548	30 800	No (d)	0.610
			--	--	--	--	--	--	29 000	No (b)	0.539	--	--	--
		W/4	33 400	No (a,b)	0.662	31 200	Yes	0.577	28 000	Yes	0.485	29 200	Yes	0.527
			33 500	No (a,b)	0.665	--	--	--	28 600	Yes	0.505	--	--	--
		Edge	31 400	No (b)	0.576	32 300	No (b)	0.606	--	--	--	--	--	--
			32 200	No (b)	0.603	--	--	--	--	--	--	--	--	--
X7080-T7E42	340730	W/2	34 600	No (a,b)	0.737	34 400	No (a)	0.730	34 300	No (a)	0.770	35 400	No (a,b)	0.822
			--	--	--	--	--	--	33 000	No (a)	0.711	--	--	--
		W/4	39 300	No (a)	0.947	37 600	No (a,b)	0.868	33 600	No (a,b)	0.734	35 400	No (a,b)	0.815
			35 000	No (a,b)	0.754	--	--	--	36 500	No (a)	0.868	38 500	No (a)	0.964
		Edge	32 300	No (a,b)	0.754	38 500	No (a)	1.073	--	--	--	--	--	--
			37 300	No (a,b)	1.006	--	--	--	--	--	--	--	--	--
7178-T6510	340616	W/2	24 300	No (c-14)	0.197	18 600	No (c-31)	0.115	18 900	No (c-13)	0.130	20 300	Yes	0.150
			--	--	--	--	--	--	20 500	No (c-14)	0.153	--	--	--
		W/4	23 900	No (c-11)	0.188	24 900	No (c-15)	0.203	19 100	Yes	0.132	18 800	Yes	0.126
			25 700	No (c-14)	0.218	--	--	--	19 200	No (c-13)	0.133	--	--	--
		Edge	22 800	No (c-14)	0.172	20 400	No (c-19)	0.138	--	--	--	--	--	--
			22 000	Yes	0.161	--	--	--	--	--	--	--	--	--

NOTES: (1) All specimens were 11/16-in. thick notched bend specimens.

(2) Indicated not meaningful if (a) the specimen was not thick enough, (b) plastic deformation was excessive, (c) the fatigue crack front deviated from straightness by the per cent indicated, which was excessive, or (d) fatigue crack was not extended far enough.

(3) 0.020 in. machined from each surface.

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TABLE XIV

SUMMARY OF AVERAGE MEANINGFUL RESULTS OF FRACTURE TOUGHNESS TESTS OF EXTRUDED 11/16x16-IN. INTEGRALLY STIFFENED ALUMINUM ALLOY PANELS

F33615-67-C-1521

Alloy and Temper	Location in Width	K_{Ic}, psi$\sqrt{in.}$ Longitudinal (L-W) As-Extruded Surface	Longitudinal (L-W) Machined Surfaces	Long-Transverse (W-L) As-Extruded Surface	Long-Transverse (W-L) Machined Surfaces
7075-T6510	W/2	26 600	--	23 900	23 800
	W/4	27 600	--	24 000	--
	Edge	25 600	26 500	--	--
7075-T73510	W/4	--	31 200	28 300	29 200
X7080-T7E42		NO MEANINGFUL DATA			
7178-T6510	W/2	--	--	--	20 300
	W/4	--	--	19 100	18 800
	Edge	22 000	--	--	--

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TABLE IV

RESULTS OF FRACTURE TOUGHNESS TESTS OF EXTRUDED 3-1/2x7-1/2-IN. ALUMINUM ALLOY BARS

F33615-67-C-1521

Alloy and Temper	ARL Sample Number	Location in Width	Location in Thickness	Longitudinal (1) K_Q, psi$\sqrt{in.}$	Longitudinal (1) Meaningful K_{Ic} (4)	Longitudinal (1) $2.5\left(\frac{K_Q}{YS}\right)^2$, in.	Long-Transverse (2) K_Q, psi$\sqrt{in.}$	Long-Transverse (2) Meaningful K_{Ic} (4)	Long-Transverse (2) $2.5\left(\frac{K_Q}{YS}\right)^2$, in.	Short-Transverse (3) K_Q, psi$\sqrt{in.}$	Short-Transverse (3) Meaningful K_{Ic} (4)	Short-Transverse (3) $2.5\left(\frac{K_Q}{YS}\right)^2$, in.
					Flatwise (L-W)			(W-L)				
7075-T6510	340619	W/2	T/2	30 900	No (b)	0.441	21 400	Yes	0.258	--	--	--
		W/2	T/4	31 100	Yes	0.436	21 100	Yes	0.247	--	--	--
				31 800(5)	Yes	0.440	20 900	Yes	0.242	--	--	--
				31 800(5)	Yes	0.442	21 900(5)	Yes	0.266	--	--	--
				--	--	--	22 100(5)	Yes	0.269	--	--	--
		W/2	Surface	31 300	No (d-22)	0.406	22 500	No (d-18)	0.267	--	--	--
				--	--	--	23 900	No (c,d-20)	0.984	--	--	--
					Edgewise (L-T)						(T-L)	
		W/2	T/2	37 200	Yes	0.637	--	--	--	17 700	No (c)	0.209
		W/4	T/2	40 300	Yes	0.718	--	--	--	19 000	No (d-14)	0.235
				--	--	--	--	--	--	19 900	No (a)	0.259
				--	--	--	--	--	--	19 200(5)	Yes	0.242
				--	--	--	--	--	--	19 200(5)	Yes	0.243
		Edge	T/2	30 000	No (d-17)	0.332	--	--	--	21 400	No (d-23)	0.219
				--	--	--	--	--	--	21 500	Yes	0.219
					Flatwise (L-W)			(W-L)				
7075-T73510	340620	W/2	T/2	34 500	No (b)	0.809	22 400	Yes	0.387	--	--	--
		W/2	T/4	33 700	No (b)	0.757	22 200	Yes	0.359	--	--	--
				--	--	--	23 500	Yes	0.402	--	--	--
				34 400(5)	Yes	0.720	23 900(5)	Yes	0.415	--	--	--
				33 200(5)	Yes	0.677	23 800(5)	Yes	0.411	--	--	--
		W/2	Surface	34 800	No (b)	0.729	24 600	Yes	0.423	--	--	--
				--	--	--	24 400	Yes	0.417	--	--	--
					Edgewise (L-T)						(T-L)	
		W/2	T/2	36 000	No (b)	0.879	--	--	--	19 100	No (a)	0.313
		W/4	T/2	36 800	No (b)	0.841	--	--	--	19 200	No (a,c)	0.303
				--	--	--	--	--	--	19 100	No (a,c)	0.300
				--	--	--	--	--	--	20 800(5)	Yes	0.360
							--	--	--	19 700(5)	Yes	0.324
		Edge	T/2	34 400	No (b)	0.664	--	--	--	24 000	No (a,c, d-14)	0.382
				--	--	--	--	--	--	24 600	No (a,c, d-20)	0.402
					Flatwise (L-W)			(W-L)				
X7080-T7E42	340732	W/2	T/2	37 800	Yes	0.874	27 200	No (a)	0.529	--	--	--
		W/2	T/4	36 300	No (b)	0.810	25 500	Yes	0.456	--	--	--
				--	--	--	26 500	Yes	0.495	--	--	--
		W/2	Surface	35 600	No (b)	0.785	28 900	No (a)	0.576	--	--	--
				--	--	--	29 300	No (a,b)	0.596	--	--	--
					Edgewise (L-T)						(T-L)	
		W/2	T/2	41 400	No (a,b)	1.050	--	--	--	24 500	No (a)	0.476
		W/4	T/2	40 700	No (a,b)	1.012	--	--	--	26 200	No (a)	0.529
				--	--	--	--	--	--	22 700	No (a)	0.395
				--	--	--	--	--	--	22 900(5)	Yes	0.402
				--	--	--	--	--	--	23 400(5)	Yes	0.420
		Edge	T/2	36 600	No (b)	0.805	--	--	--	27 900	No (a)	0.542
				--	--	--	--	--	--	25 000	No (a,b)	0.435
					Flatwise (L-W)			(W-L)				
7178-T651	340635	W/2	T/2	25 400	No (d-15)	0.275	15 900	No (d-11)	0.137	--	--	--
		W/2	T/4	22 100	No (d-20)	0.201	15 900	No (d-11)	0.132	--	--	--
				--	--	--	16 500	Yes	0.141	--	--	--
				24 700(5)	Yes	0.251	17 700(5)	Yes	0.163	--	--	--
				25 400(5)	Yes	0.266	18 300(5)	Yes	0.175	--	--	--
		W/2	Surface	19 900	No (d-12)	0.156	16 500	No (d-13)	0.132	--	--	--
				--	--	--	16 300	No (d-13)	0.130	--	--	--
					Edgewise (L-T)						(T-L)	
		W/2	T/2	26 000	No (b)	0.290	--	--	--	14 100	No (b,c)	0.129
		W/4	T/2	27 600	No (d-16)	0.298	--	--	--	12 200	No (b,c)	0.069
				--	--	--	--	--	--	15 000	No (b,c)	0.135
				--	--	--	--	--	--	14 400(5)	Yes	0.133
				--	--	--	--	--	--	14 500(5)	Yes	0.135
		Edge	T/2	19 300	No (d-12)	0.120	--	--	--	11 600	No (c)	0.055
				--	--	--	--	--	--	14 500	No (c)	0.087

NOTES: (1) Longitudinal bend specimens were 1-in. thick.

(2) Long-transverse bend specimens were 1/2-in. thick.

(3) Short-transverse bend specimens were 1/4-in. thick.

(4) Indicated not meaningful if (a) specimen was not thick enough, (b) plastic deformation was excessive, (c) fatigue crack was too long, or (d) the fatigue crack front deviated from straightness by the per cent indicated, which was excessive.

(5) These values were obtained with 1-in. thick compact tension specimens.

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TABLE XVI

SUMMARY OF AVERAGE MEANINGFUL RESULTS OF
FRACTURE-TOUGHNESS TESTS OF EXTRUDED 3-1/2x7-1/2-IN. ALUMINUM ALLOY BARS

F33615-67-C-1521

Alloy and Temper	Location in Width	Location in Thickness	K_{Ic}, psi$\sqrt{in.}$ Longitudinal (L-W)	Longitudinal (L-T)	Long-Transverse (W-L)	Short-Transverse (T-L)
7075-T6510	W/2	T/2	--	37 200	21 400	--
	W/2	T/4	31 600	40 300	21 600	19 200
	Edge	Surface	--	--	--	21 500
7075-T73510	W/2	T/2	--	--	22 400	--
	W/2	T/4	33 800	--	23 300	20 200.
	Edge	Surface	--	--	24 500	--
X7080-T7E42	W/2	T/2	37 800	--	--	--
	W/2	T/4	--	--	26 000	23 200
	Edge	Surface	--	--	--	--
7178-T651	W/2	T/2	--	--	--	--
	W/4	T/4	25 100	--	17 500	14 400
	Edge	Surface	--	--	--	--

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TABLE XVII

SUMMARY OF AVERAGE MEANINGFUL RESULTS OF FRACTURE TOUGHNESS TESTS

F33615-67-C-1521

Alloy and Temper	Direction	1/2-in. Plate		1-3/8-in. Plate		3-1/2x7-1/2-in. Extruded Bars		11/16x16-in. Extruded Panels	
		Average K_Q, psi $\sqrt{in.}$	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.	Average K_Q, psi $\sqrt{in.}$	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.	Average K_Q, psi $\sqrt{in.}$	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.	Average K_Q, psi $\sqrt{in.}$	$2.5\left(\frac{K_Q}{\sigma_{YS}}\right)^2$, in.
7075-T6-Type	L (L-W)	--	---	25 600	0.267	31 600	0.436	27 600	0.280
	LT (W-L)	--	---	21 700	0.203	21 500	0.259	24 000	0.232
	ST (T-L)	--	----	--	---	19 200	0.242	--	---
7075-T73-Type	L (L-W)	--	---	30 100	0.610	33 800	0.701	--	---
	LT (W-L)	--	---	28 600	0.455	23 400	0.425	28 300	0.514
	ST (T-L)	--	---	--	---	20 200	0.342	--	---
X7080-T7-Type	L (L-W)	—	---	35 600	0.872	37 800	0.874	--	---
	LT (W-L)	--	---	28 500	0.571	26 000	0.475	--	---
	ST (T-L)	--	---	--	---	23 200	0.411	--	---
7178-T6-Type	L (L-W)	22 000	0.179	23 300	0.202	25 100	0.258	22 000	0.161
	LT (W-L)	20 700	0.173	20 300	0.170	17 500	0.160	19 100	0.132
	ST (T-L)	--	---	—	---	14 400	0.134	--	---

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TABLE XVIII

CYCLES REQUIRED TO INITIATE FATIGUE CRACKS IN CENTER-NOTCHED SPECIMENS FROM ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

Net Stress = 3300 psi minimum to 9900 psi maximum
Gross Stress = 2700 psi minimum to 8200 psi maximum

F33615-67-C-1521

Alloy	Temper	Product	ARL Sample Number	Nominal Specimen Thickness, in.	Surface Condition or Location	Direction	No. of Tests	Number of Cycles to Initiate Crack
7075	T6510	Extruded Panel	340637	11/16	Extruded	L	3	82,300, 95,200, 116,700
					Machined[a]	L	2	120,700, 154,400
					Extruded	LT	3	98,100, 113,000, 225,200
	T6510	Extruded Bar	340619	3/4	Surface	L	2	113,500, 128,200
					T/4	L	1	148,000
7075	T73510	Extruded Panel	340639	11/16	Extruded	L	3	62,300, 68,700, 78,200
					Machined[a]	L	2	56,400, 106,500
					Extruded	LT	3	71,100,82,200, 86,900
	T73510	Extruded Bar	340620	3/4	Surface	L	2	91,100, 139,000
					T/4	L	1	97,100
X7080	T7E42	Extruded Panel	340730	11/16	Extruded	L	3	71,900, 110,600, 116,000
					Machined[a]	L	2	79,000, 85,000
					Extruded	LT	3	55,600, 56,700, 69,400
	T7342	Extruded Bar	340732	3/4	Surface	L	2	97,700, 111,000
					T/4	L	1	91, 400
	T7E41	1/2-in. Plate	343260	1/2	Rolled	L	4	80,700, 105,100, 113,300, 164,000
					Machined[a]	L	2	71,000, 116,400
					Rolled	LT	3	82,200, 90,300, 107,500
	T7E41	1-3/8-in. Plate	343259	3/4	T/2	L	3	51,600, 80,300, 86,600
					T/2	LT	3	72,900, 75,600, 83,700
7178	T6510	Extruded Panel	340616	11/16	Extruded	L	3	95,000, 98,600, 137,600
					Machined[a]	L	2	145,000, 200,100
					Extruded	LT	3	116,900, 124,600, 235,100
	T6510	Extruded Bar	340635	3/4	Surface	L	2	121,700, 155,700
					T/4	L	1	137,800
	T651	1/2-in. Plate	340457	1/2	Rolled	L	3	312,300[d], 3,874,100[d,c], 11,954,900[d]
					Machined[a]	L	2	398,100, 1,570,400[d]
					Rolled	LT	3	450,700, 6,008,600[d], 11,252,000
	T651	1-3/8-in. Plate	340450	3/4	T/2	L	3	107,600, 167,900, 208,800[b]
					T/2	LT	3	147,100, 209,100, 1,149,400

NOTES: (a) 0.020 machined from surface.
(b) Complete fracture.
(c) Failed in grip end.
(d) Hole oversize.

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TABLE XIX

RESULTS OF ACCELERATED EXFOLIATION TESTS[1] OF ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Alloy and Temper	Product	Thickness, in.	Sample Number	Degree of Susceptibility to Exfoliation: Surface	Near Surface[2]	T/4 Plane	T/2 Plane
X7080-T7E41	Plate	1/2	343260	None	--	Very Slight	--
		1-3/8	343259	--	Very Slight	--	Very Slight
7178-T651		1/2	340457	Very Slight	--	Very Slight	--
		1-3/8	340450	--	Very Slight	--	Severe[3]
7075-T6510	Extruded Shape	11/16	340637	None	--	Severe[3]	--
		3-1/2	340619	None	Severe[3]	Severe[3]	Severe[3]
7075-T73510		11/16	340639	None	--	None	--
		3-1/2	340620	None	None	None	None
X7080-T7E42		11/16	340730	None	--	Very Slight	--
		3-1/2	340731	None	Very Slight	Very Slight	Very Slight
7178-T6510		11/16	340616	None	--	Severe[3]	--
		3-1/2	340635	None	Severe[3]	Severe[3]	Severe[3]

NOTES: (1) Two week exposure to acidified 5% NaCl intermittent spray at 120 F.

(2) 3/16 in. machined off rolled surface in 1-3/8-in. plate, T/10 plane in 3-1/2-in. thick extruded bars.

(3) Specimen removed from test after only one week exposure.

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TABLE XX

RESULTS OF STRESS-CORROSION TESTS OF LONGITUDINAL SPECIMENS[1] FROM ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

Status as of June 13, 1969

F33615-67-C-1521

Alloy and Temper	Number	Alternate Immersion in 3-1/2% NaCl 182 Days		Seacoast Atmosphere 4 Years		Industrial Atmosphere 4 Years	
		F/N	Days	F/N	Days	F/N	Days
1-3/8-in. Plate							
X7080-T7E41	343259	0/3	OK 182	0/3	OK 439	0/3	OK 518
7178-T651	340450	0/3	OK 182	0/3	OK 439	0/3	OK 518
3-1/2x7-1/2-in. Extruded Bar							
7075-T6510	340619	0/3	OK 182	0/3	OK 376	0/3	OK 365
7075-T73510	340620	0/3	OK 182	0/3	OK 376	0/3	OK 365
X7080-T7E42	340731	0/3	OK 182	0/3	OK 376	0/3	OK 365
7178-T6510	340635	0/3	OK 182	0/3	OK 376	0/3	OK 365

NOTES: F/N - Number of failures over number of specimens exposed

Days - Days to failure; specimens which completed the specified period without failing, or which have not failed and are still in test are indicated by OK.

(1) Triplicate 0.437 in. diameter specimens stressed to 75 per cent of the respective yield strength.

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TABLE XXI

RESULTS OF STRESS-CORROSION TESTS OF LONG-TRANSVERSE SPECIMENS[1] FROM ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES
Status as of June 13, 1969

F33615-67-C-1521

Alloy and Temper	Sample Number	Alternate Immersion in 3-1/2% NaCl 84 or 182 Days F/N	Days	Seacoast Atmosphere 4 Years F/N	Days	Industrial Atmosphere 4 Years F/N	Days
		1/2-in. Plate 0.437 in. Specimens					
X7080-T7E41	343260	0/3	OK 182	0/3	OK 439	0/3	OK 518
7178-T651	340457	3/3	60,63,82	0/3	OK 439	0/3	OK 518
		1-3/8-in. Plate 0.437 in. Specimens					
X7080-T7E41	343259	0/3	OK 182	0/3	OK 439	0/3	OK 518
7178-T651	343450	3/3	60,82,103	0/3	OK 439	0/3	OK 518
		11/16x16-in. Extruded Ribbed Panel 0.125 in. Specimens Centered Between Upstanding Ribs					
7075-T6510	340637	0/3	OK 84	0/3	OK 165	0/3	OK 231
7075-T73510	340639	0/3	OK 84	0/3	OK 165	0/3	OK 231
X7080-T7E42	340730	0/3	OK 84	0/3	OK 165	0/3	OK 231
7178-T6510	340616	3/3	56,67,67	0/3	OK 165	0/3	OK 231
		0.125 in. Specimens Centered Under Upstanding Rib[2]					
7075-T6510	340637	3/3	25,49,58	---	--	---	--
7075-T73510	340639	0/3	OK 84	---	--	---	--
X7080-T7E42	340730	0/3	OK 84	---	--	---	--
7178-T6510	340616	3/3	10,11,13	---	--	---	--
		0.437 in. Specimens Centered Under Upstanding Rib[2]					
7075-T6510	340637	3/3	11,15,37	3/3	65,65,65	0/3	OK 365
7075-T73510	340639	0/3	OK 182	0/3	OK 376	0/3	OK 365
X7080-T7E42	340730	0/3	OK 182	0/3	OK 376	0/3	OK 365
7178-T6510	340616	3/3	3,10,13	3/3	65,65,65	0/3	OK 365
		3-1/2x7-1/2-in. Extruded Bar[2] 0.437 in. Specimens					
7075-T6510	340619	3/3	4,4,4	3/3	65,130,130	0/3	OK 365
7075-T73510	340620	0/3	OK 182	0/3	OK 376	0/3	OK 365
X7080-T7E42	340731	0/3	OK 182	0/3	OK 376	0/3	OK 365
7178-T6510	340635	3/3	3,4,4	3/3	65,65,130	0/3	OK 365

NOTES: F/N - Number of failures over number of specimens exposed.
Days - Days to failure; OK indicates specimen did not fail and either completed test or is still in test.

(1) Triplicate specimens stressed to 75 per cent of the respective yield strength.

(2) These specimens did not contain a true long-transverse grain structure.

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TABLE XXII

RESULTS OF STRESS-CORROSION TESTS OF SHORT-TRANSVERSE SPECIMENS(1) FROM 1-3/8-IN. ALUMINUM ALLOY PLATE

Status as of June 13, 1969

F33615-67-C-1521

Alloy and Temper	Sample Number	Stress % Y.S.	Alternate Immersion in 3.5% NaCl, 30 Days: F/N	Alternate Immersion in 3.5% NaCl, 30 Days: Days	Alternate Immersion in 3.5% NaCl, 84 Days: F/N	Alternate Immersion in 3.5% NaCl, 84 Days: Days	Seacoast Atmosphere 4 Years: F/N	Seacoast Atmosphere 4 Years: Days	Industrial Atmosphere 4 Years: F/N	Industrial Atmosphere 4 Years: Days
X7080-T7E41	343259	75	0/1	OK 30(2)	2/2	(3)	0/3	OK 439	3/3	199,199,206
		50	0/1	OK 30(2)	2/2	(3)	0/3	OK 439	0/3	OK 518
		42	0/1	OK 30(2)	2/2	(3)	0/3	OK 439	0/3	OK 518
		34	0/1	OK 30(2)	2/2	(3)	0/3	OK 439	0/3	OK 518
		25	0/1	OK 30(2)	0/2	OK 84(2)	0/3	OK 439	0/3	OK 518
		15	0/1	OK 30(2)	0/2	OK 84(2)	0/3	OK 439	0/3	OK 518
7178-T651	340450	50	3/3	6,6,6	-	--	3/3	127,127,127	3/3	82,82,108
		25	3/3	6,6,6	-	--	3/3	127,127,127	3/3	206,206,514
		15	1/1	9	2/2	30,70	0/3	OK 439	1/3	464,2 OK 518

Alloy and Temper	Sample Number	Stress % Y.S.	Total Immersion in Boiling 6% NaCl 96 Hours: F/N	Total Immersion in Boiling 6% NaCl 96 Hours: Hours
X7080-T7E41	343259	75	3/3	1,1,3
		50	3/3	2,2,67
		25	0/3	OK 96

NOTES: F/N - Number of failures over number of specimens exposed.
Days - Days to failure; OK indicates specimen did not fail and either completed test or is still in test.

(1) Triplicate 0.750 in. O.D. C-rings stressed to the indicated percentage of the respective yield strength.

(2) Metallographic examination after the indicated exposure verified specimen to be free of cracking.

(3) Metallographic examination after 84 days exposure revealed the presence of incipient stress-corrosion cracks which were most likely present earlier.

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TABLE XXIII

RESULTS OF STRESS-CORROSION TESTS OF SHORT-TRANSVERSE SPECIMENS[(1)] FROM EXTRUDED 3-1/2x7-1/2-IN. ALUMINUM ALLOY BARS

Status as of June 13, 1969

F33615-67-C-1521

Alloy and Temper	Sample Number	Stress % Y.S.	Alternate Immersion in 3.5% NaCl 84 days		Seacoast Atmosphere 4 Years		Industrial Atmosphere 4 Years	
			F/N	Days	F/N	Days	F/N	Days
7075-T6510	340619	50	3/3	1,2,2	3/3	5,5,65	3/3	47,132,143
		25	3/3	2,4,4	3/3	65,65,65	1/3	320,2 OK 365
		15	1/3	4,2 OK 84	3/3	65,65,337	0/3	OK 365
7075-T73510	340620	75	0/3	OK 84	0/3	OK 376	0/3	OK 365
		50	0/3	OK 84	0/3	OK 376	0/3	OK 365
X7080-T7E42	340731	75	3/3	49,84,84	0/3	OK 376	0/3	OK 365
		50	0/3	OK 84	0/3	OK 376	0/3	OK 365
		42	0/3	OK 84	0/3	OK 376	0/3	OK 365
		34	0/3	OK 84	0/3	OK 376	0/3	OK 365
		25	0/3	OK 84	0/3	OK 376	0/3	OK 365
		15	0/3	OK 84	0/3	OK 376	0/3	OK 365
7178-T6510	340635	50	3/3	1,1,1	3/3	5,5,5	3/3	12,14,26
		25	3/3	2,3,4	3/3	5,5,55	0/3	OK 365
		15	1/3	4,2 OK 84	1/3	65,2 OK 376	0/3	OK 365

NOTES: F/N - Number of failures over number of specimens exposed.
Days - Days to failure; OK indicates specimen did not fail and either completed test or is still in test.

(1) Triplicate 0.125 in. diameter specimens stressed to the indicated percentages of the respective yield strength.

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TABLE XXIV

REDUCTION IN TENSILE STRENGTH BY CORROSION OF LONGITUDINAL AND LONG-TRANSVERSE SPECIMENS(1) FROM ALUMINUM ALLOY PLATE AND EXTRUDED SHAPES

F33615-67-C-1521

Average Per Cent Loss in Tensile Strength

1/2 in. Plate

Alloy and Temper	Sample Number	Long-Transverse 0.437 in. Diameter Unstressed	Long-Transverse 0.437 in. Diameter Stressed
X7080-T7E41	343260	0	0
7178-T651	340457	6	*

1-3/8 in. Plate

Alloy and Temper	Sample Number	Longitudinal 0.437 in. Diameter Unstressed	Longitudinal 0.437 in. Diameter Stressed	Long-Transverse 0.437 in. Diameter Unstressed	Long-Transverse 0.437 in. Diameter Stressed
X7080-T7E41	343259	0	0	0	4
7178-T651	340450	11	20	11	*

11/16x16 in. Extruded Ribbed Panel

Alloy and Temper	Sample Number	Long-Transverse Between Ribs 0.125 in. Diameter Unstressed	Long-Transverse Between Ribs 0.125 in. Diameter Stressed	Long-Transverse Centered Under Upstanding Rib 0.125 in. Diameter Unstressed	Long-Transverse Centered Under Upstanding Rib 0.125 in. Diameter Stressed	Long-Transverse Centered Under Upstanding Rib 0.437 in. Diameter Unstressed	Long-Transverse Centered Under Upstanding Rib 0.437 in. Diameter Stressed
7075-T6510	340637	6	13	18	*	8	*
7075-T73510	340639	4	6	6	8	6	13
X7080-T7E42	340730	4	3	2	3	3	3
7178-T6510	340616	12	*	17	*	9	*

3-1/2x7-1/2 in. Extruded Bar

Alloy and Temper	Sample Number	Longitudinal 0.437 in. Diameter Unstressed	Longitudinal 0.437 in. Diameter Stressed	Long-Transverse 0.437 in. Diameter Unstressed	Long-Transverse 0.437 in. Diameter Stressed
7075-T6510	340619	8	11	10	*
7075-T73510	340620	3	4	11	9
X7080-T7E42	340731	1	1	3(2)	12(2)
7178-T6510	340635	8	16	17	*

NOTES: (1) Duplicate unstressed and triplicate specimens stressed to 75% of the respective yield strength were exposed to alternate immersion in 3.5% NaCl solution. The 0.437-in. diameter specimens were exposed for 182 days, and the 0.125-in. diameter specimens were exposed for 84 days.

(2) Metallographic examination of these specimens indicated the relatively high loss for the stressed specimens was the result of incipient stress-corrosion cracking.

* No value since all three specimens failed by stress-corrosion cracking.

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TABLE XXV

REDUCTION IN TENSILE STRENGTH BY CORROSION OF SHORT-TRANSVERSE SPECIMENS FROM EXTRUDED 3-1/2x7-1/2 IN. ALUMINUM ALLOY BARS[1]

F33615-67-C-1521

Alloy and Temper	Sample Number	Average Per Cent Loss in Tensile Strength						
		Unstressed	Stressed 15% Y.S.	Stressed 25% Y.S.	Stressed 34% Y.S.	Stressed 42% Y.S.	Stressed 50% Y.S.	Stressed 75% Y.S.
7075-T6510	340619	27[2]	53#[2]	*	--	--	*	--
7075-T73510	340620	18[3]	--	--	--	--	22	41[3]
X7080-T7E42	340731	10	10	12	9	13	17	*
7178-T6510	340635	28[2]	61#[2]	*	--	--	*	--

NOTES: (1) Triplicate 0.125 in. diameter tensile specimens which were stressed in direct tension to the indicated percentage of the respective yield strength, and duplicate unstressed specimens, were exposed to 3.5% NaCl solution by alternate immersion for 84 days.

(2) Metallographic examination indicated that the relatively high loss on the stressed specimens was the result of incipient stress-corrosion cracking.

(3) Metallographic examination of these specimens indicated the relatively high loss on the stressed specimens was merely the result of deeper corrosive attack than that on the unstressed specimens.

* No value since all three specimens failed by stress-corrosion cracking.

\# Value for duplicate specimens, third specimen failed by stress-corrosion cracking.

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TABLE XXVI

STRESS-CORROSION FRACTURE TOUGHNESS DATA FOR SHORT-TRANSVERSE RING-LOADED SPECIMENS[1] OF SOME EXTRUDED 3-1/2x7-1/2-IN. ALUMINUM ALLOY BARS EXPOSED IN 3-1/2% NaCl SOLUTION

F33615-67-C-1521

Alloy and Temper	Sample Number	Type of Test[2,3]	Number of Cycles	Ring No.[4]	Initial Values: Crack Length[5], in. Measured	Initial Values: Crack Length[5], in. Calculated	Initial Values: Load, lb	Initial Values: K_{Ii}[6], psi$\sqrt{in.}$	Values at Fracture: Crack Length[5], in. Measured	Values at Fracture: Crack Length[5], in. Calculated	Values at Fracture: Load, lb	Values at Fracture: K_{If}[6], psi$\sqrt{in.}$	Time to Fracture, hrs.
7075-T6510	340619	CI	---	1	0.955	1.041	2700	19 500	--	1.173	2440	22 100	318**
			---	1	0.950‡	0.977	2800	18 400	1.10	1.128	2550	21 400	260‡
		AI	43	1	1.000	0.988	2270	15 100	1.157	1.167	2030	18 200	310
			105	2	0.985	0.953	2030	12 900	1.219	1.192	1930	18 200	840
7075-T73510	340620	CI	---	1	0.965	0.977	3010	19 800	0.990	0.981	3010	19 900*	340*
		AI	108	1	1.055	1.088	2520	19 500	1.076	1.113	2460	20 000*	1080*
X7080-T7E42	340732	AI	118	1	0.990	1.033†	3110	20 800†	1.168	1.233†	2730	24 600†	1010
			97	2	1.010	1.055†	3030	20 900†	1.052	1.127†	2970	21 900†	950
7178-T6510	340635	CI	---	1	1.000	0.994	1930	13 000	1.160	1.157	1710	15 100	340
		AI	24	1	1.000	0.996	1920	13 000	1.122	1.133	1770	14 900	122
			60	1	1.000	0.990	1720	11 500	1.240	1.254	1430	15 300	264
			62	2	0.990	0.977	1510	10 000	1.200	1.240	1420	14 700	480

NOTES:

(1) Data are for single tests of 1-in. thick compact tension specimens. All specimens except one, noted ‡, were precracked in fatigue.

(2) AI - Alternate Immersion; CI - Constant Immersion.

(3) Alternate immersion cycles were accomplished manually during working hours. Specimens were submerged overnight and on weekends.

(4) Spring constant for ring No. 1 is 89.5 lb/mil. Spring constant for ring No. 2 is 20.4 lb/mil.

(5) Initial crack lengths were measured on the surfaces of the specimens. Final crack lengths were measured on fracture surfaces. Calculated crack lengths were obtained with a clip gage and compliance calibration data.

(6) Stress intensities K_{Ii} and K_{If} are based on calculated crack lengths, except where noted (†).

‡ Crack was a 1/16-in.-wide saw cut.

** Wetting agent added to solution.

* These tests were discontinued after the indicated exposure periods.

† Calculated crack lengths may be incorrect because of creep in the specimen or a defective clip gage. K values are based on measured crack lengths.

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TABLE XXVII

STRESS-CORROSION FRACTURE TOUGHNESS DATA FOR SHORT-TRANSVERSE BOLT-LOADED SPECIMENS(1) OF SOME EXTRUDED 3-1/2x7-1/2-IN. ALUMINUM ALLOY BARS EXPOSED TO 3-1/2% NaCl SOLUTION

F33615-67-C-1521

Alloy and Temper	Sample Number	Type of Test(2,3)	Exposure Period, hrs.	Method of Precracking	Initial Values: Crack Length, in.	Initial Values: Load, lb	Initial Values: K_{Ii}, psi$\sqrt{in.}$	Residual Values: Crack Length, in.	Residual Values: Load, lb	Residual Values: K_{If}, psi$\sqrt{in.}$
7075-T6510	340619	AI	800	Tension	1.015	2760	19 200	1.555	560	13 000
			800	Fatigue	0.975	2340	15 300	1.200	1410	13 500
			2500	Fatigue	0.950	2740	17 300	1.430	792	13 000
		CI	340	Fatigue	1.000	2590	17 500	1.090	2370	17 100
			1000	Fatigue	0.950	2880	18 200	1.090	1830	14 400
			2500	Tension	1.060	2580	19 200	1.500	410	8 100
			2500	Fatigue	1.005	2530	17 300	1.396	900	13 500
			2500	Fatigue	1.010	2220	15 300	1.420	813	13 000
7075-T73510	340620	AI	2150	Tension	0.965	3200	20 600	0.965	2950	19 000
			2150	Fatigue	0.990	2490	16 600	1.009	2050	14 100
		CI	340	Fatigue	0.940	3180	19 800	0.950	2850	18 000
			1000	Fatigue	0.950	3120	19 700	0.980	2670	17 500
			2150	Fatigue	0.985	2810	18 600	1.004	2400	16 400
X7080-T7E42	340732	AI	800	Fatigue	0.980	2820	18 600	0.975	2440	16 000
			2500	Tension	1.120	2750	23 200	1.389	1340	20 100
			2500	Fatigue	0.990	3130	20 900	1.082	2300	17 800
		CI	2500	Fatigue	0.975	3190	20 900	1.092	2320	18 200
			2500	Fatigue	0.985	2800	18 600	1.118	1855	15 200
7178-T6510	340635	AI	800	Tension	1.065	1920	14 400	1.485	526	10 000
			800	Fatigue	0.965	1790	11 600	1.125	1177	9 800
			2500	Fatigue	0.975	1990	13 000	1.175	945	8 600
		CI	2500	Tension	1.060	1940	14 400	1.580	350	8 700
			2500	Fatigue	0.995	1930	13 000	1.330	852	10 800

NOTES: (1) Data shown are for single tests of 1-in. thick compact tension specimens.

(2) AI - Alternate Immersion; CI - Constant Immersion.

(3) Alternate immersion cycles were continuous; 10 minutes in and 50 minutes out of solution.

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Contrails

Contrails

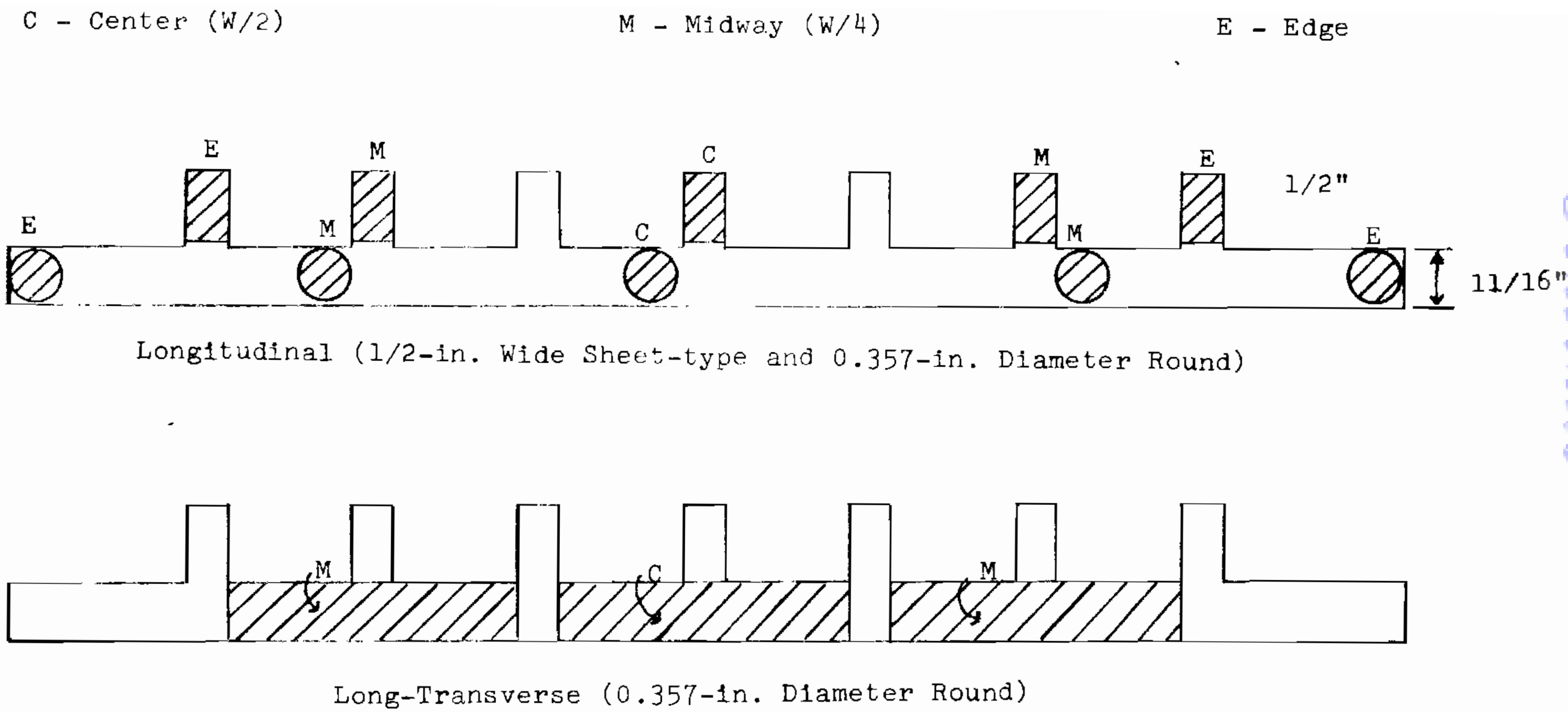

Fig. 1 Locations of Tensile Specimens in 11/16x16-in. Extruded Integrally-Stiffened Panels.

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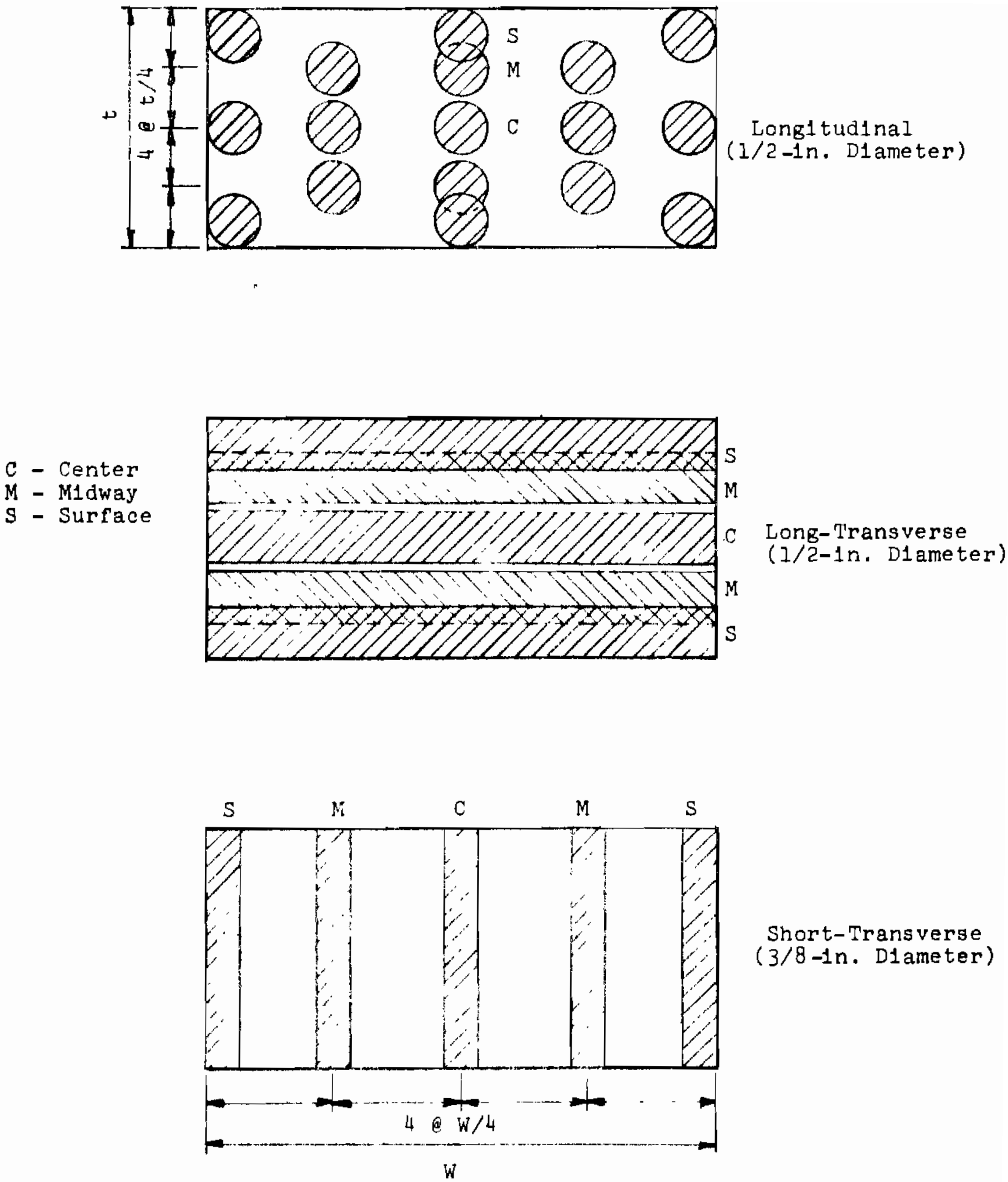

Fig. 2 Locations of Tensile Specimens in 3-1/2x7-1/2-in. Extruded Bars.

Fig. 2

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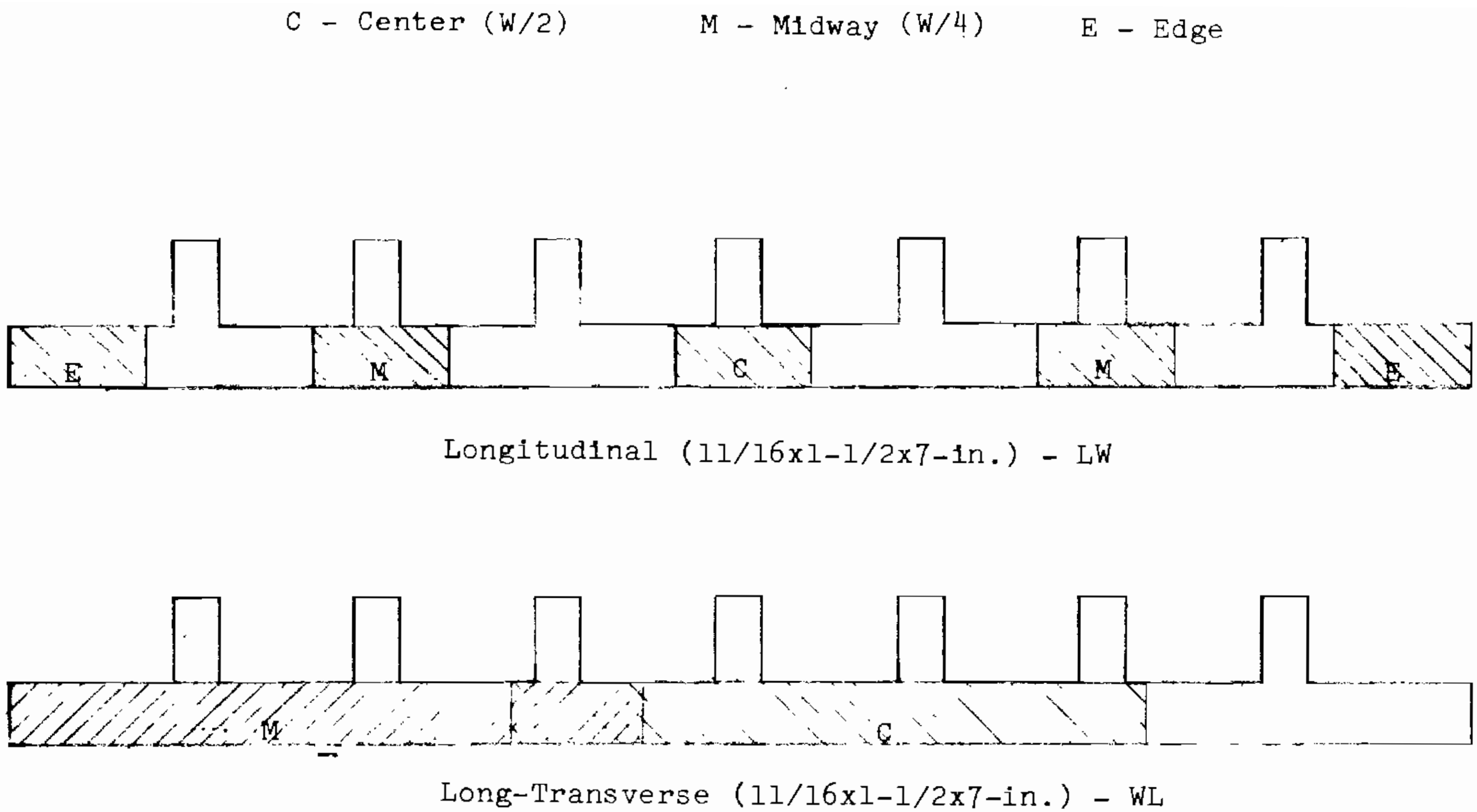

Fig. 3 Locations of Fracture Toughness Specimens in 11/16x16-in. Extruded Integrally Stiffened Panels.

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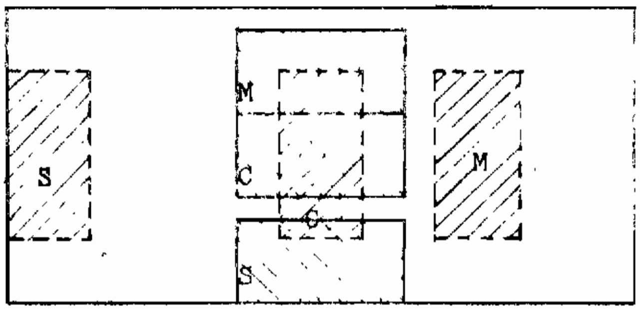
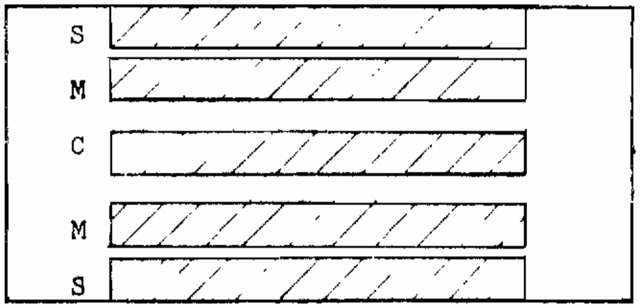
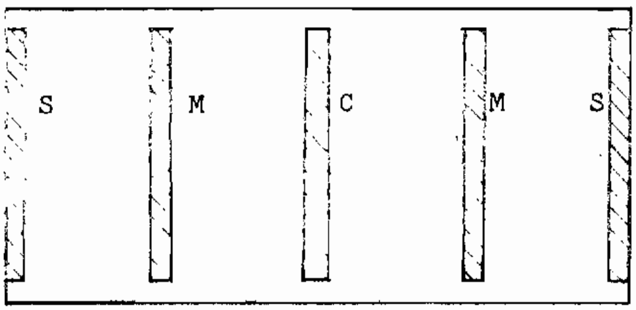


Longitudinal (1x2x9-in.)
3 Flatwise (C,M,S,) - LW
3 Edgewise (C,M,S,) - LT



C - Center
M - Midway
S - Surface

Long-Transverse
(1/2x1x5-in.)
Flatwise - WL



Short-Transverse - TL
(1/4x1/2x3-in.)

Fig. 4 Locations of Fracture Toughness Specimens in 3-1/2x7-1/2-in. Extruded Bars.

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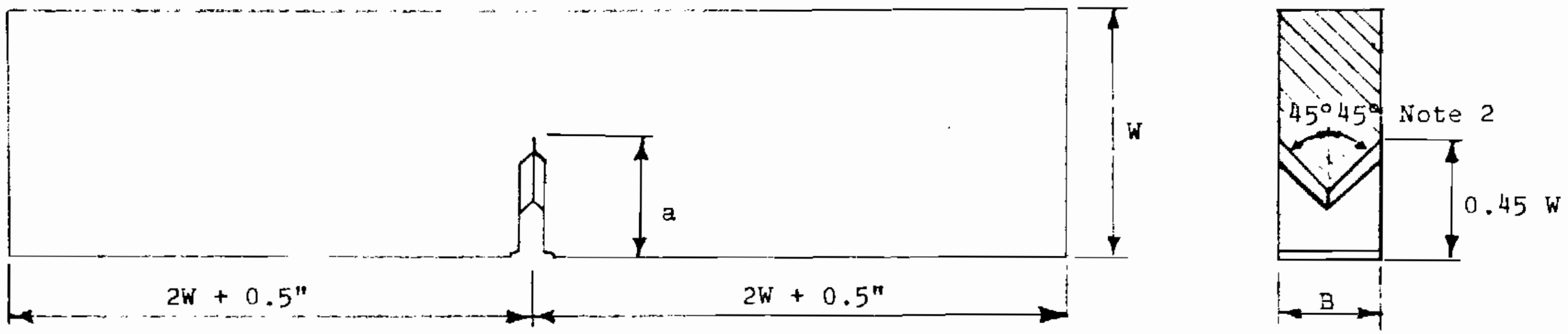

Thickness, B, in.	Width, W, in.	Length, in.	Crack Length, a, in. Note 1
1	2	9	1
11/16	1-1/2	7	1-1/2
1/2	1	5	1/2
1/4	1/2	3	1/4

Note 1 Including at least 0.050 in. of fatigue crack.

2 For 1/4-in. thick specimens, the chevron angle is 70 rather than 45 degrees.

Fig. 5 Notch-Bend Fracture-Toughness Specimen.

Contrails

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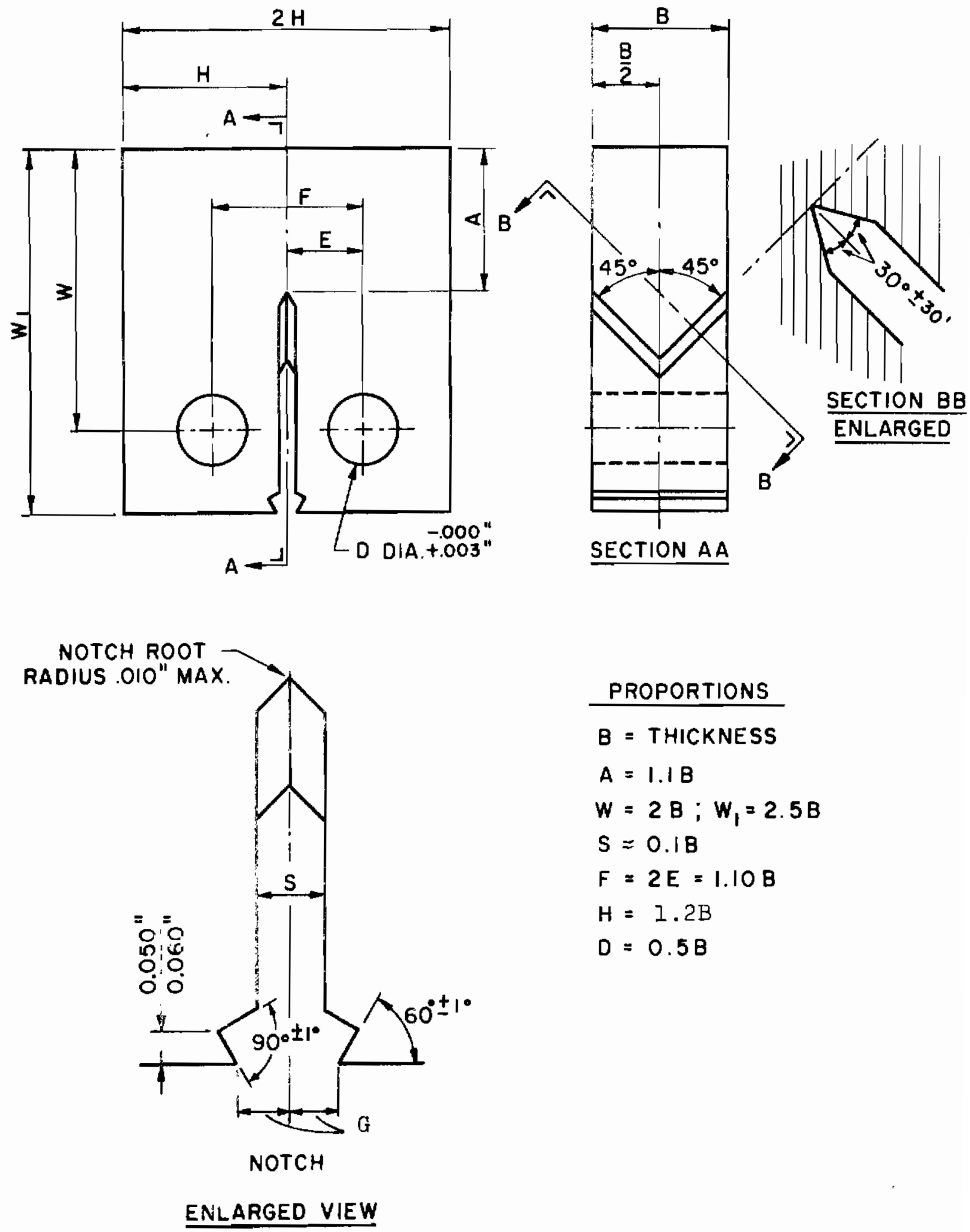

PROPORTIONS

B = THICKNESS

A = 1.1 B

W = 2 B ; W_1 = 2.5 B

S ≈ 0.1 B

F = 2E = 1.10 B

H = 1.2B

D = 0.5 B

FIG. 6 COMPACT TENSION FRACTURE TOUGHNESS SPECIMEN

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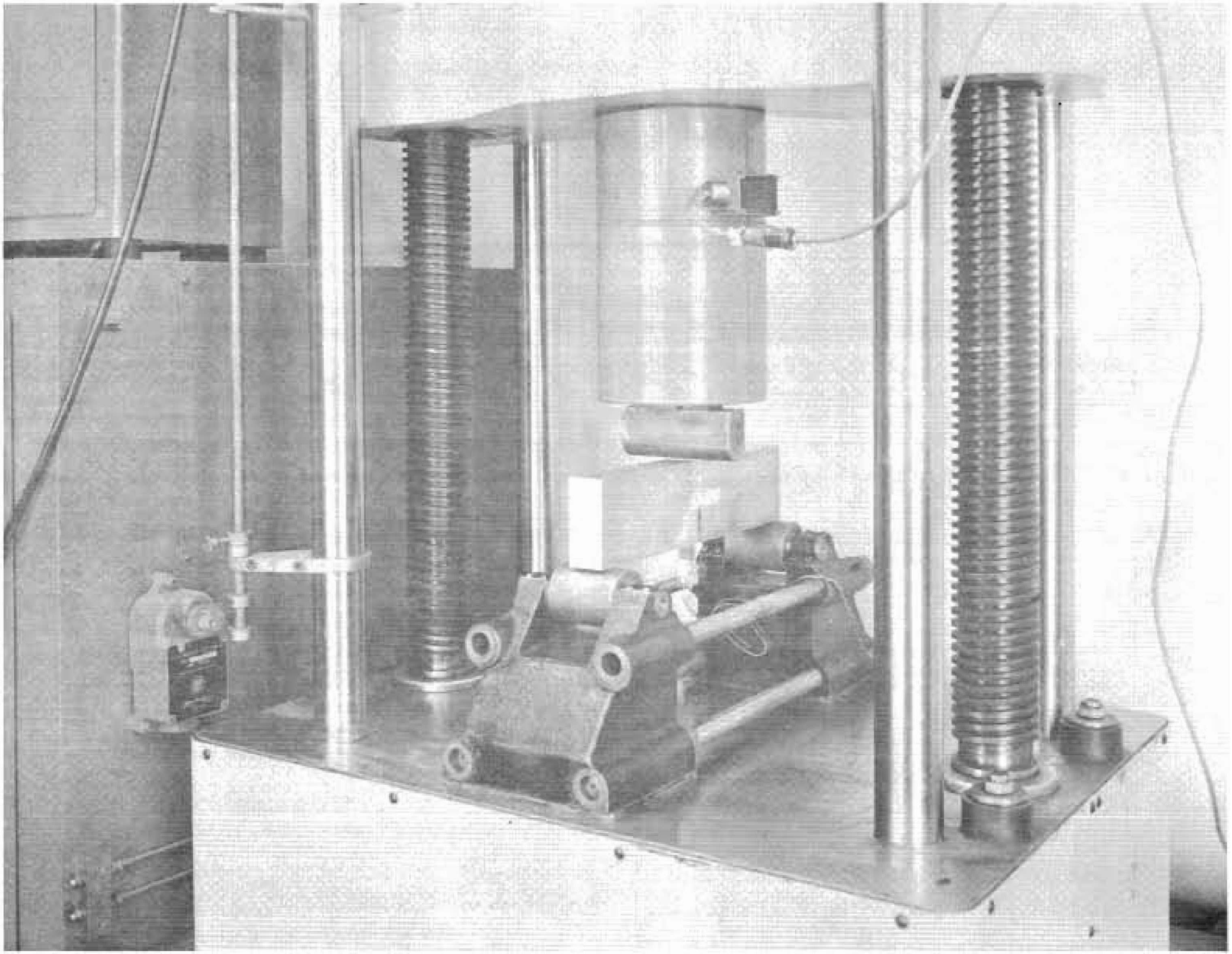

Fig. 7 Setup for Notch-Bend Fracture Toughness Test.

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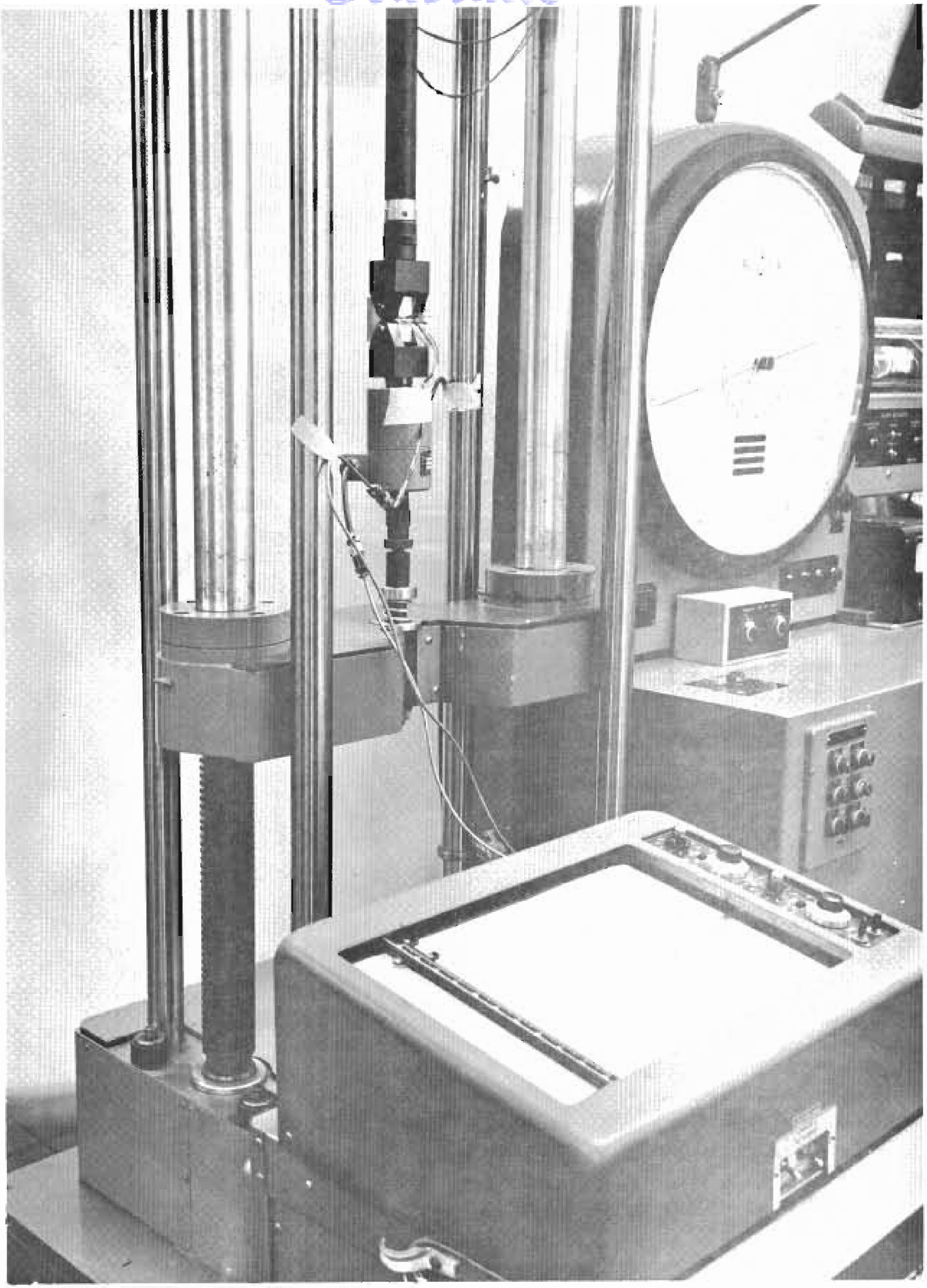

Fig. 8 Setup for Compact Tension Fracture-Toughness Test.

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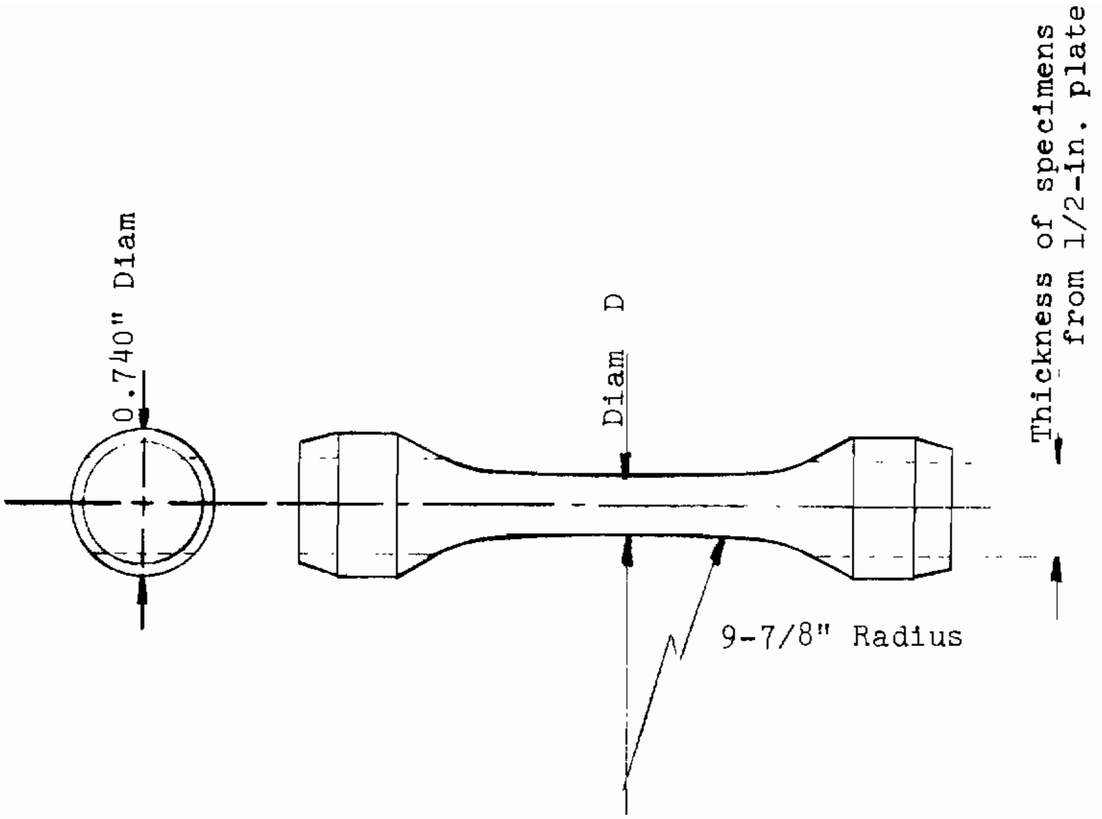

Fig. 9 Smooth Axial-Stress Fatigue Specimen.

NOTE: Specimens 0.250 in. in diameter were used to test 1/2 in. plate, and other materials at maximum stresses of 70,000 psi or higher. Specimens 0.300 in. in diameter were used for other tests.

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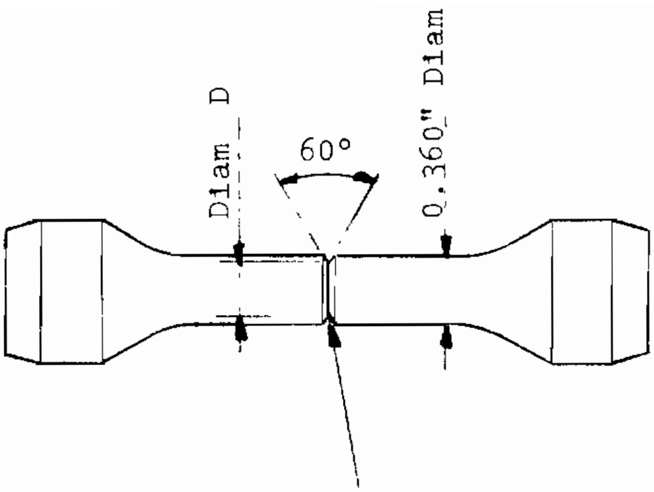

Notch Tip Radius, e

Theoretical Stress Concentration Factor, K_t	Diameter D, in.	Notch Tip Radius, e, in.
3.0	0.253	0.013
≥12	0.300	≤0.0005

Fig. 10 Notched Axial-Stress Fatigue Specimen.

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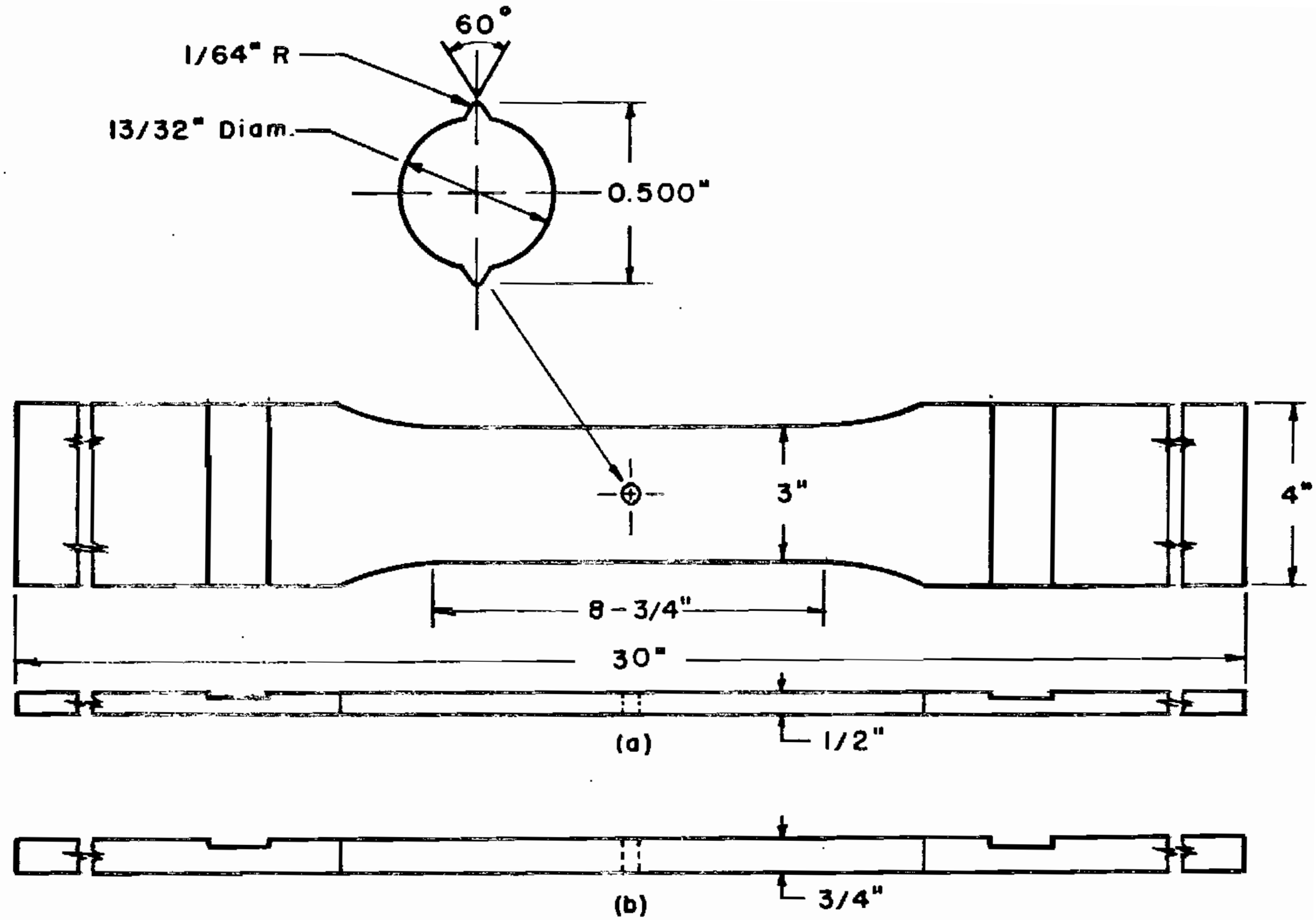

Fig. 11 **CENTER-NOTCHED FATIGUE SPECIMENS**

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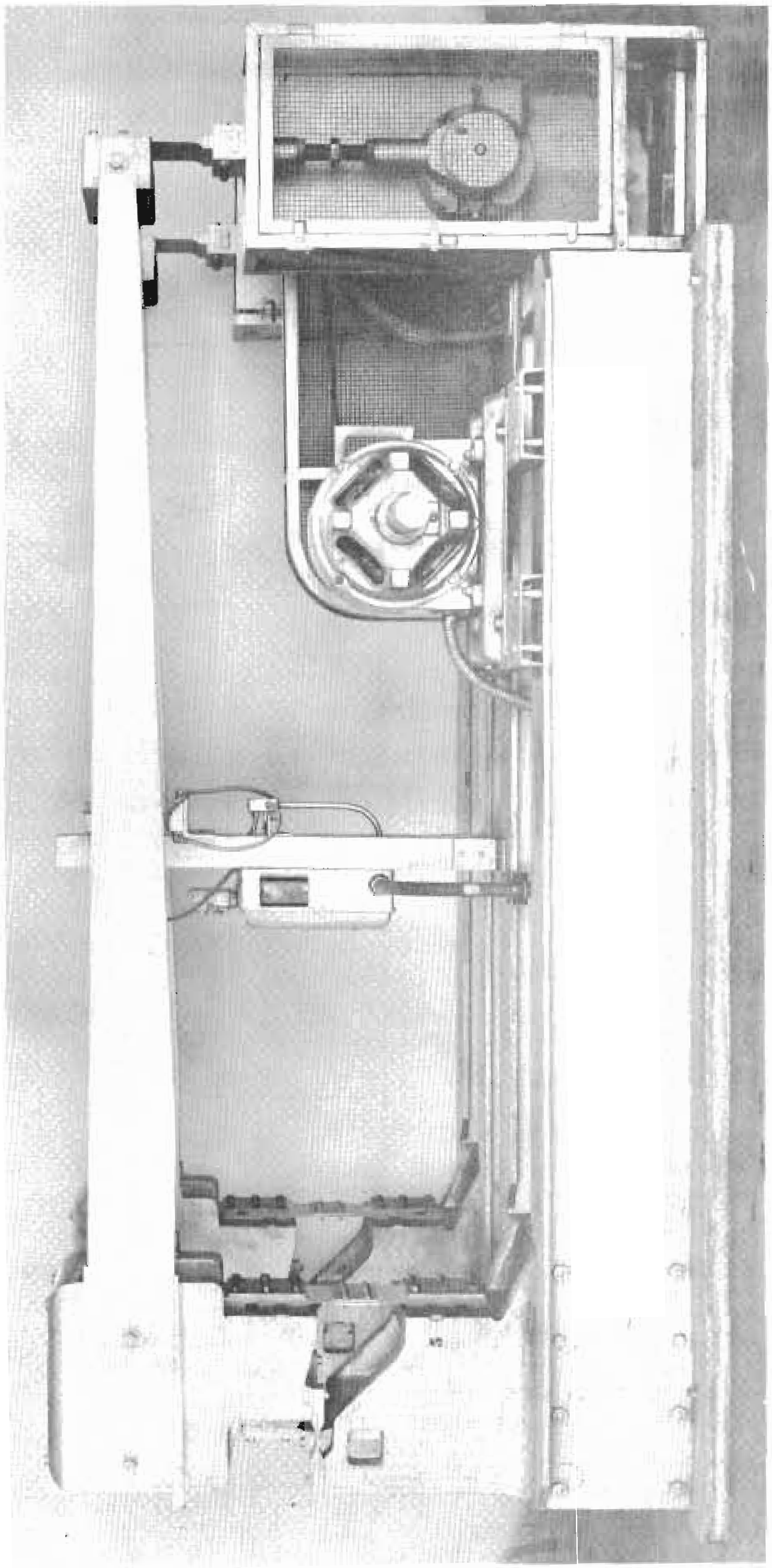

Fig. 12   50,000-lb Structural Fatigue Machine Used in Crack-Propagation Studies.

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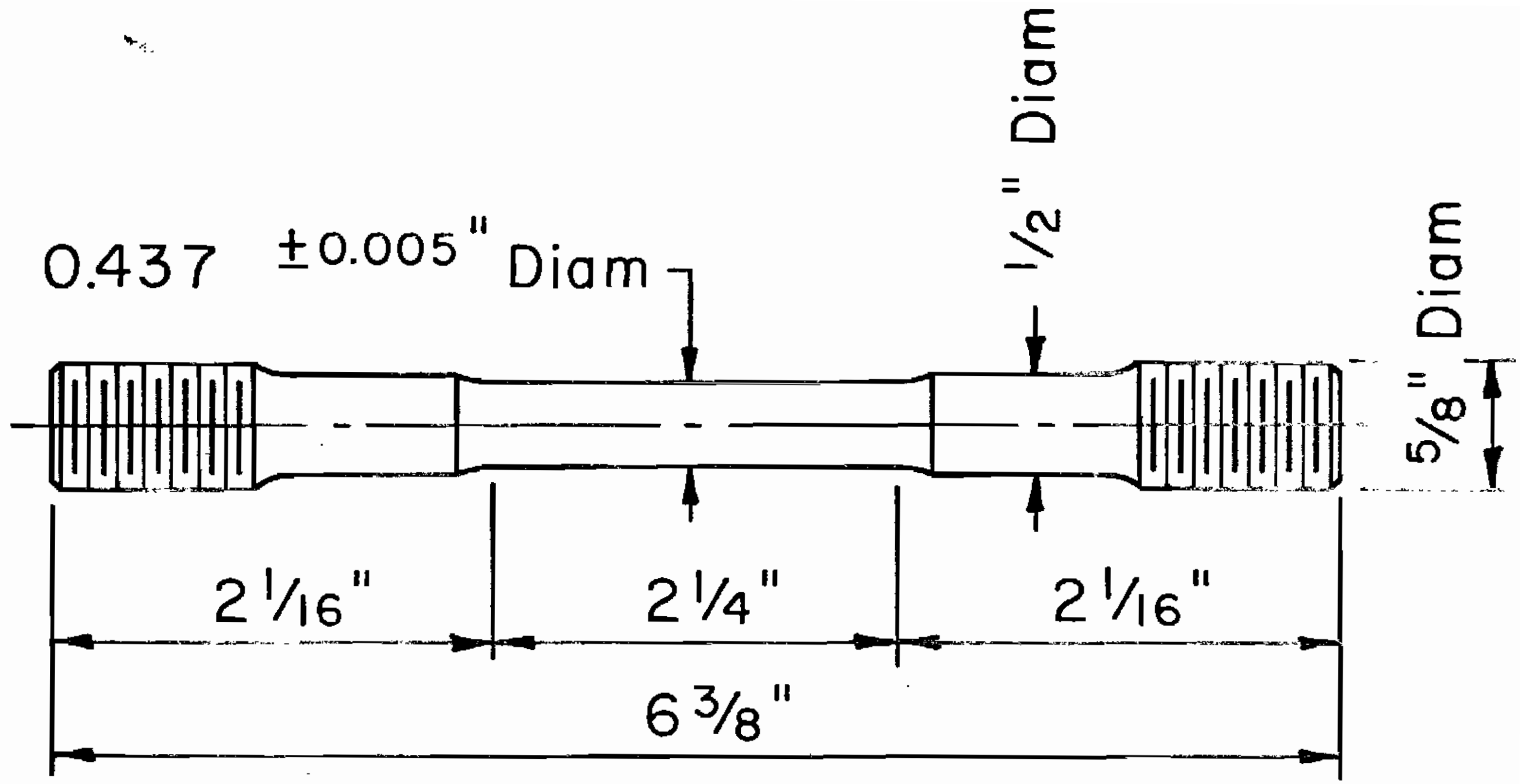

Note: Specimen from 1/2-in. plate had incomplete threads.

Fig. 13 0.437-in. Diameter Tensile Specimen for Stress Corrosion Tests.

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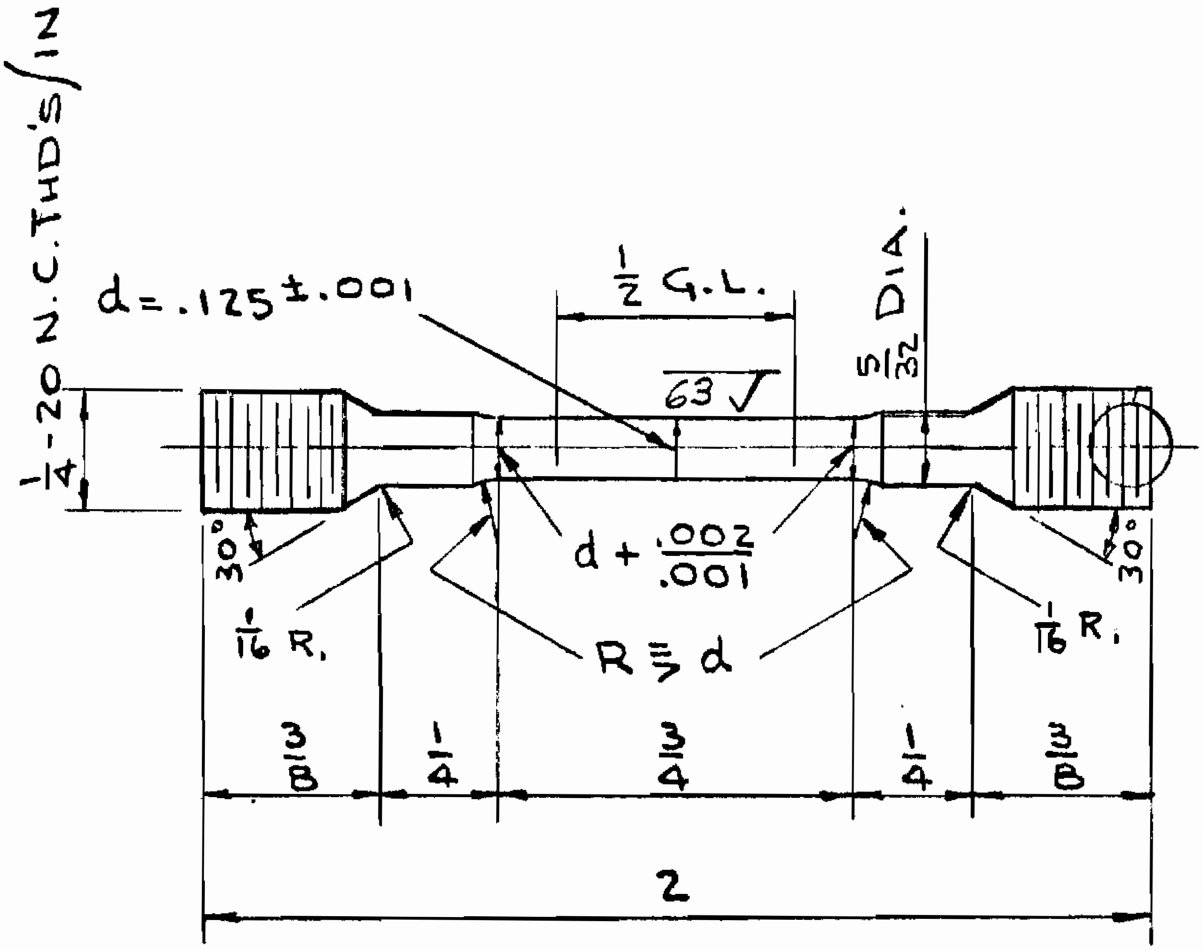

Fig. 14 0.125-in. Diameter Tensile Specimen for Stress Corrosion Tests.

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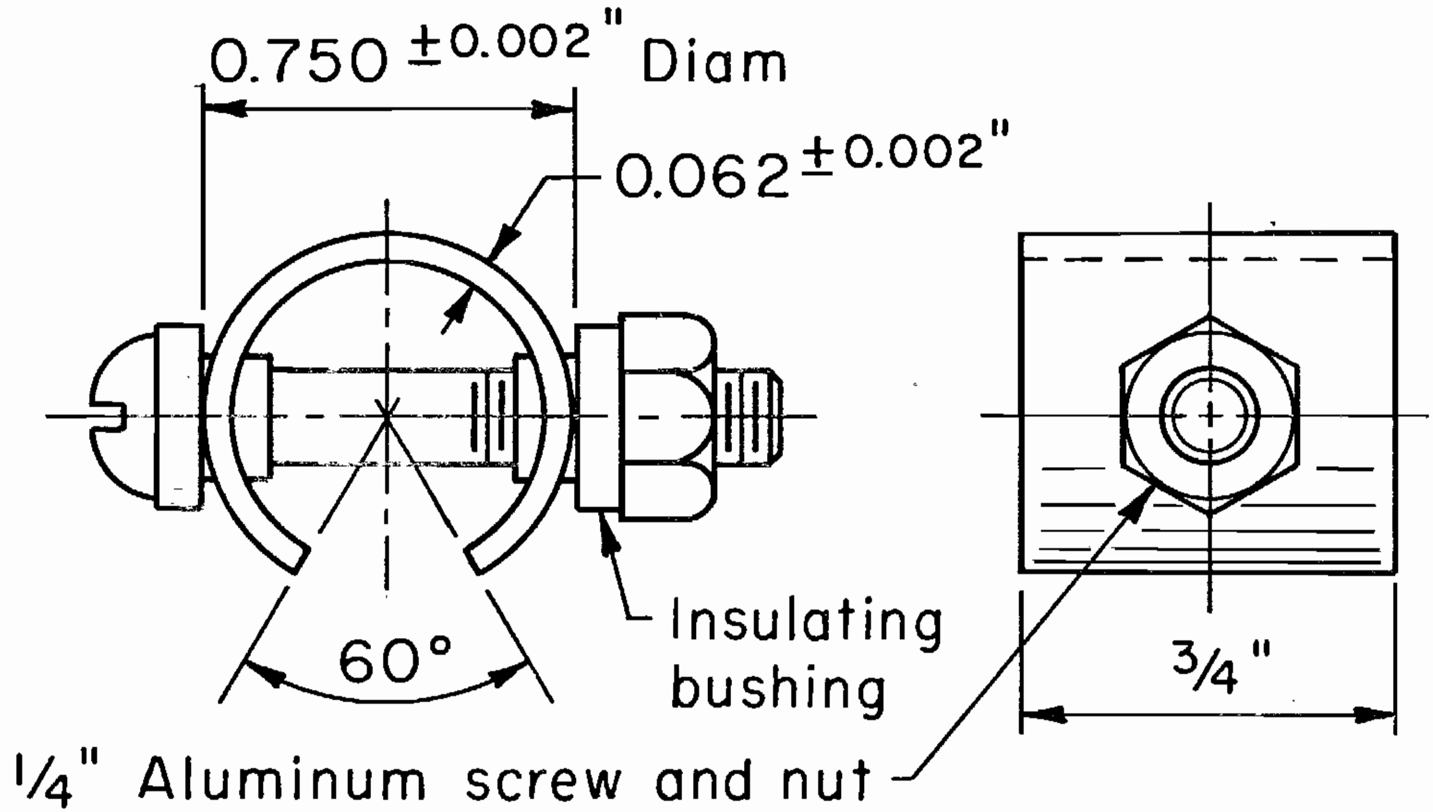

Fig. 15 C-ring Assembly for Short-Transverse Stress Corrosion Tests.

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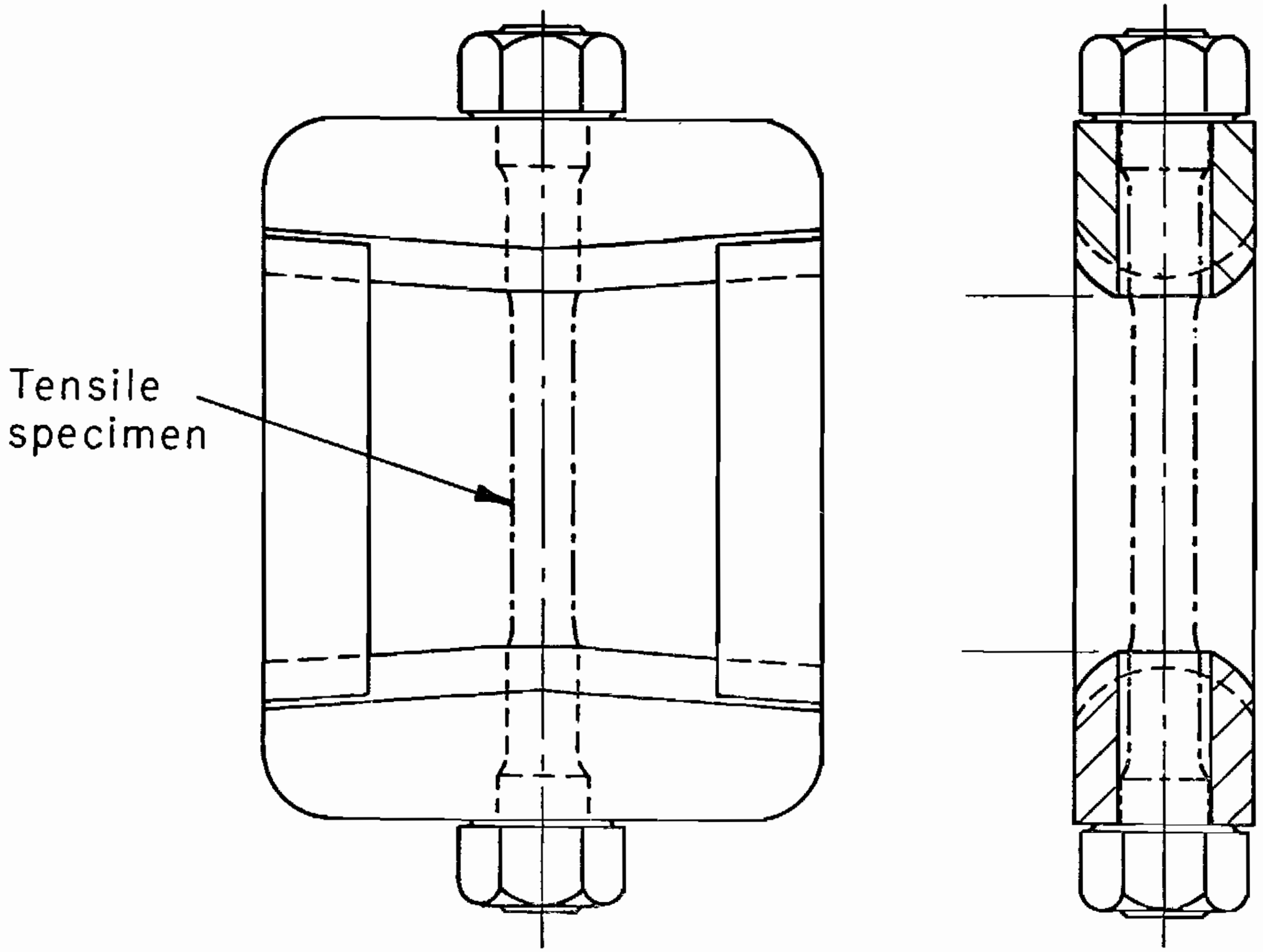

Fig. 16 Stressing Frame for Stress Corrosion Tests of Tensile Specimens.

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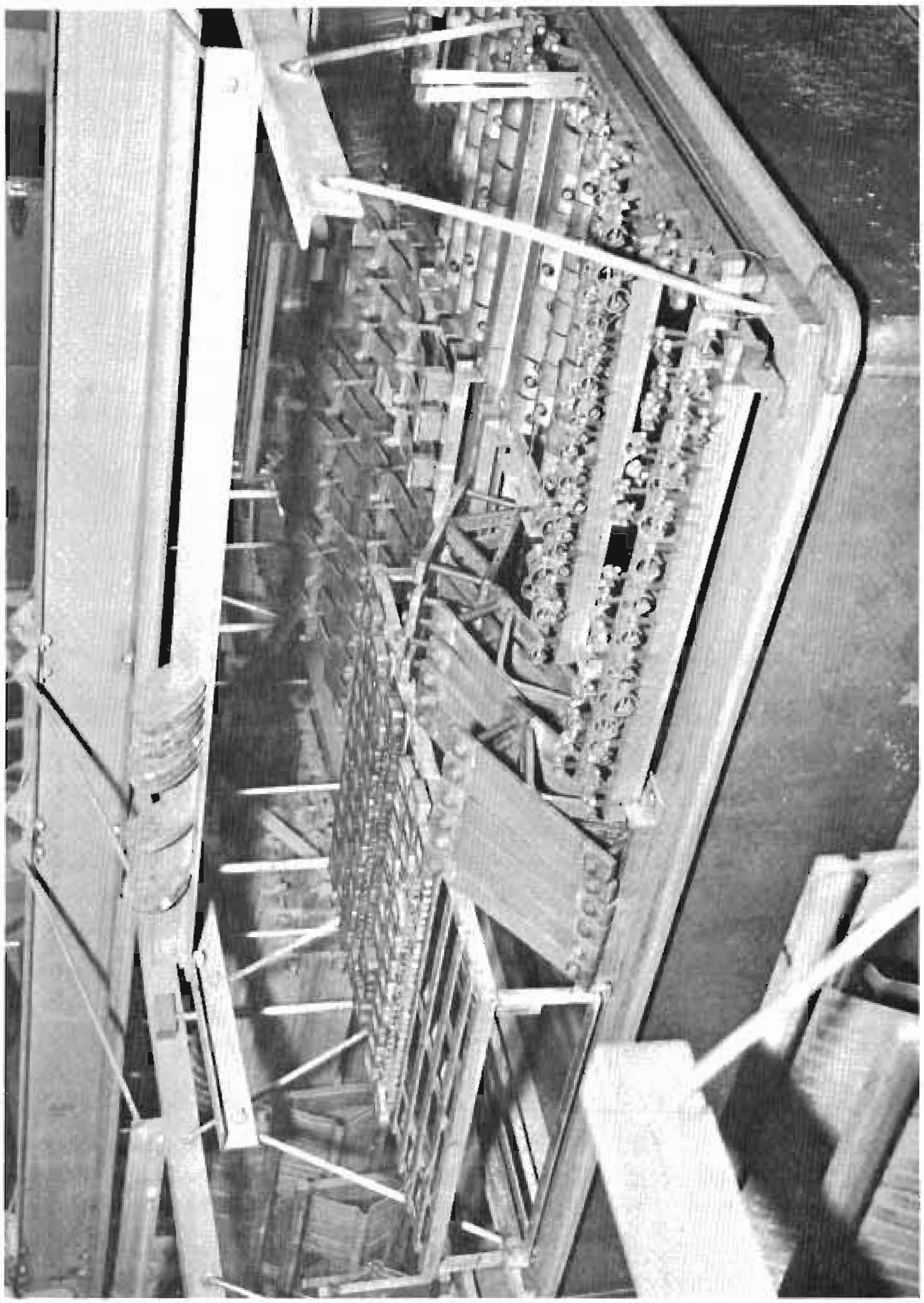

Fig. 17 Equipment for Alternate-Immersion Corrosion Tests.

Fig. 17

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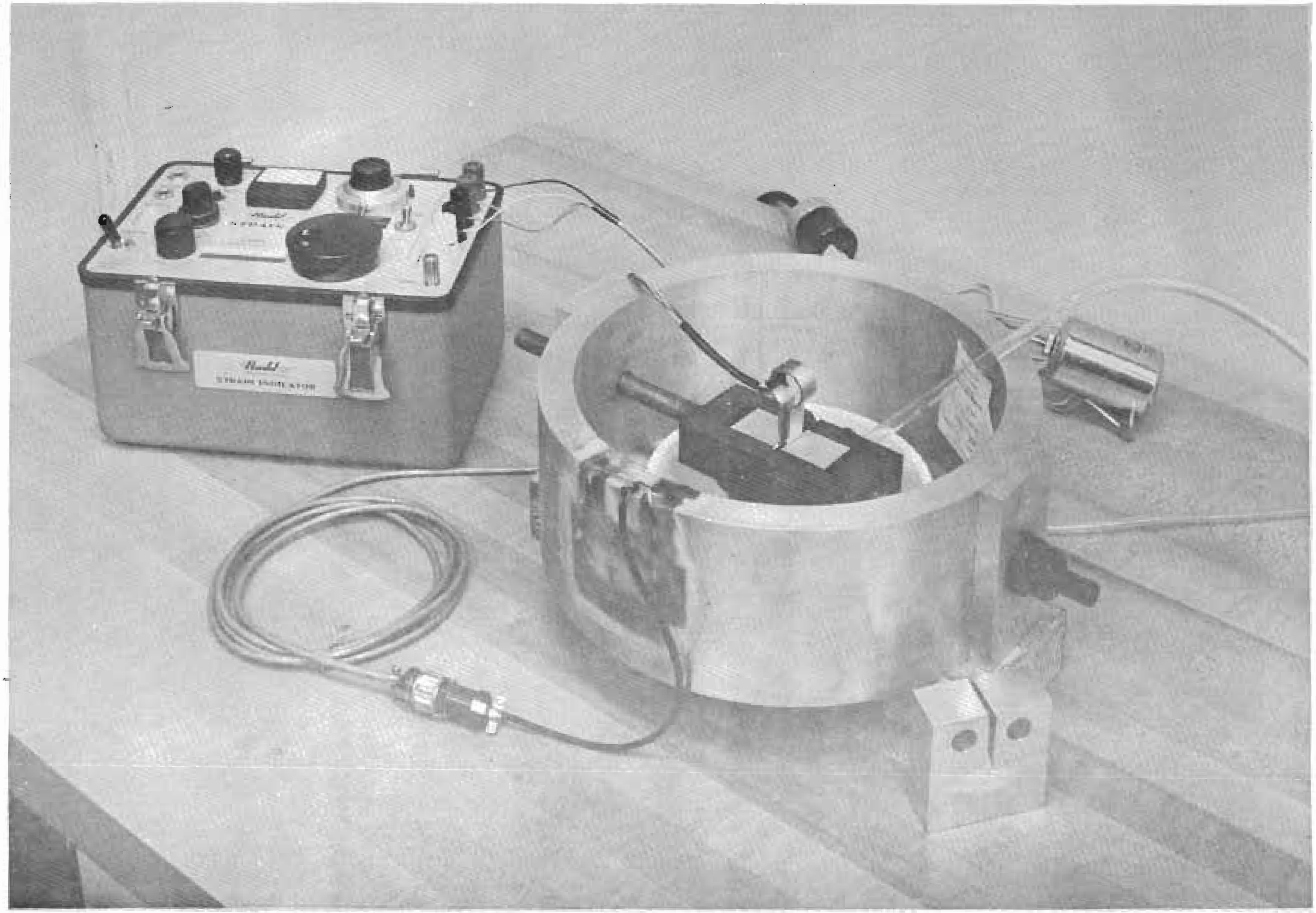

Fig. 18 Ring-Type Loading Applied to Compact Tension Specimens to Evaluate Stress-Corrosion Resistance by a Fracture-Mechanics Approach.

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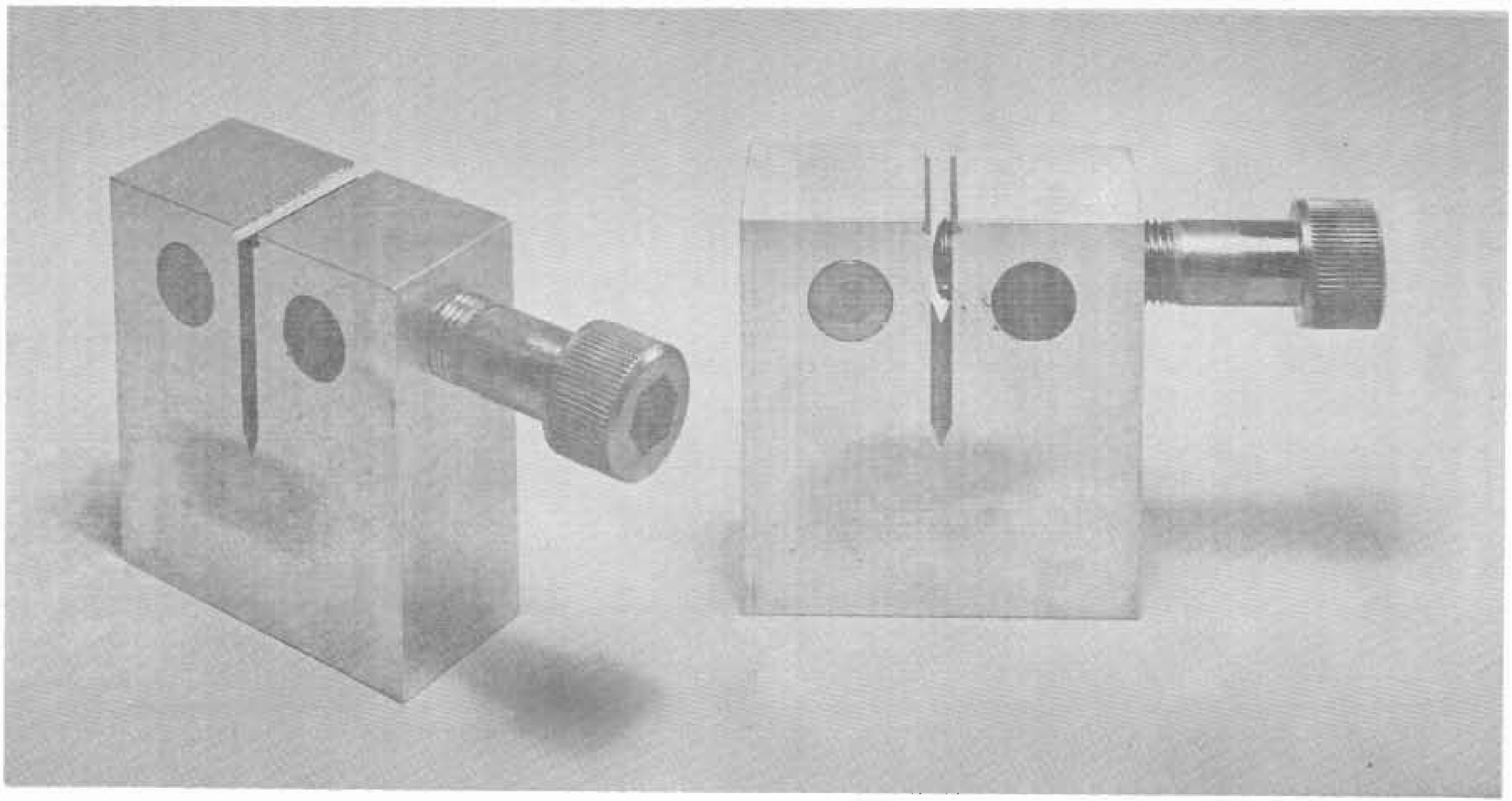

Fig. 19 Self-Loaded (Bolt-Type Loading) Compact Tension Specimen Used to Evaluate Stress-Corrosion Resistance by a Fracture-Mechanics Approach.

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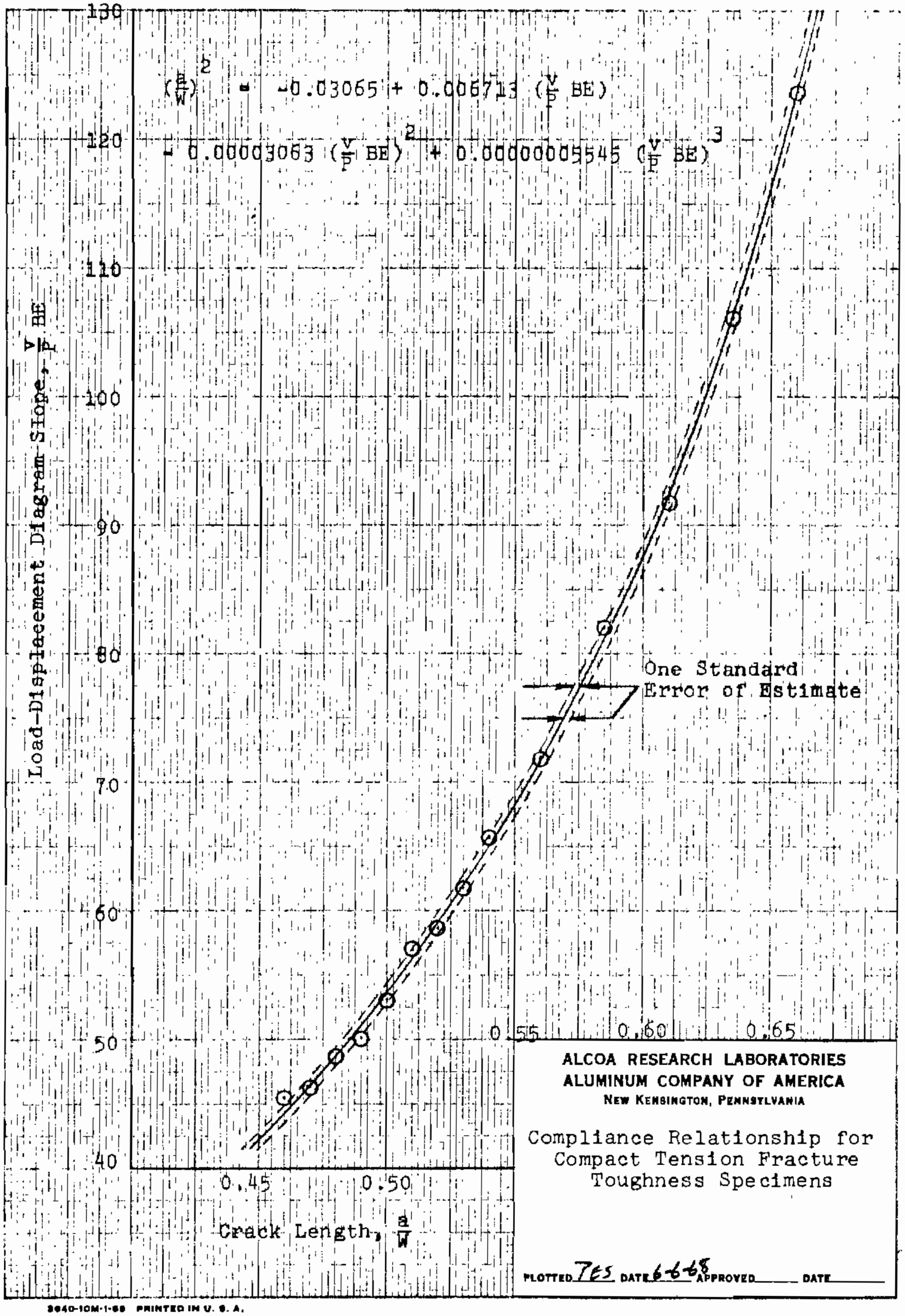

Fig. 20

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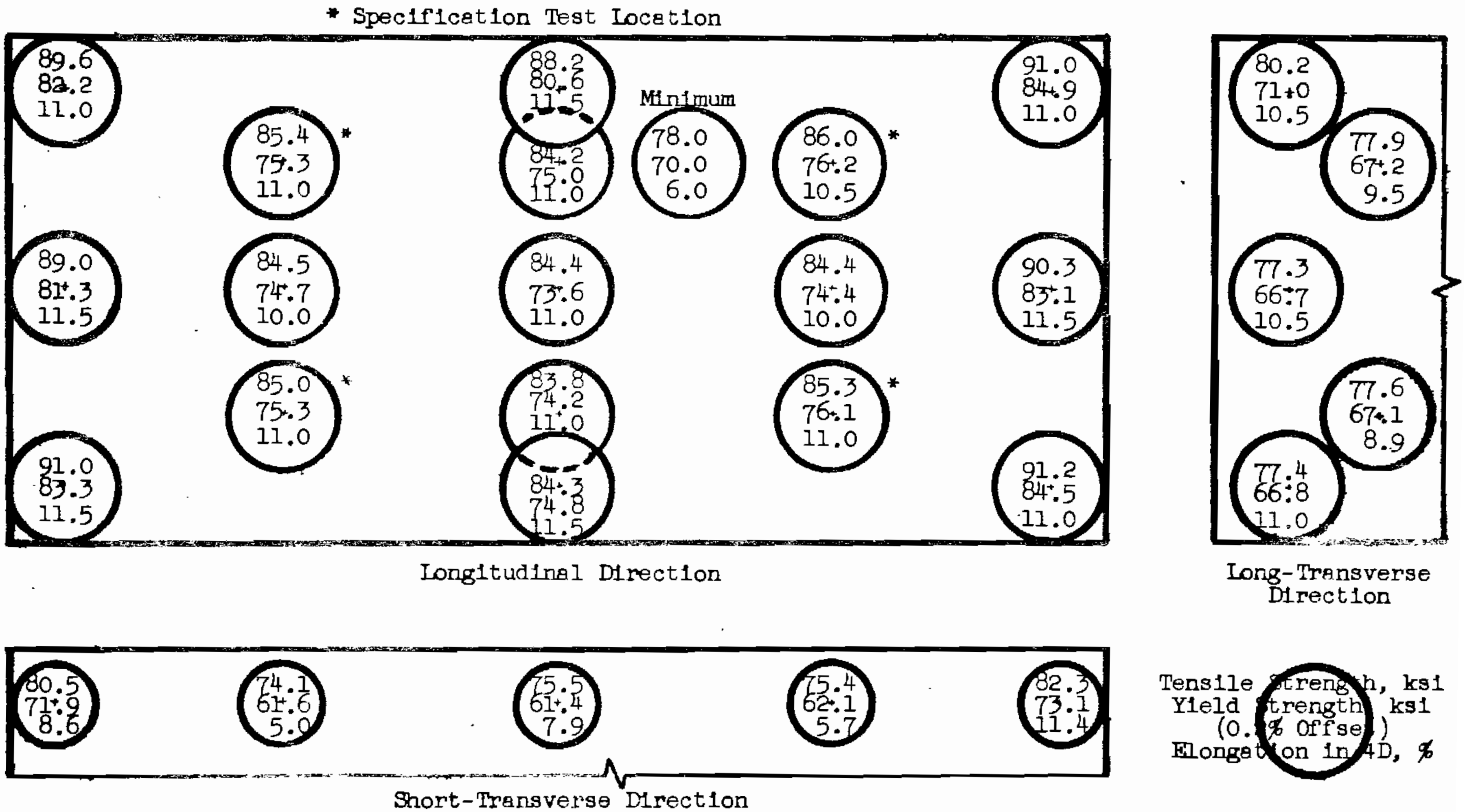

Fig. 21 Tensile Properties At Various Locations Within 7075-T6510 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340619).

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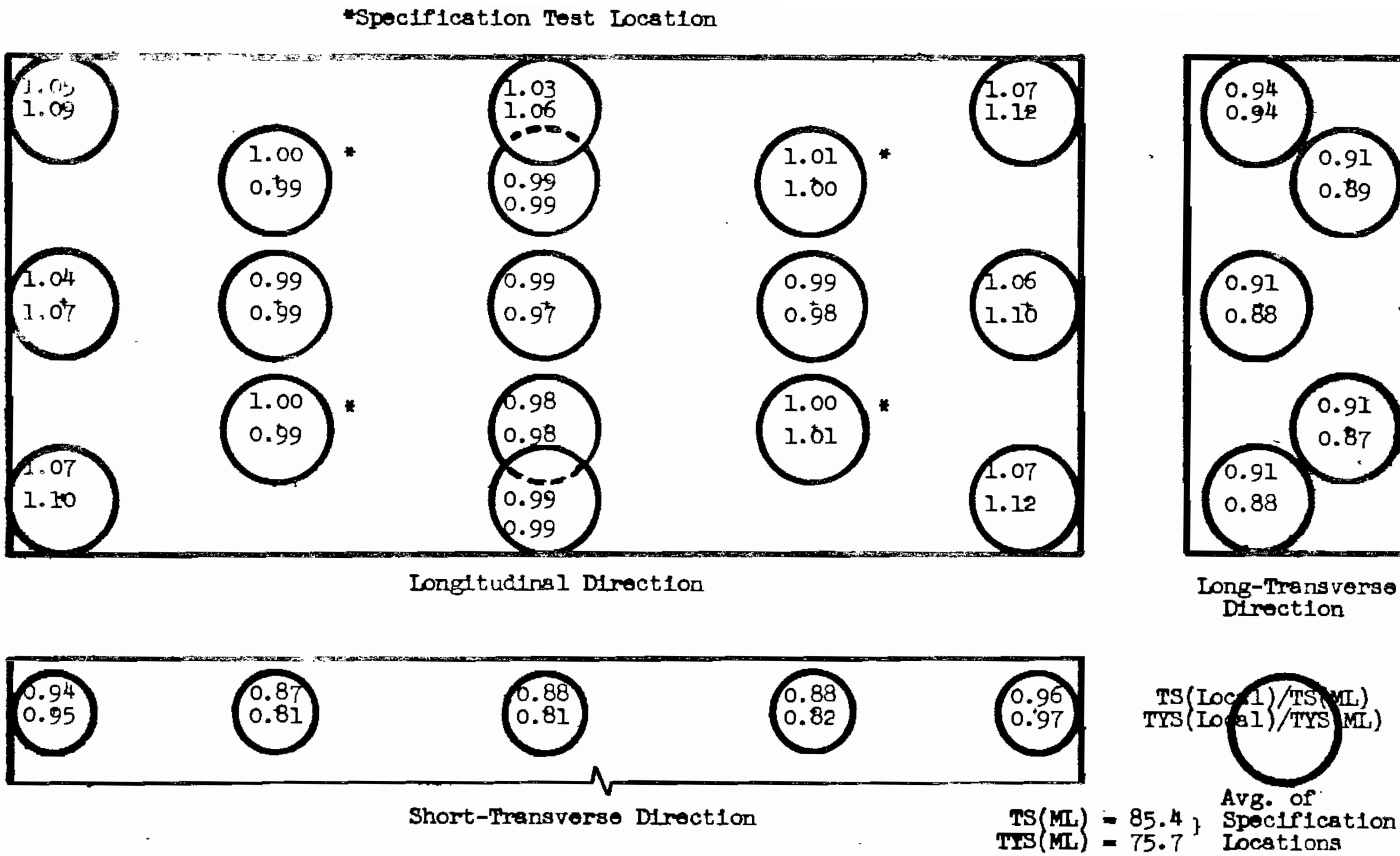

Fig. 22 Relationships Among the Tensile Properties at Various Locations Within A 7075-T6510 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340619).

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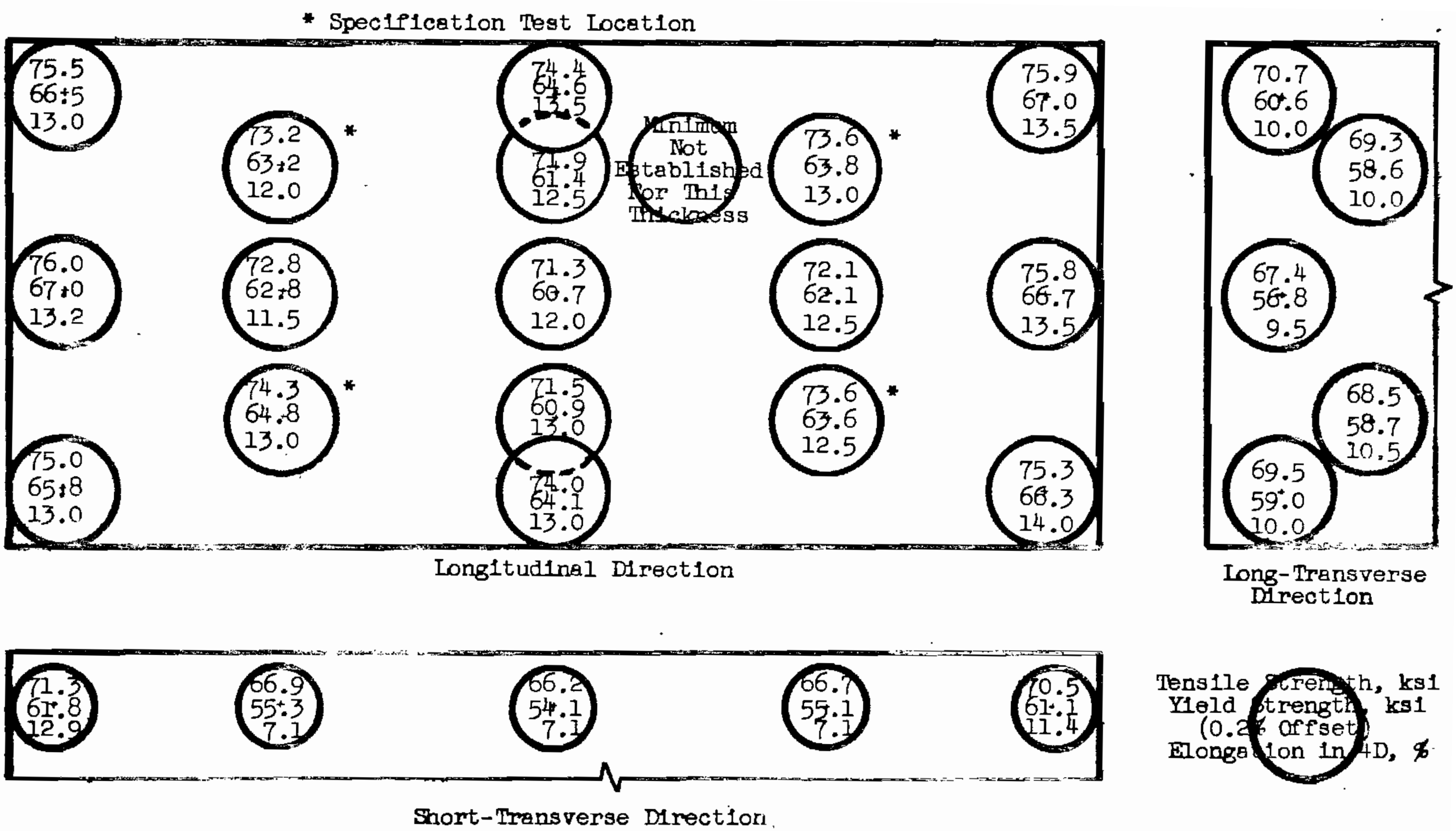

Fig. 23 Tensile Properties at Various Locations Within 7075-T73510 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340620)

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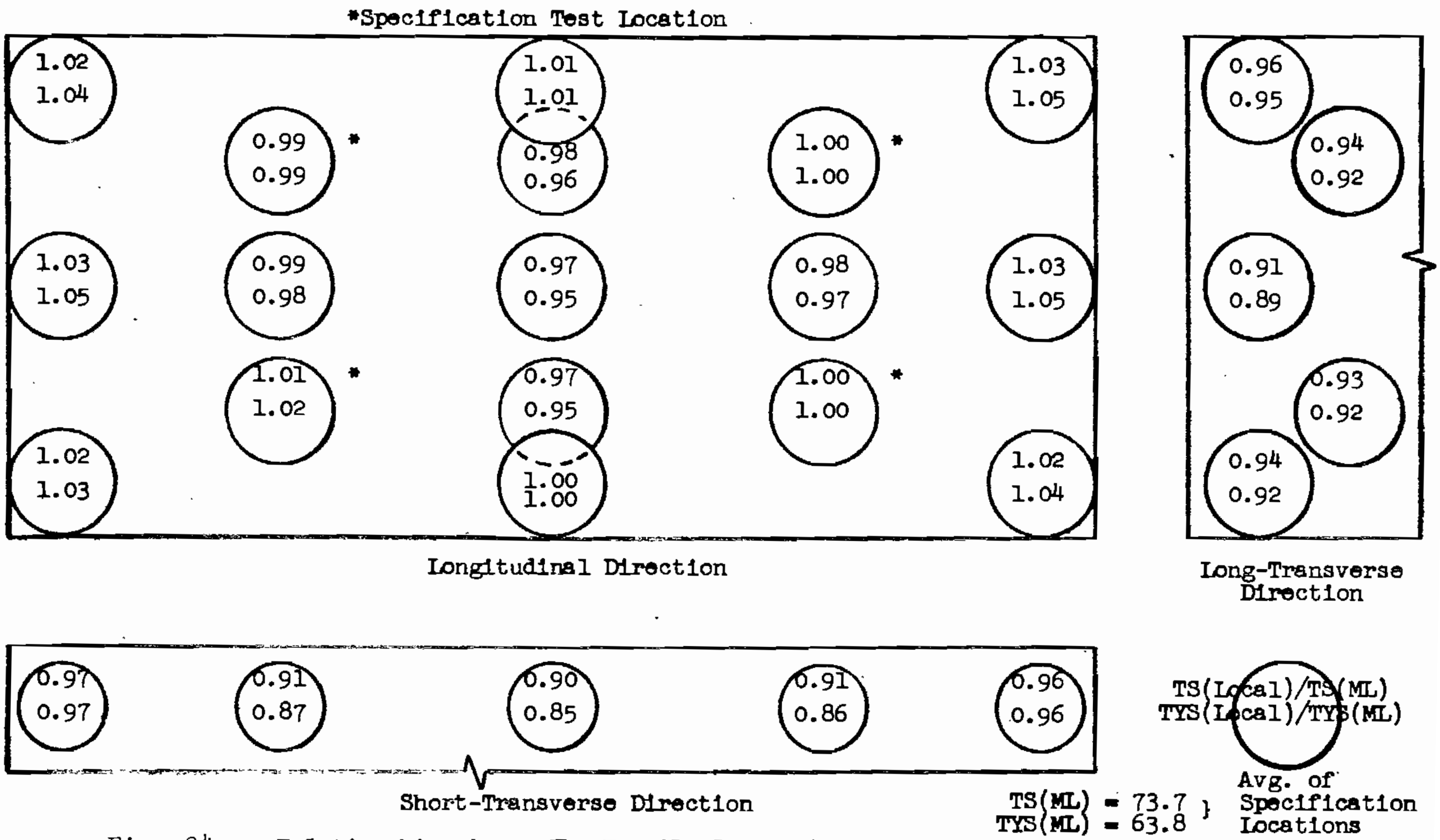

Fig. 24 Relationships Among The Tensile Properties at Various Locations Within 7075-T73510 Extruded 3-1/2x7-1/2 in. Bar (S. No. 340620).

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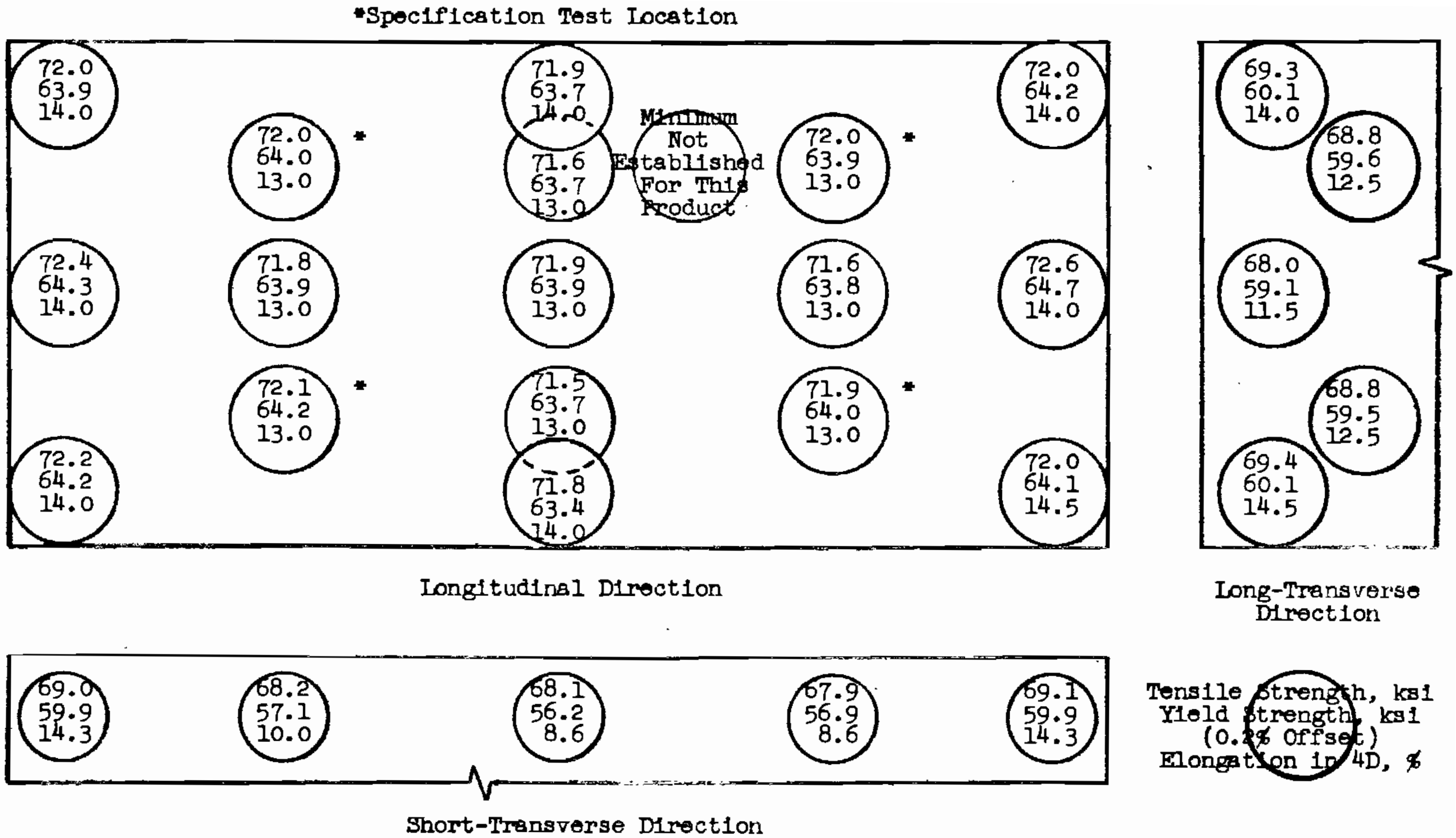

Fig. 25 Tensile Properties at Various Locations Within X7080-T7E42 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340732A).

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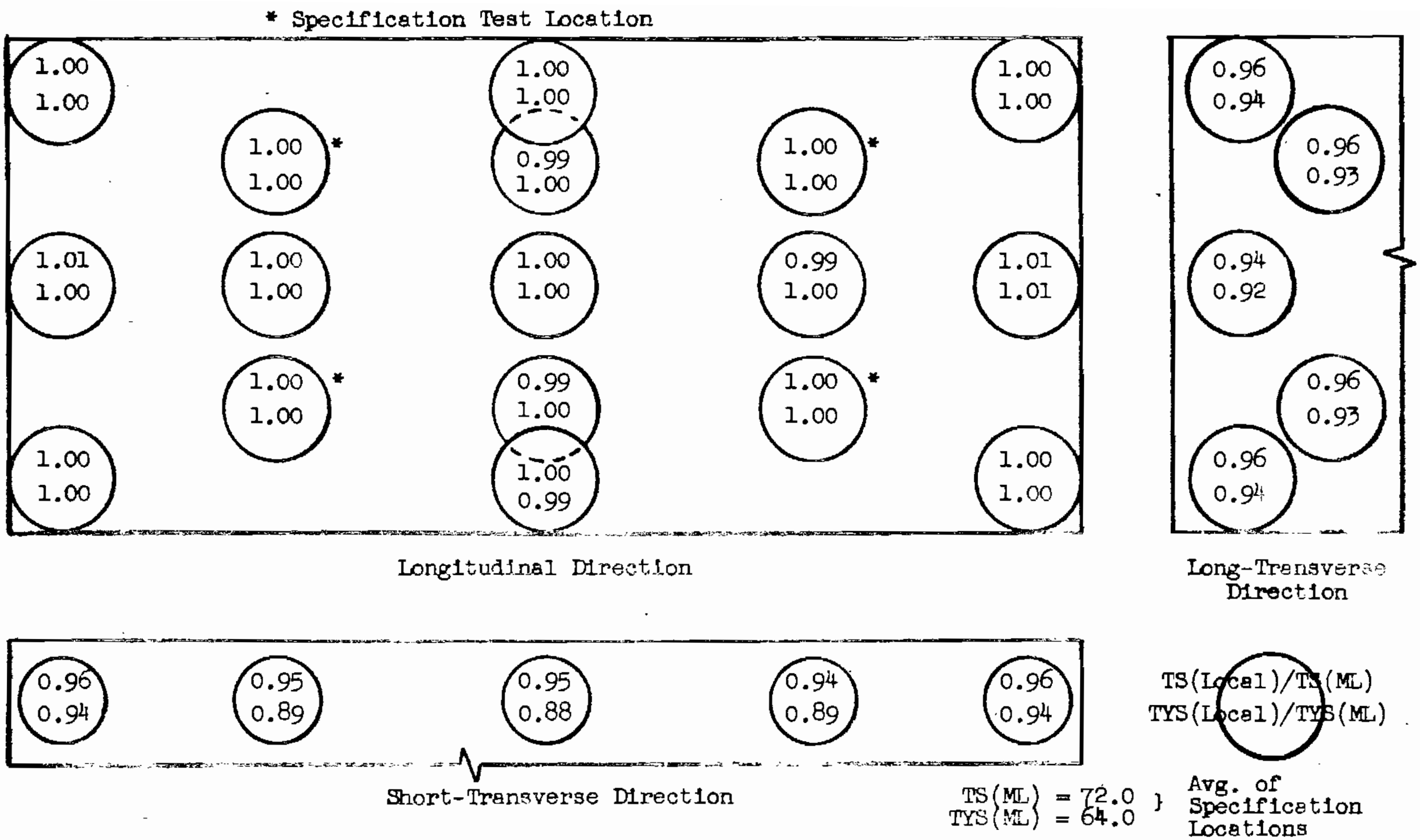

Fig. 26 Relationships Among the Tensile Properties at Various Locations Within X7080-T7E42 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340732A).

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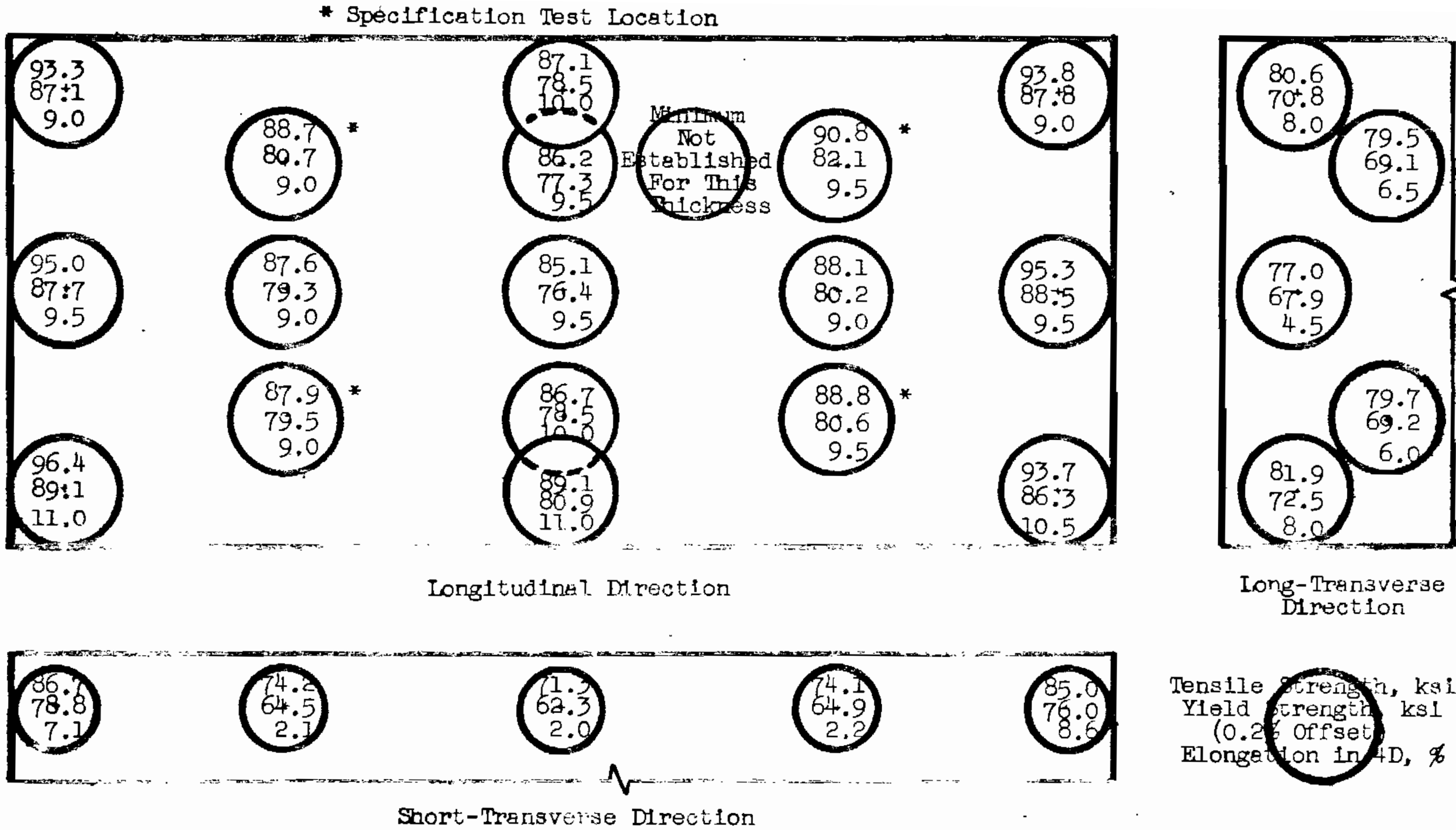

Fig. 27 Tensile Properties at Various Locations Within 7178-T6510 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340635).

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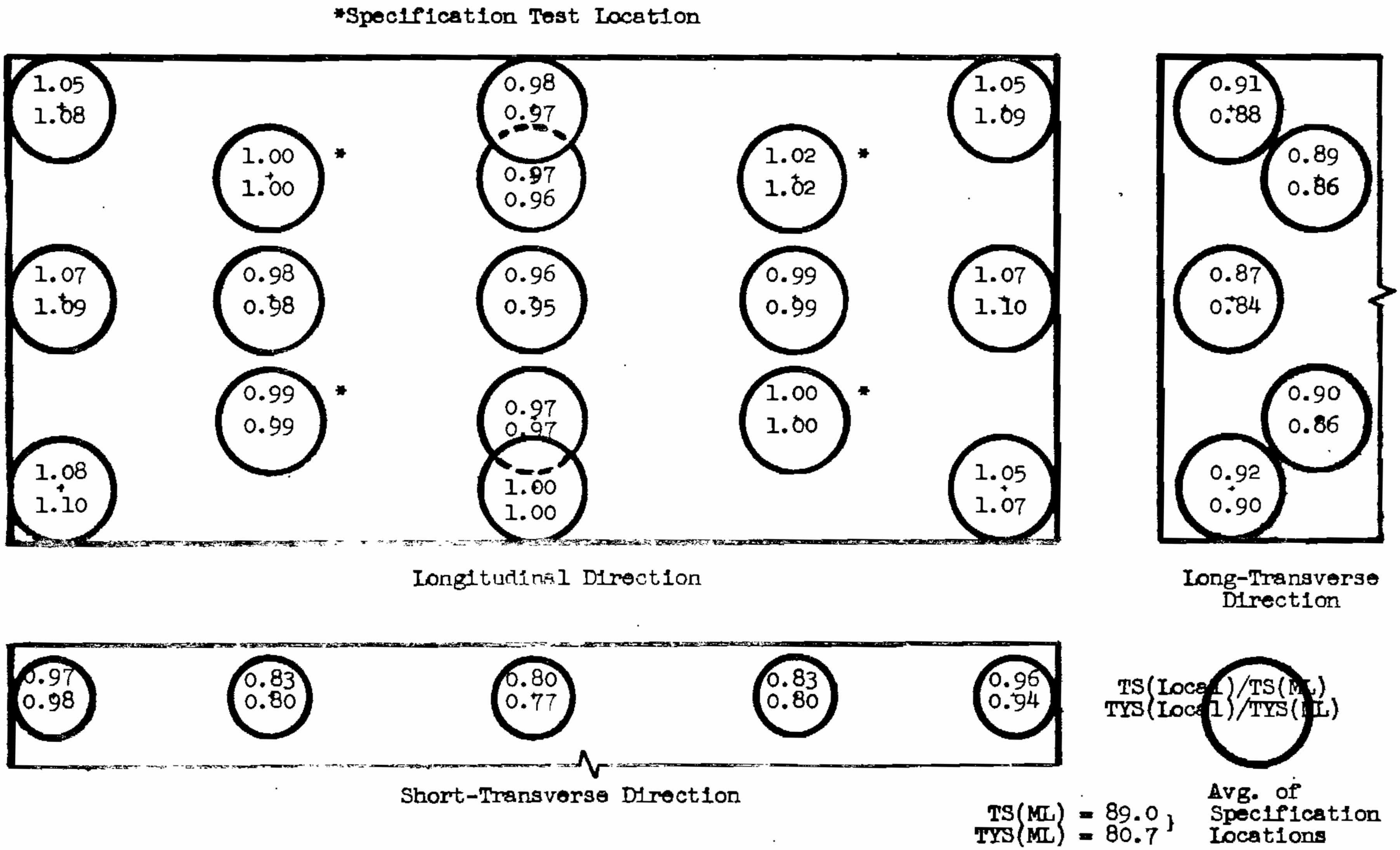

Fig. 28 Relationships Among The Tensile Properties At Various Locations Within 7178-T6510 Extruded 3-1/2x7-1/2-in. Bar (S. No. 340635).

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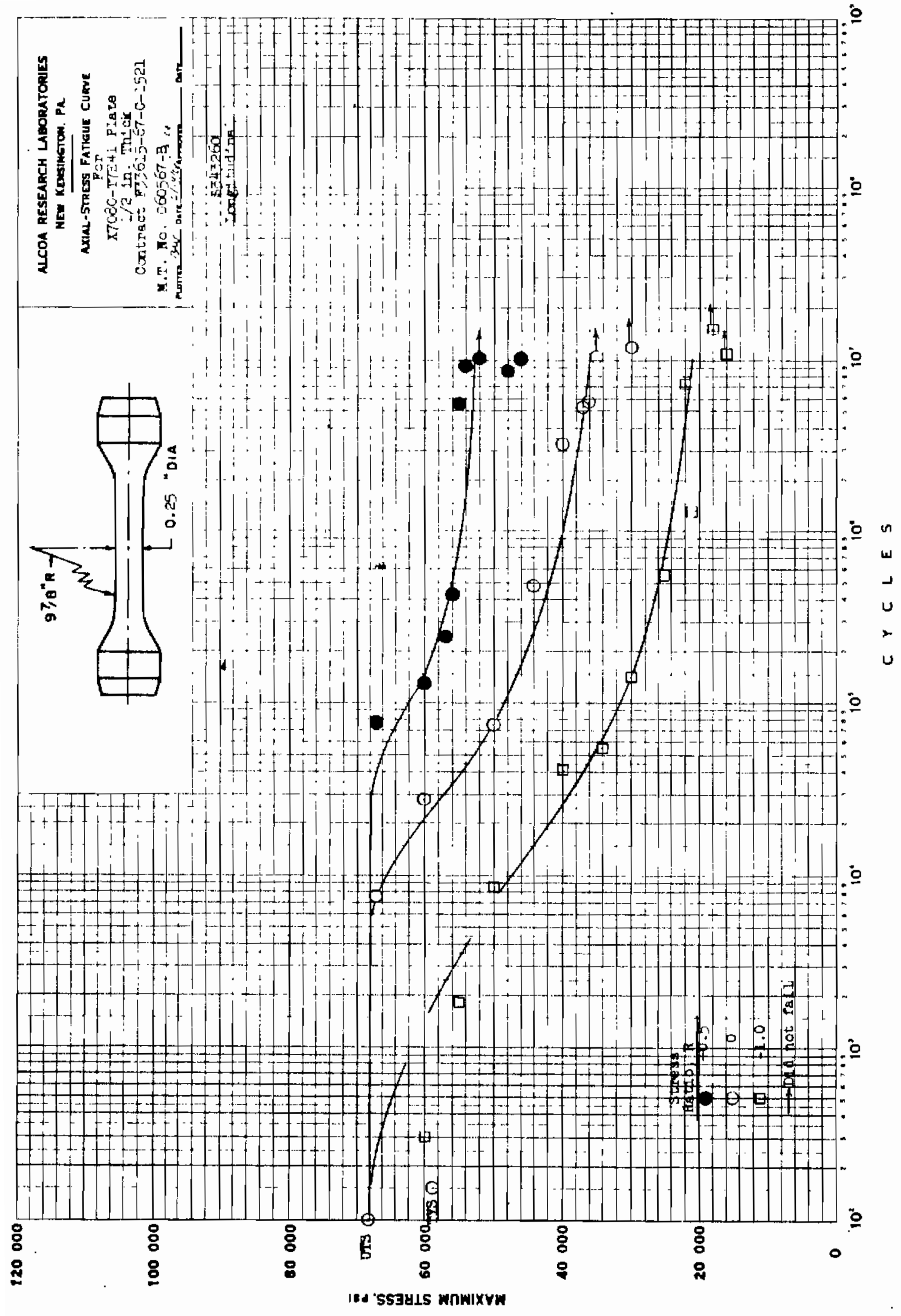

Fig. 29

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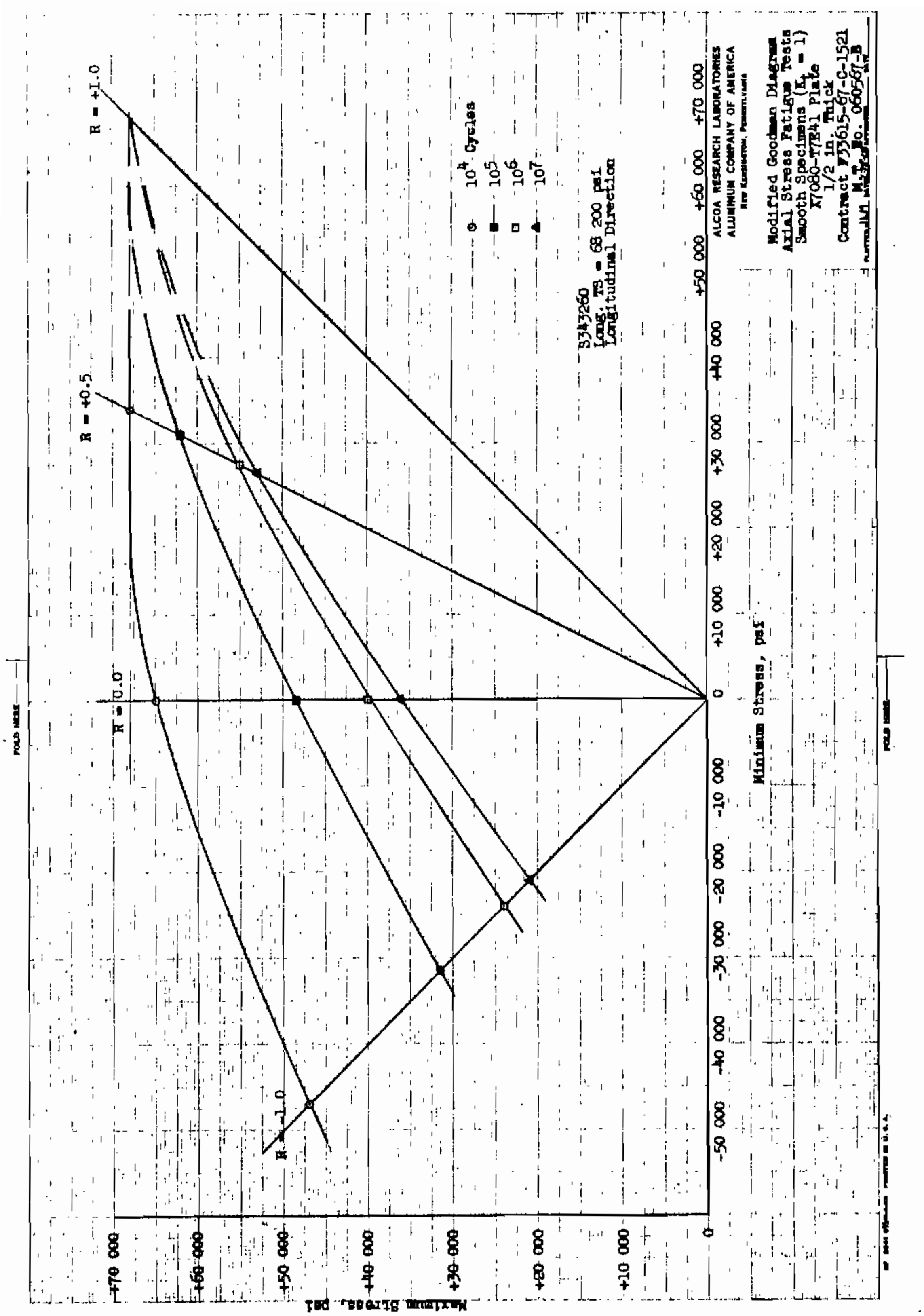

Fig. 30

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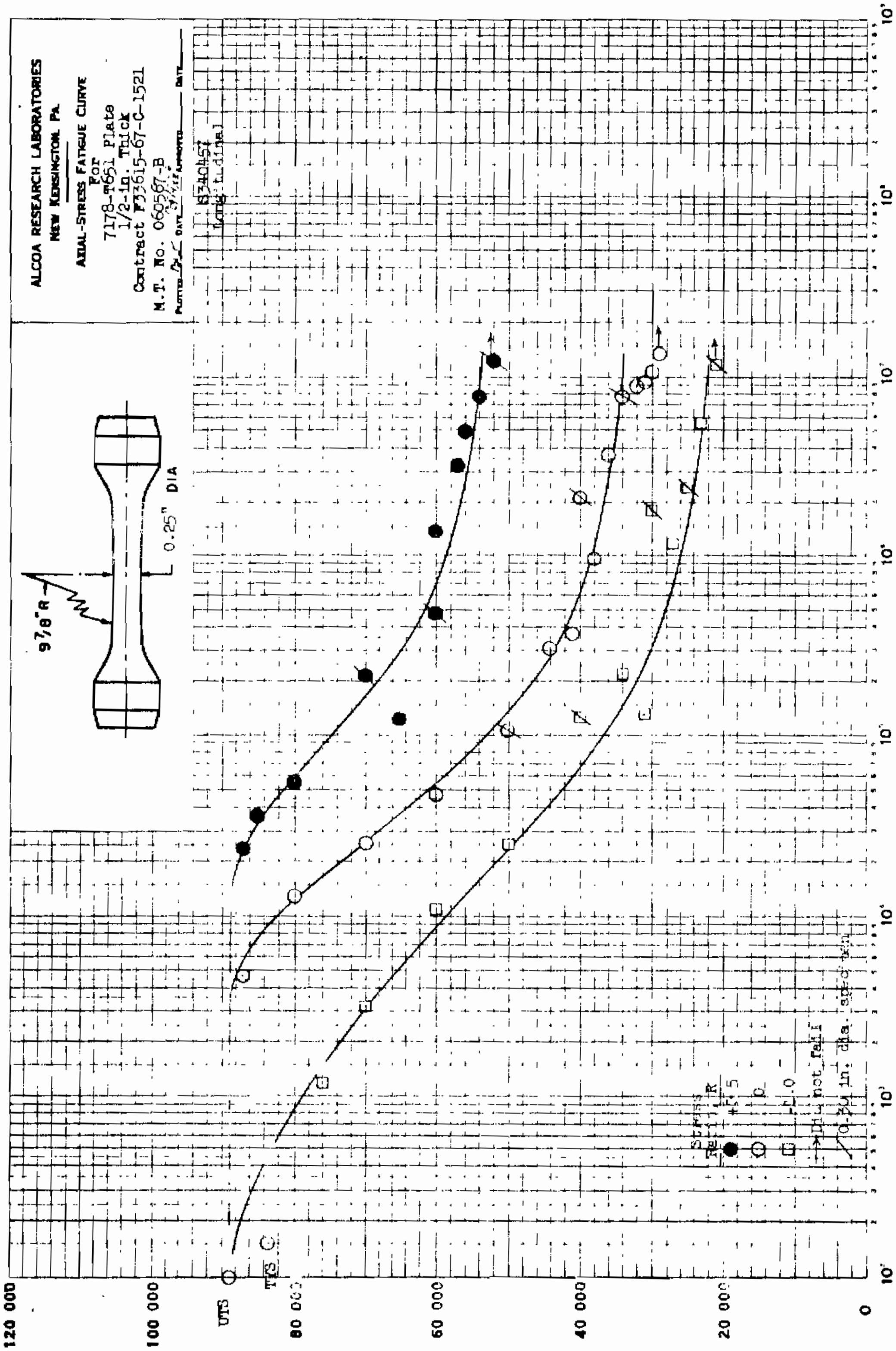

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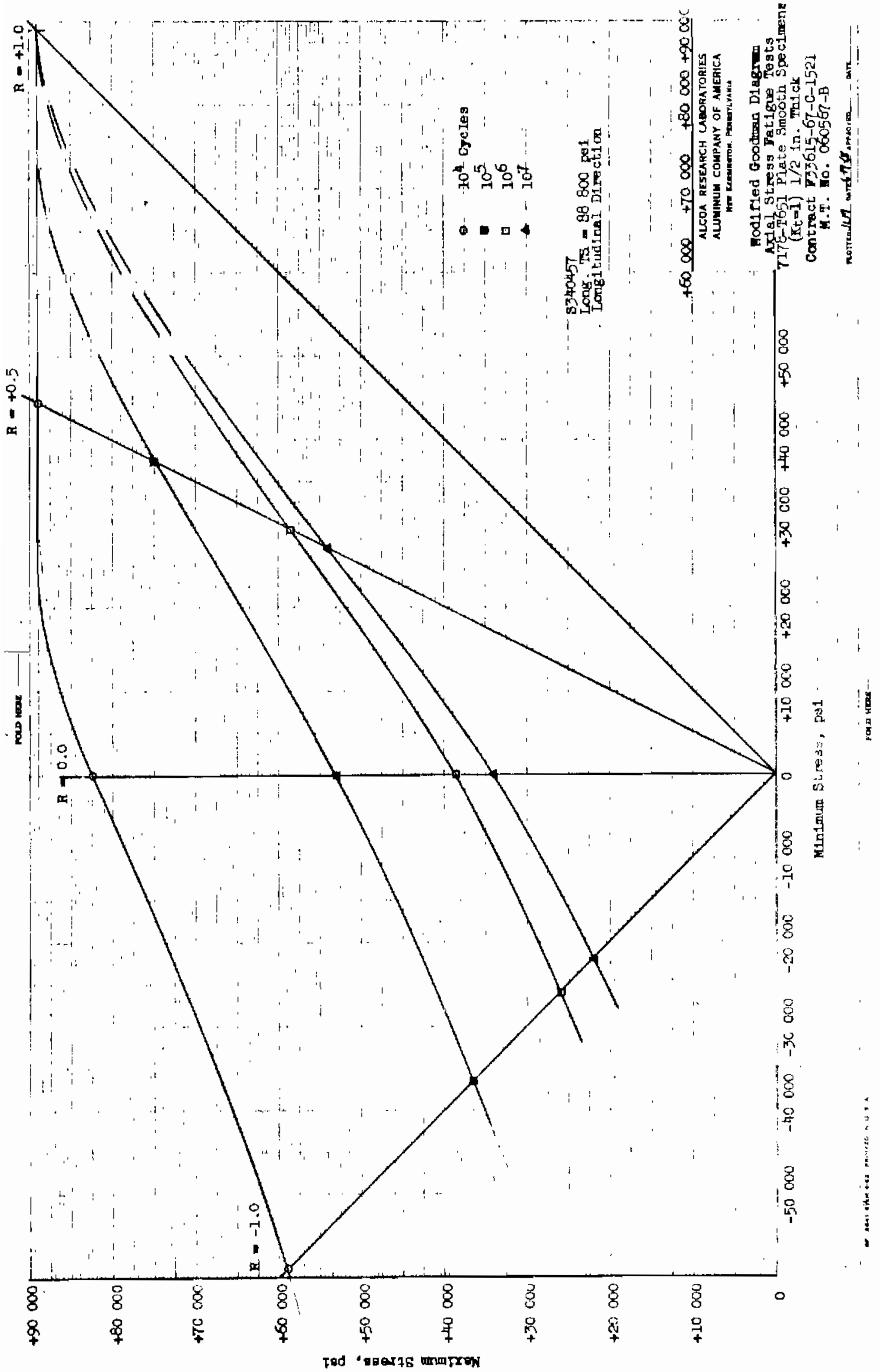

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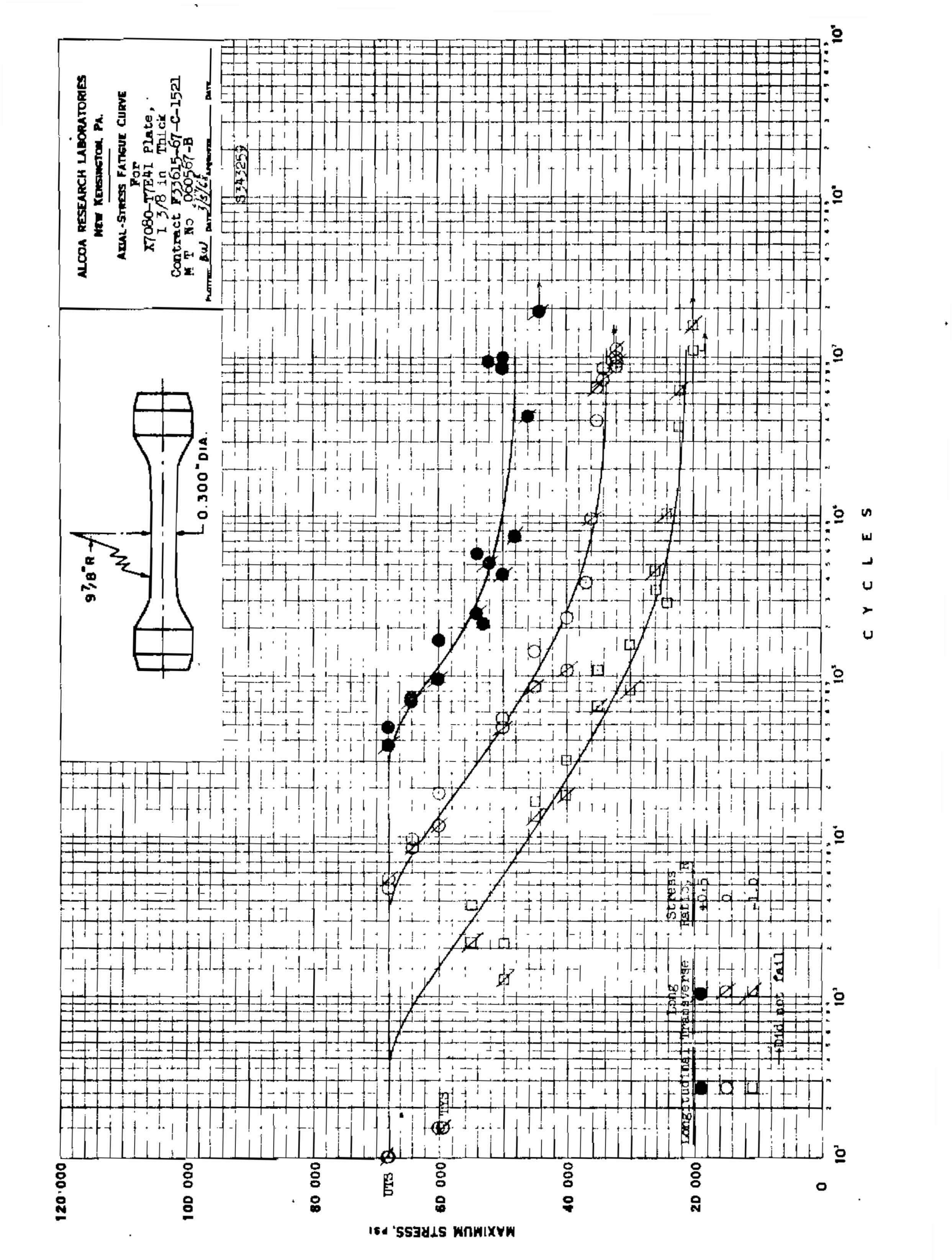

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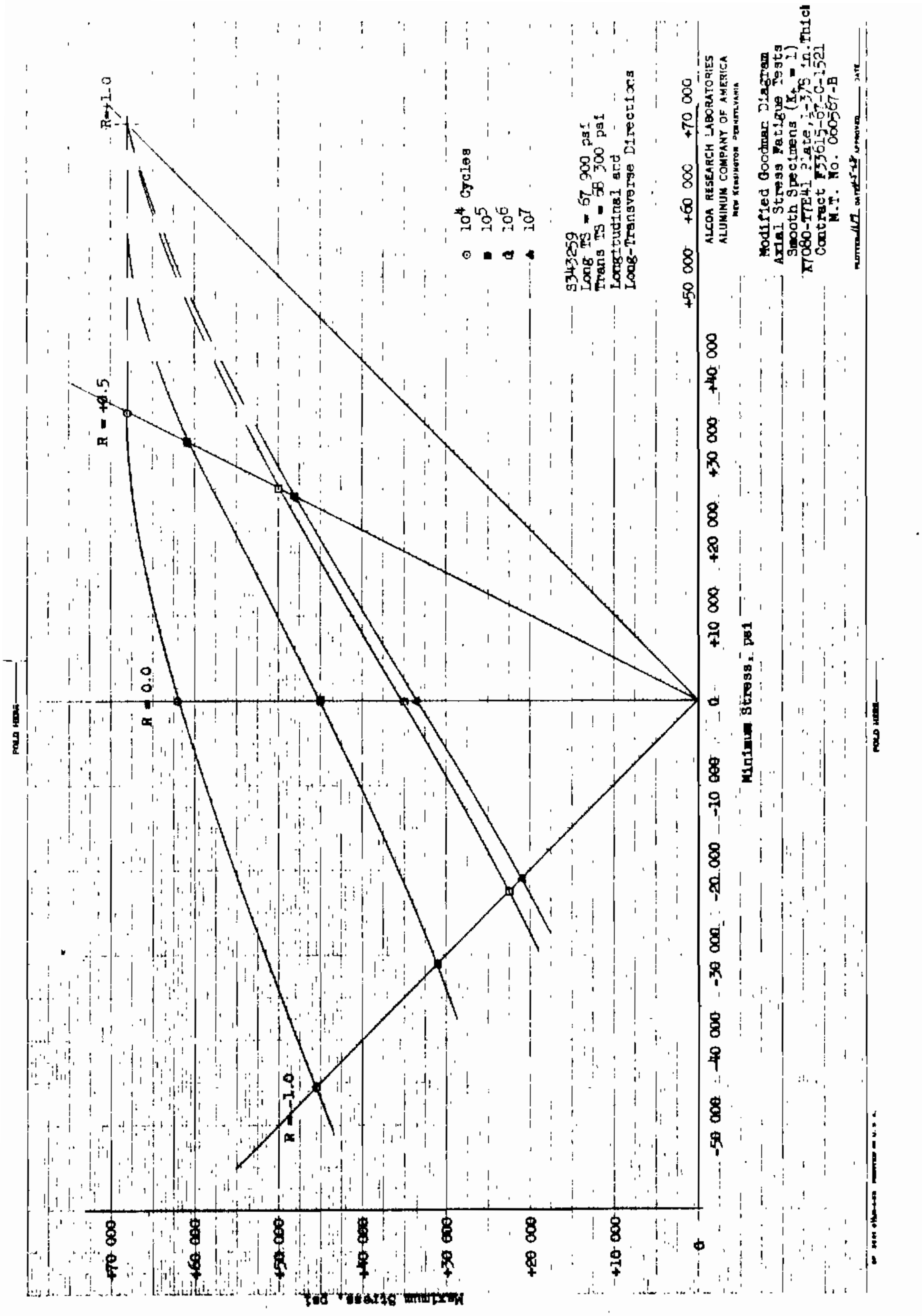

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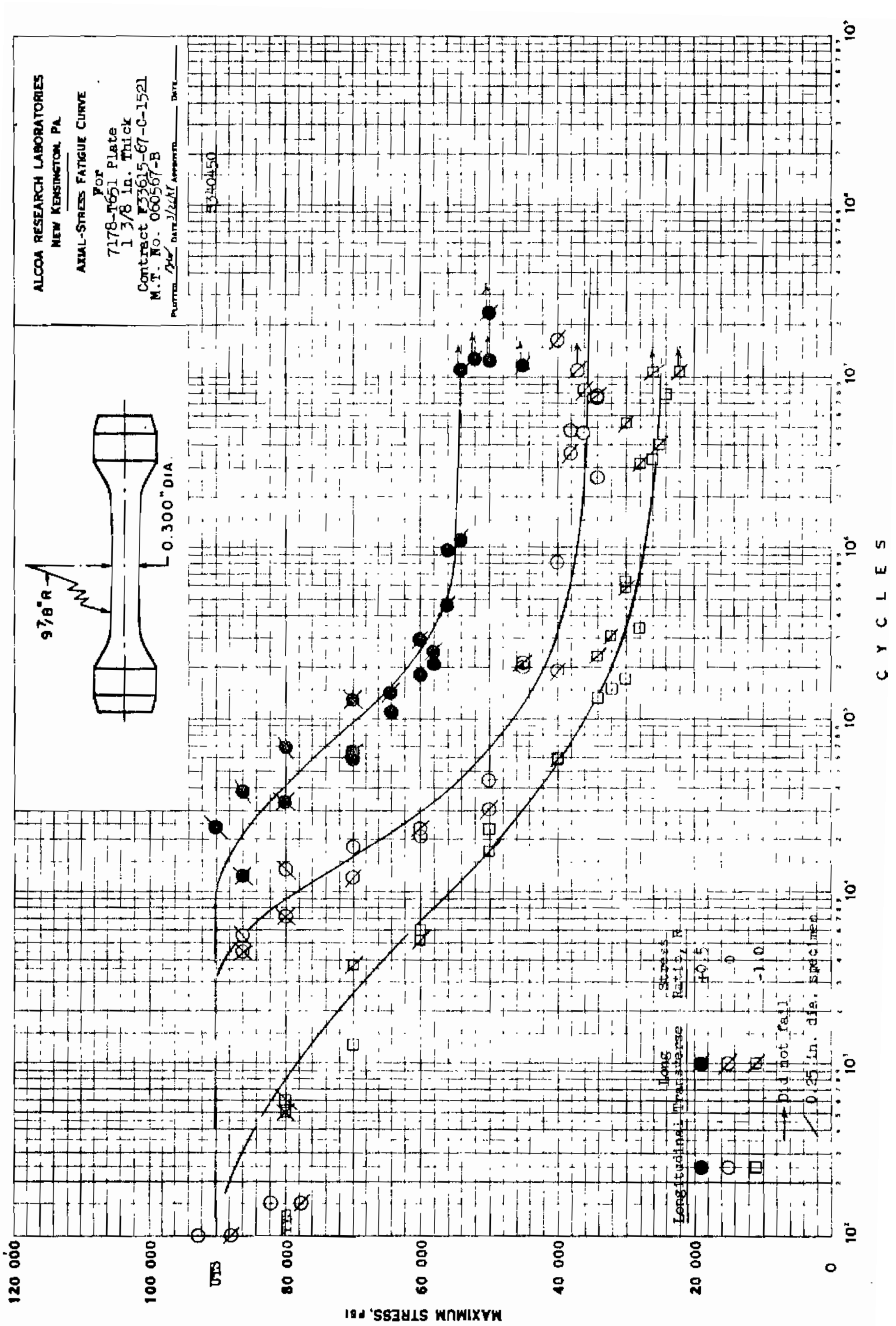

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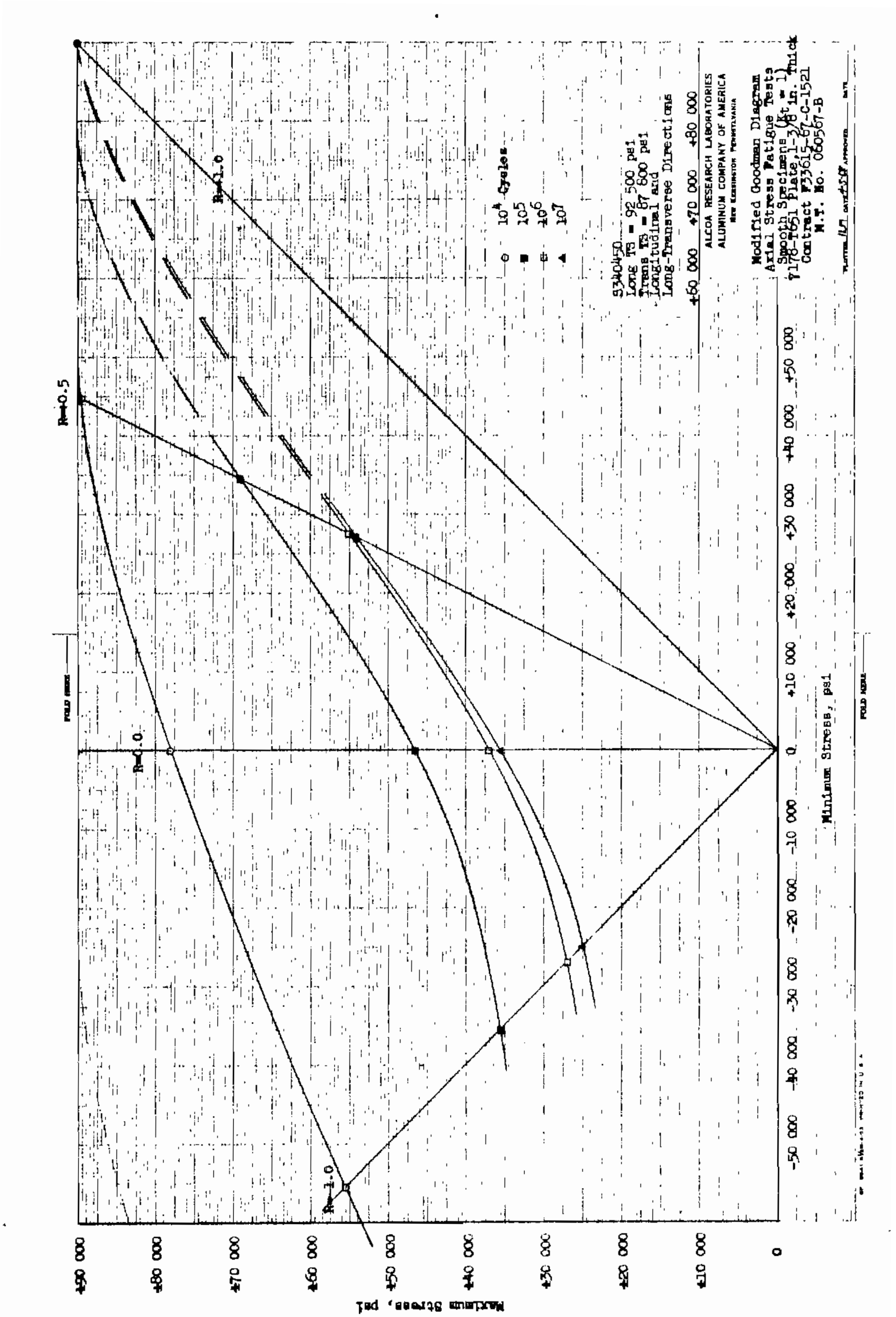

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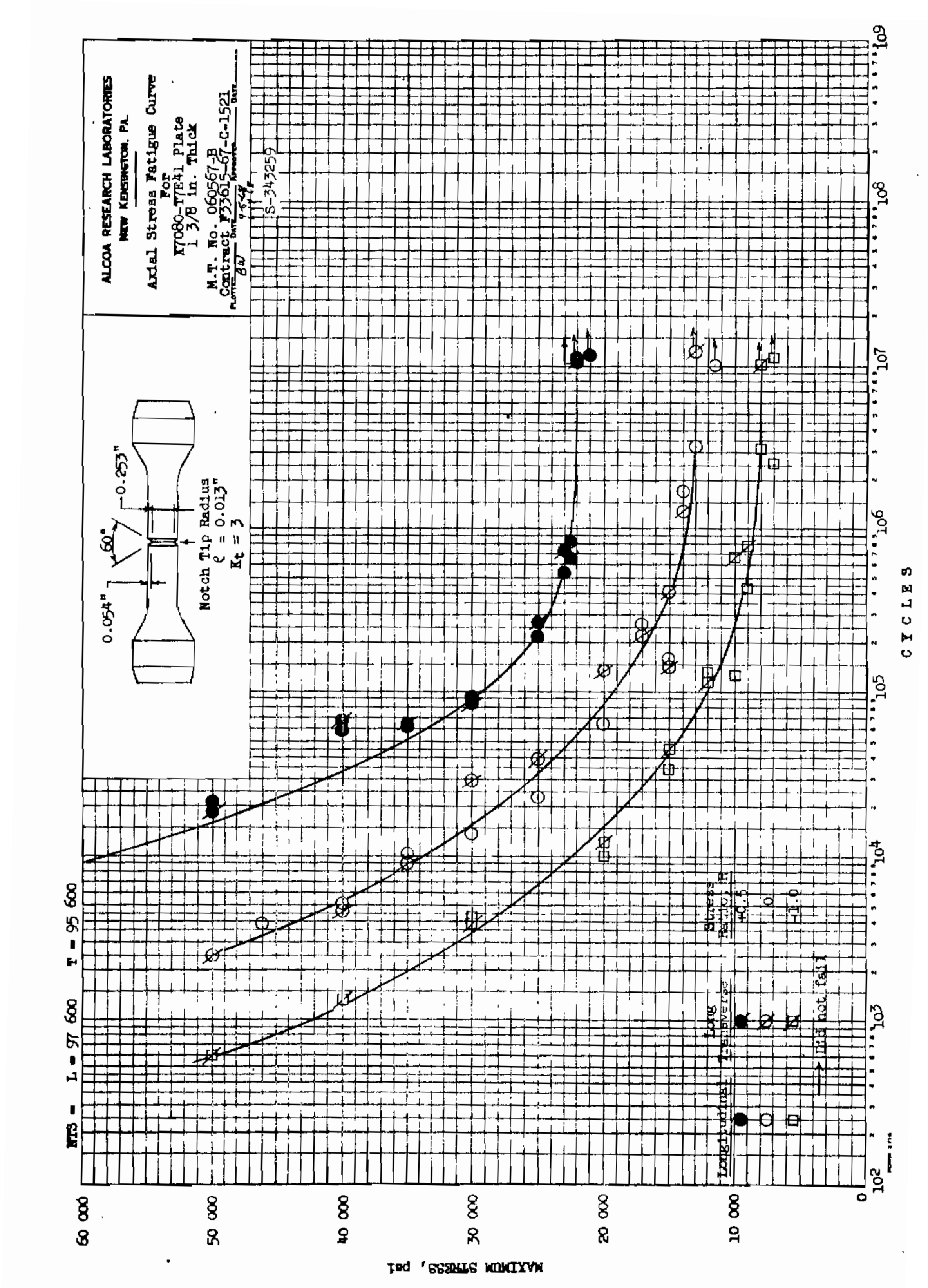

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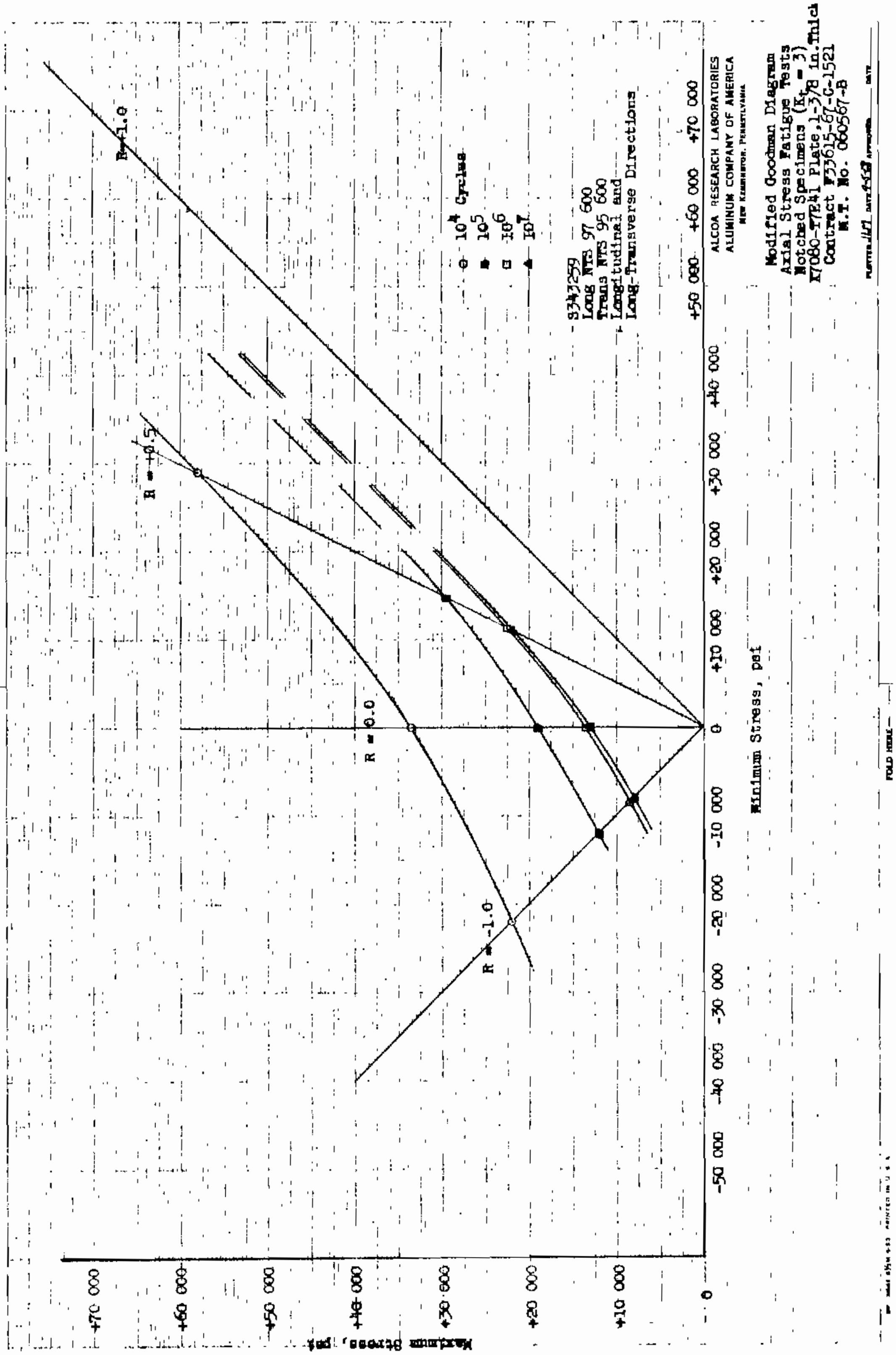

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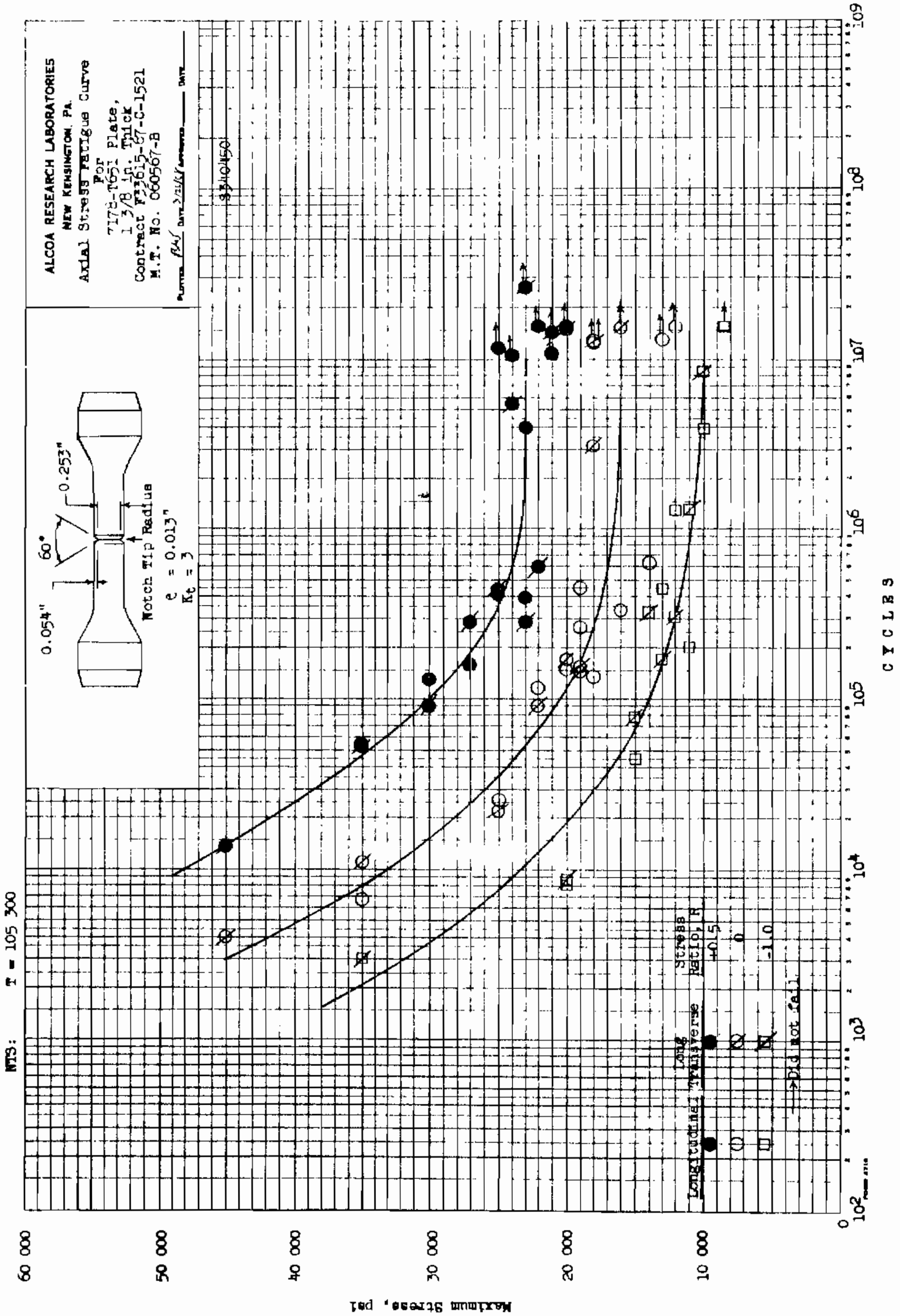

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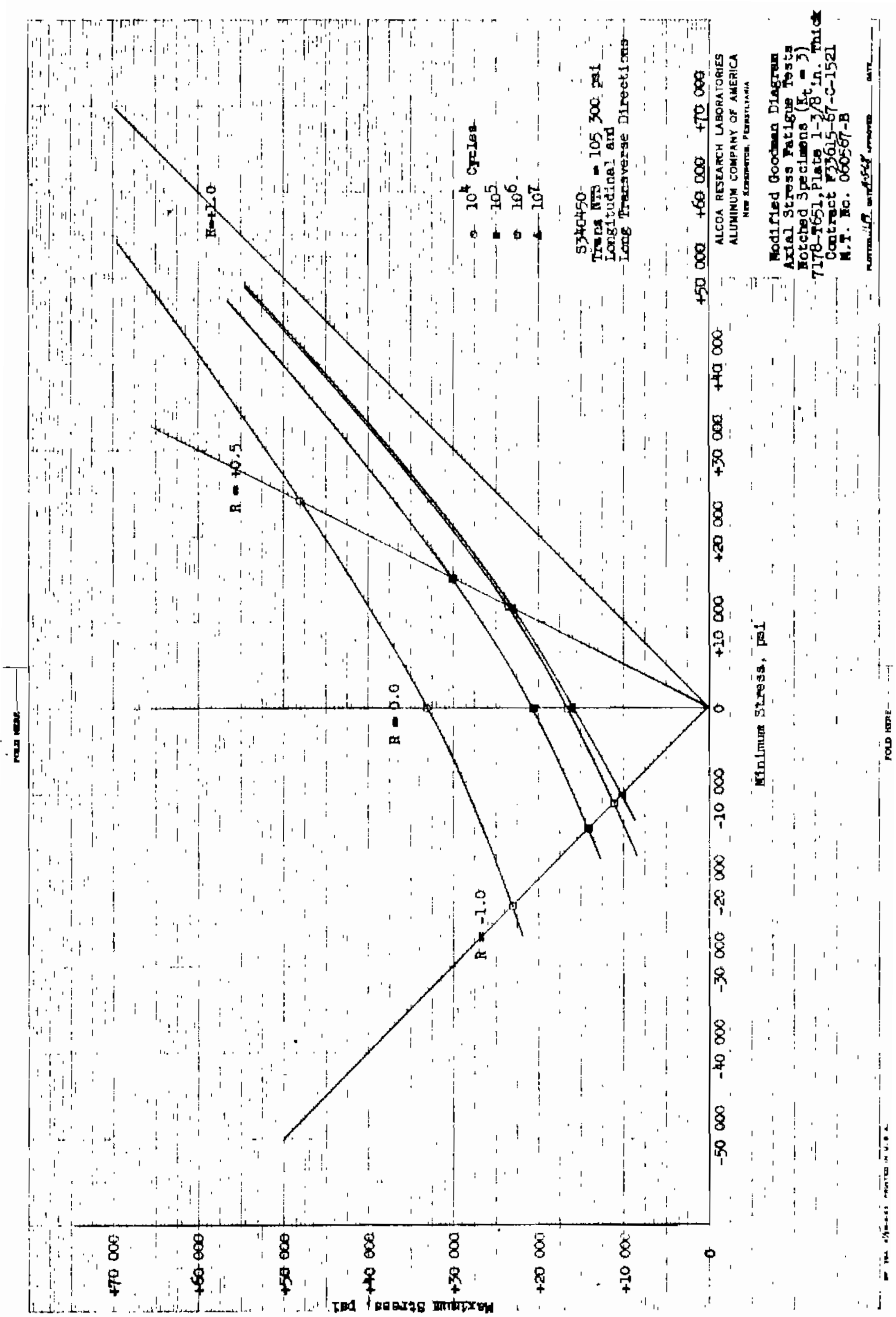

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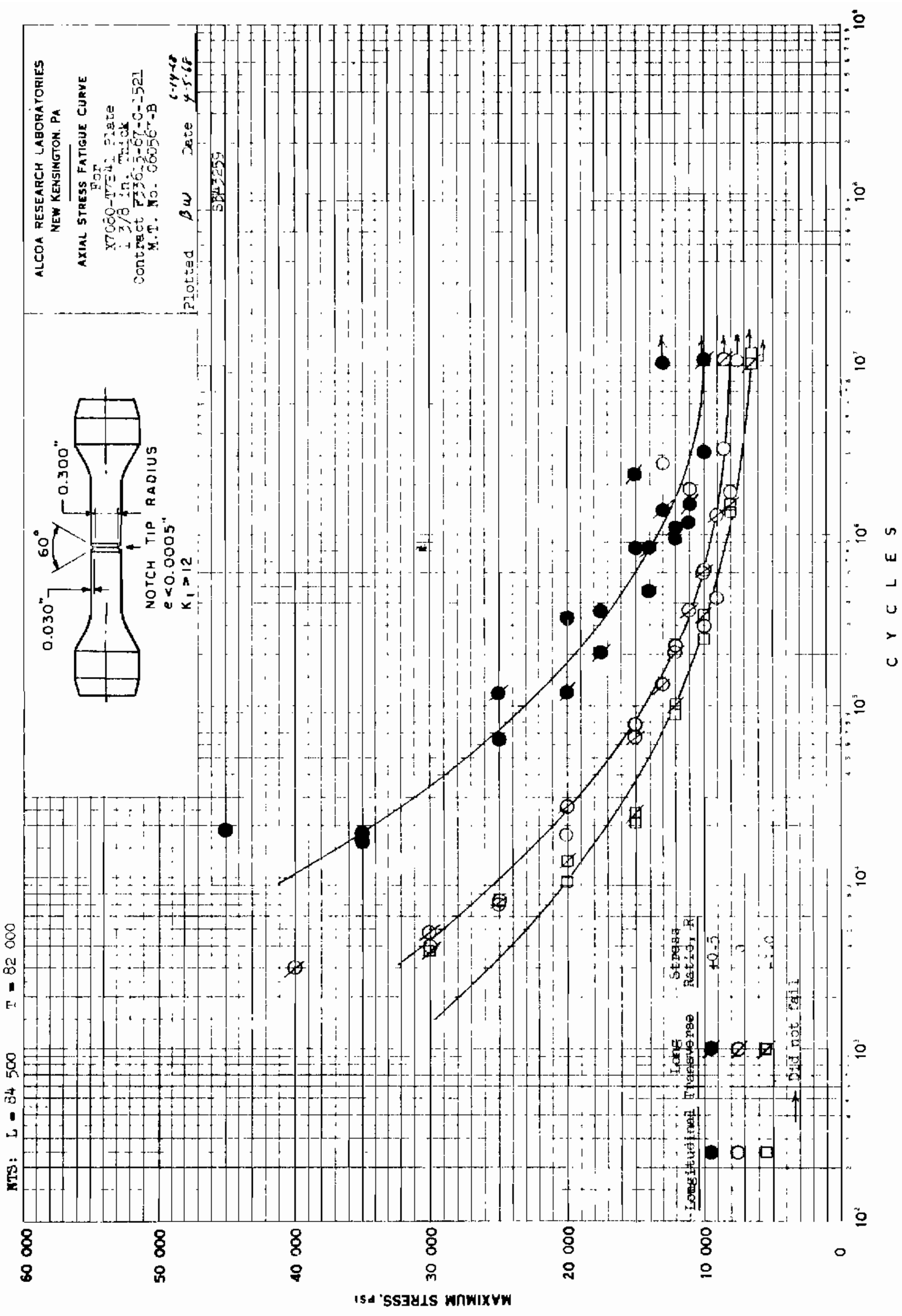

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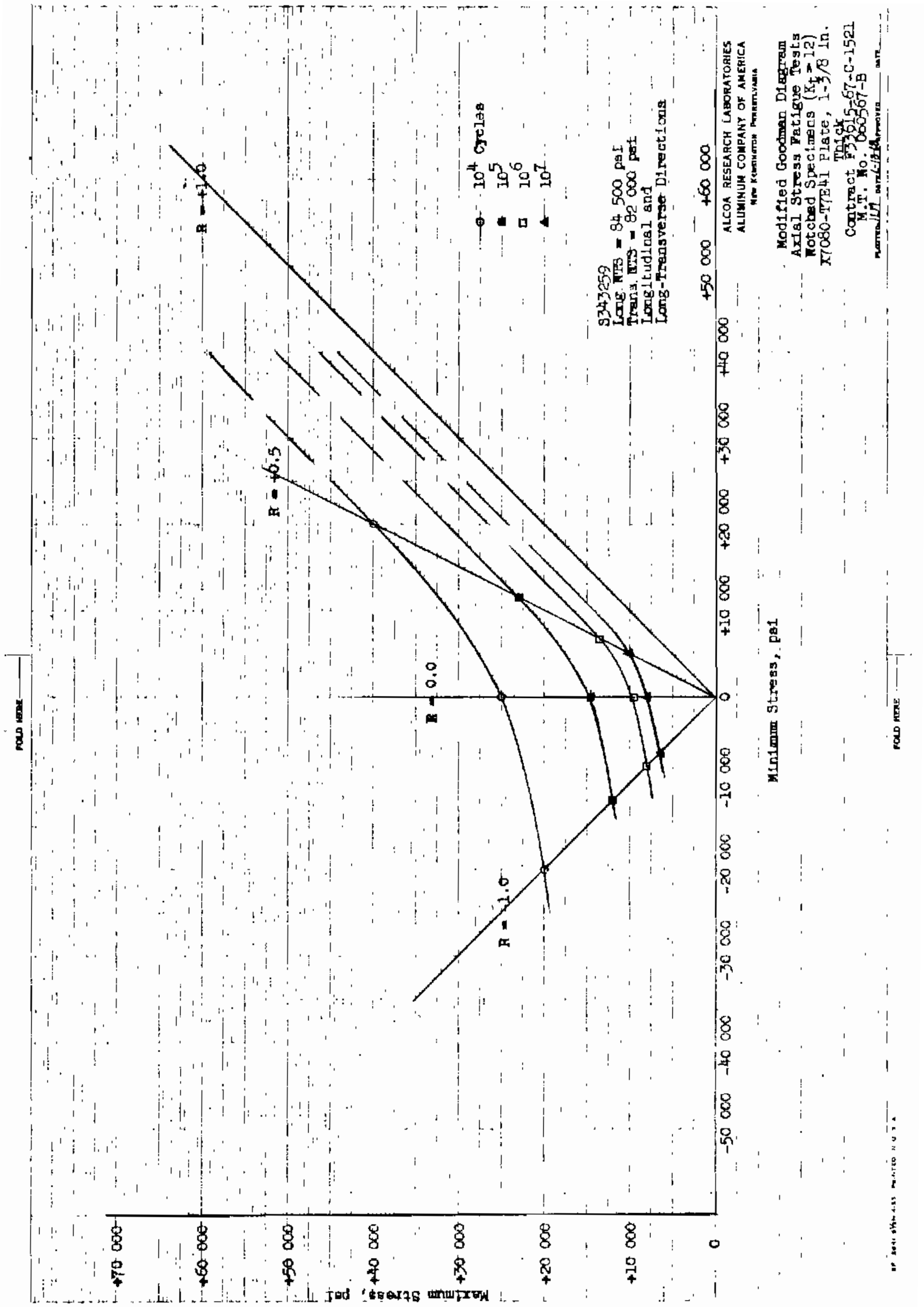

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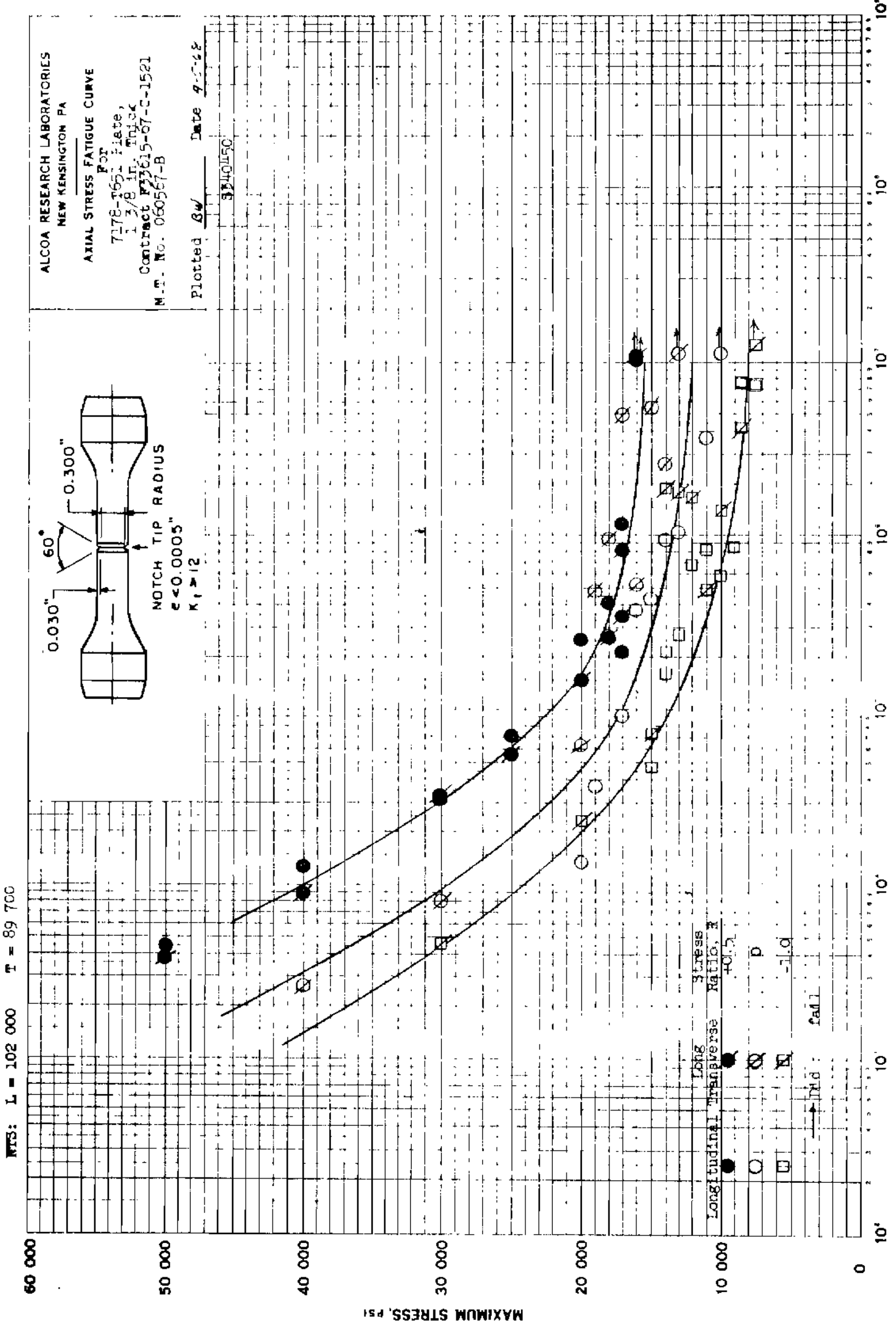

Fig. 43

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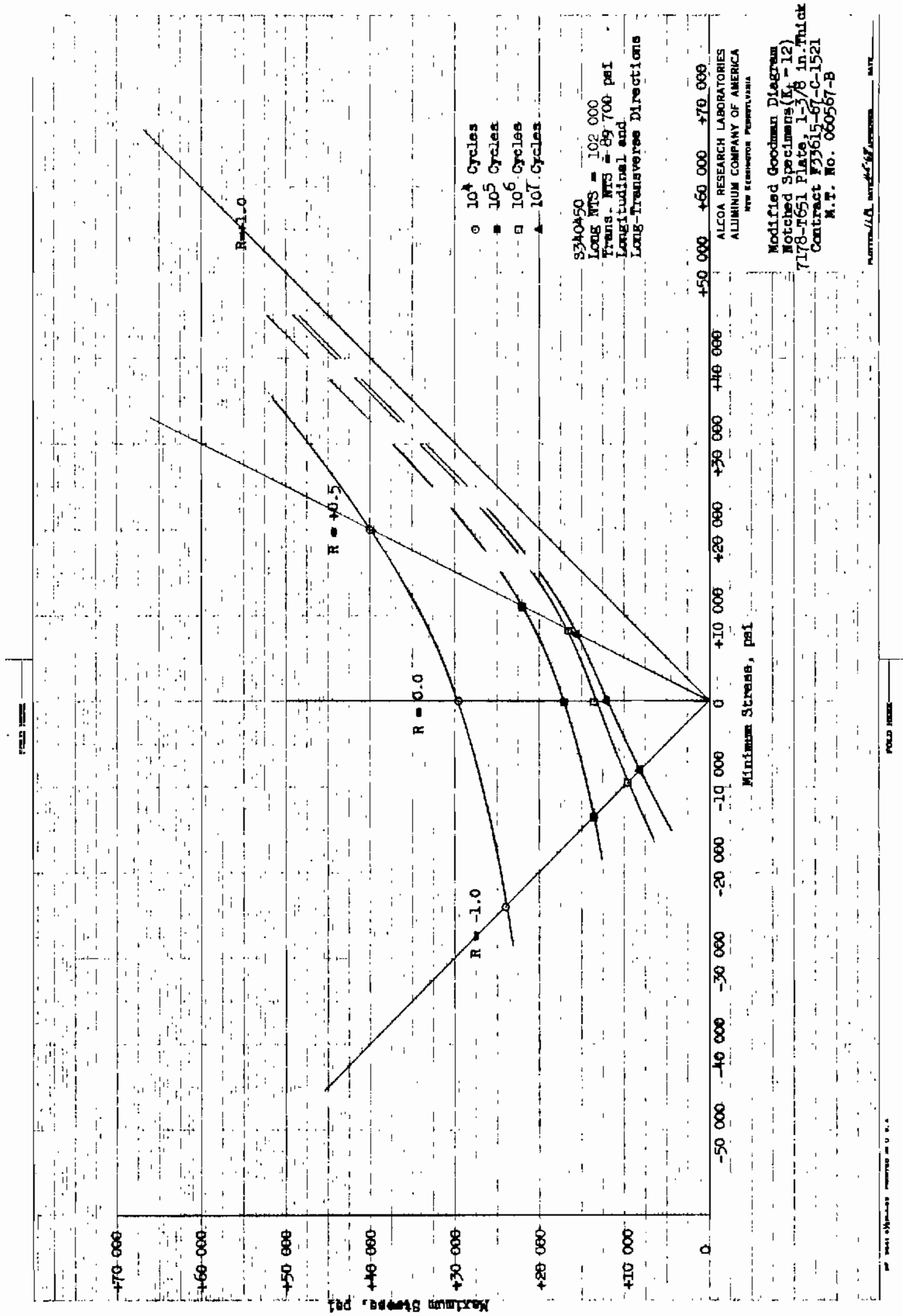

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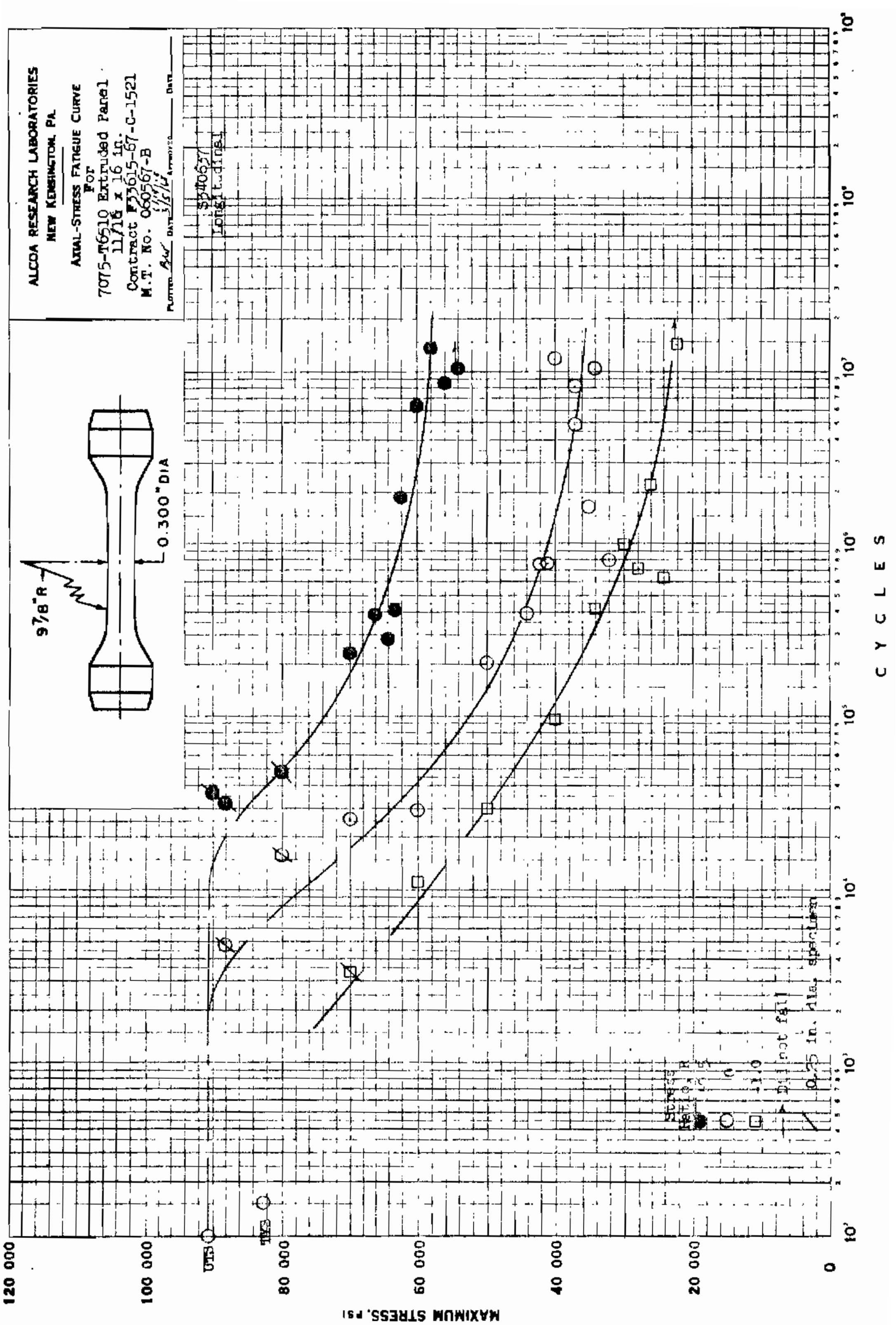

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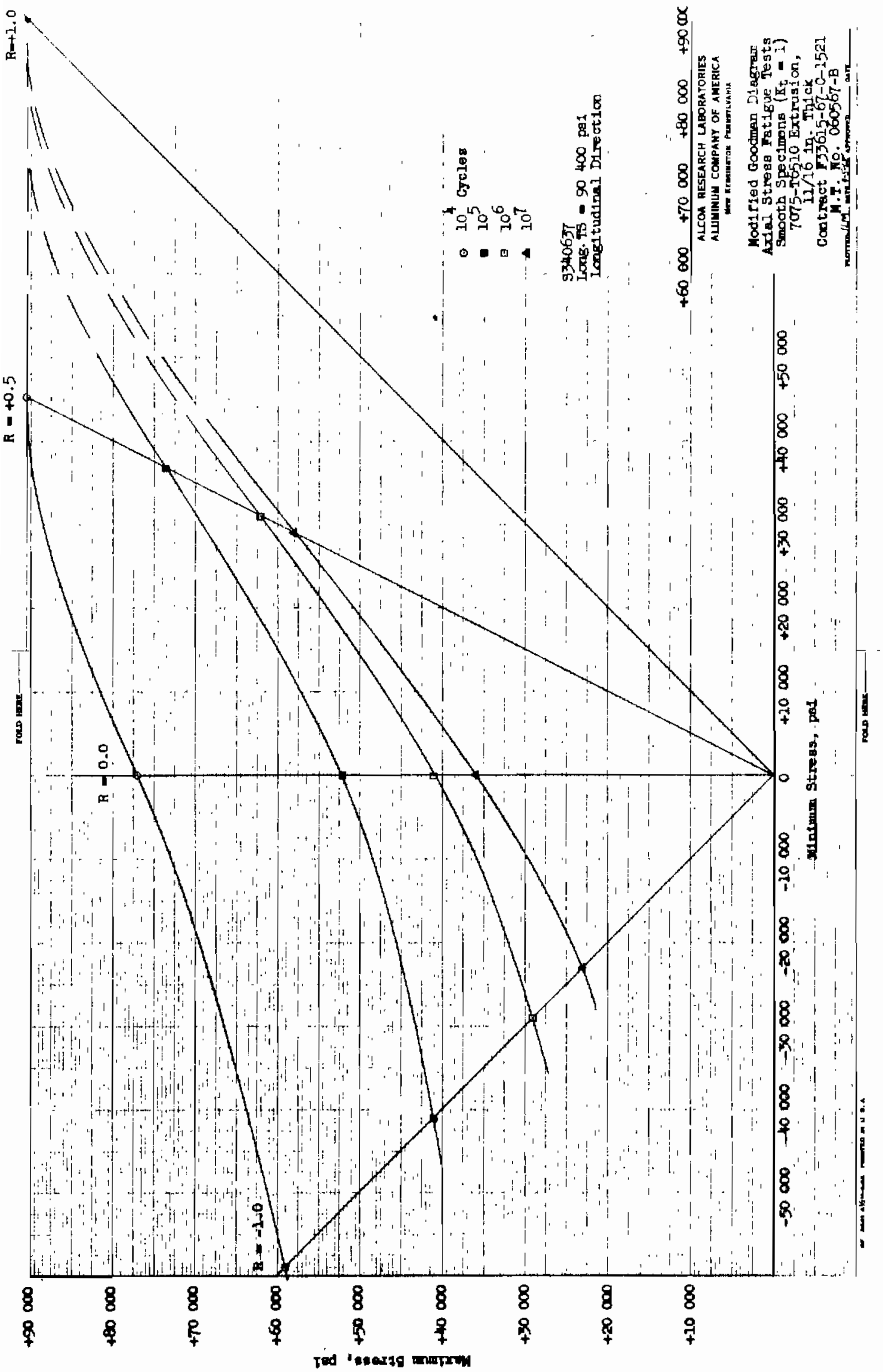

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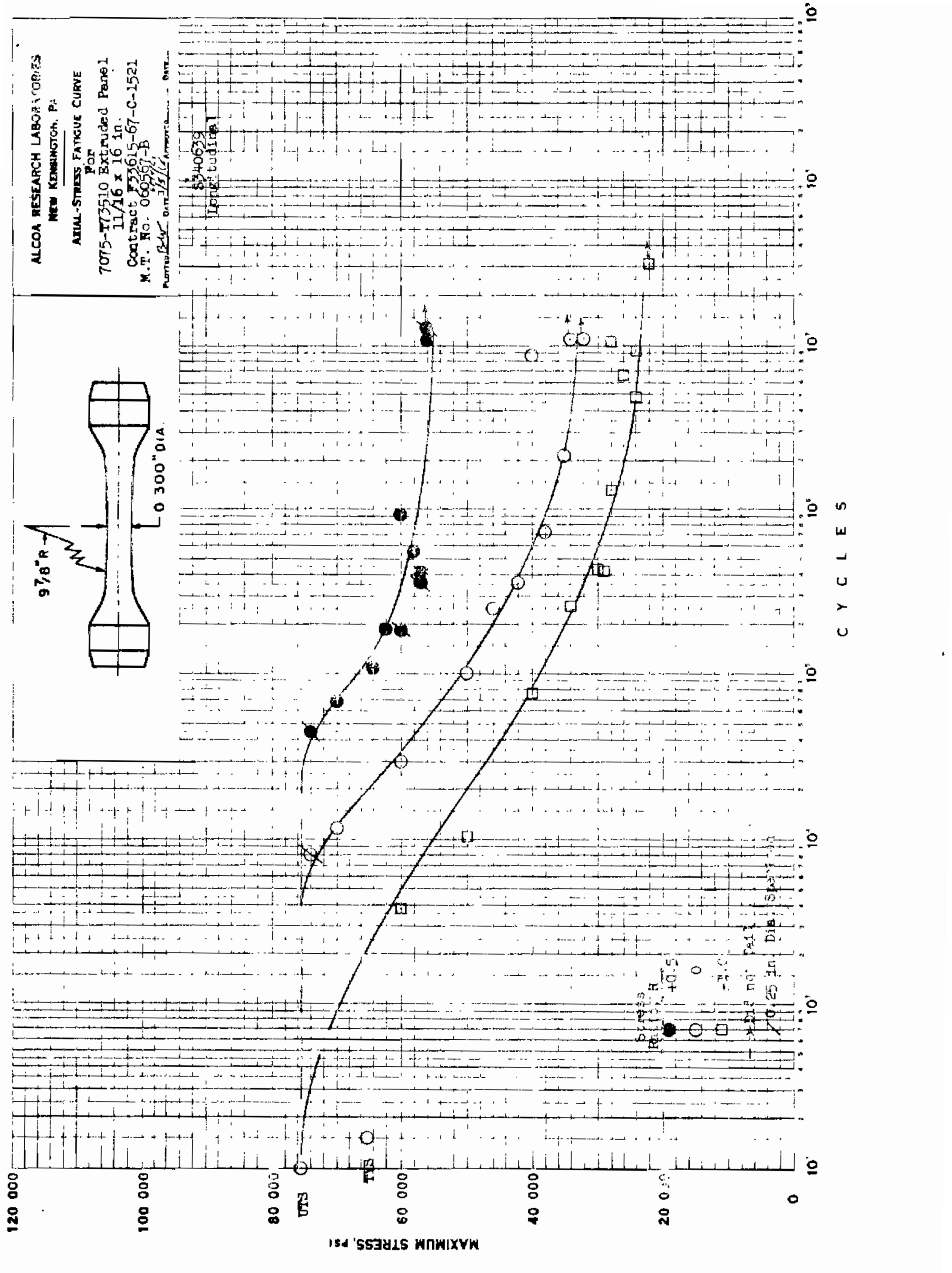

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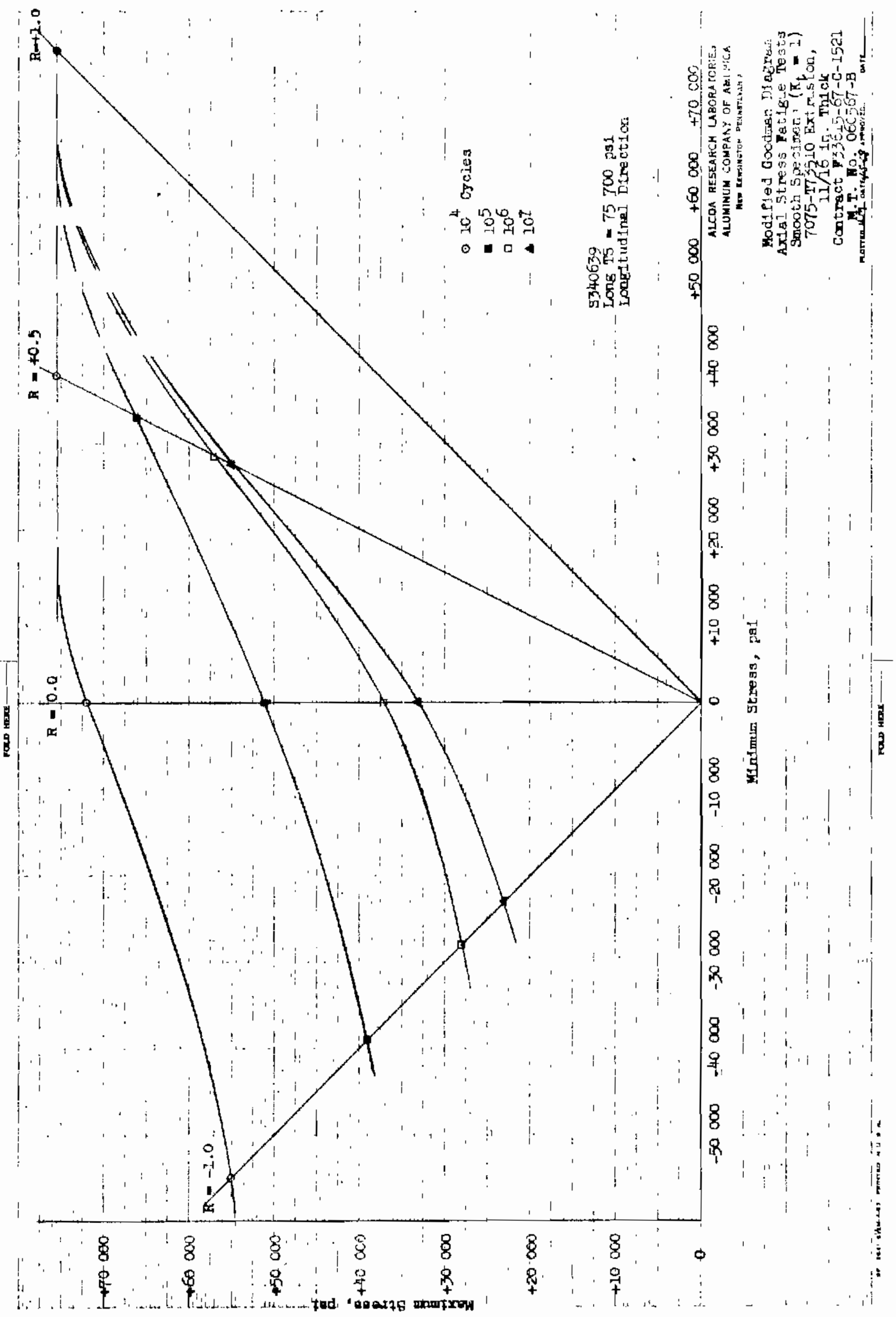

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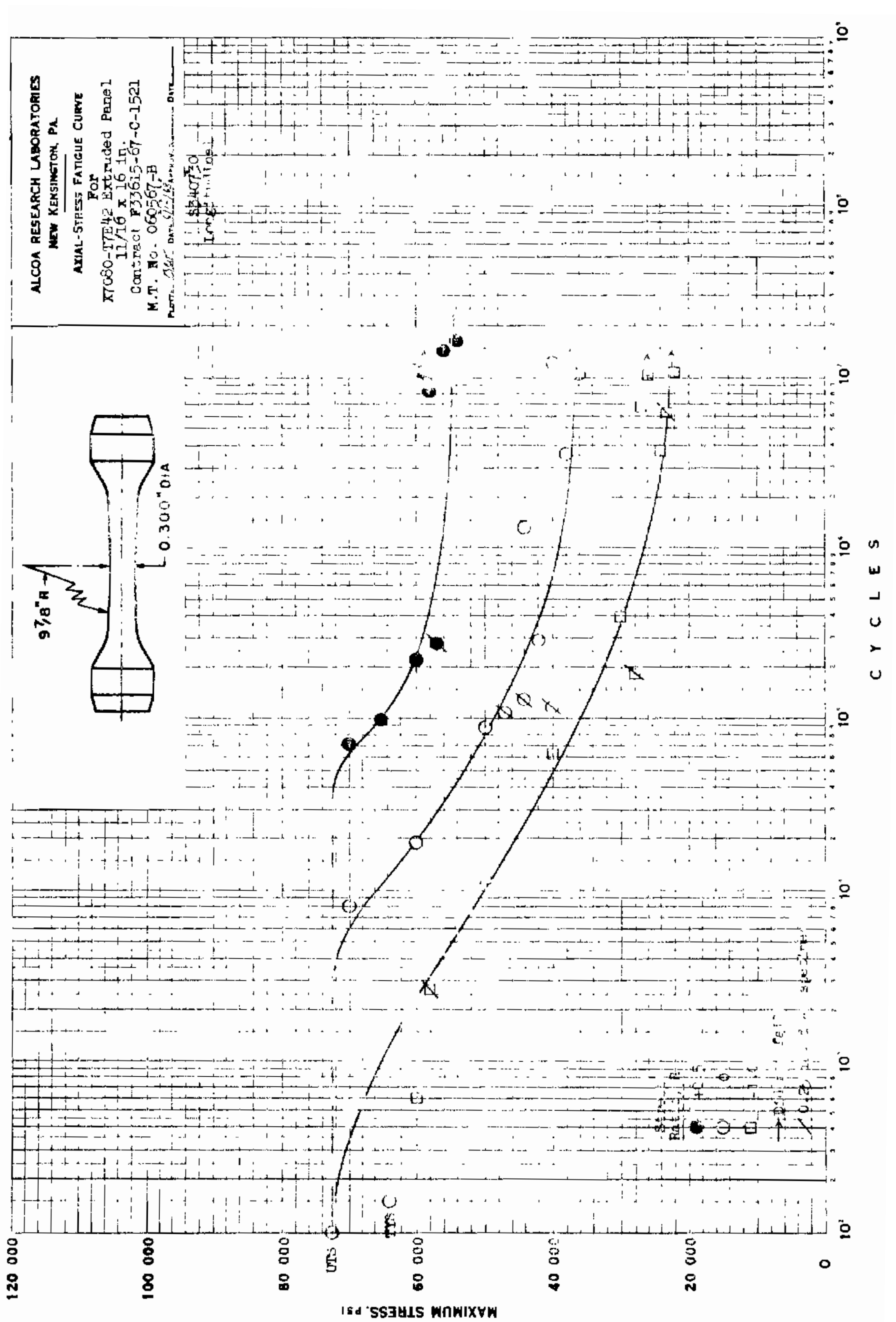

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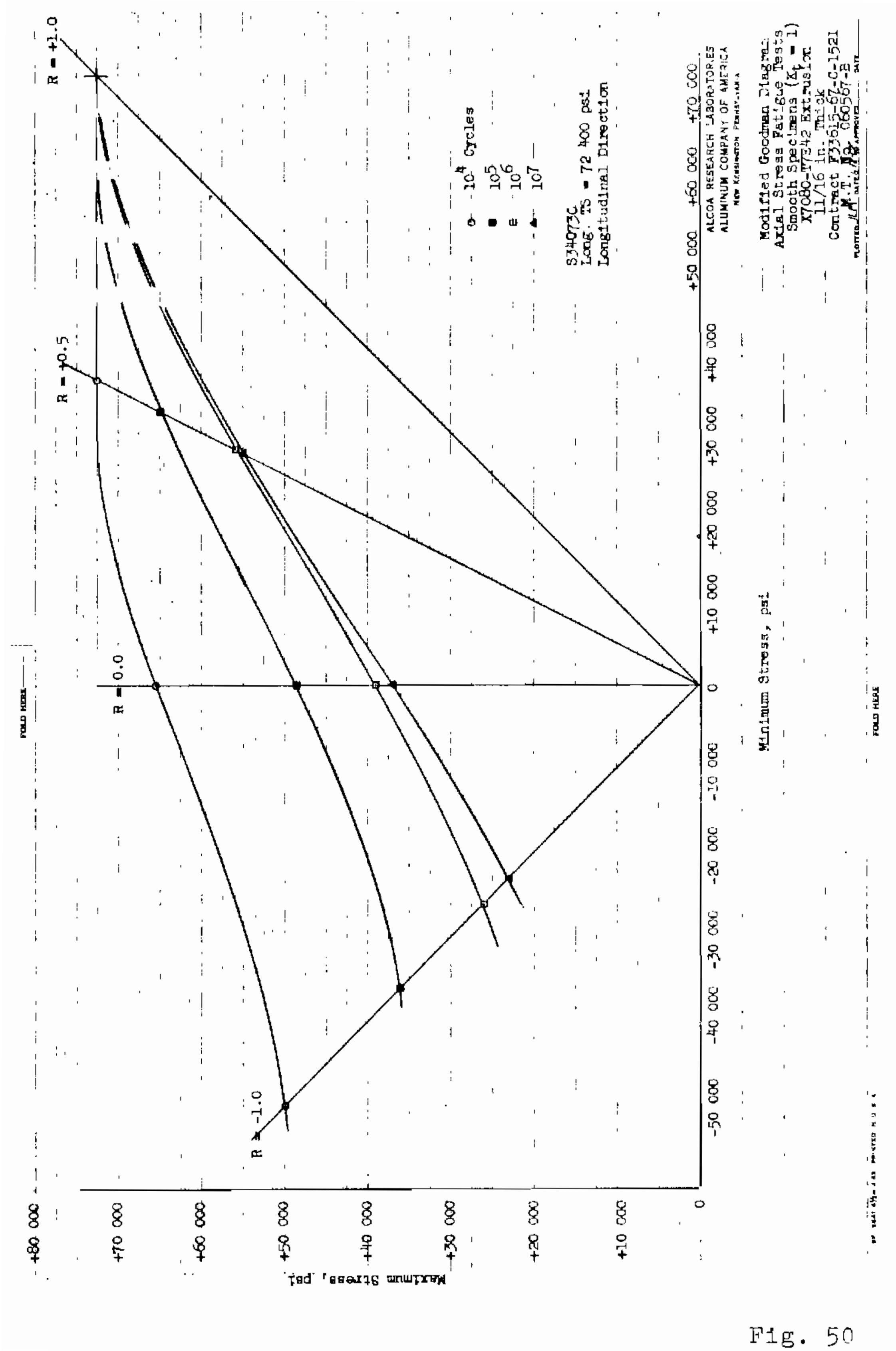

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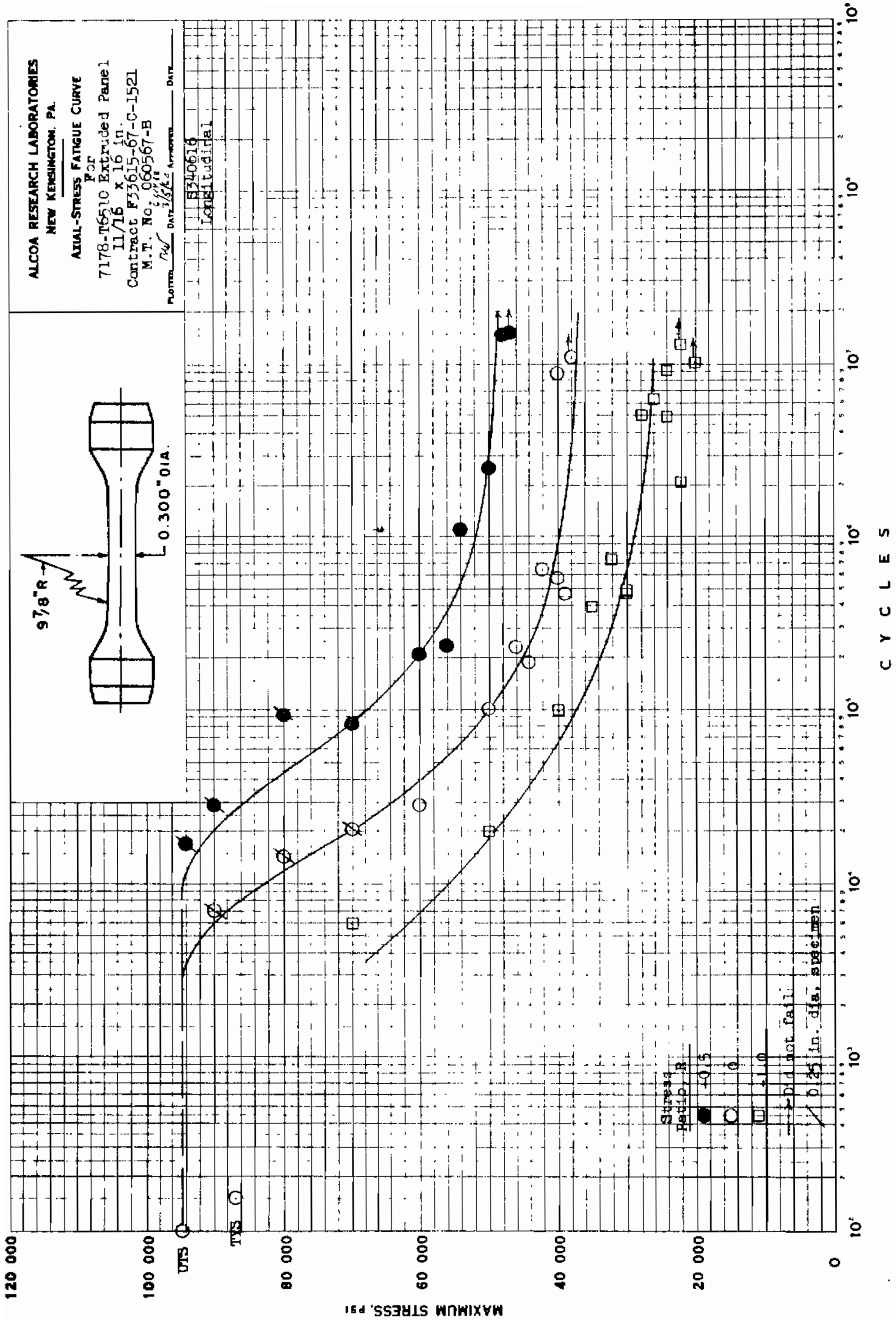

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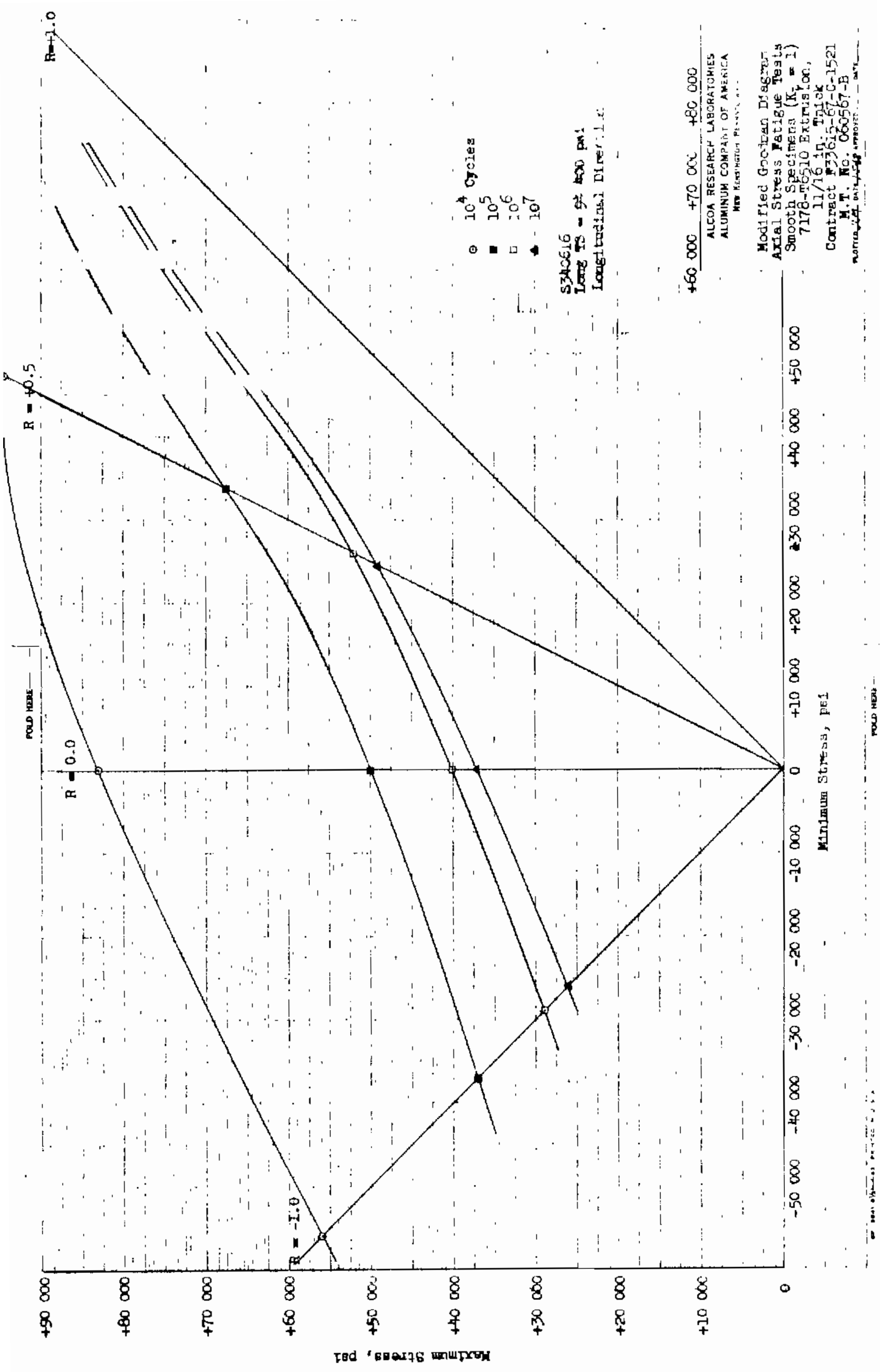

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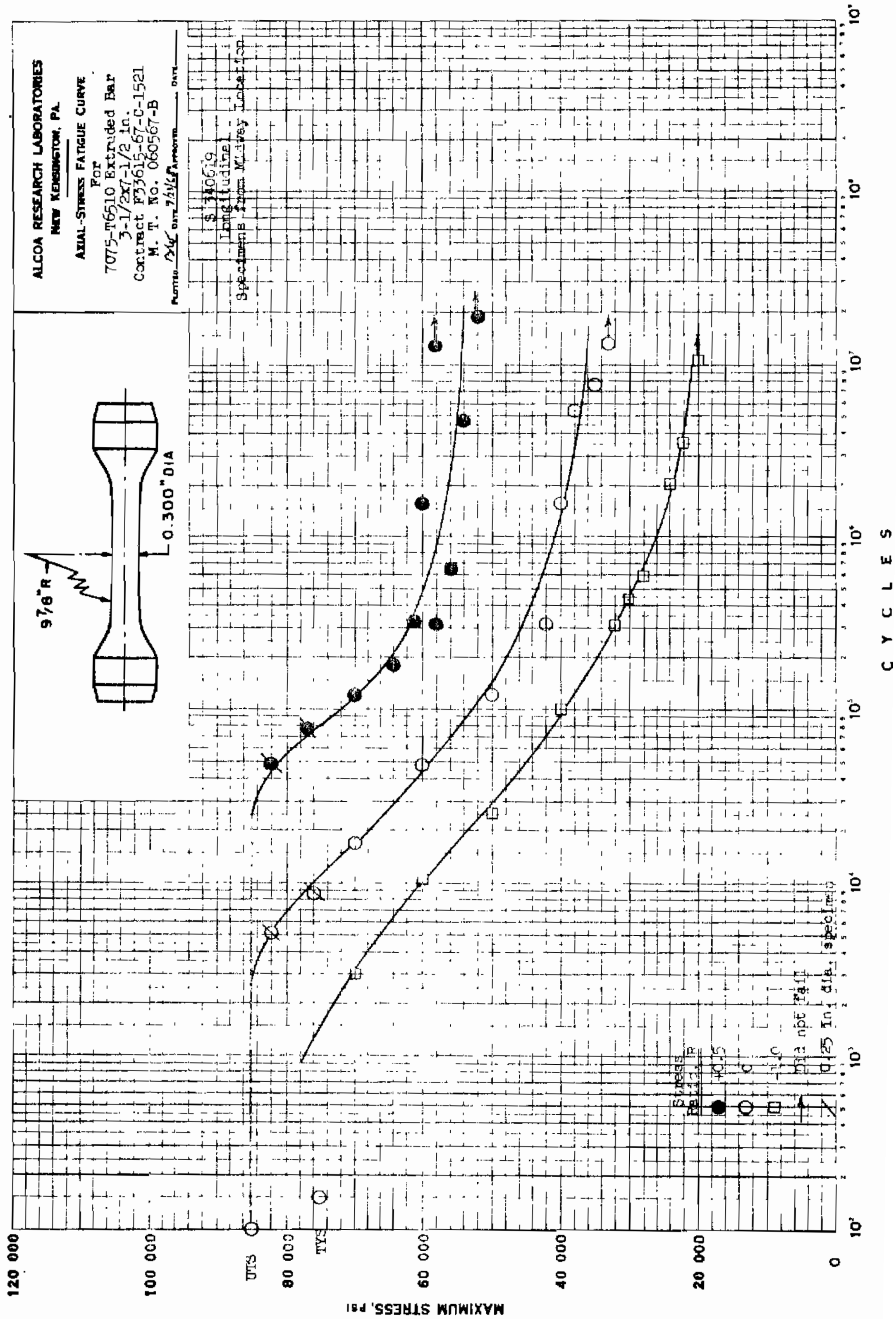

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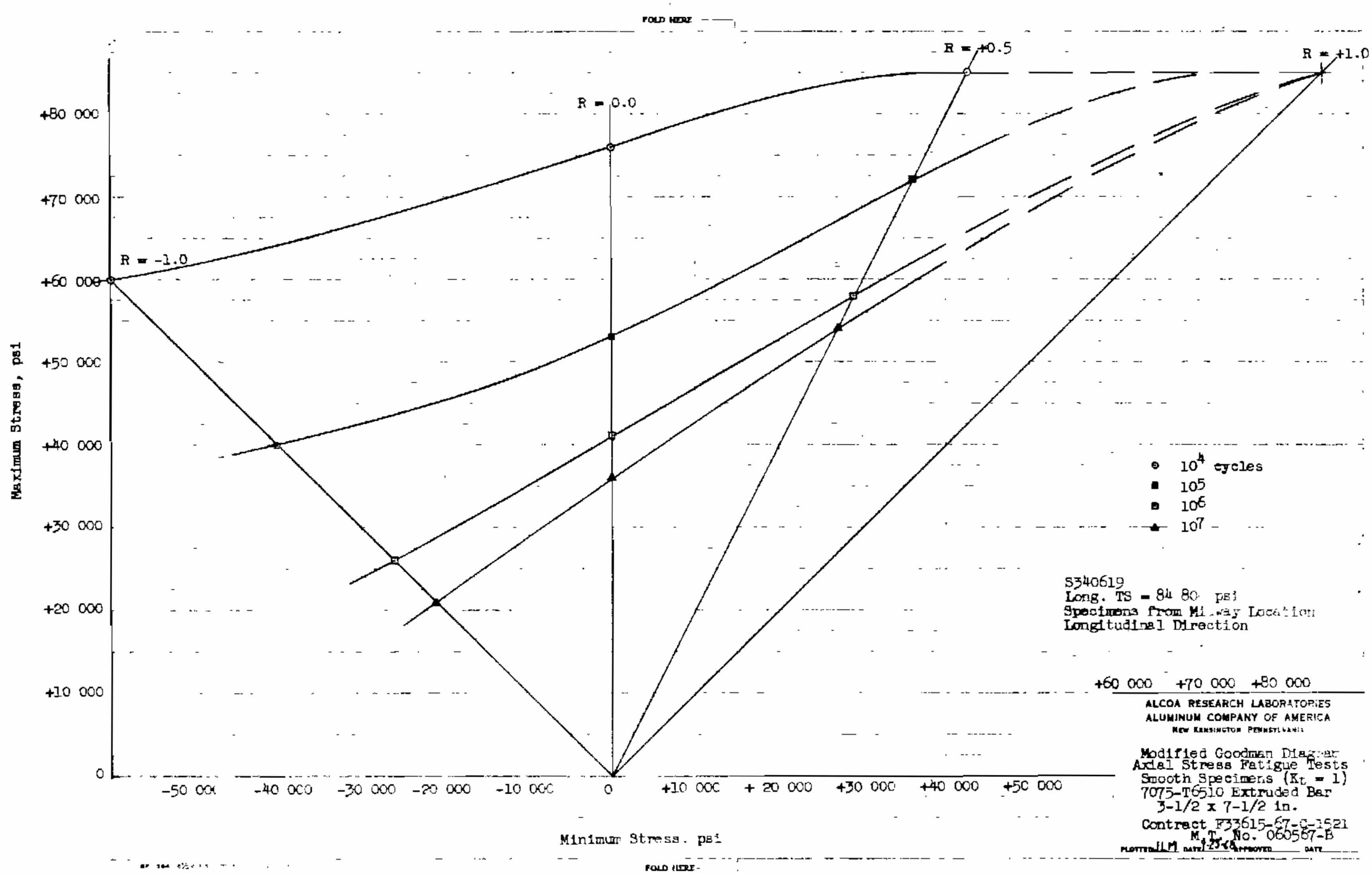

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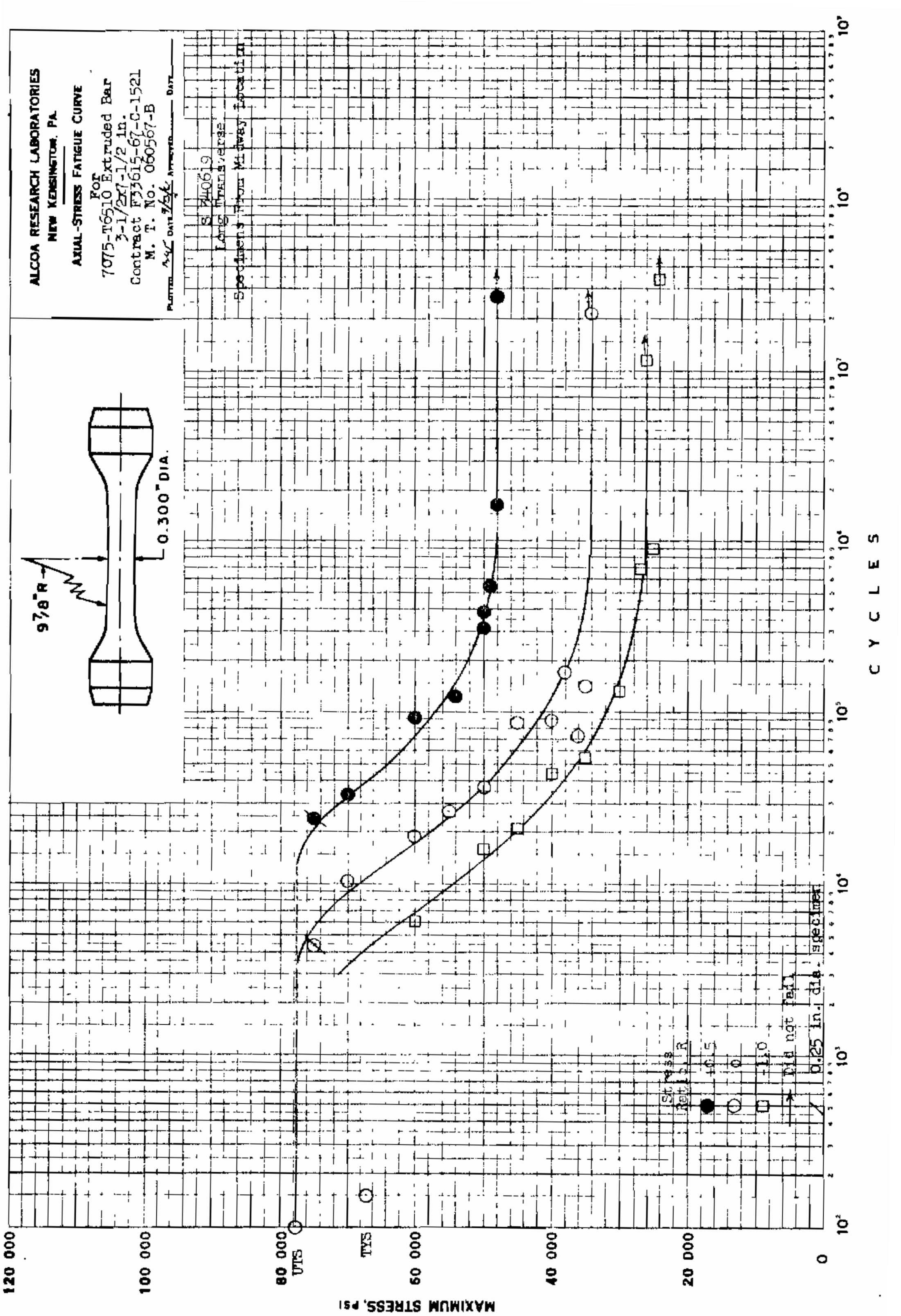

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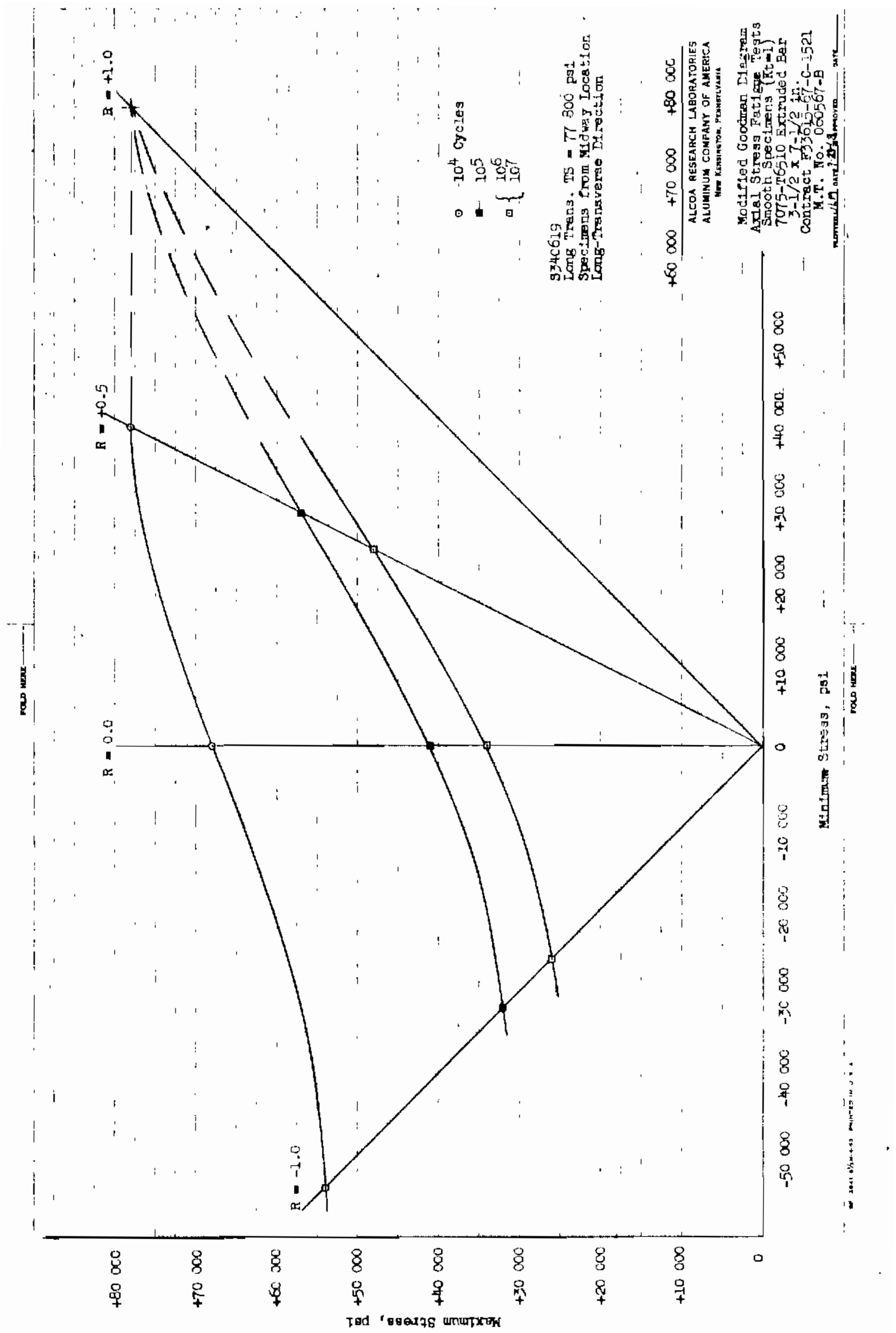

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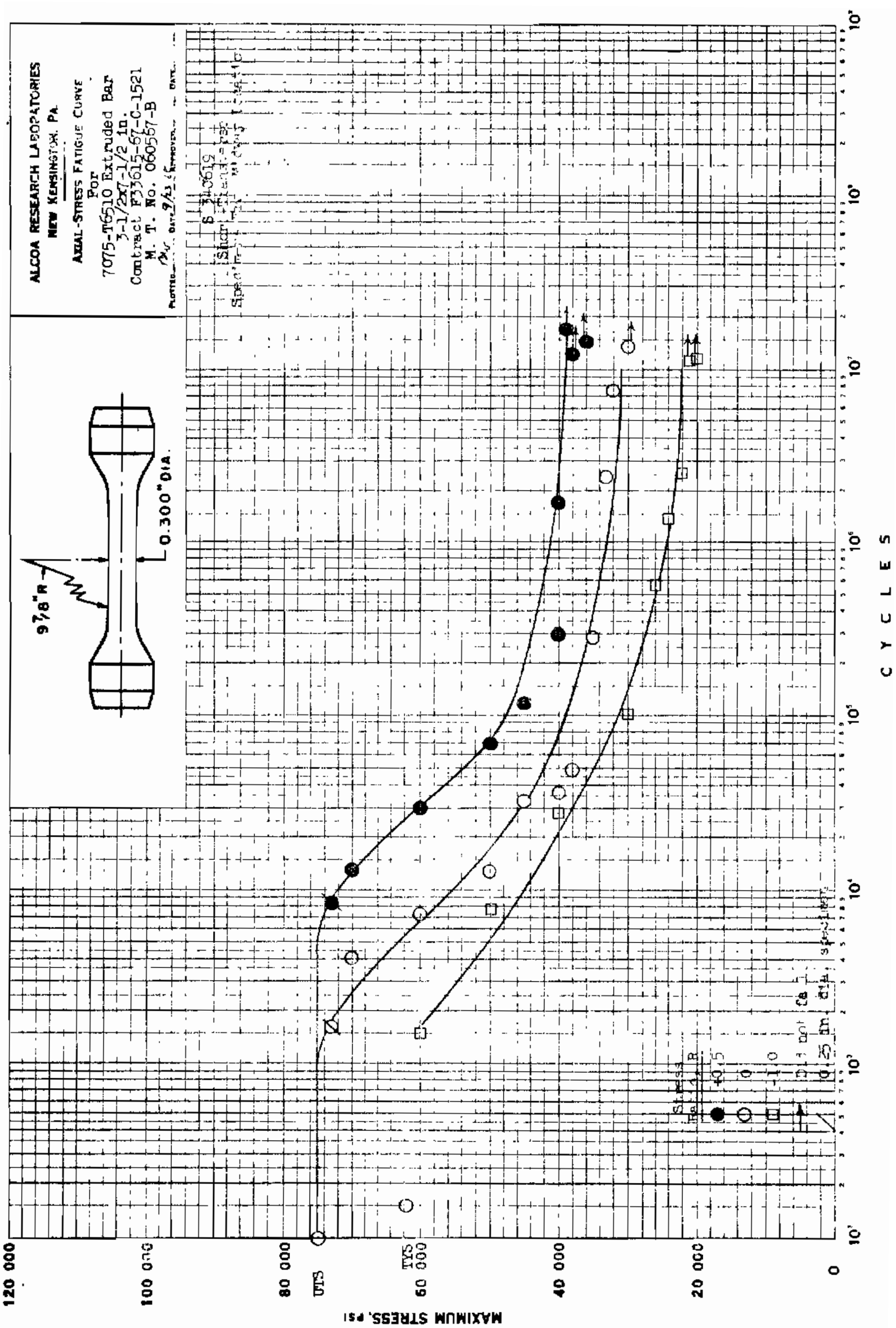

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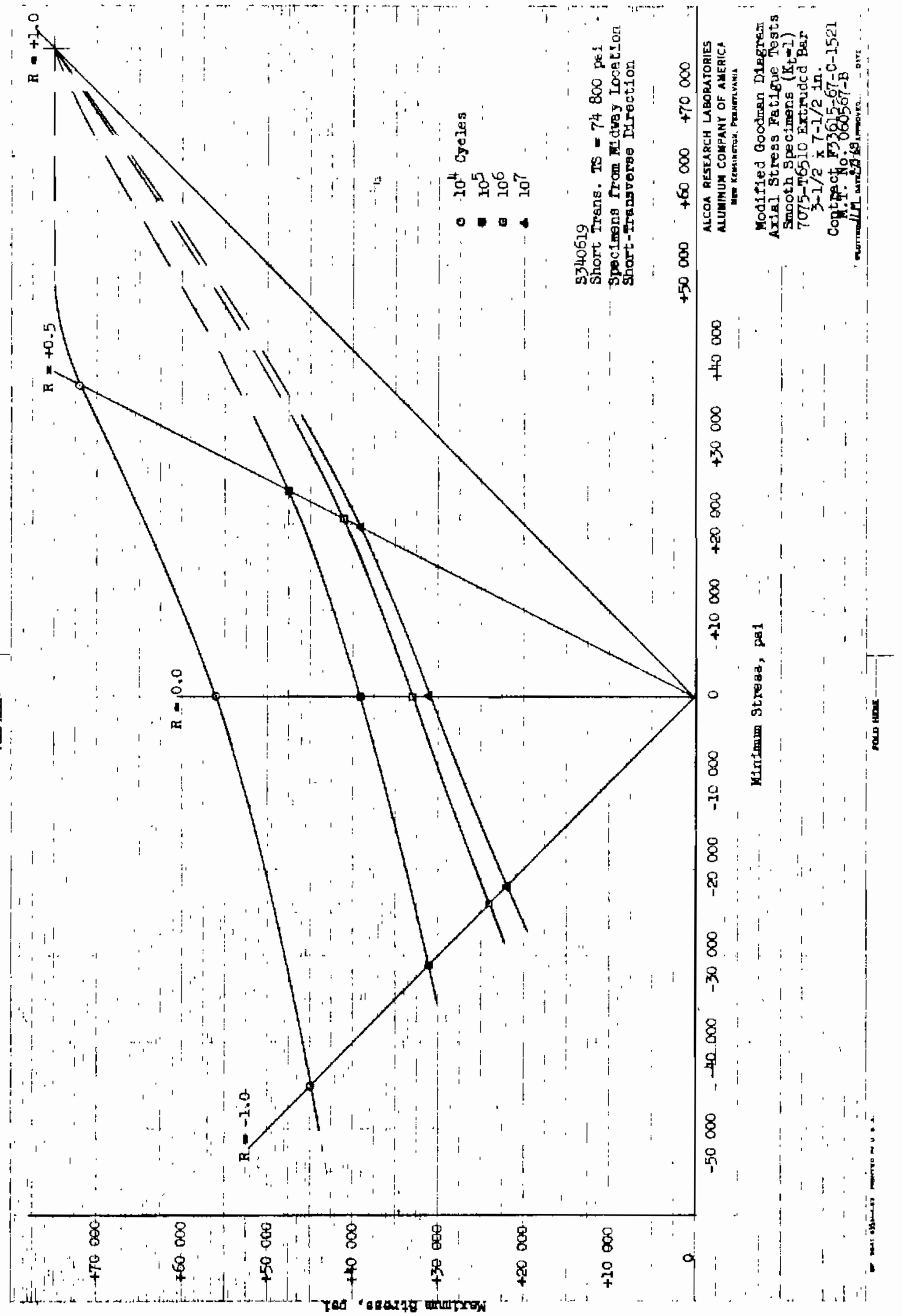

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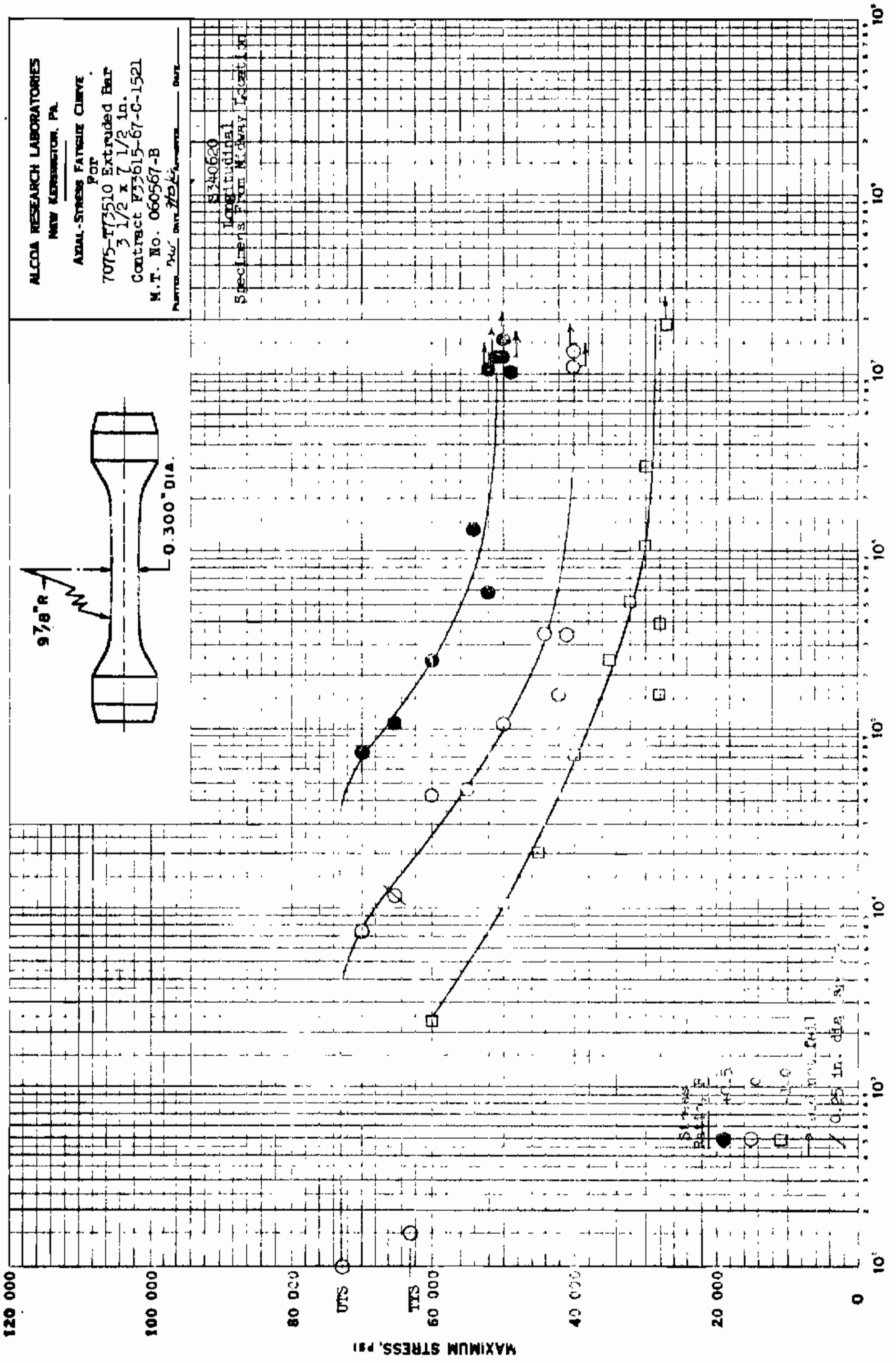

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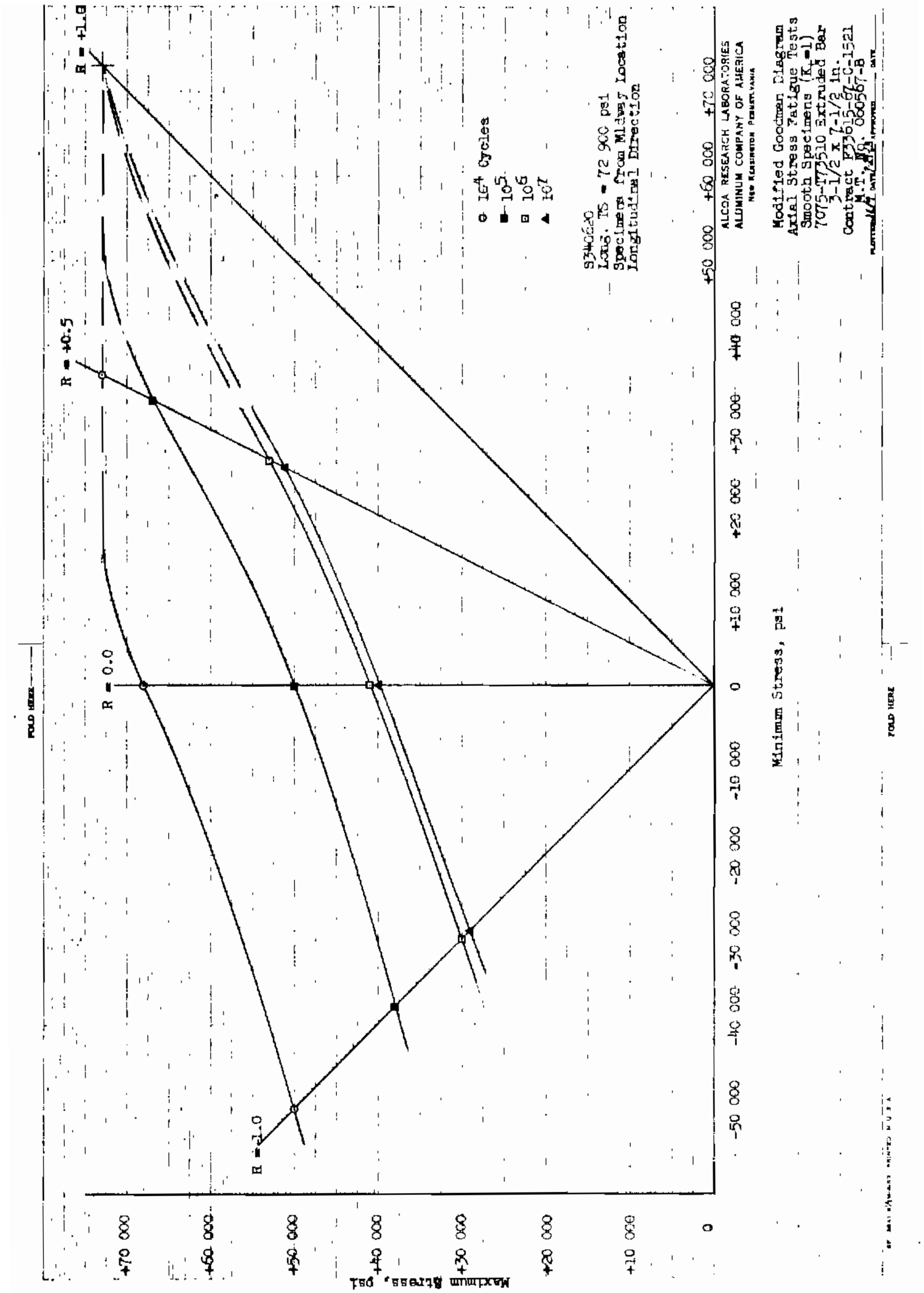

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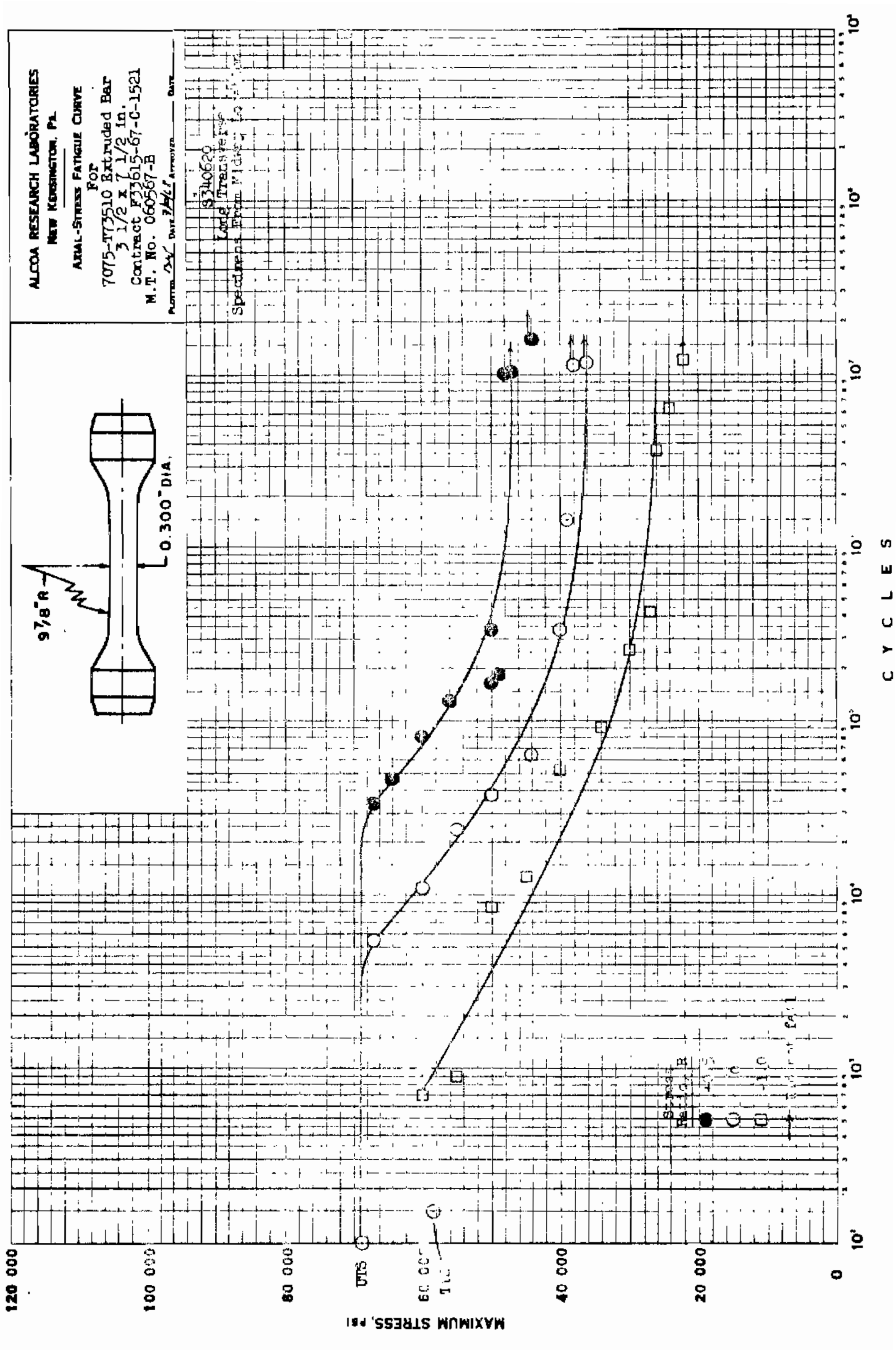

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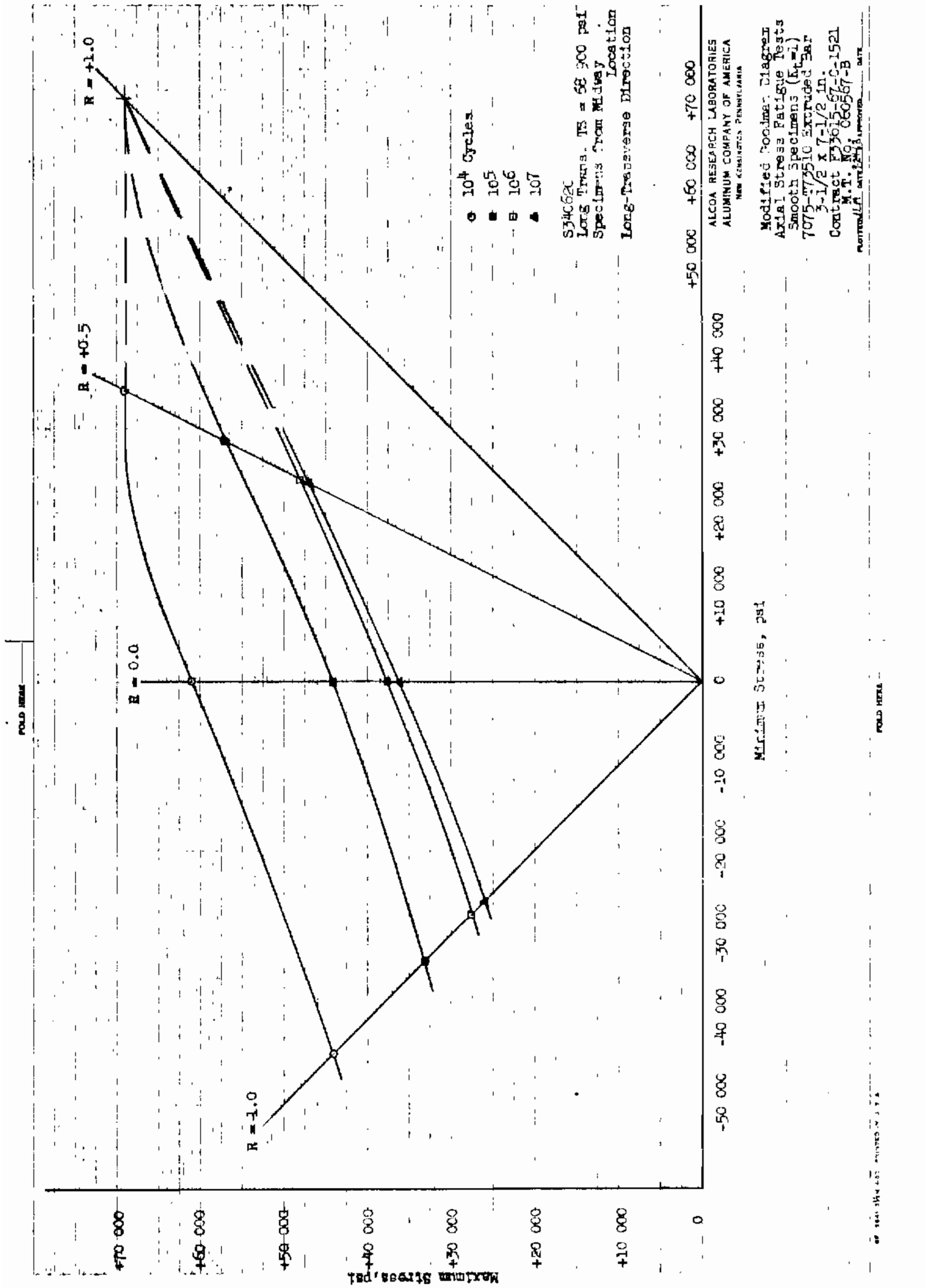

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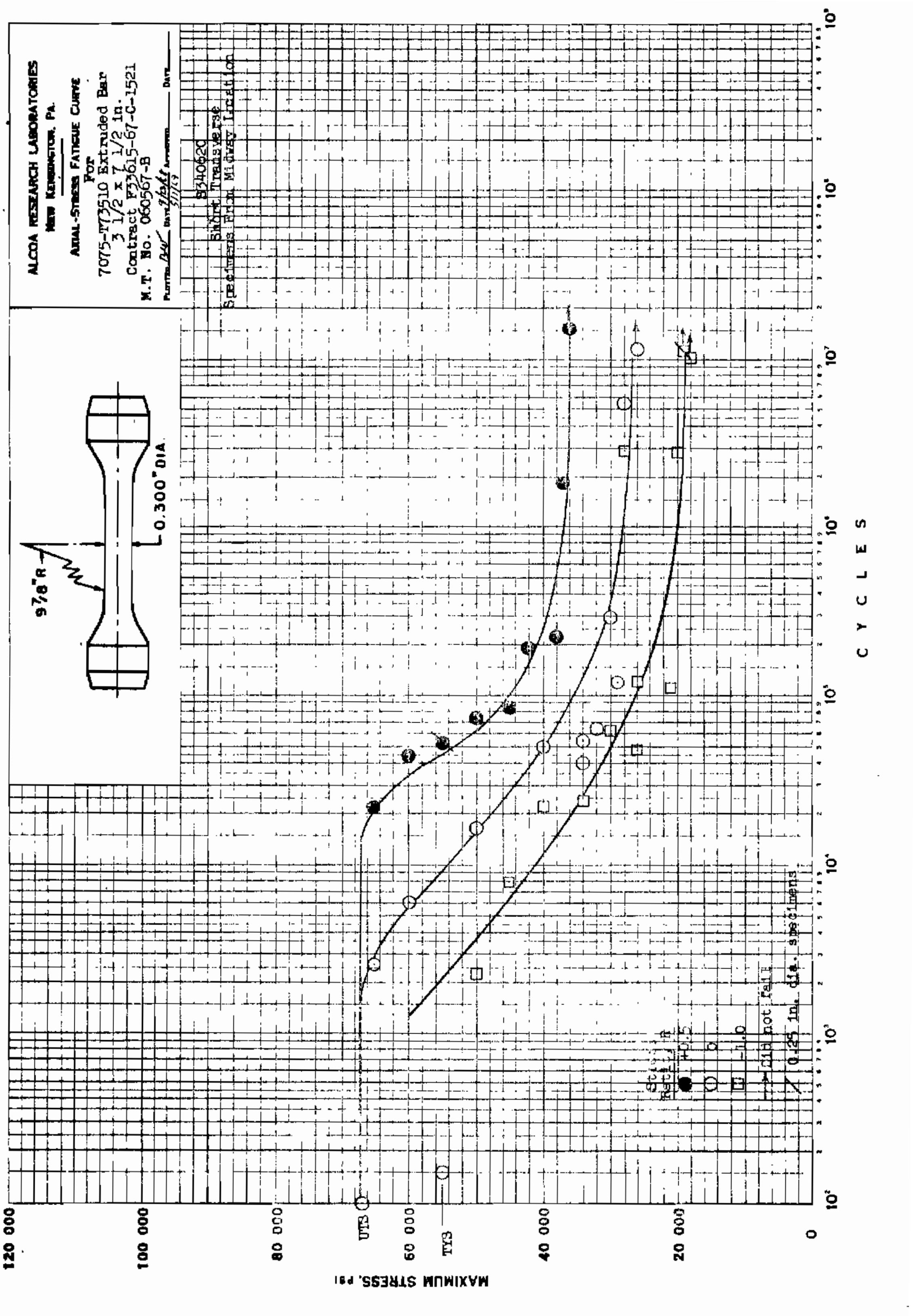

Fig. 63

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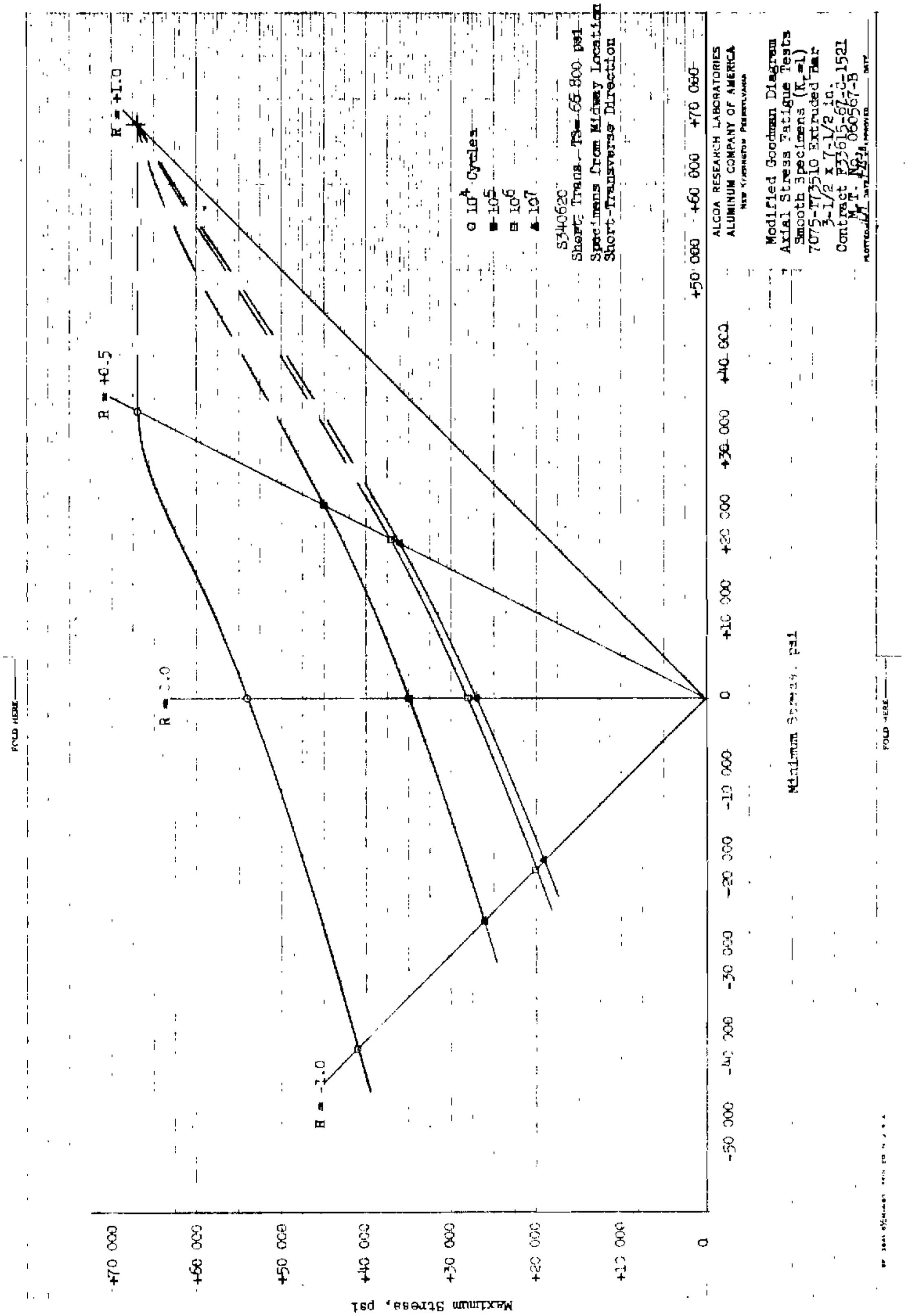

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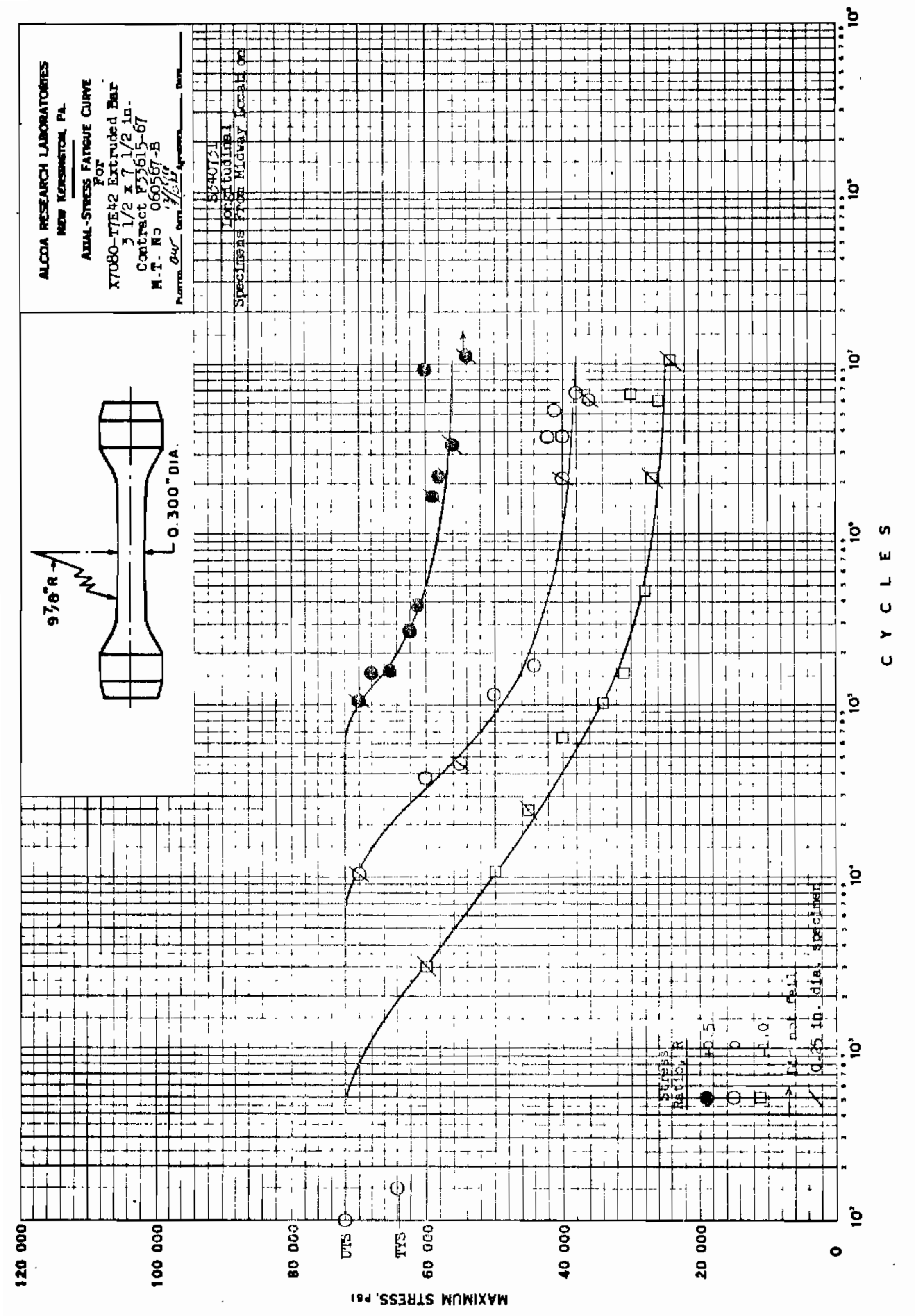

Fig. 65

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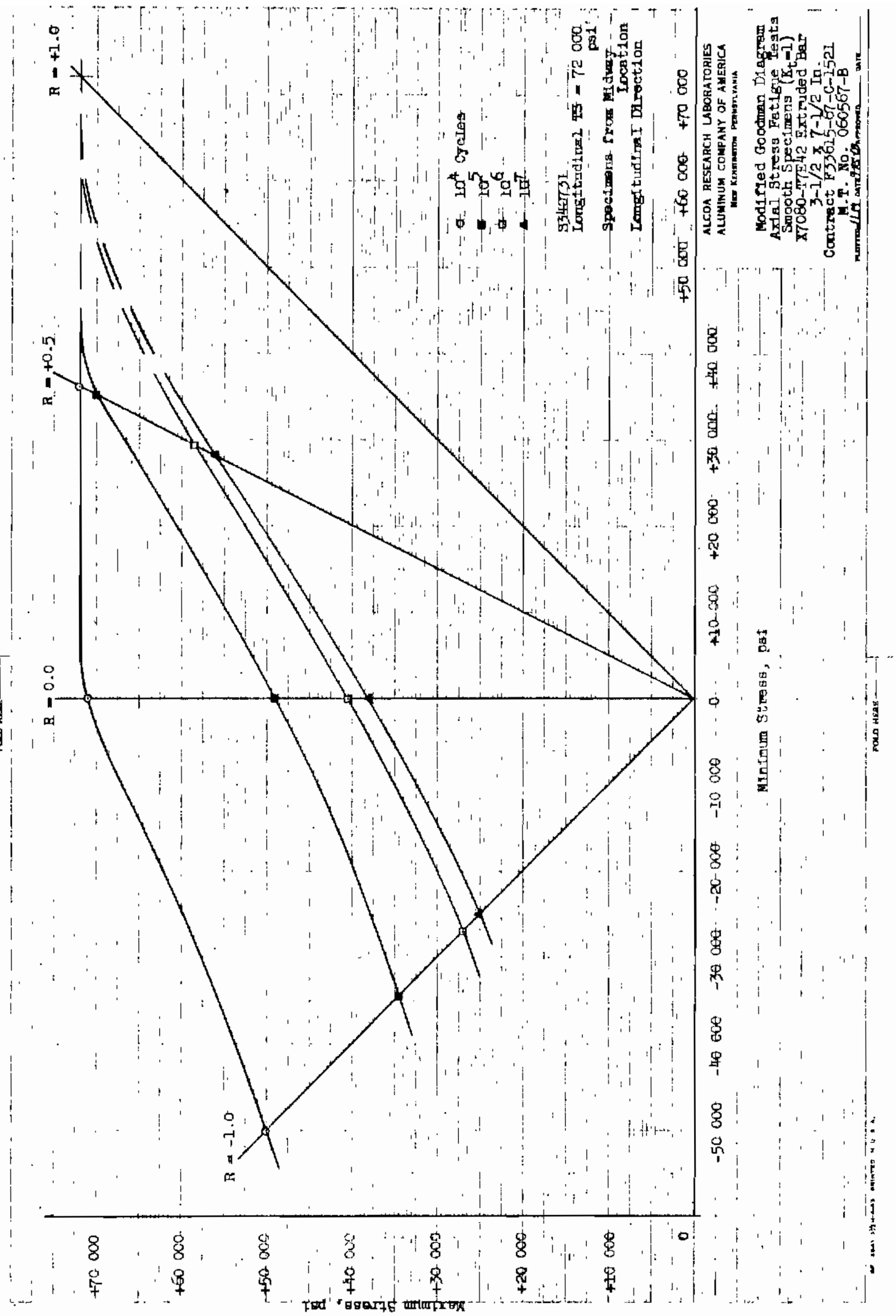

Fig. 66

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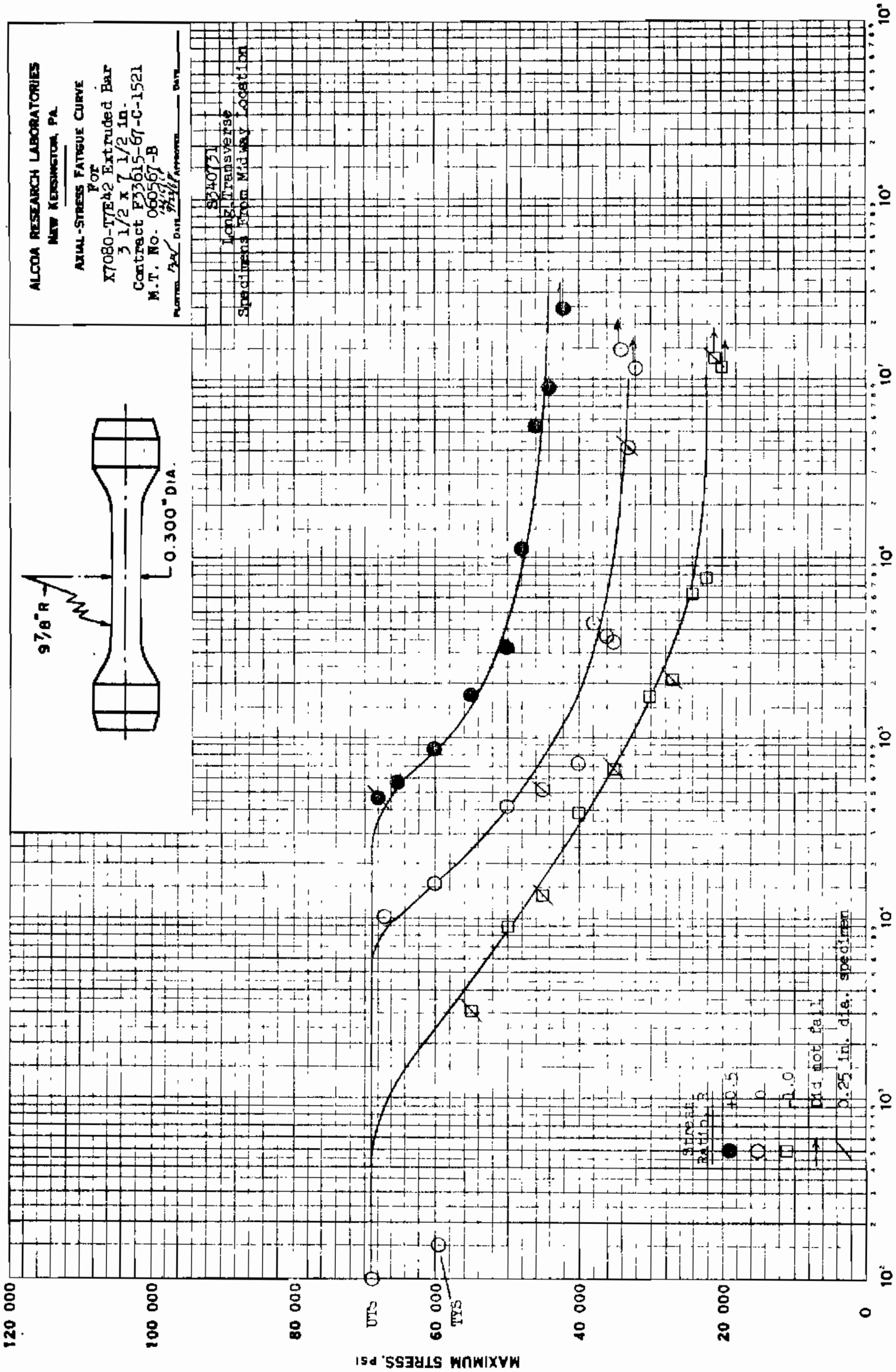

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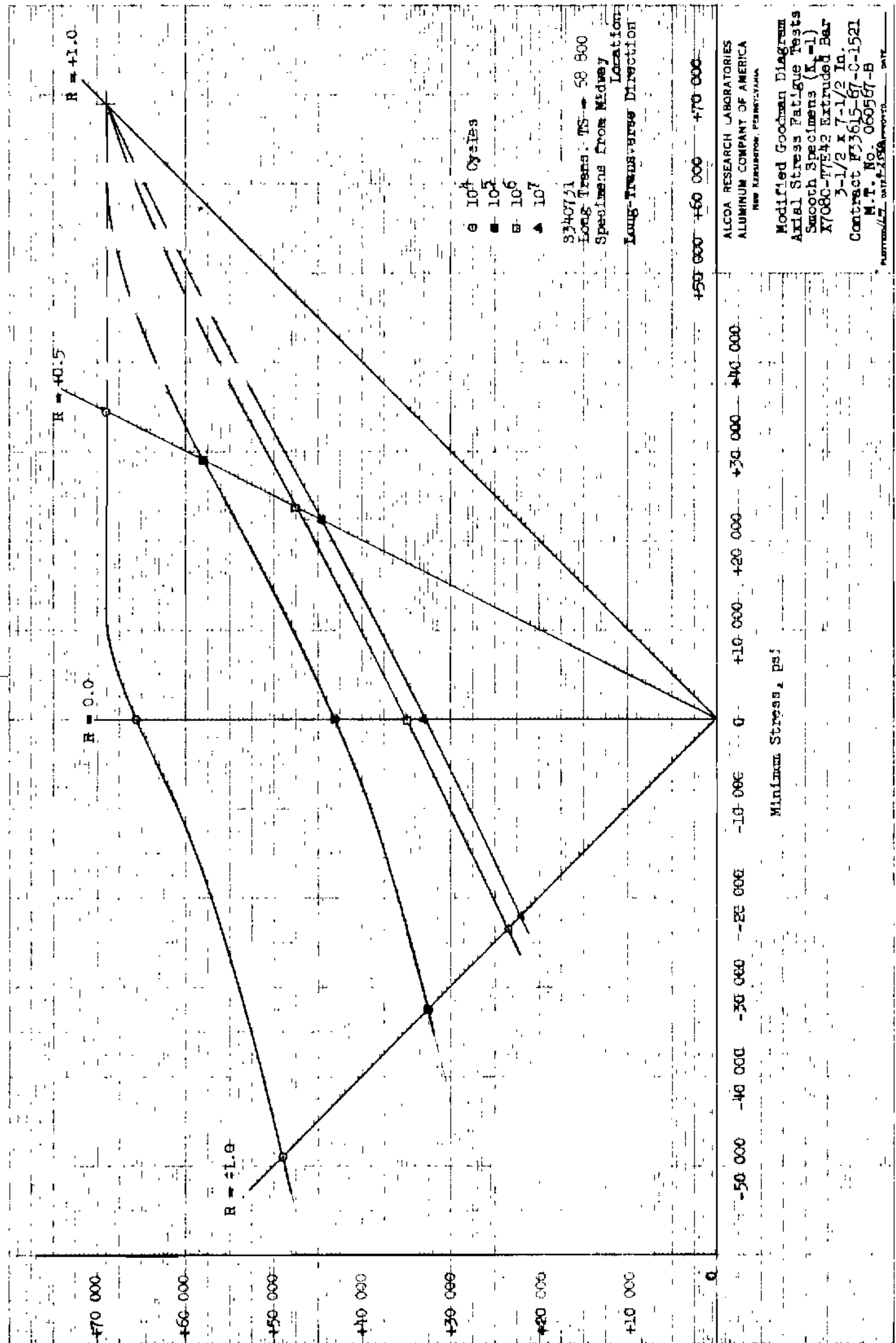

Fig. 68

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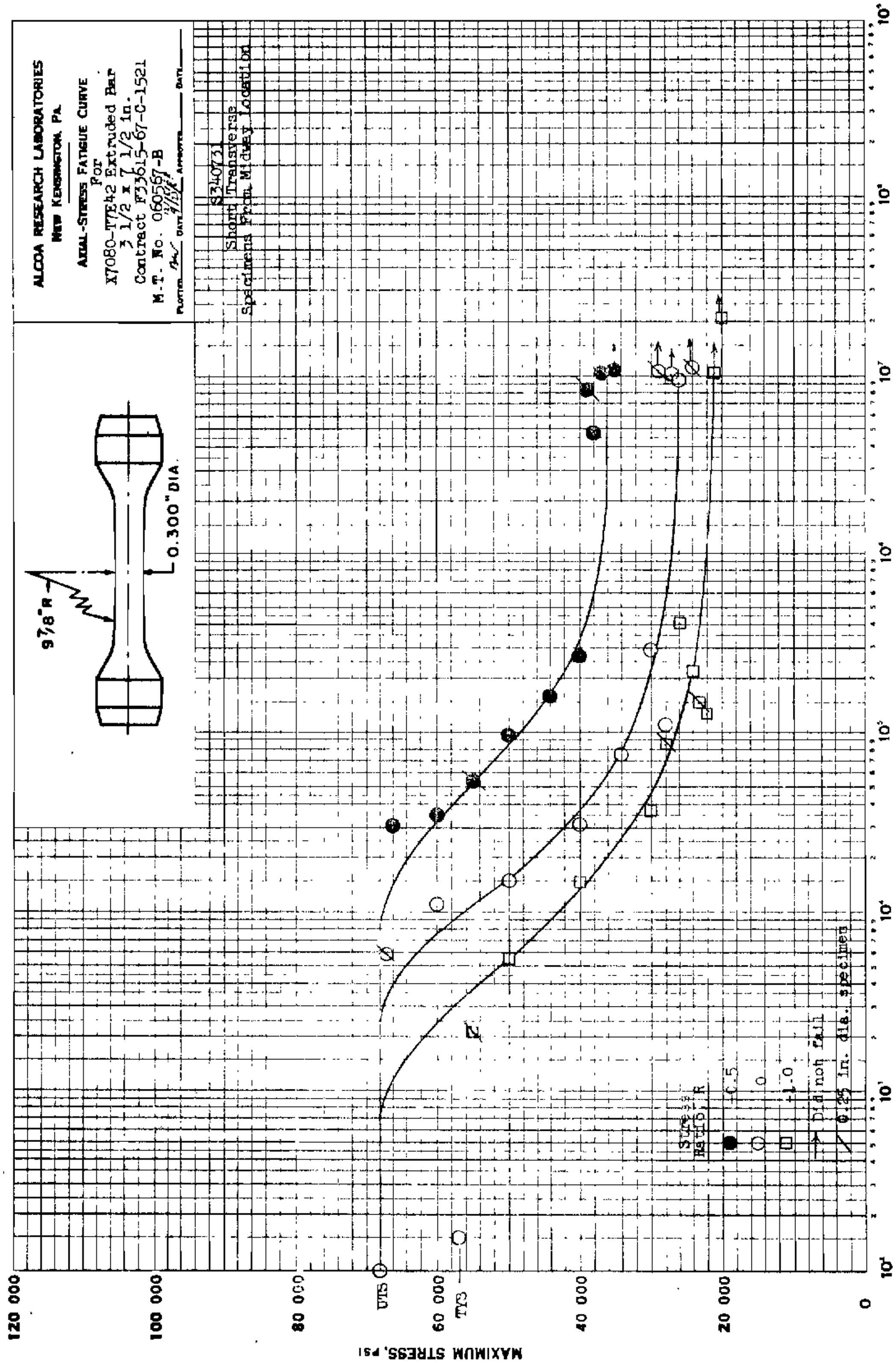

Fig. 69

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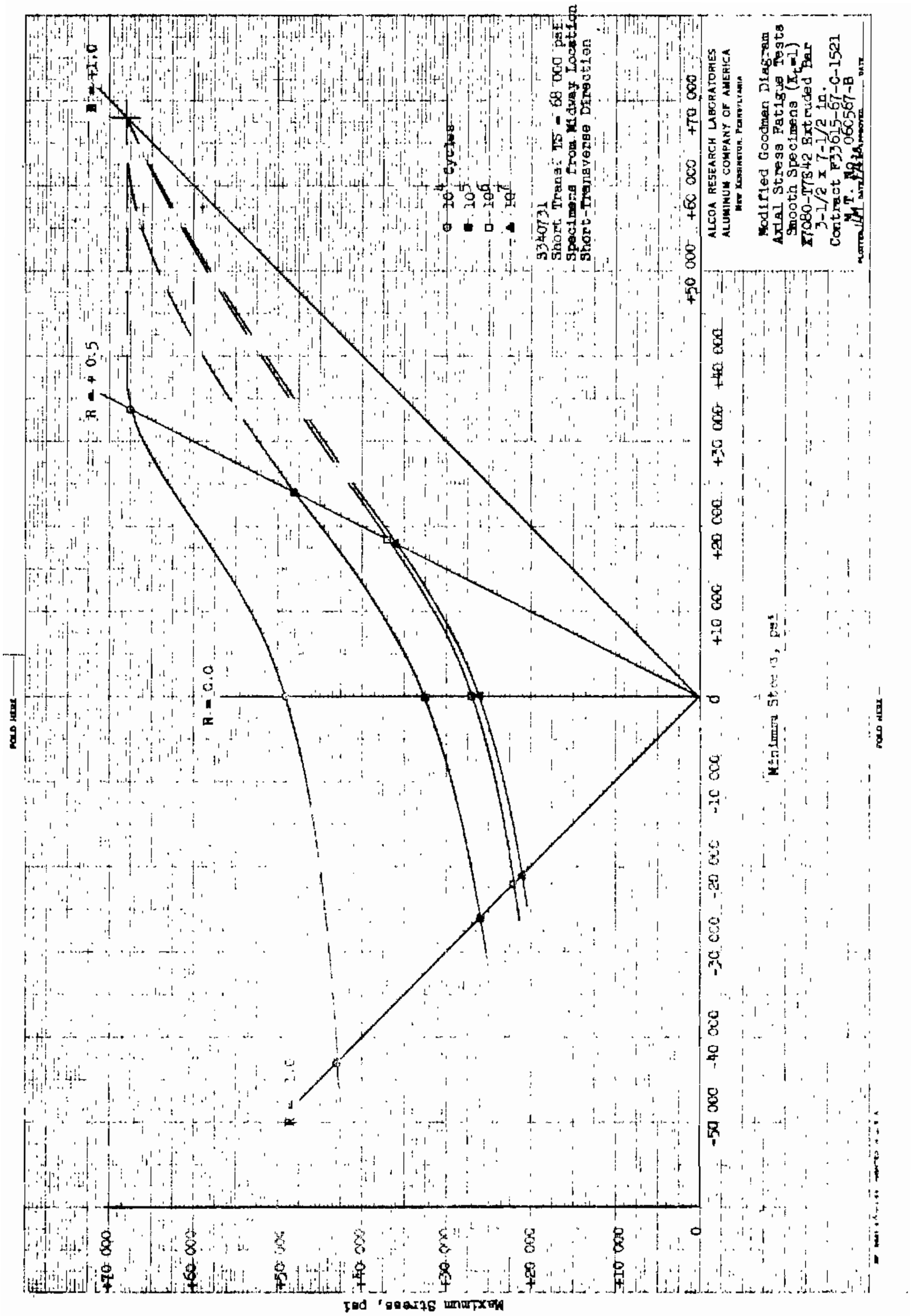

Fig. 70

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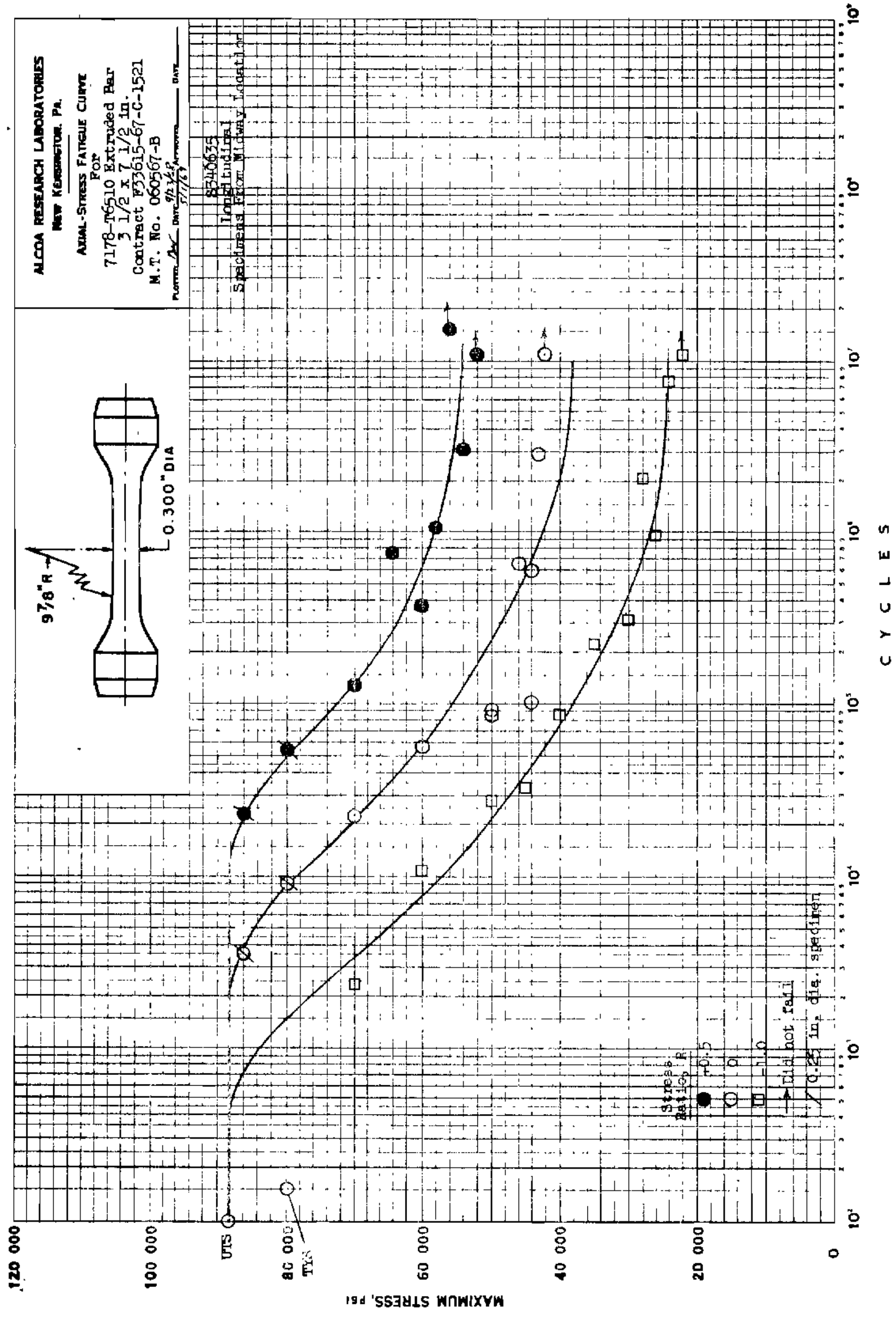

Fig. 71

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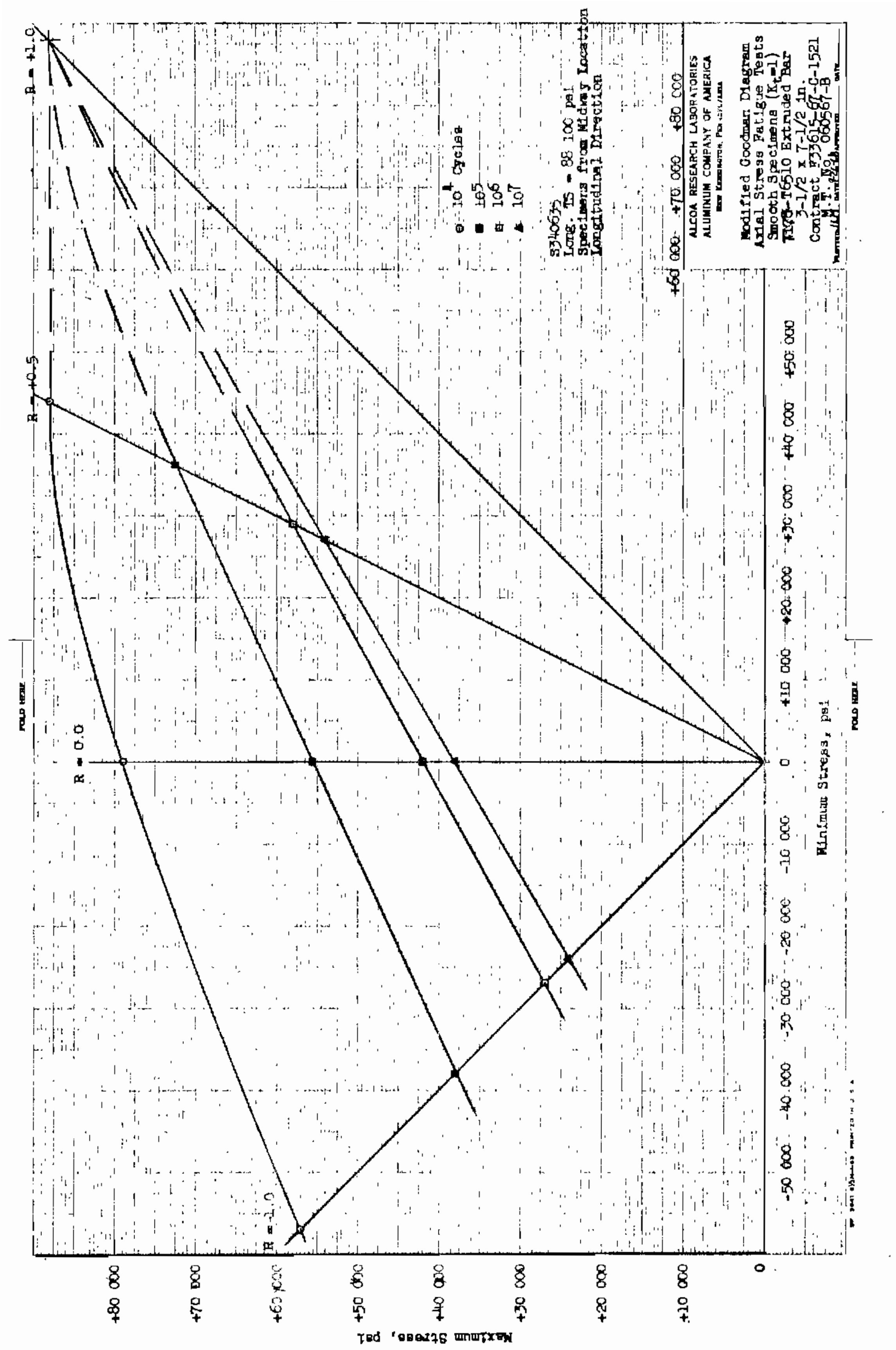

Fig. 72

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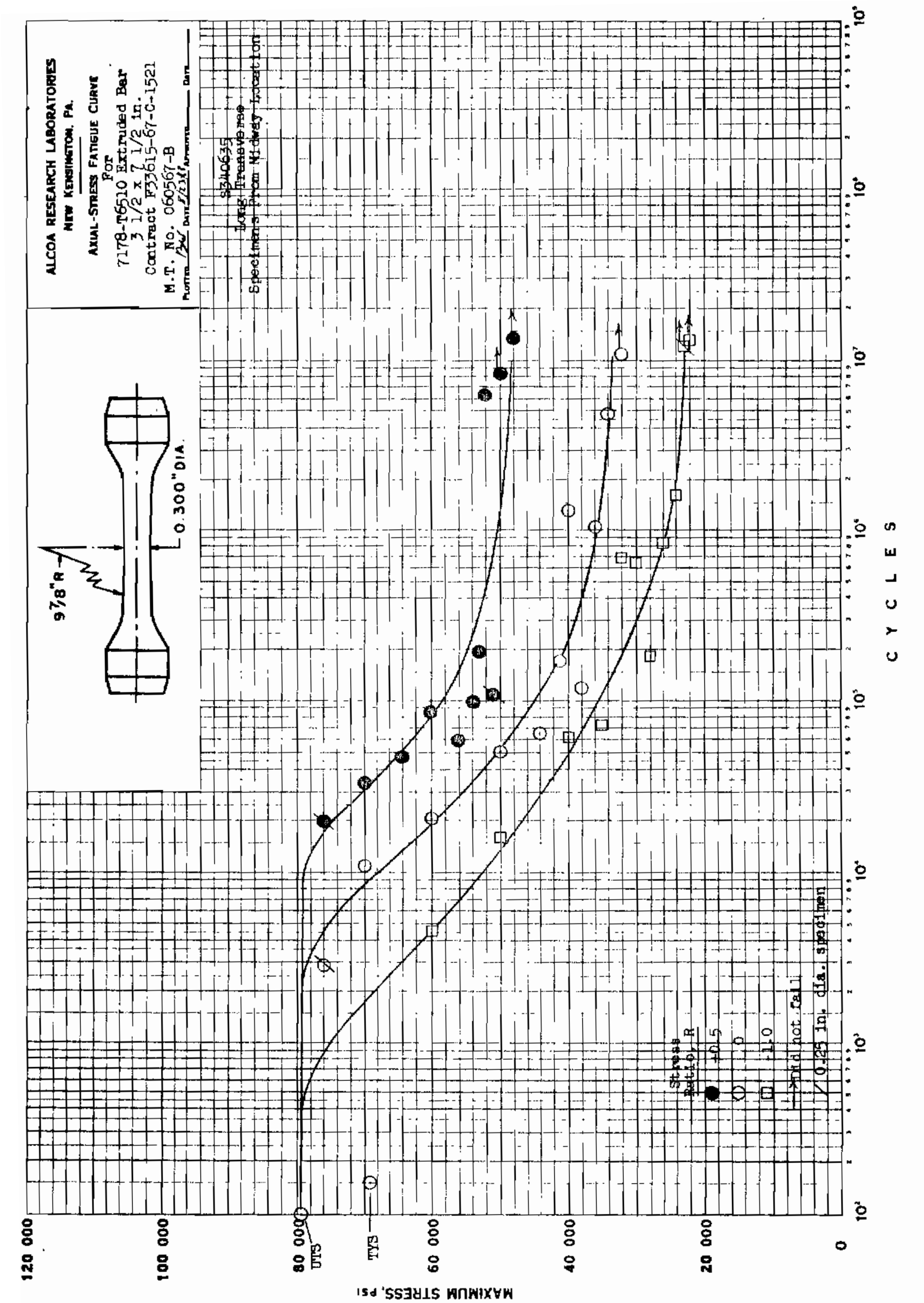

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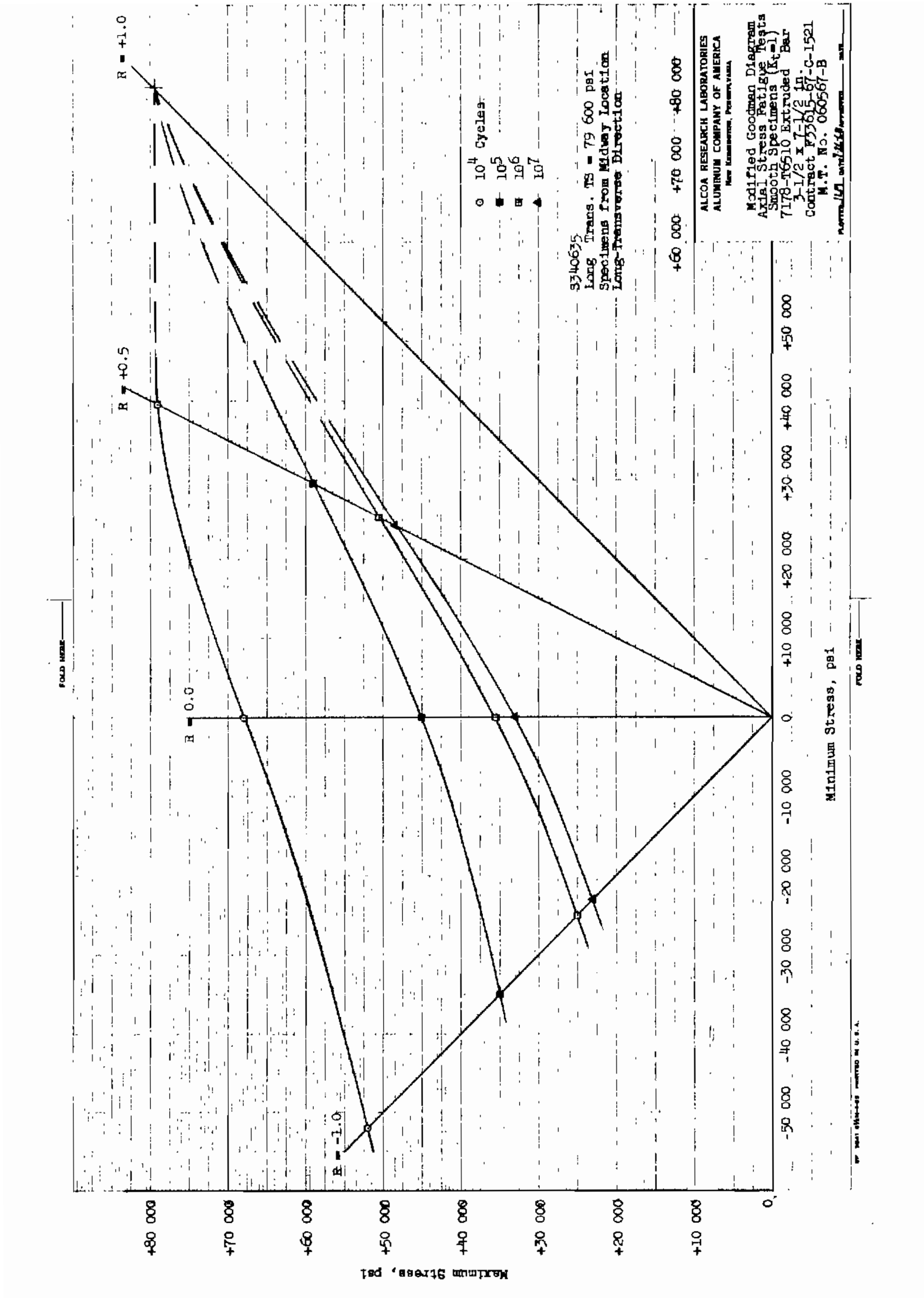

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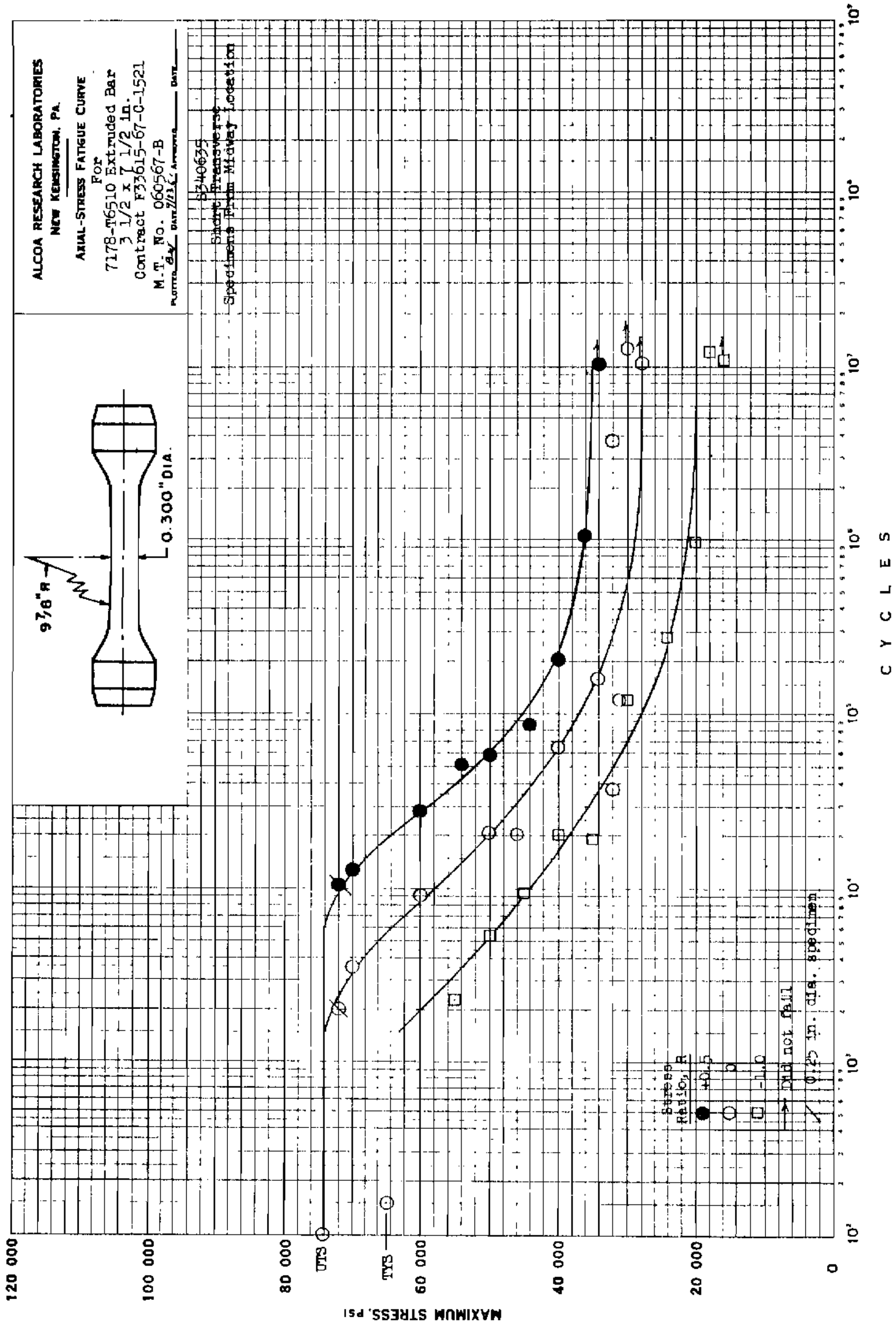

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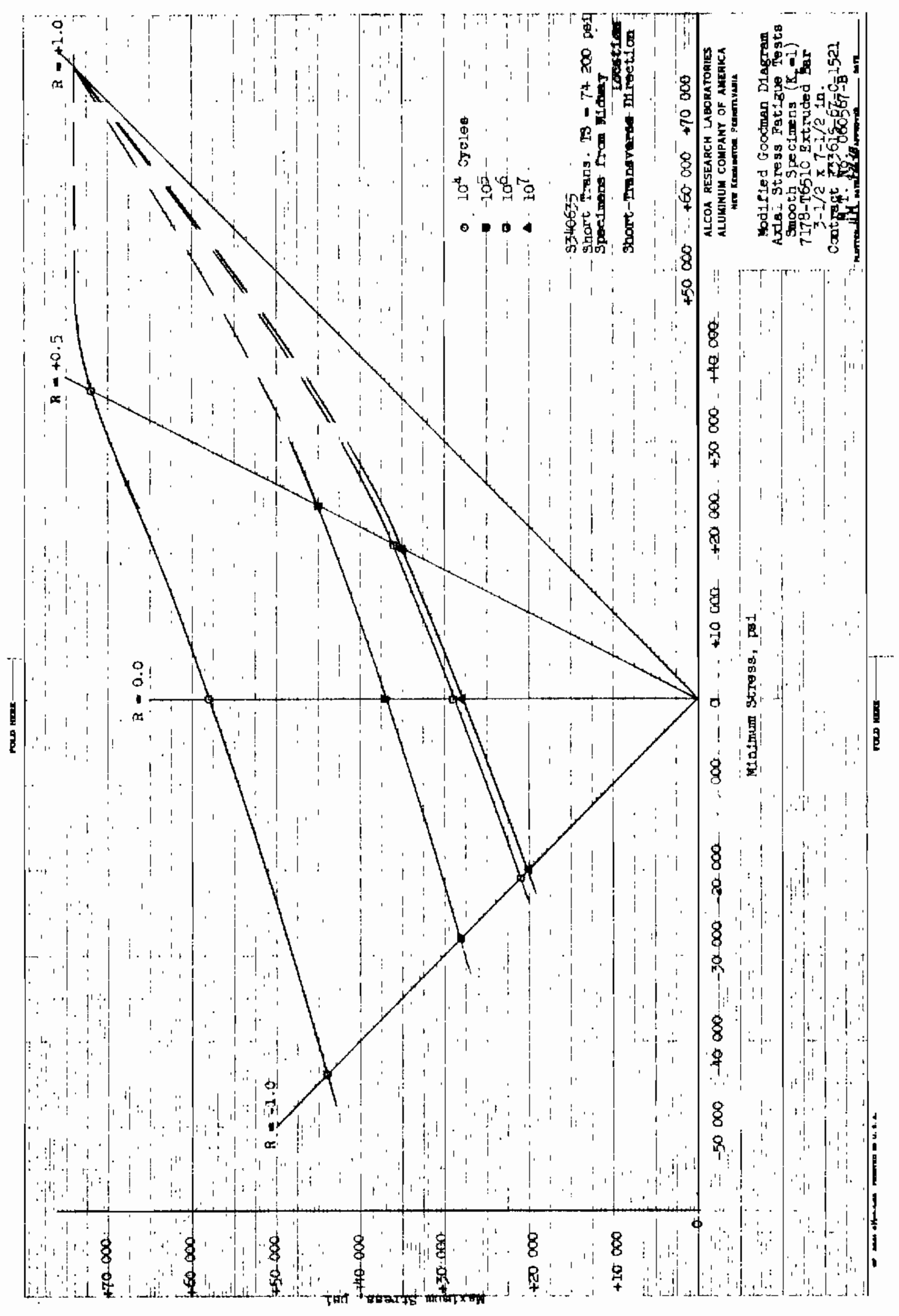

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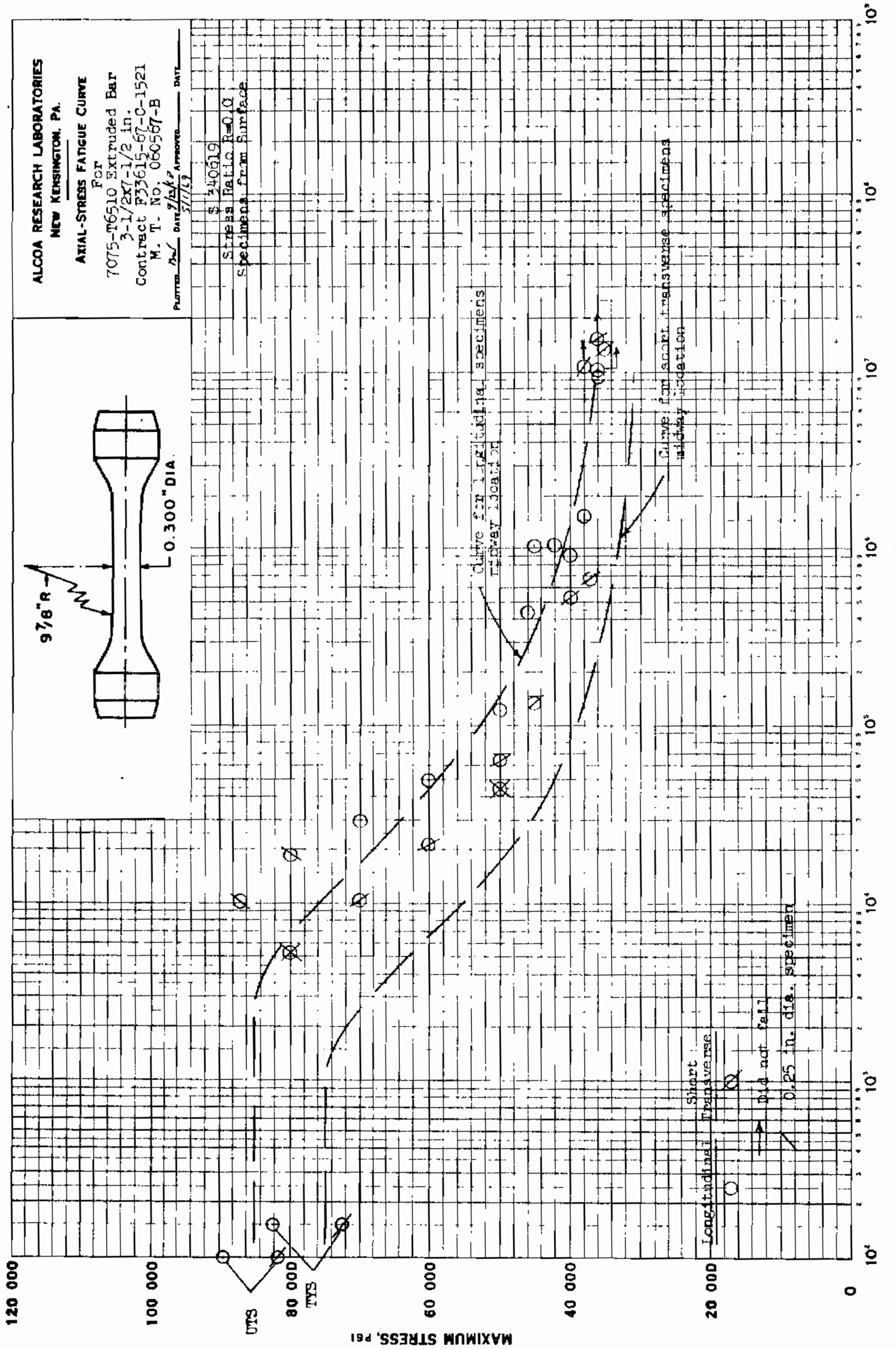

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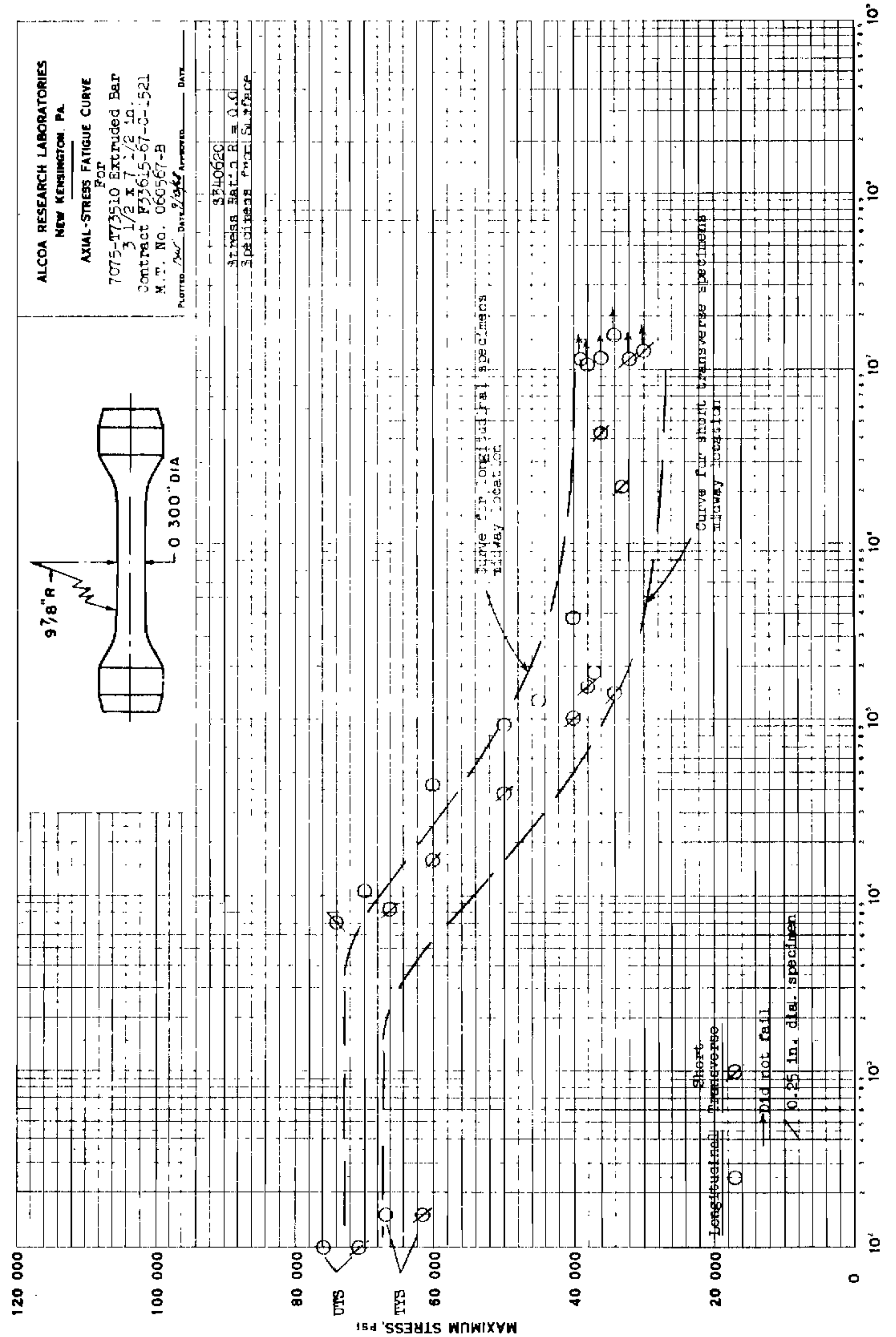

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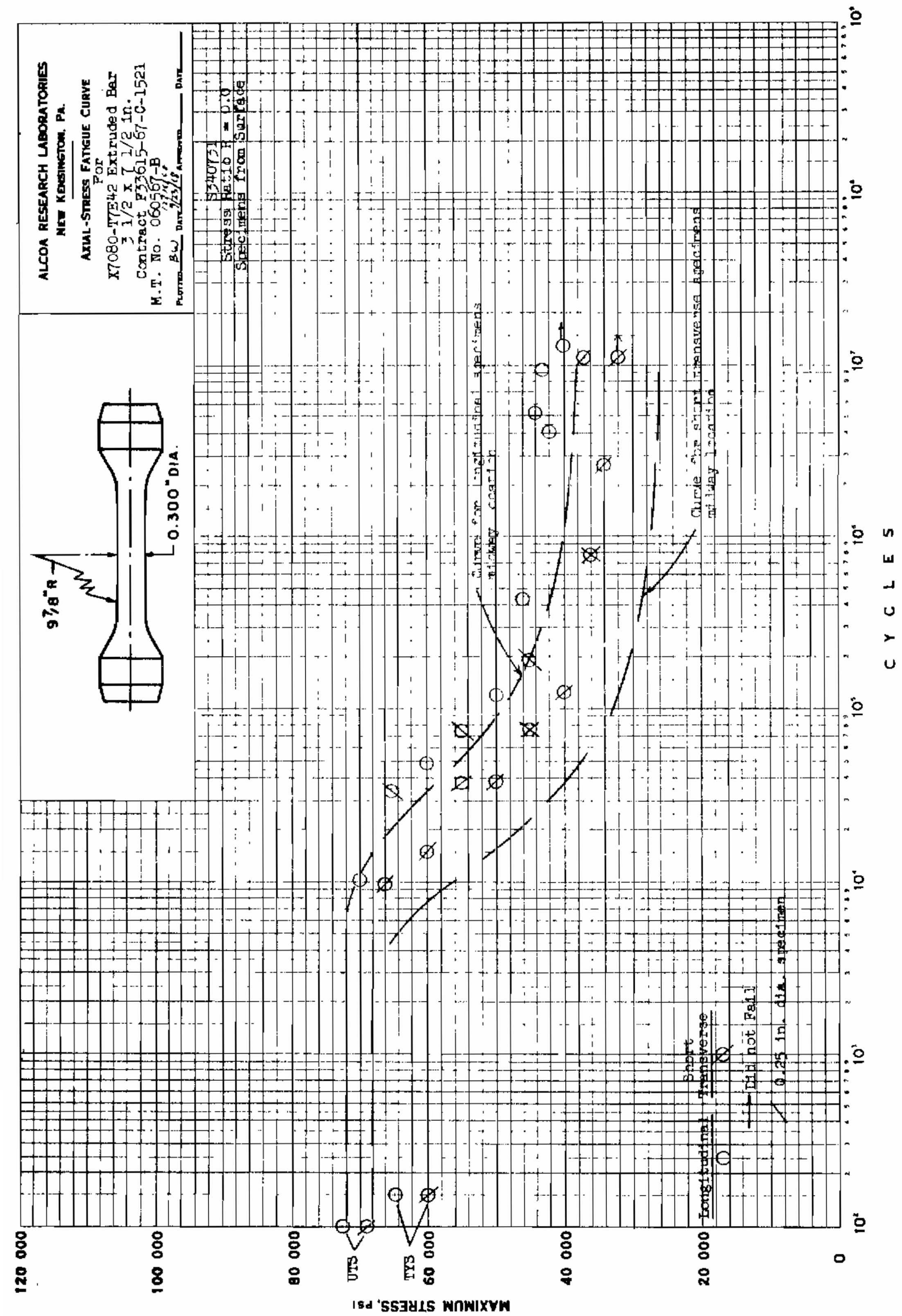

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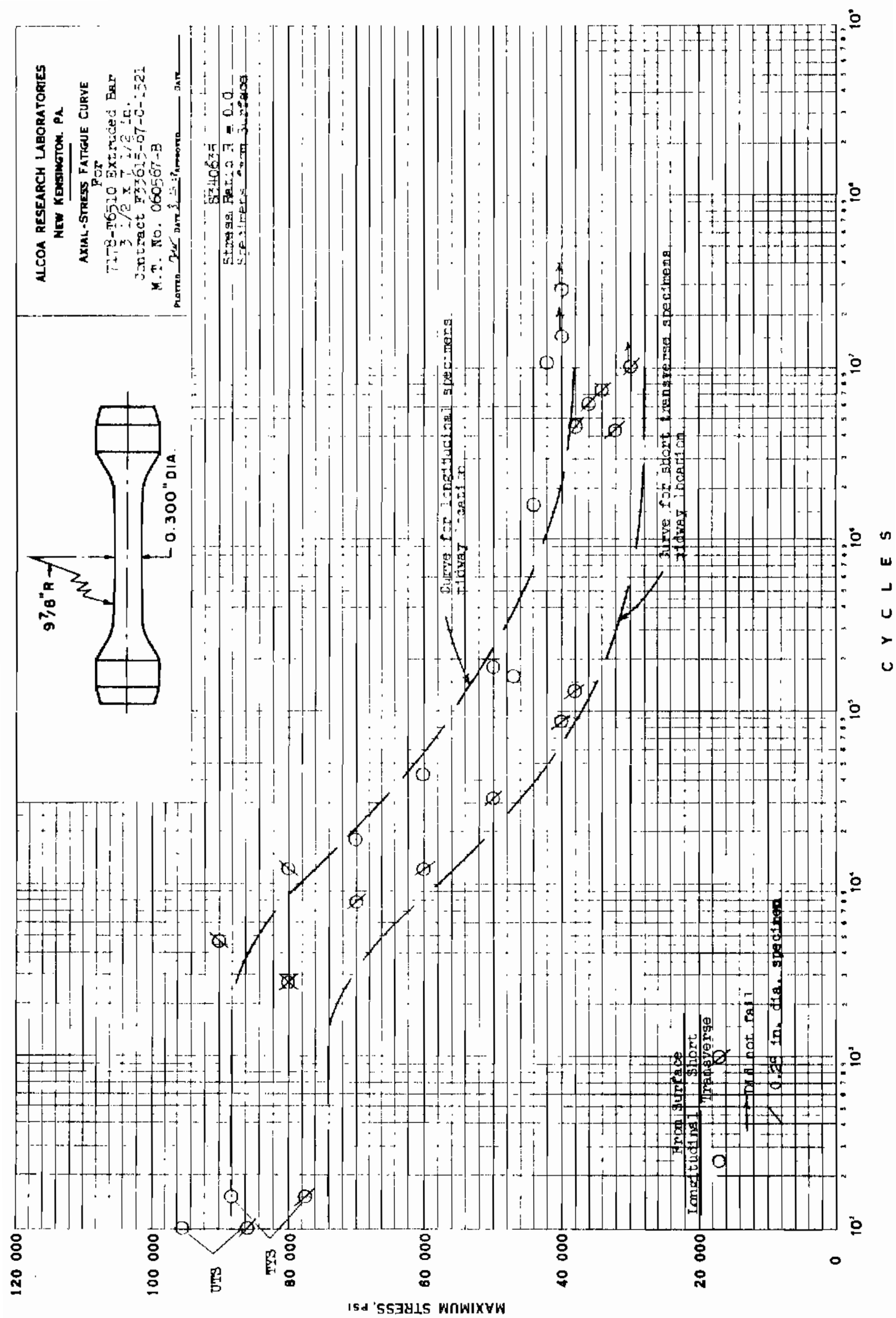

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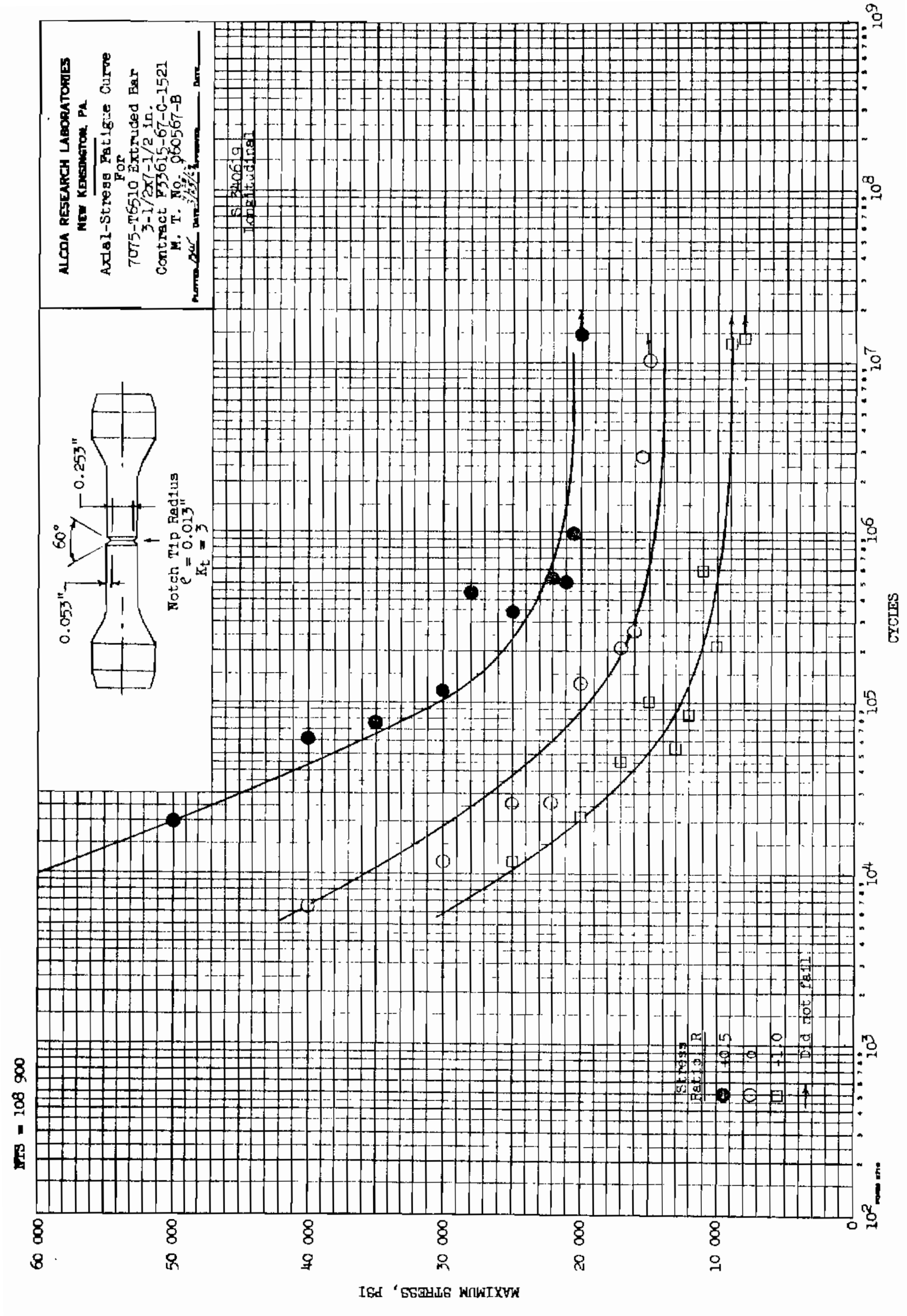

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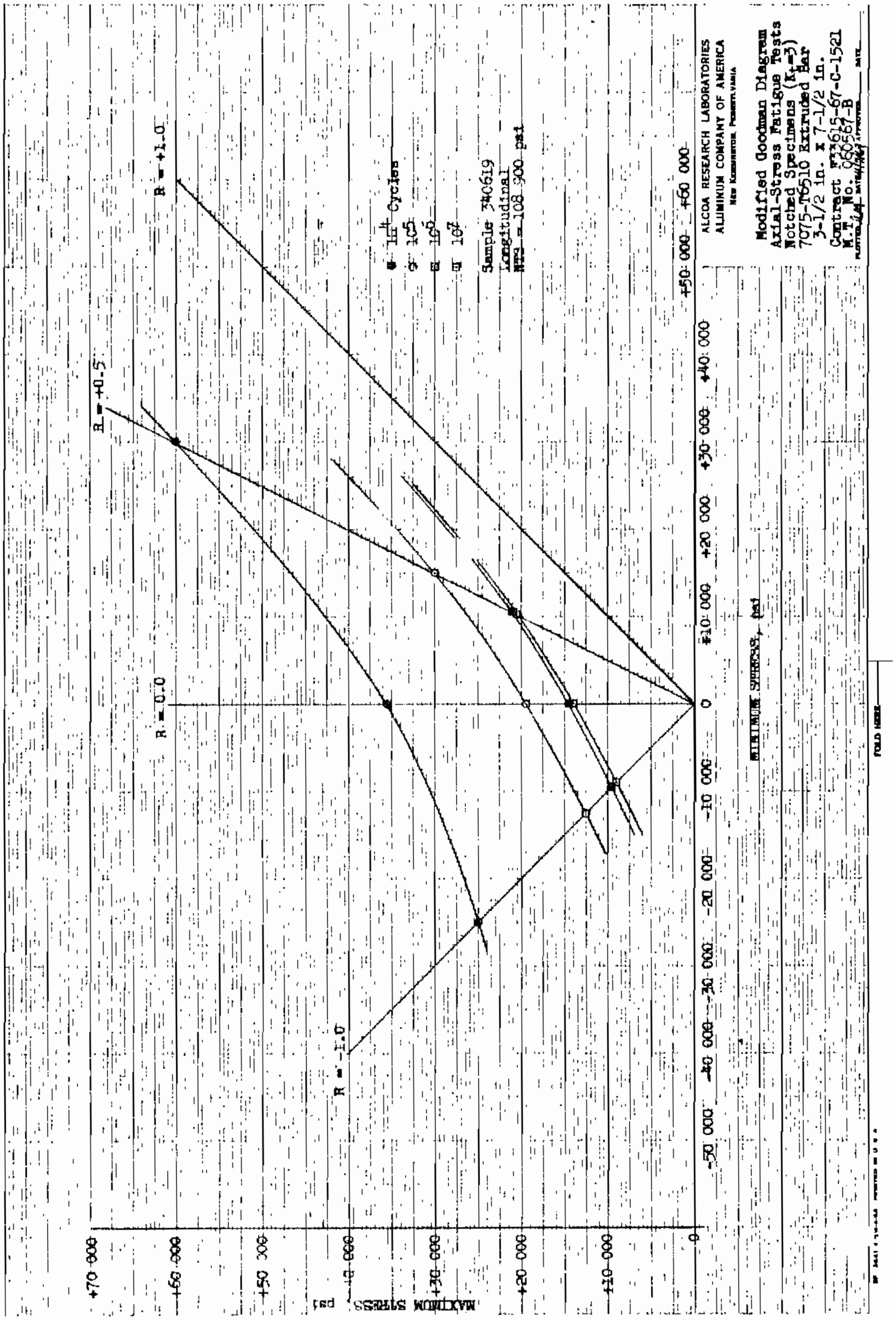

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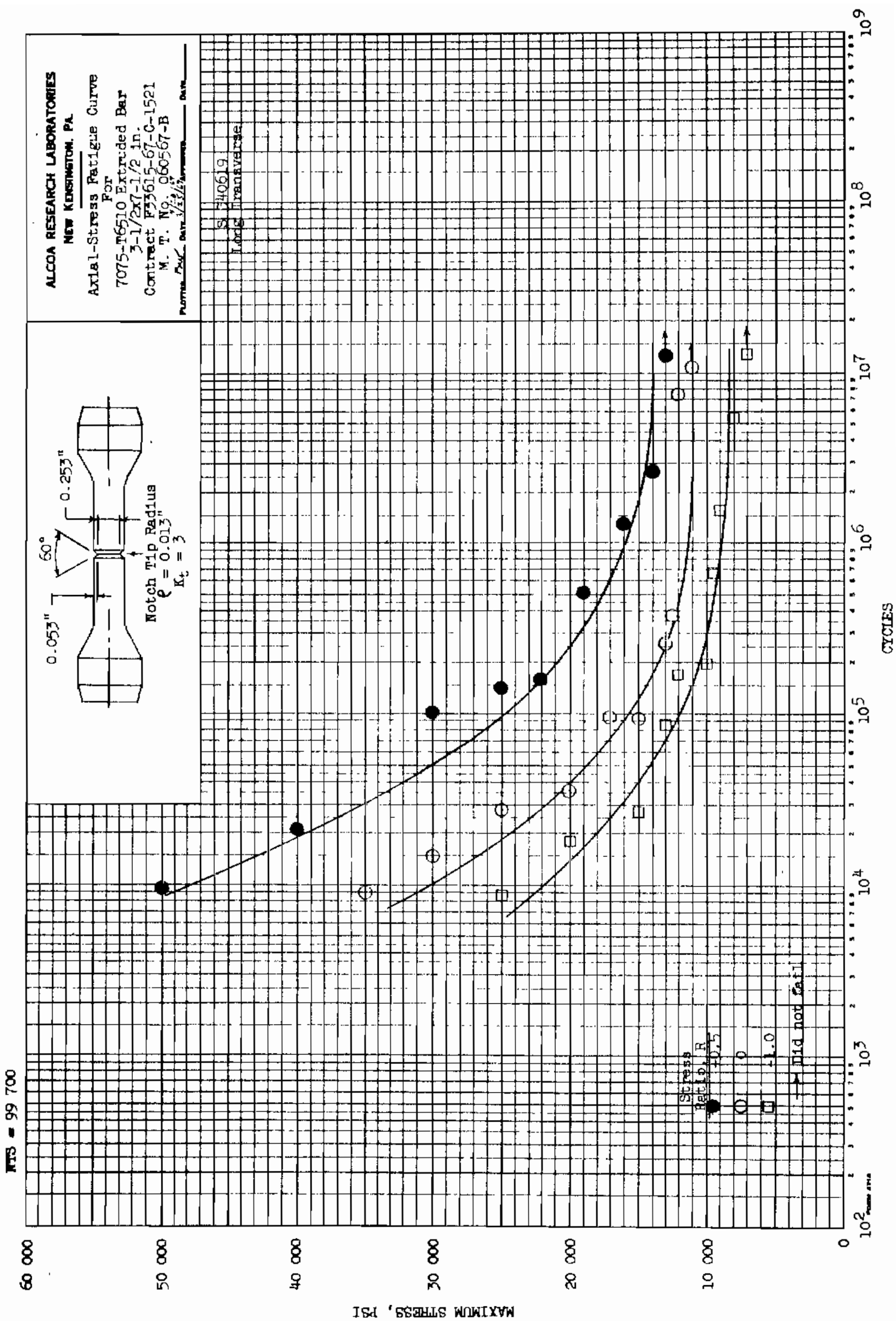

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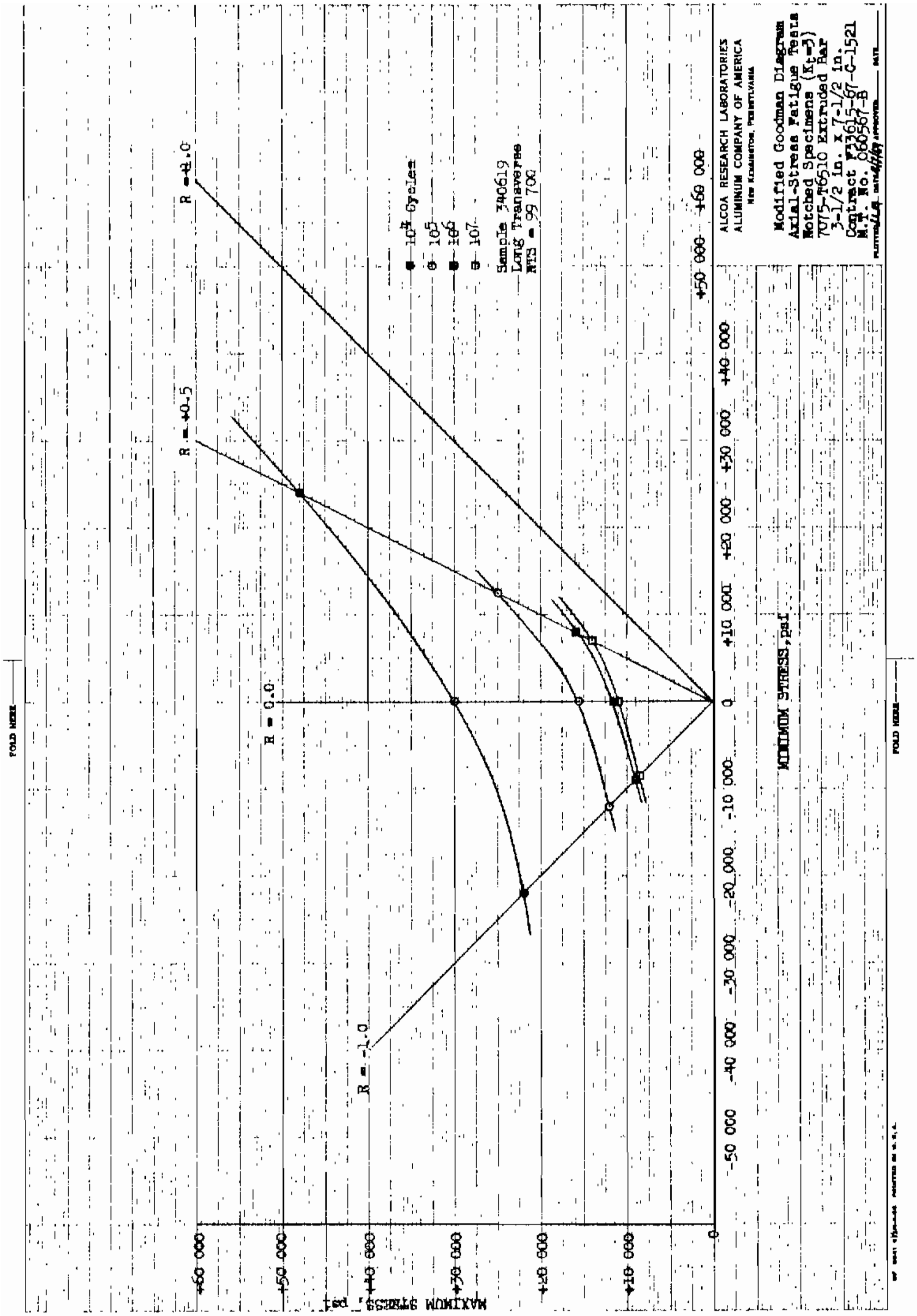

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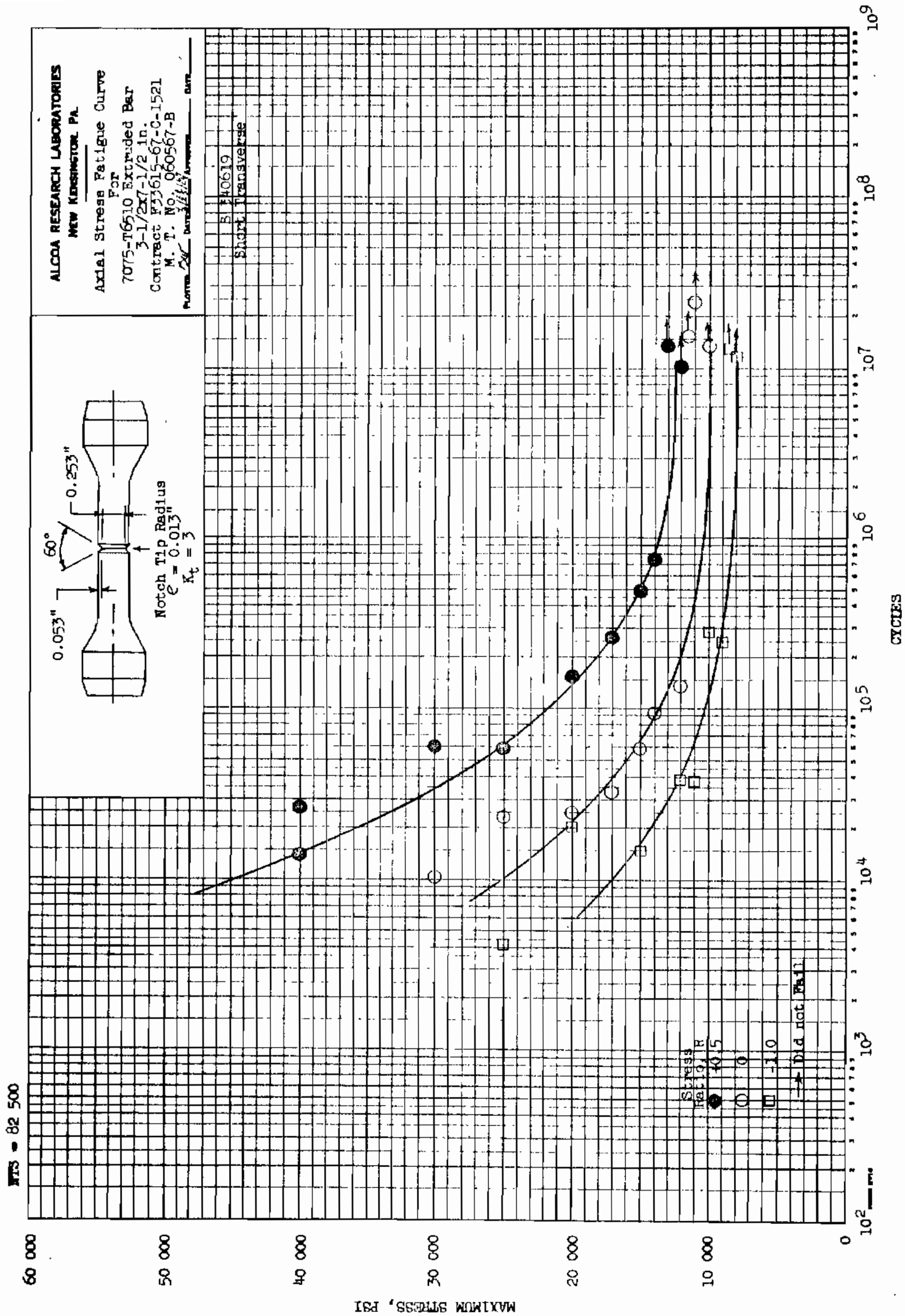

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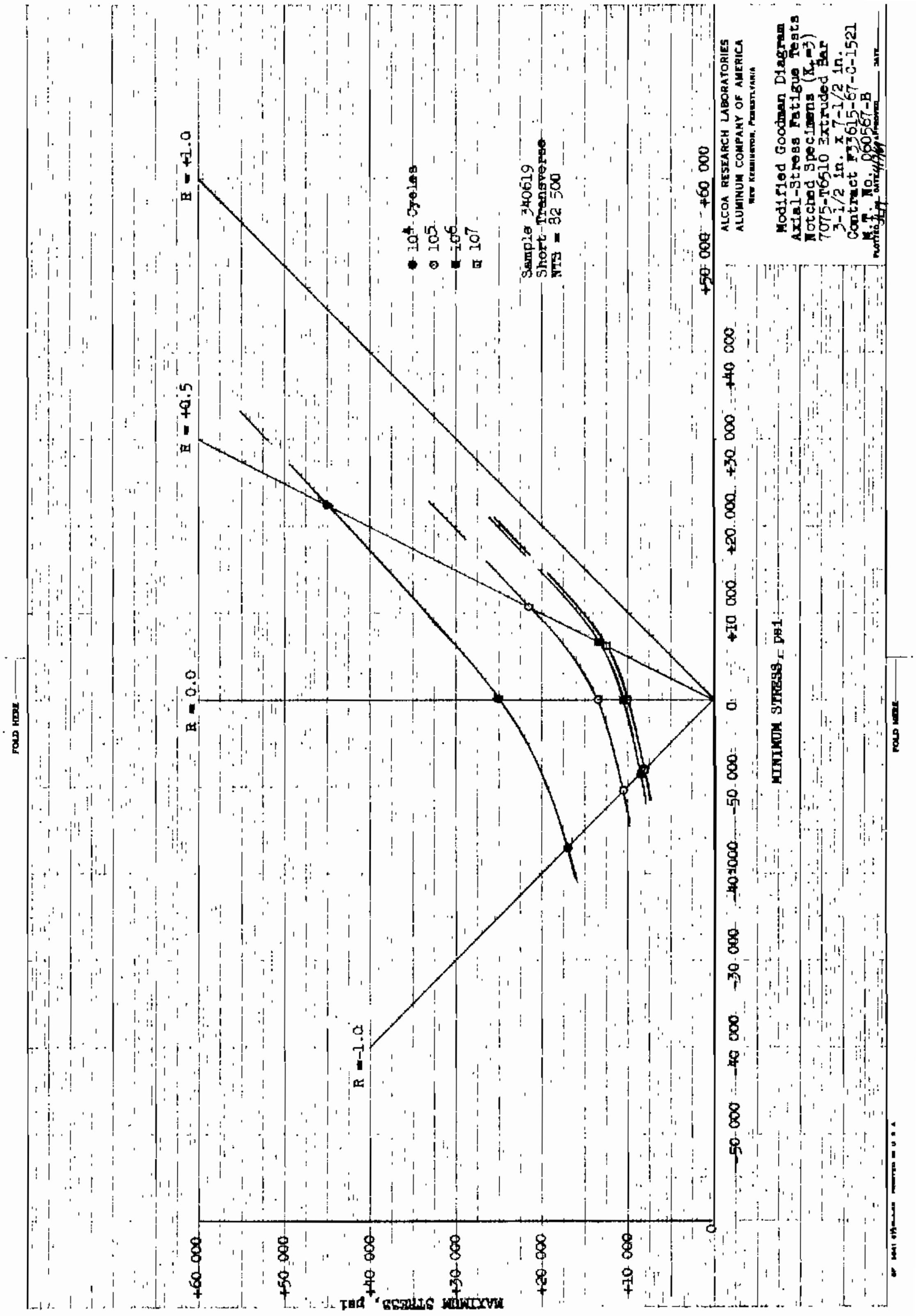

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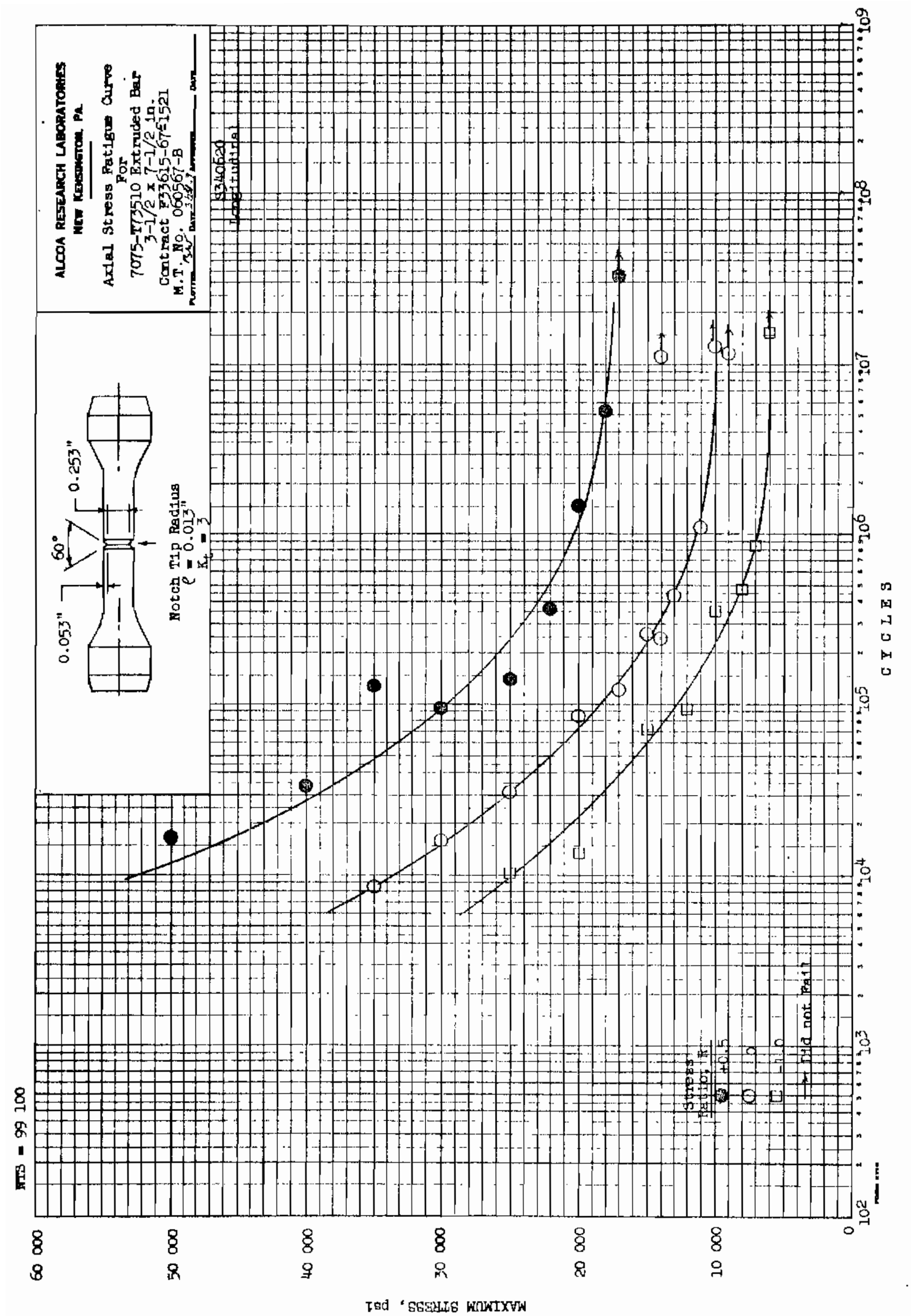

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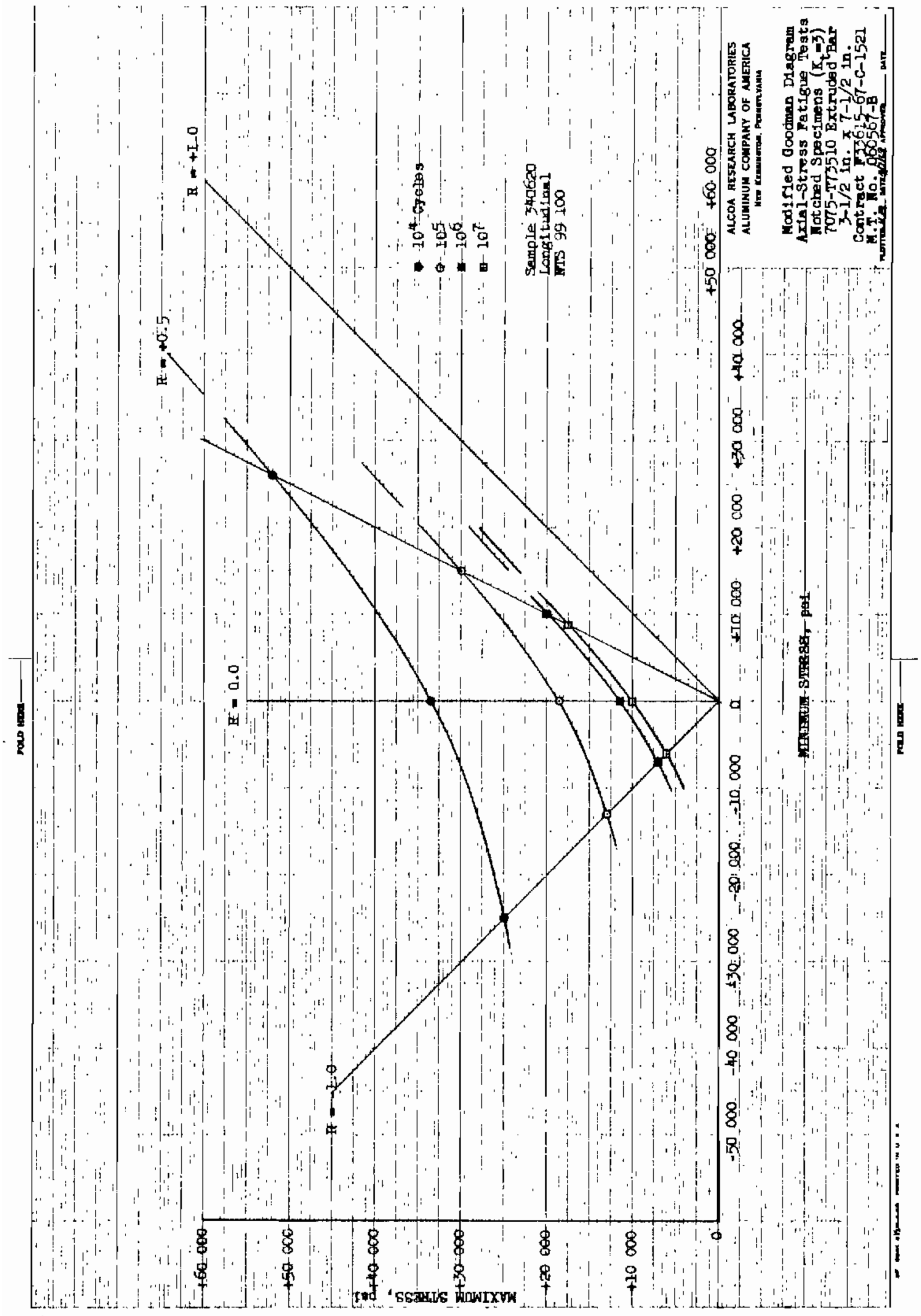

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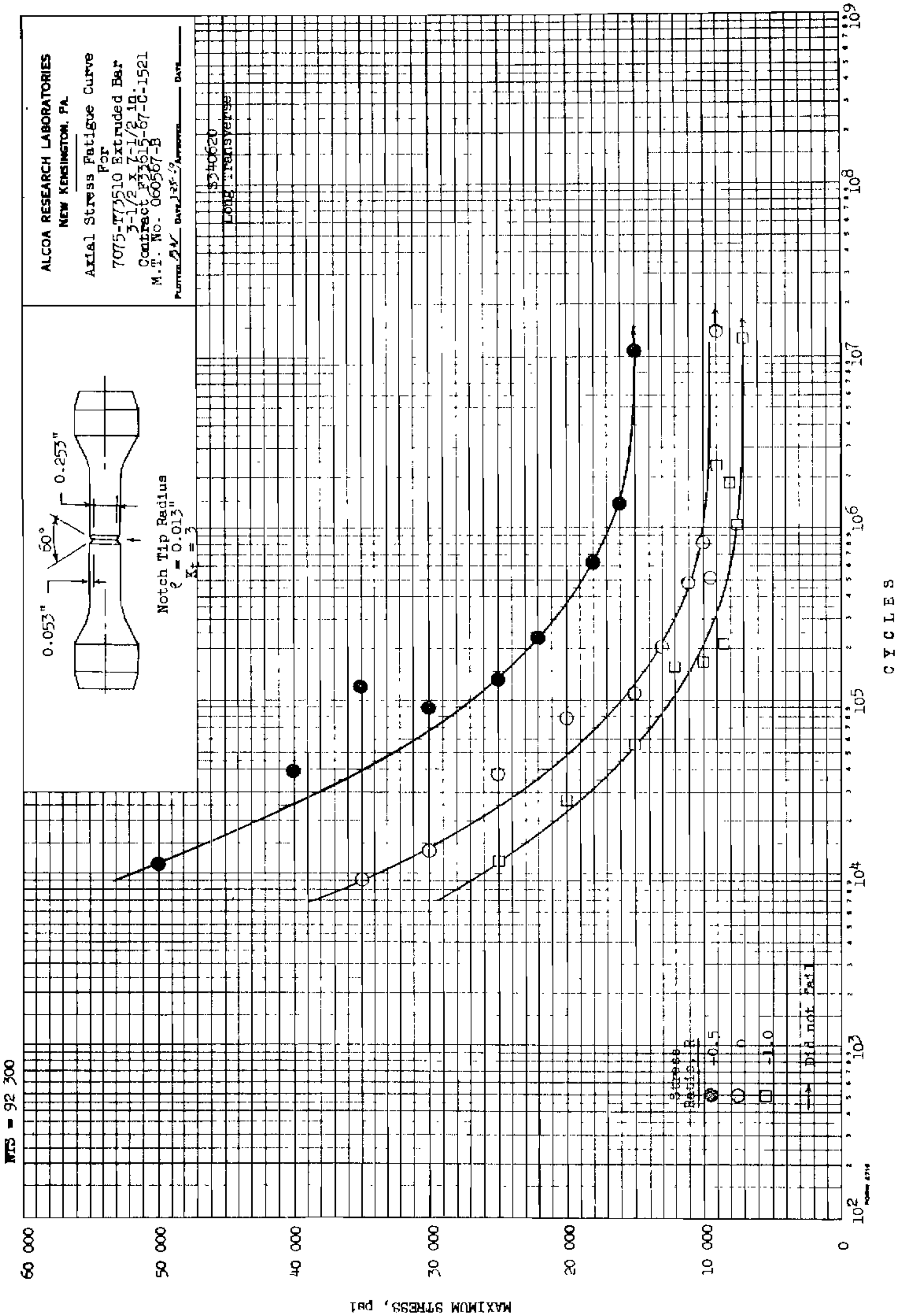

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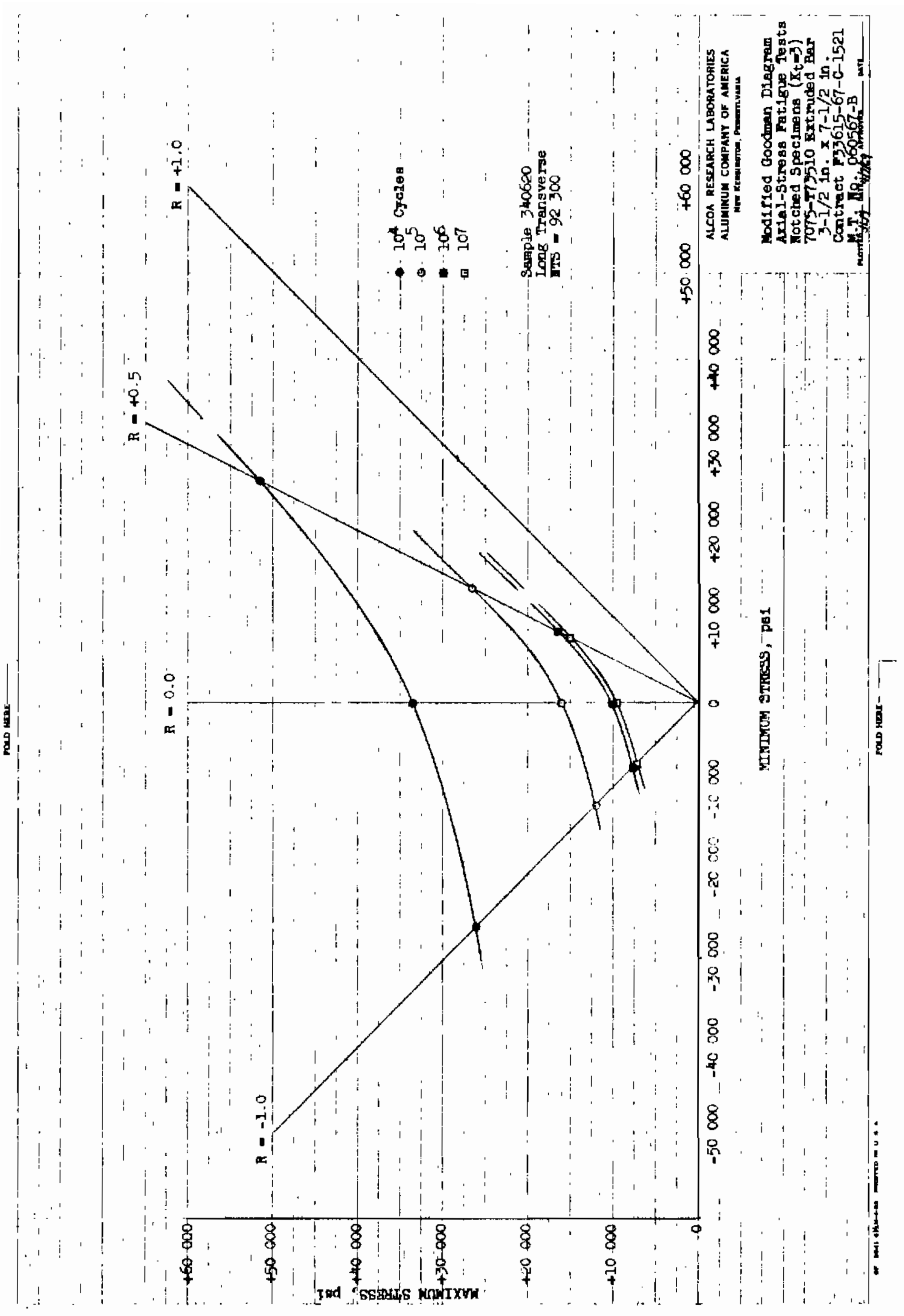

Fig. 90

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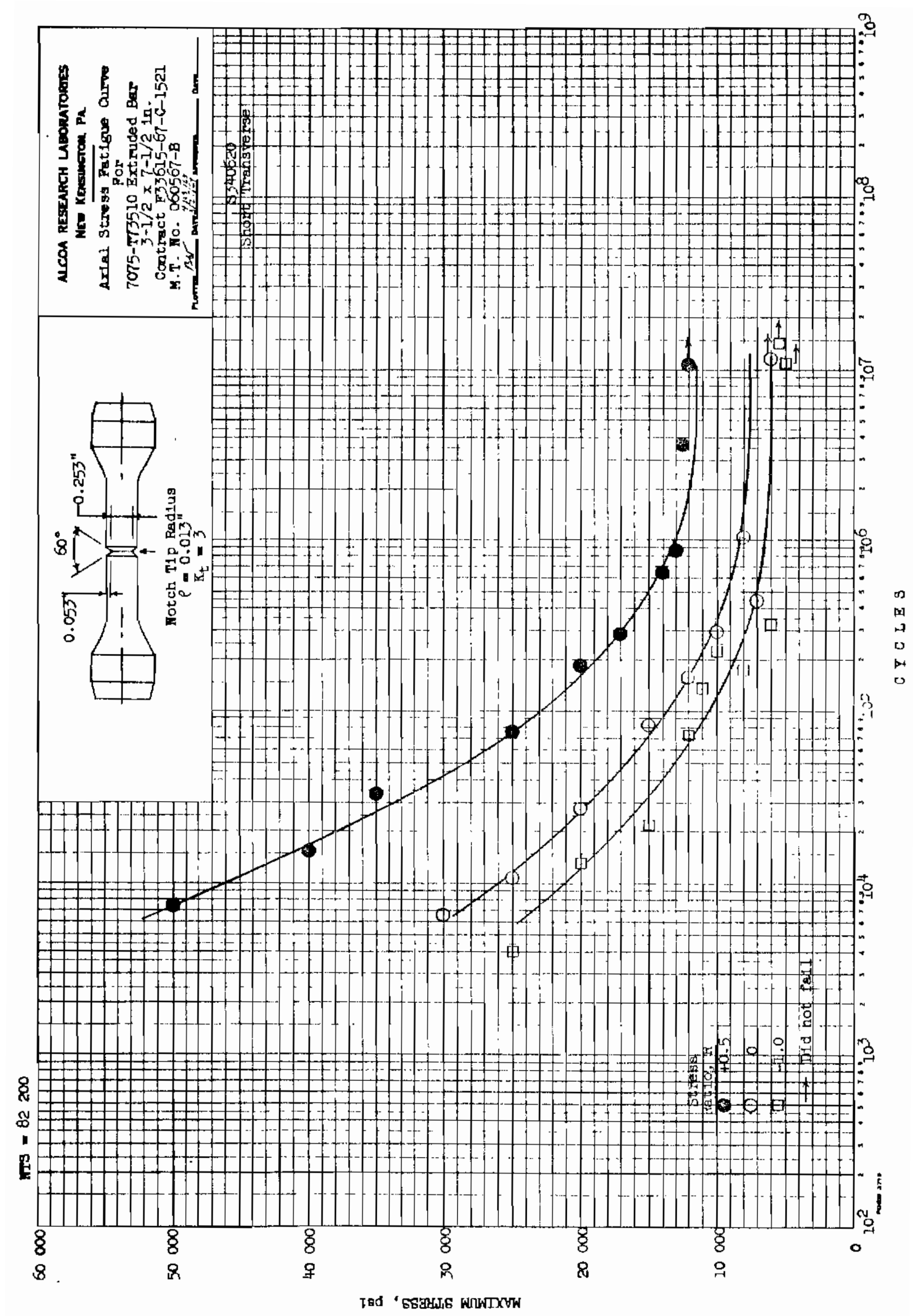

Fig. 91

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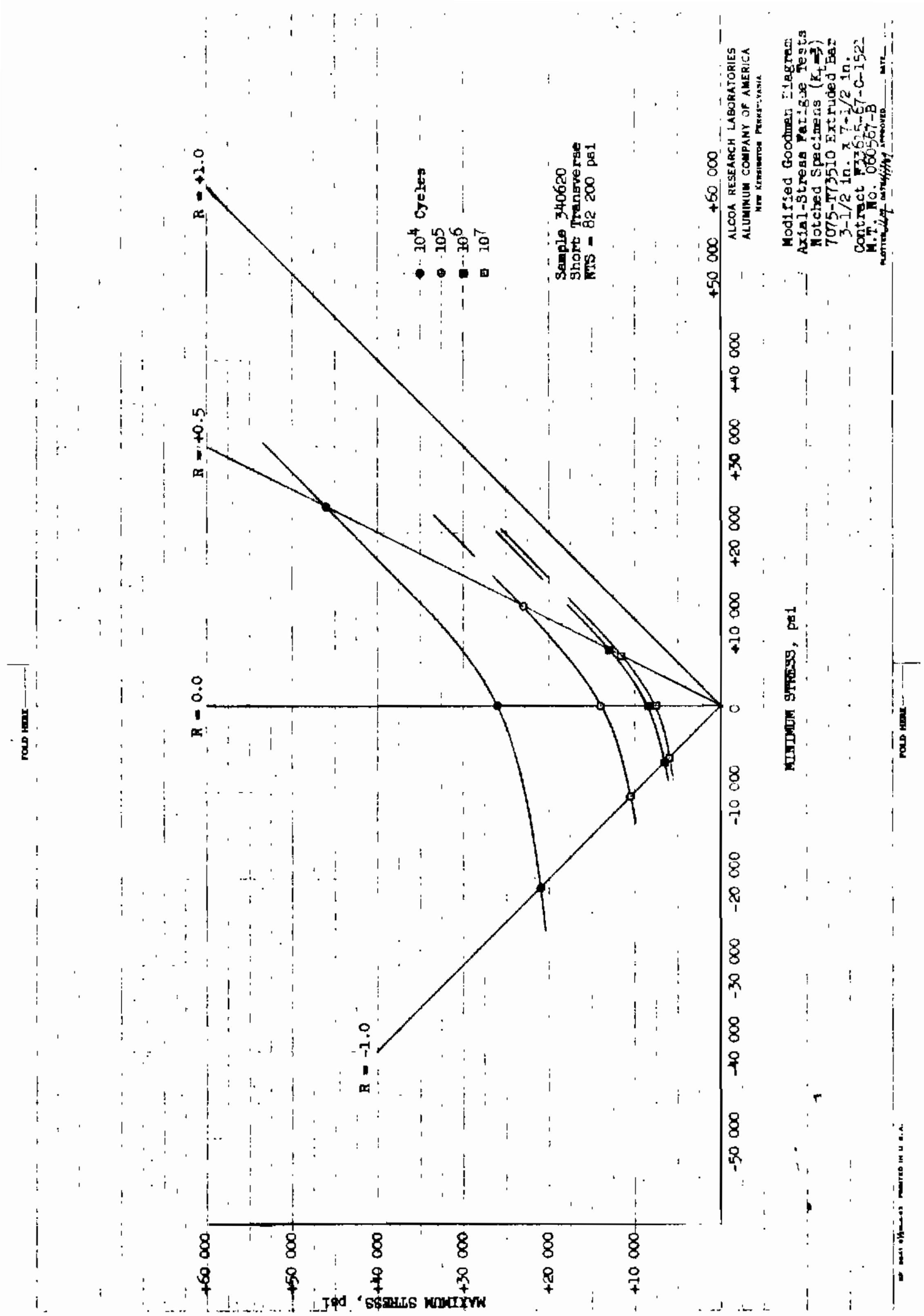

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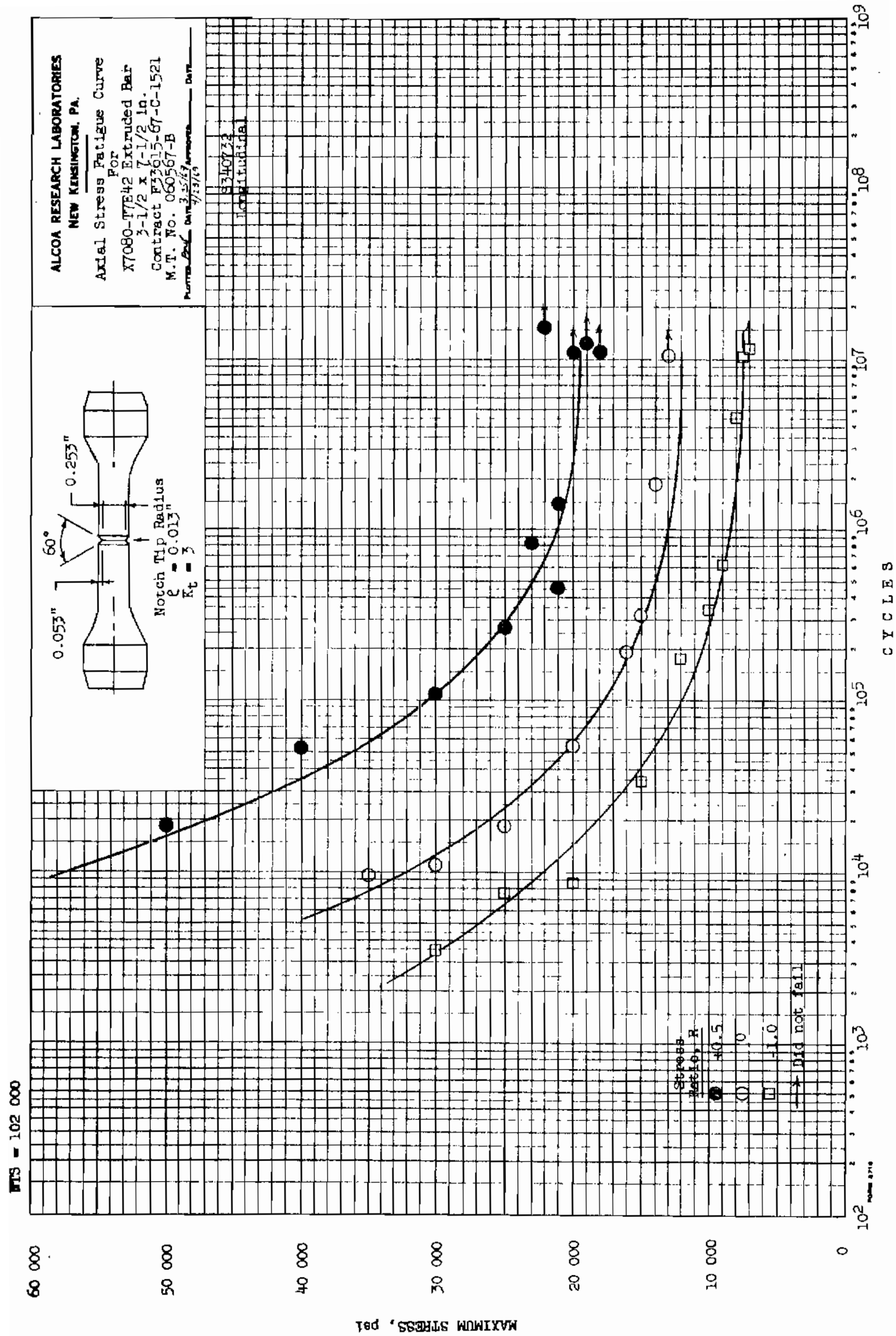

Fig. 93

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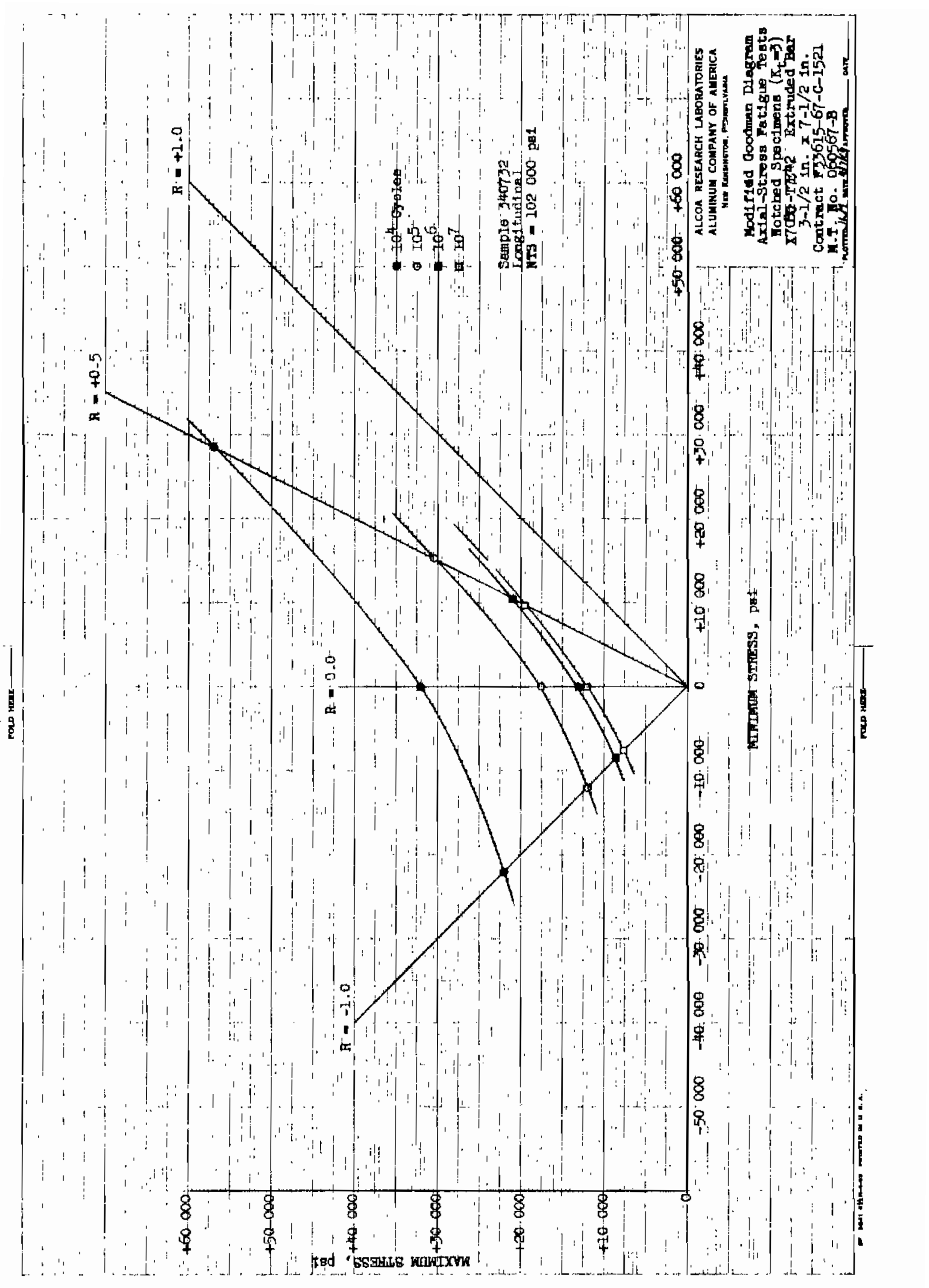

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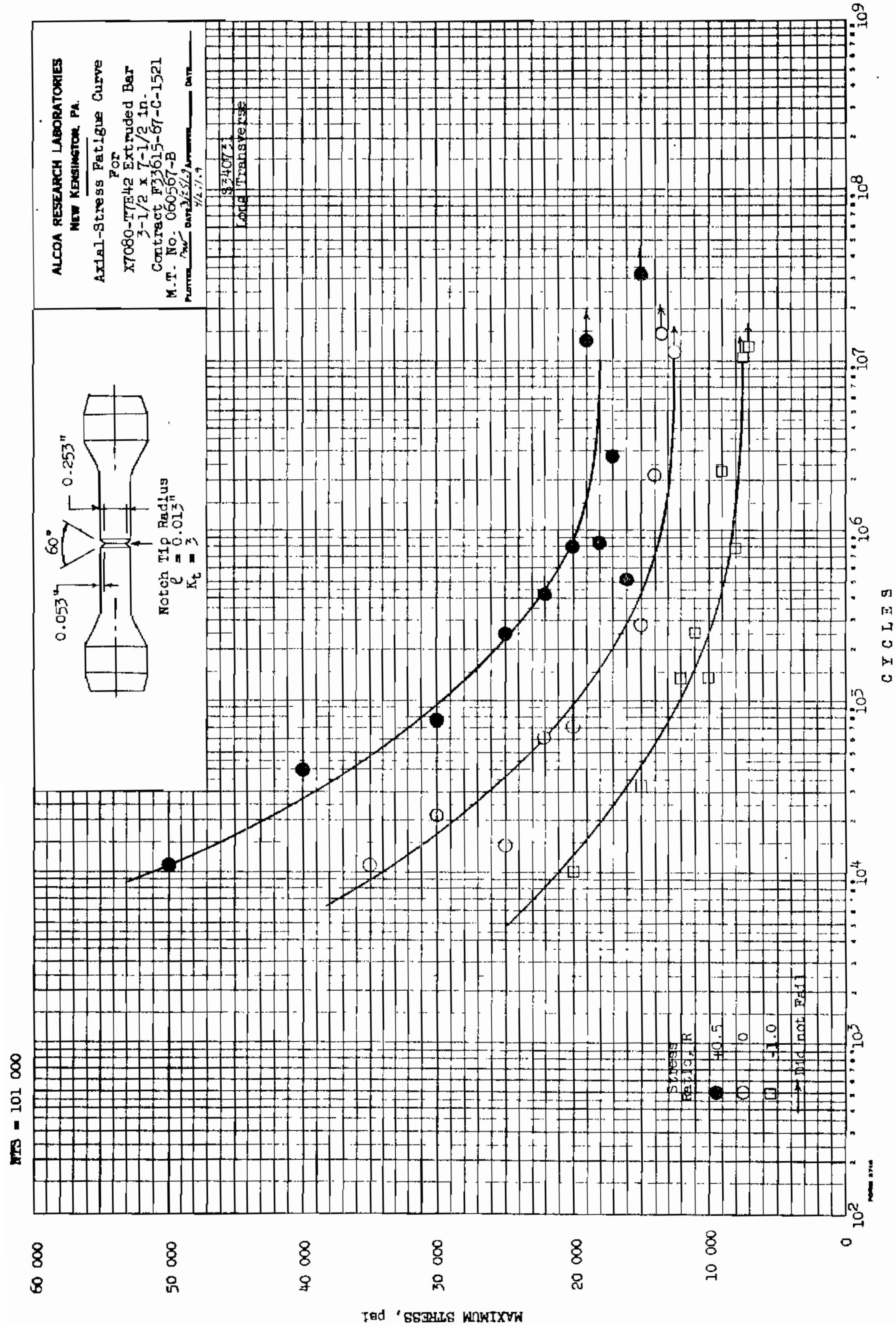

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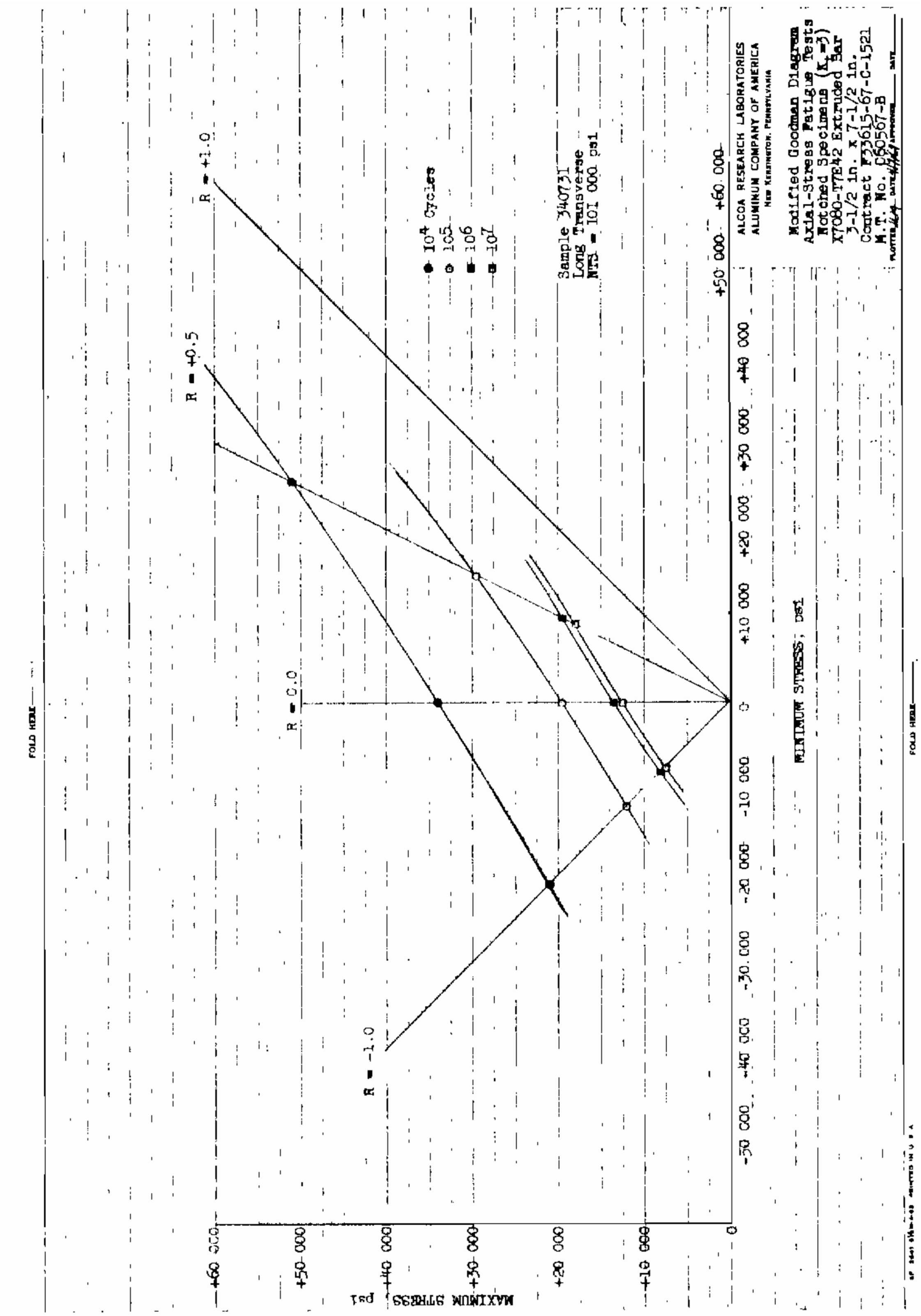

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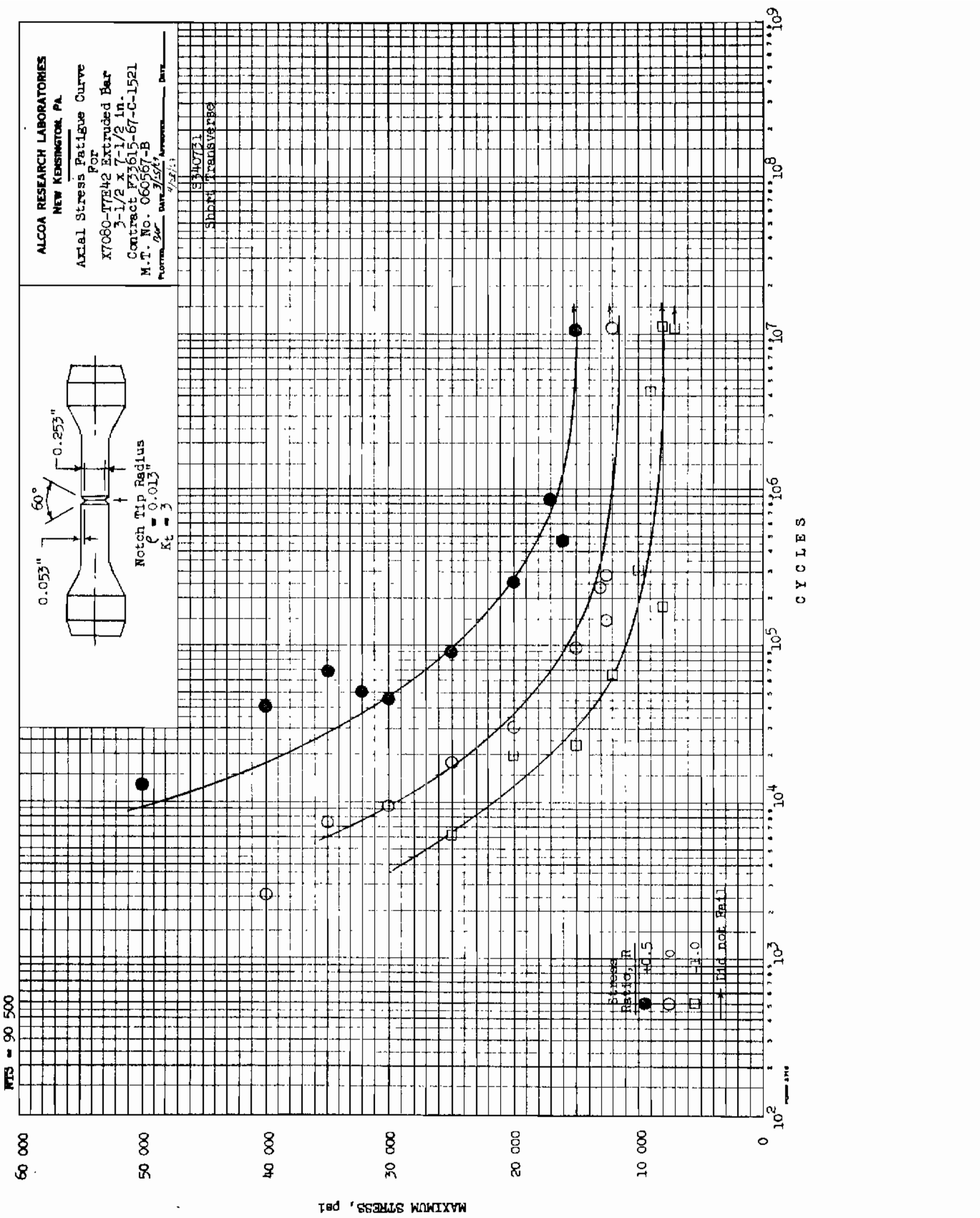

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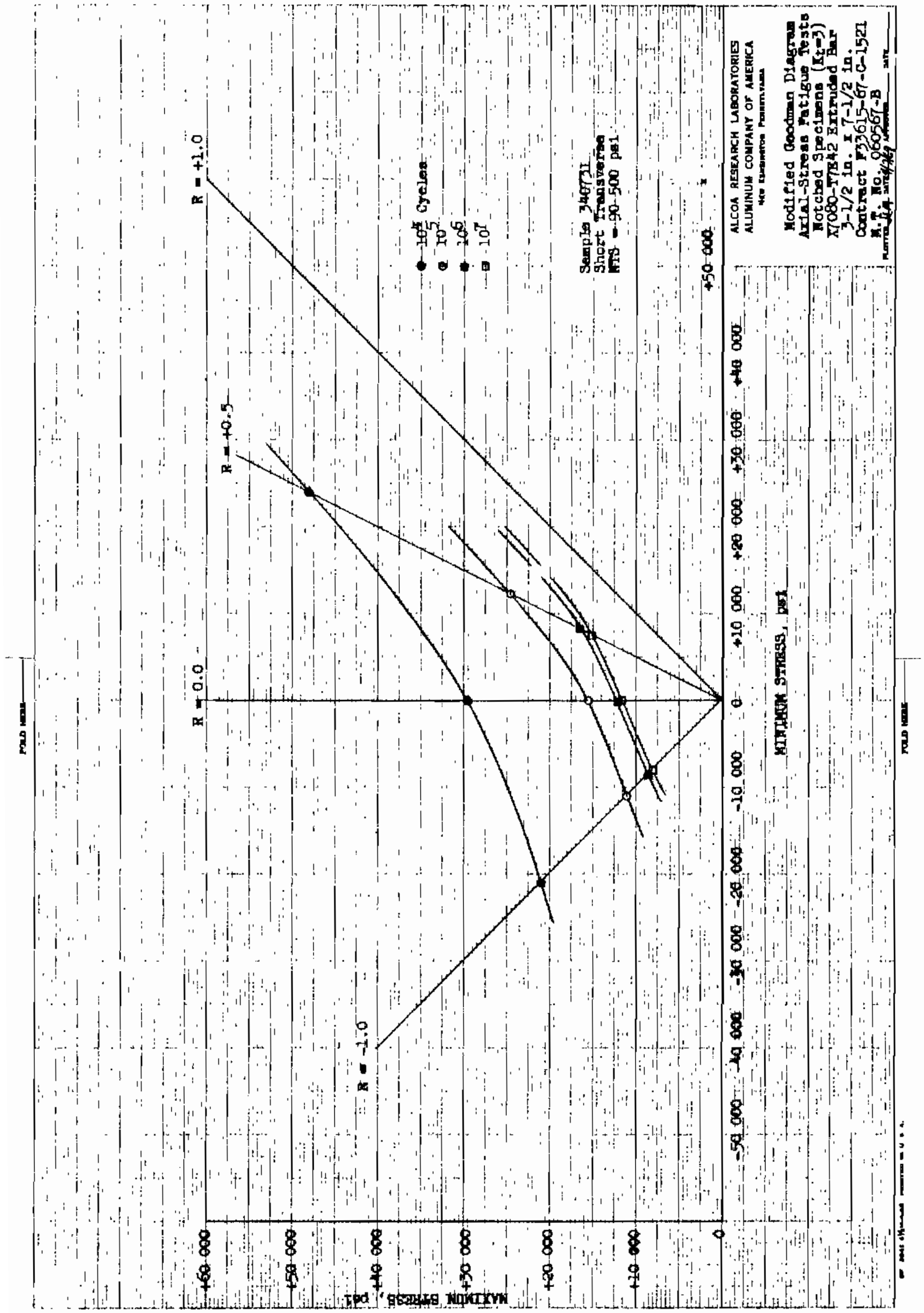

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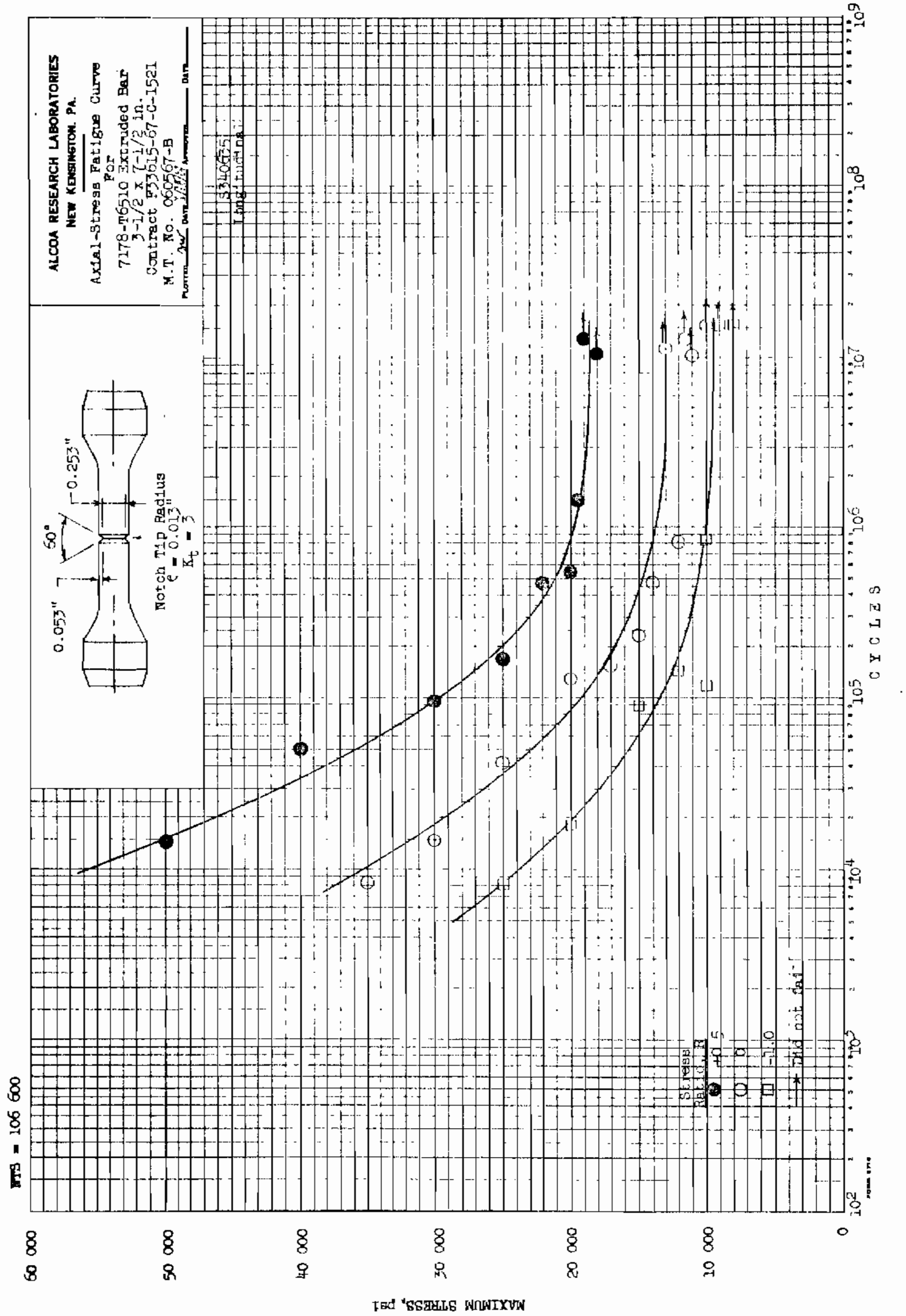

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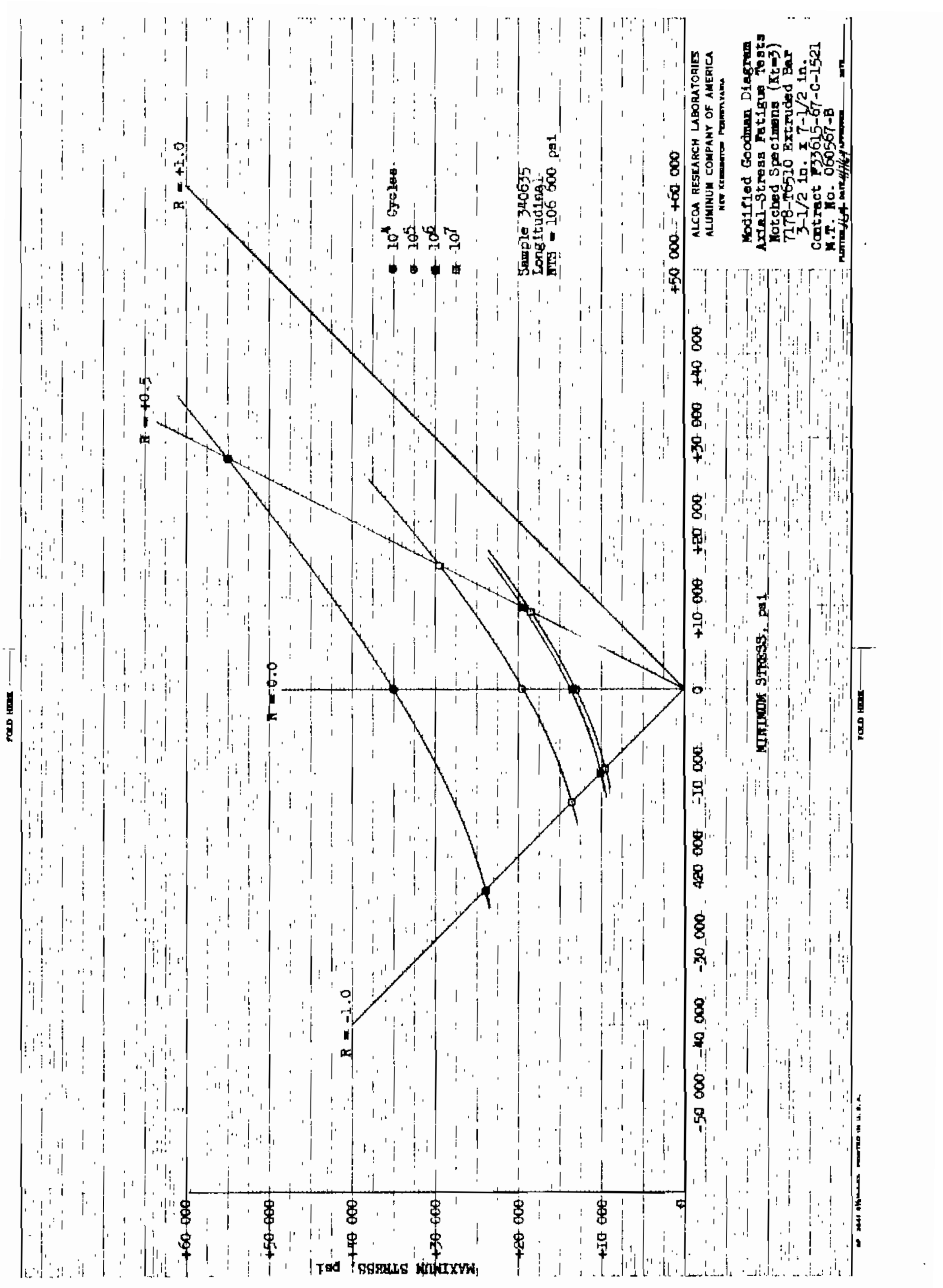

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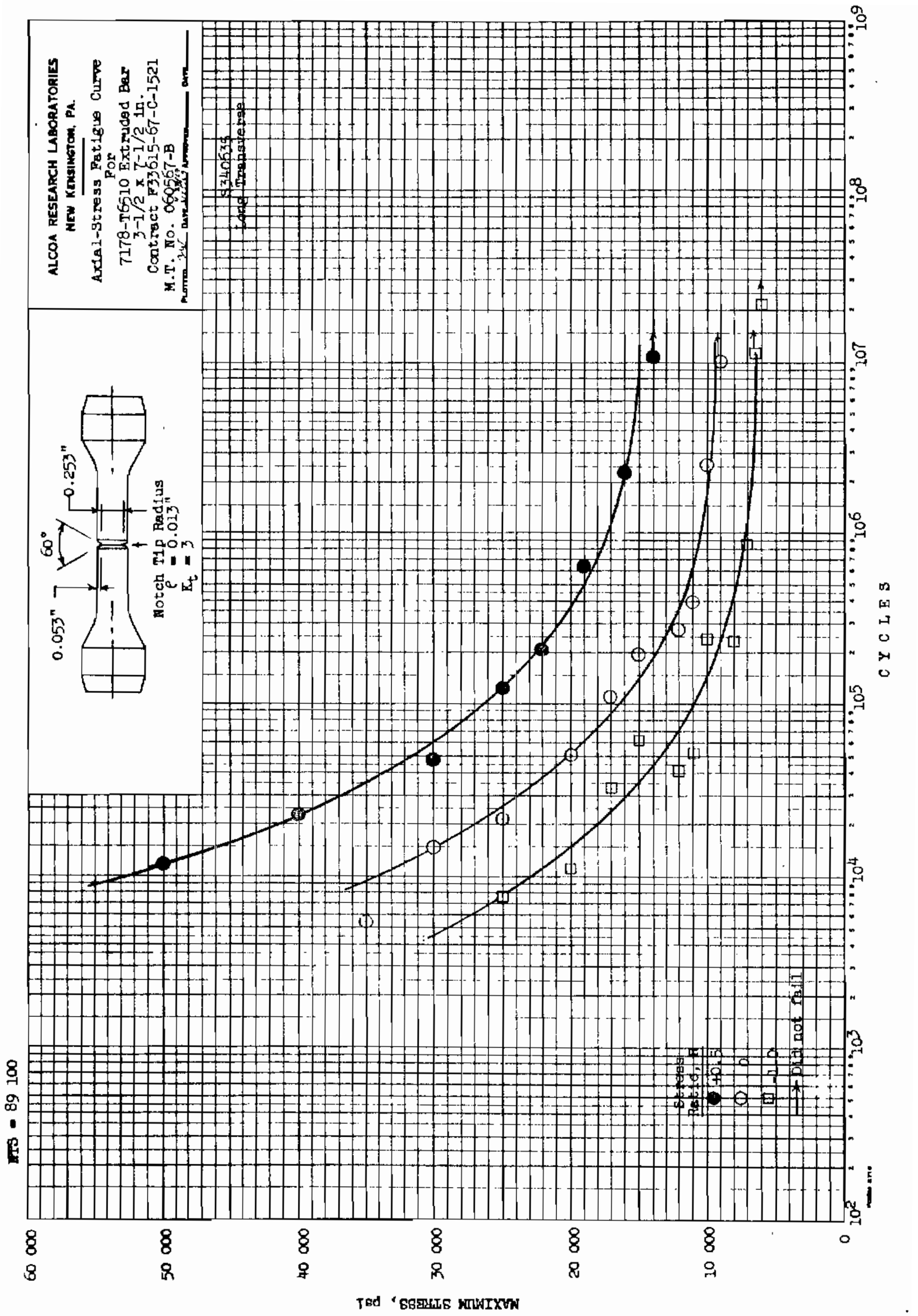

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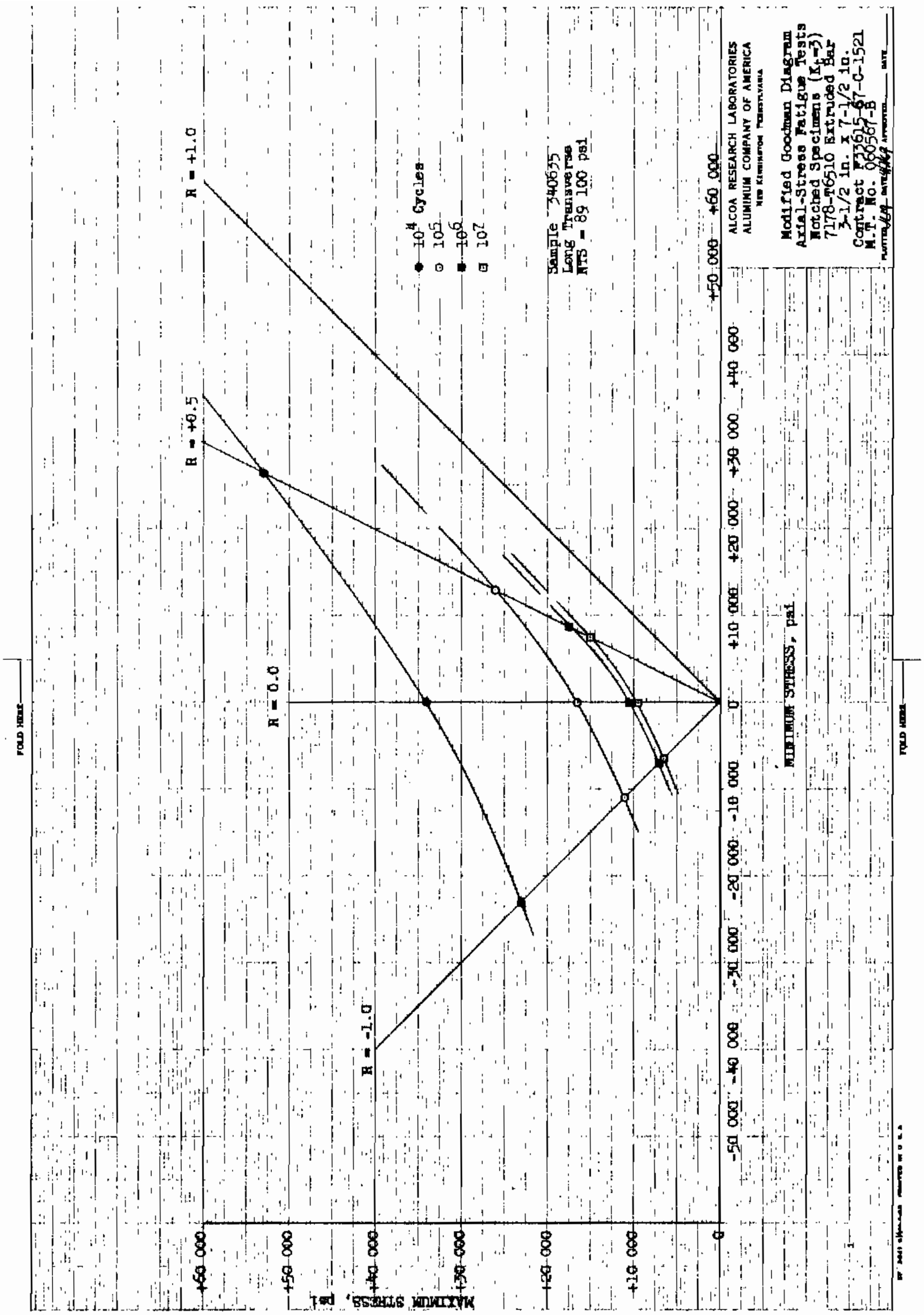

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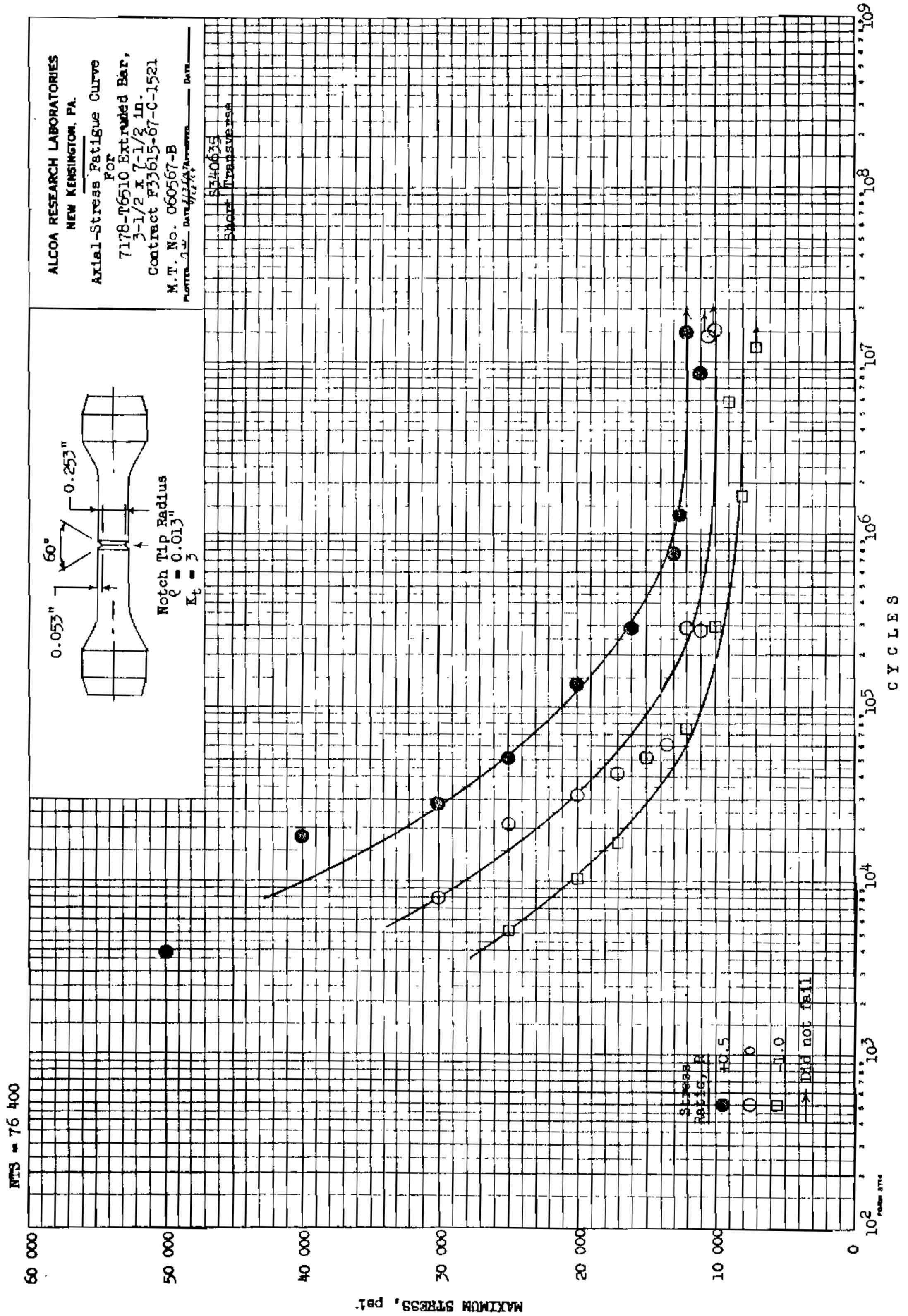

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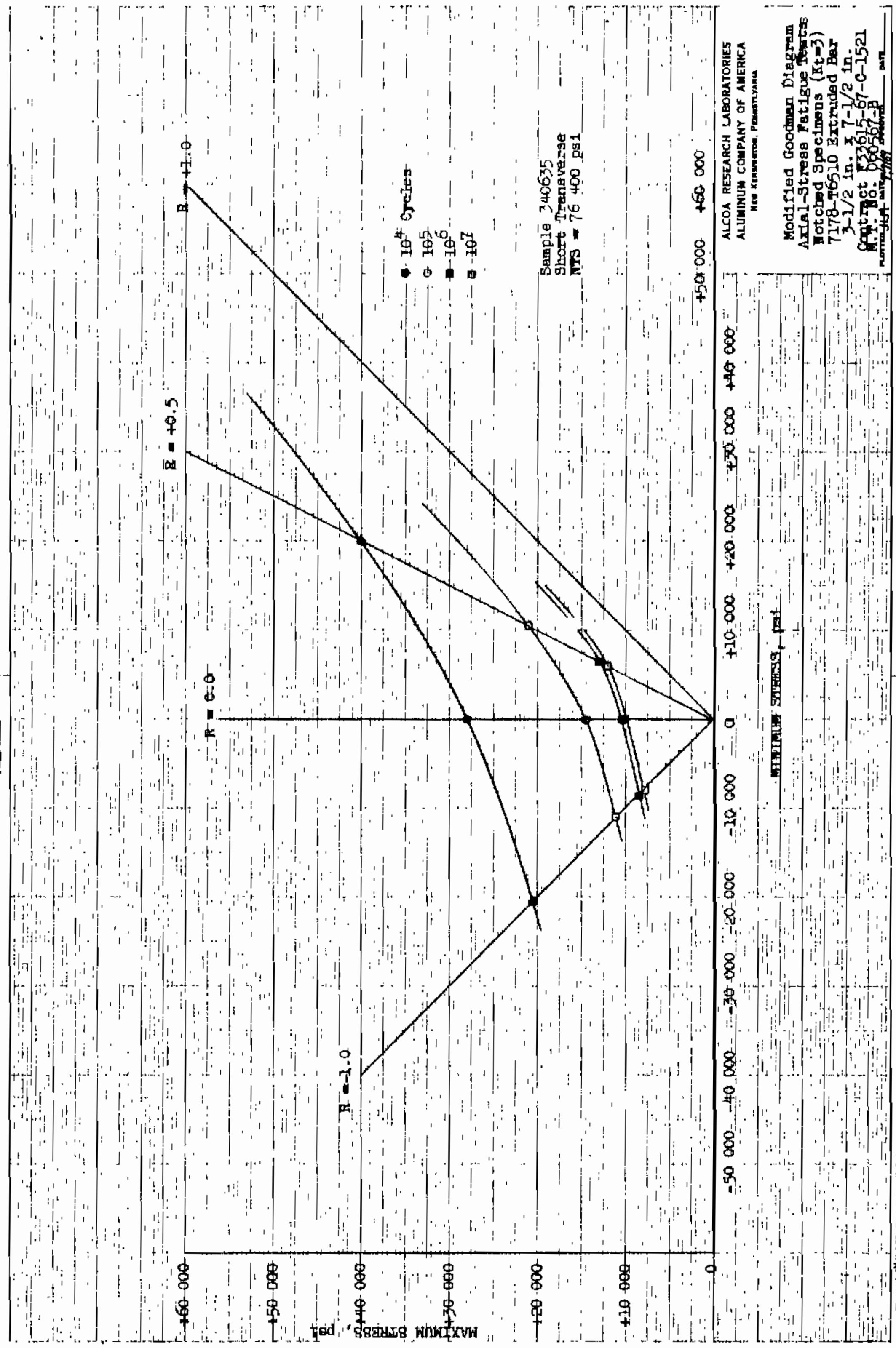

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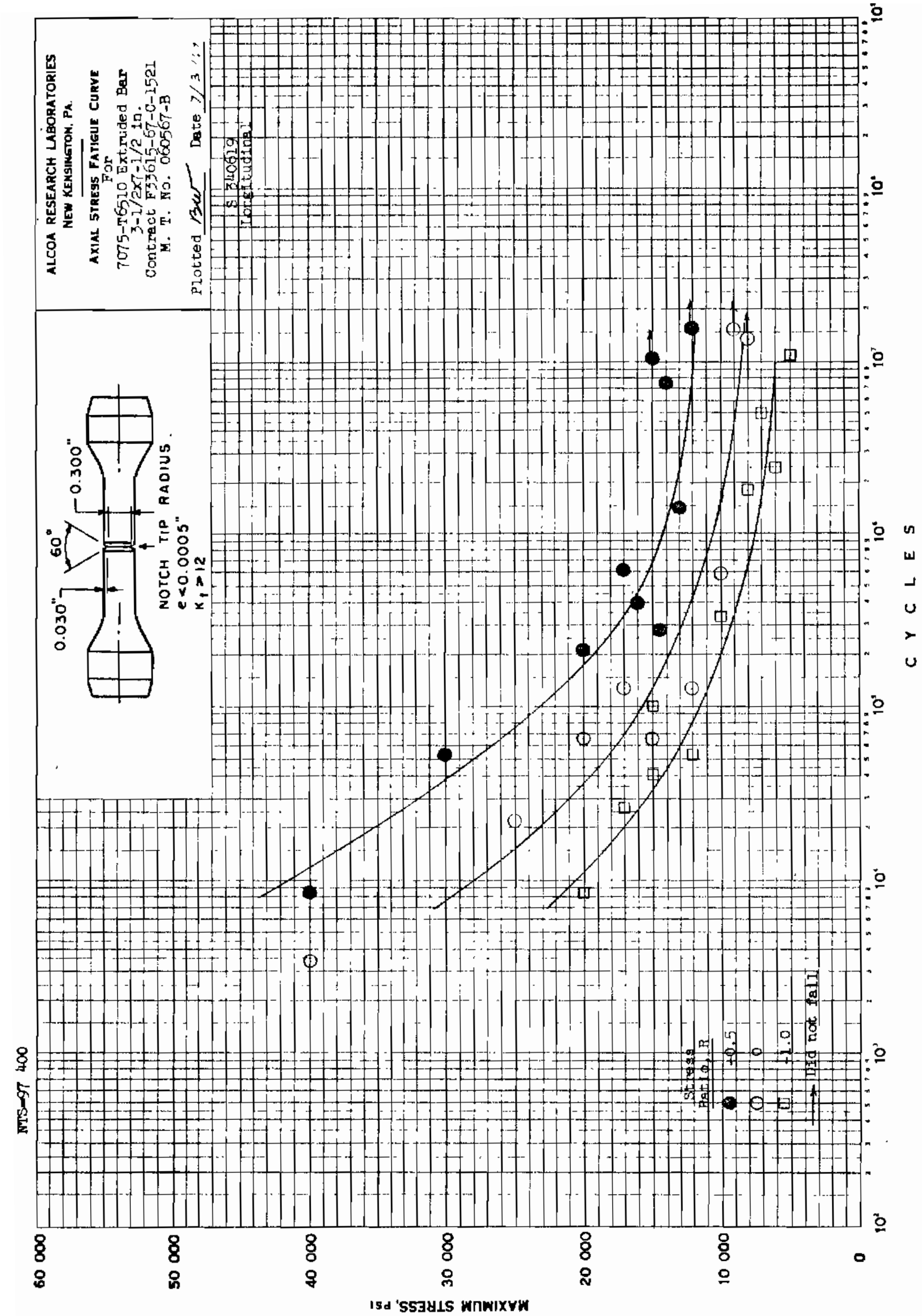

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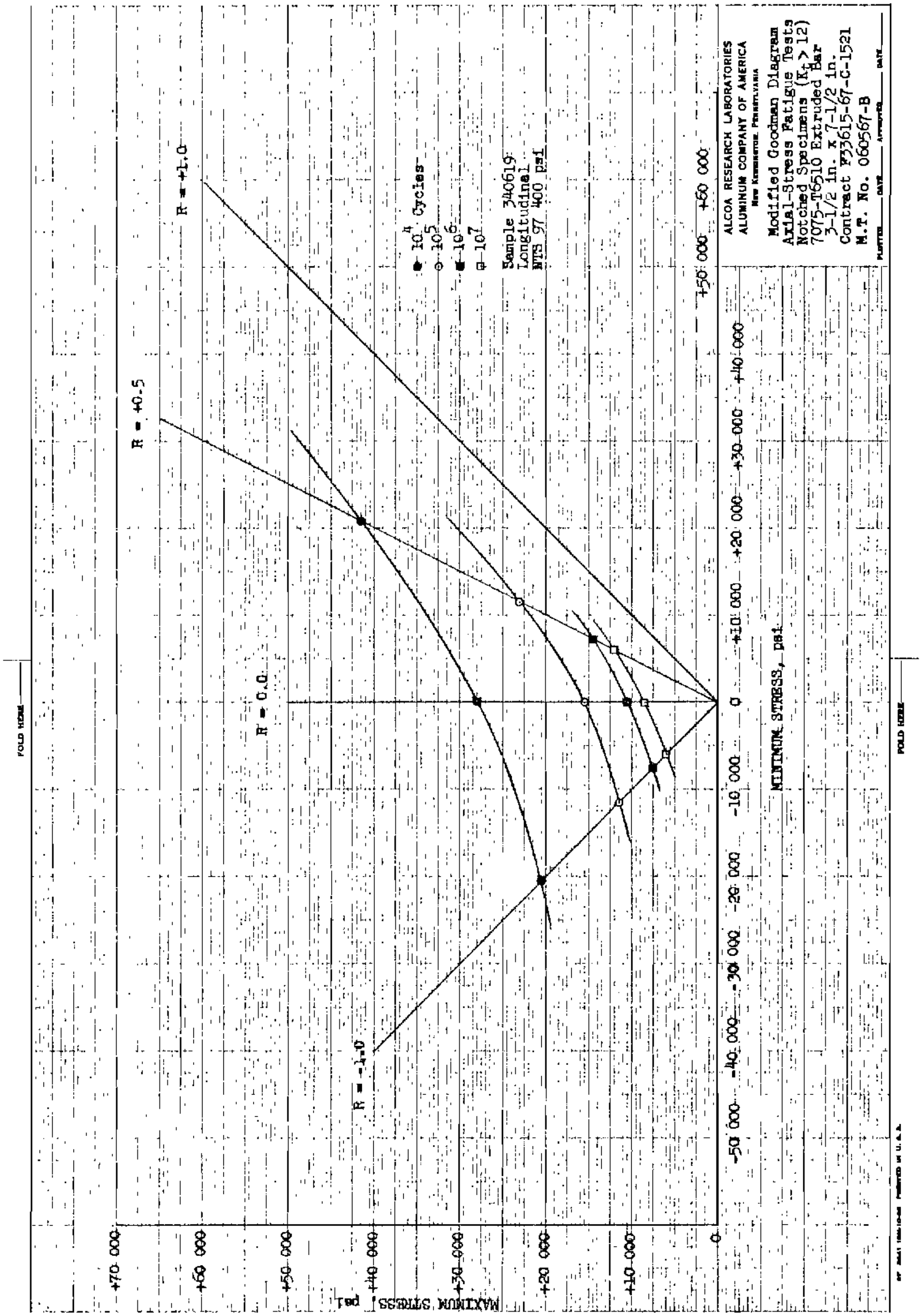

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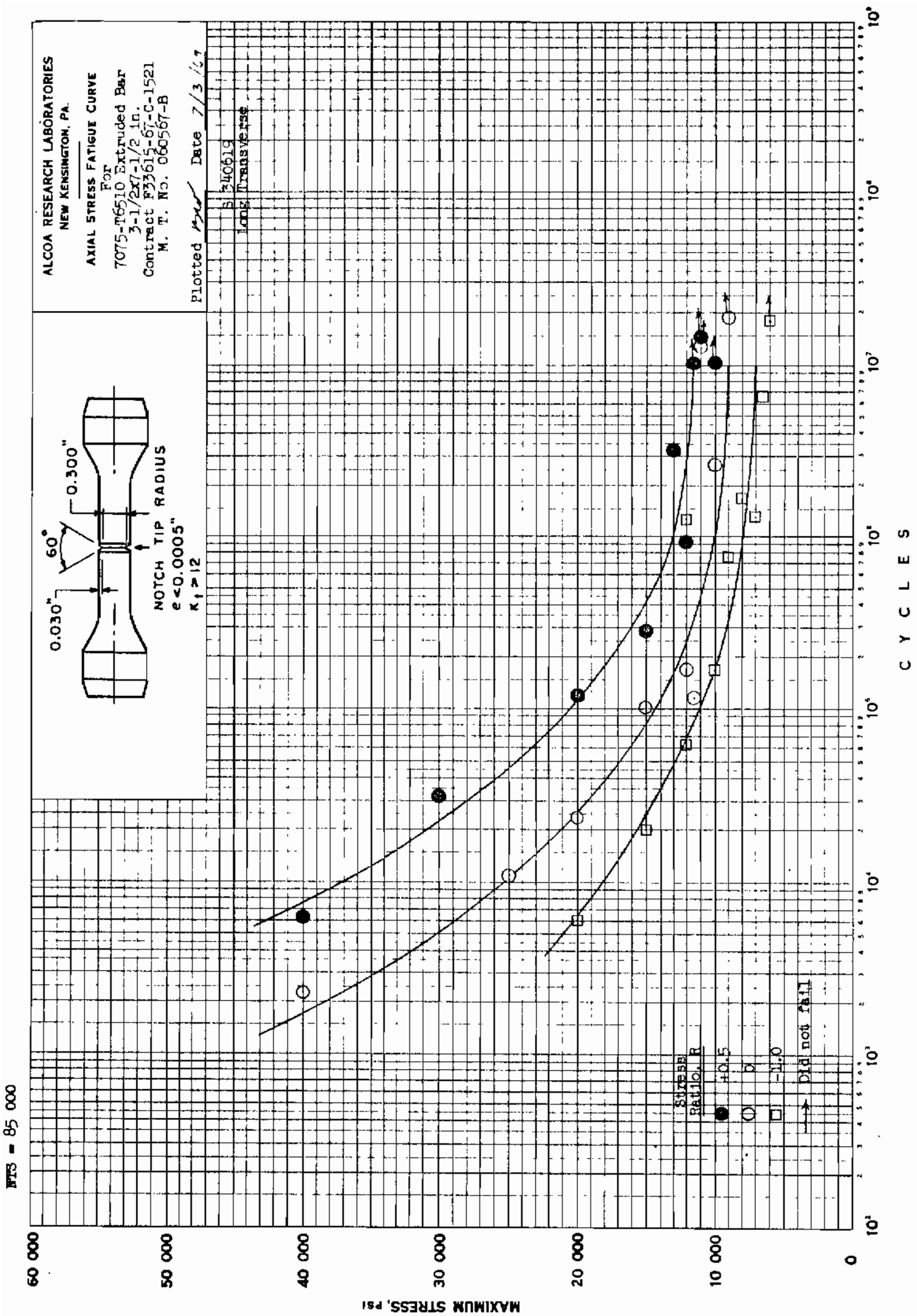

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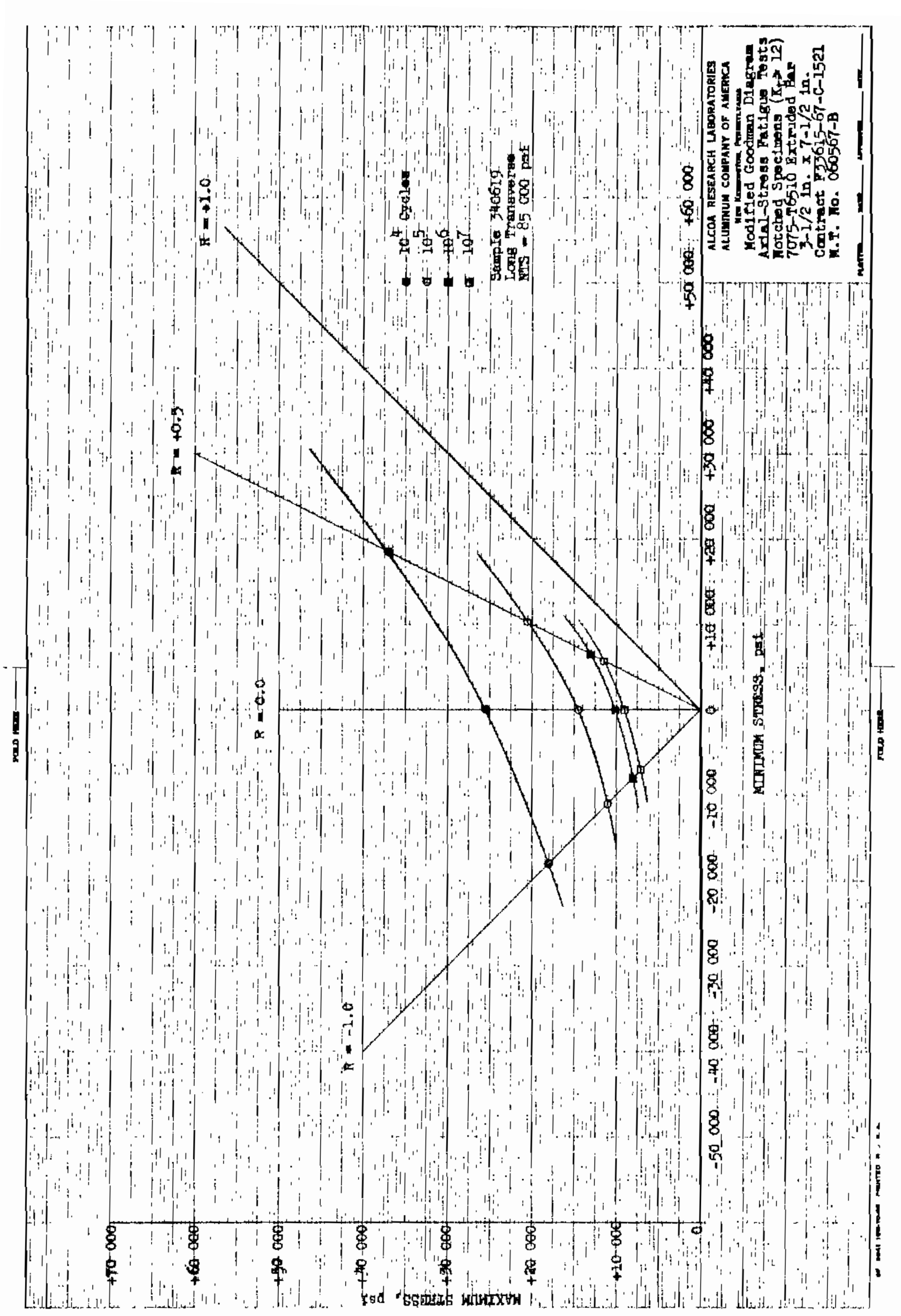

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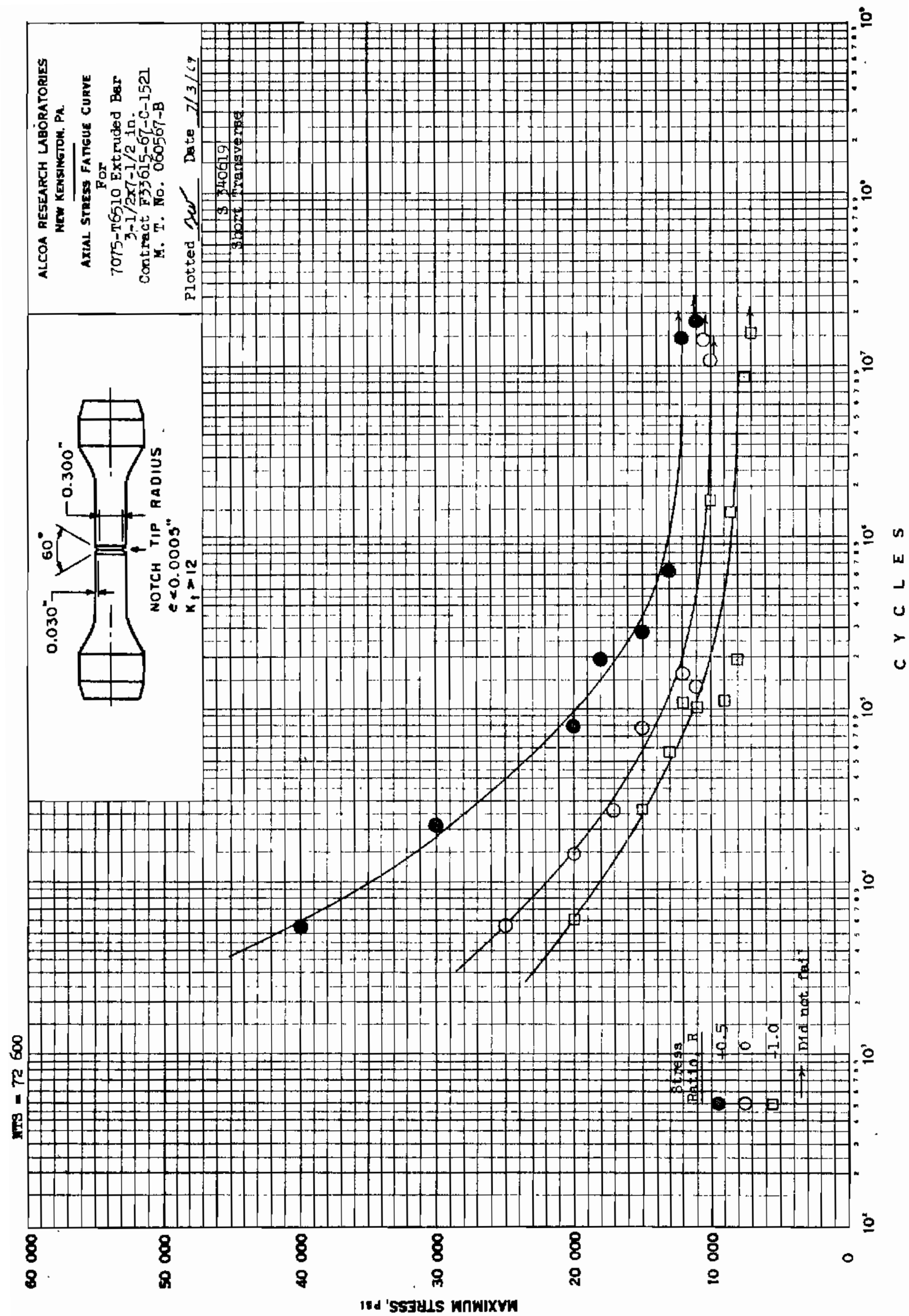

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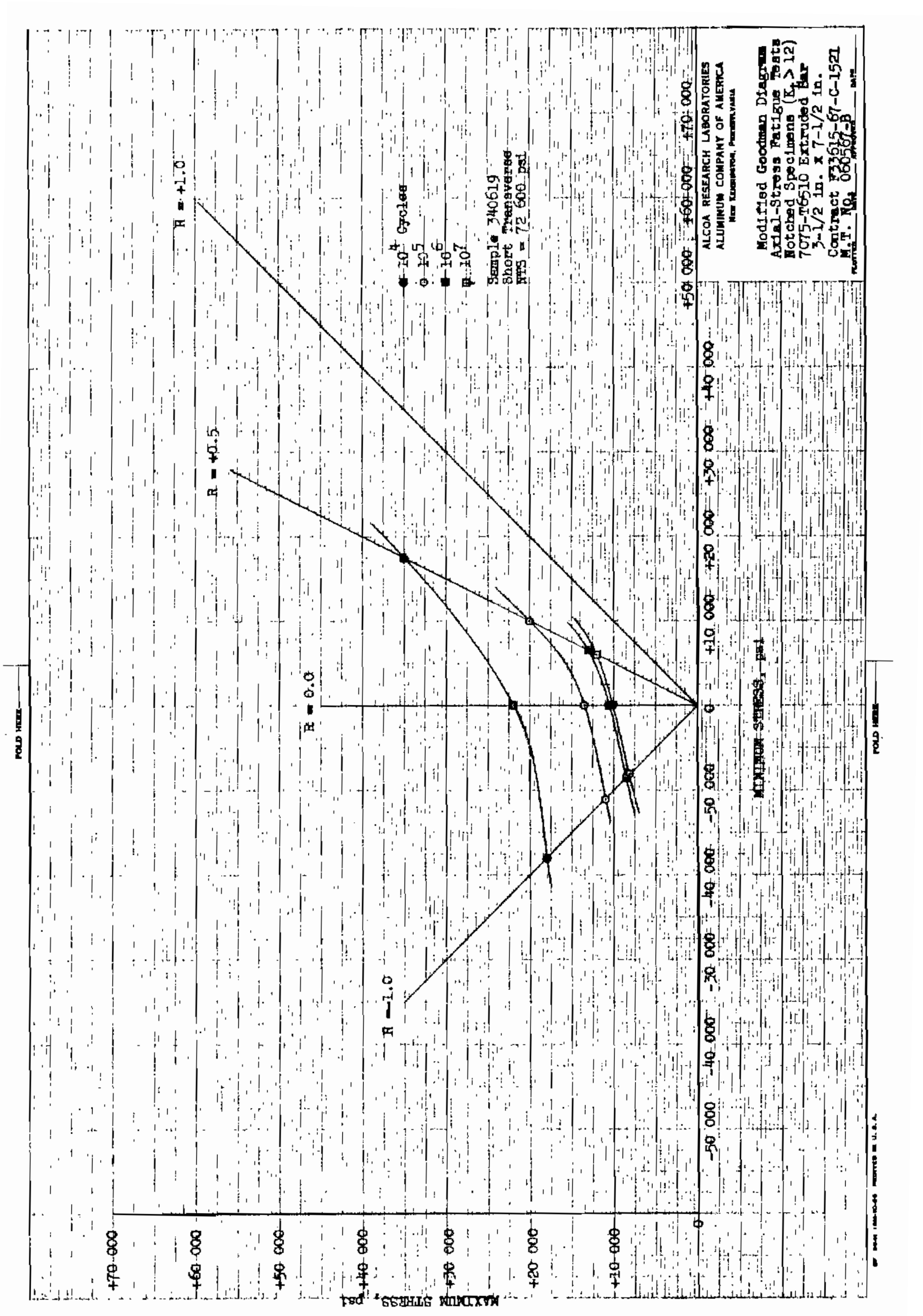

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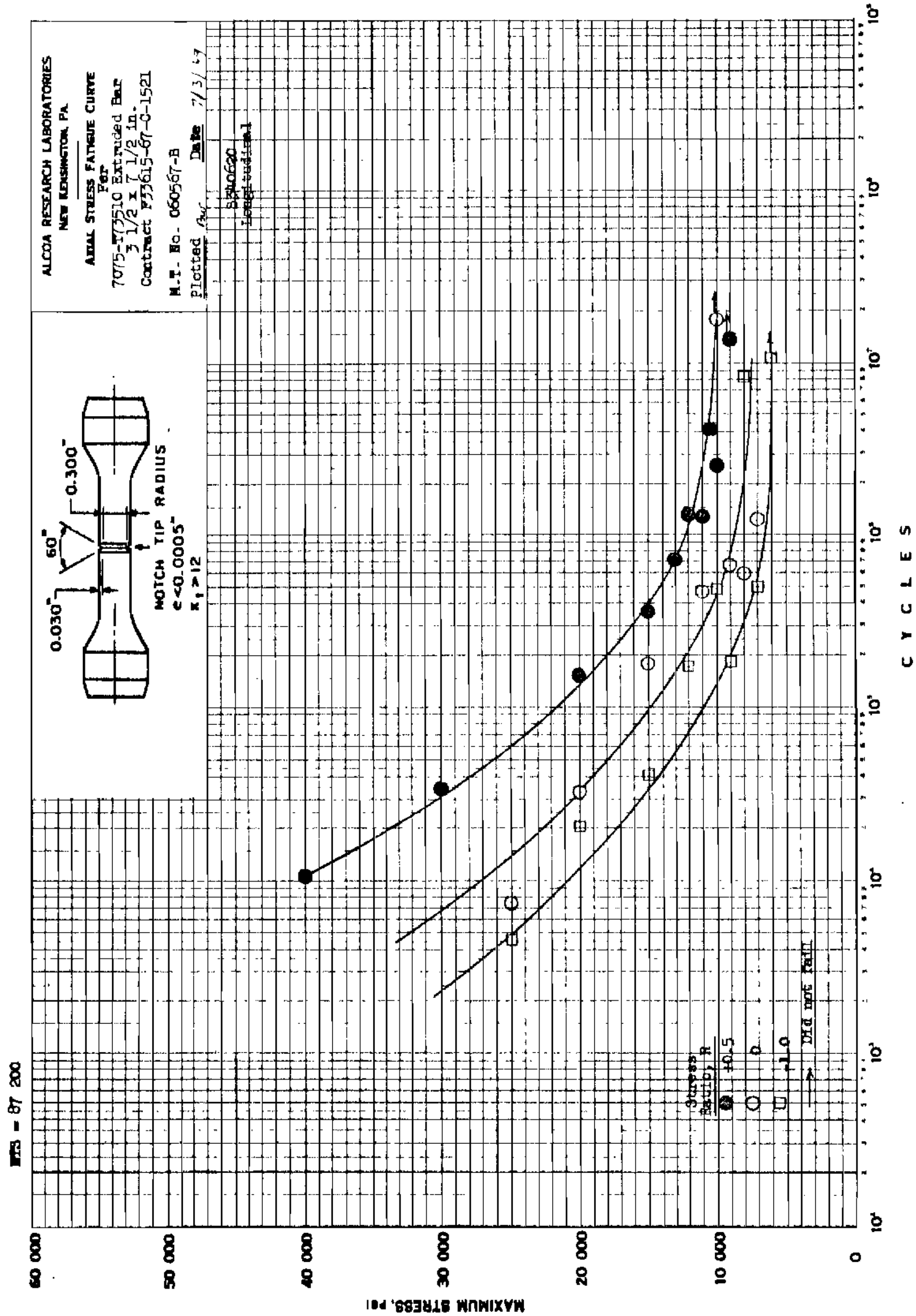

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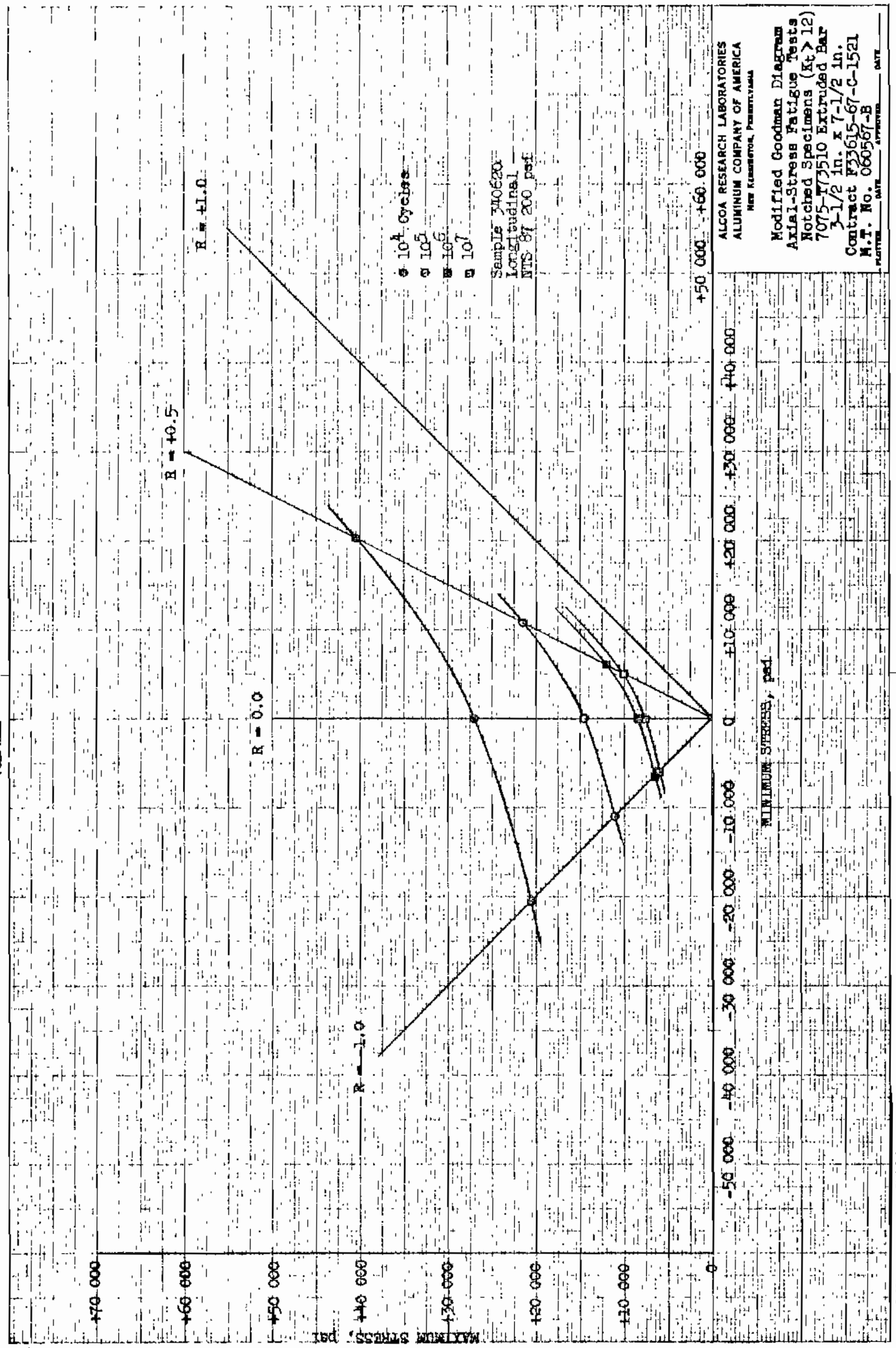

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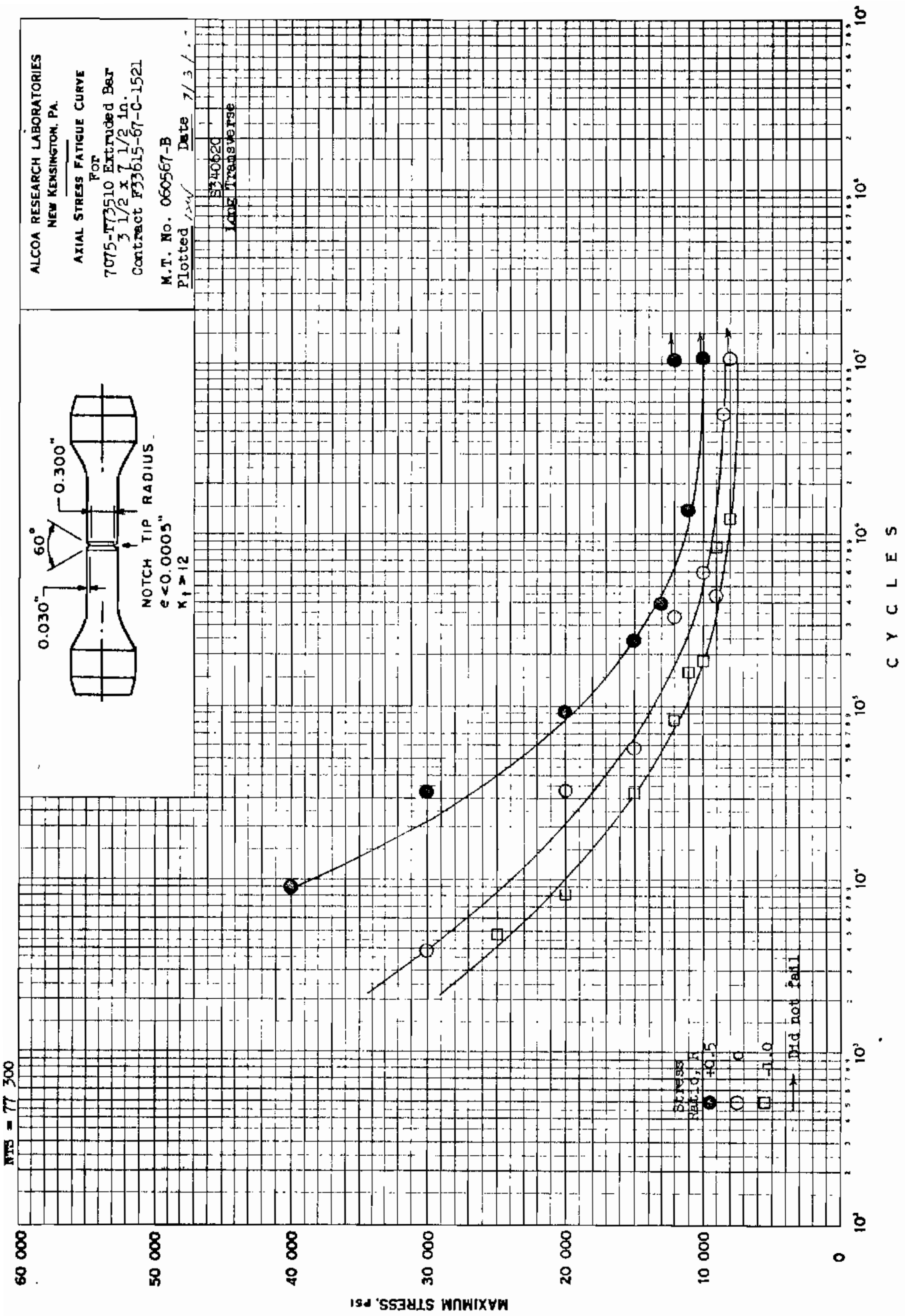

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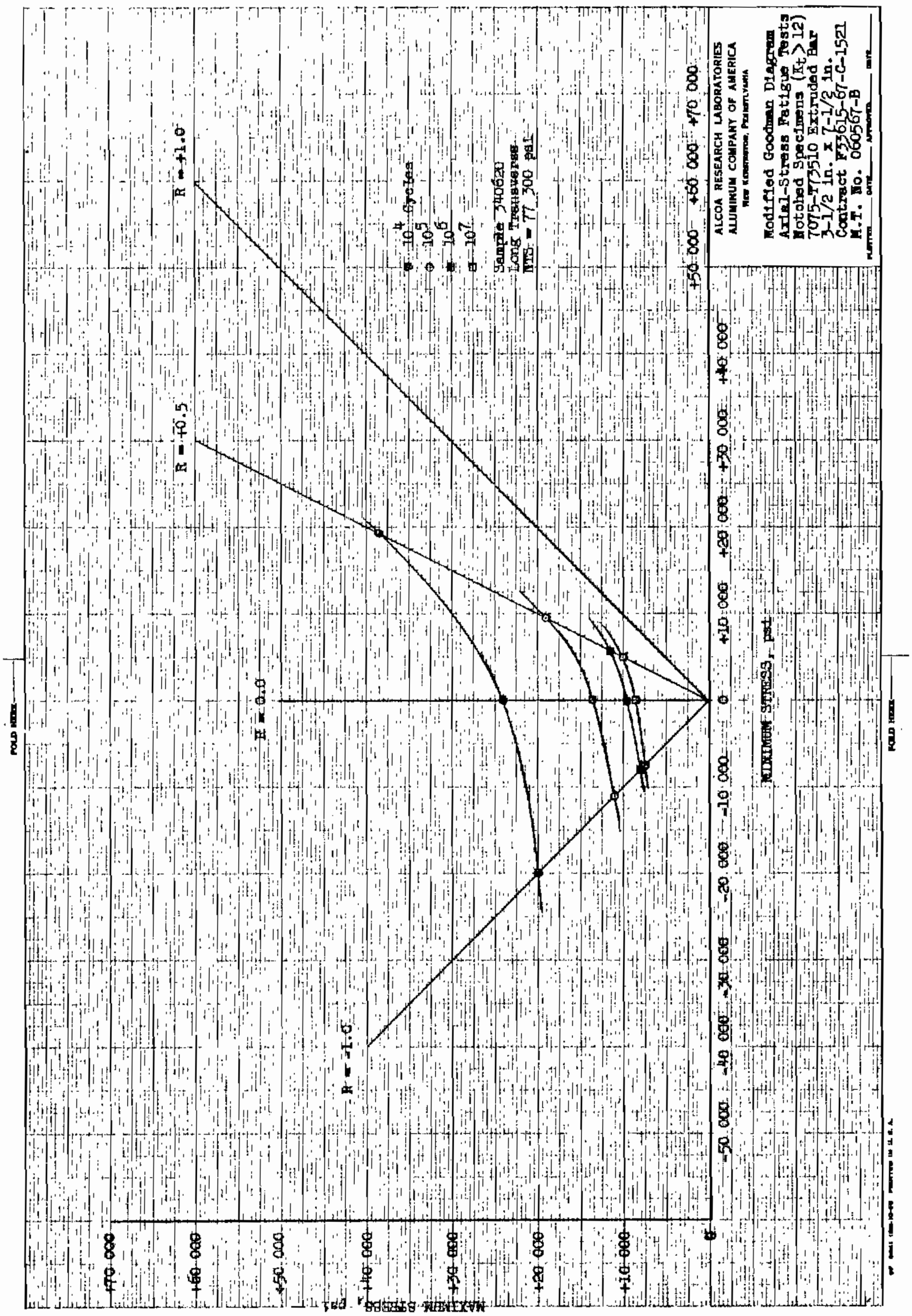

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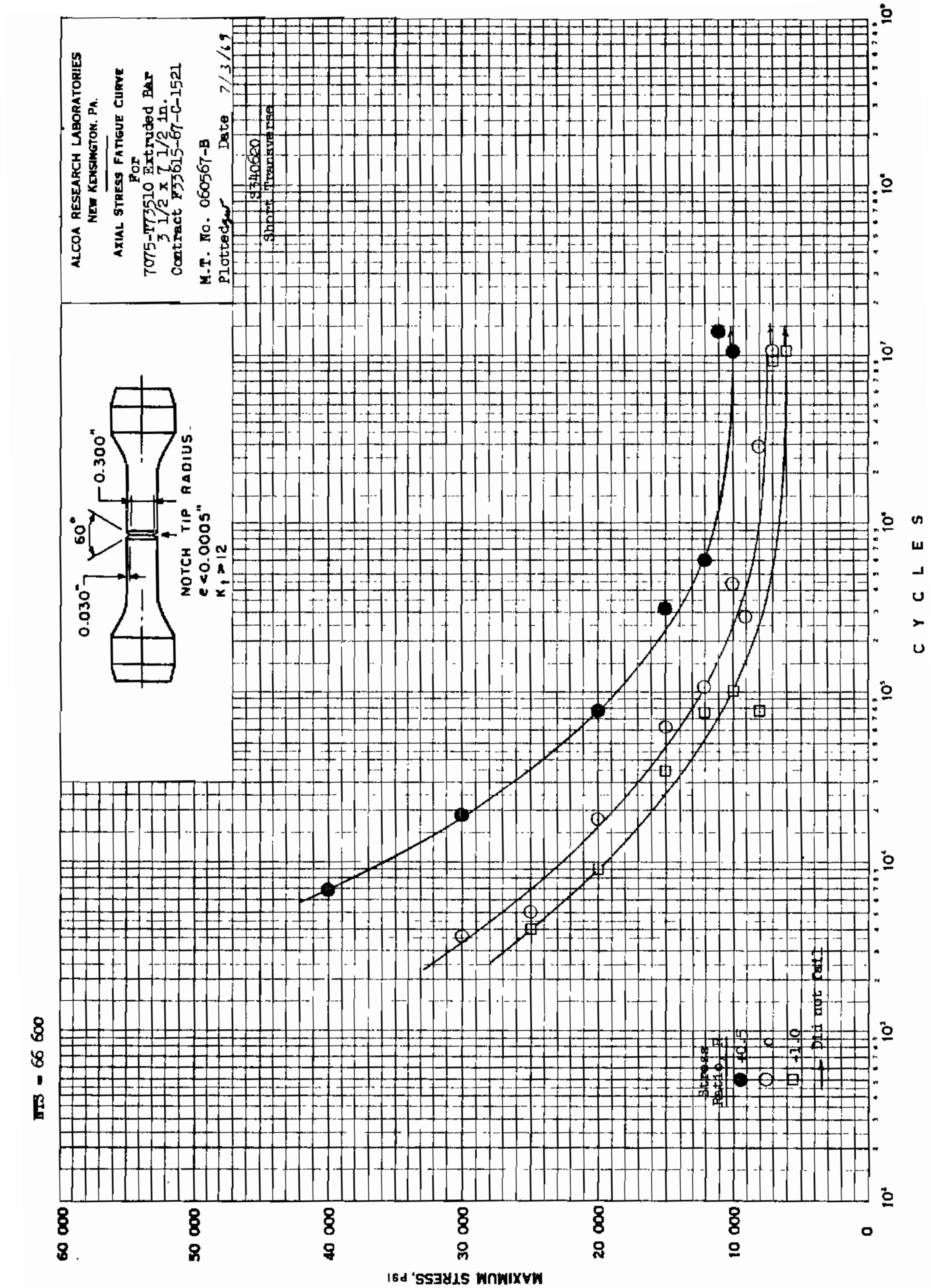

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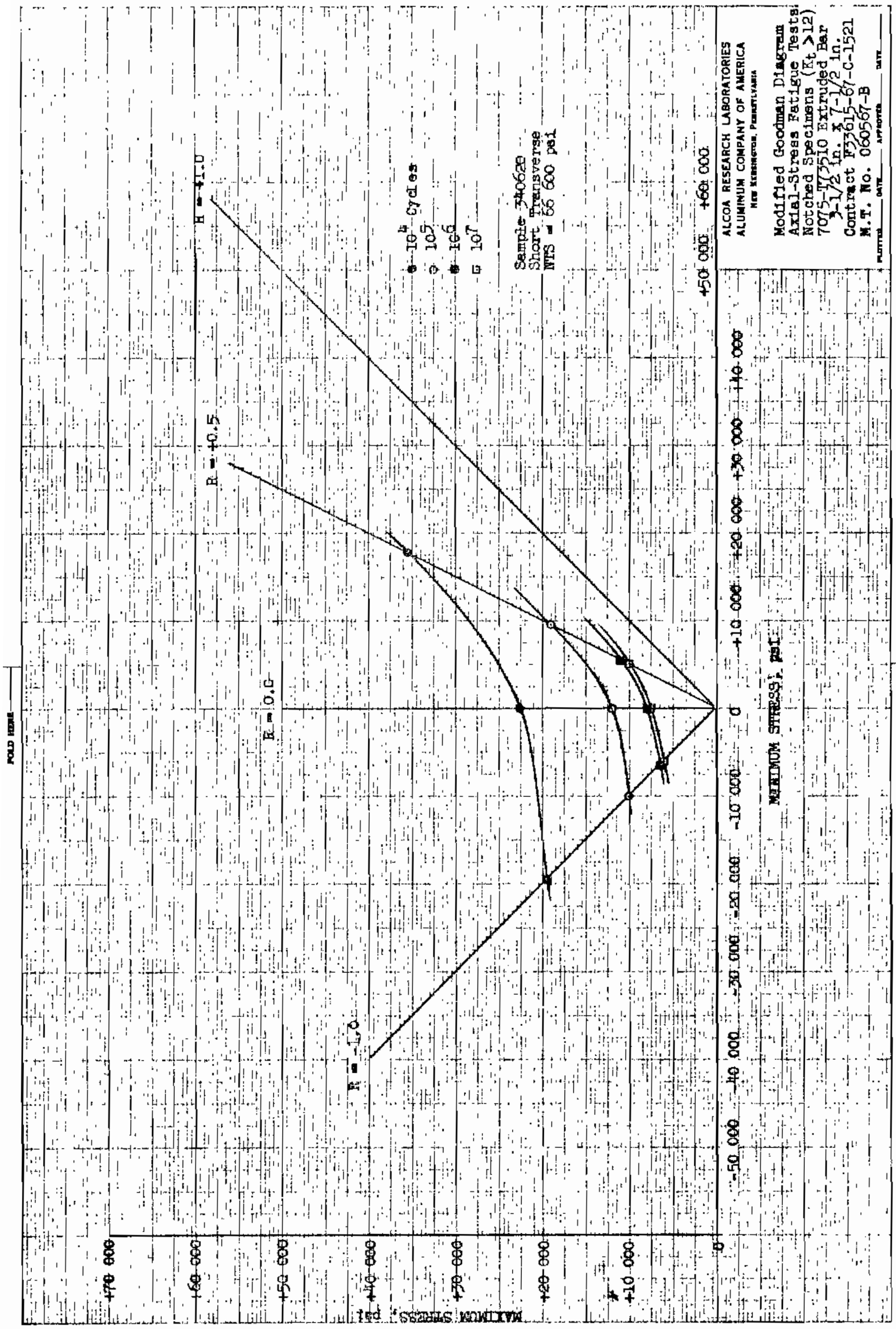

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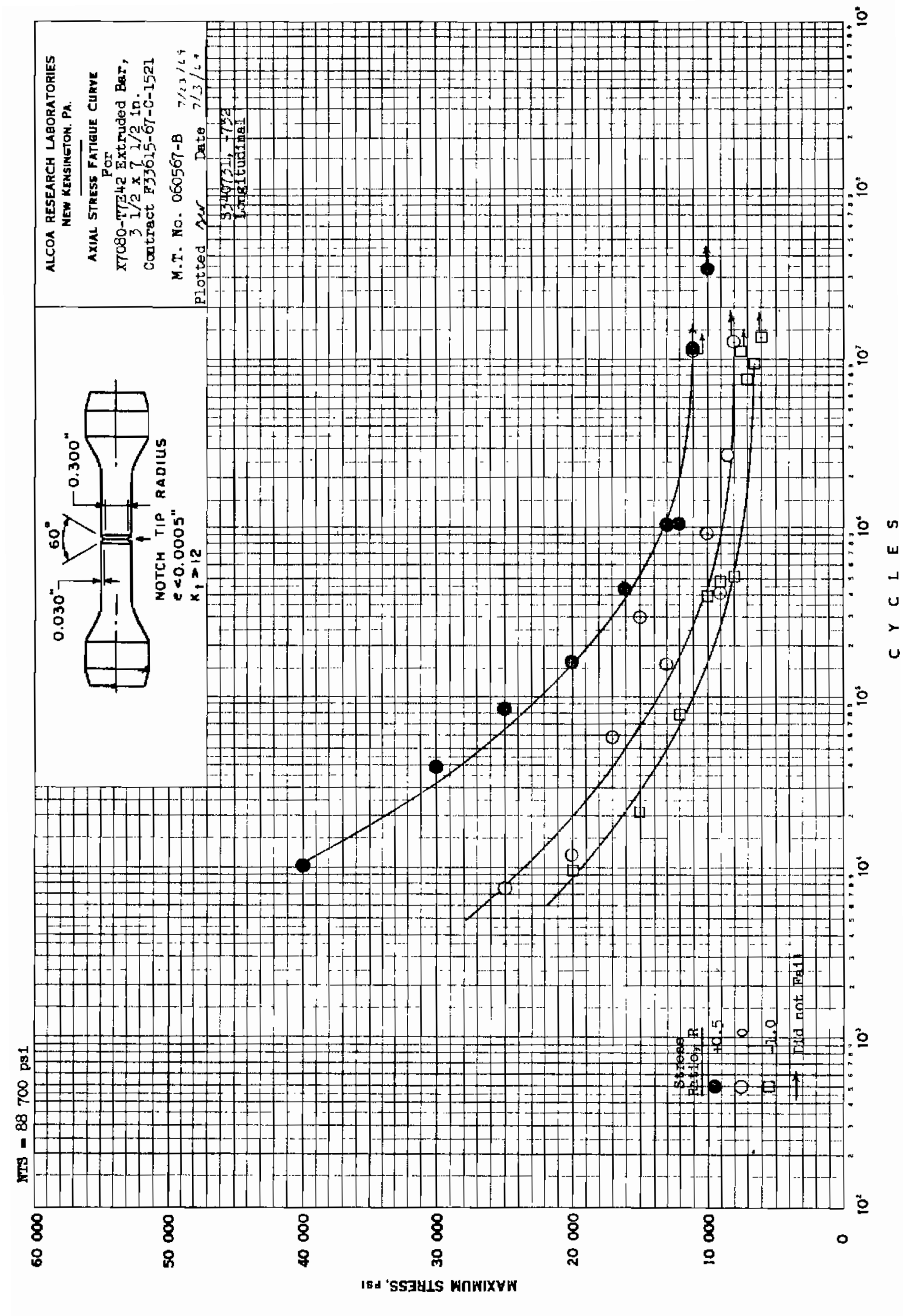

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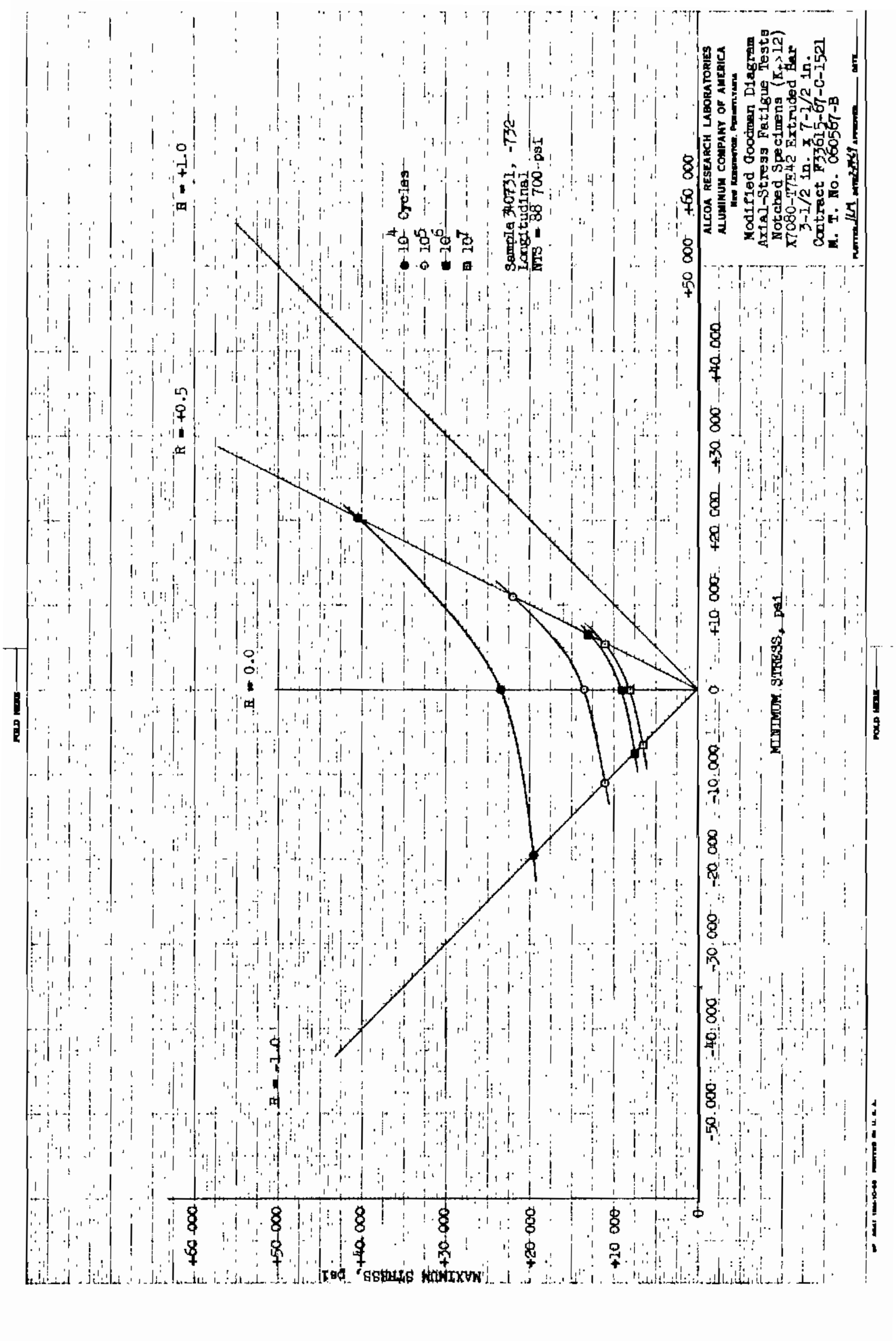

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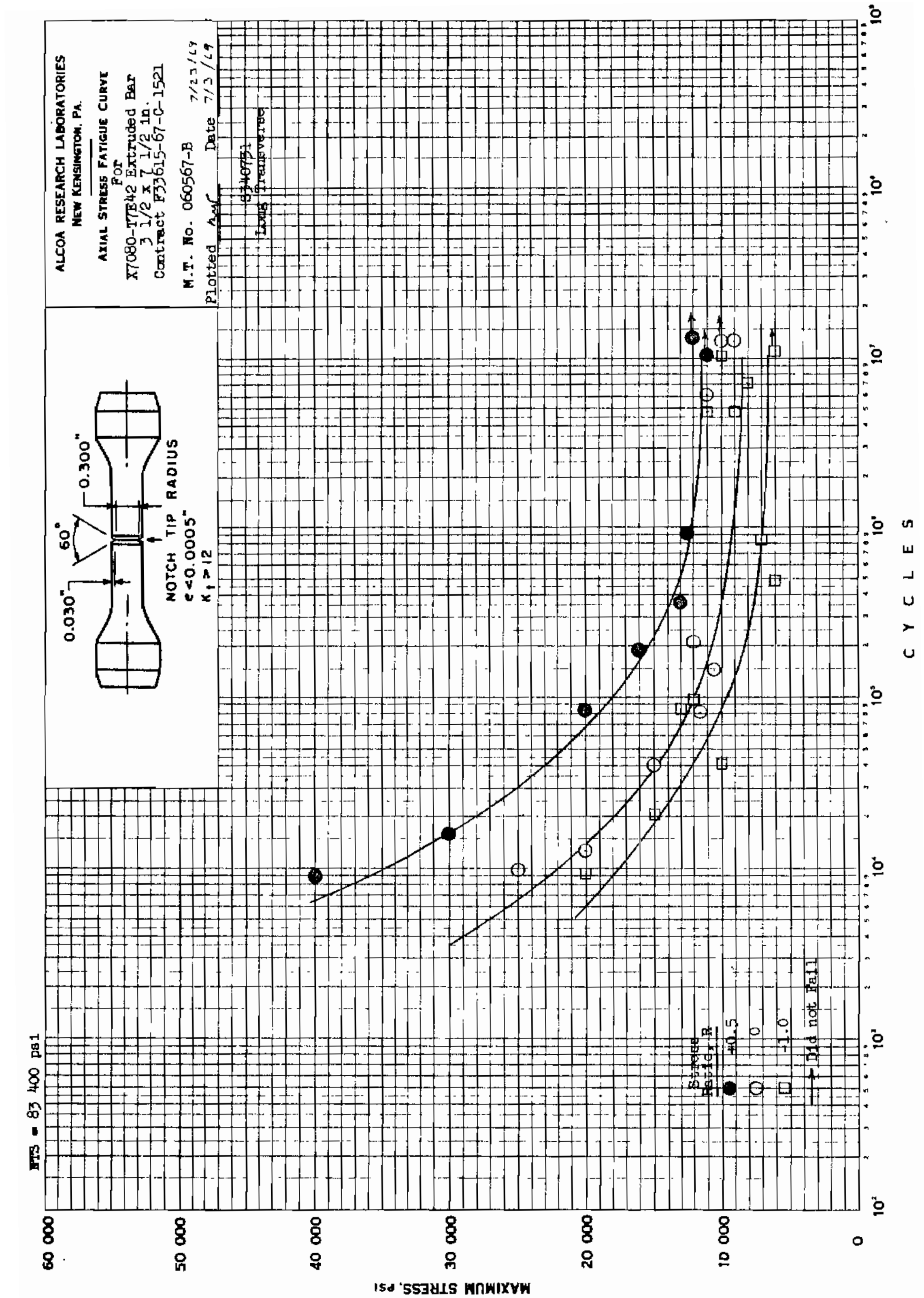

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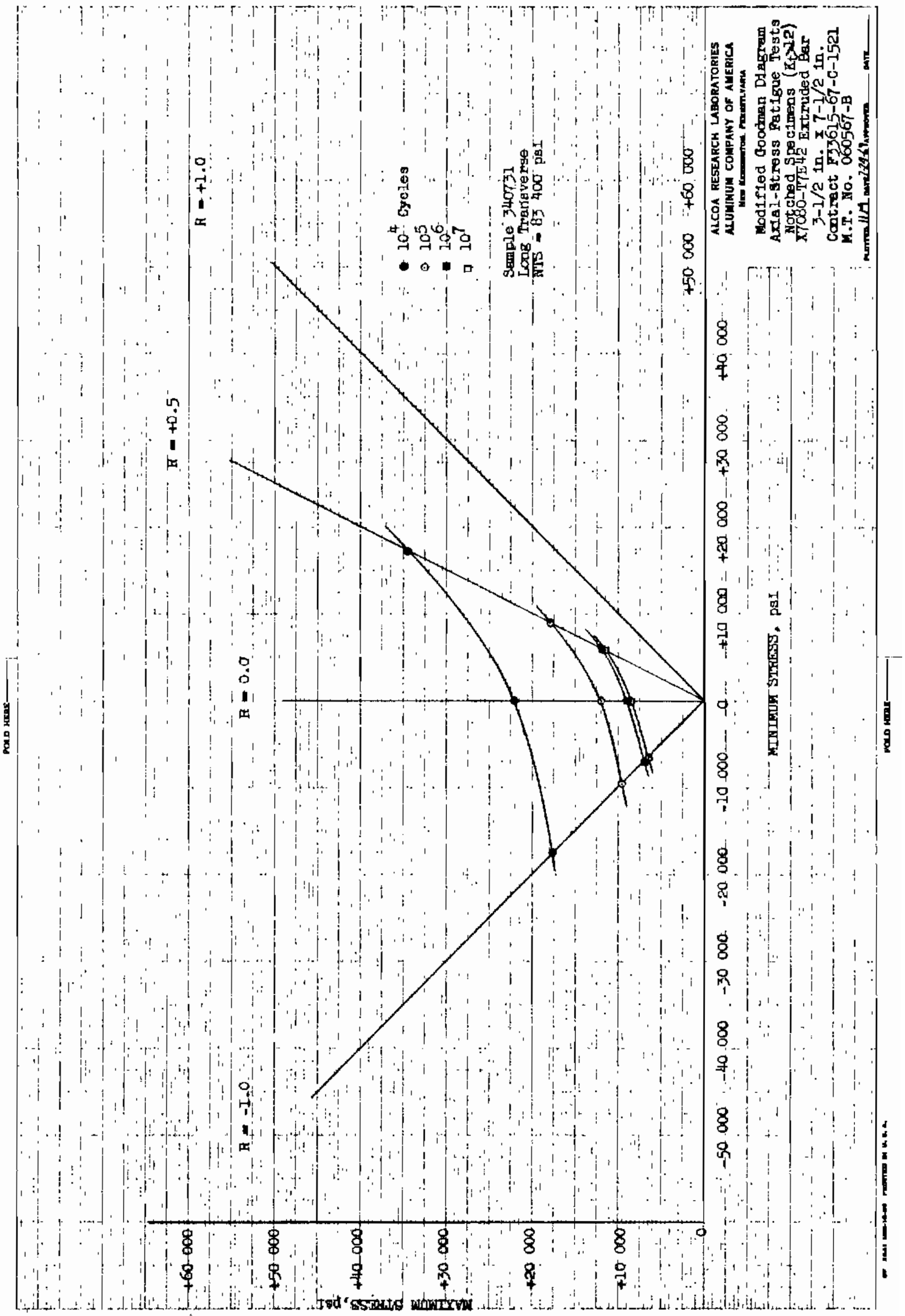

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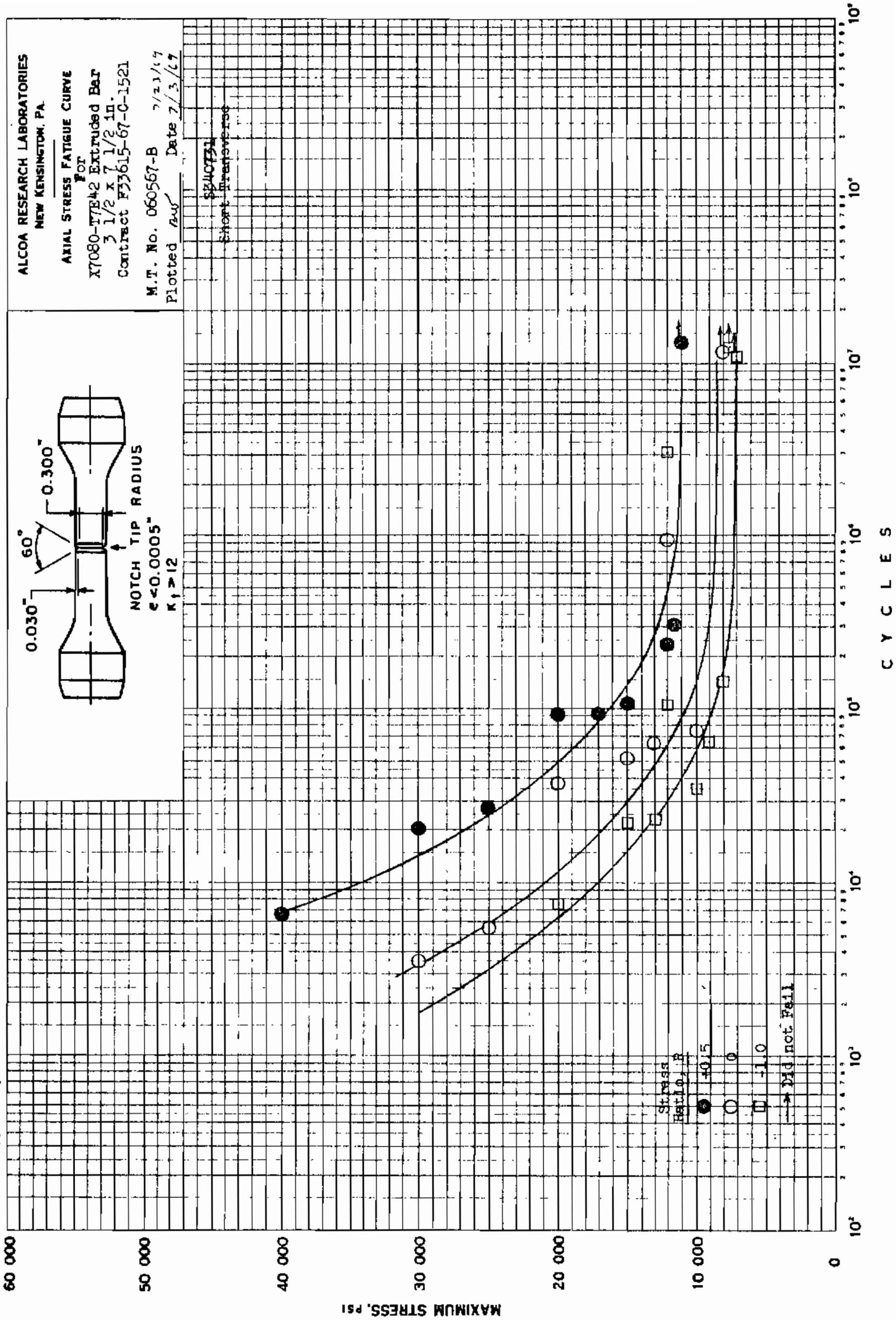

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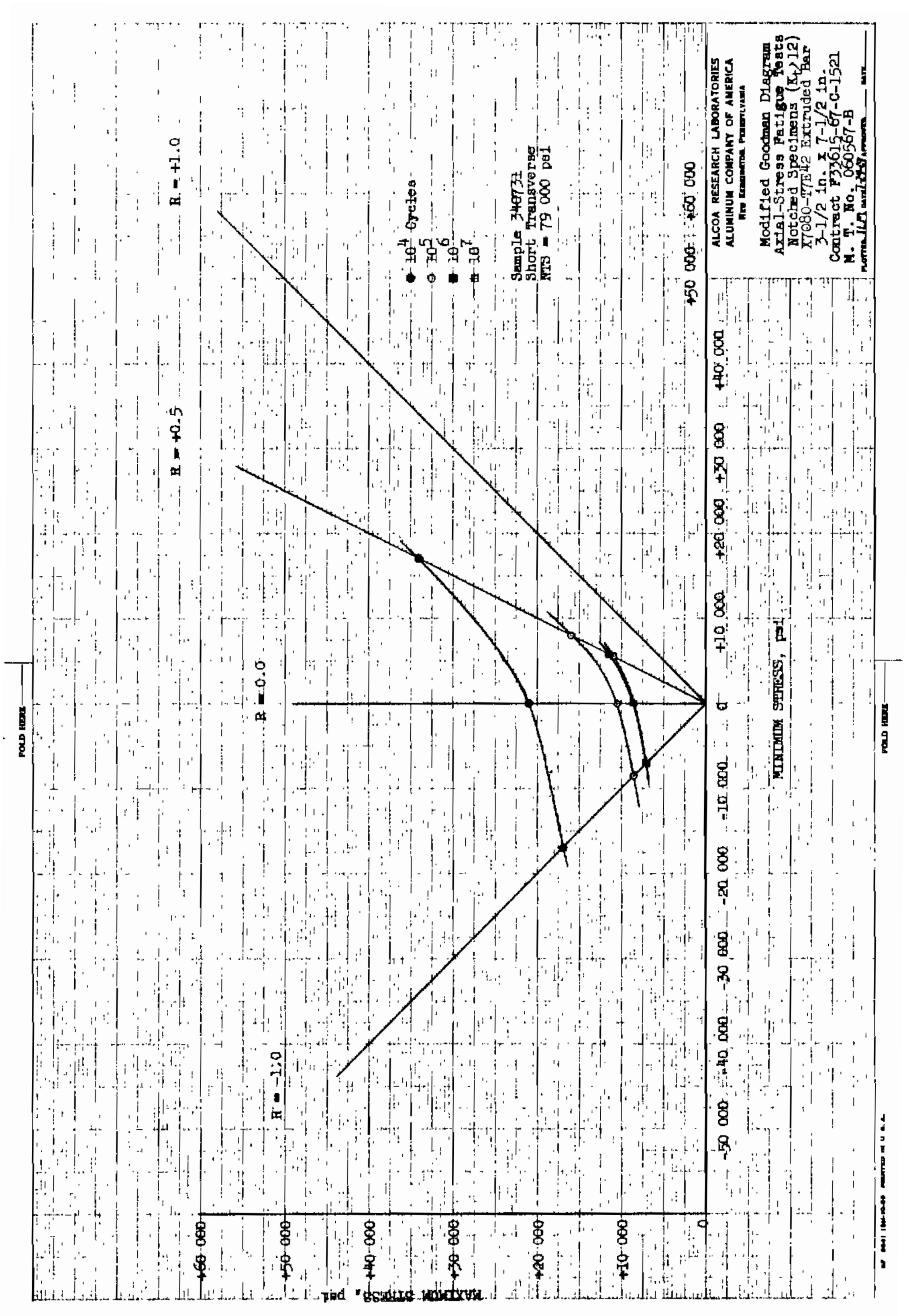

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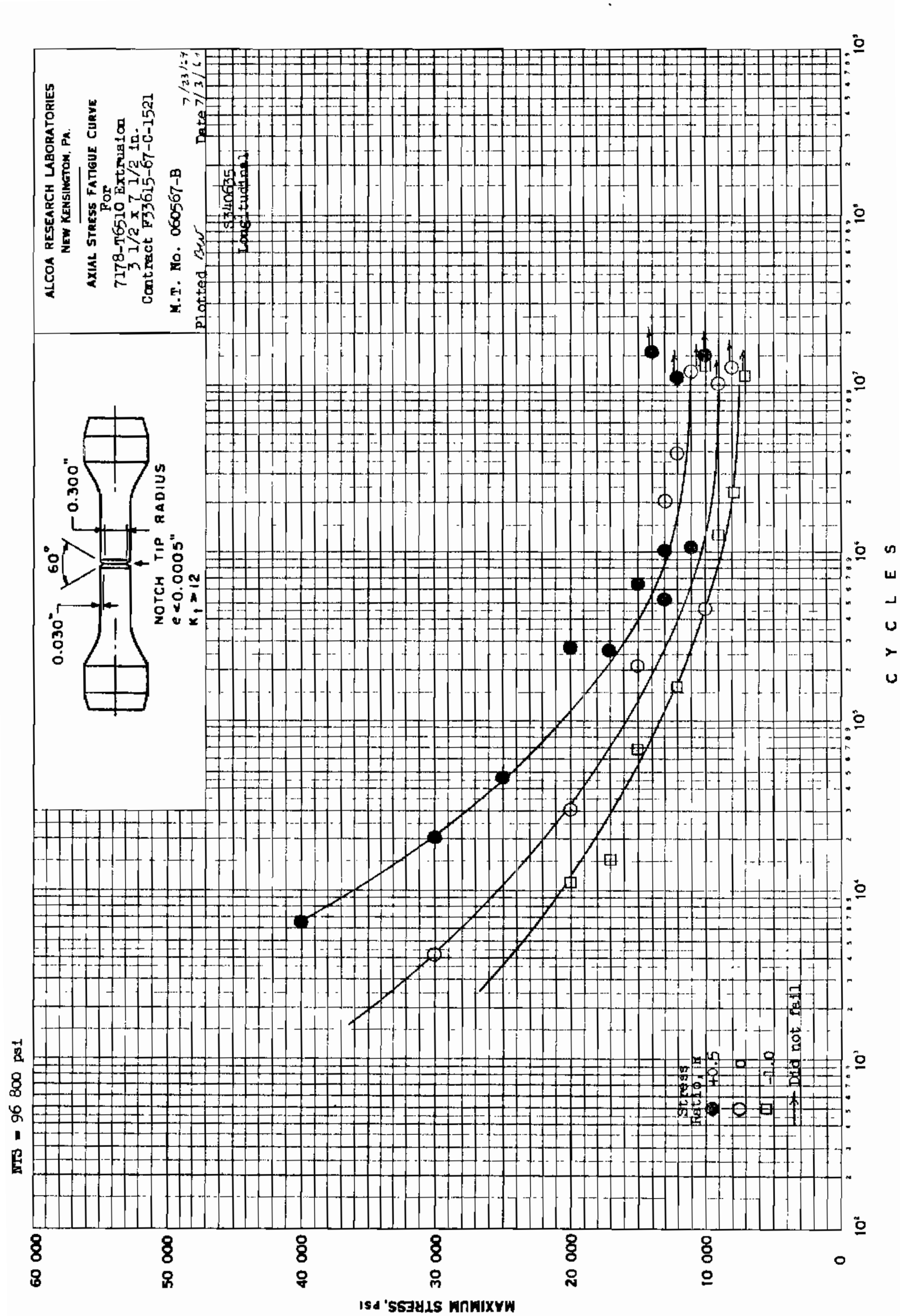

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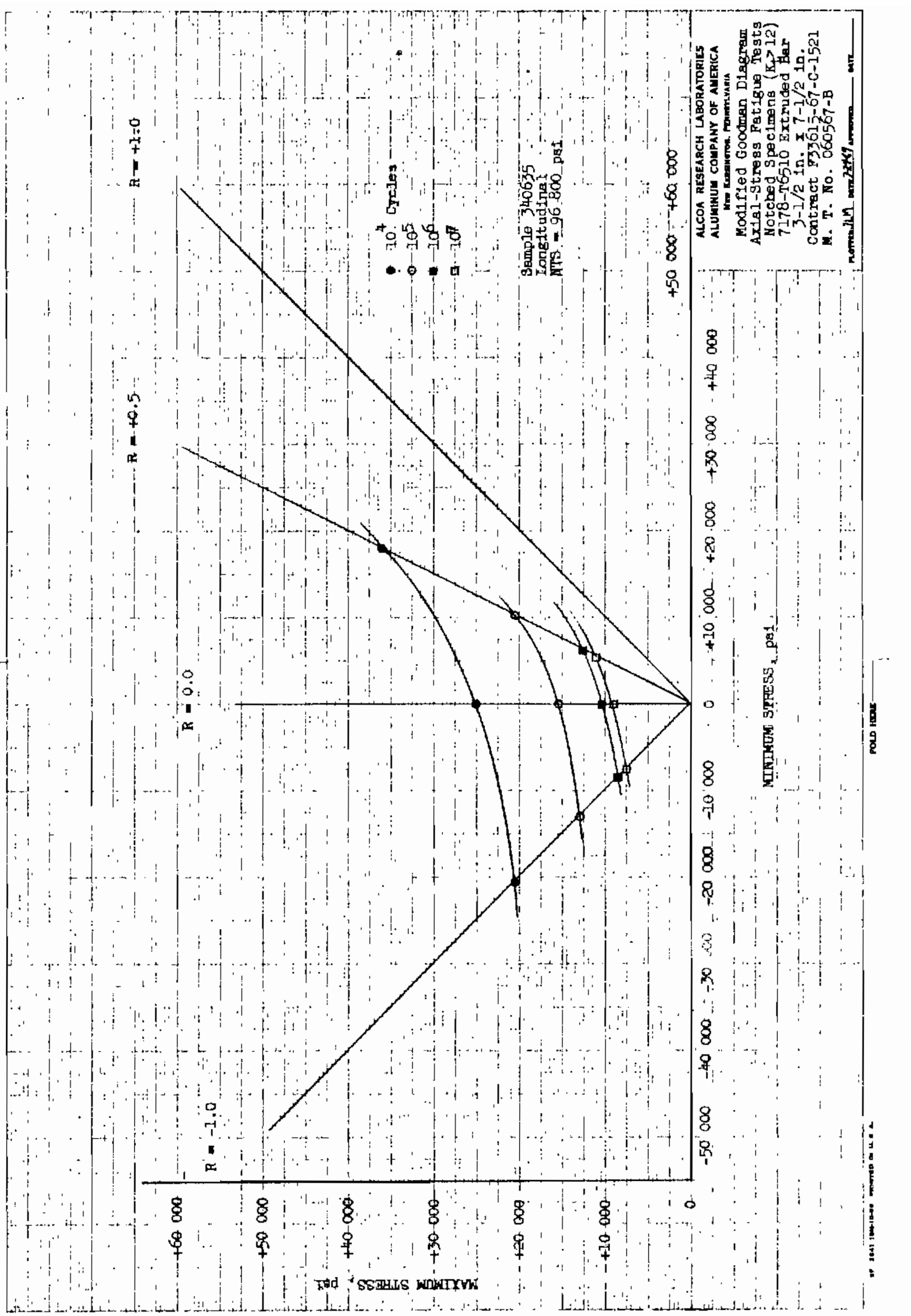

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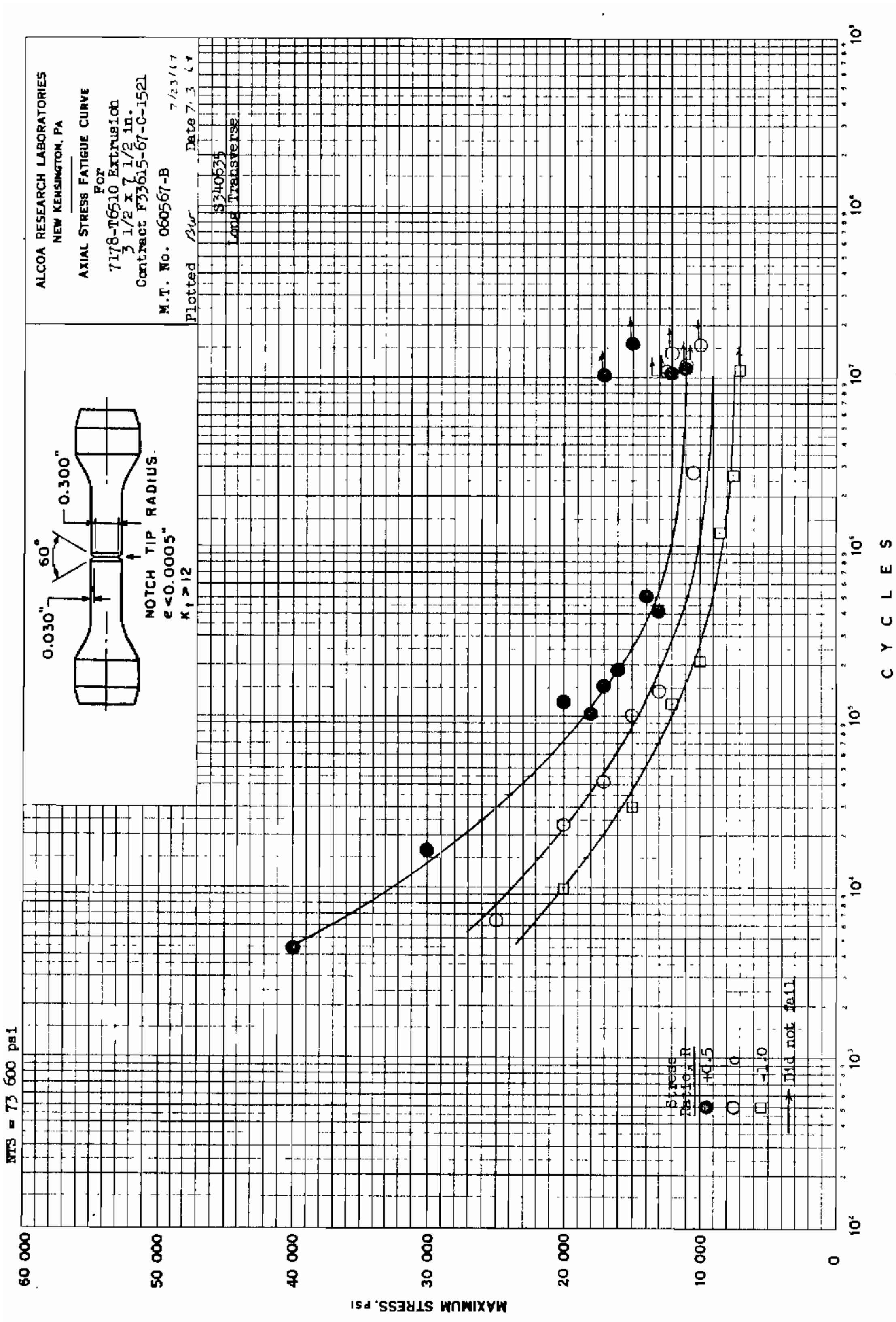

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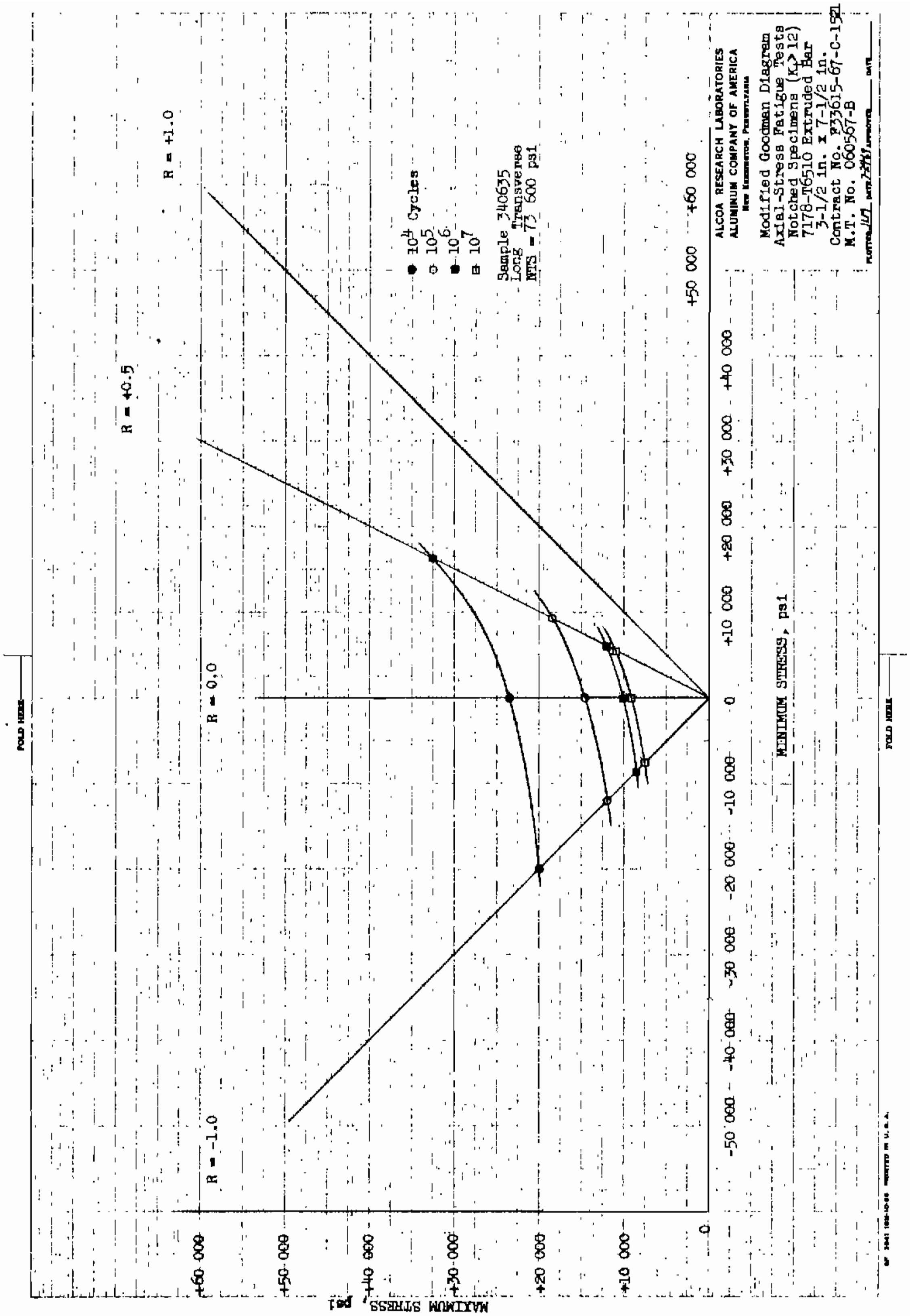

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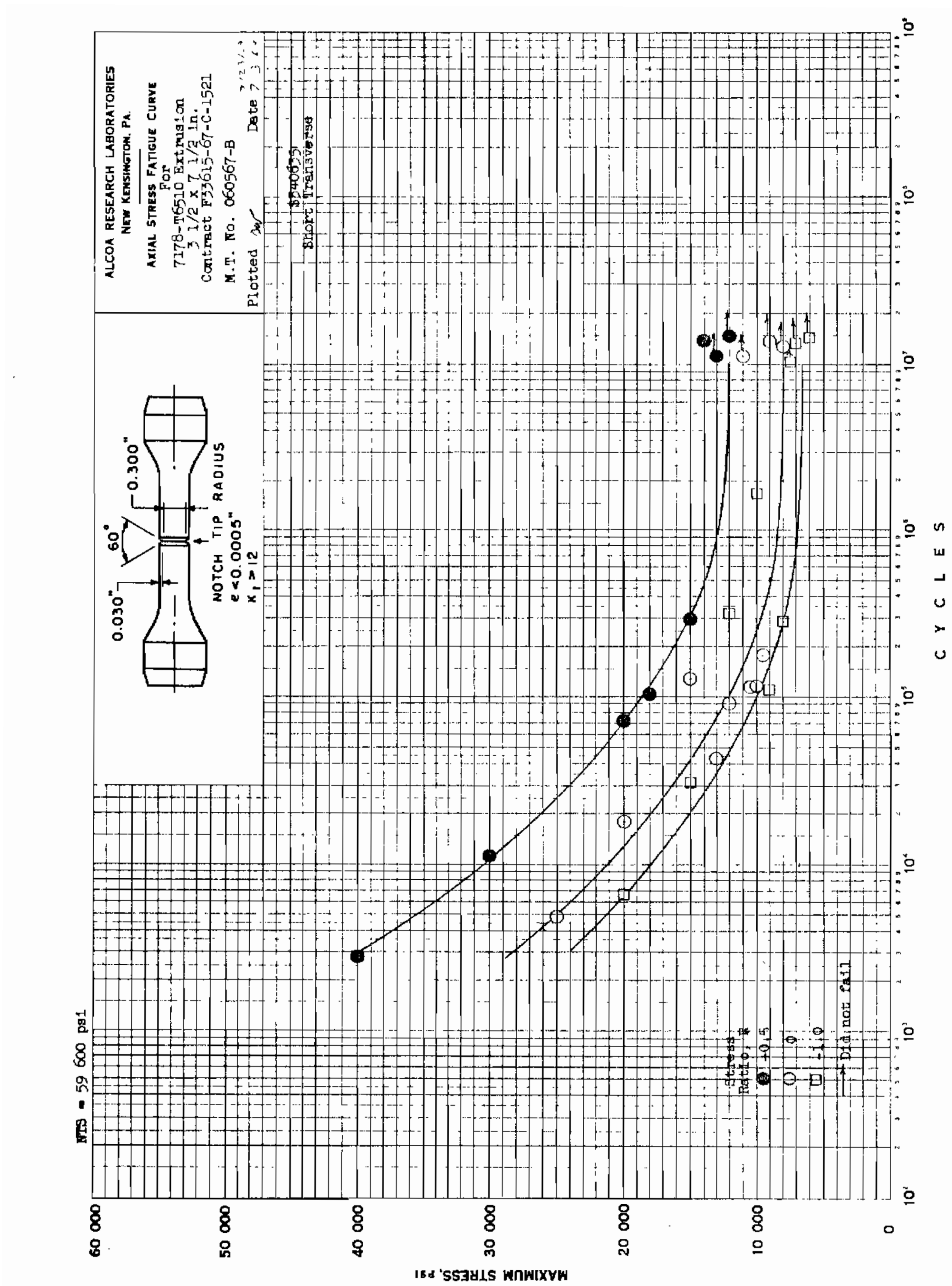

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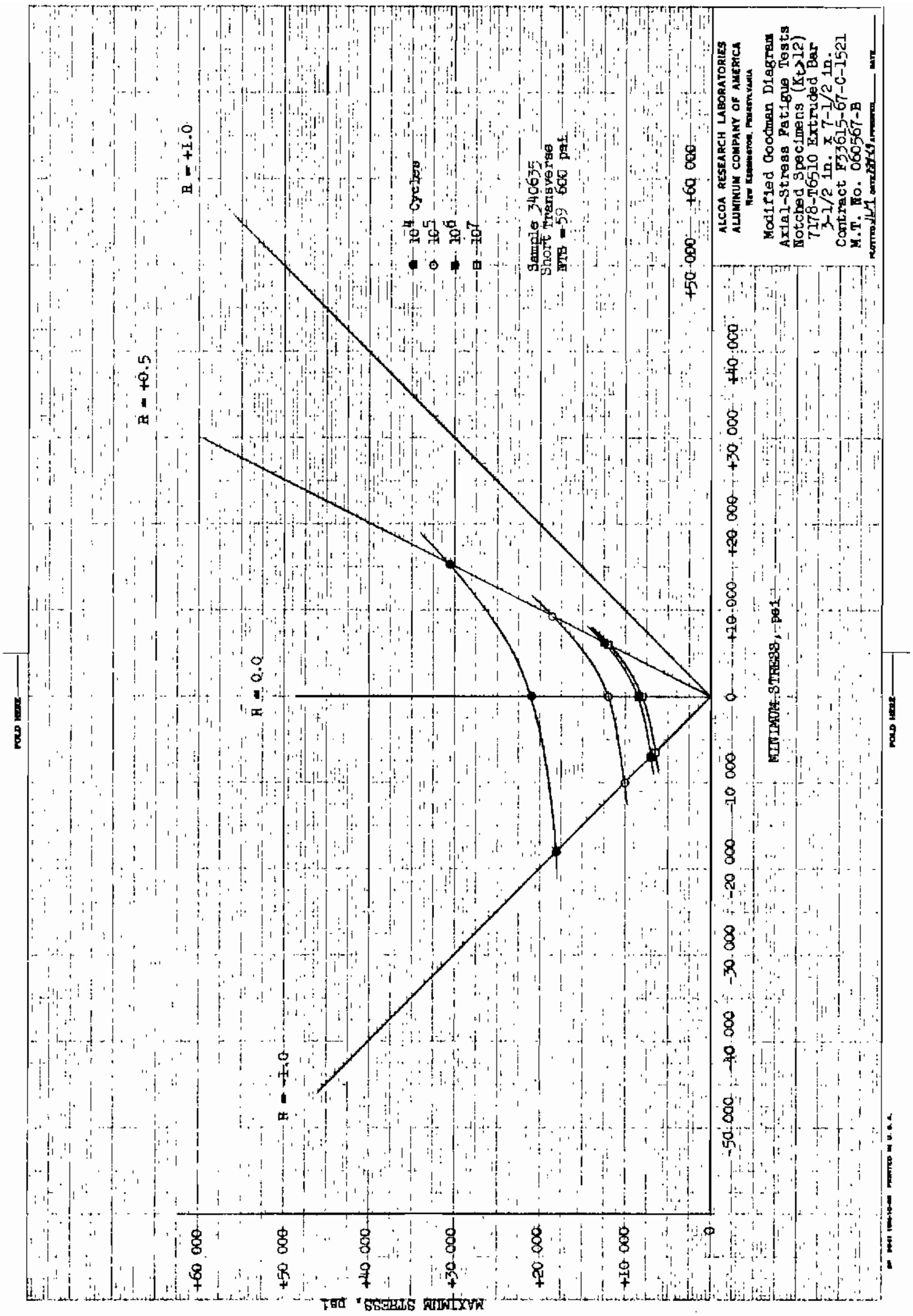

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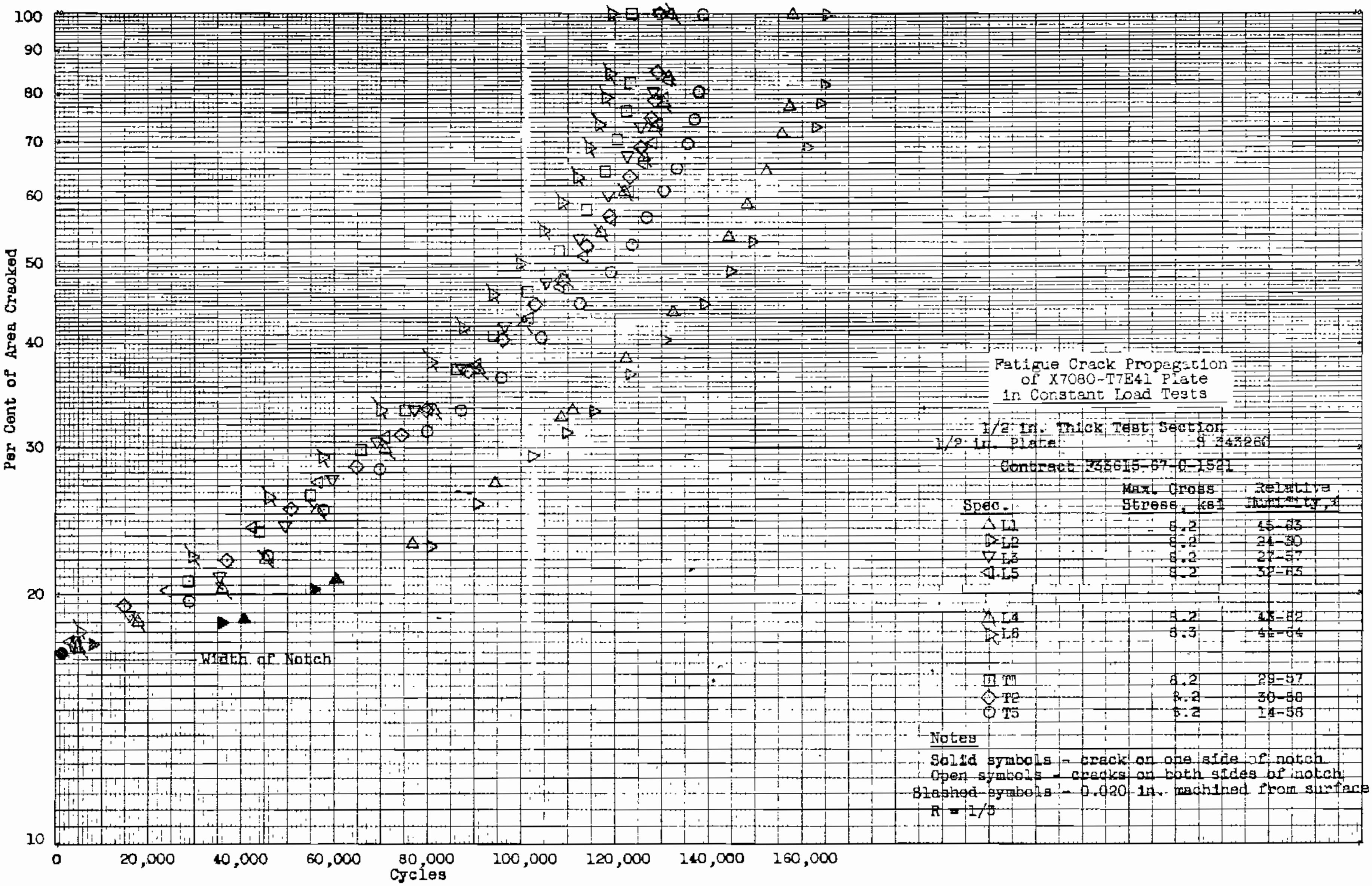

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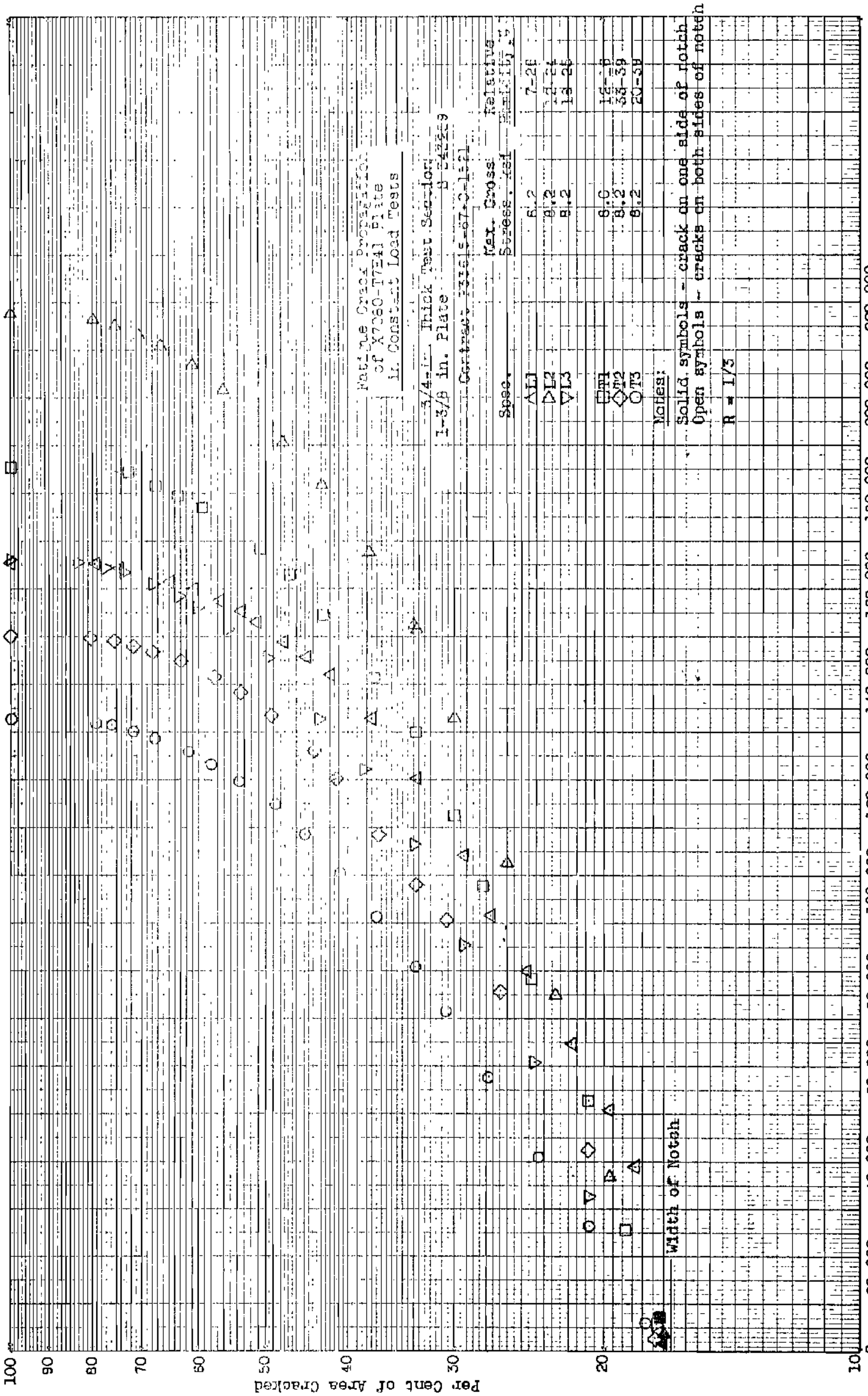

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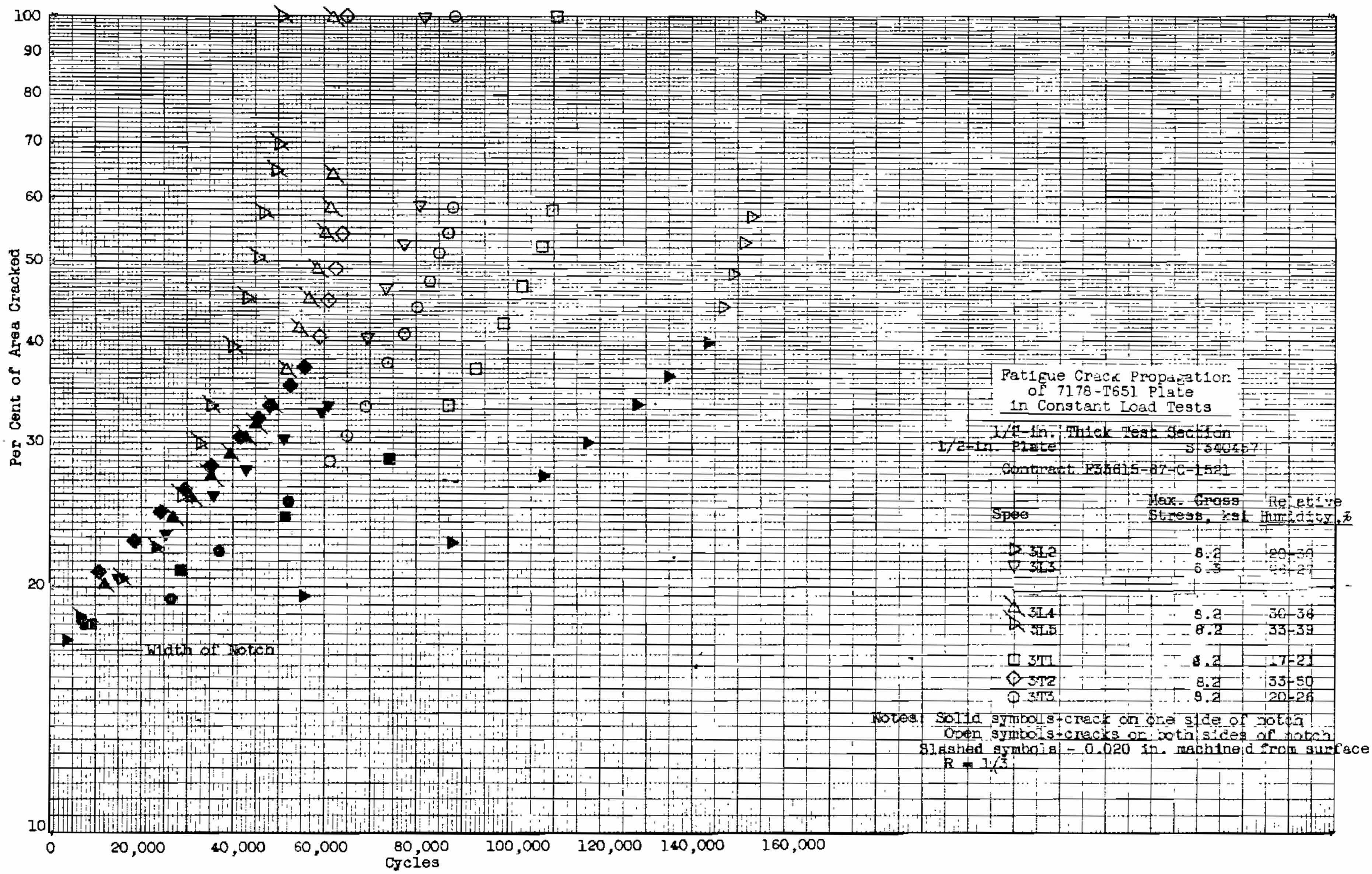

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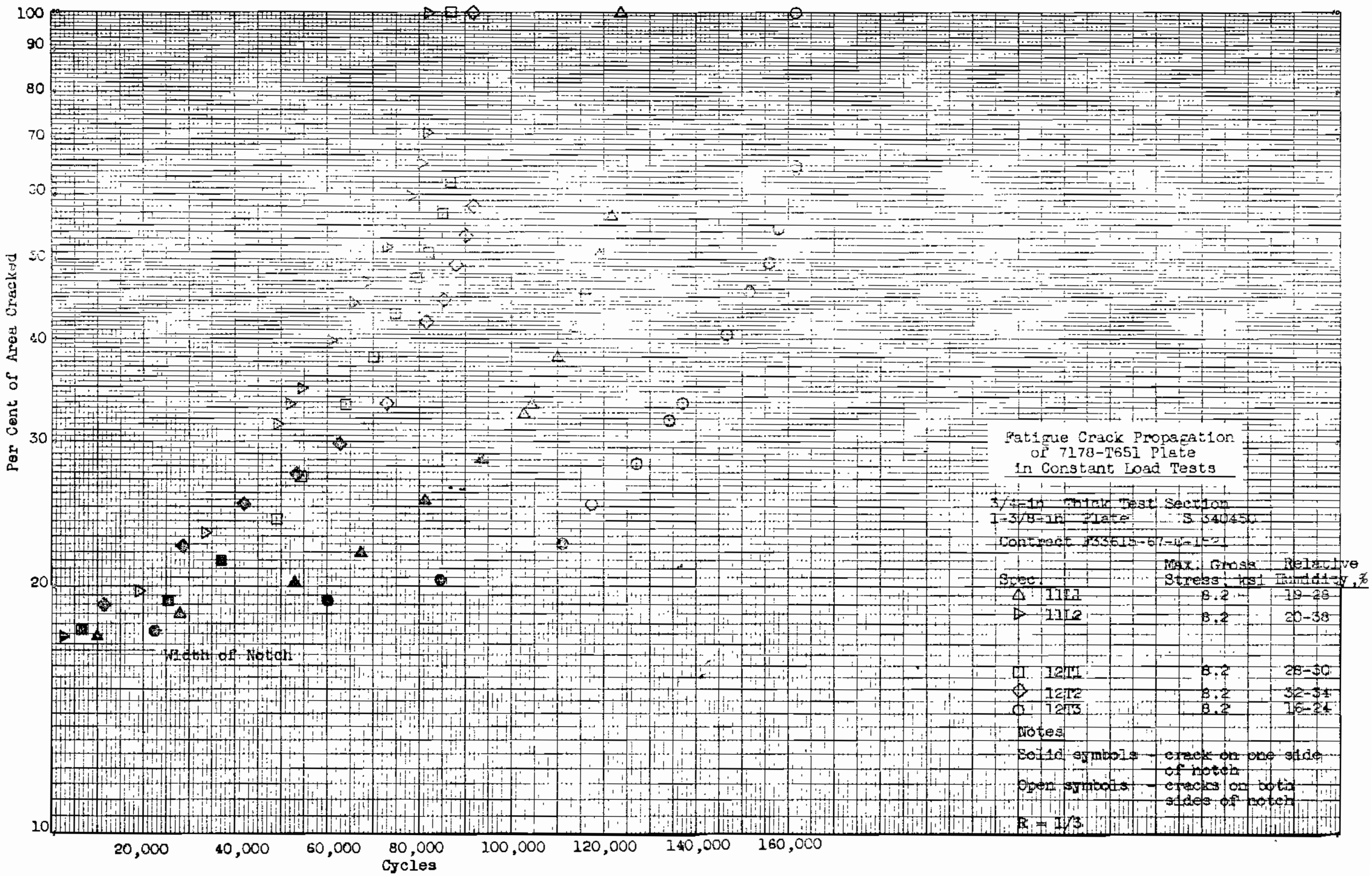

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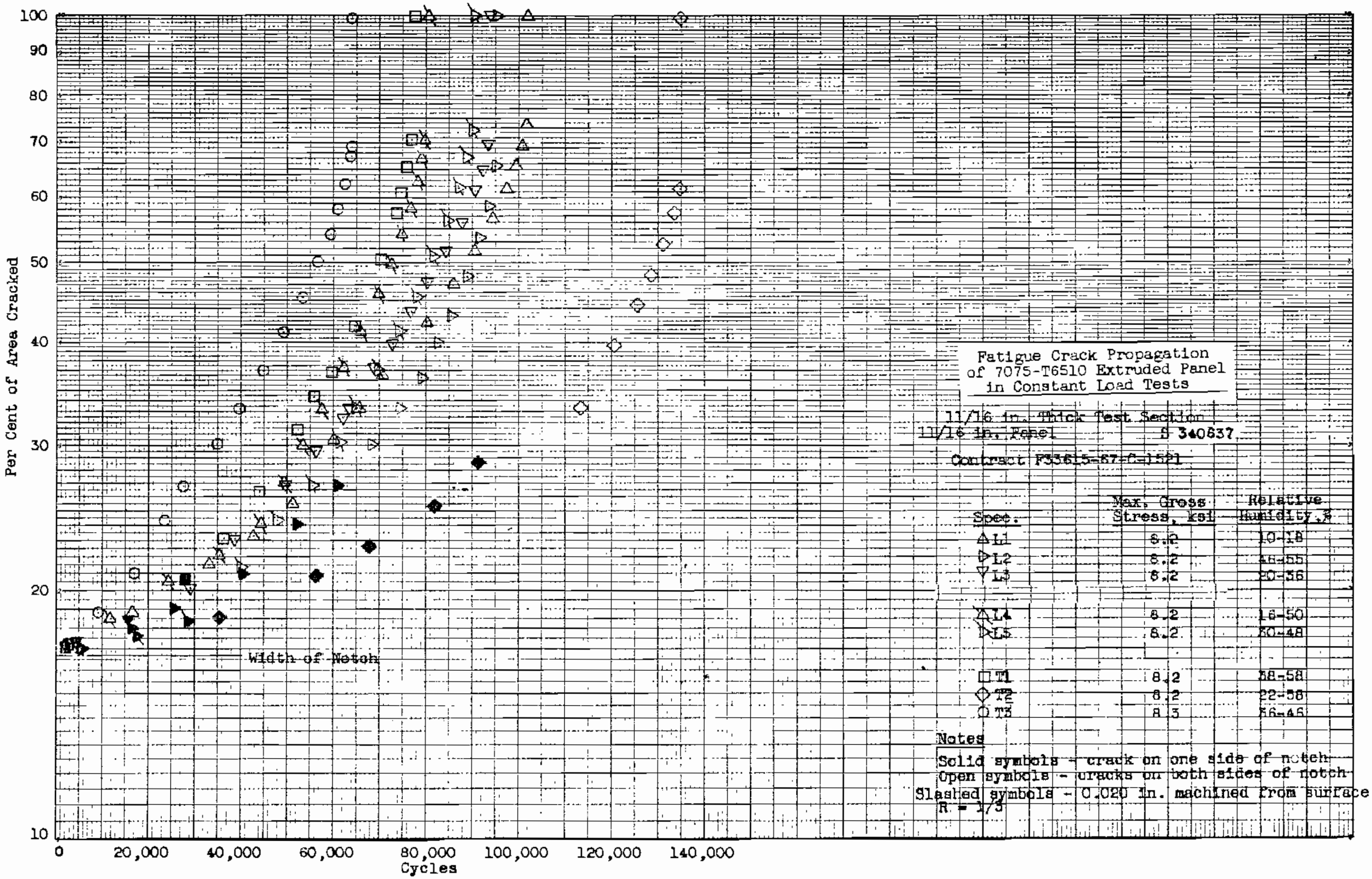

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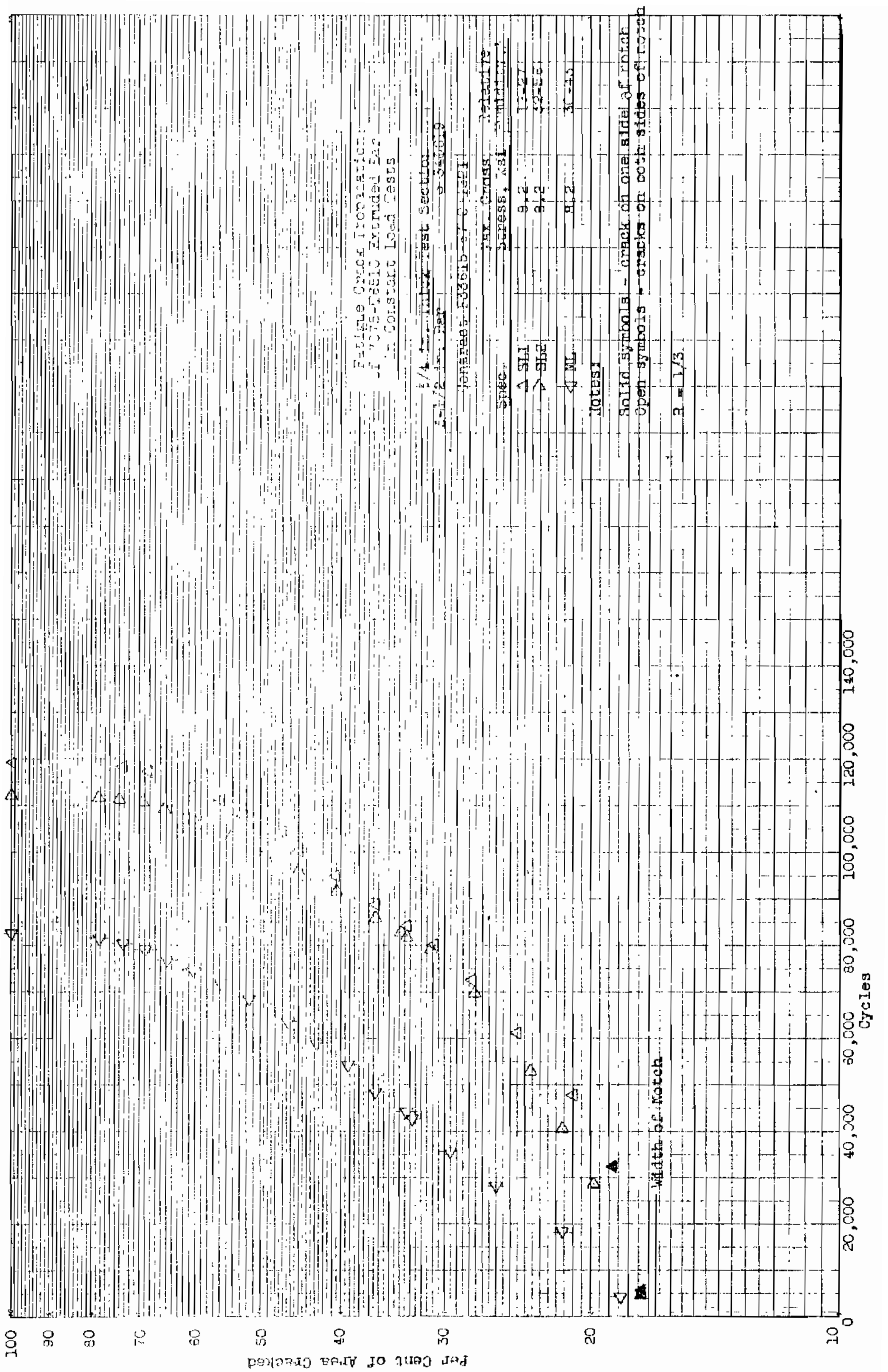

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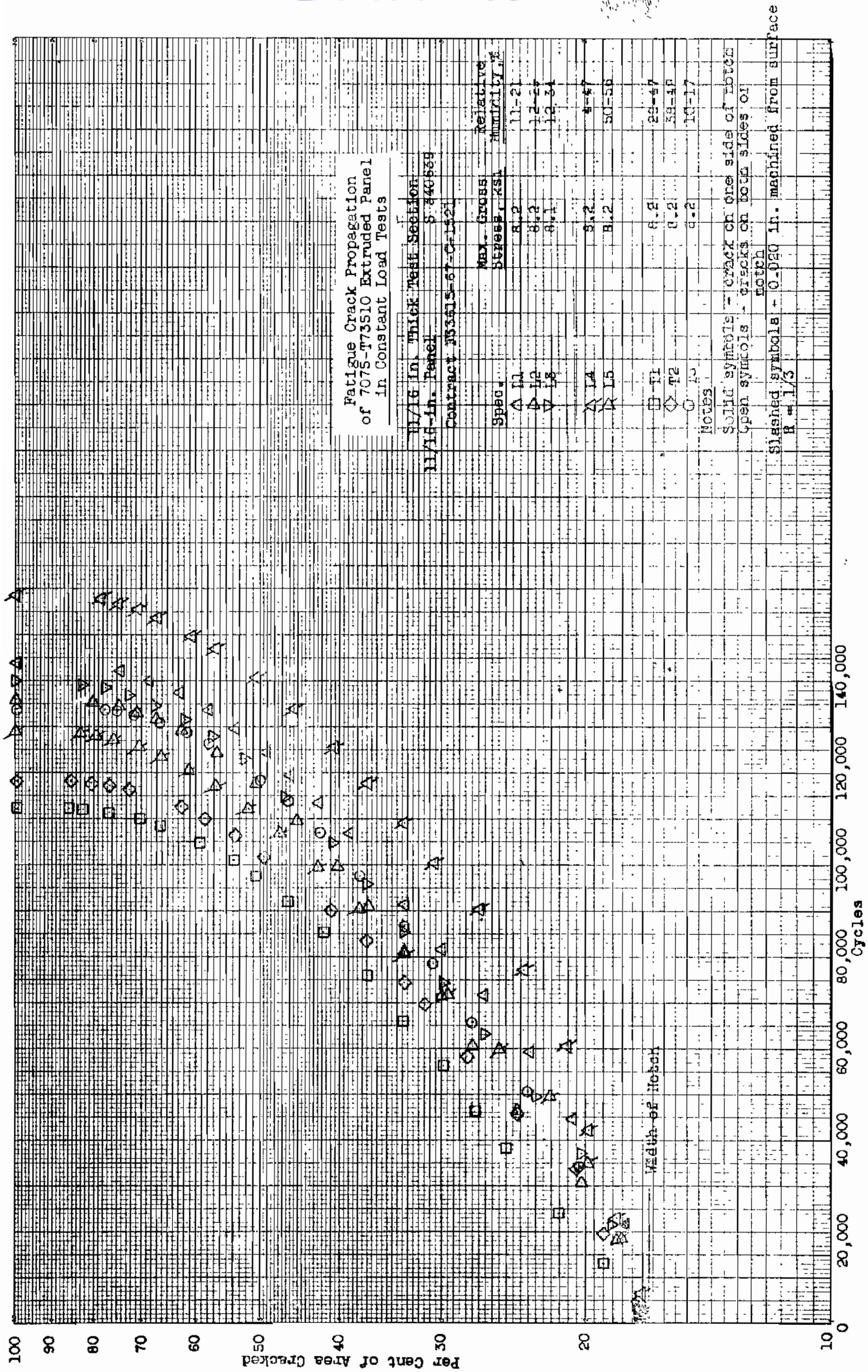

Fig. 135

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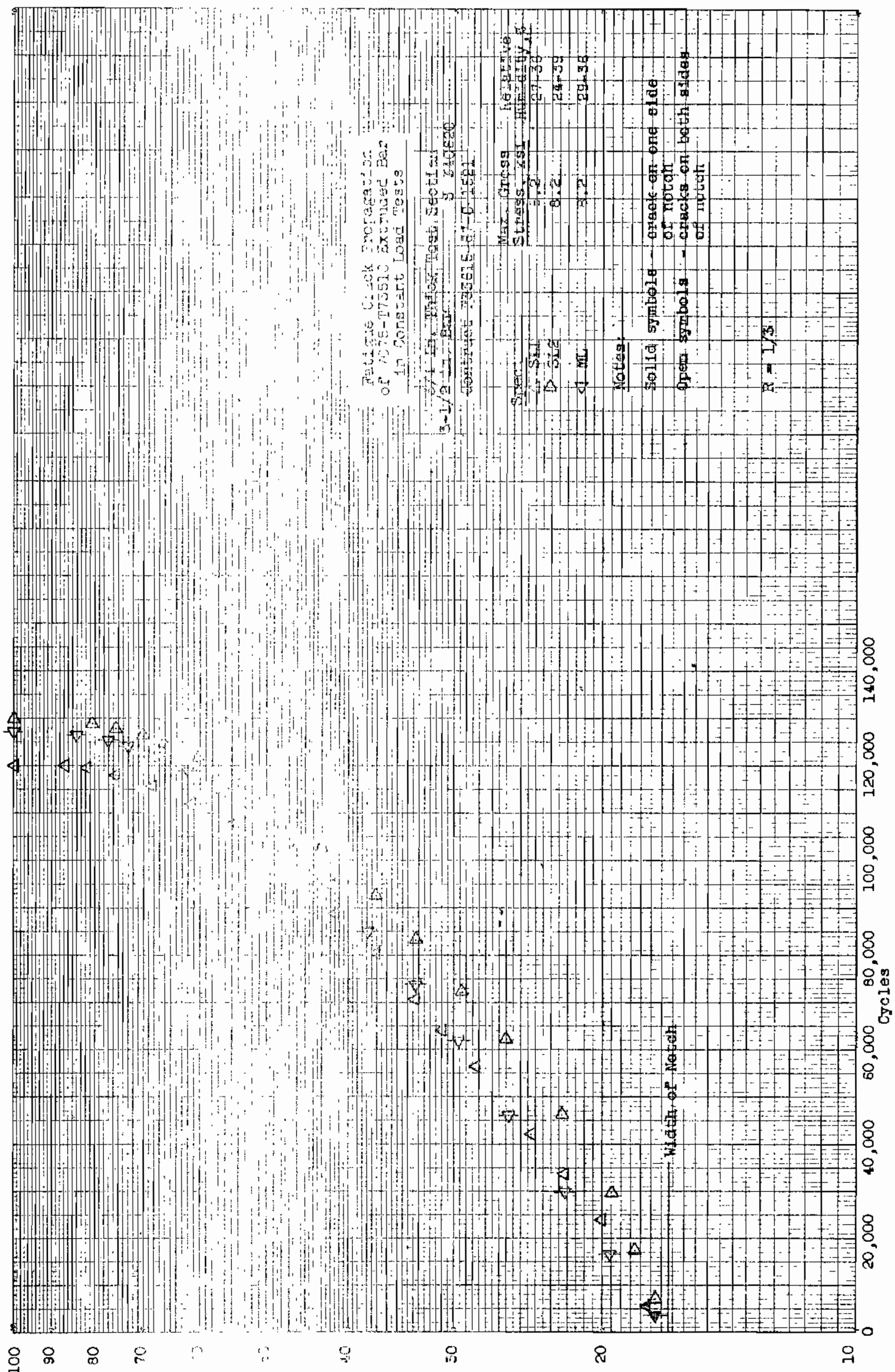

Fig. 136

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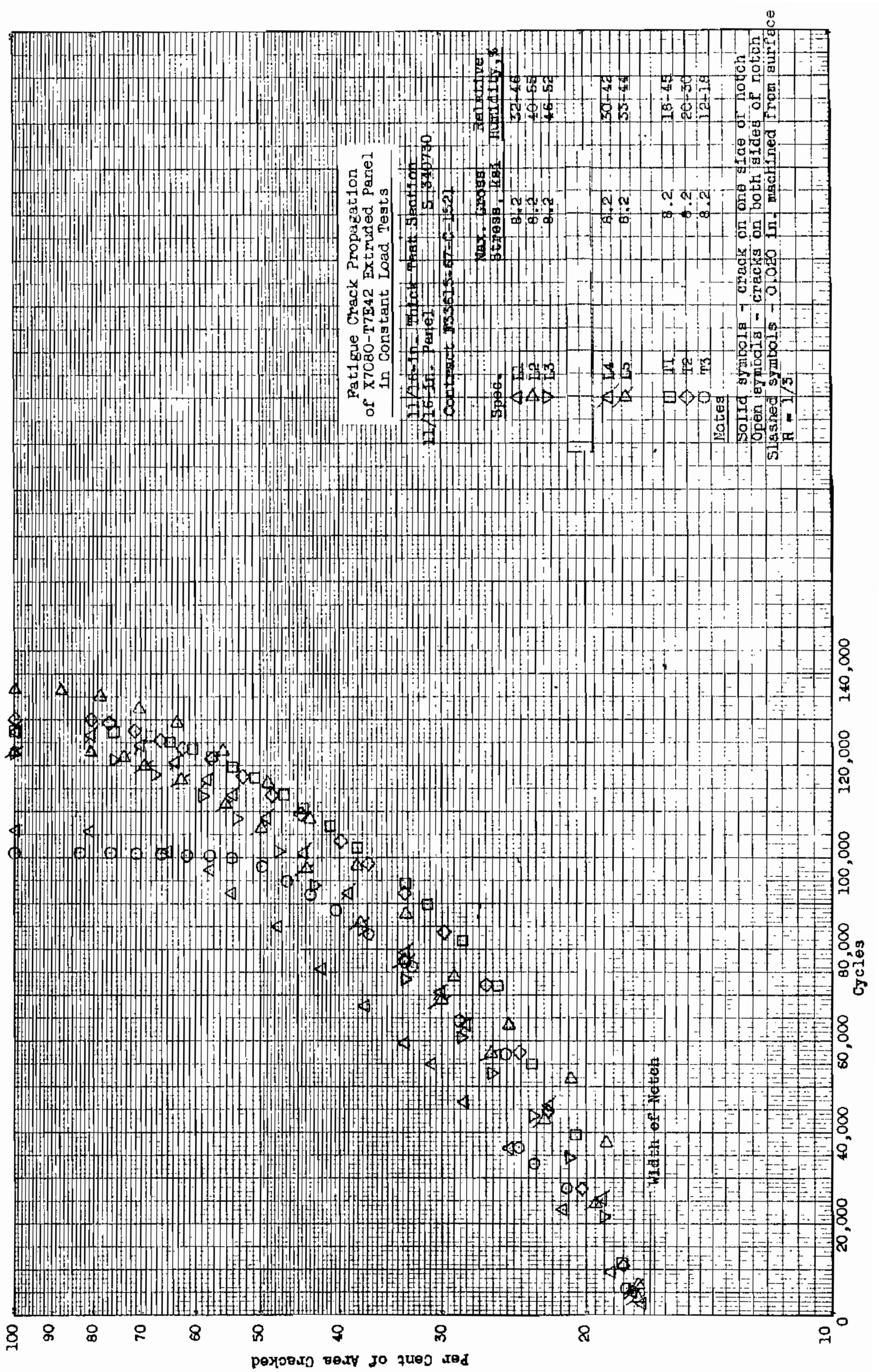

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Fig. 137

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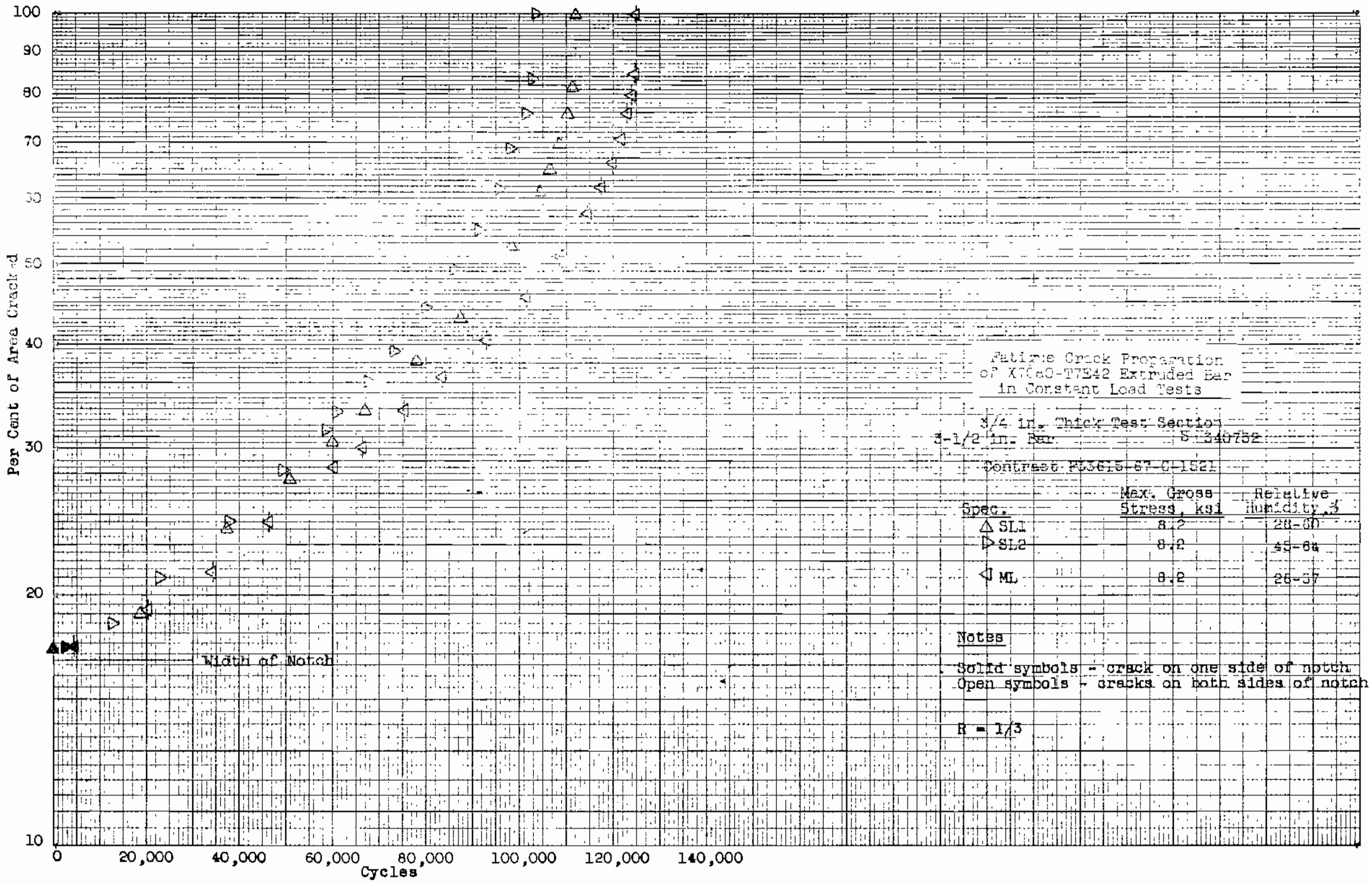

Fig. 138

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Contrails

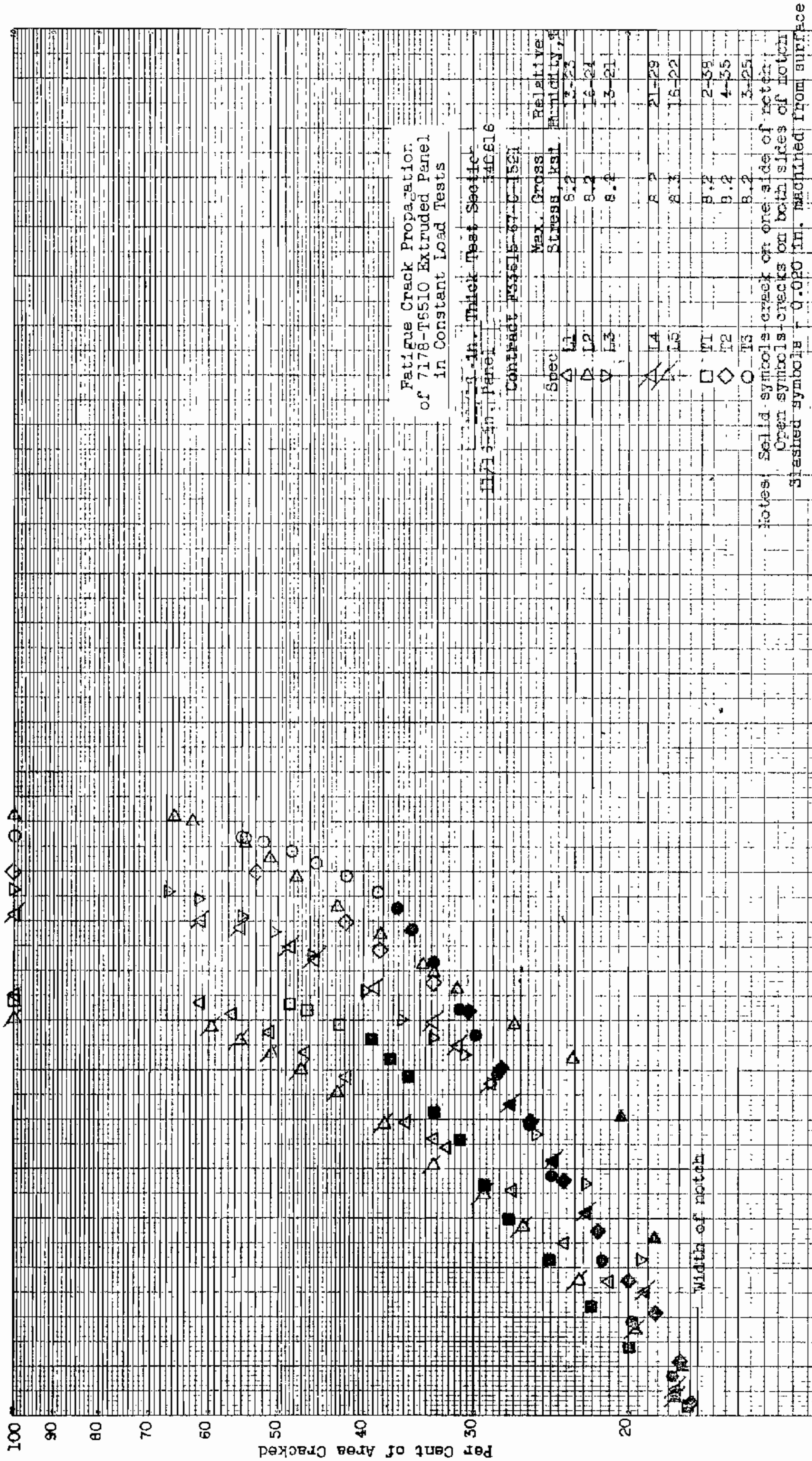

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Fig. 139

Contrails

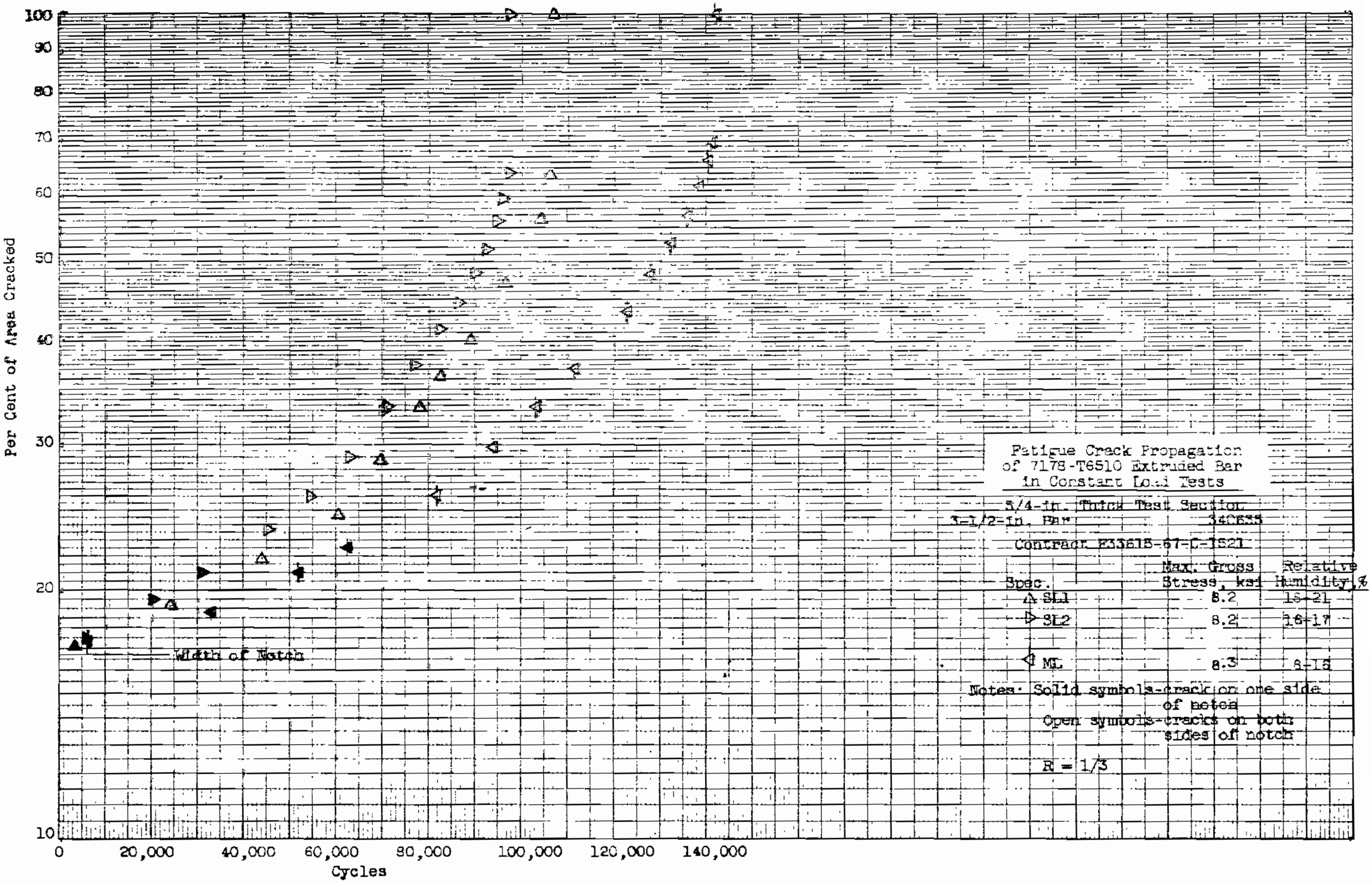

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Fig. 140

Contrails

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Contrails

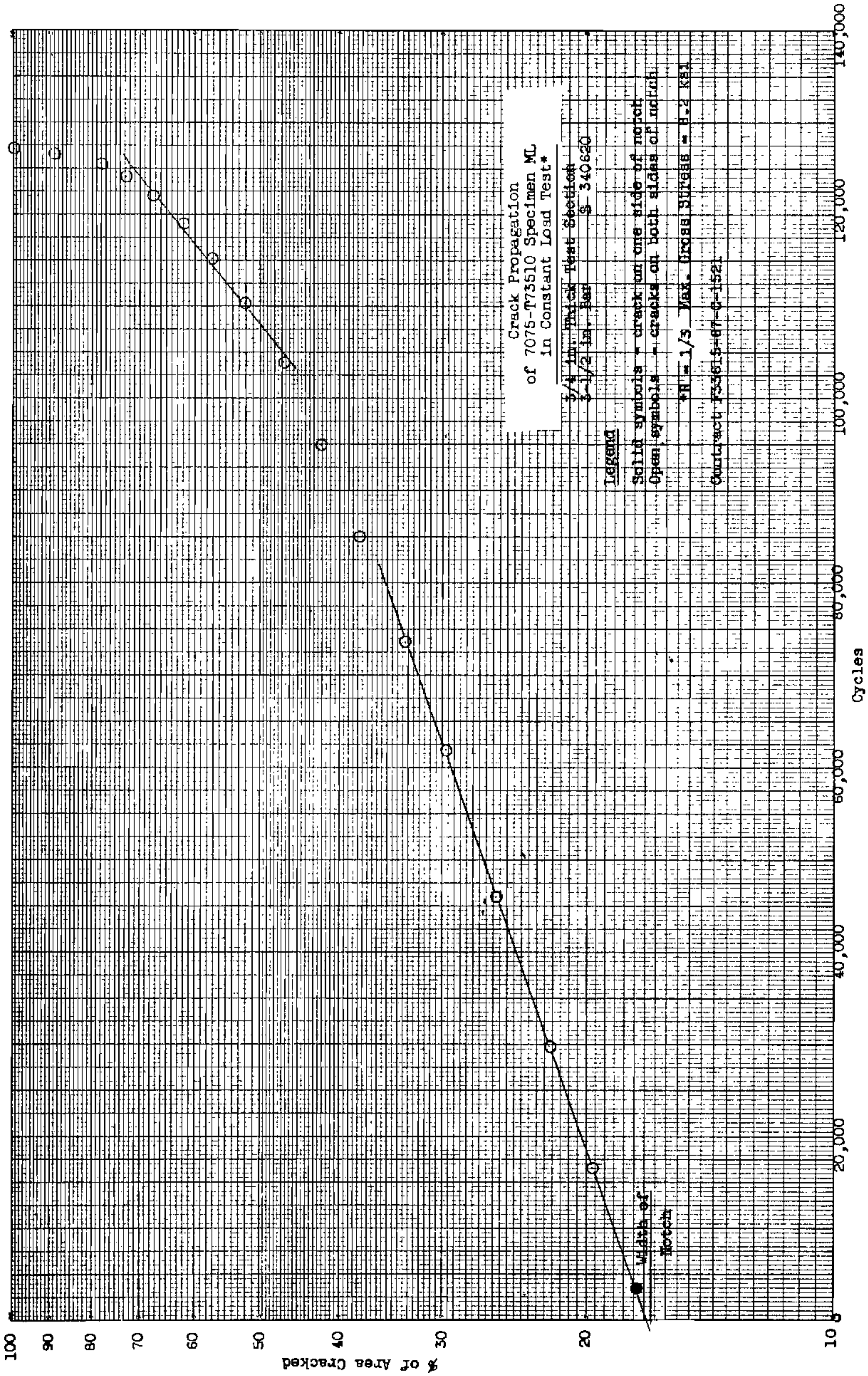
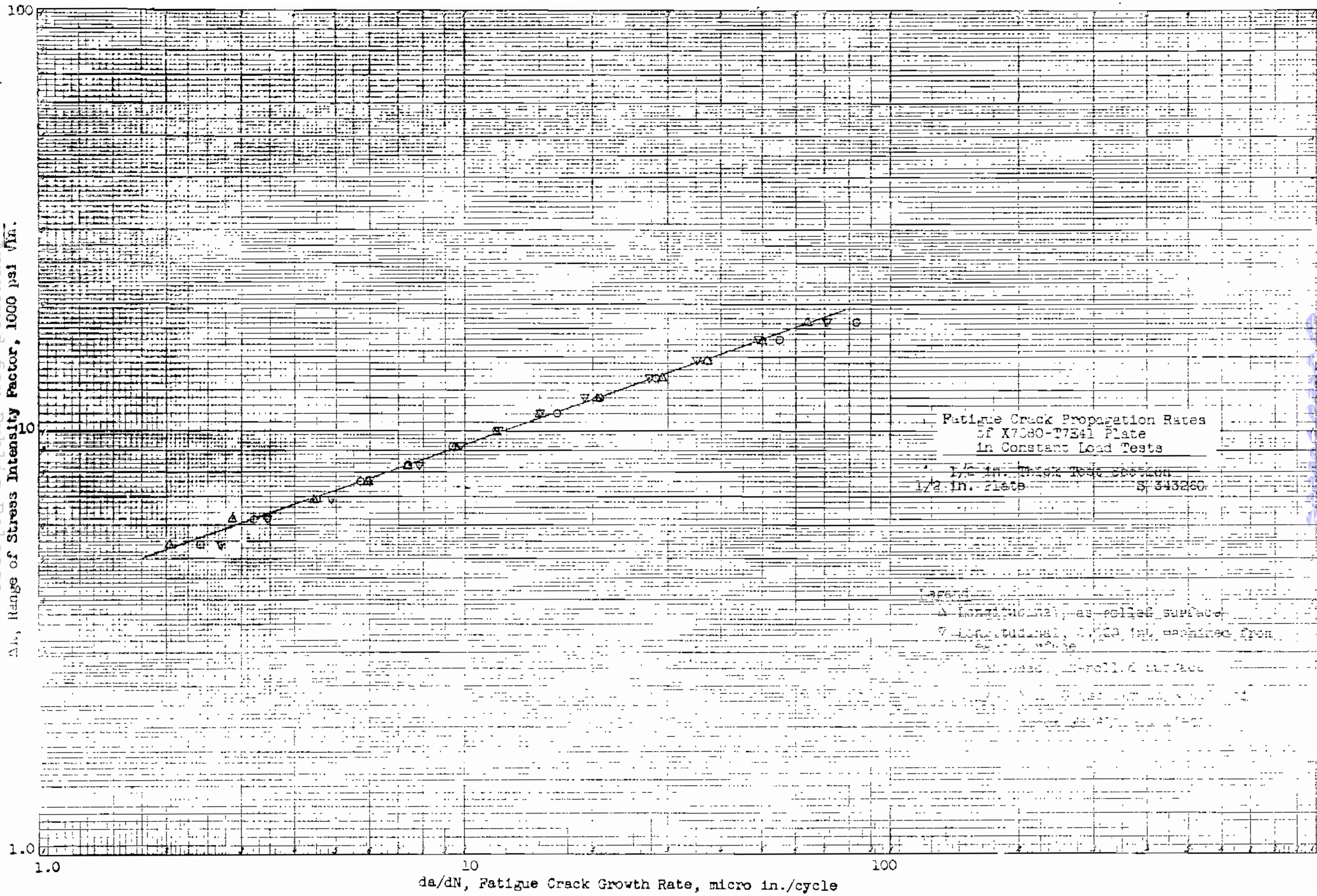


Fig. 141

Approved for Public Release



Approved for Public Release

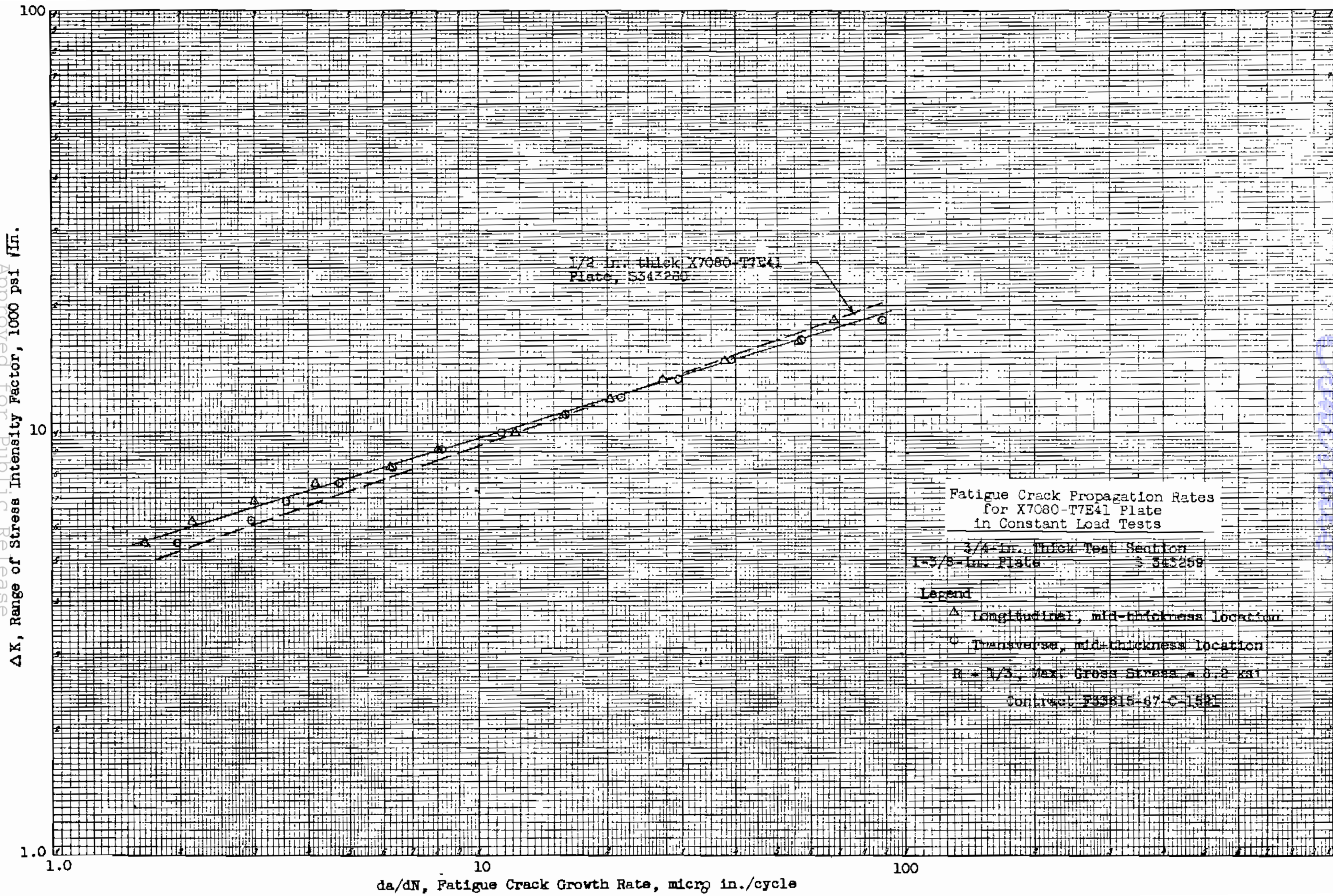


Fig. 143

Approved for Public Release

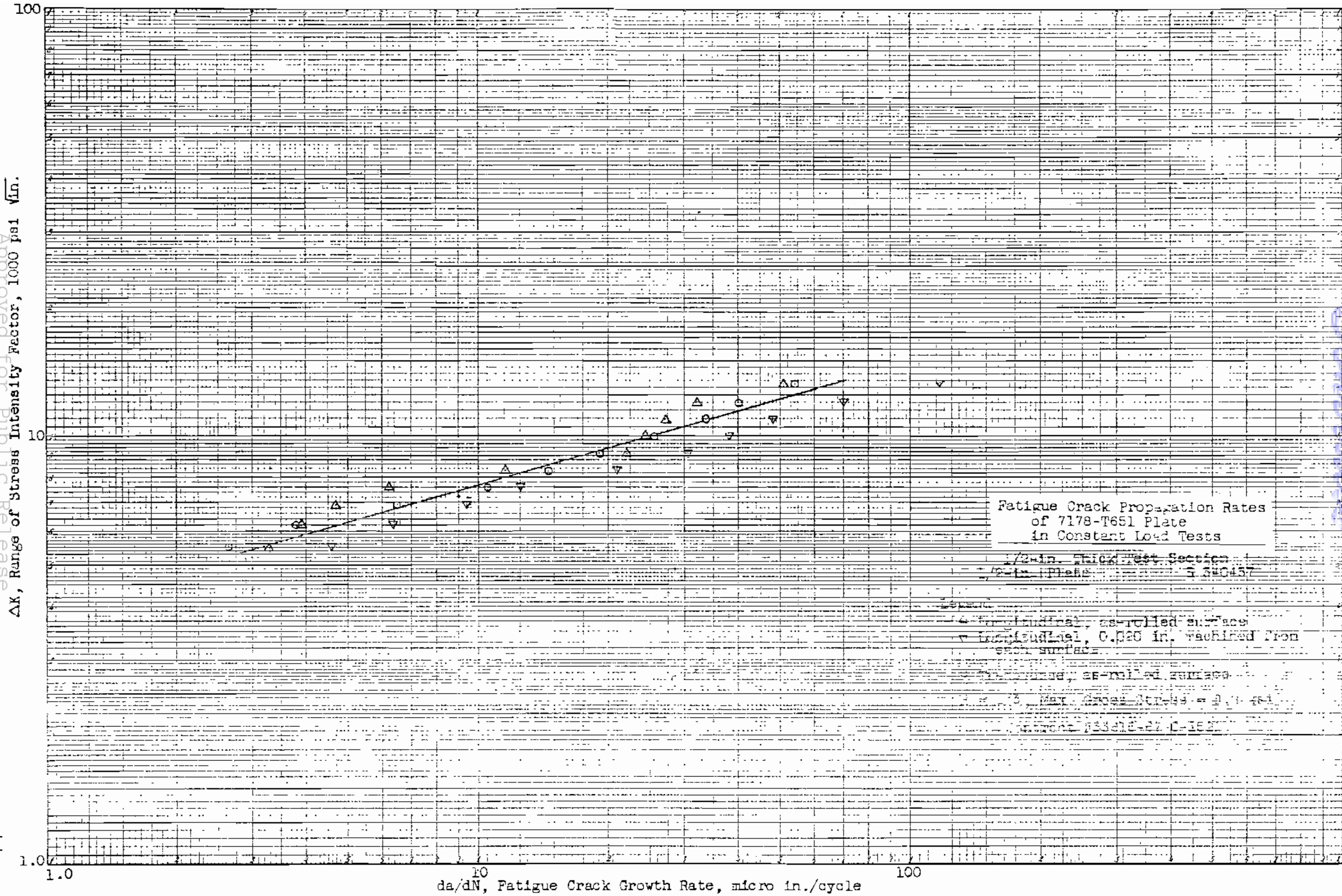
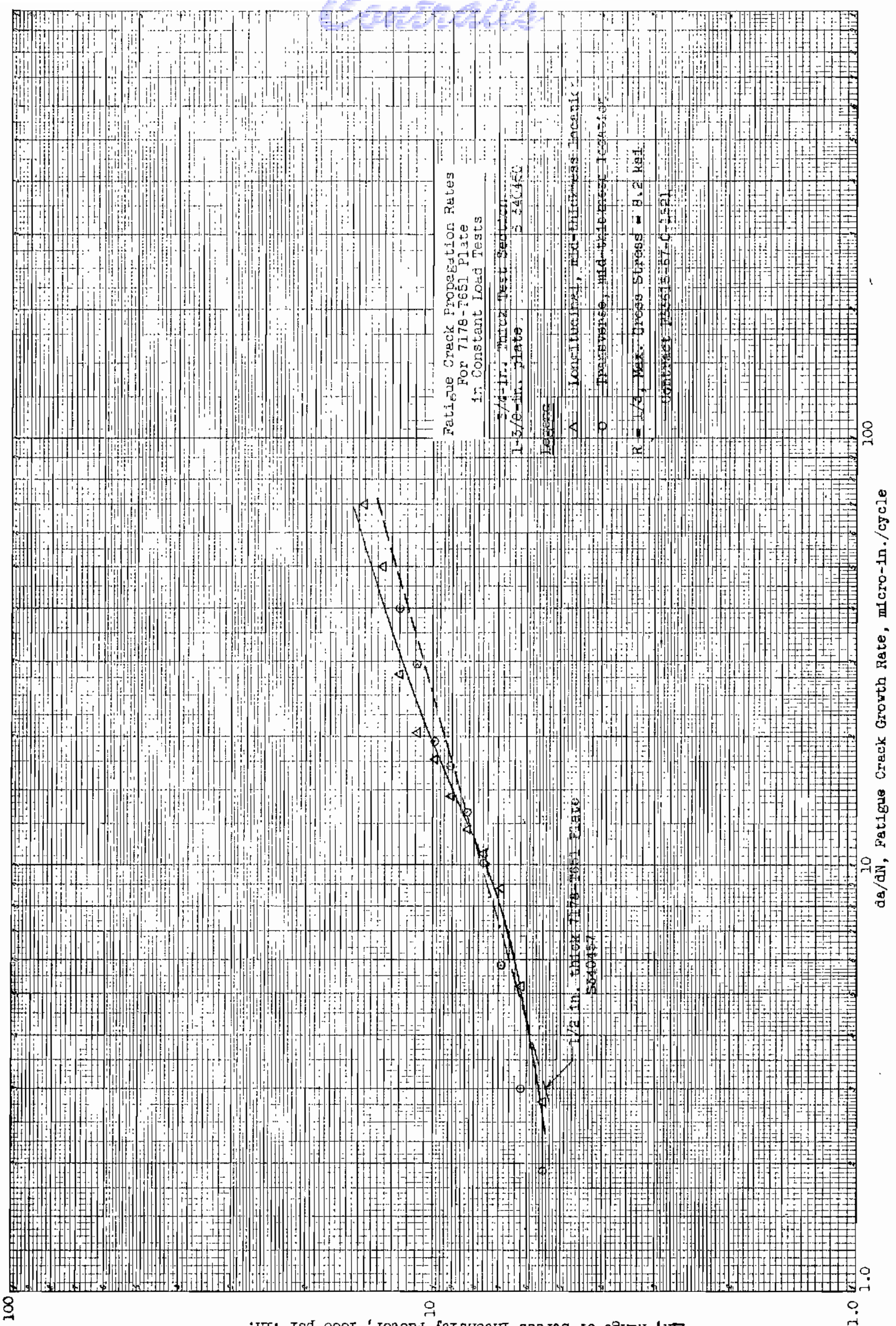


Fig. 144

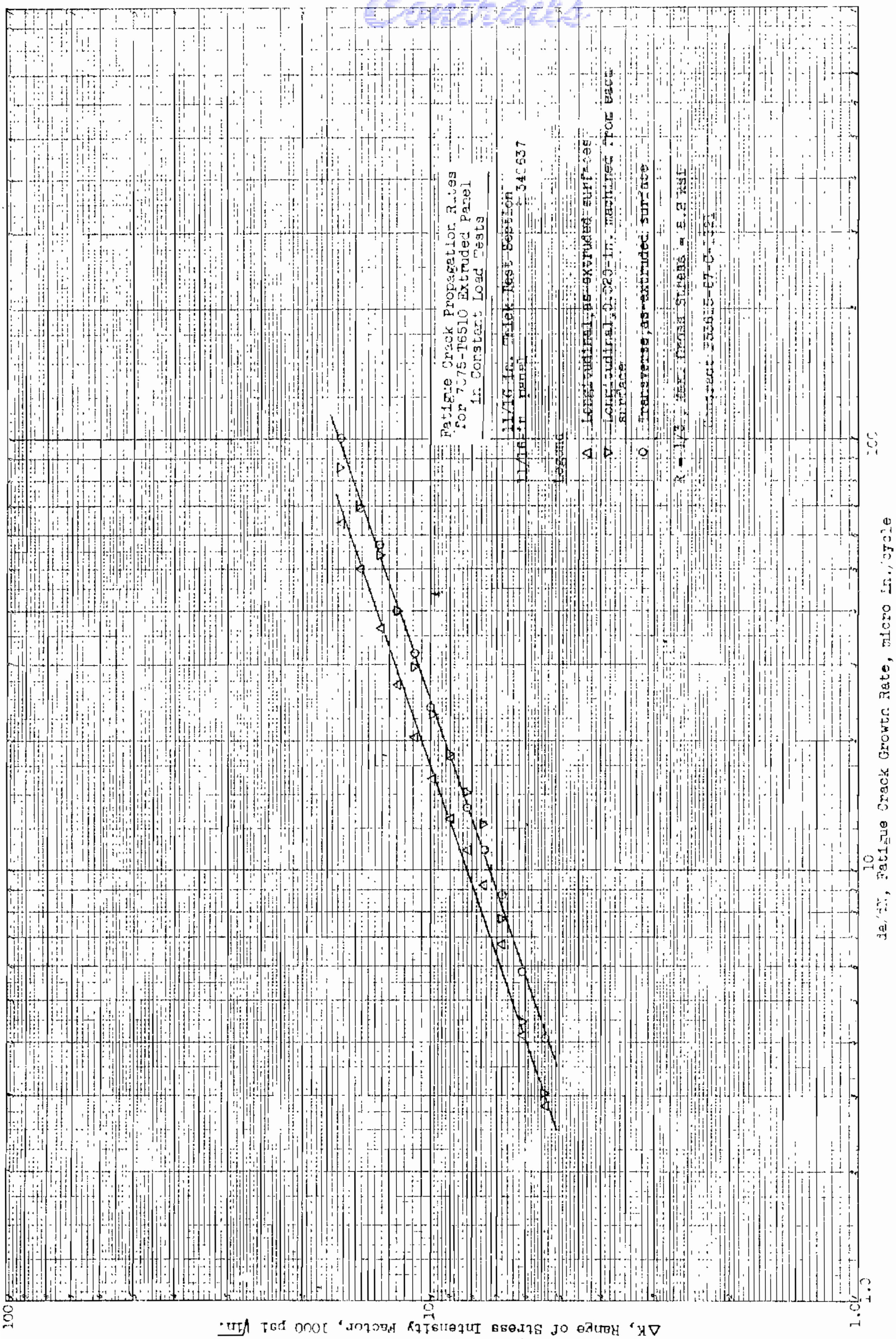
Approved for Public Release



Approved for Public Release

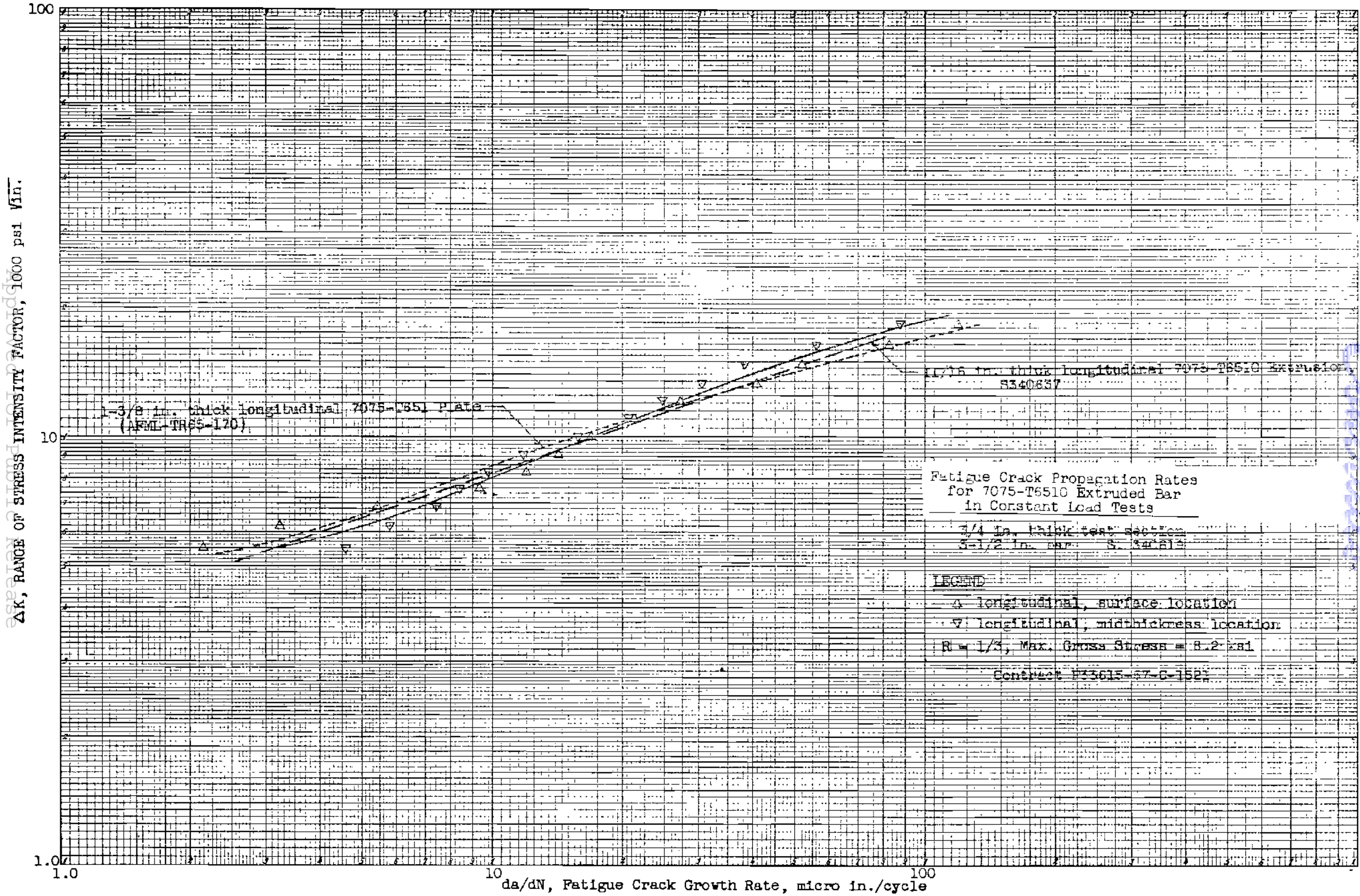
Fig. 145

Contrails



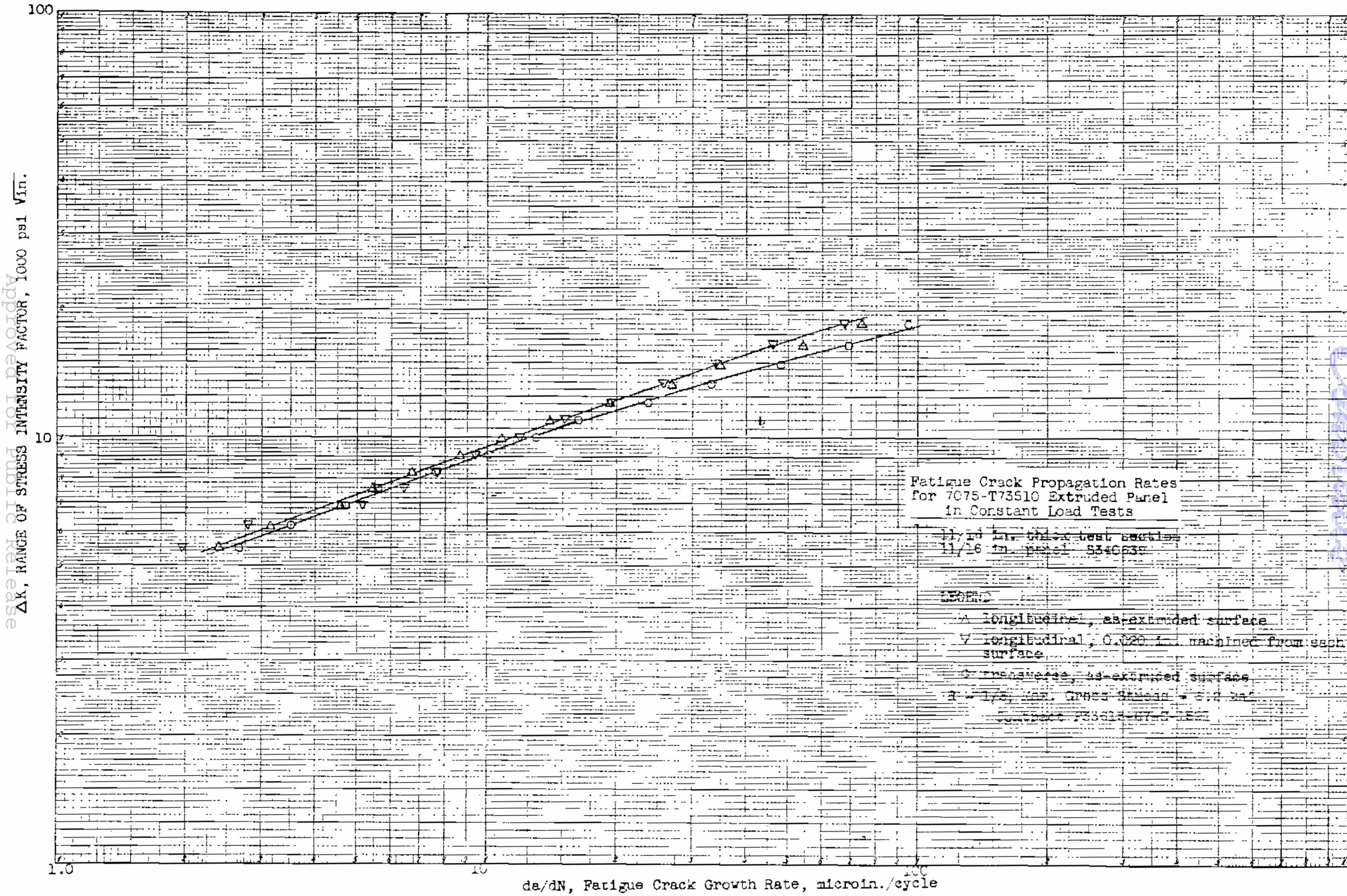
Approved for Public Release

Fig. 146



Fatigue Crack Propagation Rates
for 7075-T6510 Extruded Bar
in Constant Load Tests
3/4 in. thick test section
3-1/2 in. bar
LEGEND
△ longitudinal, surface location
▽ longitudinal, midthickness location
R = 1/3, Max. Gross Stress = 8.2 ksi
1-3/8 in. thick longitudinal 7075-T651 Plate
(AFML-TR65-170)
11/16 in. thick longitudinal 7075-T6510 Extrusion,
S340637
ΔK, RANGE OF STRESS INTENSITY FACTOR, 1000 psi √in.
da/dN, Fatigue Crack Growth Rate, micro in./cycle
1.0
10
100

Fig. 147



Approved for Public Release

Fig. 148

Contrails

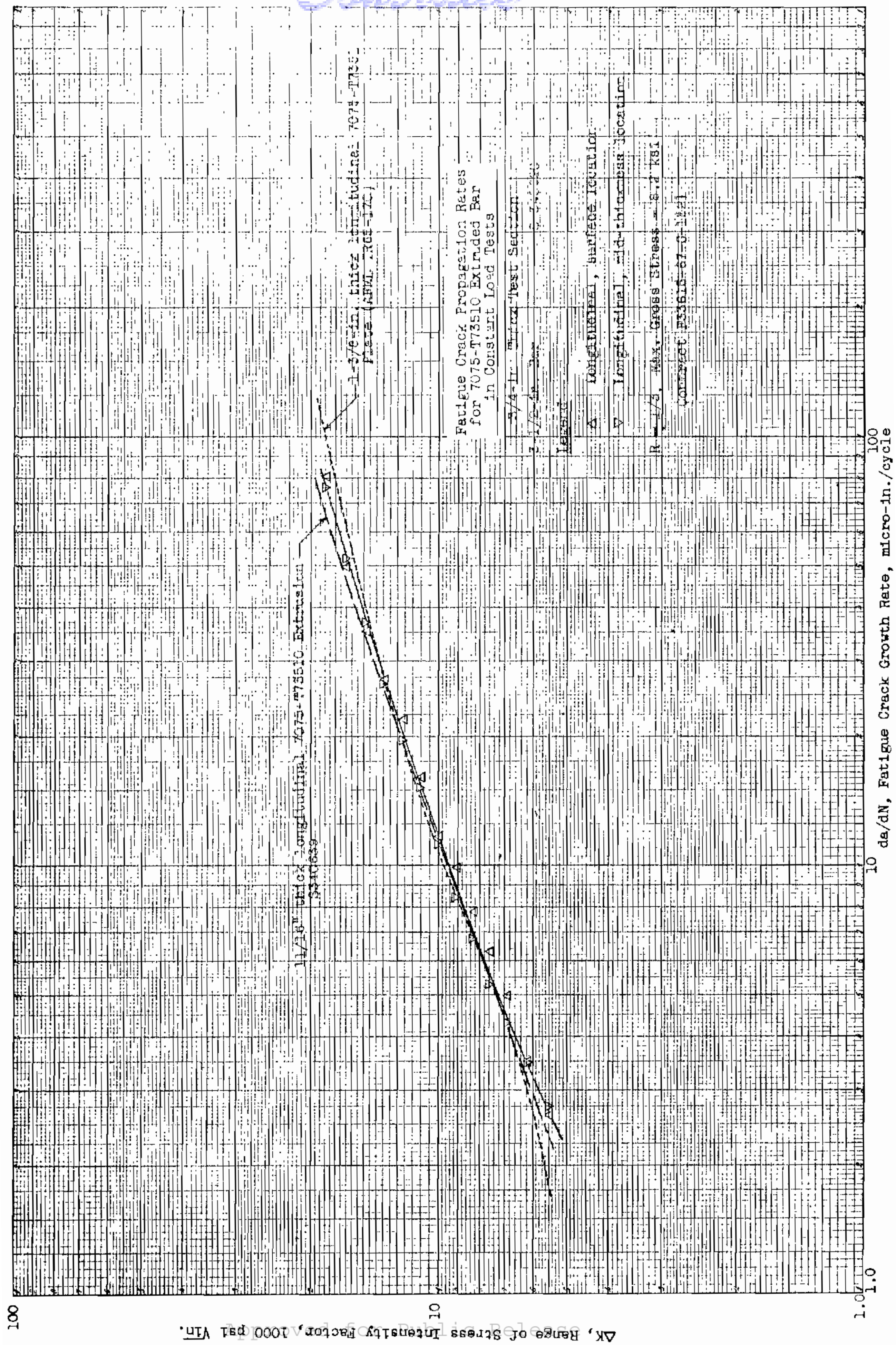
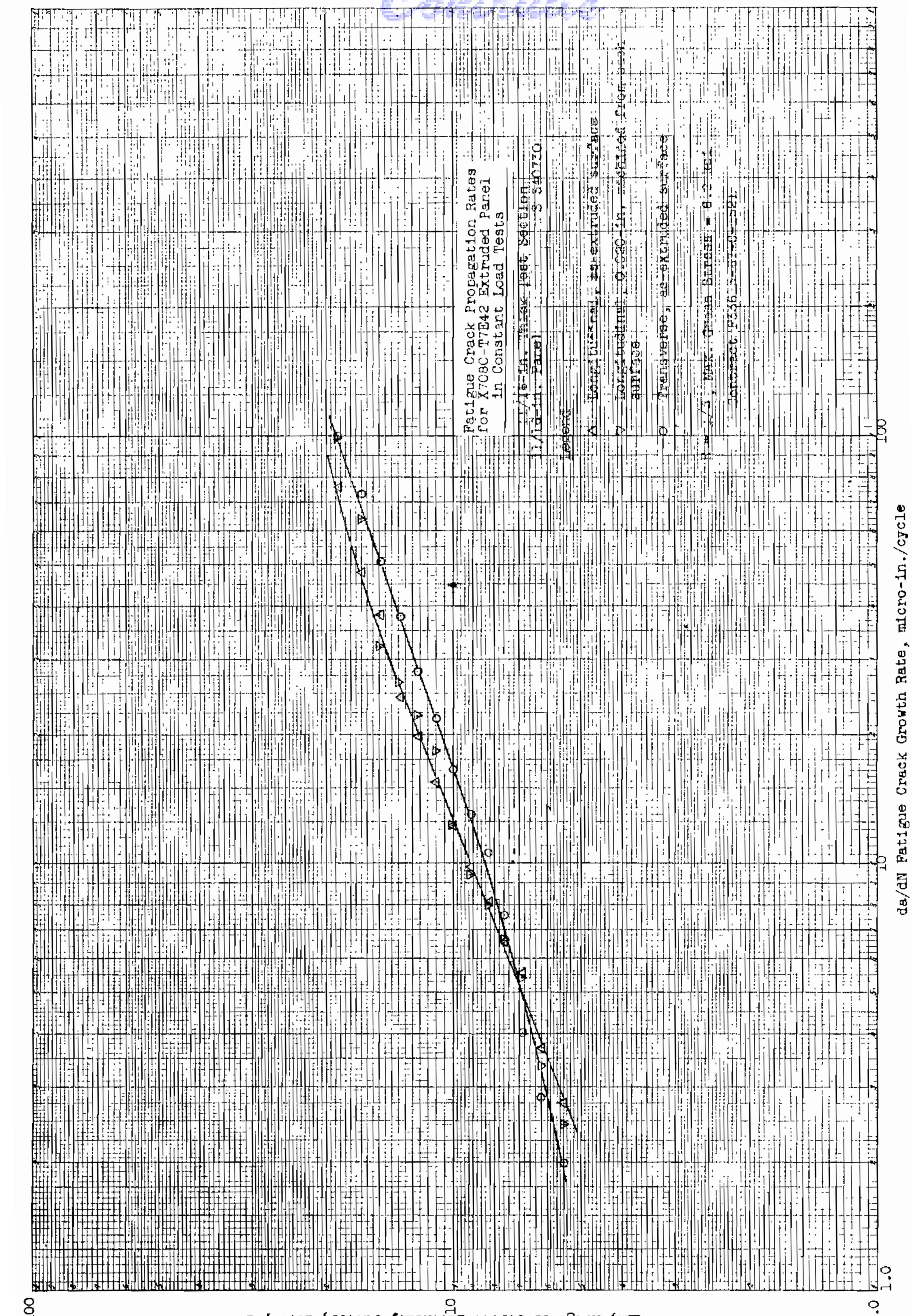
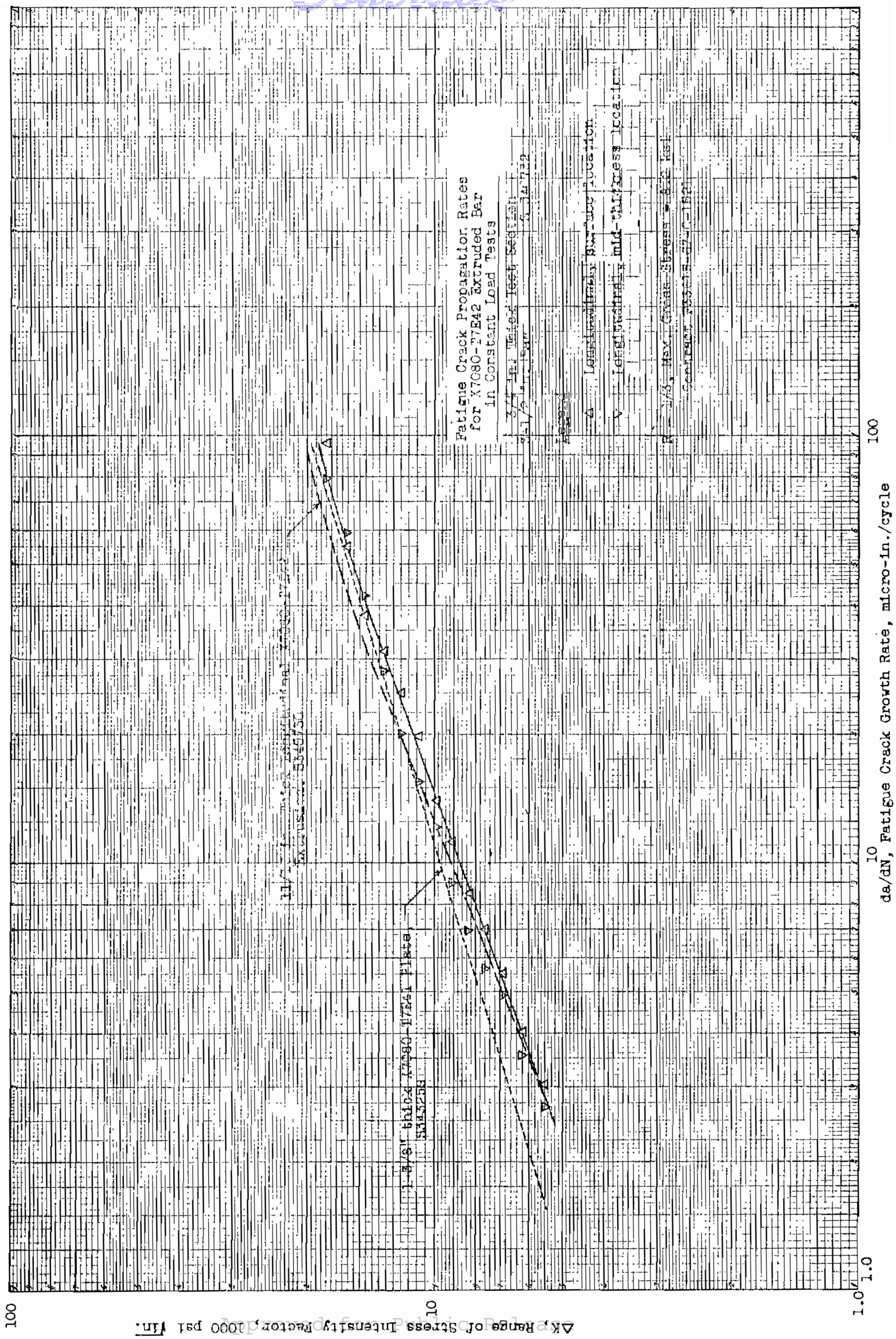


Fig. 149



Approved for Public Release

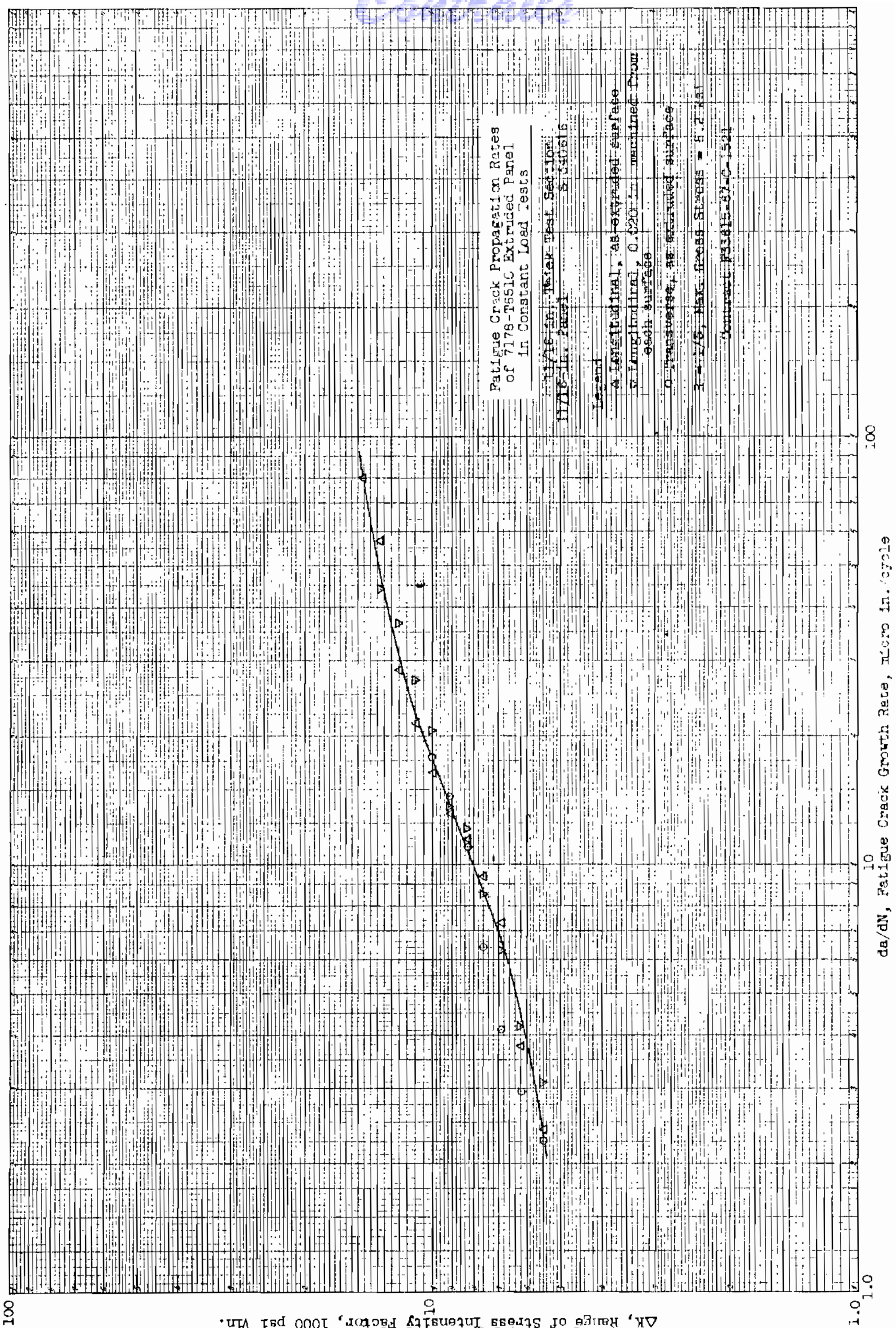
Fig. 150



Fatigue Crack Propagation Rates
for X7080-T7E42 Extruded Bar
in Constant Load Tests
3/4 in. Thick Test Section
Legend
Longitudinal, surface location
Longitudinal, mid-thickness location
1-3/8" thick X7080-T7E41 Plate, S343258
Extrusion, S340750
da/dN, Fatigue Crack Growth Rate, micro-in./cycle
ΔK, Range of Stress Intensity Factor, 1000 psi √in.

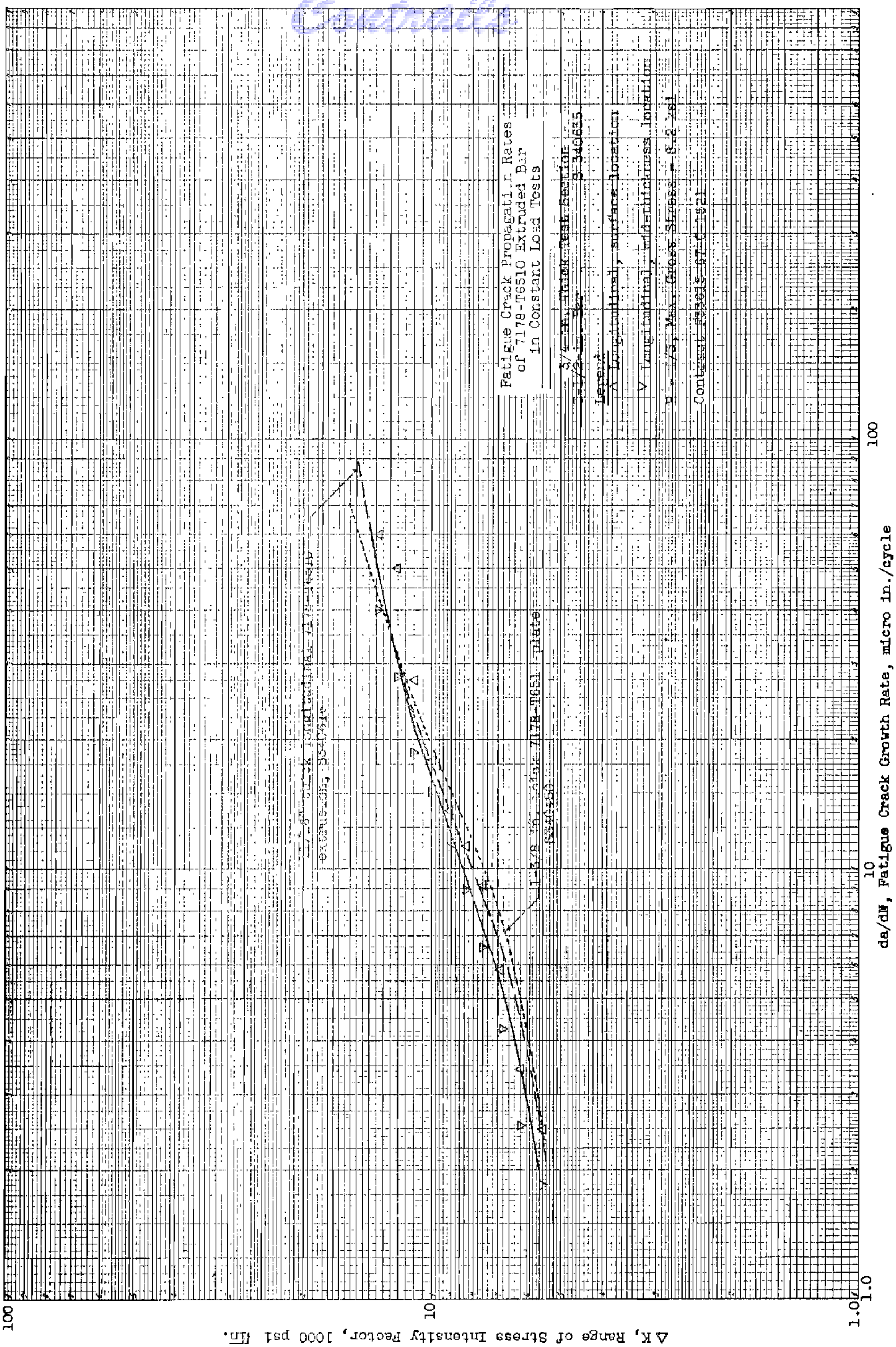
Fig. 151

Contrails



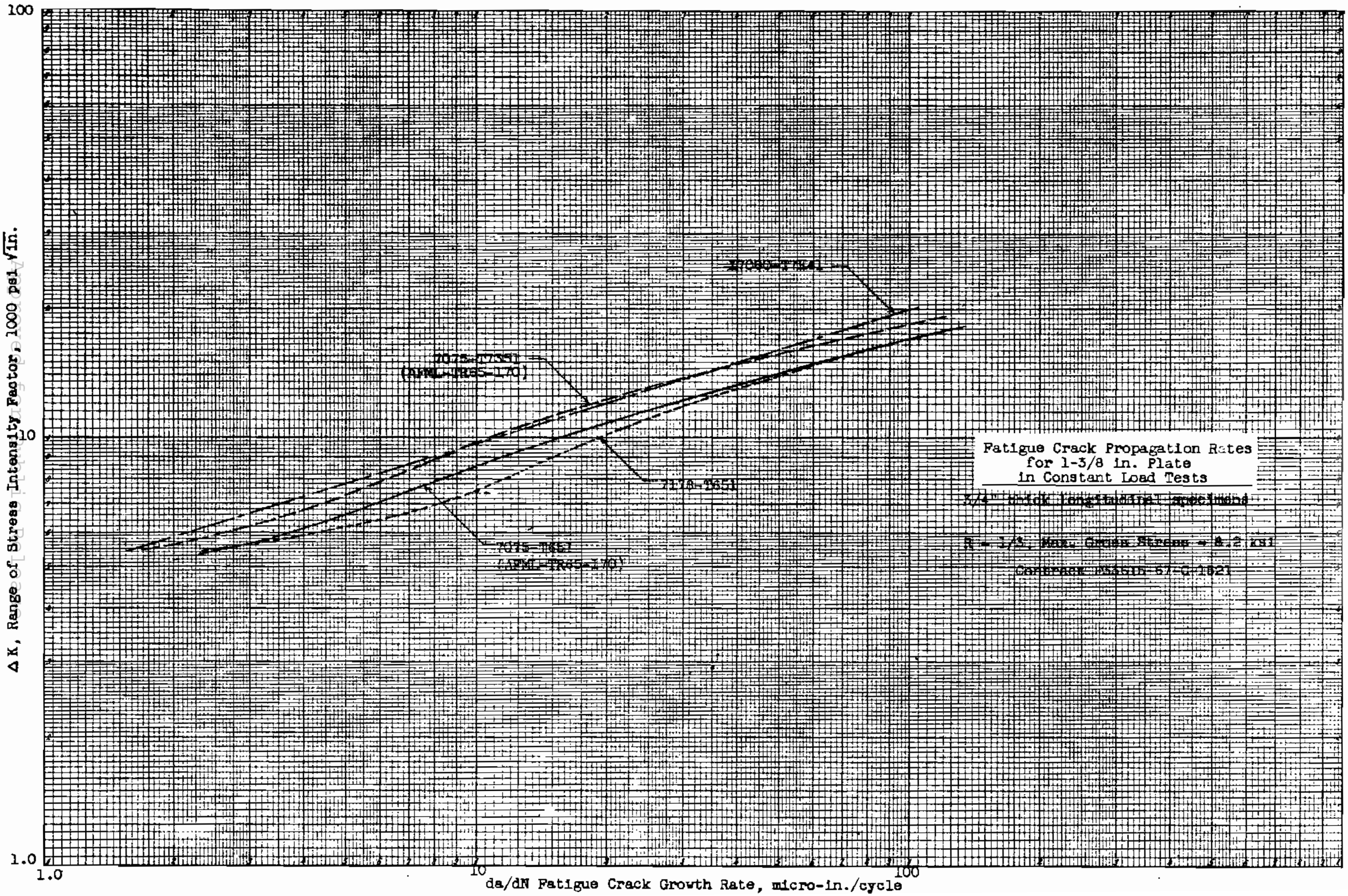
Approved for Public Release

Fig. 152



Approved for Public Release

Fig. 153



Fatigue Crack Propagation Rates
for 1-3/8 in. Plate
in Constant Load Tests
X7080-T7E41
7075-T7351
(AFML-TR65-170)
7178-T651
7075-T651
(AFML-TR65-170)
100
10
1.0
1.0
10
100
ΔK, Range of Stress Intensity Factor, 1000 psi √in.
da/dN Fatigue Crack Growth Rate, micro-in./cycle

Fig. 154

Contrails

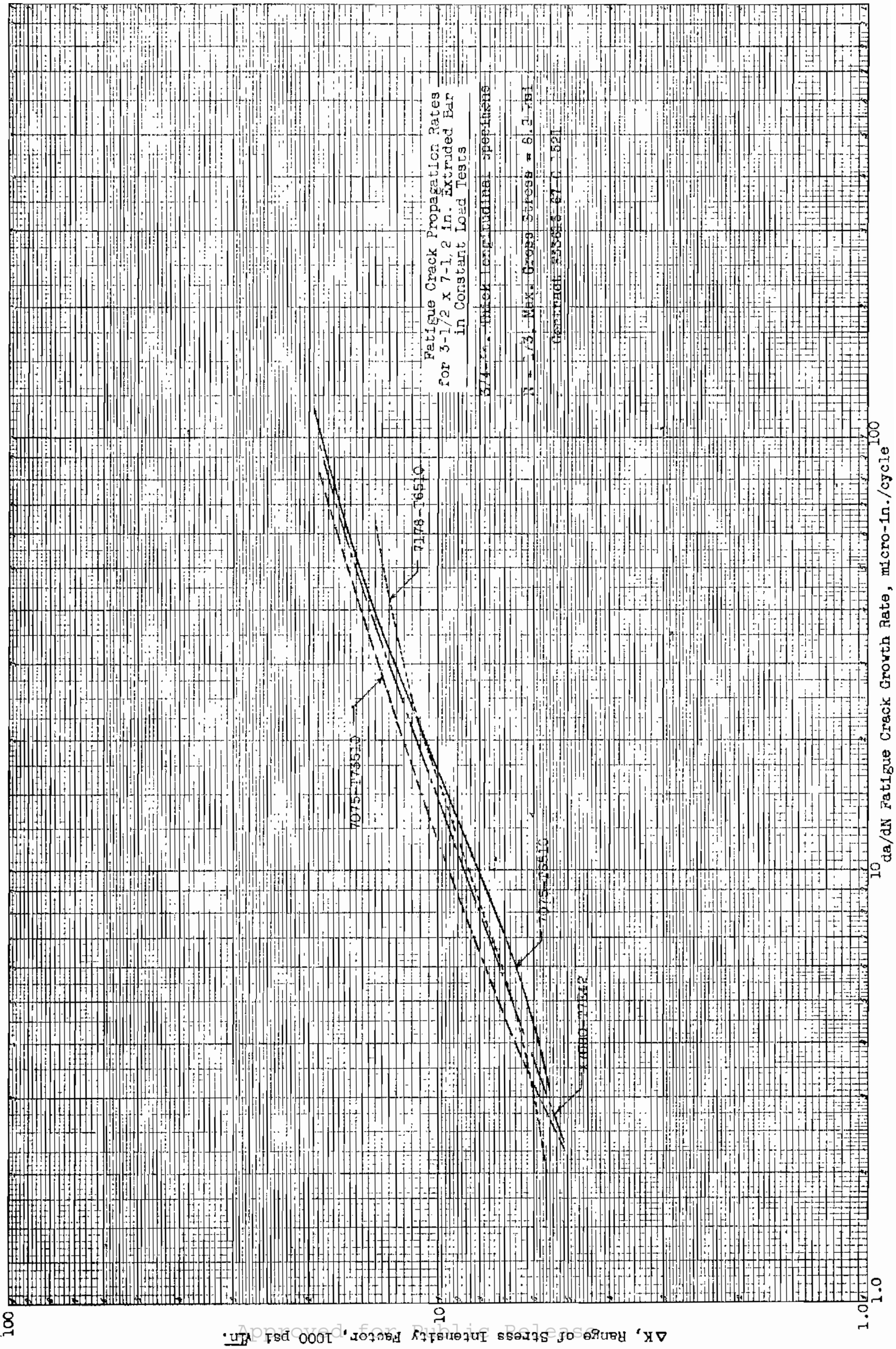


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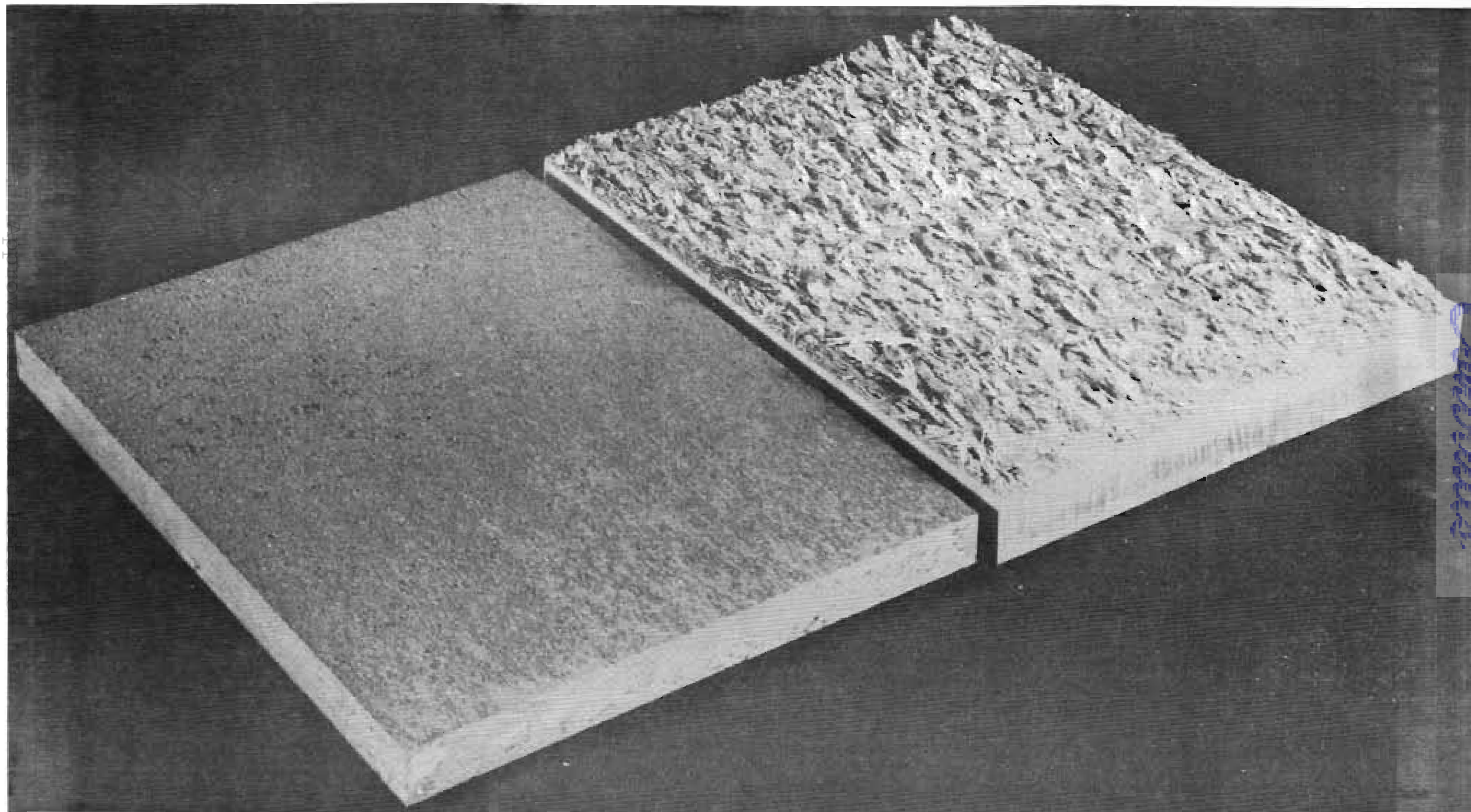
Fig. 155

S. No. 340457
1/2 in. plate - T/4 plane (2 weeks)
Very slight exfoliation

S. No. 340450
1-3/8 in. plate - T/2 plane (1 week)
Severe exfoliation

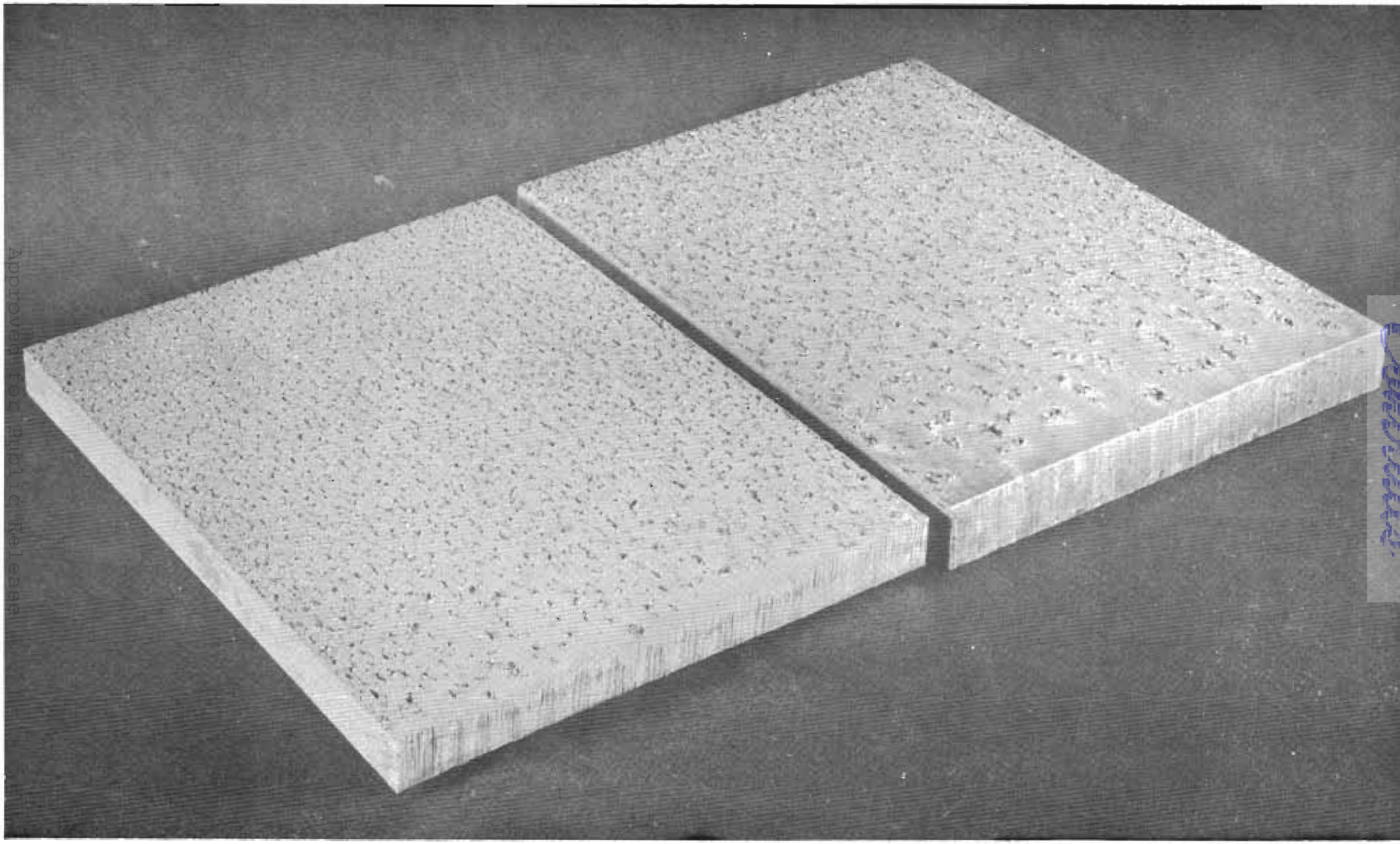


Panels From the 7178-T651 Plates After Exposure to the Accelerated Exfoliation Test. The other panels tested (1/2 in. - rolled surface, 1-3/8 in. - near surface) had an appearance similar to the 1/2 in. - T/4 plane panel.

Fig. 156

S. No. 343260
1/2 in. plate - T/4 plane (2 weeks)
Very slight exfoliation

S. No. 343259
1-3/8 in. plate - T/2 plane (2 weeks)
Very slight exfoliation



Panels From the X7080-T7E41 Plates After the Accelerated Exfoliation Test. The near-surface panel from the 1-3/8 in. plate had a similar appearance, while the rolled surface panel from the 1/2 in. plate showed only pitting and no exfoliation whatsoever.

Contrails

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Fig. 157

Contrails

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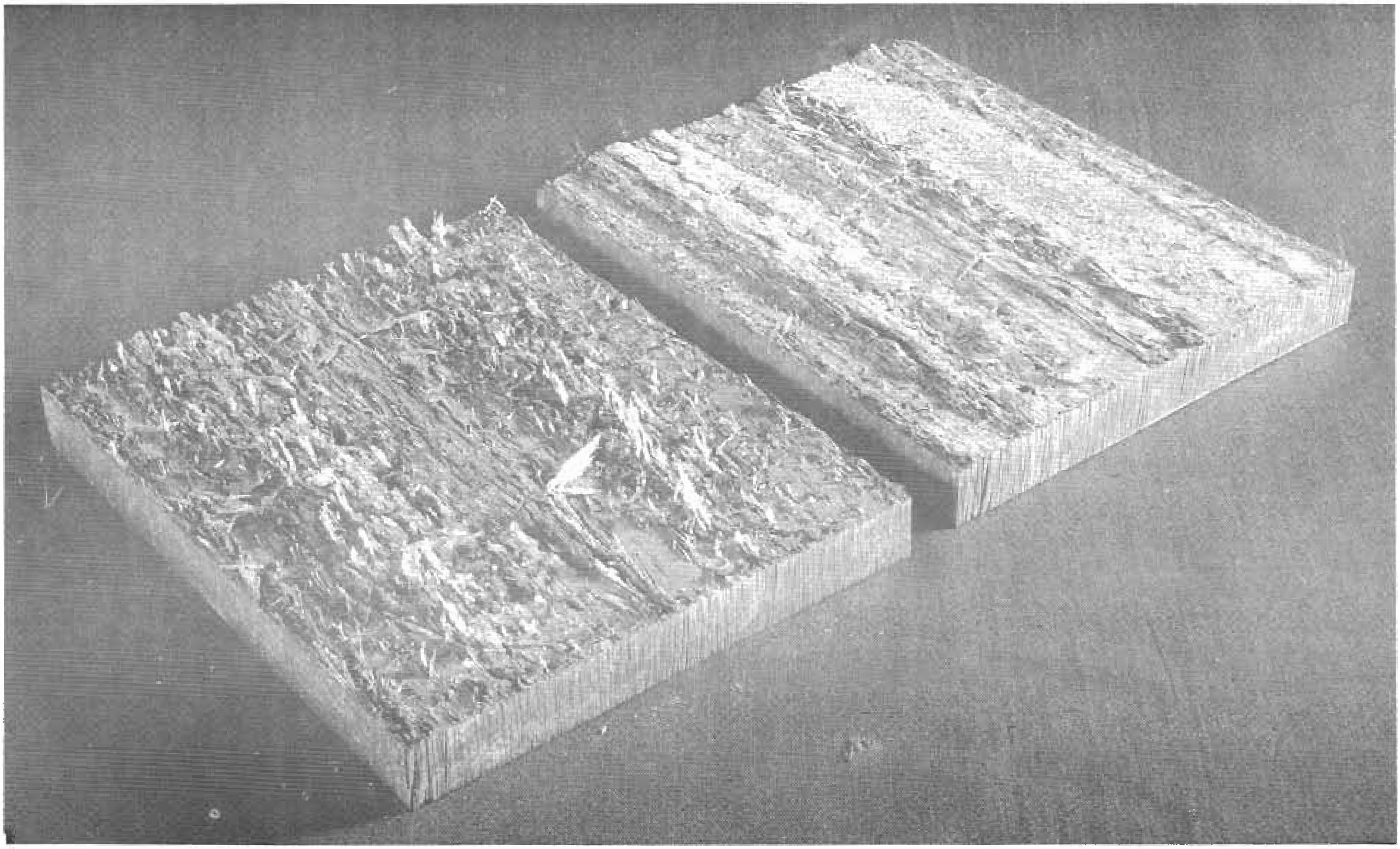
Contrails

Alloy: 7075-T6510 7178-T6510



Panels From the T/4 Planes of the 11/16x16-in. Extruded Shapes After Only One Week of Exposure in the Accelerated Exfoliation Test. Severe exfoliation developed on specimens of both samples, but no exfoliation occurred on panels exposing the extruded surface of either alloy-temper.

Fig. 158

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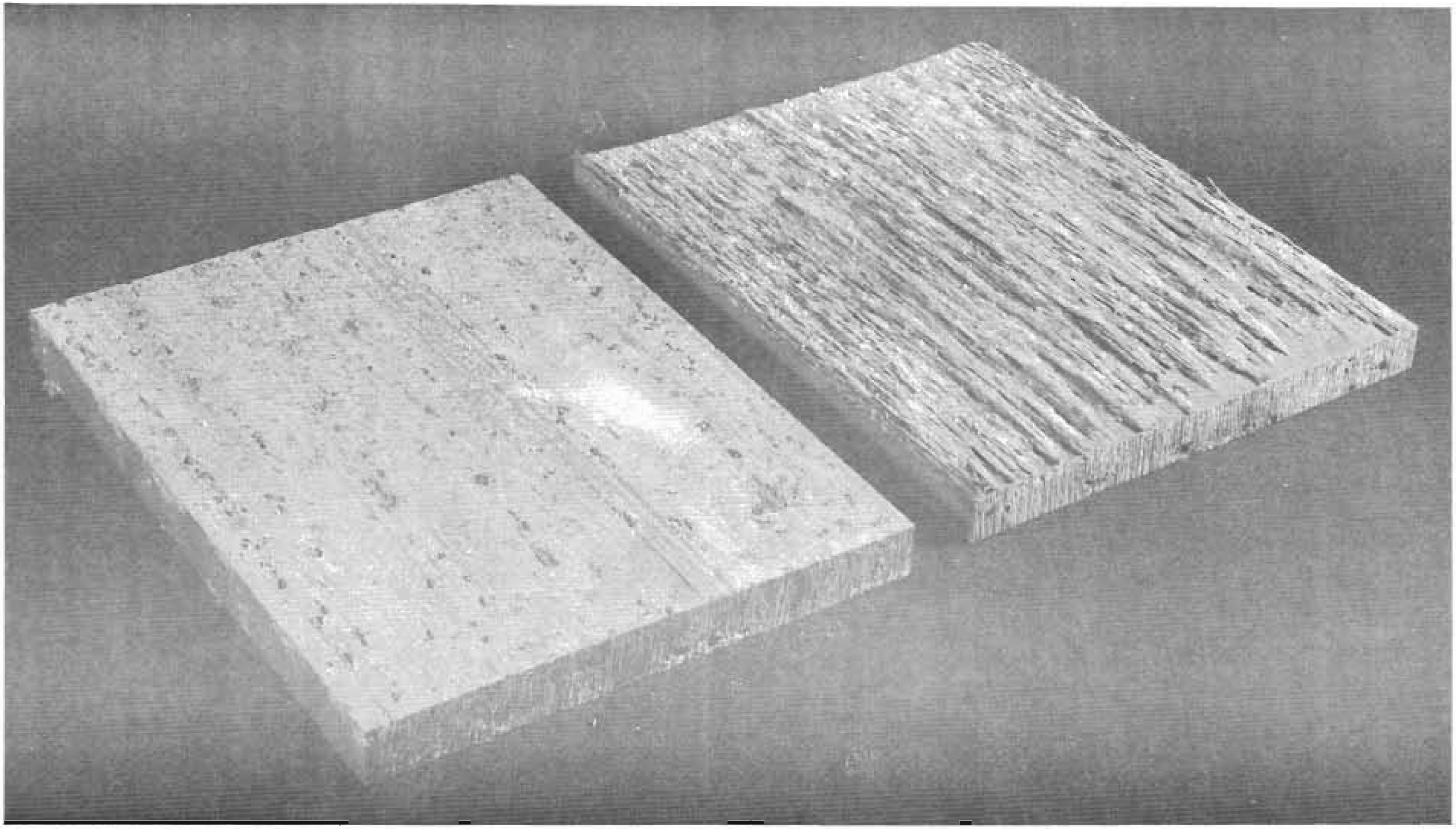
Contrails

Alloy: 7075-T6510
Location: Surface - No exfoliation

T/10 Plane - Severe Exfoliation



Panels From the Surface and the T/10 Plane of the 3-1/2x7-1/2-in. 7075-T6510 Extruded Bar, After Exposure in the Accelerated Exfoliation Test. Severe exfoliation occurred on the T/10 plane after only one week of exposure, but no exfoliation occurred on the surface after the full two-week test. This photograph is also representative of the surface and T/10 specimens from the 7178-T6510 sample.

Fig. 159

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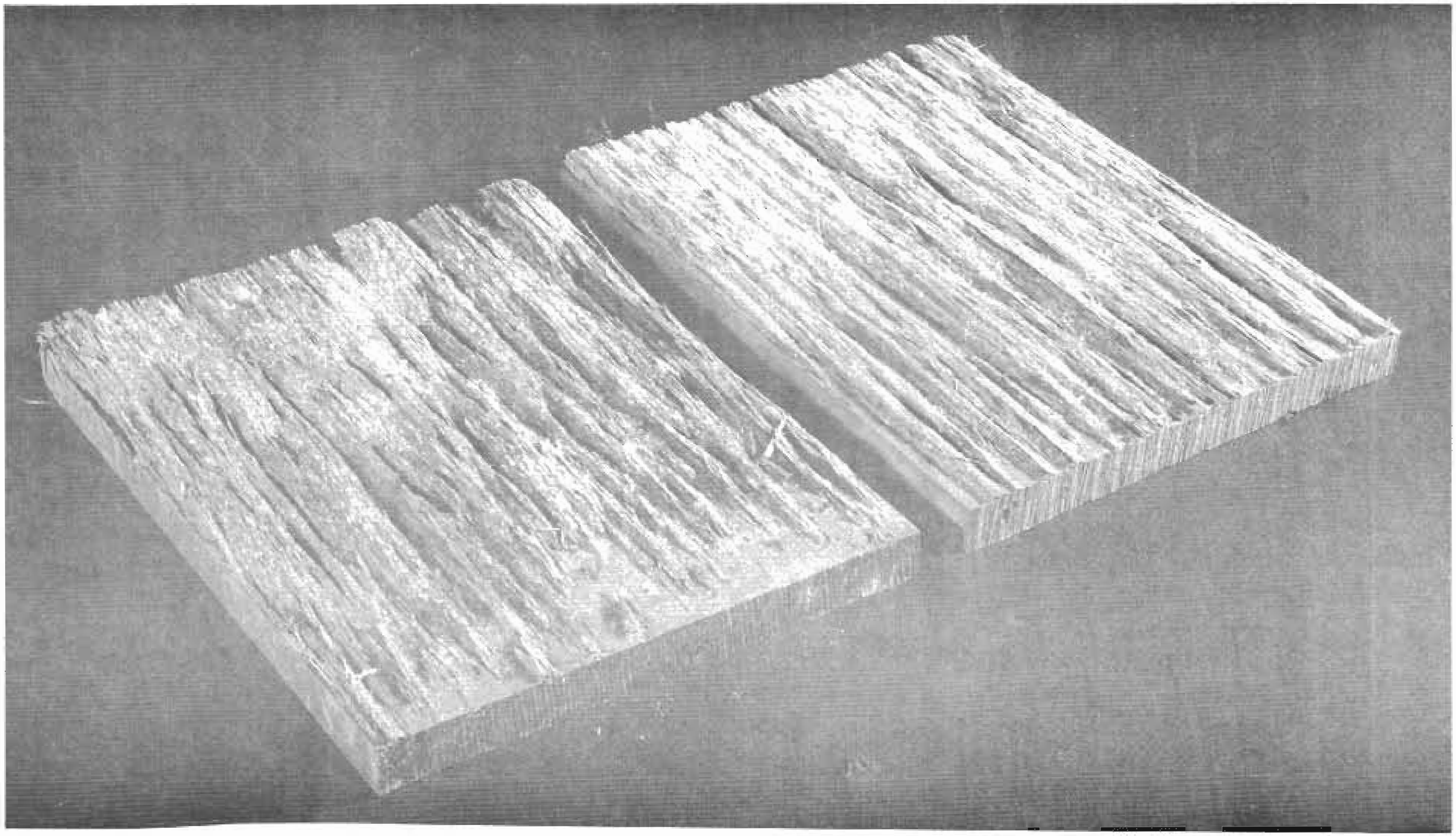
Contrails

Alloy: 7075-T6510
Location: T/4 Plane-Severe Exfoliation

T/2 Plane - Severe Exfoliation



Panels From the T/4 and T/2 Planes of the 3-1/2x7-1/2-in. 7075-T6510 Extruded Bar After Only One Week of Exposure in the Accelerated Exfoliation Test. Severe exfoliation occurred on both specimens. This photograph is also representative of the T/4 and T/2 specimens from the 7178-T6510 sample.

Fig. 160

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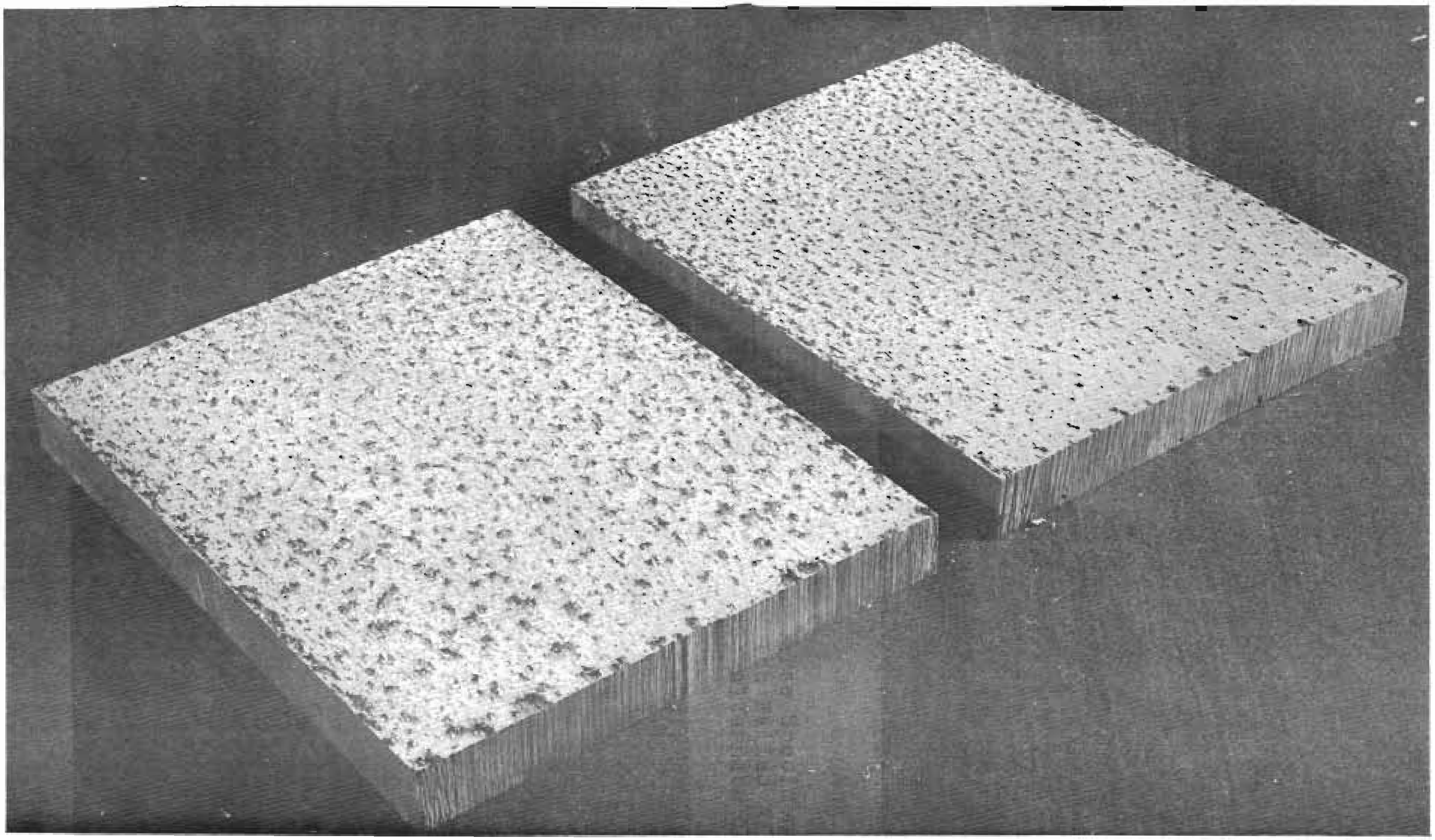
Contrails

Alloy: X7080-T7E42 - Very Slight Exfoliation   7075-T73510 - No Exfoliation



Panels From the T/4 Planes of the 11/16x16-in. Extruded Shapes After the Two-Week Accelerated Exfoliation Test. Very slight exfoliation occurred on the X7080-T7E42 specimen, but no exfoliation occurred on the 7075-T73510 specimen, or on the extruded surface specimens of either alloy-temper.

Fig. 161

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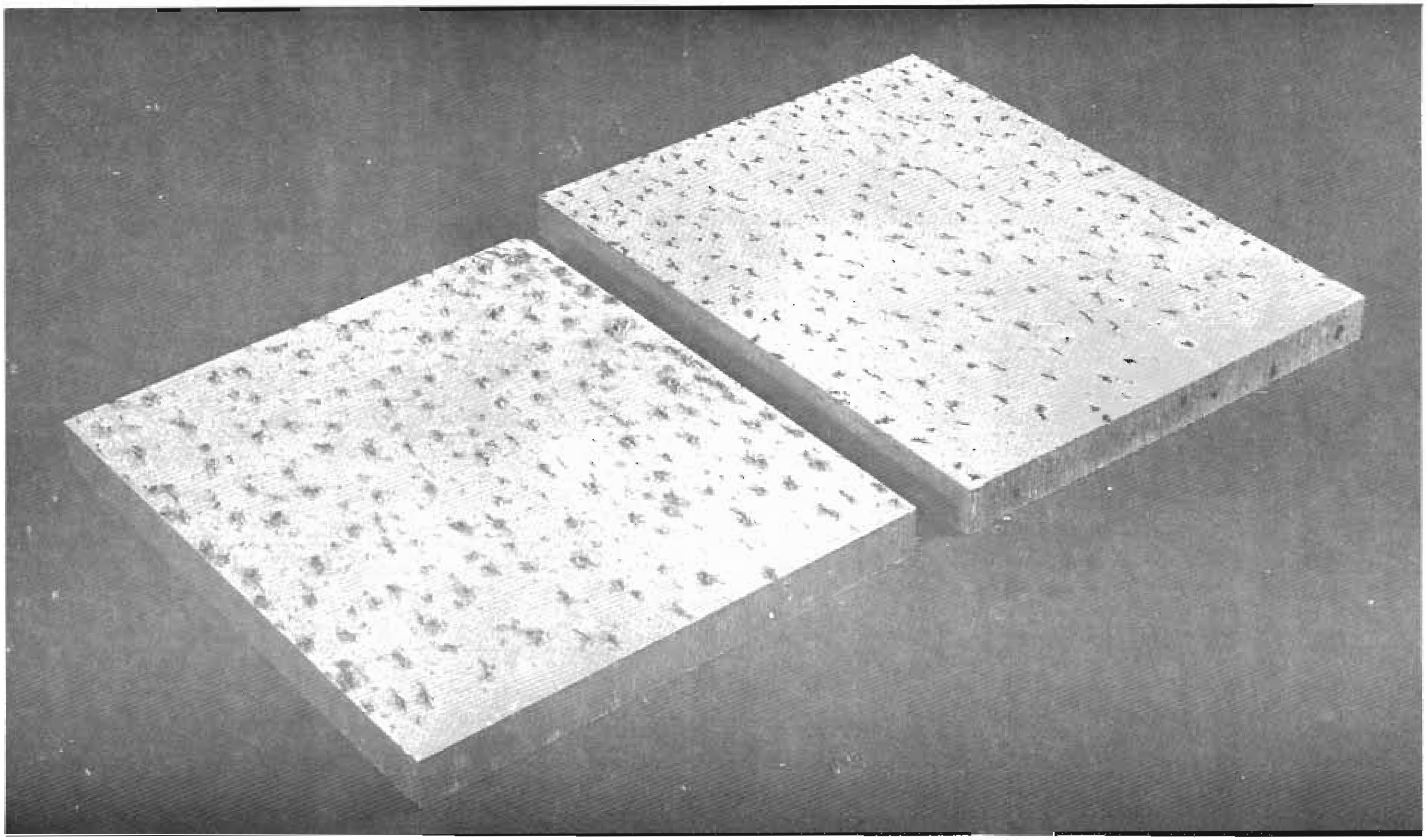
Contrails

Alloy: X7080-T7E42 - Very Slight Exfoliation

7075-T73510 - No Exfoliation



Panels From the T/4 Planes of the 3-1/2x7-1/2-in. Extruded Bars After the Two-Week Accelerated Exfoliation Test. Very slight exfoliation occurred on the X7080-T7E42 specimen, but no exfoliation occurred on the 7075-T73510 specimen, or on the extruded surface of either alloy-temper. This photograph is also representative of the specimens from the T/10 and T/2 planes of the respective samples.

Fig. 162

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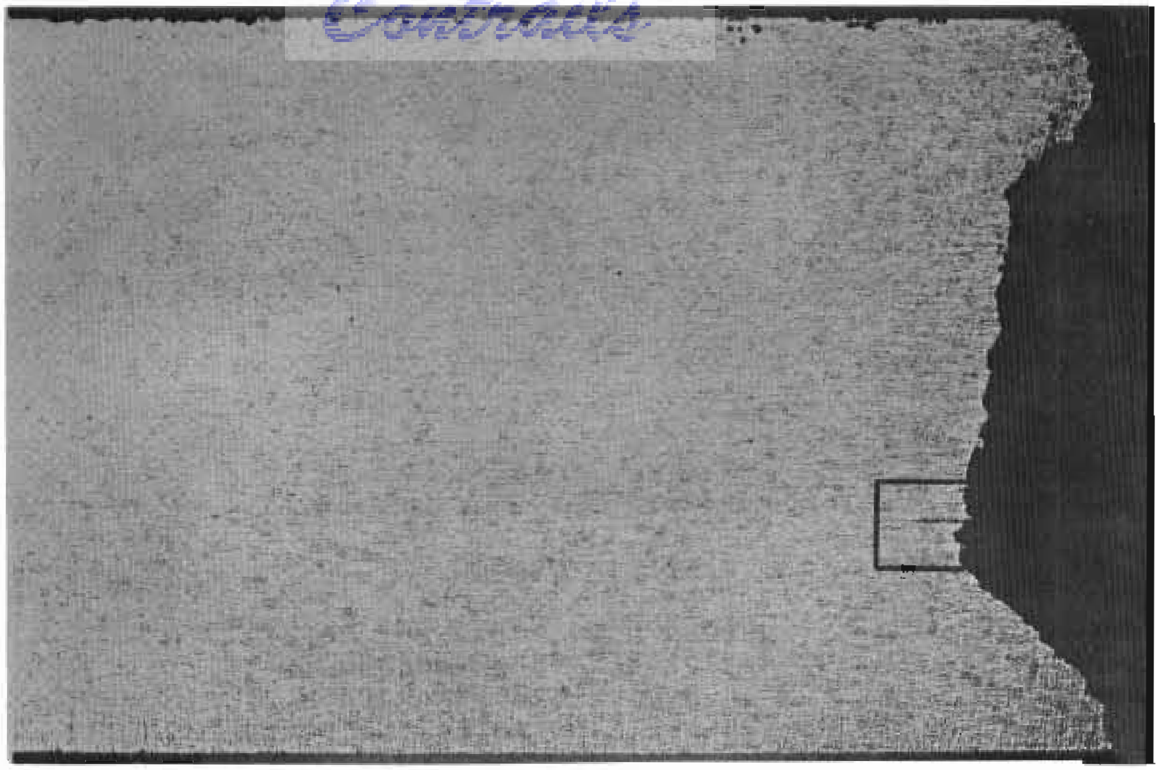
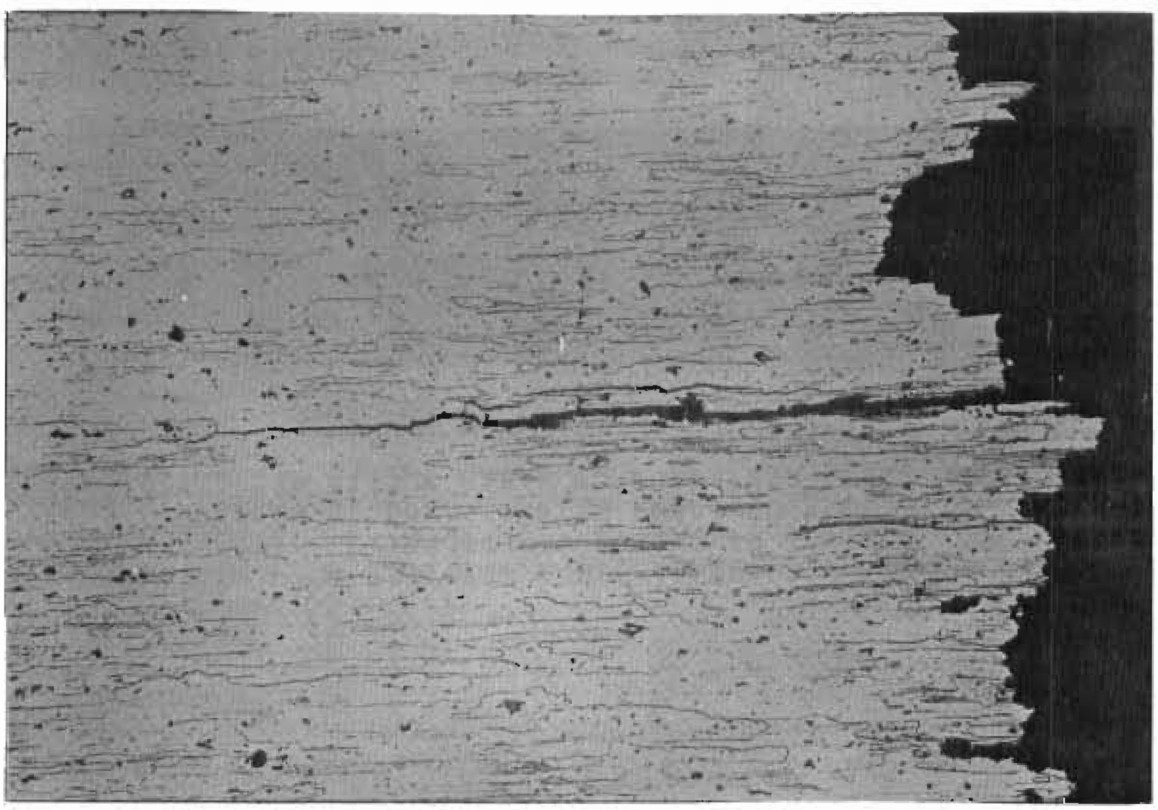


Etch: Keller's

Mag: 10X

Cross-Section of Long-Transverse Specimen From 1-3/8-in. 7178-T651 Plate Which Failed After 60 Days Exposure to 3.5% NaCl Alternate Immersion.



Etch: Keller's

Mag: 100X

Fig. 163 Higher Magnification of Above Specimen Showing an Intergranular Crack Extending in From the Fracture, Thereby Indicating Stress-Corrosion Cracking as the Mechanism of Failure.

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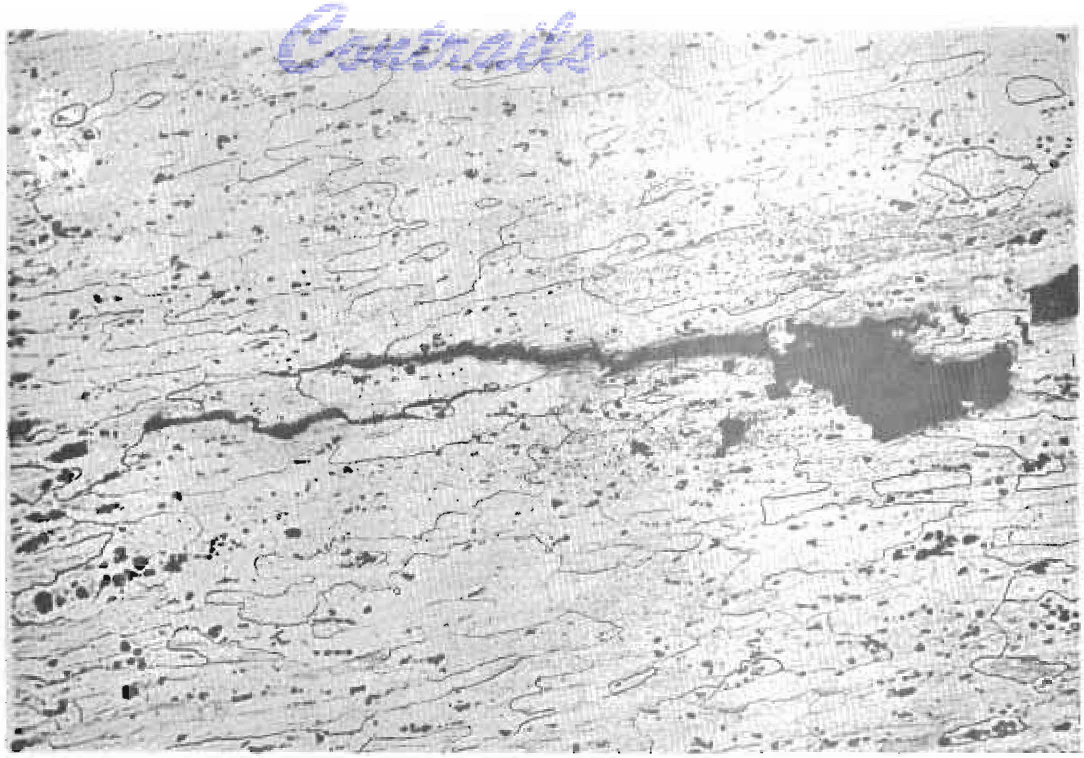
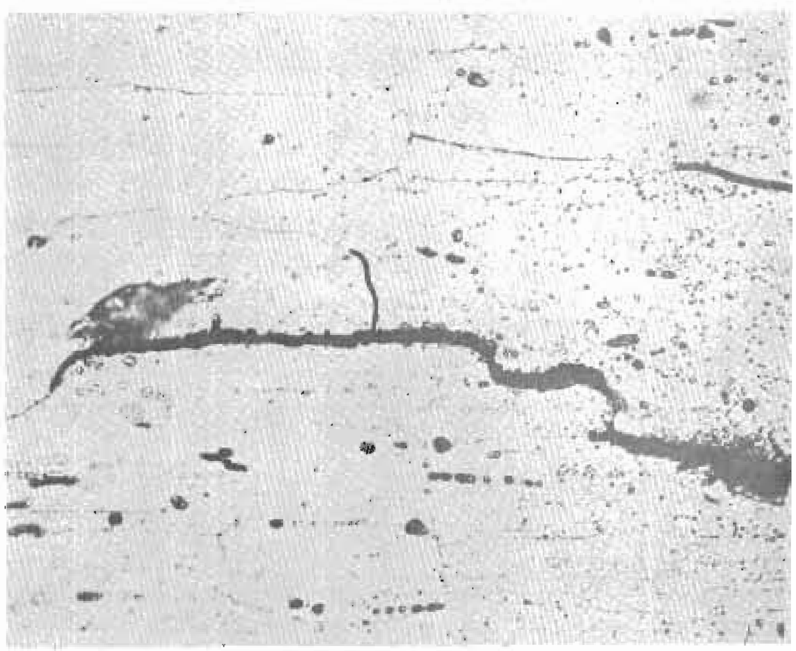
187696A

Contrails



Etch: Keller's Mag: 100X

Section Through a C-ring From the 1-3/8-in. Thick X7080-T7E41 Plate Stressed to 34% Y.S. and Exposed 84 Days to 3.5% NaCl Alternate Immersion. Intergranular stress corrosion cracks were detected emanating from corrosion pits. Photo is also representative of the cracking present in rings stressed at 42, 50 and 75% Y.S.



Etch: Keller's Mag: 500X

Fig. 164 Higher Magnification Showing the Intergranular Nature of the Leading Tip of the Stress Corrosion Crack.

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168147

Contrails

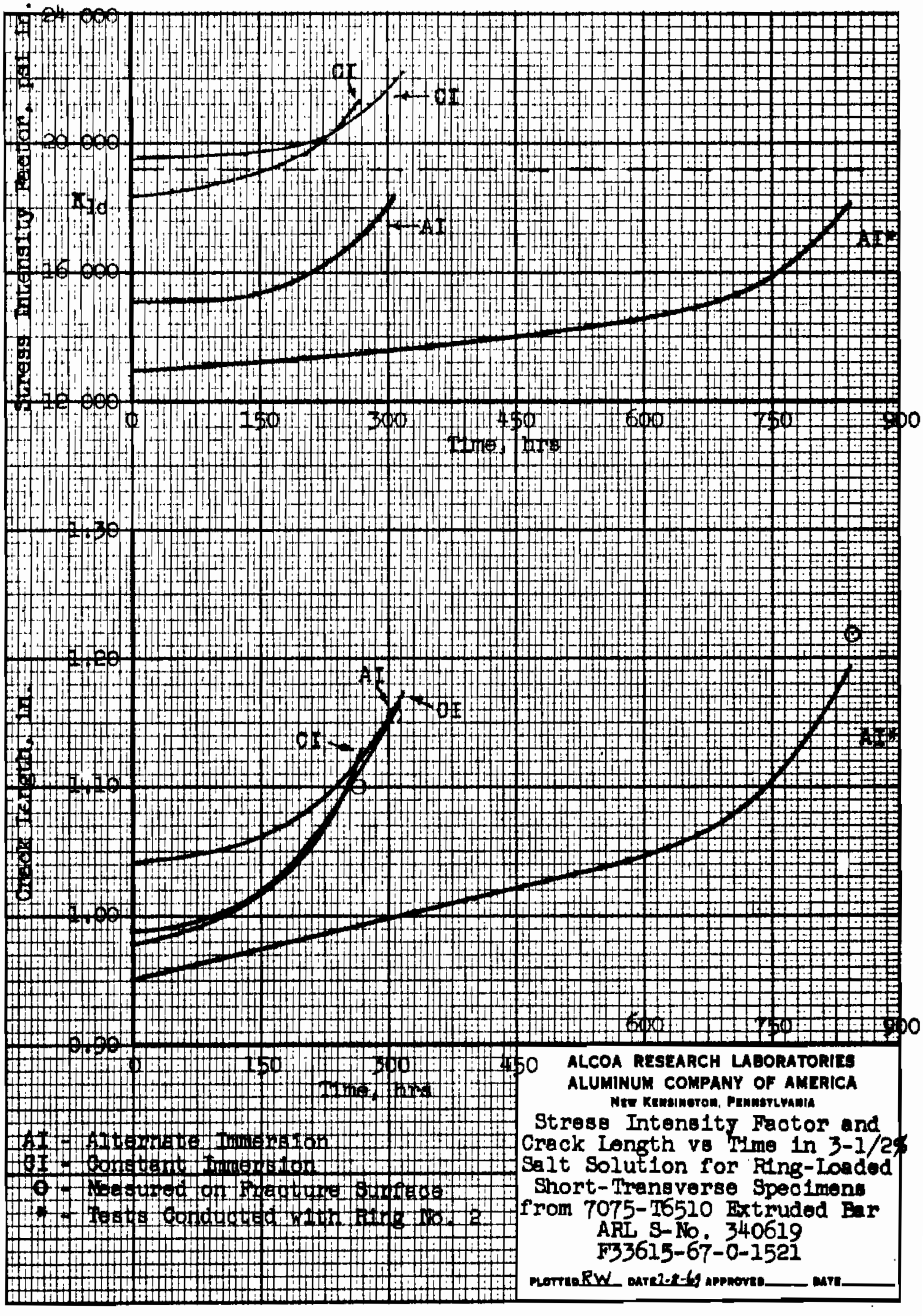

Fig. 165

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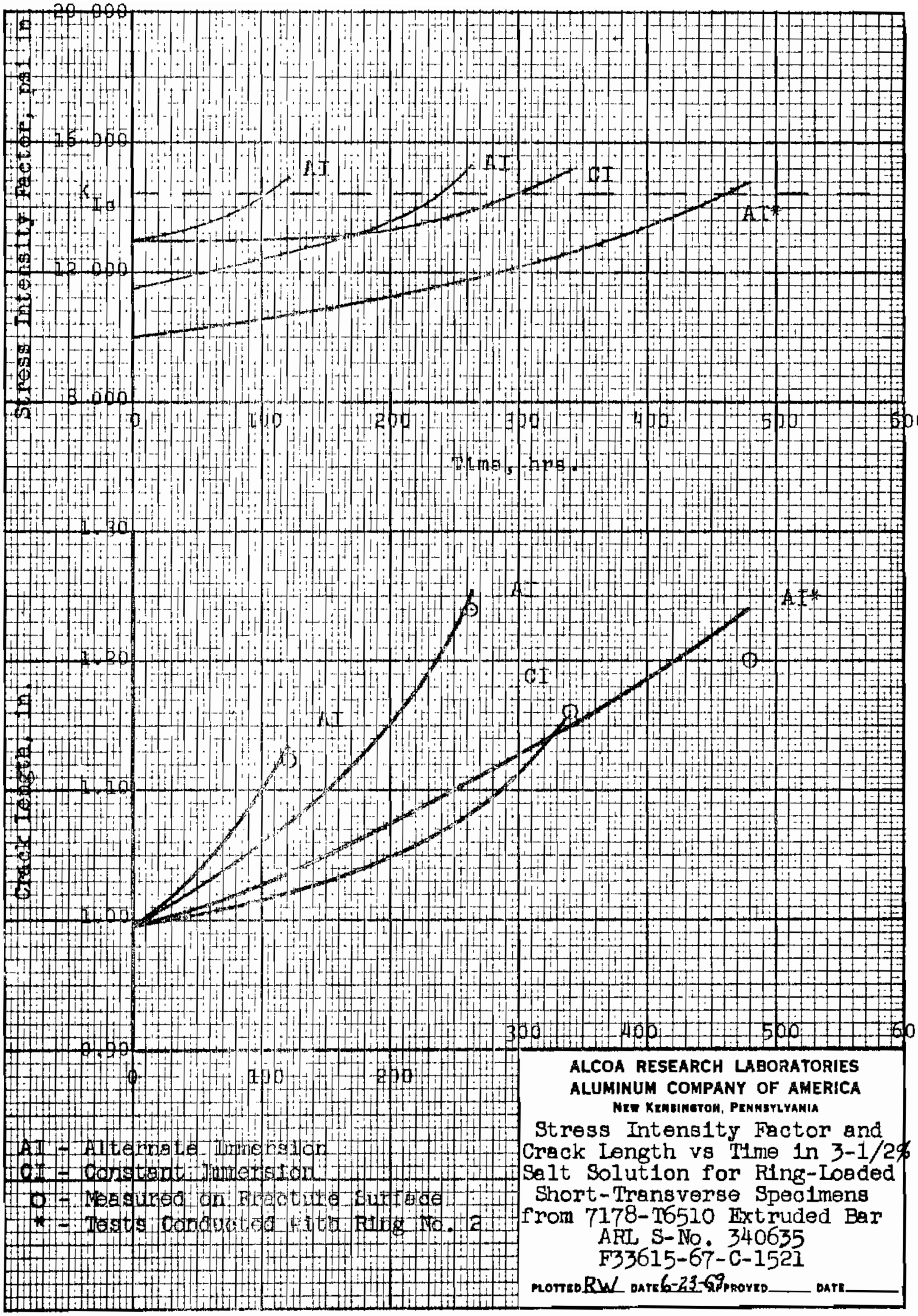

Fig. 166

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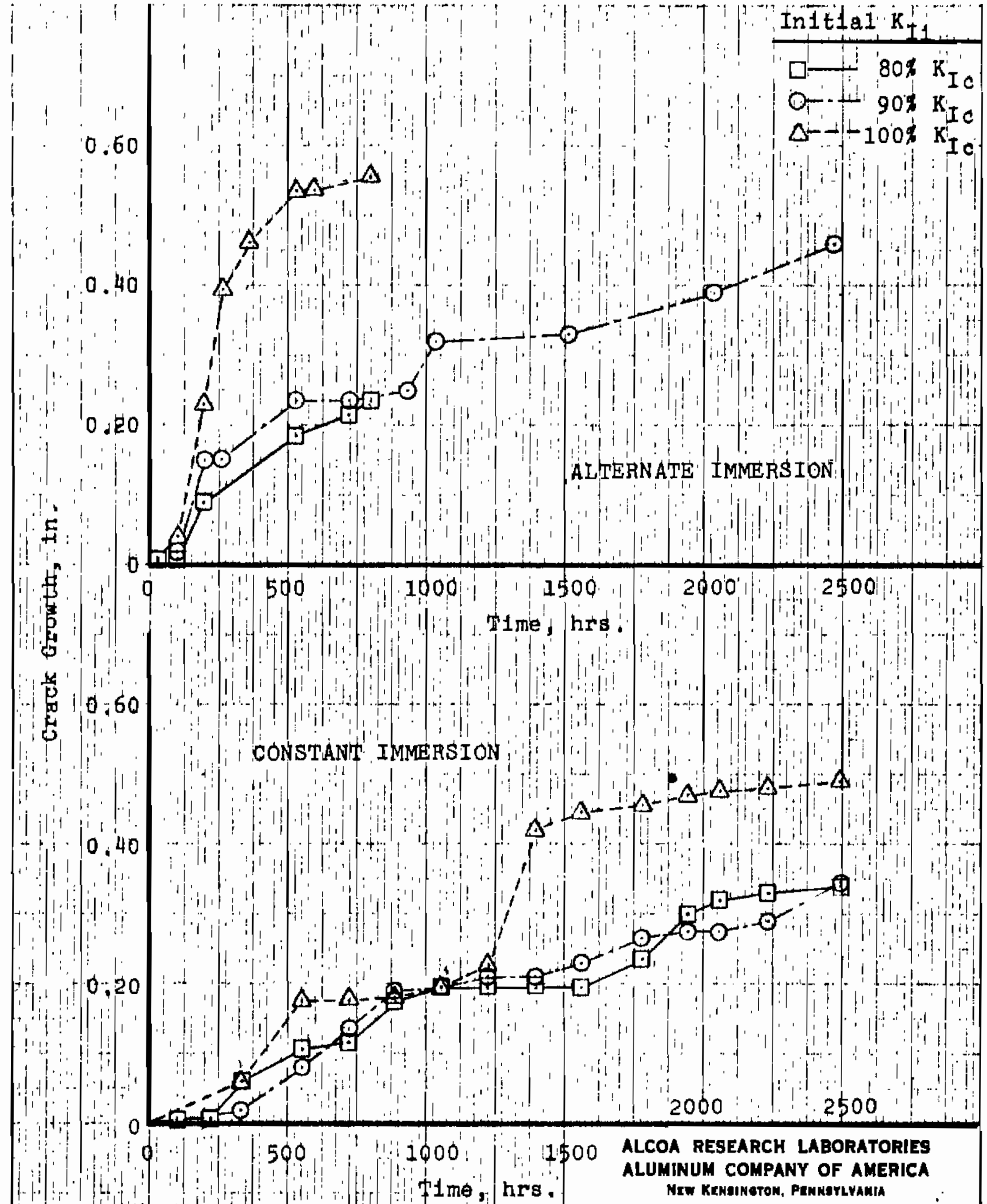
Contrails



ALCOA RESEARCH LABORATORIES
ALUMINUM COMPANY OF AMERICA
NEW KENSINGTON, PENNSYLVANIA

Crack Growth vs Time in 3-1/2% NaCl Solution for Short-Transverse Bolt Loaded Specimens from 7075-T6510 Extruded Bar

S. No. 340619

PLOTTED RW DATE 3-14-69 APPROVED ____ DATE ____

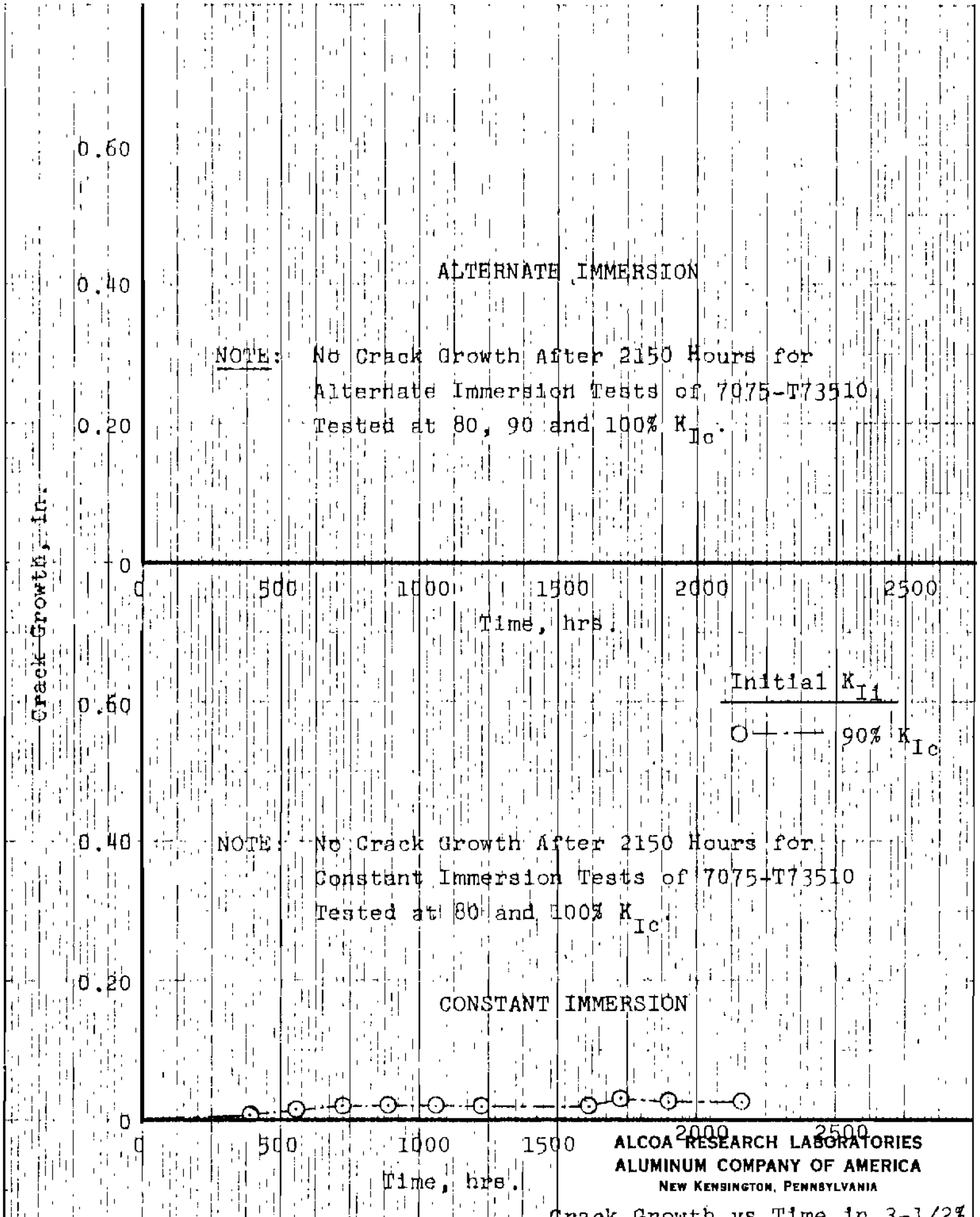
NOTES: Compact tension specimen
Width = 2.00 in.
Initial crack length = 1.00±0.05 in.
Single specimens were tested at each K_I level

9840-8M-10-66 PRINTED IN U. S. A.

Fig. 167

Approved for Public Release

Contrails



ALCOA RESEARCH LABORATORIES
ALUMINUM COMPANY OF AMERICA
NEW KENSINGTON, PENNSYLVANIA

Crack Growth vs Time in 3-1/2% NaCl Solution for Short-Transverse Bolt Loaded Specimens from 7075-T73510 Extruded Bar

S. No. 340620

PLOTTED RW DATE 3-25-6 APPROVED ______ DATE ______

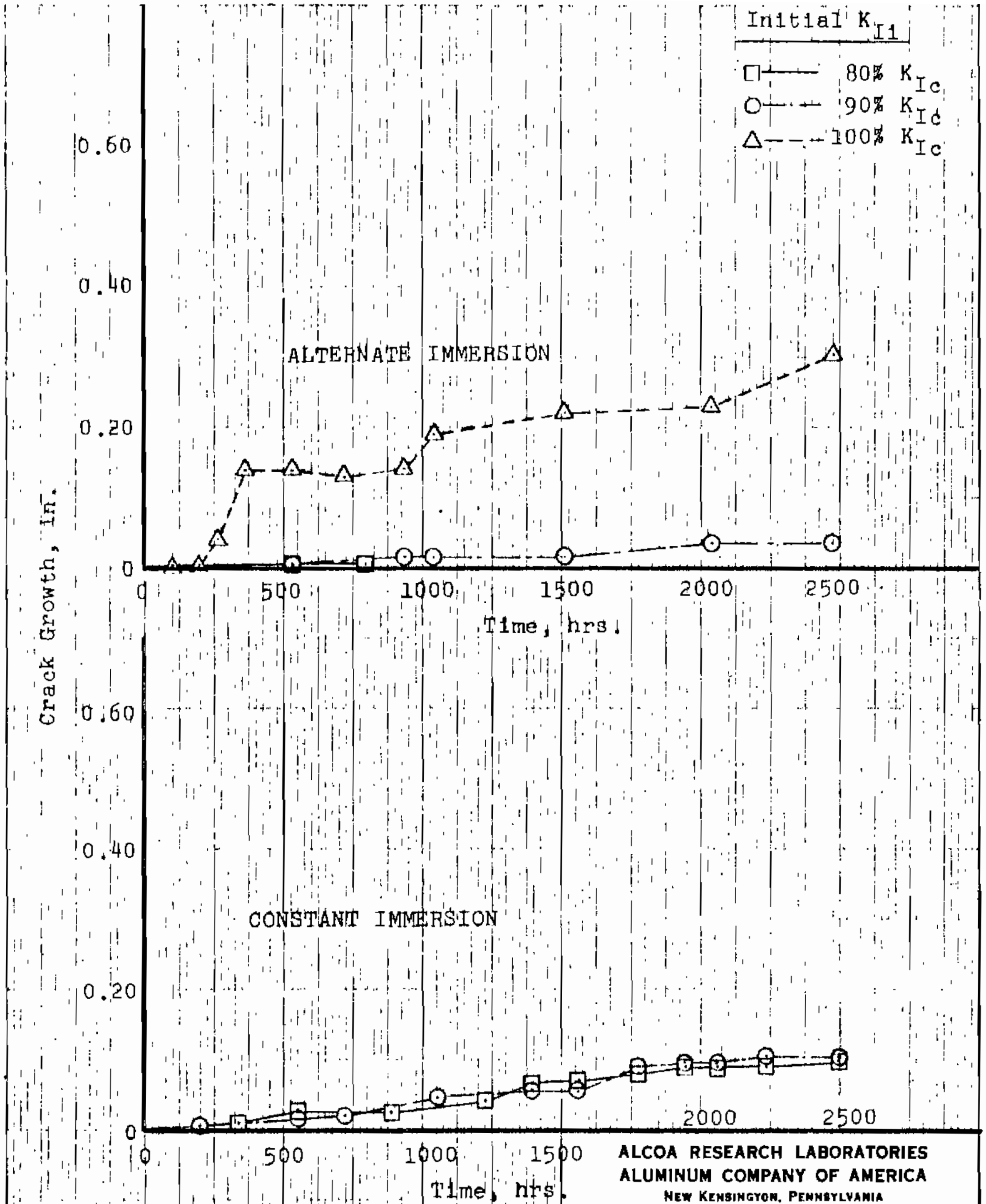
NOTES: Compact tension specimen
Width = 2.00 in.
Initial crack length = 1.00±0.05 in.
Single specimens were tested at each K_I level

3840-3M-10-66 PRINTED IN U. S. A.

Fig. 168

Approved for Public Release

Contrails



ALCOA RESEARCH LABORATORIES
ALUMINUM COMPANY OF AMERICA
NEW KENSINGTON, PENNSYLVANIA

Crack Growth vs Time in 3-1/2% NaCl Solution for Short-Transverse Bolt Loaded Specimens from X7080-T7E42 Extruded Bar

S. No. 340732

PLOTTED RW DATE 3-15-69 APPROVED ____ DATE ____

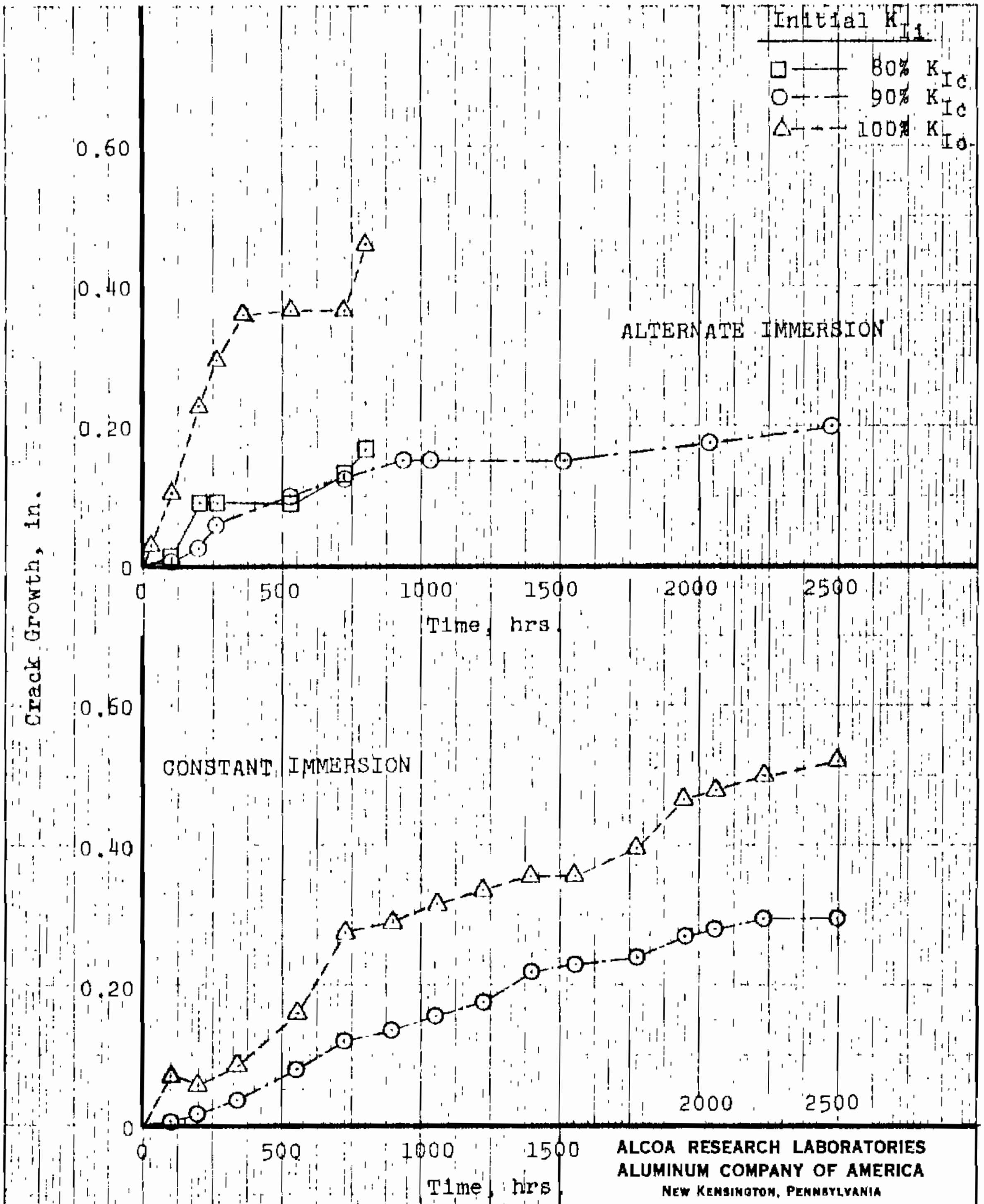
NOTES: Compact tension specimen
Width = 2.00 in.
Initial crack length = 1.00±0.05 in.
Single specimens were tested at each K_I level

8840-3M-10-68 PRINTED IN U. S. A.

Fig. 169

Approved for Public Release

Contrails



ALCOA RESEARCH LABORATORIES
ALUMINUM COMPANY OF AMERICA
NEW KENSINGTON, PENNSYLVANIA

Crack Growth vs Time in 3-1/2% NaCl Solution for Short-Transverse Bolt Loaded Specimens from 7178-T6510 Extruded Bar

S. No. 340635

PLOTTED RW DATE 3-25-69 APPROVED ____ DATE ____

NOTES: Compact tension specimen
Width = 2.00 in.
Initial crack length = 1.00±0.05 in.
Single specimens were tested at each K_I level

8840-3M-10-66 PRINTED IN U. S. A.

Fig. 170

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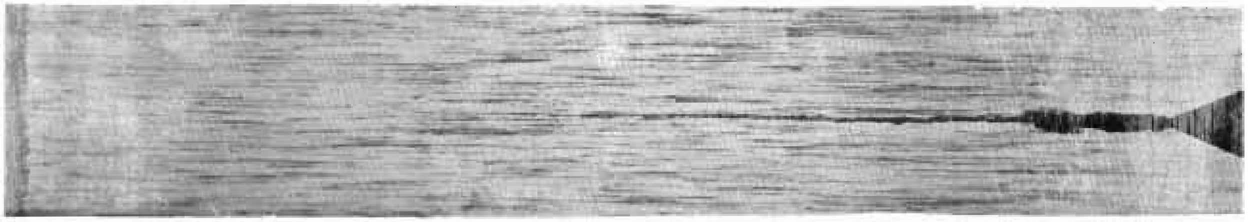
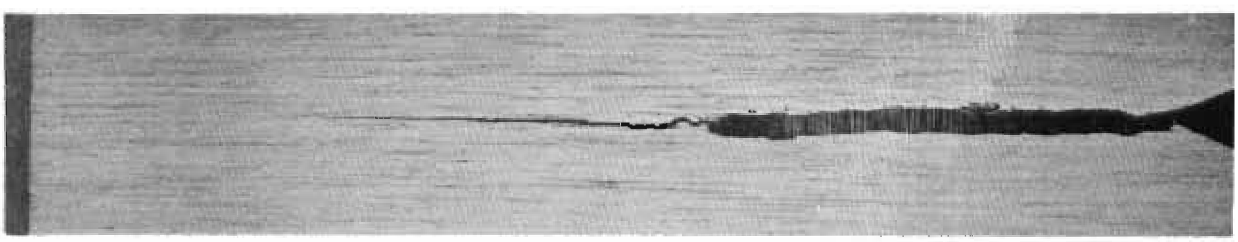
Contrails



S-No. 340619-ST4 Etch: Keller's Mag: 4X

Appearance of the Crack in a Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. 7075-T6510 Extruded Bar Loaded to 90% K_{Ic} and Exposed to Alternate Immersion in 3.5% NaCl Solution for 2500 Hours.



S-No. 340619-ST3 Etch: Keller's Mag: 4X

Fig. 171 Appearance of the Crack in a Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. 7075-T6510 Extruded Bar Loaded to 100% K_{Ic} and Immersed in 3.5% NaCl Solution for 2500 Hours.

172949A
172950A

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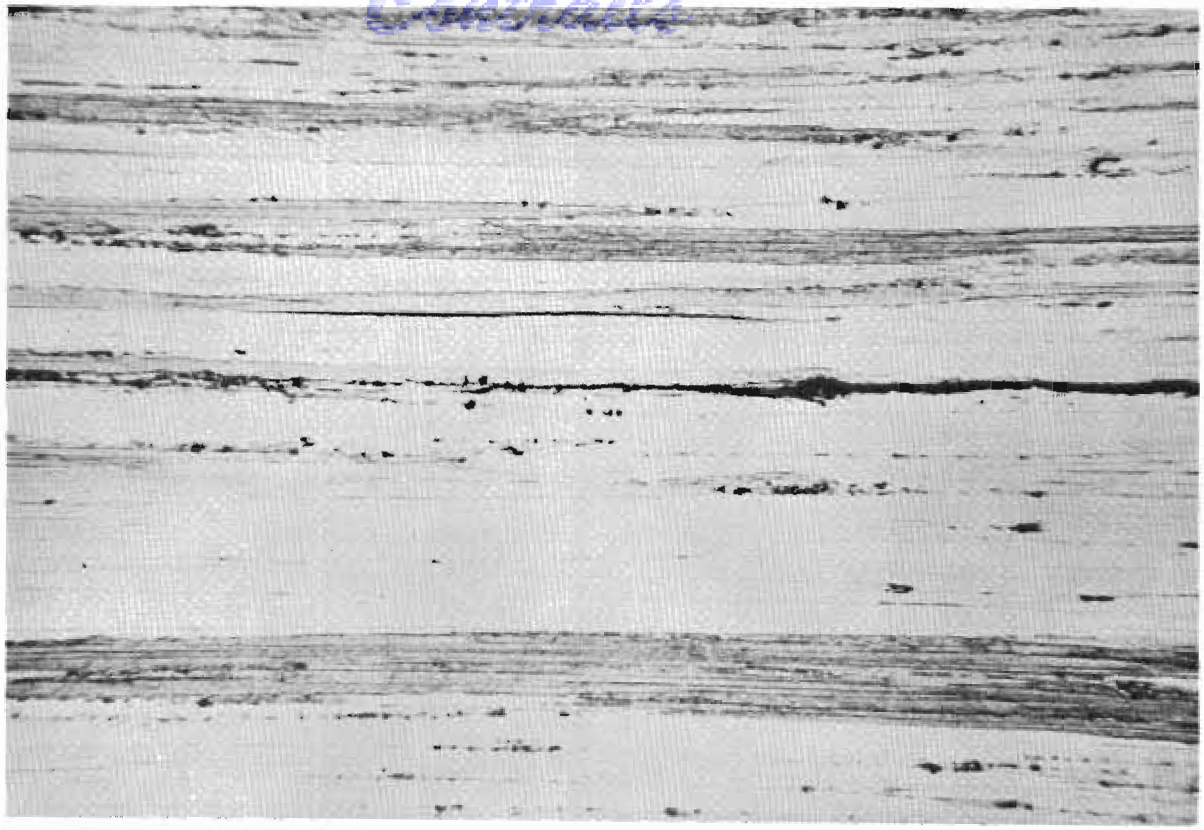
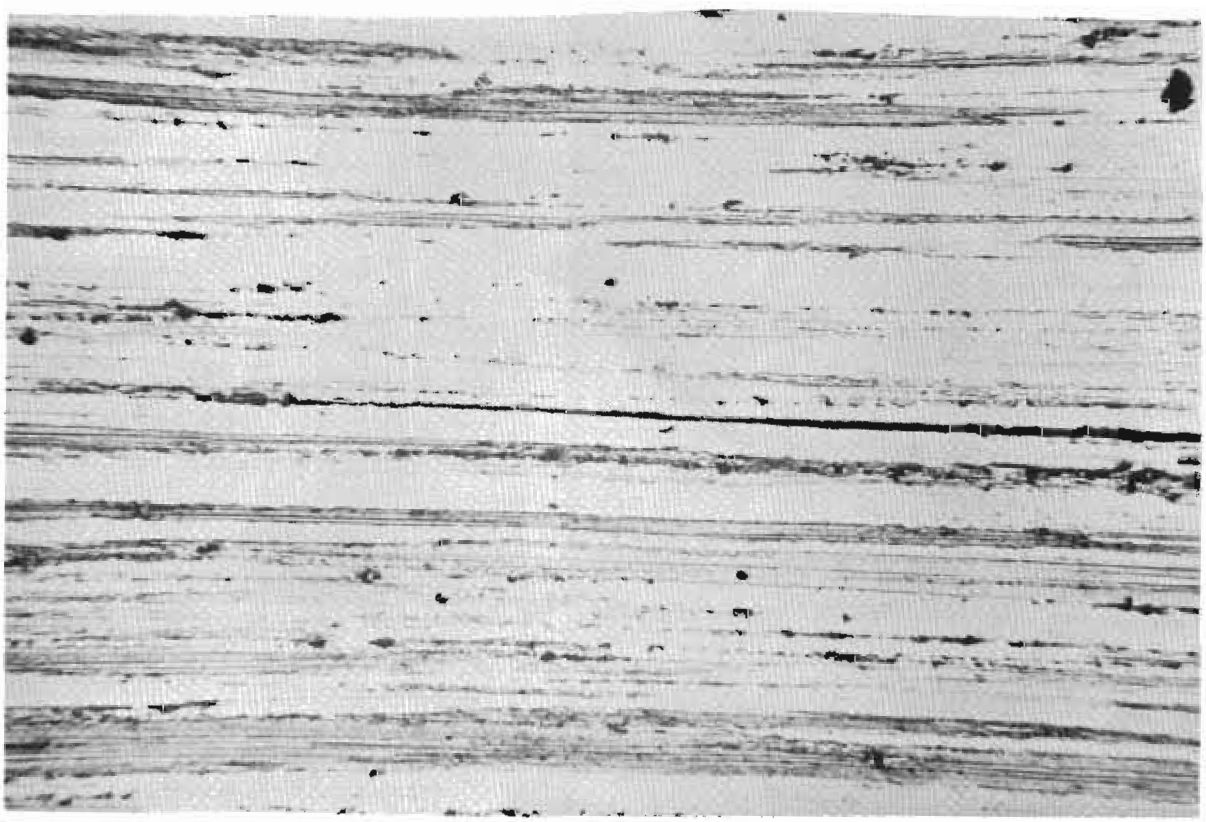
Contrails



S-No. 340619-ST4 Etch: Keller's Mag: 100X

Intergranular Nature of the Crack Tip in the Specimen Shown in Fig. 171 (Top).



S-No. 340619-ST3 Etch: Keller's Mag: 100X

172933A
172934A

Fig. 172 Intergranular Nature of the Crack Tip in the Specimen Shown in Fig. 171 (Bottom).

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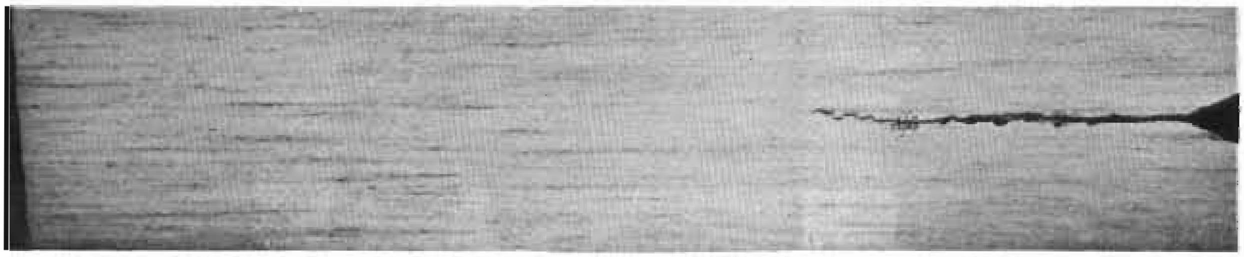
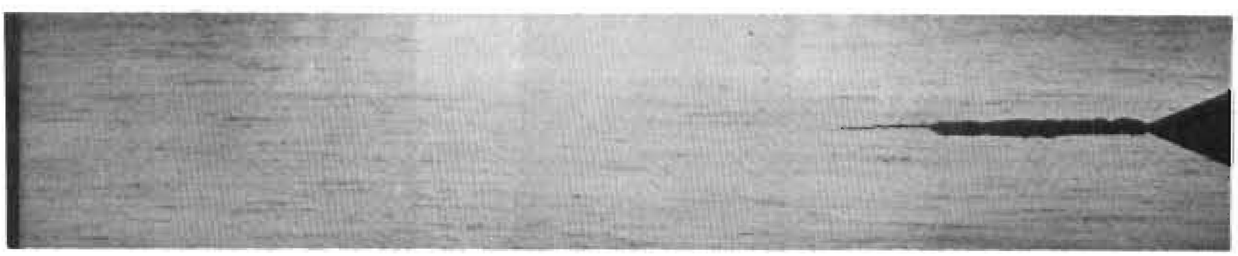
Contrails



S-No. 340620-ST12 Etch: Keller's Mag: 4X

Appearance of the Crack in a Fatigue-Precracked Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. 7075-T73510 Extruded Bar Loaded to 80% K_{Ic} and Exposed to Alternate Immersion in 3.5% NaCl Solution for 2150 Hours.

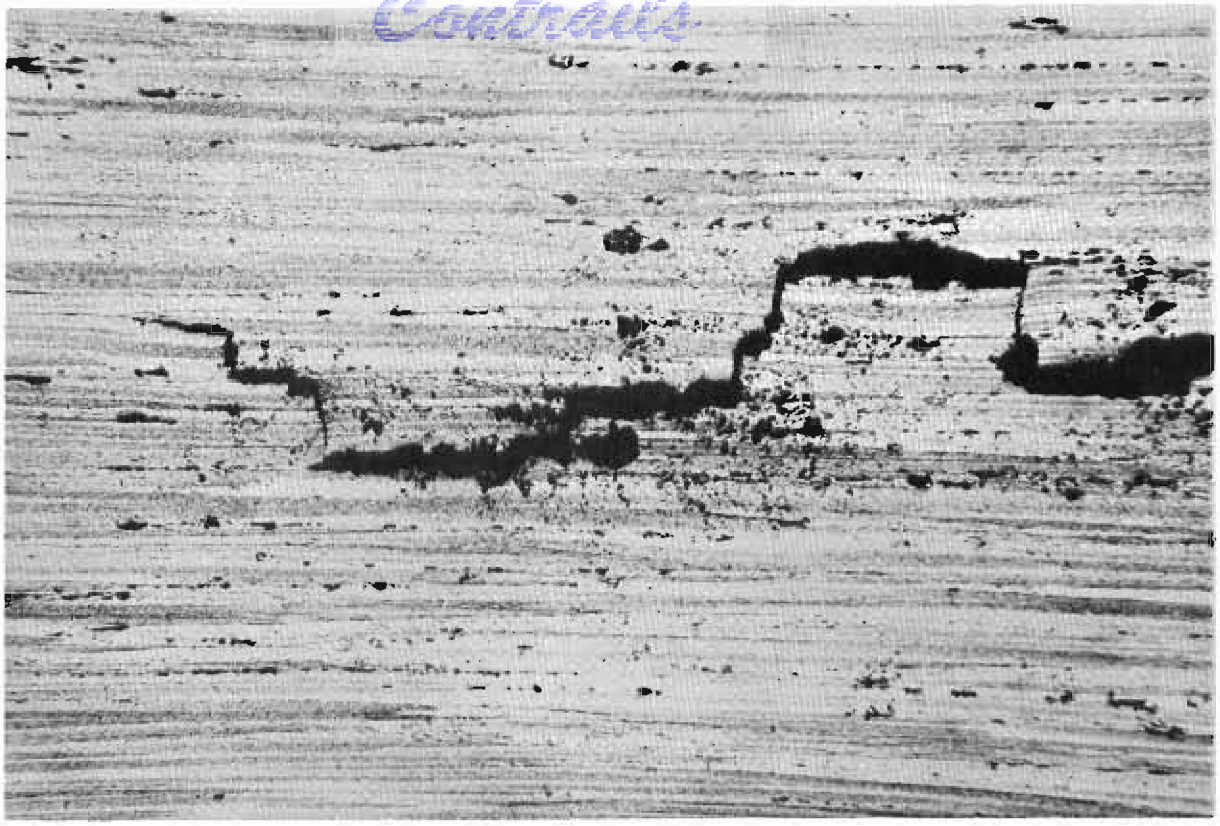


S-No. 340620-ST11 Etch: Keller's Mag: 4X

Fig. 173 Appearance of the Crack in a Fatigue-Precracked Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. 7075-T73510 Extruded Bar Loaded to 90% K_{Ic} and Immersed in 3.5% NaCl Solution for 2150 Hours.

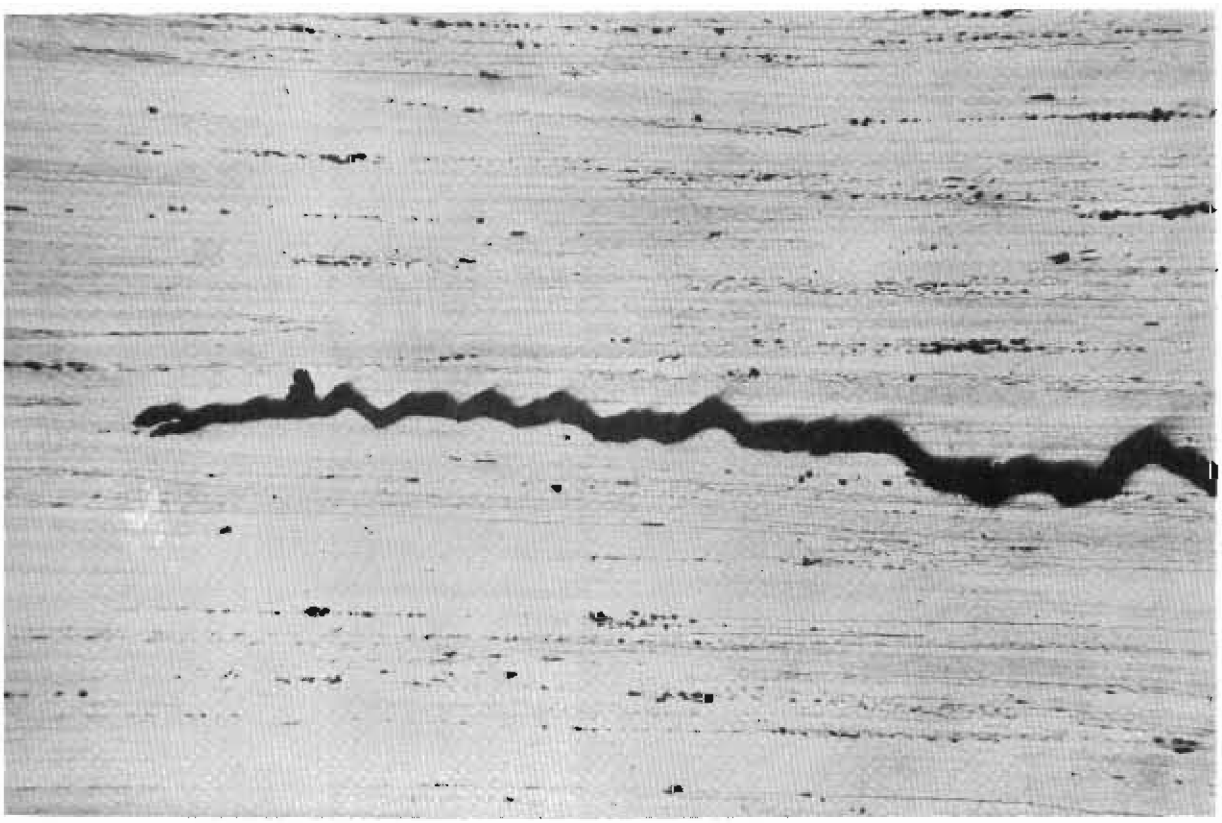
Approved for Public Release

Contrails



S-No. 340620-ST12 Etch: Keller's Mag: 100X

Transgranular Nature of the Crack Tip in the Specimen Shown in Fig. 173 (Top).



S-No. 340620-ST11 Etch: Keller's Mag: 100X

172935A
172936A

Fig. 174 Transgranular Nature of the Crack Tip in the Specimen Shown in Fig. 173 (Bottom).

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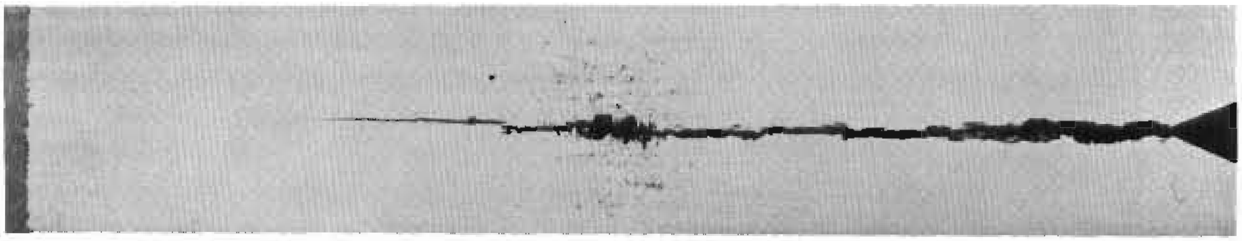
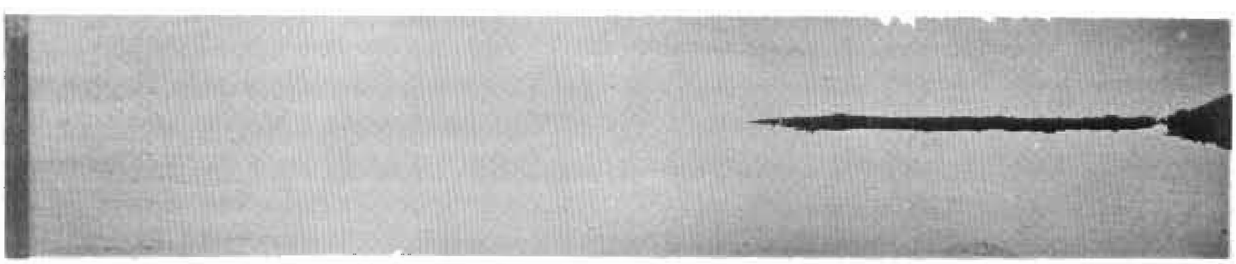
Contrails



S-No. 340732-ST3 Etch: Keller's Mag: 4X

Appearance of the Crack in a Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. X7080-T7E42 Extruded Bar Loaded to 100% K_{Ic} and Exposed to Alternate Immersion in 3.5% NaCl Solution for 2500 Hours.



S-No. 340732-ST1 Etch: Keller's Mag: 4X

Fig. 175 Appearance of the Crack in a Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. X7080-T7E42 Extruded Bar Loaded to 90% K_{Ic} and Immersed in 3.5% NaCl Solution for 2500 Hours.

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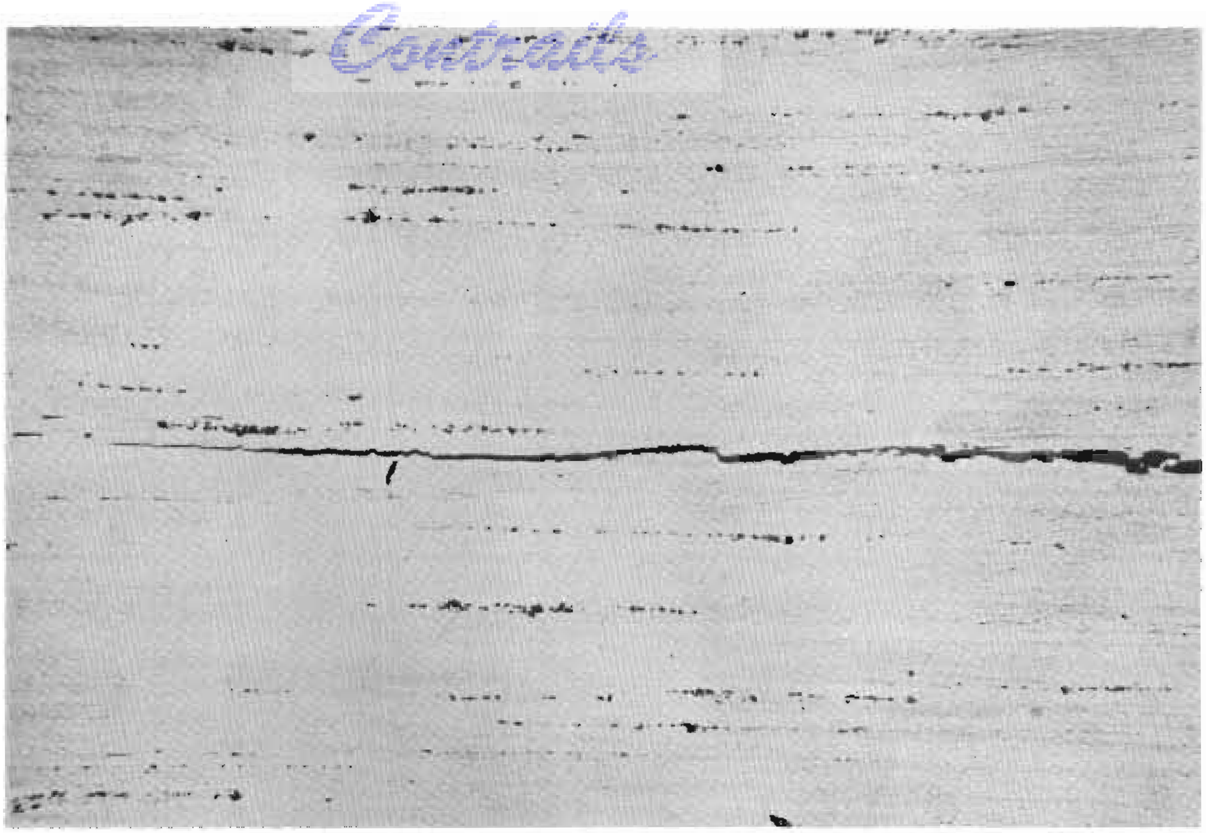
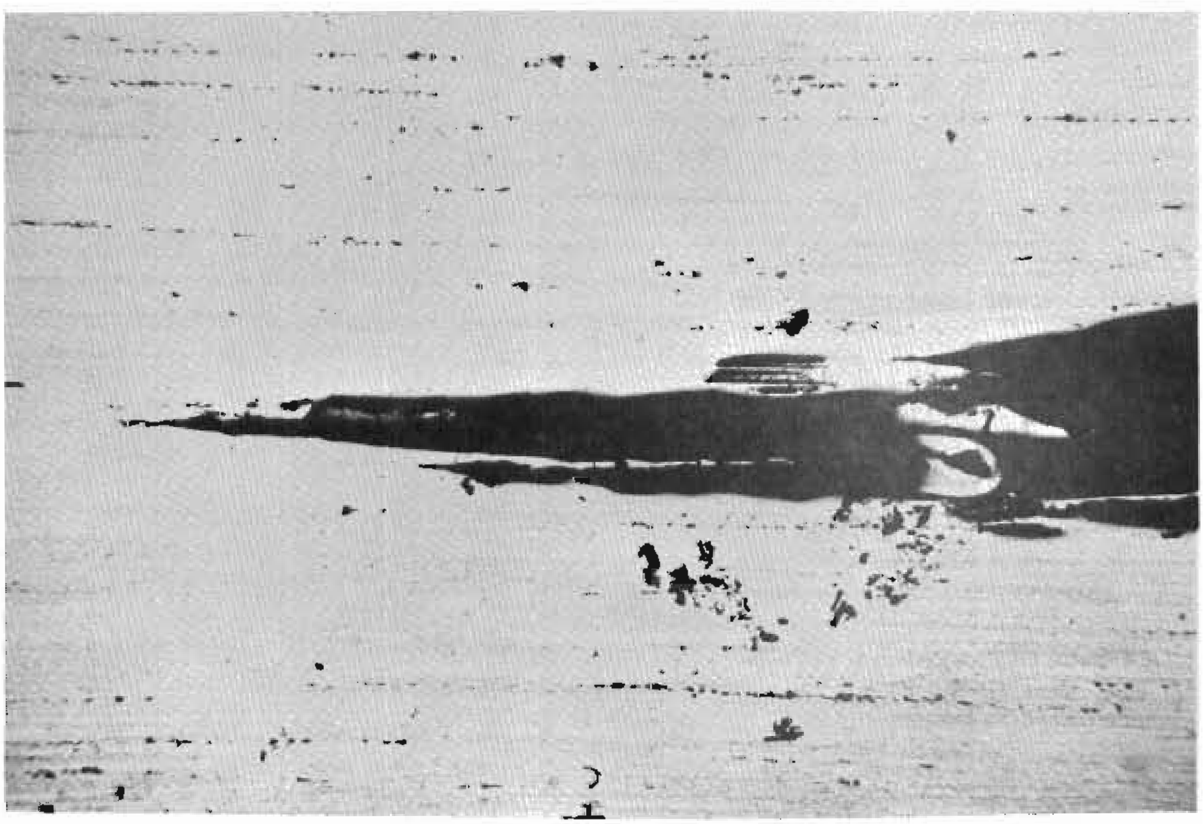
Contrails



S-No. 340732-ST3 Etch: Keller's Mag: 100X

Intergranular Nature of the Crack Tip in the Specimen Shown in Fig. 175 (Top).



S-No. 340732-ST1 Etch: Keller's Mag: 100X

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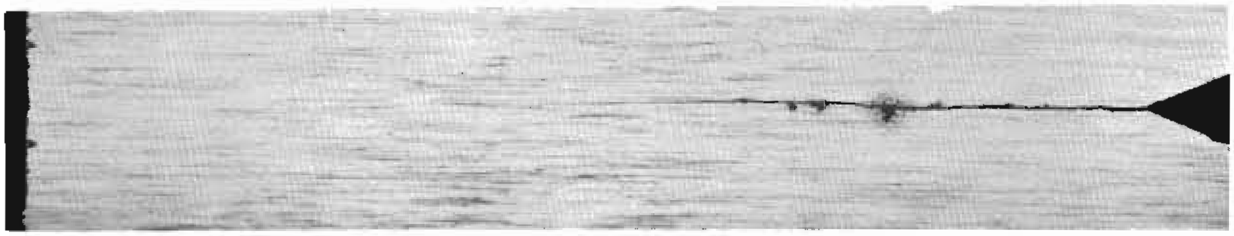
Fig. 176 Tip of the Crack Shown in Fig. 175 (Bottom).

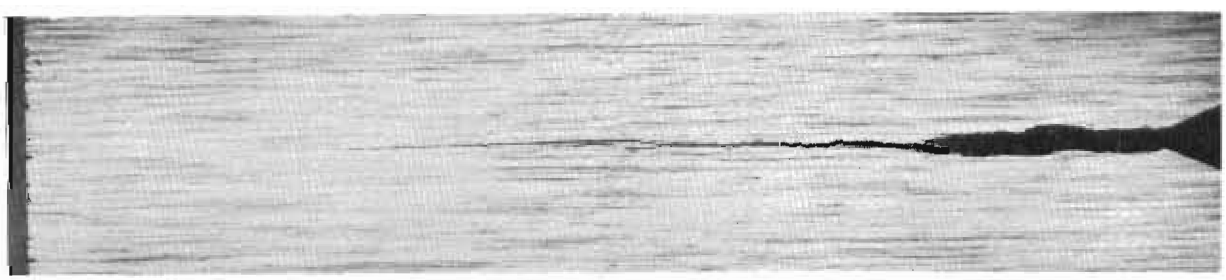
172937A
172938A

Contrails



S-No. 340635-ST4 Etch: Keller's Mag: 4X

Appearance of the Crack in a Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. 7178-T6510 Extruded Bar Loaded to 90% K_{Ic} and Exposed to Alternate Immersion in 3.5% NaCl Solution for 2500 Hours.



S-No. 340635-ST3 Etch: Keller's Mag: 4X

Fig. 177 Appearance of the Crack in a Short-Transverse Compact Tension Specimen From 3-1/2x7-1/2-in. 7178-T6510 Extruded Bar Loaded to 100% K_{Ic} and Immersed in 3.5% NaCl Solution for 2500 Hours.

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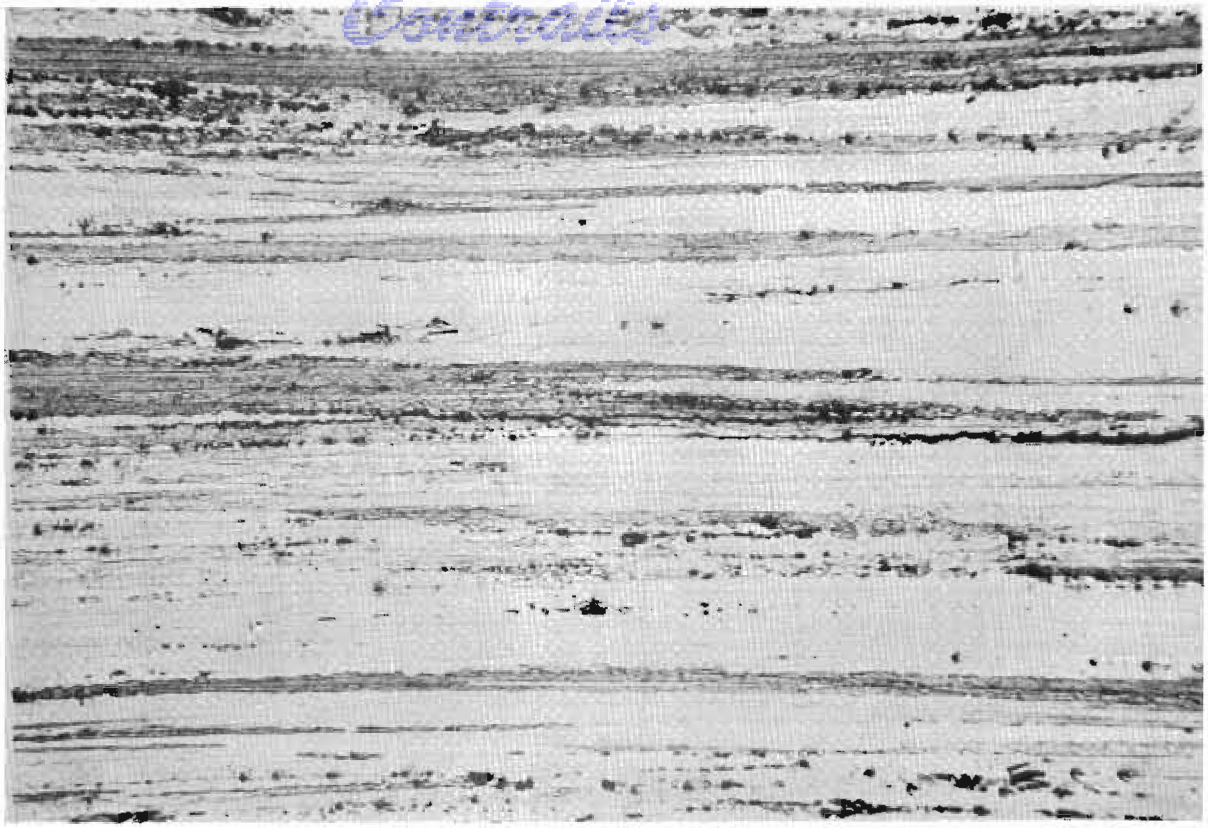
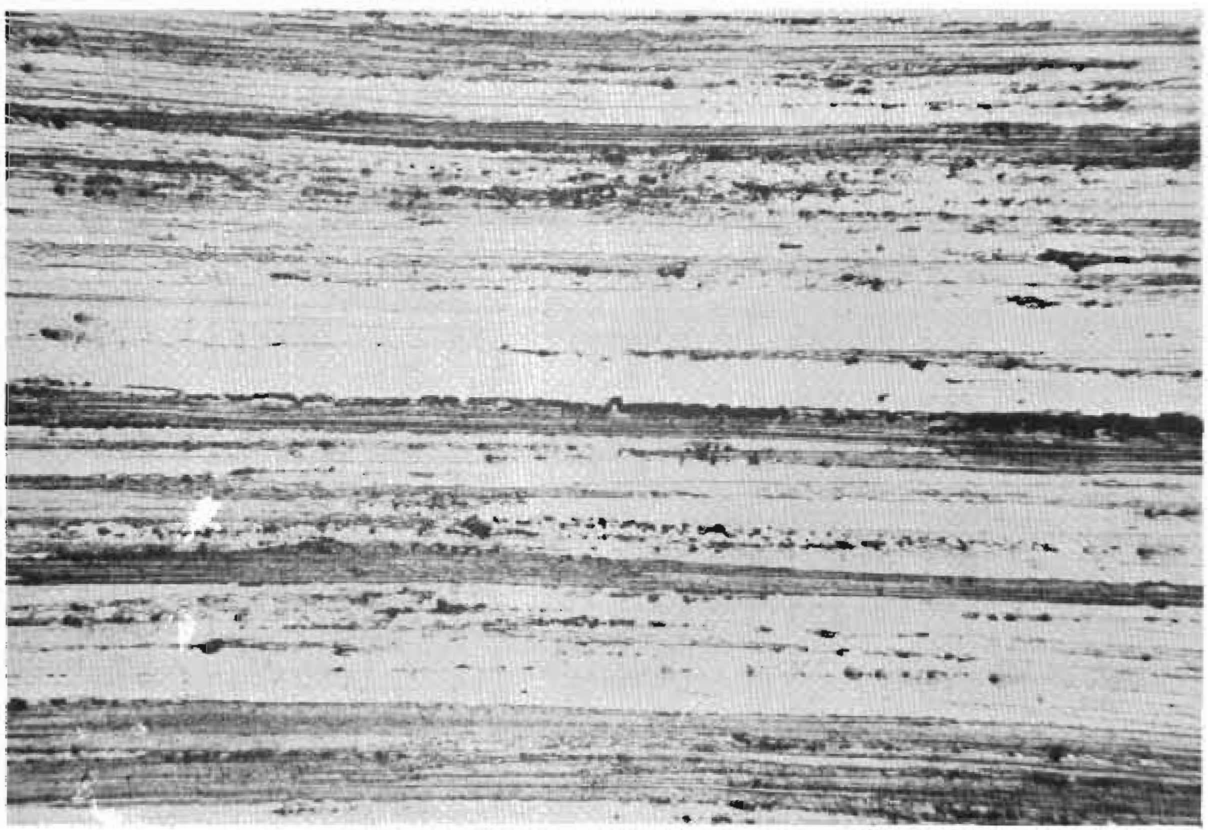


S-No. 340735-ST4 Etch: Keller's Mag: 100X

Intergranular Nature of the Crack Tip in the Specimen Shown in Fig. 177 (Top).



S-No. 340735-ST3 Etch: Keller's Mag: 100X

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Fig. 178 Intergranular Nature of the Crack Tip in the Specimen Shown in Fig. 177 (Bottom)

172939A
172940A

Contrails

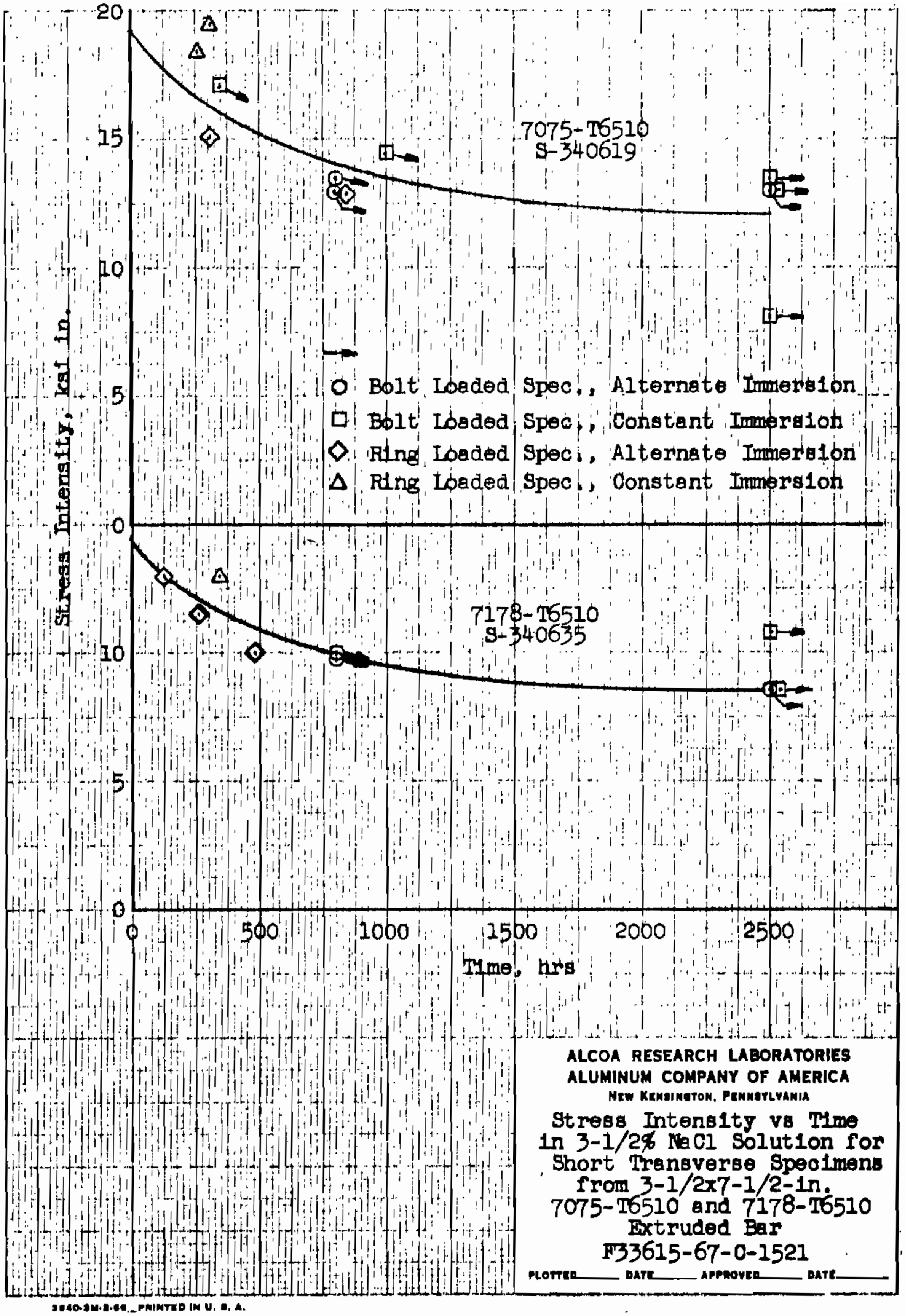

Fig. 179

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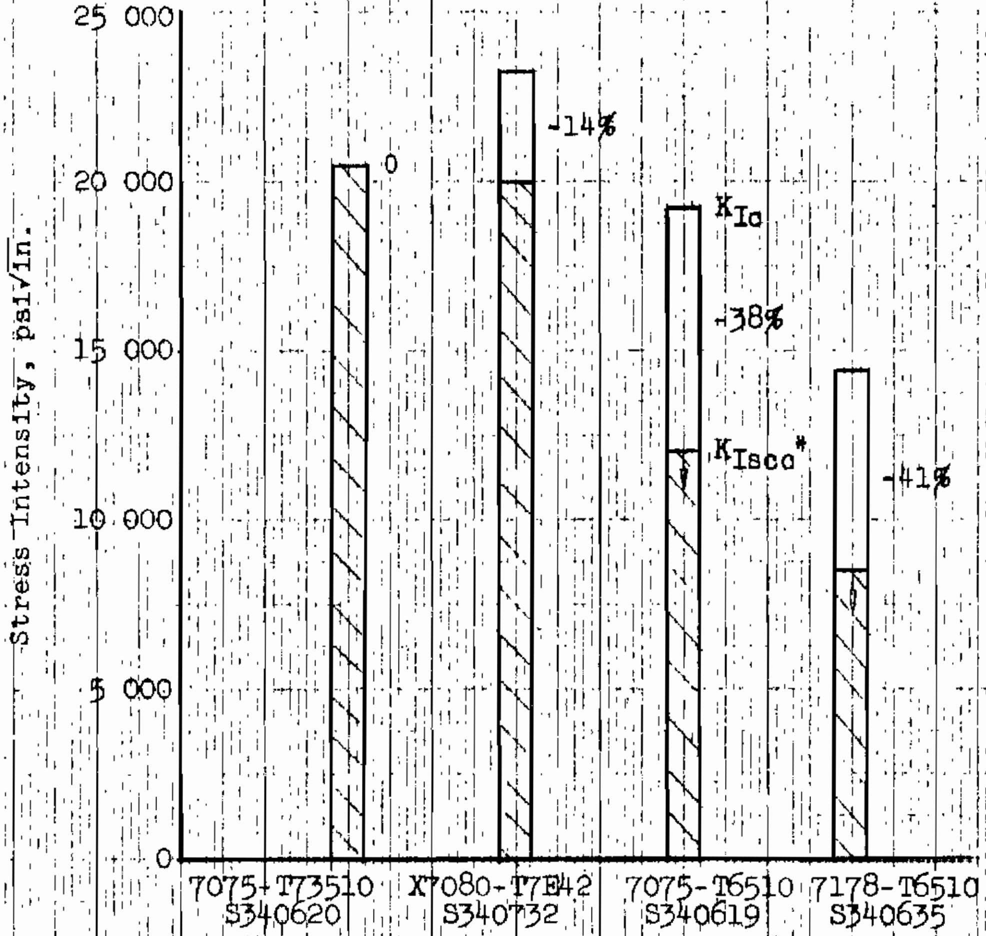

* K_{Iscc} equal to or less than these values; percentage indicates difference from K_{Ic}.

ALCOA RESEARCH LABORATORIES
ALUMINUM COMPANY OF AMERICA
NEW KENSINGTON, PENNSYLVANIA

Short-Transverse K_{Ic} and K_{Iscc} Values for Some 3-1/2x7-1/2-in. Extruded Bar

PLOTTED____ DATE____ APPROVED____ DATE____

8840-3M-2-69 PRINTED IN U. S. A.

Fig. 180

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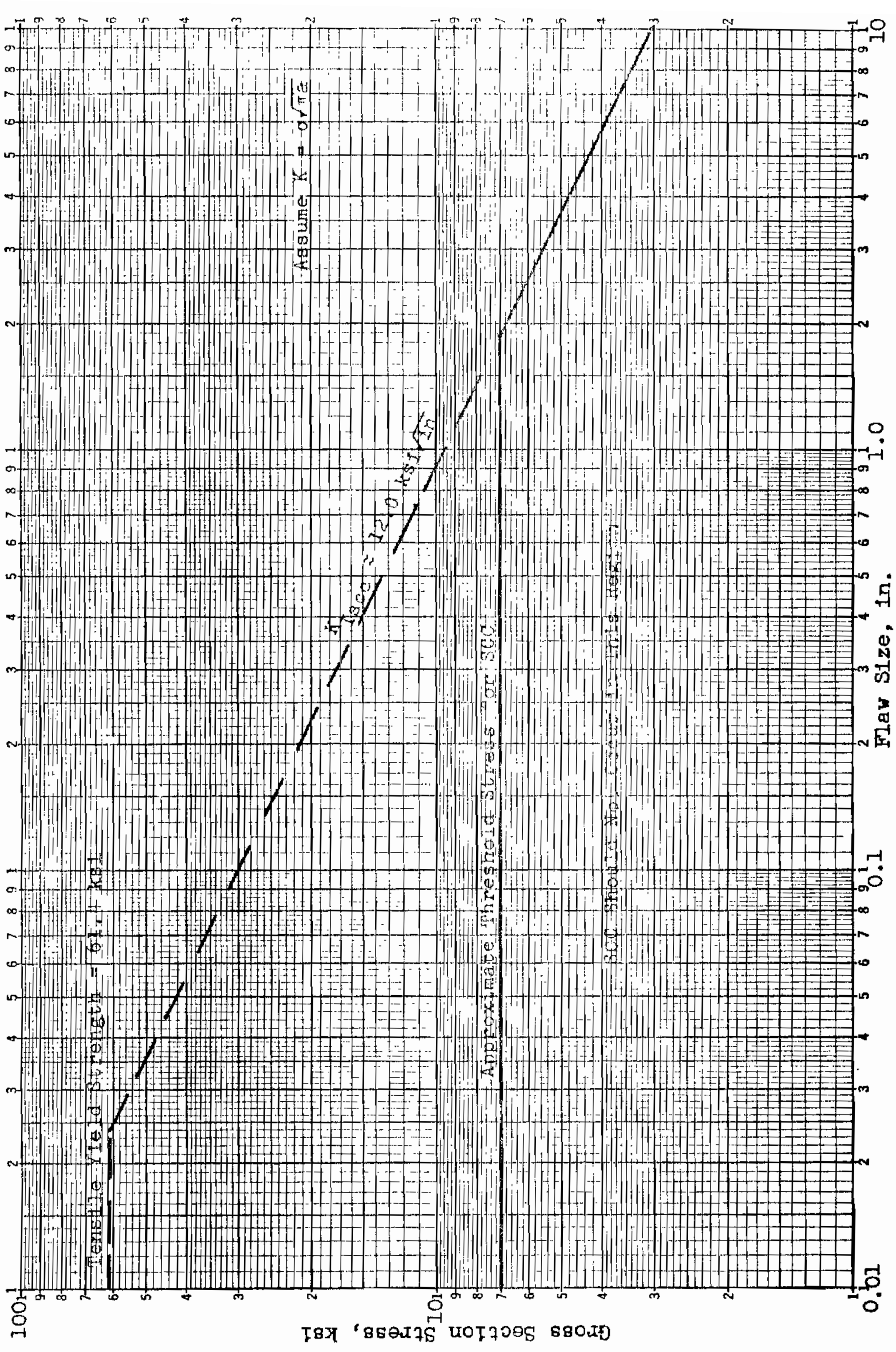

Approximate Threshold Levels for Stress-Corrosion Cracking for 3-1/2x7-1/2-in. 7075-T6510 Extruded Bar, S-340619

Fig. 181

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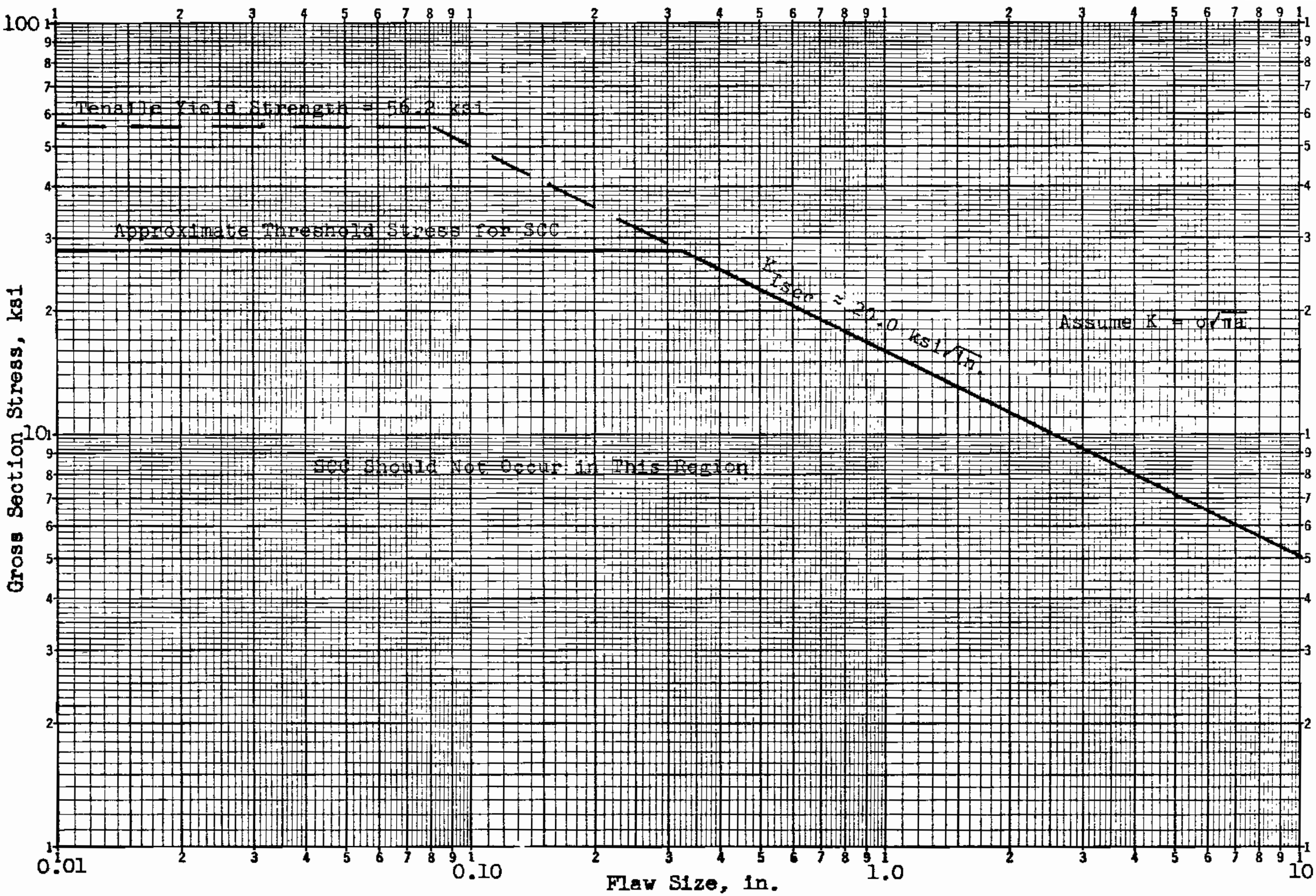
Contrails



Approximate Threshold Levels for Stress-Corrosion Cracking for 3-1/2x7-1/2-in.
X7080-T7E42 Extruded Bar, S-340732

Fig. 182

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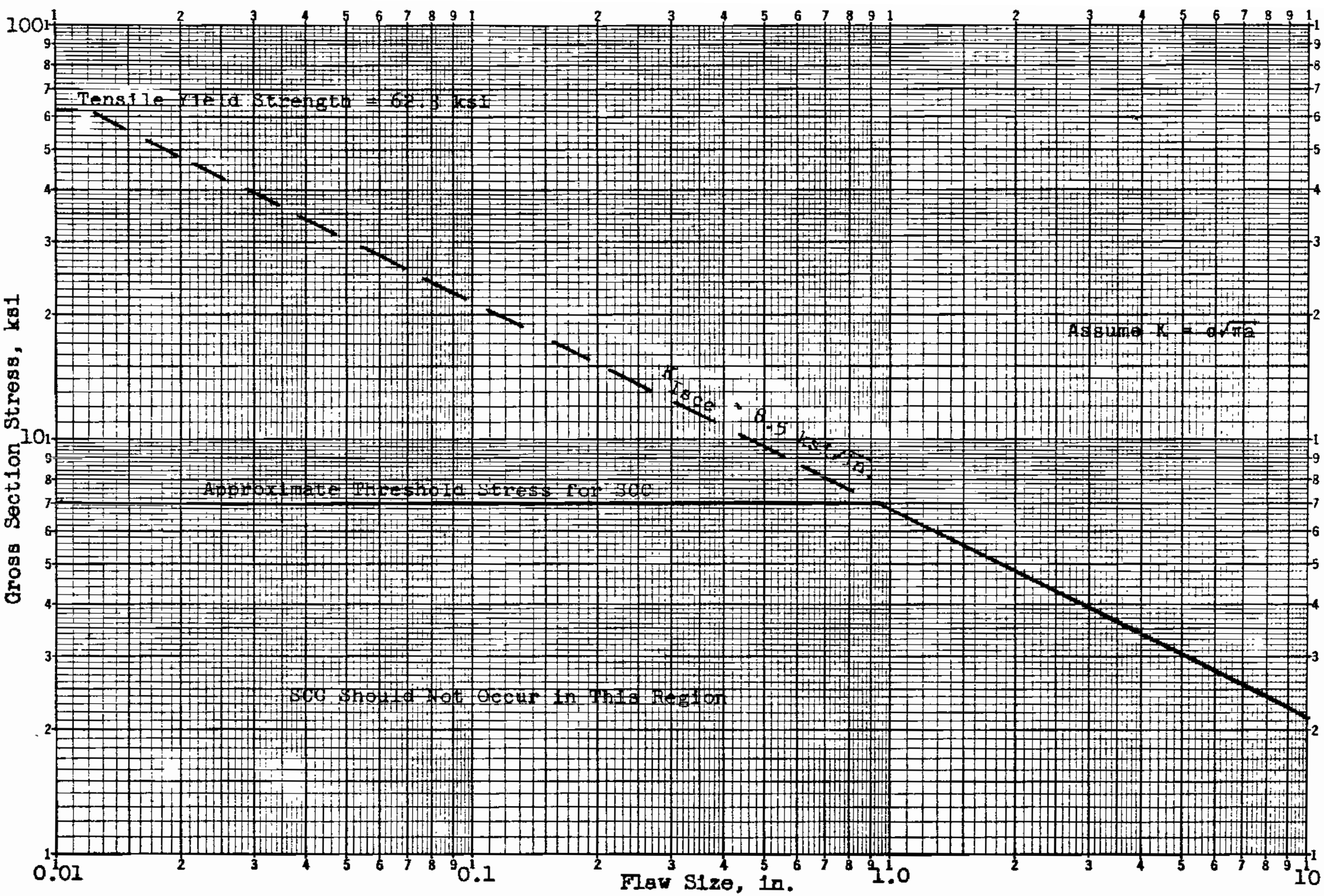

Approximate Threshold Levels for Stress-Corrosion Cracking for 3-1/2x7-1/2-in. 7178-T6510 Extruded Bar, S-340635

Fig. 183

Contrails
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Contrails

APPENDIX I

RESULTS OF FRACTURE TOUGHNESS TESTS

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RESULTS OF FRACTURE TOUGHNESS TESTS

X7080-T7E41 PLATE .500 IN. THICK

SAMPLE NUMBER 343260

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	MAXIMUM LOAD	FATIGUE CRACKING KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	PEN	APPEARANCE OF FRACTURE
L-W	C	2	1	.454	1.000	144.	6800	-1.0	507	.493	1310.	27600	73.3	.550	11100000	NO	83	A-40
			2	.494	1.000	155.	7200	-1.0	467	.488	1640.	34000	111.1	.832	11100000	NO	83	A-35
L-W	C	2	3	.454	1.000	133.	7000	-1.0	507	.500	1360.	31900	97.7	.727	11100000	NO	93	A-45
			4	.454	.999	143.	7900	-1.0	467	.515	1280.	31600	95.7	.712	11100000	NO	93	A-45
W-L	C	2	1	.494	.999	155.	8400	-1.0	465	.532	1180.	28300	77.1	.622	11100000	NO	83	A-35
			2	.494	.999	155.	8100	-1.0	513	.521	1120.	26000	64.8	.522	11100000	NO	83	A-30
W-L	C	2	3	.454	.999	143.	8100	-1.0	510	.522	1190.	30100	87.0	.701	11100000	NO	93	A-35
			4	.454	.999	143.	8200	-1.0	433	.524	1240.	31500	95.6	.770	11100010	NO	93	A-40

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
C = CENTER.
E = EDGE.
M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
A = FRACTION OBLIQUE.
B = PREDOMINANT OBLIQUE.
C = FULL OBLIQUE.
N = APPEARANCE NOT RECORDED.
X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

REMARKS -
80 OR 83 = ORIGINAL EXTRUDED OR ROLLED SURFACE.
90 OR 93 = 0.020-IN. MACHINED OFF TO REMOVE ORIGINAL SURFACE.

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RESULTS OF FRACTURE TOUGHNESS TESTS

7178-T651 PLATE .500 IN. THICK

SAMPLE NUMBER 340457

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	.500	1.000	200.	9500	-1.0	482	.499	1040.	22000	46.7	.179	00000000	YES	80	A-10
			2	.498	.999	200.	10400	-1.0	458	.522	838.	19300	35.9	.138	00000011	NO	80	A- 6
L-W	C	2	3	.460	1.000	184.	10800	-1.0	448	.535	815.	21200	43.1	.161	00000011	NO	90	A-15
			4	.460	.999	184.	11500	-1.0	542	.554	885.	24600	58.3	.218	00000010	NO	90	A- 2
W-L	C	2	3	.500	1.000	200.	9500	-1.0	455	.496	985.	20700	41.3	.173	00000000	YES	80	A- 4
			4	.500	.999	200.	11200	-1.0	460	.545	810.	20100	38.9	.163	00000011	NO	80	A- 8
W-L	C	2	1	.460	1.000	184.	10100	-1.0	388	.516	690.	16800	27.3	.114	00000011	NO	90	A- 2
			2	.460	.999	184.	9900	-1.0	300	.510	775.	18600	33.2	.139	00000001	NO	90	A- 2

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

REMARKS -
80 OR 83 = ORIGINAL EXTRUDED OR ROLLED SURFACE.
90 OR 93 = 0.020-IN. MACHINED OFF TO REMOVE ORIGINAL SURFACE.

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RESULTS OF FRACTURE TOUGHNESS TESTS

X7080-T7E41 PLATE 1.375 IN. THICK

SAMPLE NUMBER 343259

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	MAXIMUM LOAD	FATIGUE CRACKING KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	1.000	1.997	502.	7400	-1.0	503	.985	4740.	35000	117.8	.845	00000000	YES	0	A-25
			2	1.002	1.998	502.	7700	-1.0	677	1.014	4870.	37500	135.4	.971	00000000	YES	0	A-20
L-W	C	1	1	.999	2.001	1130.	7900	.1	58	1.022	4960.	34800	116.4	.835	00000000	YES	0	A-25
			2	1.000	2.001	1130.	7500	.1	61	.987	5490.	36500	128.3	.921	00000000	YES	0	A-25
			3	1.000	2.004	1130.	7500	.1	50	.990	5110.	34100	111.7	.802	00000000	YES	0	A-25
W-L	C	2	1	1.000	1.997	502.	8400	-1.0	578	1.058	3450.	28700	79.1	.579	00000000	YES	0	A-15
			2	1.000	1.997	502.	7500	-1.0	871	.994	4000.	30000	86.3	.631	00000000	YES	0	A-15
W-L	C	1	1	.999	2.002	1130.	7400	.1	49	.975	4370.	28600	78.5	.575	00000000	YES	0	A-15
			2	.999	2.003	1130.	7500	.1	55	.985	4230.	28000	75.6	.553	00000000	YES	0	A-15
			3	.999	2.002	1130.	7200	.1	46	.961	4340.	27800	74.3	.544	00000000	YES	0	A-15

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

- 1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
- 2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
- 3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
- 4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
- 5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
- 6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
- 7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
- 8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

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RESULTS OF FRACTURE TOUGHNESS TESTS

7178-T651 PLATE 1.375 IN. THICK

SAMPLE NUMBER 340450

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	1.001	2.000	925.	14900	.0	96	1.040	2890.	23200	52.2	.200	00000011	NO	0	A- 5
			2	1.000	2.000	925.	14500	.0	108	1.025	2950.	23100	51.9	.199	00000011	NO	0	A- 4
			3	.999	1.939	504.	9700	-1.0	94	1.021	2650.	22800	50.1	.194	00000010	NO	0	A- 0
L-W	C	1	1	.999	2.000	1325.	9800	.1	19	1.057	3100.	23000	50.9	.197	00000000	YES	0	A- 5
			2	1.000	2.000	1130.	8000	.1	18	1.025	3330.	23500	53.0	.205	00000000	YES	0	A- 5
			3	1.000	1.999	1130.	9000	.1	12	1.096	2950.	23400	52.7	.204	00000000	YES	0	A- 5
W-L	C	2	1	1.000	2.000	925.	14600	.0	192	1.029	2400.	18900	34.8	.148	00000011	NO	0	A- 4
			2	1.000	2.000	925.	15300	.0	137	1.058	2290.	18900	34.8	.148	00000011	NO	0	A- 5
			3	.999	1.940	504.	7600	-1.0	102	.944	2620.	19800	37.7	.162	00000000	YES	0	A- 5
			4	.999	1.938	504.	7800	-1.0	89	.956	2650.	20500	40.4	.173	00000000	YES	0	A- 0
W-L	C	1	1	.999	2.000	1325.	10000	.1	22	1.065	2770.	20800	41.7	.179	00000000	YES	0	A- 5
			2	.999	2.000	1325.	9800	.1	17	1.052	2800.	20600	40.8	.175	00000000	YES	0	A- 5
			3	.999	2.000	1325.	9900	.1	24	1.058	2670.	19900	37.9	.163	00000000	YES	0	A- 5

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * 5/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

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RESULTS OF FRACTURE TOUGHNESS TESTS

7075-T6510   EXTRUDED SHAPE   .688 IN. THICK

SAMPLE NUMBER 340637

DIR	LOC	SPECIMEN TYPE	SPECIMEN NO.	THICK	WIDTH	MAXIMUM LOAD	FATIGUE CRACKING KF	FATIGUE CRACKING STRESS RATIO	FATIGUE CRACKING CYCLES ∗ 1000	FATIGUE CRACKING CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	.657	1.500	232.	6700	-1.0	399	.765	1945.	26600	68.0	.264	00000000	YES	80	A-35
L-W	C	2	2	.658	1.500	255.	7000	-1.0	478	.740	2160.	27900	75.0	.291	00000010	NO	90	A-45
L-W	M	2	1	.663	1.501	255.	6700	-1.0	615	.724	2290.	28400	77.3	.296	00000010	NO	80	A-35
			2	.659	1.500	279.	7400	-1.0	78	.722	2215.	27600	73.1	.280	00000000	YES	80	A-40
L-W	M	2	3	.624	1.494	255.	7200	-1.0	264	.721	2085.	27700	73.5	.282	00000010	NO	90	A-45
L-W	E	2	1	.667	1.491	255.	7000	-1.0	79	.740	1970.	25600	63.0	.219	00000000	YES	80	A-15
			2	.664	1.492	232.	6300	-1.0	74	.729	2025.	25700	63.7	.222	00000000	YES	80	A-12
L-W	E	2	3	.623	1.493	232.	6200	-1.0	53	.696	2095.	26500	67.4	.235	00000000	YES	90	A-10
W-L	C	2	1	.664	1.493	232.	5700	-1.0	75	.684	2070.	23900	55.2	.232	00000010	NO	80	A-12
			2	.652	1.501	195.	4800	-1.0	112	.709	2050.	25900	60.2	.253	00000010	NO	90	A-10
W-L	C	2	3	.625	1.495	232.	5800	-1.0	72	.663	2030.	23800	54.7	.230	00001000	NO	90	A-10
W-L	M	2	1	.660	1.493	232.	5900	-1.0	85	.700	2055.	24700	58.8	.246	00000000	YES	80	A-10
			2	.660	1.492	232.	5900	-1.0	84	.691	1955.	23200	51.5	.216	00000000	YES	80	A-10
W-L	M	2	3	.625	1.494	232.	5400	-1.0	82	.626	2195.	24100	55.9	.234	00001000	NO	90	A-15

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT-RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = RQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

REMARKS -
80 OR 83 = ORIGINAL EXTRUDED OR ROLLED SURFACE.
90 OR 93 = 0.020-IN. MACHINED OFF TO REMOVE ORIGINAL SURFACE.

Approved for Public Release

Contrails

RESULTS OF FRACTURE TOUGHNESS TESTS

7075-T73510 EXTRUDED SHAPE .688 IN. THICK

SAMPLE NUMBER 340639

DIR	LOC	SPECIMEN TYPE	SPECIMEN NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	FATIGUE CRACKING KF	FATIGUE CRACKING STRESS RATIO	FATIGUE CRACKING CYCLES X 1000	FATIGUE CRACKING CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	.656	1.499	232.	5700	-1.0	89	.682	3030.	35000	117.6	.732	11000000	NO	80	A-45
L-W	C	2	2	.655	1.493	208.	4900	-1.0	371	.655	2675.	31900	97.7	.609	00101000	NO	93	A-25
L-W	M	2	1	.656	1.493	208.	5300	-1.0	218	.695	2790.	33400	107.6	.662	10100000	NO	83	A-45
			2	.652	1.495	208.	5300	-1.0	536	.690	2820.	33500	108.0	.665	10100000	NO	83	A-45
L-W	M	2	3	.620	1.501	232.	6100	-1.0	43	.695	2500.	31200	93.7	.577	00000000	YES	90	A-25
L-W	E	2	1	.664	1.491	232.	5700	-1.0	42	.685	2700.	31400	95.0	.576	00100000	NO	83	A-30
			2	.660	1.493	208.	5500	-1.0	107	.710	2610.	32200	99.4	.603	00100000	NO	83	A-35
L-W	E	2	3	.624	1.493	208.	5200	-1.0	74	.665	2720.	32300	100.0	.606	00100000	NO	93	A-30
W-L	C	2	1	.654	1.494	208.	5000	-1.0	64	.666	2560.	29200	82.1	.548	00100000	NO	83	A-12
			2	.652	1.493	208.	5000	-1.0	71	.661	2570.	29000	80.7	.539	00101000	NO	83	A-20
W-L	C	2	3	.625	1.493	208.	5000	-1.0	75	.643	2720.	30400	91.4	.610	00001000	NO	90	A-20
W-L	M	2	1	.658	1.493	208.	5100	-1.0	68	.678	2430.	28000	75.5	.485	00000000	YES	80	A-15
			2	.660	1.493	208.	5000	-1.0	66	.673	2510.	28600	78.6	.505	00000000	YES	80	A-15
W-L	M	2	3	.624	1.493	208.	4900	-1.0	83	.625	2660.	29200	82.0	.527	00001000	NO	90	A-20

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (P = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

REMARKS -
80 OR 83 = ORIGINAL EXTRUDED OR ROLLED SURFACE.
90 OR 93 = 0.020-IN. MACHINED OFF TO REMOVE ORIGINAL SURFACE.

Approved for Public Release

RESULTS OF FRACTURE TOUGHNESS TESTS

X7080-T7E42 EXTRUDED SHAPE .688 IN. THICK

SAMPLE NUMBER 340730Z

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	FATIGUE CRACKING: MAXIMUM LOAD	KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION: LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	.627	1.502	232.	9000	-1.0	18	.825	2120.	34600	115.1	.737	10100010	NO	83	A-25
L-W	C	2	2	.627	1.501	232.	6500	-1.0	30	.727	2610.	34400	114.0	.730	11000000	NO	90	A-45
L-W	M	2	1	.625	1.502	208.	5800	-1.0	51	.720	3020.	39300	148.2	.947	11000000	NO	80	A-40
			2	.627	1.502	185.	5000	-1.0	97	.715	2730.	35000	118.0	.754	11100000	NO	83	A-35
L-W	M	2	3	.626	1.501	185.	5600	-1.0	126	.741	2650.	37600	135.9	.968	11100010	NO	93	B-55
L-W	E	2	1	.627	1.502	185.	4900	-1.0	108	.704	2575.	32300	100.3	.754	11100010	NO	83	A-25
			2	.627	1.502	185.	5400	-1.0	81	.745	2730.	37300	133.7	1.006	11100010	NO	83	A-25
L-W	E	2	3	.626	1.501	185.	5400	-1.0	196	.750	2780.	38500	142.7	1.073	11000010	NO	90	A-20
W-L	C	2	1	.627	1.501	185.	11200	-1.0	100	1.041	1200.	34300	113.1	.770	10001010	NO	88	A-15
			2	.627	1.501	185.	5300	-1.0	215	.735	2460.	33000	104.5	.711	10100000	NO	93	A-18
W-L	C	2	3	.627	1.501	185.	5000	-1.0	174	.712	2770.	35400	120.7	.822	11100000	NO	93	A-20
W-L	M	2	1	.626	1.502	185.	5300	-1.0	63	.742	2470.	33400	108.5	.734	10100000	NO	83	A-30
			2	.626	1.501	185.	4900	-1.0	30	.686	3010.	36500	128.4	.968	11000000	NO	80	A-30
W-L	M	2	1	.627	1.502	185.	5100	-1.0	85	.720	2730.	35400	120.4	.815	11100010	NO	93	A-30
			2	.627	1.502	185.	5600	-1.0	44	.765	2700.	38500	142.5	.964	11000000	NO	90	A-25

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN, AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

REMARKS -
- 80 OR 83 = ORIGINAL EXTRUDED OR ROLLED SURFACE.
- 90 OR 93 = 0.020-IN. MACHINED OFF TO REMOVE ORIGINAL SURFACE.

Contrails

Approved for Public Release

RESULTS OF FRACTURE TOUGHNESS TESTS

7178-T6510 EXTRUDED SHAPE .688 IN. THICK

SAMPLE NUMBER 340616

DIR	LOC	SPECIMEN TYPE	SPECIMEN NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	KF	STRESS RATIO	CYCLES * 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-W	C	2	1	.654	1.500	494.	14000	-1.0	766	.752	1820.	24300	56.9	.197	00000011	NO	80	A-30
L-W	C	2	2	.625	1.499	529.	13600	-1.0	455	.681	1537.	18600	33.2	.115	00000011	NO	90	A-20
L-W	M	2	1	.651	1.497	529.	15200	-1.0	188	.752	1770.	23900	55.0	.188	00000011	NO	90	A-30
			2	.652	1.501	529.	16500	-1.0	151	.795	1755.	25700	63.7	.218	00000011	NO	80	A-30
L-W	M	2	3	.626	1.500	529.	16900	-1.0	131	.786	1655.	24900	59.5	.203	00000011	NO	90	A-25
L-W	E	2	1	.662	1.497	529.	15100	-1.0	54	.756	1700.	22800	49.9	.172	00000011	NO	80	A- 8
			2	.667	1.498	494.	13600	-1.0	51	.746	1695.	22000	46.5	.161	00000001	NO	80	A-10
L-W	E	2	3	.623	1.500	424.	11900	-1.0	77	.725	1540.	20400	40.0	.138	00000011	NO	90	A- 5
W-L	C	2	1	.646	1.499	424.	11400	-1.0	89	.719	1500.	19900	34.5	.130	00000011	NO	80	A- 5
			2	.643	1.499	354.	10200	-1.0	179	.750	1512.	20500	40.4	.153	00000010	NO	80	A- 5
W-L	C	2	3	.626	1.499	354.	10300	-1.0	151	.742	1485.	20300	39.7	.150	00000001	NO	90	A- 2
W-L	M	2	1	.648	1.500	354.	9100	-1.0	200	.701	1580.	19100	35.3	.132	00000000	YES	80	A- 5
			2	.648	1.499	354.	10000	-1.0	84	.746	1440.	19200	35.5	.133	00000011	NO	80	A- 5
W-L	M	2	3	.625	1.498	354.	9400	-1.0	451	.697	1500.	19800	33.8	.126	00000001	NO	90	A- 5

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.

1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)

2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN A0)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (A0/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

REMARKS -
80 OR 83 = ORIGINAL EXTRUDED OR ROLLED SURFACE.
90 OR 93 = 0.020-IN. MACHINED OFF TO REMOVE ORIGINAL SURFACE.

Contrails

Approved for Public Release

Contrails

RESULTS OF FRACTURE TOUGHNESS TESTS

7075-T6510 EXTRUDED BAR 3.500 IN. THICK

SAMPLE NUMBER 340619

SPECIMEN DIR	LOC	TYPE	NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	RFM	APPEARANCE OF FRACTURE
L-T	C	2	1	1.000	1.997	591.	9900	-1.0	92	1.063	4430.	37200	132.7	.637	00000000	YES	0	A-20
L-W	C	2	1	1.000	2.001	591.	10200	-1.0	181	1.085	3570.	30900	91.9	.441	00100010	NO	3	B-55
L-T	M	2	1	1.000	1.999	591.	8700	-1.0	98	.989	5450.	40300	156.5	.718	00000000	YES	0	A-15
L-W	M	2	1	.998	2.000	591.	9500	-1.0	134	1.040	3870.	31100	93.0	.436	00000010	NO	0	A-40
L-W	M	1	1	1.000	2.002	1484.	10000	.1	126	.995	4720.	31800	97.0	.440	00000000	YES	0	A-20
			2	1.000	2.002	1484.	10600	.1	132	1.035	4450.	31800	97.4	.442	00000000	YES	0	X-**
L-T	S	2	1	1.000	1.999	502.	8600	-1.0	184	1.076	3500.	30000	86.3	.332	00000010	NO	0	A-30
L-W	S	2	1	1.000	1.999	502.	8800	-1.0	197	1.088	3590.	31300	94.3	.406	00000010	NO	0	A-40
W-L	C	2	1	.500	1.001	200.	9500	-1.0	245	.500	1010.	21400	44.1	.258	00000000	YES	0	A- 4
W-L	M	2	1	.500	.999	200.	8700	-1.0	518	.469	1090.	21100	42.8	.247	00000000	YES	0	A- 8
			2	.500	.999	200.	9500	-1.0	526	.495	995.	20900	42.0	.242	00000000	YES	0	A-10
W-L	M	1	1	1.000	1.996	1484.	10200	.1	146	1.003	3200.	21900	46.1	.266	00000000	YES	0	A- 8
			2	1.000	1.992	1484.	9800	.1	132	.974	3350.	22100	46.8	.269	00000000	YES	0	A- 6
W-L	S	2	1	.500	.999	200.	10900	-1.0	260	.537	930.	22500	48.7	.267	00000010	NO	0	A- 8
			2	.498	.999	200.	12100	-1.0	249	.566	865.	23200	51.9	.284	00001011	NO	0	A-14
T-L	C	2	1	.251	.499	39.	7700	-1.0	168	.289	225.	17700	30.3	.209	00001000	NO	0	A- 0
T-L	C	1	1	1.001	2.002	1484.	9600	.1	122	.965	2985.	19200	35.5	.242	00000000	YES	0	A- 2
			2	1.000	1.996	1484.	9300	.1	127	.941	3070.	19200	35.5	.243	00000000	YES	0	A- 3
T-L	M	2	1	.249	.499	39.	7000	-1.0	133	.274	266.	19000	34.6	.235	00000010	NO	0	A- 0
			2	.250	.499	39.	6200	-1.0	432	.256	315.	19900	38.0	.259	11000000	NO	0	A- 0
T-L	S	2	1	.251	.500	39.	8200	-1.0	482	.298	257.	21400	44.2	.219	00001010	NO	0	A-12
			2	.251	.500	39.	6900	-1.0	163	.274	305.	21500	44.3	.219	00000000	YES	0	A-16

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PO*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PO*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (B = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (B = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

Approved for Public Release

Contrails

RESULTS OF FRACTURE TOUGHNESS TESTS

7075-T73510 EXTRUDED BAR 3.500 IN. THICK

SAMPLE NUMBER 340620

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-T	C	2	1	1.001	2.000	502.	7900	-1.0	294	1.030	4560.	36000	124.6	.879	00100000	NO	3	A-25
L-W	C	2	1	.999	1.999	502.	7500	-1.0	218	.992	4630.	34500	114.6	.809	00100000	NO	3	A-20
L-T	M	2	1	1.001	2.000	502.	7400	-1.0	186	.989	4980.	36800	130.0	.841	00100000	NO	3	A-25
L-W	M	2	1	.999	1.998	502.	7900	-1.0	195	1.026	4270.	33700	109.0	.757	00100000	NO	3	A-35
L-W	M	1	1	1.001	1.996	1484.	9300	.1	136	.946	5470.	34400	114.1	.726	00000000	YES	0	A-31
			2	1.000	2.003	1484.	9300	.1	153	.950	5280.	33200	106.2	.677	00000000	YES	0	X-**
L-T	S	2	1	1.000	1.998	502.	7800	-1.0	146	1.014	4460.	34400	113.9	.664	00100000	NO	3	A-15
L-W	S	2	1	1.001	1.999	502.	7800	-1.0	149	1.023	4450.	34800	116.2	.729	00100000	NO	3	A-25
W-L	C	2	1	.500	1.000	200.	10100	-1.0	422	.515	1000.	22400	48.0	.387	00000000	YES	0	A- 6
W-L	M	2	1	.500	.999	200.	9200	-1.0	341	.485	1090.	22200	47.4	.369	00000000	YES	0	A-10
			2	.500	.999	200.	8800	-1.0	389	.471	1205.	23500	53.1	.402	00000000	YES	0	A-10
W-L	M	1	1	1.001	1.997	1484.	9400	.1	145	.949	3780.	23900	54.8	.415	00000000	YES	0	A- 9
			2	1.001	1.996	1484.	9300	.1	136	.946	3775.	23800	54.3	.411	00000000	YES	0	A- 9
W-L	S	2	1	.500	.999	200.	8600	-1.0	264	.465	1285.	24600	58.2	.423	00000000	YES	0	A-10
			2	.500	.999	200.	8800	-1.0	283	.470	1255.	24400	57.3	.417	00000000	YES	0	A-18
T-L	C	2	1	.251	.500	39.	9700	-1.0	354	.319	103.	10100	9.9	.088	00001001	NO	0	A- 0
T-L	C	2	A	.250	.501	39.	6300	-1.0	74	.261	298.	19100	35.5	.313	11000000	NO	0	A-12
T-L	C	1	1	1.001	2.002	1484.	9300	.1	150	.944	3330.	20800	41.5	.360	00000000	YES	0	A- 7
			2	1.001	2.002	1484.	9100	.1	114	.929	3225.	19700	37.4	.324	00000000	YES	0	A- 6
T-L	M	2	1	.250	.499	39.	7700	-1.0	119	.288	245.	19200	35.5	.303	11001000	NO	0	A- 0
			2	.250	.499	39.	7400	-1.0	150	.281	255.	19100	35.2	.300	11001000	NO	0	A- 0
T-L	S	2	1	.251	.499	39.	7100	-1.0	131	.276	333.	24000	55.4	.382	11000010	NO	0	A-16
			2	.251	.499	39.	7600	-1.0	116	.288	316.	24600	58.3	.402	11001010	NO	0	A-20

ALL LOADS IN POUNDS, ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (12.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

Approved for Public Release

Contrails

RESULTS OF FRACTURE TOUGHNESS TESTS

X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK

SAMPLE NUMBER 340732D

		SPECIMEN				FATIGUE CRACKING					AT TWO PER CENT CRACK EXTENSION							APPEARANCE
DIR	LOC	TYPE	NO.	THICK	WIDTH	MAXIMUM LOAD	KF	STRESS RATIO	CYCLES X 1000	CRACK LENGTH	LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	OF FRACTURE
L-T	C	2	1	1.001	2.001	502.	7100	-1.0	144	.962	5850.	41400	164.9	1.050	11100000	NO	3	A-30
L-W	C	2	1	1.001	2.001	502.	7800	-1.0	76	1.019	4880.	37800	137.2	.874	00000000	YES	0	B-60
L-T	M	2	1	1.000	2.001	502.	7500	-1.0	90	.999	5430.	40700	159.5	1.012	11100000	NO	3	A-25
L-W	M	2	1	1.001	2.001	502.	7900	-1.0	86	1.031	4590.	36300	126.4	.810	00100000	NO	3	A-40
L-T	S	2	1	1.001	2.001	502.	8200	-1.0	74	1.051	4480.	36600	128.7	.805	00100010	NO	3	A-25
L-W	S	2	1	1.001	2.001	502.	8300	-1.0	98	1.059	4310.	35600	122.1	.785	00100010	NO	3	A-45
W-L	C	2	1	.501	.877	200.	12300	-1.0	411	.453	998.	27200	71.1	.529	11000000	NO	0	A- 6
W-L	M	2	1	.501	.877	200.	11700	-1.0	369	.440	980.	25500	62.4	.456	01000000	NO	0	A-15
			2	.501	.877	200.	11600	-1.0	440	.438	1030.	26500	67.6	.495	01000000	NO	0	A-12
W-L	S	2	1	.501	.877	200.	12900	-1.0	229	.465	1010.	28900	80.1	.576	11000000	NO	0	A-25
			2	.501	.877	200.	13900	-1.0	273	.485	950.	29300	82.8	.596	11100000	NO	3	A-28
T-L	C	2	1	.252	.500	39.	5700	-1.0	82	.245	423.	24500	57.8	.476	11000000	NO	0	A- 4
T-L	C	1	7	1.000	2.000	1130.	7600	.1	85	.997	3380.	22900	50.8	.402	00000000	YES	0	A- 3
			9	1.000	2.000	1130.	7600	.1	82	.990	3490.	23400	52.9	.420	00000000	YES	0	A- 2
T-L	M	2	1	.252	.500	39.	6300	-1.0	51	.261	407.	26200	66.1	.529	11000000	NO	0	A- 4
			2	.252	.500	39.	6100	-1.0	57	.255	367.	22700	49.4	.395	11000000	NO	0	A- 0
T-L	S	2	1	.250	.499	39.	6900	-1.0	71	.271	399.	27900	74.9	.542	11000000	NO	0	A-30
			2	.248	.500	39.	8600	-1.0	58	.303	285.	25000	60.1	.435	11101000	NO	3	A-25

ALL LOADS IN POUNDS. ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * S/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE, G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
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3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

Approved for Public Release

RESULTS OF FRACTURE TOUGHNESS TESTS

7178-T6510 EXTRUDED BAR 3.500 IN. THICK

SAMPLE NUMBER 340635

DIR	LOC	SPECIMEN TYPE	NO.	THICK	WIDTH	FATIGUE CRACKING MAXIMUM LOAD	KF	STRESS RATIO	CYCLES K 1000	CRACK LENGTH	AT TWO PER CENT CRACK EXTENSION LOAD	KQ	G	R	VALID? 12345678	MEANINGFUL KIC?	REM	APPEARANCE OF FRACTURE
L-T	C	2	1	1.000	2.000	502.	8700	-1.0	302	1.085	3000.	26000	65.0	.290	00100010	NO	3	A- 5
L-W	C	2	1	1.000	2.000	502.	8100	-1.0	170	1.045	3130.	25400	61.8	.275	00000010	NO	0	A-10
L-T	M	2	1	1.001	1.996	502.	8600	-1.0	273	1.078	3210.	27600	73.4	.295	00000010	NO	0	A- 5
L-W	M	2	1	1.001	1.996	502.	8800	-1.0	233	1.089	2520.	22100	47.0	.201	00000010	NO	0	A- 5
L-W	M	1	1	.999	2.002	1130.	8100	.1	32	1.037	3440.	24700	59.2	.251	00000000	YES	0	A- 8
			2	1.000	2.007	1130.	8500	.1	30	1.068	3390.	25400	62.6	.266	00000000	YES	0	A-12
L-T	S	2	1	1.001	1.999	502.	7800	-1.0	117	1.018	2490.	19300	35.7	.120	00000010	NO	0	A- 5
L-W	S	2	1	1.001	2.000	502.	8200	-1.0	165	1.053	2430.	19900	38.1	.156	00000010	NO	0	A- 5
W-L	C	2	1	.500	.999	200.	8600	-1.0	476	.464	835.	15900	24.4	.137	00000011	NO	0	A- 2
W-L	M	2	1	.500	.999	200.	9100	-1.0	491	.481	790.	15900	24.3	.132	00000011	NO	0	A- 2
			2	.500	.999	200.	8500	-1.0	503	.461	870.	16500	26.0	.141	00000001	NO	0	A- 2
W-L	M	1	1	1.000	1.999	1130.	8000	.1	45	1.030	2480.	17700	30.2	.163	00000000	YES	0	A- 0
			2	1.001	2.001	1130.	8100	.1	42	1.041	2540.	18300	32.6	.175	00000000	YES	0	A- 2
W-L	S	2	1	.500	.999	200.	10100	-1.0	225	.515	735.	16500	26.1	.132	00000011	NO	0	A- 4
			2	.500	1.000	200.	10500	-1.0	208	.527	700.	16300	25.6	.130	00000011	NO	0	A- 4
T-L	E	2	1	.251	.500	39.	8500	-1.0	70	.303	163.	14100	19.2	.129	00101001	NO	3	A- 0
T-L	C	1	7	1.001	2.002	1130.	7600	.1	71	.997	2130.	14400	20.0	.133	00000001	NO	0	A- 0
			8	.998	2.003	1130.	7600	.1	58	.994	2150.	14500	20.3	.135	00000001	NO	0	A- 0
T-L	M	2	1	.248	.499	39.	7900	-1.0	101	.290	152.	12200	14.4	.089	00101011	NO	3	A- 0
			2	.250	.499	39.	7700	-1.0	111	.288	192.	15000	21.8	.135	00001011	NO	0	A- 4
T-L	S	2	1	.250	.501	39.	9600	-1.0	38	.319	118.	11600	12.9	.055	00001001	NO	0	A- 0
			2	.250	.499	39.	8000	-1.0	54	.293	178.	14500	20.2	.087	00001001	NO	0	A- 0

ALL LOADS IN POUNDS, ALL DIMENSIONS IN INCHES.

LOCATION IN THE WIDTH OR THICKNESS.
- C = CENTER.
- E = EDGE.
- M = MIDWAY BETWEEN CENTER AND EDGE OR SURFACE.
- S = SURFACE.

APPEARANCE OF FRACTURE - PERCENT OBLIQUE.
- A = FRACTION OBLIQUE.
- B = PREDOMINANT OBLIQUE.
- C = FULL OBLIQUE.
- N = APPEARANCE NOT RECORDED.
- X = CRACK PROPAGATED OUT OF PLANE.

TYPE OF SPECIMEN AND STRESS INTENSITY FORMULA.
- 1 = COMPACT TENSION. KQ = PQ*SQRT(A)/(B*W)*(29.6 - 185.5*(A/W) + 655.7*(A/W)**2 - 1017.0*(A/W)**3 + 638.9*(A/W)**4)
- 2 = NOTCH BEND. KQ = PQ*SQRT(A)/(B*W) * 5/W * (2.9 - 4.6*(A/W) + 21.8*(A/W)**2 - 37.6*(A/W)**3 + 38.7*(A/W)**4)

KF IS MAXIMUM STRESS-INTENSITY FOR LAST STEP OF FATIGUE CRACKING.
CYCLES INDICATES TOTAL CYCLES TO INITIATE AND PROPAGATE THE FATIGUE CRACK.
KQ IS CANDIDATE VALUE OF PLANE-STRAIN FRACTURE TOUGHNESS, KIC.
G IS STRAIN-ENERGY RELEASE RATE. G = KQ**2 / E

VALID - ALL ZEROS INDICATES A VALID TEST. TESTS MAY BE INVALID FOR THE FOLLOWING REASONS.

1 = SPECIMEN NOT THICK ENOUGH. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN B)
2 = FATIGUE CRACK TOO SHORT. (R = 2.5*(KQ/SYLD)**2 IS LESS THAN AO)
3 = EXCESSIVE YIELDING BEFORE CRACK EXTENSION. TEST FAILED 80 PER CENT OFFSET CRITERION. (SAME AS REMARK 3.)
4 = FATIGUE CRACK INCLINED 10 OR MORE DEGREES TO THE CENTER PLANE OF THE MACHINED NOTCH. (SAME AS REMARK 5.)
5 = CRACK LENGTH / WIDTH (AO/W) NOT BETWEEN 0.45 AND 0.55.
6 = FATIGUE CRACK NOT EXTENDED FAR ENOUGH FROM THE MACHINED NOTCH. (SAME AS REMARK 7.)
7 = FATIGUE CRACK FRONT DEVIATED FROM STRAIGHTNESS BY MORE THAN THE ALLOWED AMOUNT.
8 = KF GREATER THAN 0.5*KQ FOR LAST STEP OF FATIGUE CRACKING.

Contrails

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Contrails

APPENDIX II

RESULTS OF AXIAL-STRESS FATIGUE TESTS

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RESULTS OF AXIAL-STRESS FATIGUE TESTS

LOAD OR STRESS CYCLING

X7080-T7E41 PLATE .500 IN. THICK

C LOCATION. L DIRECTION. KT = 1.

ARL SAMPLE NUMBER 343260

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	13	.2485	14	50268	67000.	7.7000	4	1
	1	.2490	22	42568	60000.	1.3640	5	1
	20	.2485	20	52868	57000.	2.4770	5	1
	11	.2488	20	50168	56000.	4.2480	5	1
	19	.2490	20	52268	55000.	5.6696	6	1
	4	.2491	22	42568	54000.	9.2239	6	1
	16	.2483	22	50668	52000.	1.0202	7	0
	18	.2487	22	21468	48000.	8.4387	6	1
	58	.2480	22	21968	46000.	1.0237	7	1
.0	14	.2487	14	50268	67000.	7.6000	3	1
	2	.2491	14	42568	60000.	2.7700	4	1
	3	.2496	14	42568	50000.	7.5500	4	1
	12	.2476	14	50168	44000.	4.8630	5	1
	9	.2489	18	43068	40000.	3.2667	6	1
	17	.2485	20	51768	37000.	5.2564	6	1
	21	.2488	20	52968	36000.	5.8420	6	1
	19	.2494	18	52068	35000.	1.0189	7	0
	28	.2489	20	22168	32000.	1.8635	7	81
	28	.2489	17	22168	30000.	1.1996	7	0
-1.0	8	.2486	14	43068	60000.	3.0000	2	1
	15	.2493	14	50268	55000.	1.8000	3	1
	7	.2493	14	42668	50000.	8.5000	3	1
	5	.2492	14	42568	40000.	4.1400	4	1
	23	.2489	20	60568	34000.	5.6000	4	1
	6	.2489	14	42568	30000.	1.4610	5	1
	10	.2489	14	43068	25000.	5.5540	5	1
	24	.2489	22	60568	22000.	7.1079	6	1
	38	.2490	13	21468	20500.	1.3051	6	1
	22	.2488	18	52968	18000.	1.5242	7	0
	48	.2489	13	22068	18000.	7.2380	6	91
	48	.2489	13	21568	16000.	1.2191	7	0

REMARKS
- 0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
- 1 = NORMAL TEST. SPECIMEN FAILED.
- 81 = NORMA TEST. SPECIMEN FAILED. SPECIMEN TESTED PREVIOUSLY AT 30000 PSI FOR 11.996.000 CYCLES.
- 91 = NORMAL TEST. SPECIMEN FAILED. SPECIMEN TESTED PREVIOUSLY AT 16000 PSI FOR 12.191.000 CYCLES.

RESULTS OF AXIAL-STRESS FATIGUE TESTS

LOAD OR STRESS CYCLING

7178-T651 PLATE .500 IN. THICK

C LOCATION. L DIRECTION. KT = 1.

ARL SAMPLE NUMBER 340457

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	22	.2495	13	60568	87000.	2.3700	4	1
	17	.2495	14	50268	85000.	3.5900	4	1
	11	.2495	14	42968	80000.	5.5300	4	1
	31	.3004	14	111467	70000.	2.1730	5	1
	25	.2497	13	60668	65000.	1.2460	5	1
	21	.2498	20	52068	60000.	1.4472	6	1
	32	.3000	14	111467	60000.	4.8310	5	1
	13	.2502	20	50268	57000.	3.2417	6	1
	1	.2485	20	42668	56000.	4.9229	6	1
	18	.2489	20	51068	54000.	7.7730	6	1
	34	.3001	22	112067	54000.	8.9020	6	4
	35	.3003	22	112867	54000.	7.5710	5	1
	33	.3003	14	111467	52000.	1.2270	7	0
.0	23	.2490	13	60568	87000.	4.7000	3	1
	2	.2488	14	42968	80000.	1.2900	4	1
	3	.2493	14	42968	70000.	2.5900	4	1
	6	.2486	14	42968	60000.	4.7500	4	1
	37	.3006	22	111367	50000.	1.0940	5	1
	4	.2495	20	42968	44000.	3.0260	5	1
	12	.2494	20	50168	41000.	3.6780	5	1
	36	.3005	22	111367	40000.	2.1202	6	1
	26	.2495	13	60668	38000.	9.5300	5	1
	8	.2497	20	42968	36000.	3.6516	6	1
	39	.3004	22	111467	34000.	7.7346	6	1
	14	.2492	18	50268	32000.	8.8132	6	1
	19	.2490	18	50668	31000.	9.3471	6	1
	40	.3011	14	112767	31000.	9.4097	6	4
	20	.2498	18	51368	30000.	1.1153	7	1
	27	.2493	19	60768	29000.	1.3715	7	0
-1.0	24	.2502	13	60568	76000.	1.2000	3	1
	16	.2495	14	50268	70000.	3.2000	3	1
	10	.2495	14	42968	60000.	1.0800	4	1
	7	.2488	14	42968	50000.	2.5300	4	1
	41	.3005	14	111467	40000.	1.3140	5	1
	5	.2499	18	42968	34000.	2.2010	5	1
	9	.2488	18	42968	31000.	1.3660	5	1
	42	.3004	14	112067	30000.	1.8579	6	1
	28	.2499	22	61168	27000.	1.2179	6	1
	43	.3006	14	112167	25000.	2.4509	6	1
	15	.2490	22	50268	23000.	5.6411	6	1
	44	.3003	14	112267	21000.	1.2260	7	0

REMARKS
- 0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
- 1 = NORMAL TEST. SPECIMEN FAILED.
- 4 = SPECIMEN FAILED AT SPLIT RING OR IN FILLET.

Contrails

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E41 PLATE 1.375 IN. THICK
C LOCATION. L DIRECTION. KT = 1.
ARL SAMPLE NUMBER 343259

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	18	.2986	19	12468	68000.	4.8300	4	1
	19	.2986	20	12568	64000.	7.1500	4	1
	3	.2987	18	101867	60000.	1.7760	5	1
	12	.2990	18	112167	54000.	5.9590	5	1
	16	.2994	22	121867	53000.	2.1200	5	1
	13	.2990	18	112267	52000.	9.6611	6	1
	5	.2988	18	102067	50000.	9.7536	6	1
	25	.2985	14	31168	50000.	8.5910	6	1
.0	23	.2988	18	30168	69900.	.5000	0	1
	20	.3000	20	12568	68000.	4.9000	3	1
	21	.2985	20	12568	64000.	9.9000	3	1
	1	.2987	18	101867	60000.	1.8500	4	1
	2	.2992	18	101867	50000.	5.5600	4	1
	24	.2984	18	30168	45000.	1.4650	5	1
	4	.2993	18	101967	40000.	2.3180	5	1
	11	.2992	22	110667	37000.	3.9010	5	1
	30	.2987	14	32268	35000.	3.9390	6	1
	6	.2988	22	102567	34000.	8.7680	6	1
	28	.2997	19	31868	32000.	8.7192	6	1
	9	.2991	16	111367	32000.	9.8850	6	1
-1.0	29	.2989	14	31868	55000.	3.7000	3	1
	22	.2982	20	12668	50000.	2.2000	3	1
	26	.2986	14	30468	45000.	1.6700	4	1
	7	.2989	18	102567	40000.	3.0900	4	1
	27	.2983	14	31868	35000.	1.1280	5	1
	8	.3000	18	102567	30000.	1.5990	5	1
	17	.2988	22	10368	26000.	3.4990	5	1
	10	.2987	18	102667	24000.	2.9570	5	1
	15	.2986	22	121167	22000.	3.6081	6	1
	14	.2989	22	112967	20000.	1.1542	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E41 PLATE 1.375 IN. THICK
C LOCATION. LT DIRECTION. KT = 1.
ARL SAMPLE NUMBER 343259

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	20	.2987	20	12668	68000.	3.7600	4	1
	19	.2996	20	12668	64000.	6.8900	4	1
	3	.2990	18	101967	60000.	9.3400	4	1
	16	.2986	18	10368	54000.	2.4700	5	1
	18	.2986	20	12268	52000.	5.0630	5	1
	6	.2998	20	102667	50000.	4.3560	5	1
	30	.2989	13	32568	48000.	7.4700	5	1
	13	.2994	16	112467	46000.	4.2197	6	1
	9	.2985	18	102767	44000.	1.9196	7	0
.0	22	.2984	20	12668	68000.	5.5000	3	1
	23	.2987	20	12668	64000.	8.6000	3	1
	1	.2997	18	101867	60000.	1.1900	4	1
	2	.2990	18	101867	50000.	4.8200	4	1
	24	.2985	14	30668	45000.	8.3700	4	1
	4	.2991	18	101967	40000.	1.0370	5	1
	10	.2997	22	110667	36000.	9.8350	5	1
	29	.2997	19	32568	35000.	6.4936	6	1
	7	.2985	16	102667	34000.	7.0365	6	1
	15	.2989	15	10368	32000.	9.4437	6	1
	28	.2985	15	31868	32000.	1.1880	7	0
-1.0	26	.2986	13	31868	55000.	2.2000	3	1
	21	.2984	20	12668	50000.	1.3000	3	1
	25	.2985	13	30668	45000.	1.3900	4	1
	5	.2987	18	102567	40000.	1.8400	4	1
	27	.2990	14	31868	35000.	6.5800	4	1
	8	.2987	18	102667	30000.	8.0300	4	1
	17	.2987	22	10368	26000.	4.5100	5	1
	11	.2985	14	111367	24000.	1.0244	6	1
	14	.2990	22	121367	22000.	6.1710	6	1
	12	.2996	13	111767	20000.	1.6177	7	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T651 PLATE 1.375 IN. THICK
C LOCATION. L DIRECTION. KT = 1.
ARL SAMPLE NUMBER 340450

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	36	.2497	13	31568	90000.	2.3900	4	1
	35	.2498	13	31468	86000.	3.8300	4	1
	33	.2492	13	31468	80000.	6.8800	4	1
	28	.3004	13	31568	70000.	6.4900	4	1
	6	.3004	14	100467	70000.	5.9900	4	1
	17	.3010	20	121967	64000.	1.1540	5	1
	4	.3008	18	100367	60000.	1.7990	5	1
	18	.3007	20	121967	58000.	2.1510	5	1
	16	.3010	22	110767	56000.	9.6410	5	1
	10	.3000	18	100967	54000.	1.1431	7	0
	5	.3008	18	100367	50000.	1.2763	7	0
.0	34	.2492	13	31468	86000.	5.6000	3	1
	32	.2493	13	31468	80000.	1.3400	4	1
	23	.3001	18	30168	70000.	1.8500	4	1
	1	.3012	18	100367	60000.	2.0900	4	1
	3	.3006	18	100367	50000.	4.4900	4	1
	19	.3001	22	121967	45000.	2.0530	5	1
	2	.3006	16	100367	40000.	8.0360	5	1
	21	.3010	20	122167	38000.	4.8099	6	1
	11	.3002	16	101267	36000.	4.6401	6	1
	26	.3004	16	122767	34000.	2.5787	6	1
	13	.3005	16	101667	34000.	7.5478	6	1
-1.0	31	.2497	13	31468	80000.	6.0000	2	1
	25	.3010	18	30168	70000.	1.3030	3	1
	24	.3003	18	30168	60000.	6.0000	3	1
	9	.2996	14	100567	50000.	2.2900	4	1
	6	.3014	14	100467	40000.	5.9800	4	1
	12	.2993	14	101667	34000.	1.3740	5	1
	20	.3003	22	122067	32000.	1.5340	5	1
	27	.3007	19	122867	30000.	1.7300	5	1
	8	.3009	14	100467	30000.	6.2660	5	1
	22	.3006	22	122067	28000.	3.4490	5	1
	14	.3008	13	102767	26000.	3.2894	6	1
	15	.2998	13	110667	24000.	7.9614	6	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T651 PLATE 1.375 IN. THICK
C LOCATION. LT DIRECTION. KT = 1.
ARL SAMPLE NUMBER 340450

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	35	.2494	13	31568	86000.	1.2700	4	1
	33	.2497	13	31468	80000.	3.3600	4	1
	5	.3009	14	100467	70000.	6.6300	4	1
	36	.2505	13	31568	70000.	1.2890	5	1
	25	.3010	20	122667	64000.	1.4420	5	1
	3	.3009	14	100367	60000.	2.9390	5	1
	20	.3007	20	122067	58000.	2.4430	5	1
	27	.3002	20	122267	56000.	4.5720	5	1
	14	.3006	17	102467	54000.	1.1178	6	1
	18	.3006	20	110767	52000.	1.3193	7	0
	15	.2998	20	102767	50000.	2.3397	7	0
	26	.3010	22	122067	45000.	1.1740	7	0
.0	34	.2496	13	31469	86000.	4.5000	3	1
	32	.2499	13	31468	80000.	7.2000	3	1
	23	.3011	18	30168	70000.	1.2200	4	1
	1	.3007	18	100367	60000.	2.3200	4	1
	2	.3000	18	100367	50000.	3.0600	4	1
	21	.3007	22	122067	45000.	2.1650	5	1
	28	.3009	20	122767	40000.	1.6374	7	1
	4	.3004	16	100467	40000.	1.9350	5	1
	22	.2992	13	122167	38000.	3.5256	6	1
	13	.3005	16	110267	37000.	1.0994	7	0
	11	.3010	14	101767	36000.	8.1483	6	4
	7	.3007	16	100467	34000.	7.7473	6	1
-1.0	31	.2497	13	31468	80000.	5.0000	2	1
	25	.3012	13	31468	70000.	3.6000	3	1
	24	.3008	18	30168	60000.	5.3000	3	1
	8	.3005	14	100567	50000.	1.7100	4	1
	6	.3010	14	100467	40000.	5.9800	4	1
	10	.2999	14	101667	34000.	2.3490	5	1
	12	.2997	14	102467	32000.	3.0520	5	1
	29	.3006	19	122867	30000.	5.7800	5	1
	9	.3007	14	101267	30000.	5.3735	6	1
	16	.3003	13	103067	28000.	3.2060	6	1
	30	.3006	18	122967	26000.	1.1112	7	0
	17	.3005	13	110267	25000.	4.0069	6	1
	19	.3005	13	111167	22000.	1.1065	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
4 = SPECIMEN FAILED AT SPLIT RING OR IN FILLET.

Approved for Public Release
Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E41 PLATE 1.375 IN. THICK
C LOCATION. L DIRECTION. KT = 3.
APL SAMPLE NUMBER 343259

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	21	.2546	13	12368	50000.	2.1100	4	1
	20	.2536	13	12368	40000.	5.7800	4	1
	30	.2543	18	31868	35000.	6.0500	4	1
	3	.2551	21	110267	30000.	9.1300	4	1
	4	.2558	17	110867	25000.	2.2200	5	1
	17	.2545	13	121867	23000.	5.3890	5	1
	27	.2751	14	20268	22500.	9.2400	5	1
	9	.2537	13	120567	22000.	1.1476	7	0
	8	.2534	13	113067	21000.	1.2088	7	0
.0	10	.2532	14	120667	46000.	3.9000	3	1
	23	.2551	13	12468	40000.	5.2000	3	1
	28	.2532	14	30668	35000.	1.0400	4	1
	22	.2540	13	12468	30000.	1.4000	4	1
	7	.2552	17	110867	25000.	2.3000	4	1
	1	.2541	21	103067	20000.	6.4400	4	1
	29	.2570	14	31868	17000.	2.5800	5	1
	2	.2554	21	103067	15000.	1.6360	5	1
	18	.2525	17	11868	14000.	1.7540	6	1
	11	.2540	14	120667	13000.	3.2404	6	1
	15	.2538	14	121367	11500.	1.0031	7	0
-1.0	24	.2529	13	12468	30000.	4.3000	3	1
	5	.2541	17	110867	20000.	1.0100	4	1
	6	.2534	17	110867	15000.	3.4500	4	1
	12	.2547	21	121267	12000.	1.4010	5	1
	13	.2544	21	121267	10000.	1.3230	5	1
	19	.2535	17	12268	9000.	4.2910	5	1
	14	.2532	17	121367	8000.	3.1467	6	1
	25	.2549	17	12468	7000.	1.1697	7	0
	16	.2528	21	122667	7000.	2.5438	6	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E41 PLATE 1.375 IN. THICK
C LOCATION. LT DIRECTION. KT = 3.
APL SAMPLE NUMBER 343259

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	26	.2539	19	31168	67600.	3.0000	3	1
	18	.2530	13	12468	50000.	1.8600	4	1
	17	.2539	13	12368	40000.	6.7700	4	1
	27	.2541	18	31968	35000.	6.4600	4	1
	3	.2529	21	110267	30000.	8.4300	4	1
	8	.2529	17	110967	25000.	2.6930	5	1
	14	.2535	13	121867	23000.	7.1830	5	1
	24	.2538	14	20568	22500.	6.6410	5	1
	10	.2543	13	121167	22000.	1.0485	7	0
.0	28	.2542	14	31968	50000.	2.5000	3	1
	19	.2537	13	12468	40000.	4.6000	3	1
	25	.2547	14	30668	35000.	2.9000	3	1
	20	.2538	13	12468	30000.	2.9900	4	1
	7	.2530	17	110967	25000.	3.9500	4	1
	1	.2544	21	103067	20000.	1.3950	5	1
	22	.2538	18	32068	17000.	2.2420	5	1
	2	.2542	21	110367	15000.	1.4790	5	1
	30	.2526	18	32168	15000.	4.0670	5	1
	15	.2538	13	122667	14000.	1.3377	6	1
	9	.2540	14	120967	13000.	1.2606	7	0
-1.0	6	.2544	14	32068	50000.	6.0000	2	1
	21	.2534	13	12468	30000.	3.8000	3	1
	4	.2549	17	110967	20000.	1.2500	4	1
	5	.2543	17	110967	15000.	4.5800	4	1
	11	.2539	21	121267	12000.	1.1920	5	1
	12	.2544	21	121267	10000.	6.7620	5	1
	16	.2535	14	11968	9000.	7.9260	5	1
	13	.2554	21	121367	8000.	1.0313	7	0
	29	.2541	14	31868	4000.	1.3000	3	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS

LOAD OR STRESS CYCLING
7178-T651 PLATE 1.375 IN. THICK
C LOCATION. L DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340450

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	14	.2517	14	101667	35000.	5.5100	4	1
	6	.2516	14	100567	30000.	1.2830	5	1
	11	.2517	17	101067	27000.	1.5850	5	1
	7	.2516	14	100567	25000.	1.1928	7	0
	23	.2523	13	122067	25000.	4.0510	5	1
	29	.2515	21	122867	24000.	1.0174	7	0
	18	.2515	21	103167	23000.	3.2160	5	1
	12	.2521	17	10368	23000.	3.9821	6	1
	22	.2515	17	122067	22000.	1.5648	7	0
	21	.2524	14	120167	21000.	1.0361	7	0
	5	.2520	17	100267	20000.	1.5496	7	0
.0	26	.2525	17	11768	35000.	6.8000	3	1
	13	.2517	21	101067	25000.	2.6200	4	1
	24	.2522	14	122067	22000.	1.2070	5	1
	1	.2518	21	92267	20000.	1.5210	5	1
	28	.2519	17	122867	19000.	2.6370	5	1
	25	.2521	14	122067	19000.	4.5300	5	1
	30	.2520	17	122867	18000.	1.2954	7	0
	17	.2513	21	103167	18000.	1.4230	5	1
	2	.2517	21	92267	16000.	3.3040	5	1
	3	.2524	21	92267	14000.	6.3530	5	1
	20	.2502	17	112067	13000.	1.2799	7	0
	4	.2518	21	92567	12000.	1.5378	7	0
-1.0	8	.2510	21	100967	20000.	8.2000	3	1
	9	.2515	21	100967	15000.	4.5500	4	1
	16	.2519	14	10468	13000.	4.4580	5	1
	15	.2512	21	101867	12000.	1.2993	6	1
	27	.2524	21	122167	11000.	2.0310	5	1
	10	.2517	21	101667	10000.	3.9494	6	1
	19	.2528	17	111067	8500.	1.5783	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS

LOAD OR STRESS CYCLING
7178-T651 PLATE 1.375 IN. THICK
C LOCATION. LT DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340450

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	28	.2519	22	20168	45000.	1.3900	4	1
	9	.2520	14	101667	35000.	5.4400	4	1
	3	.2524	14	100567	30000.	8.9500	4	1
	6	.2526	17	100967	27000.	2.8290	5	1
	12	.2515	20	102567	25000.	4.4740	5	1
	24	.2523	14	10568	24000.	5.5153	6	1
	25	.2525	13	10868	23000.	2.5391	7	0
	13	.2520	20	102567	23000.	2.8720	5	1
	14	.2518	21	102767	22000.	5.9100	5	1
	17	.2520	13	112467	21000.	1.4676	7	0
	15	.2526	17	103067	20000.	1.5634	7	0
.0	26	.2527	14	11768	45000.	4.0000	3	1
	27	.2524	14	11768	33000.	1.1600	4	1
	7	.2521	25	100967	25000.	2.2400	4	1
	18	.2517	14	122067	22000.	8.8600	4	1
	1	.2520	21	100267	[illegible]0000.	1.7330	5	1
	16	.2517	21	103167	19000.	1.4800	5	1
	20	.2526	21	10468	19000.	1.6230	5	1
	8	.2520	21	101067	18000.	1.2776	7	0
	22	.2525	21	10468	18000.	3.1954	6	1
	2	.2519	21	100267	16000.	1.5234	7	0
-1.0	30	.2522	14	20268	35000.	3.0000	3	1
	4	.2519	21	100967	20000.	8.8000	3	1
	5	.2521	21	100967	15000.	7.8800	4	1
	21	.2527	14	10468	14000.	3.2560	5	1
	23	.2519	14	10568	13000.	1.7530	5	1
	10	.2518	21	101967	12000.	3.0360	5	1
	19	.2507	21	122167	11000.	1.3522	6	1
	11	.2509	21	101967	10000.	8.4943	6	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release
Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E41 PLATE 1.375 IN. THICK
C LOCATION. L DIRECTION. KT = 12.
ARL SAMPLE NUMBER 343259

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	22	.3004	19	31168	35000.	1.6400	4	1
	3	.3031	14	120567	25000.	6.4100	4	1
	4	.3010	14	120567	20000.	3.3330	5	1
	13	.2988	14	11768	17500.	3.5560	5	1
	7	.2995	13	121567	15000.	8.2390	5	1
	20	.3001	17	30468	14000.	4.6840	5	1
	14	.3010	14	12268	13000.	1.0558	7	0
	19	.3009	17	30168	12000.	9.3320	5	1
	29	.2996	21	32768	11000.	1.2255	6	1
	30	.3006	21	40568	10000.	3.3060	6	1
.0	24	.3023	19	31168	30000.	4.1000	3	1
	23	.2999	19	31168	25000.	7.1000	3	1
	1	.2998	17	110967	20000.	1.7700	4	1
	2	.3010	17	110967	15000.	7.8500	4	1
	9	.2998	17	121867	13000.	2.6648	6	1
	10	.3007	14	122167	12000.	2.2670	5	1
	16	.3000	21	12568	11000.	1.9024	6	1
	15	.2995	17	12368	10000.	2.9420	5	1
	17	.2999	21	12668	10000.	5.8280	5	1
	21	.3003	17	30668	9000.	4.2390	5	1
	27	.3014	21	32168	8500.	3.2835	6	1
	28	.3017	17	32668	8000.	1.8197	6	1
	25	.3005	17	32768	7500.	1.1087	7	0
-1.0	26	.3006	17	31268	20000.	9.6000	3	1
	5	.3030	21	121267	15000.	2.0800	4	1
	8	.3007	17	121867	12000.	8.8600	4	1
	6	.3004	17	121567	10000.	2.4950	5	1
	11	.3009	17	11268	8000.	1.4289	6	1
	12	.3011	21	11868	6500.	1.2387	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E41 PLATE 1.375 IN. THICK
C LOCATION. LT DIRECTION. KT = 12.
ARL SAMPLE NUMBER 343259

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	27	.2996	13	40968	45000.	1.9100	4	1
	18	.2987	19	31168	35000.	1.7800	4	1
	5	.3001	13	12368	25000.	1.2440	5	1
	3	.3003	21	121167	20000.	1.2700	5	1
	12	.2999	14	20268	17500.	2.1270	5	1
	8	.3004	14	122167	15000.	2.3177	6	1
	16	.2988	17	30668	14000.	8.3380	5	1
	9	.3001	14	122267	13000.	1.4528	6	1
	17	.2994	17	30868	12000.	1.1603	6	1
	25	.2999	21	32868	11000.	1.5771	6	1
	26	.3009	21	32968	10000.	1.1063	7	0
.0	28	.2995	13	40968	40000.	3.0000	3	1
	20	.3003	19	31168	30000.	4.8000	3	1
	19	.3002	19	31168	25000.	7.4000	3	1
	1	.3003	17	110967	20000.	2.6600	4	1
	2	.3000	21	121167	15000.	6.7800	4	1
	30	.3009	13	41168	13000.	1.3930	5	1
	11	.3002	17	12368	12000.	2.0620	5	1
	22	.2986	17	31268	11000.	3.6220	5	1
	15	.2997	17	20568	10000.	6.2450	5	1
	24	.3000	21	32668	9000.	1.3446	6	1
	23	.3005	17	32168	8500.	1.0897	7	0
-1.0	29	.3002	13	41068	30000.	3.7000	3	1
	13	.2988	21	40368	20000.	1.2800	4	1
	4	.3000	21	121267	15000.	2.4700	4	1
	7	.2999	17	121867	12000.	1.0390	5	1
	6	.3008	17	121567	10000.	3.4610	5	1
	10	.2992	21	11768	8000.	1.5490	6	1
	21	.2999	17	31268	6500.	1.0022	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T651 PLATE 1.375 IN. THICK
C LOCATION. L DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340450

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	N X10	REMARKS
.5	27	.2979	14	11768	50000.	4.5000	3	1
	26	.2986	14	11768	40000.	1.3200	4	1
	3	.2974	14	101067	30000.	3.1900	4	1
	4	.2992	14	101067	25000.	7.2100	4	1
	5	.2983	14	101067	20000.	2.5510	5	1
	8	.2991	17	101367	18000.	4.0350	5	1
	18	.2972	21	121167	17000.	2.1740	5	1
	21	.2974	14	10368	17000.	1.1916	6	1
	14	.2986	21	112067	16000.	1.0258	7	0
.0	30	.2993	00	11668	102000.	.5000	0	1
	1	.2990	21	100967	20000.	1.3800	4	1
	29	.2973	22	20168	19000.	3.6700	4	1
	19	.2978	13	122067	18000.	2.7110	5	1
	6	.2971	17	101367	17000.	9.1100	4	1
	24	.2984	17	11068	16000.	3.7460	5	1
	2	.2975	21	100967	15000.	4.3460	5	1
	28	.3001	22	20168	14000.	9.3290	5	1
	10	.2975	17	102567	13000.	1.0473	6	1
	11	.2974	17	102767	11000.	3.7043	6	1
	12	.2975	21	110367	10000.	1.1484	7	0
-1.0	7	.2979	17	101367	15000.	4.7900	4	1
	22	.2973	17	11068	14000.	2.1770	5	1
	25	.2969	21	11768	14000.	1.6330	5	1
	13	.2975	21	111767	13000.	2.6940	5	1
	9	.2979	17	102067	12000.	6.8630	5	1
	23	.2989	14	11068	11000.	8.0360	5	1
	15	.2971	21	120467	10000.	5.9760	5	1
	16	.2980	21	120567	9000.	8.4840	5	1
	20	.2996	13	122967	8500.	7.5267	6	1
	17	.2993	21	120667	7500.	7.2954	6	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T651 PLATE 1.375 IN. THICK
C LOCATION. LT DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340450

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	N X10	REMARKS
.5	25	.2984	14	11768	50000.	3.8000	3	1
	24	.2987	14	11768	40000.	8.9000	3	1
	3	.2984	14	101067	30000.	3.3600	4	1
	4	.2977	14	101067	25000.	5.6300	4	1
	5	.2971	17	101367	20000.	1.5310	5	1
	8	.2975	17	101967	18000.	2.6910	5	1
	15	.2991	17	121267	17000.	8.0960	5	1
	21	.2994	14	11167	17000.	3.4220	5	1
	12	.2990	21	112967	16000.	1.1420	7	0
.0	30	.2974	00	11668	89700.	.5000	0	1
	27	.2975	14	11768	40000.	2.7000	3	1
	26	.2976	14	11768	30000.	8.0000	3	1
	1	.2977	21	100967	20000.	6.3300	4	1
	19	.2994	14	11168	19000.	4.8940	5	1
	16	.2979	13	121967	18000.	9.5020	5	1
	7	.2970	17	101667	17000.	4.9889	6	1
	18	.2981	17	10868	16000.	5.2760	5	1
	2	.2988	17	100967	15000.	5.5496	6	1
	20	.2982	17	11168	14000.	2.6355	6	1
	14	.2993	17	120667	13000.	1.1487	7	0
-1.0	29	.2987	14	11768	30000.	4.6000	3	1
	28	.2994	14	11768	20000.	2.2900	4	1
	6	.2980	17	101367	15000.	7.3100	4	1
	22	.2989	21	11268	14000.	1.9139	6	1
	17	.2986	21	122267	13000.	1.7968	6	1
	9	.2974	21	111667	12000.	1.7234	6	1
	23	.2976	14	11268	11000.	4.9380	5	1
	10	.2994	21	111767	10000.	1.4697	6	1
	11	.2978	17	112867	8500.	4.2095	6	1
	13	.2978	17	113067	7500.	1.3280	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED SHAPE .688 IN. THICK
M LOCATION, L DIRECTION, KT = 1.
APL SAMPLE NUMBER 340637

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	34	.2497	13	40868	90000.	3.7000	4	1
	32	.2504	18	31968	88000.	3.2100	4	1
	31	.2497	18	31868	80000.	4.8000	4	1
	8	.3004	18	121367	70000.	2.3210	5	1
	15	.3014	18	10468	66000.	3.8660	5	1
	4	.2993	22	120867	64000.	2.7760	5	1
	26	.2990	18	20668	63000.	4.0990	5	1
	9	.3015	20	121867	62000.	1.8814	6	1
	1	.3014	22	120467	60000.	6.3855	6	1
	16	.3007	18	10568	58000.	1.3932	7	1
	7	.3015	15	121367	56000.	8.5130	6	1
	11	.3015	15	122167	54000.	1.0158	7	0
.0	35	.2501	19	40968	88000.	4.8000	3	1
	33	.2498	14	31968	80000.	1.6000	4	1
	29	.3007	13	40868	70000.	2.5600	4	1
	3	.3004	20	120567	60000.	2.9400	4	1
	2	.3013	20	120567	50000.	2.0170	5	1
	5	.3015	20	121267	44000.	3.9590	5	1
	17	.3008	22	10868	42000.	7.5740	5	1
	12	.3000	14	122267	41000.	7.6470	5	1
	6	.3000	20	121267	40000.	1.1888	7	1
	22	.3016	19	12568	37000.	8.0366	6	1
	13	.3007	14	122667	37000.	4.9192	6	83
	24	.2999	14	13068	35000.	1.7124	6	1
	27	.3002	18	32168	34000.	1.0376	7	1
	25	.3014	16	20268	32000.	7.9160	5	1
-1.0	36	.2500	13	40968	70000.	3.3000	3	1
	30	.3015	13	40968	60000.	1.1400	4	1
	18	.3007	22	10868	50000.	3.0300	4	1
	10	.3005	22	121867	40000.	9.6600	4	1
	14	.3015	20	122667	34000.	4.2010	5	1
	19	.3002	20	11868	30000.	9.9010	5	1
	20	.3002	20	12068	28000.	7.0140	5	1
	21	.3011	22	12268	26000.	2.2752	6	1
	23	.3008	16	12968	24000.	6.3480	5	1
	28	.3015	13	32668	22000.	1.4516	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
83 = APPROXIMATE FATIGUE LIFE. COUNTER FAILED.
SPECIMEN FAILED MORE THAN 1/8-IN. OFF CENTER.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED SHAPE .688 IN. THICK
M LOCATION, L DIRECTION, KT = 1.
APL SAMPLE NUMBER 340639

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	31	.2497	18	31968	74000.	4.5400	4	1
	2	.2999	18	121467	70000.	6.9000	4	1
	6	.2999	20	121967	64000.	1.1460	5	1
	10	.2997	18	10568	62000.	1.8780	5	1
	5	.3006	22	121967	60000.	9.2160	5	1
	35	.2493	14	42568	60000.	1.8460	5	1
	12	.2999	15	11868	58000.	5.5200	5	1
	34	.2495	14	42468	57000.	3.6250	5	1
	16	.3010	18	13068	57000.	4.1540	5	1
	15	.2993	18	12068	56000.	1.0184	7	1
	33	.2495	18	42368	56000.	1.2520	7	0
.0	32	.2490	14	32668	74000.	8.0000	3	1
	26	.3005	14	31968	70000.	1.2200	4	1
	1	.3003	20	120567	60000.	3.0600	4	1
	3	.2995	20	120567	50000.	1.0060	5	1
	9	.2990	22	10468	46000.	2.5150	5	1
	19	.3001	18	20668	42000.	3.5330	5	1
	14	.3001	15	12068	40000.	8.7182	6	1
	17	.3004	15	13168	38000.	7.1130	5	1
	18	.3000	15	20168	35000.	2.1662	6	1
	27	.2996	20	32768	34000.	1.1280	7	0
	22	.2997	15	20768	32000.	1.1279	7	0
-1.0	29	.3008	13	40968	70000.	1.0000	2	1
	25	.3001	14	31968	60000.	3.8000	3	1
	11	.3003	20	40268	50000.	1.0500	4	1
	4	.3000	18	121467	40000.	7.6900	4	1
	7	.2995	22	122767	34000.	2.6290	5	1
	13	.3012	19	11968	30000.	4.4220	5	1
	20	.2997	22	20668	29000.	4.1870	5	1
	8	.3008	22	122767	28000.	1.0759	7	1
	30	.2997	19	41168	28000.	1.3725	6	1
	21	.2996	22	20668	26000.	6.7731	6	1
	23	.3008	16	21468	24000.	4.7981	6	1
	28	.2990	19	32868	24000.	9.2735	6	1
	24	.3004	15	22068	22000.	3.0450	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORM. TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED SHAPE .688 IN. THICK
M LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340730

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	5	.3001	22	42568	70000.	7.0600	4	1
	22	.3012	22	52768	65000.	9.7100	4	1
	1	.2999	22	42468	60000.	2.2010	5	1
	30	.2496	18	61068	59000.	1.1010	7	0
	21	.3010	22	52268	58000.	8.2022	6	1
	28	.2497	13	60768	57000.	2.7450	5	1
	19	.2998	19	51368	56000.	1.4656	7	1
	8	.2996	19	50368	54000.	1.6437	7	0
.0	10	.3017	14	50368	70000.	8.0000	3	1
	3	.3014	22	42568	60000.	1.9200	4	1
	2	.3010	19	42468	50000.	8.8000	4	1
	26	.2494	13	60568	47000.	1.1470	5	1
	9	.3006	14	50268	44000.	1.4155	6	1
	27	.2498	13	60568	44000.	1.3220	5	1
	15	.3000	14	50868	42000.	2.9370	5	1
	31	.2495	20	61068	40000.	1.2160	5	1
	4	.2989	19	42568	40000.	1.2526	7	4
	17	.3011	15	51368	38000.	3.5609	6	1
	23	.3012	20	60568	37000.	1.1154	7	0
	20	.3014	15	51768	36000.	1.0747	7	1
-1.0	11	.3004	14	50368	60000.	6.0000	2	1
	25	.2496	13	60568	58000.	2.7000	3	1
	12	.3004	14	50368	55000.	6.5000	3	1
	6	.2995	14	42568	50000.	1.2100	4	1
	7	.2999	14	42568	40000.	6.1800	4	1
	13	.3007	14	50368	30000.	3.9590	5	1
	32	.2497	22	61368	28000.	1.8630	5	1
	18	.3018	20	51368	27000.	6.7802	6	1
	24	.3013	13	61068	26000.	1.0169	7	1
	14	.3008	14	50368	24000.	3.7751	6	1
	29	.2501	13	60768	23000.	6.3188	6	1
	16	.3003	16	51368	22000.	1.0111	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
4 = SPECIMEN FAILED AT SPLIT RING OR IN FILLET.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED SHAPE .688 IN. THICK
M LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340616

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	35	.2495	13	40569	94000.	1.7200	4	1
	32	.2500	18	31869	90000.	2.8800	4	1
	31	.2503	18	31868	80000.	9.1300	4	1
	13	.2995	18	121367	70000.	8.1700	4	1
	1	.2993	20	112467	60000.	2.1019	5	1
	15	.3015	22	10268	56000.	2.3749	5	1
	4	.2996	20	112767	54000.	1.1286	6	1
	7	.2999	16	120467	50000.	2.5490	6	1
	17	.3002	15	10469	49000.	1.4900	7	0
	10	.2999	16	120767	47000.	1.5608	7	0
.0	36	.2500	13	40569	90000.	7.0000	3	1
	34	.2500	19	31969	80000.	1.4600	4	1
	33	.2495	18	31869	70000.	2.0700	4	1
	11	.3014	20	121167	60000.	2.9200	4	1
	2	.3009	20	112767	50000.	1.0230	5	1
	16	.3017	22	10468	46000.	2.3240	5	1
	6	.3007	20	120467	44000.	1.8960	5	1
	12	.3005	20	121167	42000.	6.4660	5	1
	19	.3009	22	10568	40000.	5.7800	5	1
	5	.3007	20	112867	40000.	8.7224	6	4
	27	.3000	14	30868	39000.	4.6800	5	1
	9	.3013	20	120667	38000.	1.1257	7	0
-1.0	30	.3001	13	40868	70000.	5.9000	3	1
	14	.3008	22	121867	50000.	1.9800	4	1
	3	.3013	20	112767	40000.	9.9600	4	1
	18	.3012	18	10568	35000.	3.9600	5	1
	8	.2995	20	120467	32000.	7.1720	5	1
	21	.2993	22	11168	30000.	4.8770	5	1
	20	.3010	22	11067	30000.	4.7000	5	1
	23	.2995	22	11768	28000.	4.9993	6	1
	22	.3012	22	11168	26000.	6.2763	6	1
	25	.3003	22	20268	24000.	4.9354	6	1
	24	.3014	20	12668	24000.	9.2379	6	4
	26	.2997	16	20668	22000.	2.0624	6	1
	28	.2999	18	32668	22000.	1.3025	7	0
	29	.3000	13	40168	20000.	1.0004	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
4 = SPECIMEN FAILED AT SPLIT RING OR IN FILLET.

Approved for Public Release
Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	32	.2492	3	22668	82000.	4.8600	4	1
	31	.2497	3	22668	77000.	7.7400	4	1
	1	.3011	4	12368	70000.	1.2300	5	1
	3	.3004	4	12368	64000.	1.8190	5	1
	8	.3002	6	12468	61000.	3.2460	5	1
	6	.3004	4	12368	60000.	1.6285	6	1
	12	.3005	3	20268	58000.	3.1170	5	1
	26	.3015	3	71568	58000.	1.3012	7	0
	18	.3014	4	22068	56000.	6.5000	5	1
	19	.3017	3	22168	54000.	4.7164	6	1
	21	.3010	14	22868	52000.	1.9511	7	0
.0	34	.2498	6	22468	82000.	5.2000	3	1
	33	.2493	6	22668	76000.	8.7000	3	1
	14	.3012	2	20768	70000.	1.7300	4	1
	2	.3009	6	12368	60000.	4.8200	4	1
	5	.3006	6	12368	50000.	1.2640	5	1
	9	.3015	4	12468	42000.	3.1370	5	1
	7	.3005	6	12368	40000.	1.6582	6	1
	11	.3004	2	13168	38000.	5.3982	6	1
	17	.3015	2	21968	35000.	7.7283	6	1
	23	.3010	3	22868	33000.	1.3365	7	0
-1.0	25	.3003	14	31968	70000.	3.0000	3	1
	24	.3008	14	31968	60000.	1.0600	4	1
	4	.3012	6	12368	50000.	2.5400	4	1
	10	.3014	6	13068	40000.	1.0000	5	1
	13	.3007	6	20568	32000.	3.0930	5	1
	27	.3003	13	71768	30000.	3.2900	5	1
	15	.3006	2	20968	28000.	5.9560	5	1
	16	.3010	4	21468	24000.	2.0956	6	1
	20	.3005	3	22768	22000.	3.5046	6	1
	22	.3003	4	30168	20000.	1.0842	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 1.
APL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	31	.2496	13	71468	75000.	2.4100	4	1
	1	.3005	2	12968	70000.	3.3800	4	1
	4	.3007	4	13168	60000.	9.0200	4	1
	8	.3006	4	20168	54000.	1.2630	5	1
	22	.3009	6	71568	50000.	3.1120	5	1
	14	.3009	3	22168	50000.	3.8990	5	1
	18	.3006	15	40368	49000.	5.4940	5	1
	9	.3011	4	20268	48000.	2.6850	7	0
.0	32	.2496	13	71668	75000.	8.4000	3	10
	11	.3015	2	20768	70000.	1.0400	4	1
	2	.3005	2	12968	60000.	1.9300	4	1
	26	.3009	14	71768	55000.	2.6900	4	1
	5	.3002	6	13168	50000.	3.6800	4	1
	28	.3004	14	71768	45000.	8.6590	4	1
	6	.3014	4	13168	40000.	9.7900	4	1
	21	.3004	4	71068	38000.	1.7500	5	1
	13	.3007	3	21968	36000.	7.1430	5	1
	15	.3010	2	31568	35000.	1.4716	6	1
	10	.3012	3	20568	34000.	2.1599	7	0
-1.0	17	.3011	14	31968	60000.	6.1000	3	1
	16	.3009	14	31968	50000.	1.6900	4	1
	24	.3015	13	71668	45000.	2.1100	4	1
	3	.3006	6	13168	40000.	4.4900	4	1
	25	.3007	13	71668	35000.	5.3900	4	1
	7	.3012	6	13168	30000.	1.3740	5	1
	19	.3003	2	41568	27000.	6.9740	5	1
	27	.3012	13	71768	26000.	1.1792	7	1
	20	.3002	2	41668	25000.	9.9470	5	1
	12	.3011	16	21968	24000.	3.3392	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 1.
APL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	31	.2499	13	71668	73000.	9.3000	3	1
	10	.3009	2	31968	70000.	1.2800	4	1
	1	.3001	6	20168	60000.	3.0000	4	1
	3	.3003	3	20168	50000.	6.8900	4	1
	24	.3010	3	52768	45000.	1.1900	5	1
	6	.3004	2	20768	40000.	2.9560	5	1
	27	.2999	6	71468	40000.	1.7381	6	1
	25	.3008	6	52768	39000.	1.7334	7	0
	21	.3007	4	40368	38000.	1.2253	7	0
	11	.2999	2	30468	36000.	1.4717	7	0
.0	32	.2497	13	71668	73000.	1.6000	3	1
	16	.3003	14	32068	70000.	4.1000	3	1
	15	.3003	14	32068	60000.	7.3000	3	1
	2	.3005	4	20168	50000.	1.3200	4	1
	29	.3008	14	71768	45000.	3.2400	4	1
	4	.3001	3	20168	40000.	3.6200	4	1
	28	.3004	13	71668	39000.	4.9600	4	1
	8	.3009	2	21968	35000.	2.9340	5	1
	19	.3006	2	40168	33000.	2.4617	6	1
	7	.3005	2	20968	32000.	7.5024	6	1
	13	.2996	13	31568	30000.	1.3759	7	0
-1.0	18	.3006	14	32068	60000.	1.5000	3	1
	17	.3002	14	32068	50000.	7.7000	3	1
	14	.3004	14	31968	40000.	2.9300	4	1
	9	.3006	3	22668	30000.	1.0230	5	1
	20	.3002	4	40268	26000.	5.7100	5	1
	12	.3006	3	31268	24000.	1.4410	6	1
	22	.3007	15	40468	22000.	2.5408	6	1
	26	.3007	15	52868	21000.	1.1121	7	0
	23	.3003	16	41768	20000.	1.1892	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	1	.3000	4	31268	70000.	7.4000	4	1
	3	.2996	13	40868	65000.	1.1240	5	1
	10	.3005	2	31968	60000.	2.4900	5	1
	11	.3003	16	32068	54000.	1.3852	6	1
	12	.2995	16	32268	52000.	5.8360	5	1
	23	.3005	2	71768	52000.	1.1035	7	0
	22	.3001	3	61468	51000.	1.2624	7	0
	16	.3003	2	40868	50000.	1.5950	7	0
	25	.3003	3	72268	50000.	1.2638	7	0
	13	.2993	16	32568	49000.	1.0097	7	1
.0	2	.2999	4	31268	70000.	7.6000	3	1
	32	.2486	2	100168	65000.	1.2000	4	1
	5	.3001	4	31368	60000.	4.3100	4	1
	24	.3007	6	72468	55000.	4.6300	4	1
	8	.3002	4	31468	50000.	1.1110	5	1
	18	.2999	5	40868	44000.	3.4730	5	1
	26	.3007	13	72468	42000.	1.5560	5	1
	19	.2999	4	41768	41000.	3.4050	5	1
	30	.3005	2	80568	40000.	1.1619	7	0
	9	.3005	4	31568	40000.	1.3629	7	0
-1.0	6	.3005	13	31368	60000.	2.4000	3	1
	4	.3007	13	31268	50000.	1.1200	4	1
	27	.3003	6	72468	45000.	2.0100	4	1
	7	.2998	13	31368	40000.	7.2900	4	1
	14	.3007	2	40468	35000.	2.4980	5	1
	21	.3000	3	61468	32000.	5.3450	5	1
	28	.3004	13	72468	30000.	1.1175	6	1
	15	.3005	2	40468	30000.	3.0189	5	1
	29	.3002	2	72968	28000.	1.6090	5	1
	20	.2992	6	61368	28000.	3.9910	5	1
	17	.3000	15	40868	27000.	1.9320	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 1.
APL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	27	.2991	13	72568	67000.	3.4100	4	1
	2	.3001	4	31268	64000.	4.7600	4	1
	30	.3000	13	72668	60000.	9.0400	4	1
	10	.3000	3	41568	56000.	1.3790	5	1
	12	.3003	3	41668	50000.	1.6730	5	1
	26	.3001	6	72568	50000.	3.4200	5	1
	17	.3002	4	61068	49000.	1.8720	5	1
	18	.3001	4	61168	48000.	1.1008	7	1
	15	.2997	13	42668	47000.	1.0086	7	0
	13	.2999	3	41668	44000.	1.6125	7	0
.0	9	.3001	13	41068	67000.	5.5000	3	1
	4	.3001	4	31368	60000.	1.1500	4	1
	24	.2999	13	72568	55000.	2.4200	4	1
	3	.3001	13	31268	50000.	3.8400	4	1
	22	.3002	13	62468	44000.	6.4200	4	1
	5	.3002	4	31368	40000.	3.3790	5	1
	25	.2994	6	72468	39000.	1.4907	6	1
	19	.3000	6	61468	38000.	1.1908	7	0
	8	.3000	14	41368	36000.	1.2008	7	0
-1.0	7	.2990	13	31368	60000.	7.0000	2	1
	28	.3002	13	72568	55000.	8.0000	2	1
	6	.3001	13	31368	50000.	9.6000	3	1
	29	.2998	13	72568	45000.	1.3000	4	1
	1	.3003	13	31268	40000.	5.3800	4	1
	11	.2997	3	41668	34000.	9.2400	4	1
	14	.3005	4	41768	30000.	2.5790	5	1
	20	.2998	2	61968	27000.	4.2670	5	1
	16	.2992	15	50868	26000.	3.7076	6	1
	21	.3000	2	61968	24000.	6.5028	6	1
	23	.3000	16	62868	22000.	1.2243	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 1.
APL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	27	.3007	13	72668	65000.	2.2100	4	1
	1	.3003	4	31368	60000.	4.5000	4	1
	32	.2495	2	100168	55000.	5.3200	4	1
	3	.3006	4	31368	50000.	7.4400	4	1
	18	.3005	13	62468	45000.	3.4800	4	1
	11	.3007	14	42668	42000.	1.9750	5	1
	22	.3004	2	62868	38000.	2.2630	5	1
	25	.2998	15	70968	37000.	1.8283	6	1
	12	.3002	4	61768	36000.	1.5452	7	0
.0	28	.3002	13	72668	65000.	2.6000	3	1
	4	.2998	4	31468	60000.	6.2000	3	1
	6	.3003	4	31468	50000.	1.7000	4	1
	7	.3004	14	32068	40000.	5.1000	4	1
	10	.3007	4	41868	34000.	4.0100	4	1
	8	.3004	2	32168	34000.	5.4100	4	1
	15	.3005	13	62468	32000.	6.4100	4	1
	17	.3010	4	62468	30000.	2.9450	5	1
	21	.2996	2	71168	29000.	1.2220	5	1
	13	.3001	6	62068	28000.	5.6895	6	1
	23	.3003	13	62868	26000.	1.1939	7	0
-1.0	2	.2999	13	31468	50000.	2.3000	3	1
	29.	.2997	13	72668	45000.	7.9000	3	1
	5	.3006	13	31468	40000.	2.2500	4	1
	9	.3005	3	40868	34000.	2.4600	4	1
	16	.3003	13	62568	30000.	6.3400	4	1
	14	.2999	13	62168	28000.	2.9511	6	1
	19	.3000	13	62568	26000.	1.2480	5	1
	30	.2998	2	72668	26000.	4.8300	4	1
	26	.3003	2	71168	21000.	1.1770	5	1
	20	.2999	2	62568	20000.	2.8369	6	1
	31	.2490	4	92468	19000.	1.1603	7	0
	24	.3000	2	62868	18000.	1.0402	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340731Z
340731Y

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	29	.2495	14	90668	70000.	1.0770	5	1
	8	.2995	13	70868	68000.	1.5560	5	1
	6	.3023	13	70368	65000.	1.6170	5	1
	16	.2998	6	71568	62000.	2.7740	5	1
	19	.2998	13	80968	61000.	3.7820	5	1
	1	.2998	6	70968	60000.	9.2156	6	1
	25	.2487	15	82168	59000.	1.7116	6	1
	18	.3004	13	80168	58000.	2.2220	7	1
	22	.2498	15	81668	56000.	3.3073	6	1
	26	.2501	2	82368	54000.	1.1196	7	1
.0	30	.2500	14	90668	70000.	1.0400	4	1
	2	.3005	13	70368	60000.	3.8400	4	1
	21	.2496	2	81468	55000.	4.5800	4	1
	5	.3002	13	70368	50000.	1.1830	5	1
	9	.2989	3	70868	44000.	1.7360	5	1
	20	.2995	2	81268	42000.	3.7294	6	1
	10	.3000	3	70868	41000.	5.3222	6	1
	7	.3014	13	70368	40000.	3.8004	6	6
	28	.2500	6	90468	40000.	2.1662	6	1
	17	.2996	3	80168	38000.	5.8244	6	1
	23	.2499	2	82068	36000.	6.2109	6	1
-1.0	31	.2498	14	90668	60000.	3.0000	3	1
	4	.3000	13	70368	50000.	1.1100	4	1
	32	.2503	14	90668	45000.	2.4600	4	1
	3	.2995	13	70368	40000.	6.6000	4	1
	12	.2995	13	71168	34000.	1.0510	5	1
	13	.2998	13	71168	31000.	1.5570	5	1
	11	.3004	13	70868	30000.	6.7504	6	4
	15	.3001	13	71568	28000.	4.6750	5	1
	24	.2504	16	82168	27000.	2.1459	6	1
	14	.3003	13	71168	26000.	6.0288	6	1
	27	.2509	14	82368	24000.	1.0455	7	3

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
3 = SPECIMEN FAILED MORE THAN 1/8-IN. OFF CENTER.
4 = SPECIMEN FAILED AT SPLIT RING OR IN FILLET.
5 = SPECIMEN FAILED INSIDE GRIP OR HOUSING.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 1.
APL SAMPLE NUMBER 340731Y

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	25	.2504	14	92468	68000.	4.6500	4	1
	10	.3000	13	80868	65000.	5.7700	4	1
	4	.2998	3	70868	60000.	8.6600	4	1
	11	.2999	13	80868	55000.	1.7450	5	1
	7	.2999	4	71768	50000.	3.1950	5	1
	20	.2959	4	90968	48000.	1.1786	6	1
	16	.3007	15	90368	46000.	5.3955	6	1
	12	.3003	2	81468	44000.	8.9216	6	1
	13	.3000	4	82368	42000.	2.4293	7	0
.0	18	.3001	14	90668	67000.	1.0100	4	1
	1	.3009	13	70368	60000.	1.5900	4	1
	5	.2994	13	70868	50000.	4.2200	4	1
	26	.2503	14	92468	45000.	5.2900	4	1
	6	.2997	3	70868	40000.	7.2300	4	1
	23	.2985	14	92368	38000.	4.3220	5	1
	8	.2997	4	71568	36000.	3.6400	5	1
	22	.3004	15	92768	35000.	3.4070	5	1
	19	.3001	15	90968	34000.	1.4553	7	0
	31	.2504	3	93068	33000.	4.0834	6	1
	14	.2993	16	82368	32000.	1.2176	7	0
-1.0	27	.2503	14	92468	55000.	3.1000	3	1
	3	.3007	13	70368	50000.	8.8000	3	1
	28	.2501	14	92468	45000.	1.3500	4	1
	2	.3009	13	70368	40000.	3.8800	4	1
	30	.2506	14	92568	35000.	6.7800	4	1
	9	.2978	13	71568	30000.	1.6900	5	1
	29	.2484	14	92468	27000.	2.0870	5	1
	15	.3007	13	90368	24000.	6.3060	5	1
	21	.2999	4	91268	22000.	7.6980	5	1
	32	.2483	4	93068	21000.	1.3710	7	0
	17	.2993	13	90468	20000.	1.2237	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 1.
APL SAMPLE NUMBER 340731Z

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	20	.2989	14	92568	66000.	3.0600	4	1
	6	.3004	4	71268	60000.	3.5000	4	1
	31	.2503	2	100168	55000.	5.3900	4	1
	7	.2996	4	71268	50000.	9.6900	4	1
	9	.2980	4	71268	44000.	1.6390	5	1
	18	.3004	6	90568	40000.	2.7280	5	1
	28	.2505	16	92768	39000.	8.1658	6	1
	23	.2994	6	92768	38000.	4.7528	6	1
	22	.2994	6	91868	37000.	1.0398	7	1
	19	.3000	6	90568	35000.	1.0995	7	0
.0	25	.2501	14	92568	67000.	5.8000	3	1
	1	.3000	13	70368	60000.	1.1700	4	1
	5	.3002	2	71268	50000.	1.5000	4	1
	8	.2993	2	71268	40000.	3.1400	4	1
	10	.2995	2	71668	34000.	7.4100	4	1
	21	.2999	13	91868	30000.	2.9740	5	1
	32	.2498	14	100268	29000.	1.0724	7	0
	11	.2997	2	71668	28000.	1.1470	5	1
	4	.3003	13	91868	27000.	1.0019	7	0
	17	.2999	16	91368	26000.	9.5012	6	1
	29	.2489	14	92768	24000.	1.1565	7	0
-1.0	26	.2501	14	92568	55000.	2.1000	3	1
	2	.2988	13	70368	50000.	5.6000	3	1
	3	.2999	13	70368	40000.	1.4900	4	1
	12	.2995	13	80168	30000.	3.7300	4	1
	27	.2500	14	92768	28000.	8.5500	4	1
	14	.3016	14	81668	26000.	4.0320	5	1
	13	.3006	14	81668	24000.	2.2330	5	1
	30	.2502	15	100368	23000.	1.4970	5	1
	16	.2999	3	92368	22000.	1.3100	5	1
	24	.2995	15	92468	21000.	1.0130	7	0
	15	.2999	3	90968	20000.	2.0994	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release
Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	33	.2947	13	80568	86000.	2.2900	4	1
	31	.2491	14	50868	80000.	5.4100	4	1
	5	.3010	13	41668	70000.	1.3080	5	1
	22	.3005	13	80668	64000.	7.5530	5	1
	1	.3006	13	41568	60000.	3.7290	5	1
	24	.3007	15	80768	59000.	1.0389	6	1
	19	.3006	16	72968	56000.	1.5171	7	0
	10	.3008	14	52368	54000.	3.0839	6	1
	11	.3014	15	60768	52000.	1.1220	7	0
.0	34	.2498	13	80568	86000.	3.5000	3	1
	32	.2495	14	50868	80000.	9.0000	3	1
	3	.3008	13	41668	70000.	2.2600	4	1
	4	.3009	13	41668	60000.	5.7400	4	1
	2	.3007	14	50768	50000.	9.1200	4	1
	23	.3008	22	80768	50000.	8.4800	4	1
	16	.3009	20	71168	46000.	6.5360	5	1
	25	.3017	22	80768	44000.	5.9280	5	1
	13	.3007	15	61768	44000.	1.0230	5	1
	20	.3014	13	72968	43000.	2.9296	6	1
	12	.3011	16	60768	42000.	1.1223	7	0
-1.0	7	.3017	13	41768	70000.	2.4000	3	1
	6	.3016	13	41768	69000.	1.1300	4	1
	8	.3008	13	41768	50000.	2.7900	4	1
	26	.3008	13	80868	45000.	3.3900	4	1
	9	.3012	14	50868	40000.	8.7400	4	1
	21	.3016	13	73168	35000.	2.2360	5	1
	14	.3013	16	61868	30000.	3.1470	5	1
	27	.3004	14	81568	28000.	2.0826	6	1
	18	.3011	13	72668	26000.	9.6370	5	1
	15	.3009	16	61968	24000.	1.6823	6	1
	17	.3014	15	71168	22000.	1.1271	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 1.
APL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	31	.2491	13	80568	76000.	1.9000	4	1
	7	.2999	14	40768	70000.	3.4100	4	1
	29	.3016	13	80868	64000.	4.7500	4	1
	3	.3016	13	41768	60000.	8.5800	4	1
	27	.3012	22	80868	56000.	5.9100	4	1
	15	.3018	13	61768	54000.	9.8400	4	1
	30	.3005	14	82068	53000.	1.4780	5	1
	22	.3007	19	72968	52000.	6.3366	6	1
	34	.2490	20	90968	51000.	1.1630	5	1
	25	.3010	14	82068	50000.	9.8564	6	1
	19	.2978	22	62468	48000.	1.3808	7	0
.0	32	.2498	13	[illegible]	76000.	2.9000	3	1
	2	.3000	13	41768	70000.	1.1200	4	1
	1	.3004	13	41768	[illegible]	2.0200	4	1
	8	.3006	14	50768	[illegible]	5.0300	4	1
	10	.3004	19	52468	44000.	6.5700	4	1
	23	.3002	20	72968	41000.	1.7590	5	1
	9	.3007	19	52368	40000.	1.3704	6	1
	28	.3016	22	80868	36000.	1.2130	5	1
	12	.3007	16	52768	36000.	1.0955	6	1
	17	.2978	15	61866	34000.	4.7986	6	1
	13	.3017	15	52468	32000.	1.1073	7	0
-1.0	6	.3005	14	50768	60000.	4.6000	3	1
	4	.3002	14	50668	50000.	1.6100	4	1
	5	.3011	14	50668	40000.	6.1300	4	1
	20	.3017	13	62668	35000.	7.3200	4	1
	24	.3001	13	73168	32000.	6.8820	5	1
	11	.3010	19	52468	30000.	6.4120	5	1
	26	.2985	19	80568	28000.	1.8550	5	1
	16	.3017	13	61868	26000.	9.4330	5	1
	18	.3009	15	62468	24000.	1.6770	6	1
	33	.2492	15	82368	23000.	1.2366	7	0
	21	.3006	15	62668	22000.	1.3563	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 1.
APL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	31	.2499	13	90668	72000.	1.0700	4	1
	6	.3012	14	50768	70000.	1.3100	4	1
	3	.3003	14	50668	60000.	2.7900	4	1
	24	.3006	13	80868	54000.	5.2600	4	1
	10	.3004	14	50868	50000.	5.8200	4	1
	11	.3013	22	70168	44000.	3.1100	4	1
	22	.3003	22	80968	44000.	8.7100	4	1
	12	.3005	22	70168	40000.	2.0820	5	1
	16	.2999	18	71268	36000.	1.0710	6	1
	14	.2999	20	70368	34000.	1.0450	7	0
.0	32	.2496	14	90668	72000.	2.0000	3	1
	8	.2997	14	50668	70000.	3.5000	3	1
	1	.3002	14	50668	60000.	9.1000	3	1
	5	.3005	14	50768	50000.	2.0900	4	1
	23	.3006	13	80868	46000.	2.0700	4	1
	4	.3004	14	50668	40000.	6.5300	4	1
	13	.3011	22	70168	34000.	1.5930	5	1
	30	.3002	14	90668	32000.	3.7684	6	1
	26	.2997	16	82068	32000.	3.7500	4	1
	19	.3010	15	73168	31000.	1.2270	5	1
	17	.3004	20	72968	30000.	1.2995	7	0
	15	.3011	19	70368	28000.	1.0450	7	0
-1.0	29	.3003	14	90668	55000.	2.3000	3	1
	2	.3010	14	50668	50000.	5.4000	3	1
	28	.3012	14	90668	45000.	9.4000	3	1
	7	.3001	14	50768	40000.	2.0600	4	1
	26	.2997	14	82368	35000.	1.9400	4	1
	9	.3008	14	50868	30000.	1.2600	5	1
	18	.3005	14	73168	24000.	2.7710	5	1
	20	.3013	16	73168	20000.	9.8350	5	1
	25	.3010	13	81568	18000.	1.2510	7	3
	21	.3000	14	80168	16000.	1.1129	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
3 = SPECIMEN FAILED MORE THAN 1/8-IN. OFF CENTER.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.0	12	.2497	14	92768	87000.	1.0200	4	1
	11	.2499	2	31968	80000.	1.8400	4	1
	4	.3011	2	22768	70000.	2.9400	4	1
	1	.3005	2	22968	60000.	4.9700	4	1
	2	.3009	2	22968	50000.	1.2580	5	1
	9	.3007	3	52368	46000.	4.2780	5	1
	5	.3011	15	40268	45000.	1.0031	6	1
	7	.3012	13	71668	42000.	1.0421	6	1
	3	.3008	13	40168	40000.	9.1000	5	1
	6	.3005	15	50768	38000.	1.5382	6	1
	8	.3006	13	41868	36000.	9.3427	6	6
	10	.3004	6	71768	36000.	1.0413	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.
6 = SPECIMEN FAILED INSIDE GRIP OR HOUSING.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. ST DIRECTION. KT = 1.
APL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.0	12	.2499	14	92768	80000.	5.3000	3	1
	4	.3012	2	22968	70000.	1.0100	4	1
	1	.3001	2	22968	60000.	2.1500	4	1
	11	.2493	14	71868	50000.	4.4500	4	1
	2	.3014	2	22968	50000.	6.3200	4	1
	5	.3009	14	71768	45000.	1.3380	5	1
	3	.3013	3	40368	40000.	5.3071	6	1
	9	.3009	4	71768	38000.	1.1022	7	0
	7	.3000	16	50768	37000.	6.7899	5	1
	8	.3010	3	52768	36000.	1.5336	7	0
	6	.3005	2	41768	35000.	1.3586	7	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Contrails
Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. L DIRECTION. KT = 1.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.0	11	.2492	13	72668	74000.	7.1000	3	1
	1	.3000	4	31568	70000.	1.1000	4	1
	2	.3003	4	31568	60000.	4.2800	4	1
	3	.3000	3	40368	50000.	9.3100	4	1
	10	.3006	2	100168	45000.	1.3020	5	1
	4	.3004	13	41668	40000.	3.8220	5	1
	9	.3004	16	71168	39000.	1.0988	7	1
	8	.3002	3	62868	38000.	1.0984	7	0
	6	.3002	15	42668	37000.	1.8950	5	1
	7	.3003	3	62168	36000.	1.1907	7	0
	5	.3001	4	41868	34000.	1.5810	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. ST DIRECTION. KT = 1.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.0	1	.3007	4	31568	66000.	8.3000	3	1
	2	.3000	4	31568	60000.	1.6100	4	1
	3	.3009	4	31568	50000.	3.9800	4	1
	7	.3000	4	62468	40000.	1.0350	5	1
	4	.3000	2	72668	38000.	1.5420	5	1
	10	.3001	6	72568	36000.	4.3531	6	1
	8	.3003	13	62468	34000.	1.4470	5	1
	9	.3004	16	70968	33000.	2.1035	6	1
	6	.3004	15	42668	32000.	1.1833	7	0
	5	.3007	6	41868	30000.	1.3183	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. L DIRECTION. KT = 1.
APL SAMPLE NUMBER 3407317

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.0	4	.2994	13	80868	70000.	1.0400	4	1
	11	.2502	14	92668	65000.	3.4300	4	1
	1	.2996	13	80168	60000.	4.9000	4	1
	9	.2500	14	92668	55000.	7.4200	4	1
	2	.3002	13	80168	50000.	1.2270	5	1
	6	.2998	2	91268	46000.	4.3120	5	1
	10	.2503	4	92368	45000.	1.9360	5	1
	5	.2995	14	90968	44000.	5.2232	6	1
	8	.3000	13	93068	43000.	9.4822	6	1
	7	.2999	4	91368	42000.	4.0082	6	1
	3	.3008	2	90668	40000.	1.2822	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. ST DIRECTION. KT = 1.
APL SAMPLE NUMBER 3407317

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.0	4	.3003	13	80968	66000.	9.7000	3	1
	1	.2997	13	80168	60000.	1.5100	4	1
	8	.3002	14	92768	55000.	3.7400	4	1
	2	.3003	13	80168	50000.	3.8900	4	1
	9	.2503	14	92768	45000.	7.6400	4	1
	3	.2996	13	80168	40000.	1.3040	5	1
	6	.3019	16	91668	37000.	1.1559	7	1
	10	.2502	3	100368	36000.	7.7870	5	1
	5	.3002	16	91368	34000.	2.6389	6	1
	7	.2999	3	92468	32000.	1.1603	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. L DIRECTION. KT = 1.
ARL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	N X10	REMARKS
.0	12	.2496	13	80668	90000.	4.7000	3	1
	11	.2505	13	80668	80000.	1.2400	4	1
	1	.3009	13	73168	70000.	1.8000	4	1
	2	.3006	20	62568	60000.	4.3500	4	1
	3	.3000	20	62568	50000.	1.8410	5	1
	9	.3009	20	90968	47000.	1.6060	5	1
	5	.3001	19	80568	44000.	1.6317	6	1
	7	.3020	20	90368	42000.	1.0720	7	1
	4	.3009	20	62668	40000.	1.5377	7	0
	6	.2998	19	82068	40000.	2.8654	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
S LOCATION. ST DIRECTION. KT = 1.
ARL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	N X10	REMARKS
.0	[illegible]	.2495	13	80668	80000.	2.7000	3	1
	1	.3009	13	73168	70000.	7.8000	3	1
	2	.3008	20	62568	60000.	1.2600	4	1
	3	.3009	13	62568	50000.	3.1600	4	1
	4	.3008	20	62668	40000.	2.5100	4	1
	10	.3017	19	90368	38000.	1.2870	5	1
	9	.3020	22	81668	38000.	4.5526	6	1
	6	.3013	22	81368	36000.	6.3058	6	1
	5	.3008	22	70168	34000.	7.2598	6	1
	7	.3017	13	80168	32000.	4.3843	6	1
	9	.3006	22	80868	30000.	1.0282	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Contrails

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
W LOCATION. L DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	19	.2524	13	30569	50000.	1.9900	4	1
	16	.2535	13	22169	40000.	6.1900	4	1
	23	.2531	13	31969	35000.	7.6900	4	1
	2	.2531	13	32168	30000.	1.1920	5	1
	17	.2522	13	22169	28000.	4.3950	5	1
	3	.2532	5	41568	25000.	3.4190	5	1
	13	.2530	1	71568	22000.	5.2760	5	1
	18	.2536	3	30469	21000.	5.1210	5	1
	22	.2537	4	31169	20500.	9.7830	5	1
	9	.2534	13	42368	20000.	1.4841	7	0
.0	1	.2535		20268	108900.	.5000	0	1
	20	.2524	13	40569	40000.	6.4000	3	1
	4	.2529	14	32268	25000.	2.5700	4	1
	29	.2527	4	41169	22000.	2.6700	4	1
	7	.2542	5	41668	20000.	1.2930	5	1
	8	.2541	5	41668	17000.	2.1360	5	1
	15	.2531	1	71868	16000.	2.5820	5	1
	14	.2526	1	71668	15500.	2.8796	6	1
	10	.2525	13	51368	15000.	1.0553	7	0
	24	.2526	13	41969	3000.	1.2200	4	1
-1.0	27	.2532	1	33169	90000.	1.3160	7	0
	21	.2536	13	30569	25000.	1.1900	4	1
	5	.2528	14	32268	20000.	2.2200	4	1
	26	.2523	13	41869	17000.	4.5400	4	1
	6	.2523	13	32268	15000.	1.0340	5	1
	30	.2535	3	41669	13000.	5.4900	4	1
	11	.2529	5	71068	12000.	8.2700	4	1
	28	.2534	1	40769	11000.	5.9400	5	1
	12	.2532	5	71068	10000.	2.1250	5	1
	25	.2536	1	32469	8000.	1.4291	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
W LOCATION. LT DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	29	.2532	13	41969	50000.	3.6000	3	1
	16	.2537	14	30569	40000.	2.1200	4	1
	4	.2523	14	32569	30000.	1.0040	5	1
	24	.2540	3	32769	25000.	1.4480	5	1
	12	.2534	1	71268	22000.	1.6680	5	1
	15	.2525	3	30569	19000.	5.0450	5	1
	17	.2529	3	30569	16000.	1.3799	6	1
	18	.2527	3	30769	14000.	2.6968	6	1
	19	.2533	3	31069	13000.	1.3201	7	0
.0	1	.2534		20268	99700.	.5000	0	1
	30	.2526	13	42369	35000.	8.9000	3	1
	7	.2536	13	42369	30000.	1.4900	4	1
	2	.2536	14	32268	25000.	2.8200	4	1
	5	.2523	1	71068	20000.	3.5600	4	1
	25	.2532	3	32769	17000.	9.3700	4	1
	6	.2524	1	71068	15000.	9.2600	4	1
	14	.2535	3	12969	13000.	2.6260	5	1
	21	.2530	3	31769	12500.	3.7430	5	1
	9	.2521	5	71068	12000.	7.4732	6	1
	20	.2524	4	31269	11000.	1.1126	7	0
-1.0	27	.2517	13	42369	25000.	8.7000	3	1
	3	.2528	14	32268	20000.	1.7900	4	1
	8	.2533	1	71068	15000.	2.7600	4	1
	22	.2536	4	41169	13000.	8.5400	4	1
	11	.2541	1	71169	12000.	1.7220	5	1
	10	.2537	1	71068	10000.	1.9920	5	1
	28	.2540	4	41069	9500.	6.6980	5	1
	23	.2534	2	32469	9000.	1.5980	6	1
	13	.2537	5	71768	8000.	5.4273	6	1
	26	.2520	2	33169	7000.	1.3161	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
W LOCATION. ST DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	17	.2527	13	30569	40000.	2.6500	4	1
	29	.2523	13	42369	40000.	1.4000	4	1
	4	.2537	14	32568	30000.	6.1900	4	1
	5	.2529	1	71568	25000.	5.8500	4	1
	13	.2524	3	12969	20000.	1.5780	5	1
	14	.2516	3	12969	17000.	2.5799	5	1
	15	.2523	3	13069	15000.	4.9600	5	1
	22	.2526	3	32469	14000.	7.4950	5	1
	18	.2549	4	31769	13000.	1.2922	7	0
	16	.2519	3	13169	12000.	1.0160	7	0
.0	1	.2531		20268	82500.	.5000	0	1
	12	.2527	13	42469	30000.	1.0400	4	1
	2	.2525	14	32268	25000.	2.3600	4	1
	6	.2536	1	71068	20000.	2.4900	4	1
	27	.2542	3	41669	17000.	3.2800	4	1
	8	.2535	1	71168	15000.	5.9200	4	1
	26	.2527	3	41669	14000.	9.2600	4	1
	10	.2520	1	71268	12000.	1.4240	5	1
	25	.2525	4	41169	11500.	1.5384	7	0
	21	.2529	4	32469	11000.	2.4180	7	0
	19	.2526	1	31769	10000.	1.3826	7	0
-1.0	30	.2523	13	42469	25000.	4.2000	3	1
	3	.2526	14	32568	20000.	2.0600	4	1
	7	.2525	5	71068	15000.	1.5100	4	1
	11	.2526	1	71568	12000.	3.8800	4	1
	28	.2531	3	41669	11000.	3.7700	4	1
	9	.2529	1	71169	10000.	2.8490	5	1
	23	.2536	2	32569	9000.	2.4880	5	1
	24	.2542	2	32569	8500.	1.2943	7	0
	20	.2537	2	31869	8000.	1.1750	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	26	.2526	14	11469	50000.	1.6500	4	1
	27	.2523	14	11469	40000.	3.3700	4	1
	28	.2526	14	11469	35000.	1.2980	5	1
	2	.2527	5	40568	30000.	9.6700	4	1
	4	.2527	5	40868	25000.	1.4600	5	1
	6	.2532	5	40968	22000.	3.6350	5	1
	5	.2524	5	40868	20000.	1.5252	6	1
	11	.2513	1	70568	18000.	5.3451	6	1
	15	.2518	3	121868	17000.	3.2532	7	0
.0	1	.2527		20268	99100.	.5000	0	1
	29	.2530	14	11469	35000.	8.5000	3	1
	7	.2518	13	41068	30000.	1.5900	4	1
	3	.2531	13	22069	25000.	3.1000	4	1
	8	.2521	13	41068	20000.	8.5600	4	1
	12	.2523	1	110768	17000.	1.2430	5	1
	16	.2517	3	10269	15000.	2.5970	5	1
	24	.2528	3	20769	14000.	2.4520	5	1
	13	.2521	1	110768	14000.	1.1433	7	0
	19	.2529	3	10668	13000.	5.3420	5	1
	21	.2521	3	10669	11000.	1.1185	6	1
	23	.2526	5	11369	10000.	1.2851	7	0
	22	.2519	3	10769	9000.	1.1449	7	0
-1.0	30	.2523	13	22069	25000.	1.0300	4	1
	9	.2522	13	41069	20000.	1.3800	4	1
	10	.2516	13	41068	15000.	7.1100	4	1
	25	.2521	4	30669	12000.	9.3300	4	1
	17	.2522	4	10269	10000.	3.5530	5	1
	14	.2528	3	121768	8000.	4.7460	5	1
	18	.2529	5	10369	7000.	8.4880	5	1
	20	.2520	5	10669	6000.	1.5510	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	26	.2527	13	30569	50000.	1.1400	4	1
	25	.2530	13	22069	40000.	3.8800	4	1
	24	.2522	13	22069	35000.	1.2300	5	1
	6	.2523	13	41568	30000.	8.7500	4	1
	30	.2523	4	30669	25000.	1.3330	5	1
	17	.2536	4	11469	22000.	2.2530	5	1
	11	.2513	3	10369	18000.	6.2500	5	1
	15	.2522	4	11369	16000.	1.4416	6	1
	14	.2518	4	10869	15000.	1.0924	7	1
.0	1	.2532		20268	92300.	.5000	1	1
	28	.2521	13	30569	35000.	9.1000	3	1
	4	.2519	13	41068	30000.	1.3800	4	1
	20	.2524	13	30569	25000.	3.7500	4	1
	2	.2518	13	41068	20000.	7.3400	4	1
	8	.2518	3	10269	15000.	1.1080	5	1
	12	.2528	4	10769	13000.	2.0490	5	1
	13	.2513	4	10769	11000.	4.7330	5	1
	19	.2519	5	12069	10000.	3.0310	5	1
	21	.2520	3	20569	9500.	5.1190	5	1
	16	.2521	3	11169	9000.	1.4720	7	0
-1.0	10	.2522	4	10369	80000.	1.9119	6	1
	27	.2523	13	30569	25000.	1.1900	4	1
	3	.2529	13	41069	20000.	2.6000	4	1
	5	.2528	13	41068	15000.	5.7200	4	1
	7	.2511	1	111468	12000.	1.5790	5	1
	9	.2522	5	10269	10000.	1.6920	5	1
	20	.2521	1	12069	9000.	2.3869	6	1
	23	.2532	3	20669	8500.	2.1140	5	1
	22	.2524	3	20669	7500.	1.0157	6	1
	18	.2524	4	11469	7000.	1.3049	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 3.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	19	.2524	13	30569	50000.	7.4000	3	1
	29	.2521	13	42369	40000.	1.5600	4	1
	30	.2527	13	42369	35000.	3.3300	4	1
	4	.2524	1	110568	25000.	7.6900	4	1
	9	.2526	1	111368	20000.	1.8690	5	1
	10	.2520	3	12069	17000.	2.8910	5	1
	14	.2519	3	20769	14000.	6.4730	5	1
	20	.2529	4	30669	13000.	3.4930	5	1
	21	.2525	4	30769	12500.	1.6210	6	1
	15	.2523	3	21069	12000.	1.0830	7	1
.0	1	.2529		20269	82200.	.5000	0	1
	28	.2530	13	42369	30000.	6.7000	3	1
	2	.2521	13	41168	25000.	1.1200	4	1
	5	.2524	1	110568	20000.	2.7400	4	1
	7	.2522	1	110568	15000.	3.2600	4	1
	11	.2532	4	12069	12000.	1.5920	5	1
	12	.2520	4	12069	10000.	2.9870	5	1
	17	.2523	3	21969	8000.	1.0931	6	1
	19	.2518	3	22069	7000.	4.4040	5	1
	23	.2519	2	40769	6000.	1.1831	7	0
-1.0	27	.2524	13	42369	25000.	4.0000	3	1
	3	.2534	13	41168	20000.	1.3500	4	1
	6	.2524	1	110568	15000.	2.1900	4	1
	8	.2526	1	110668	12000.	7.2400	4	1
	26	.2531	1	42369	11000.	1.3900	5	1
	13	.2517	1	12169	10000.	2.2760	5	1
	16	.2522	3	21969	9000.	1.7560	5	1
	22	.2516	3	32769	6000.	3.2670	5	1
	25	.2524	5	42169	5500.	1.4406	7	0
	24	.2522	2	41569	5000.	1.1157	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, L DIRECTION, KT = 3.
APL SAMPLE NUMBER 340732C

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	24	.2494	14	11369	50000.	1.8700	4	1
	25	.2522	14	11369	40000.	5.3800	4	1
	1	.2517	1	100868	30000.	1.1190	5	1
	4	.2509	1	100868	25000.	2.6990	5	1
	23	.2501	4	21069	23000.	8.2110	5	1
	17	.2526	1	120268	22000.	1.5325	7	0
	7	.2469	1	101168	21000.	4.5120	5	1
	30	.2506	3	30369	21000.	1.4859	6	1
	20	.2517	13	121069	20000.	1.0797	7	0
	14	.2506	1	112668	19000.	1.2850	7	0
	8	.2501	5	101468	18000.	1.1160	7	0
.0	11	.2500		71068	102000.	.5000	0	1
	27	.2501	14	11369	35000.	9.4000	3	1
	26	.2502	14	11369	30000.	1.1500	4	1
	5	.2529	1	100968	25000.	1.8900	4	1
	2	.2534	1	100868	20000.	5.4000	4	1
	10	.2507	5	112168	16000.	1.9750	5	1
	21	.2509	4	21969	15000.	3.1810	5	1
	13	.2515	5	112668	14000.	1.8757	6	1
	12	.2526	5	112168	13000.	1.0560	7	0
-1.0	29	.2500	13	30369	30000.	3.4000	3	1
	28	.2531	14	11369	25000.	7.6000	3	1
	6	.2495	1	101068	20000.	3.6000	3	1
	3	.2501	1	100868	15000.	3.4400	4	1
	9	.2507	1	112568	12000.	1.7740	5	1
	15	.2502	5	112968	10000.	3.4260	5	1
	18	.2525	5	120368	9000.	6.1100	5	1
	16	.2528	5	112968	8000.	4.5161	6	1
	22	.2515	5	21069	7500.	1.0164	7	1
	19	.2511	5	120368	7000.	1.1732	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, LT DIRECTION, KT = 3.
APL SAMPLE NUMBER 340731Y

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	26	.2499	14	11369	50000.	1.1100	4	1
	27	.2526	14	11369	40000.	3.9200	4	1
	4	.2541	1	101068	30000.	7.7600	4	1
	1	.2506	1	100968	25000.	2.4940	5	1
	9	.2514	1	120968	22000.	4.1720	5	1
	11	.2515	1	123068	20000.	7.9160	5	1
	24	.2531	1	21169	19000.	1.2952	7	0
	14	.2517	1	121168	18000.	8.3290	5	1
	21	.2501	1	20469	17000.	2.7742	6	1
	15	.2506	1	121268	16000.	5.0220	5	1
	17	.2525	5	121668	15000.	3.2249	7	0
.0	18	.2496		71068	101000.	.5000	0	1
	28	.2500	14	11469	35000.	1.1300	4	1
	30	.2530	13	30369	30000.	2.1600	4	1
	5	.2495	1	101068	25000.	1.4400	4	1
	25	.2495	14	31869	22000.	6.2000	4	1
	2	.2514	1	100968	20000.	7.1200	4	1
	[illegible]	[illegible]	1	112668	15000.	2.7940	5	1
	20	.2514	1	20369	14000.	2.1469	6	1
	19	.2533	1	12769	13500.	1.4696	7	0
	10	.2515	5	120968	12500.	1.1665	7	0
-1.0	6	.2529	1	101068	20000.	1.0100	4	1
	3	.2503	1	101068	15000.	3.2100	4	1
	7	.2511	1	112568	12000.	1.4290	5	1
	29	.2500	4	21169	11000.	2.5080	5	1
	12	.2495	1	121068	10000.	1.3890	5	1
	23	.2517	1	21069	9000.	2.2296	6	1
	13	.2527	1	121068	8000.	7.7960	5	1
	22	.2505	1	20569	7500.	1.0276	7	0
	16	.2520	1	121268	7000.	1.2690	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, ST DIRECTION, KT = 3.
APL SAMPLE NUMBER 340731Z

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	16	.2491	13	30369	50000.	1.3600	4	1
	18	.2546	13	30369	40000.	4.3300	4	1
	19	.2511	13	31869	35000.	6.8000	4	1
	30	.2488	13	42369	32000.	5.2200	4	1
	7	.2501	1	101468	30000.	4.5600	4	1
	1	.2531	1	101068	25000.	9.9600	4	1
	9	.2505	1	112568	20000.	2.5620	5	1
	11	.2532	1	12269	17000.	8.5560	5	1
	14	.2513	4	21169	16000.	4.6940	5	1
	13	.2474	5	12769	15000.	1.0976	7	0
.0	6	.2509		71068	90500.	.5000	0	1
	27	.2506	13	41869	40000.	2.6000	3	1
	20	.2522	13	31869	35000.	7.4000	3	1
	21	.2523	13	31869	30000.	9.5000	3	1
	28	.2524	13	41869	25000.	1.8000	4	1
	2	.2527	1	101069	20000.	3.0200	4	1
	3	.2500	1	101069	15000.	9.4800	4	1
	15	.2491	4	21269	13000.	2.3010	5	1
	29	.2499	1	42369	12500.	2.8270	5	1
	23	.2491	3	32769	12500.	1.4900	5	1
	12	.2508	1	12369	12000.	1.1058	7	0
-1.0	17	.2505	13	30369	25000.	6.2000	3	1
	22	.2512	13	31869	20000.	1.9900	4	1
	4	.2484	1	101068	15000.	2.3100	4	1
	8	.2520	1	101468	12000.	6.6100	4	1
	5	.2504	1	101168	10000.	3.0480	5	1
	25	.2521	1	41569	9000.	4.3463	6	1
	24	.2507	1	40969	8000.	1.1237	7	0
	10	.2532	4	121768	8000.	1.7960	5	1
	26	.2517	1	41769	7000.	1.1029	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, L DIRECTION, KT = 3.
APL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	22	.2523	13	30469	50000.	1.4400	4	1
	23	.2526	13	30469	40000.	5.0100	4	1
	2	.2526	1	102368	30000.	9.3700	4	1
	19	.2528	3	30469	25000.	1.6840	5	1
	9	.2532	1	111568	22000.	4.6170	5	1
	10	.2533	1	111968	20000.	5.4260	5	1
	18	.2533	4	30469	19500.	1.4941	6	1
	13	.2536	5	21869	19000.	1.3039	7	0
	11	.2524	1	112068	18000.	1.0631	7	0
.0	1	.2528		20568	106600.	.5000	0	1
	30	.2544	13	41869	35000.	8.2000	3	1
	4	.2526	1	102468	30000.	1.4900	4	1
	5	.2538	1	30469	25000.	4.2300	4	1
	3	.2538	1	102368	20000.	1.3410	5	1
	28	.2537	3	32869	17000.	1.5710	5	1
	8	.2535	4	21269	15000.	2.3340	5	1
	29	.2536	4	40769	14000.	4.7600	5	1
	27	.2525	5	31869	13000.	1.1648	7	0
	12	.2534	4	21269	12000.	8.0950	5	1
	20	.2524	5	30469	11500.	1.3171	7	0
	16	.2527	5	22469	11000.	1.0184	7	0
	14	.2536	1	21769	10000.	1.5396	7	0
-1.0	21	.2534	13	30469	25000.	8.2000	3	1
	6	.2535	1	102468	20000.	1.7800	4	1
	7	.2535	1	102468	15000.	8.8400	4	1
	24	.2523	4	30569	12000.	1.4750	5	1
	15	.2531	3	22169	10000.	1.2070	5	1
	26	.2537	5	31769	10000.	8.2650	5	1
	25	.2526	5	31069	9000.	1.5456	7	0
	17	.2532	1	22469	8000.	1.5623	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, LT DIRECTION, KT = 3.
APL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	22	.2543	13	31969	50000.	1.2000	4	1
	17	.2531	13	30469	40000.	2.2700	4	1
	2	.2531	1	102468	30000.	4.8600	4	1
	7	.2531	4	21369	25000.	1.2250	5	1
	8	.2535	4	21369	22000.	2.0080	5	1
	9	.2539	4	21369	19000.	6.1740	5	1
	11	.2531	4	21469	16000.	2.2571	6	1
	12	.2541	4	21769	14000.	1.1141	7	0
.0	1	.2535		20568	89100.	.5000	0	1
	29	.2529	13	41869	35000.	5.4000	3	1
	18	.2532	13	30469	30000.	1.4800	4	1
	3	.2541	1	102568	25000.	2.1600	4	1
	4	.2527	1	102568	20000.	5.1300	4	1
	27	.2525	4	41069	17000.	1.1090	5	1
	10	.2536	4	21469	15000.	1.9780	5	1
	13	.2531	3	22169	12000.	2.7690	5	1
	24	.2528	3	32669	11000.	3.9910	5	1
	20	.2530	3	31769	10000.	2.5349	6	1
	21	.2538	3	31969	9000.	1.0012	7	0
-1.0	19	.2525	13	30469	25000.	7.6000	3	1
	6	.2530	1	102568	20000.	1.1300	4	1
	5	.2541	1	102568	15000.	6.2400	4	1
	15	.2529	3	22469	12000.	4.1200	4	1
	28	.2528	3	41669	11000.	5.1500	4	1
	14	.2541	3	22169	10000.	2.4150	5	1
	16	.2547	3	30369	8000.	2.3530	5	1
	23	.2525	3	32569	7000.	8.6300	5	1
	26	.2542	3	40769	6500.	1.1297	7	0
	25	.2532	3	32869	6000.	2.1296	7	0
	30	.2528	13	41869	1700.	3.3300	4	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, ST DIRECTION, KT = 3.
APL SAMPLE NUMBER 341635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	29	.2522	13	41469	51000.	3.8000	3	1
	16	.2530	13	30469	40000.	1.8200	4	1
	2	.2520	1	102568	30000.	2.8000	4	1
	18	.2532	4	41069	25000.	5.2100	4	1
	6	.2528	3	22469	20000.	1.3700	5	1
	7	.2532	3	22469	16000.	2.8880	5	1
	8	.2530	3	22569	13000.	7.7380	5	1
	25	.2530	4	40969	12500.	1.3645	6	1
	13	.2532	1	30369	12000.	1.4941	7	0
	9	.2536	3	22669	11000.	9.5690	6	1
.0	1	.2532		20568	76400.	.5000	0	1
	14	.2528	13	30469	30000.	7.9000	3	1
	17	.2529	13	30469	25000.	2.1000	4	1
	3	.2528	1	102568	20000.	3.1500	4	1
	28	.2529	3	41749	17000.	4.1700	4	1
	10	.2525	1	30369	15000.	5.0700	4	1
	27	.2530	3	41669	13500.	6.2000	4	1
	11	.2528	1	30369	12000.	2.9200	5	1
	20	.2544	5	32469	11000.	2.8120	5	1
	21	.2533	5	32469	10500.	1.4261	7	0
	19	.2535	1	31069	10000.	1.5404	7	0
-1.0	24	.2526	4	40869	80000.	1.4822	6	1
	15	.2542	13	30469	25000.	5.2000	3	1
	5	.2535	1	111468	20000.	1.0500	4	1
	30	.2536	13	41469	17000.	1.6400	4	1
	4	.2524	1	102568	15000.	5.0900	5	1
	12	.2535	3	30369	12000.	7.6800	4	1
	23	.2532	4	40969	10000.	2.9870	5	1
	22	.2540	5	33169	9000.	5.8496	6	1
	26	.2537	5	41169	7000.	1.2239	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	27	.2980	26	62569	40000.	8.4000	3	1
	4	.2981	26	62569	30000.	5.2500	4	1
	10	.3010	17	43069	20000.	2.1700	5	1
	12	.3005	17	50569	17000.	6.1120	5	1
	13	.2983	29	52769	16000.	3.9750	5	1
	11	.3006	17	43069	15000.	1.0284	7	0
	20	.2985	29	60269	14500.	2.7450	5	1
	15	.2976	29	52669	14000.	7.5258	6	1
	23	.2996	19	60469	13000.	1.4645	6	1
	25	.2999	21	60969	12000.	1.5773	7	0
.0	1	.2982		20568	97400.	.5000	0	1
	6	.2982	13	41168	40000.	3.4000	3	1
	28	.2995	26	62569	25000.	2.1700	4	1
	2	.3002	14	32568	20000.	6.7000	4	1
	26	.3005	27	60969	17000.	1.2880	5	1
	8	.2995	19	12868	15000.	6.5200	4	1
	9	.2975	19	12869	12000.	1.3140	5	1
	14	.3009	30	52269	10000.	5.8330	5	1
	21	.3004	21	60269	9000.	1.5251	7	0
	16	.3011	30	52669	8000.	1.3597	7	0
-1.0	5	.2988	21	40468	20000.	8.4000	3	1
	30	.2980	26	62569	17000.	2.6000	4	1
	29	.2975	26	62569	15000.	4.0400	4	1
	3	.2995	14	32569	15000.	1.0550	5	1
	7	.2986	19	12869	12000.	5.3700	4	1
	17	.2988	27	52769	10000.	3.2830	5	1
	18	.3006	27	52769	8000.	1.8590	6	1
	19	.2997	19	52869	7000.	4.9465	6	1
	22	.2984	19	60269	6000.	2.4639	6	1
	24	.2985	19	60569	5000.	1.0164	7	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	29	.2998	26	62669	40000.	6.2000	3	1
	8	.2996	26	62569	30000.	3.1600	4	1
	9	.3010	17	102469	20000.	1.1840	5	1
	13	.3000	19	12969	15000.	2.8460	5	1
	30	.2986	19	71569	14000.	2.7090	5	1
	27	.2983	27	60969	13000.	3.1817	6	1
	14	.2991	21	42869	12000.	9.1160	5	1
	24	.3010	28	60569	11500.	1.0002	7	0
	18	.2990	21	51269	11000.	1.4850	7	0
	15	.3007	21	43069	10000.	1.0583	7	0
.0	1	.2985		20568	85000.	.5000	0	1
	7	.3003	12	41168	40000.	2.3000	3	1
	26	.2987	26	62669	25000.	1.1000	4	1
	2	.2984	21	40468	20000.	2.4300	4	1
	5	.2978	21	40468	15000.	1.0440	5	1
	11	.2986	19	12969	12000.	1.7150	5	1
	28	.3009	19	61069	11500.	1.1759	5	1
	23	.3008	17	52769	11000.	1.2952	7	0
	16	.2988	19	51469	10000.	2.7202	6	1
	21	.2984	20	51669	9000.	1.9184	7	0
-1.0	3	.2993	21	40468	20000.	6.1000	3	1
	4	.3006	21	40468	15000.	2.0100	4	1
	6	.3003	21	40468	12000.	1.2865	6	1
	12	.2976	19	12969	12000.	6.3100	4	1
	10	.2990	19	12869	10000.	1.7230	5	1
	20	.2987	19	51669	9000.	7.6580	5	1
	17	.3009	20	51469	8000.	1.7326	6	1
	19	.3001	20	51569	7000.	1.3649	6	1
	25	.3016	21	52869	6500.	6.6605	6	1
	22	.2990	19	51969	6000.	1.8404	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
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RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340619

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	26	.3015	26	62669	40000.	5.5000	3	1
	25	.2993	26	62669	30000.	2.1200	4	1
	7	.2988	17	102268	20000.	7.9000	4	1
	19	.3007	27	60969	18000.	1.9510	5	1
	8	.2981	17	102268	15000.	2.8500	5	1
	11	.2979	27	52269	13000.	6.1840	5	1
	30	.2986	17	71569	12500.	5.0780	5	1
	10	.2992	21	50569	12000.	1.4640	7	0
	13	.2986	29	60969	11000.	1.8063	7	0
.0	1	.3005		20568	72600.	.5000	0	1
	5	.3006	13	70269	25000.	5.6000	3	1
	2	.2987	21	40469	20000.	1.4800	4	1
	28	.2982	13	70269	17000.	2.6200	4	1
	4	.3003	17	102268	15000.	7.7600	4	1
	9	.3004	17	102268	12000.	1.5880	5	1
	29	.2979	17	71569	11500.	2.6490	5	1
	21	.2988	28	61069	11000.	1.3730	5	1
	24	.3007	27	61169	10500.	1.4060	7	0
	15	.3007	17	60269	10000.	1.1134	7	0
-1.0	16	.2982	30	60769	29000.	1.1620	5	1
	20	.3014	27	60969	20000.	6.1000	3	1
	3	.2986	21	40568	15000.	2.7200	4	1
	27	.3004	26	62669	13000.	5.7500	4	1
	6	.3005	17	102368	12000.	1.1190	5	1
	14	.3003	30	60269	11000.	1.0240	5	1
	12	.2984	19	52769	10000.	1.7238	6	1
	18	.3006	9	60669	8500.	1.4665	6	1
	22	.2984	19	61069	8000.	1.9520	5	1
	17	.2977	30	60269	7500.	8.5082	6	1
	23	.2985	28	61069	7000.	1.5604	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, L DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	13	.3008	13	70269	40000.	1.0700	4	1
	28	.2984	13	70269	30000.	3.4000	4	1
	5	.3000	17	110668	20000.	1.5380	5	1
	7	.3000	17	110668	15000.	3.5440	5	1
	9	.3005	20	12169	13000.	7.0440	5	1
	14	.2997	17	51269	12000.	1.3393	6	1
	10	.2998	17	50569	11000.	1.2795	6	1
	27	.3004	26	62769	10500.	4.0813	6	1
	15	.3006	21	51969	10000.	2.5691	6	1
	16	.2980	21	52169	9000.	1.3498	7	0
.0	1	.2978		20568	87200.	.5000	0	1
	29	.3012	13	70269	25000.	7.4000	3	1
	2	.2980	13	41168	20000.	3.2800	4	1
	4	.2987	13	41168	15000.	1.8390	5	1
	30	.3003	30	71469	13000.	9.0900	4	1
	11	.3010	17	50669	11000.	4.6190	5	1
	21	.3004	30	60969	10000.	1.8050	7	0
	19	.3005	27	60369	9000.	6.6740	5	1
	20	.3002	29	60469	8000.	5.9280	5	1
	25	.2983	19	61669	7000.	1.2771	6	1
	26	.2991	17	63069	6000.	1.0106	7	0
-1.0	23	.2984	13	70269	25000.	4.6000	3	1
	3	.3003	13	41168	20000.	2.0200	4	1
	6	.2985	17	110668	15000.	4.0700	4	1
	8	.3006	17	111568	12000.	1.7600	5	1
	12	.2982	17	50569	10000.	4.9290	5	1
	18	.2980	20	60369	9000.	1.8520	5	1
	17	.2990	20	52769	8000.	8.3908	6	1
	22	.3000	19	61169	7000.	4.9720	5	1
	24	.2983	19	61169	6000.	1.0841	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	24	.2997	26	62669	40000.	8.9000	3	1
	27	.3010	26	62769	30000.	3.2500	4	1
	4	.2981	17	110668	20000.	9.1200	4	1
	5	.2997	17	50768	15000.	2.4210	5	1
	12	.3007	17	51369	13000.	3.9710	5	1
	11	.3002	17	50769	12000.	1.0320	7	0
	29	.3018	19	71469	11500.	5.2820	5	1
	13	.2994	17	51369	11000.	1.4627	6	1
	14	.2991	17	51469	10000.	1.1184	7	0
.0	1	.2997		20568	77300.	.5000	0	1
	9	.2989	13	70269	30000.	3.8000	3	1
	2	.2977	17	110668	20000.	3.3100	4	1
	10	.3006	19	12869	15000.	5.7500	4	1
	17	.3002	27	52969	12000.	3.3950	5	1
	25	.2996	17	71669	11000.	2.4680	5	1
	15	.3006	17	52269	10000.	5.9800	5	1
	20	.3000	29	60269	9000.	4.3500	5	1
	22	.3001	20	61669	8500.	4.9752	6	1
	16	.3002	17	52269	8000.	1.0933	7	0
-1.0	7	.3001	13	70269	25000.	4.8000	3	1
	6	.3003	17	111468	20000.	8.2000	3	1
	3	.3006	17	110668	15000.	3.2000	4	1
	8	.2984	17	111568	12000.	8.1700	4	1
	26	.3001	26	62669	11000.	1.6230	5	1
	18	.3005	27	60269	10000.	1.8540	5	1
	21	.3000	29	60569	9000.	8.1280	5	1
	19	.3006	27	60269	8000.	1.2279	6	1
	23	.3008	19	71569	7000.	1.4030	5	1
	28	.3004	27	71669	6500.	2.5461	6	1
	30	.2998	27	71769	5500.	8.7512	6	1

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7075-T73510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340620

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES	X10 N	REMARKS
.5	21	.2977	26	62769	40000.	6.8000	3	1
	22	.2998	26	62769	30000.	1.8800	4	1
	3	.3003	17	111368	20000.	7.8800	4	1
	28	.2997	17	71669	17000.	9.7200	4	1
	8	.2982	27	52869	15000.	3.1700	5	1
	13	.3004	20	60369	12000.	5.9530	5	1
	17	.2978	17	60969	11000.	1.4014	7	0
	16	.2983	20	60469	10000.	1.0344	7	0
.0	1	.2998		20568	66600.	.5000	0	1
	24	.2981	13	70269	30000.	3.6000	3	1
	25	.3000	13	70269	25000.	5.1000	3	1
	2	.2984	17	111368	20000.	1.8200	4	1
	4	.3005	17	111368	15000.	6.1700	4	1
	30	.2989	19	72269	14000.	2.2620	5	1
	9	.2982	21	52869	12000.	1.1220	5	1
	11	.3007	29	60369	10000.	4.3760	5	1
	18	.2981	20	60969	9000.	2.8340	5	1
	14	.2983	29	60369	8000.	2.9049	6	1
	19	.3010	17	61669	7000.	1.0748	7	0
-1.0	23	.2998	13	70269	25000.	4.0000	3	1
	5	.3004	17	111468	20000.	8.8000	3	1
	6	.3007	17	111468	15000.	3.4800	4	1
	7	.3004	17	111568	12000.	7.5500	4	1
	10	.2983	29	60369	10000.	1.0070	5	1
	29	.3011	19	71669	9000.	9.4500	4	1
	12	.3007	20	60369	8000.	7.7300	4	1
	26	.2996	21	71669	7500.	1.4070	5	1
	15	.2996	27	60369	7000.	9.1831	6	1
	27	.2975	21	71669	6500.	9.3327	6	1
	20	.2994	17	62569	6000.	1.0848	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

Contrails

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, L DIRECTION, KT = 12.
ARL SAMPLE NUMBER 340731Y
340732C

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	30	.2995	13	70769	40000.	1.0400	4	1
	28	.2993	13	70769	30000.	3.9000	4	1
	11	.2990	13	72269	25000.	8.4000	4	1
	1	.3002	17	101469	20000.	1.6290	5	1
	5	.2993	17	101468	16000.	4.3350	5	1
	22	.3009	20	12369	12000.	1.0730	6	1
	13	.3003	17	10269	11000.	1.1782	7	0
	12	.3019	17	121868	10000.	3.3452	7	0
.0	3	.2997		71068	88700.	.5000	0	1
	29	.3006	13	70769	25000.	7.6000	3	1
	2	.2999	17	101468	20000.	1.1900	4	1
	10	.3008	17	101768	17000.	5.8700	4	1
	6	.2991	17	101568	15000.	2.9140	5	1
	9	.2994	17	101668	13000.	1.5630	5	1
	24	.3010	20	61069	11000.	1.2041	7	0
	14	.3007	17	10869	10000.	9.2250	5	1
	19	.3003	21	12169	9000.	4.0550	5	1
	21	.3002	20	12369	8500.	2.6834	6	1
	18	.3004	17	11469	8000.	1.2563	7	0
-1.0	7	.3003	17	101668	20000.	9.6000	3	1
	4	.3001	17	101568	15000.	2.1000	4	1
	8	.2992	17	101668	12000.	7.8600	4	1
	15	.2996	17	10969	10000.	3.9440	5	1
	23	.3006	20	60969	9000.	4.8030	5	1
	16	.3002	17	10969	8000.	5.1120	5	1
	26	.3002	20	63069	7500.	1.2439	7	0
	20	.3000	21	12169	7000.	7.5545	6	1
	17	.3004	17	10969	6500.	9.3861	6	1
	25	.2993	20	62469	6000.	1.3334	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, LT DIRECTION, KT = 12.
ARL SAMPLE NUMBER 340731Z
340731Y

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	26	.3002	13	71569	40000.	8.8000	3	1
	11	.3001	13	72169	30000.	1.6300	4	1
	1	.3010	17	101568	20000.	8.3800	4	1
	5	.3003	17	101568	16000.	1.9230	5	1
	14	.3014	19	12169	13000.	3.5070	5	1
	27	.3008	21	72169	12500.	9.0030	5	1
	25	.3003	30	71569	12000.	1.3667	7	0
	10	.2997	27	71169	11000.	1.0650	7	0
.0	3	.2995		71068	83400.	.5000	0	1
	29	.2996	13	72169	25000.	9.8000	3	1
	2	.3012	17	101568	20000.	1.2800	4	1
	6	.2959	17	101668	15000.	4.0100	4	1
	9	.2998	17	102368	12000.	2.1010	5	1
	18	.3003	20	20369	11500.	8.1000	4	1
	17	.3002	20	13069	11000.	6.0545	6	1
	19	.3010	20	20369	10500.	1.4870	5	1
	15	.3008	19	12369	10000.	1.2538	7	0
	12	.3006	20	121868	9000.	1.2722	7	1
-1.0	7	.3000	17	101668	20000.	9.2000	3	1
	4	.2996	17	101568	15000.	2.0400	4	1
	23	.3006	26	63069	13000.	8.4600	4	1
	8	.3001	17	101768	12000.	9.6700	4	1
	30	.3004	29	72169	11000.	4.8060	6	1
	13	.2995	19	12169	10000.	4.0700	4	1
	16	.3001	20	12469	10000.	1.0312	7	1
	28	.2994	27	72169	9000.	4.8593	6	1
	20	.3006	20	20369	8000.	7.0469	6	1
	21	.3004	29	61769	7000.	8.3780	5	1
	22	.3003	19	63069	6000.	4.9210	5	1
	24	.2996	19	70769	6000.	1.1284	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
X7080-T7E42 EXTRUDED BAR 3.500 IN. THICK
M LOCATION, ST DIRECTION, KT = 12.
ARL SAMPLE NUMBER 340731Z

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	25	.3010	13	72169	40000.	6.7000	3	1
	26	.3002	13	72169	30000.	2.0400	4	1
	29	.3008	13	72269	25000.	2.7400	4	1
	1	.3003	17	101668	20000.	9.0800	4	1
	21	.2995	28	72169	17000.	9.2600	4	1
	13	.2999	19	71469	15000.	1.0870	5	1
	14	.3010	19	71469	12000.	2.3710	5	1
	19	.3011	21	72169	11500.	3.0530	5	1
	15	.2993	29	71569	11000.	1.3638	7	0
.0	20	.2997		71068	79000.	.5000	0	1
	28	.2993	13	72269	30000.	3.5000	3	1
	27	.3002	13	72169	25000.	5.5000	3	1
	2	.2978	17	101668	20000.	3.7200	4	1
	4	.2991	17	101668	15000.	5.2500	4	1
	8	.3006	21	12769	13000.	6.2800	4	1
	7	.3001	17	102168	12000.	9.4000	5	1
	22	.2993	30	72169	11000.	1.5424	7	0
	11	.3009	19	71469	10000.	7.5300	4	1
	18	.2999	29	72169	9000.	1.5537	7	0
	17	.2991	19	71769	8000.	1.2322	7	1
-1.0	5	.2994	17	101668	20000.	7.5000	3	1
	3	.3008	17	101668	15000.	2.2200	4	1
	24	.3001	28	72169	13000.	2.3700	4	1
	6	.2990	17	101768	12000.	3.0016	6	1
	30	.2990	13	72269	12000.	1.0780	5	1
	16	.2994	19	71769	10000.	3.5000	4	1
	23	.3007	27	72169	9000.	6.5900	4	1
	9	.3001	20	63069	8000.	1.4530	5	1
	12	.3008	20	71469	7500.	1.2816	7	1
	10	.2992	20	70769	7000.	1.1282	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Approved for Public Release

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. L DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	25	.2986	13	71569	40000.	6.6000	3	1
	26	.3008	13	71569	30000.	2.0500	4	1
	29	.3011	13	72269	25000.	4.6500	4	1
	2	.3018	17	102568	20000.	2.7400	5	1
	7	.3001	19	41769	17000.	2.5930	5	1
	22	.2986	27	62469	15000.	6.4450	5	1
	17	.2998	28	70769	14000.	1.5695	7	0
	11	.2998	21	71869	13000.	1.0505	6	1
	8	.2991	19	41869	13000.	5.2990	5	1
	27	.3007	27	62569	12000.	1.1282	7	0
	9	.2998	19	41869	11000.	1.0830	6	1
	16	.3006	28	61769	10000.	1.5000	7	0
.0	1	.2980		20568	96800.	.5000	0	1
	28	.3005	13	71569	30000.	4.2000	3	1
	3	.3011	17	102868	20000.	3.0300	4	1
	10	.2991	17	42369	15000.	2.1400	5	1
	6	.3001	21	72269	13000.	2.0056	6	1
	14	.2990	27	52969	12000.	3.8958	6	1
	21	.3001	28	70169	11000.	1.2294	7	0
	18	.2993	27	61769	10000.	4.5700	5	1
	24	.2996	20	63069	9000.	1.0082	7	0
	19	.3018	27	61869	8000.	1.3232	7	0
-1.0	5	.2994	17	111468	20000.	1.1600	4	1
	30	.3006	13	72269	17000.	1.5300	4	1
	4	.2994	17	102868	15000.	6.8200	4	1
	12	.2998	17	42469	12000.	1.6330	5	1
	13	.3008	17	42469	10000.	1.2823	7	0
	20	.2990	30	62069	9000.	1.3748	6	1
	15	.3006	29	62369	7930.	2.3180	6	1
	23	.3000	29	62569	7000.	1.1359	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. LT DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	27	.2990	13	71569	40000.	4.4000	3	1
	29	.3003	13	71569	30000.	1.6500	4	1
	2	.2988	17	102868	20000.	1.2700	5	1
	20	.3003	27	70769	18000.	1.0400	5	1
	11	.3006	27	63069	17000.	1.0108	7	0
	30	.3008	20	72269	17000.	1.5330	5	1
	21	.2994	27	70769	16000.	1.8820	5	1
	7	.3006	21	61669	15000.	1.5707	7	0
	19	.2986	27	70769	14000.	5.0530	5	1
	14	.2991	19	70169	13000.	4.0190	5	1
	16	.2984	17	70569	12000.	1.0802	7	0
	15	.3008	19	70169	11000.	1.1692	7	0
.0	1	.2985		20568	73600.	.5000	0	1
	28	.3011	13	71569	25000.	6.4000	3	1
	3	.3008	17	102868	20000.	2.3000	4	1
	10	.2990	27	62469	17000.	4.1000	4	1
	6	.3026	17	111468	15000.	1.0280	5	1
	24	.3007	27	70969	13000.	1.4630	5	1
	26	.2994	17	71069	12500.	1.1115	7	0
	13	.3008	29	63069	12000.	1.4236	7	0
	17	.2982	21	70569	11000.	1.1998	7	0
	25	.2992	27	70969	10500.	2.8053	6	1
	9	.3011	30	62369	10000.	1.5294	7	0
-1.0	5	.3027	17	111468	20000.	9.7000	3	1
	4	.2986	17	102868	15000.	3.0000	4	1
	22	.2977	27	70869	12000.	1.2770	5	1
	23	.2998	27	70869	10000.	2.1400	5	1
	12	.2986	28	63069	8500.	1.2446	6	1
	18	.2998	27	70569	7500.	2.6821	6	1
	8	.2990	20	61969	7000.	1.1034	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

RESULTS OF AXIAL-STRESS FATIGUE TESTS
LOAD OR STRESS CYCLING
7178-T6510 EXTRUDED BAR 3.500 IN. THICK
M LOCATION. ST DIRECTION. KT = 12.
ARL SAMPLE NUMBER 340635

STRESS RATIO	SPECIMEN NO.	DIAM.	MACHINE	DATE TEST BEGAN	NOMINAL MAXIMUM STRESS	FATIGUE LIFE CYCLES X10	N	REMARKS
.5	27	.2980	13	72269	40000.	2.8000	3	1
	29	.3013	13	72269	30000.	1.1600	4	1
	5	.3006	17	102968	20000.	7.1600	4	1
	30	.2989	19	72369	18000.	1.0470	5	1
	2	.2989	17	102868	15000.	2.9480	5	1
	23	.2981	28	71469	14000.	1.4237	7	0
	16	.2982	29	70769	13000.	1.1628	7	0
	25	.2983	17	71769	12500.	1.0298	7	0
	11	.2998	21	62369	12000.	1.4943	7	0
.0	1	.2997		20568	59600.	.5000	0	1
	28	.2980	13	72269	25000.	4.9000	3	1
	3	.2994	17	102968	20000.	1.8000	4	1
	6	.3010	17	102968	15000.	1.3350	5	1
	24	.3017	30	71469	13000.	4.3600	4	1
	20	.3004	28	71469	12000.	9.0100	4	1
	17	.3006	30	70769	11000.	1.1599	7	0
	18	.2997	27	71169	10500.	1.1870	5	1
	12	.3008	19	62469	10000.	1.2020	5	1
	21	.3006	30	71469	9500.	1.7910	5	1
	15	.3002	30	63069	9000.	1.4257	7	0
	14	.3013	19	62469	8000.	1.3212	7	0
-1.0	7	.3002	17	111468	20000.	6.7000	3	1
	4	.2983	17	102968	15000.	3.1500	4	1
	8	.2979	27	71169	12000.	3.2080	5	1
	22	.3015	29	71469	10000.	1.6889	6	1
	26	.2981	19	71769	9000.	1.1650	5	1
	9	.3001	19	61769	8000.	2.8870	5	1
	19	.2984	21	71169	7500.	1.0556	7	0
	13	.2991	28	62469	7000.	1.3423	7	0
	10	.2980	19	61769	6000.	1.4443	7	0

REMARKS
0 = NORMAL TEST. SPECIMEN DID NOT FAIL.
1 = NORMAL TEST. SPECIMEN FAILED.

Contrails

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Contrails

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Contrails

APPENDIX III

FATIGUE CRACK PROPAGATION DATA

Approved for Public Release

CRACK PROPAGATION FOR CENTER-NOTCHED FATIGUE SPECIMENS

Constant Load Tests, Maximum Gross Stress in Cycle = 8.2 ksi. Stress Ratio = 1/3
X7080-T7E41 Plate

343260, LONG. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
343260L1_ X7080T751			T = .4993 IN.	SIP = 8.1 KSI
(118000.) 0.	.000	.000	.500	16.66
2400.	.000	.015	.515	17.16
34100.	.050	.040	.560	18.66
55000.	.080	.125	.625	20.83
76300.	.015	.175	.690	22.99
92100.	.072	.245	.815	27.16
104400.	.150	.330	.980	32.66
107400.	.160	.340	1.000	33.32
120000.	.245	.405	1.150	38.32
126800.	.325	.490	1.315	43.82
134100.	.390	.565	1.455	48.48
142300.	.470	.645	1.615	53.82
144300.	.540	.725	1.765	58.81
149300.	.625	.815	1.940	64.65
153000.	.720	.930	2.150	71.64
154600.	.790	1.030	2.320	77.31
155600.	.920	1.160	2.580	85.64
343260L2_ X7080T751			T = .4990 IN.	SIP = 8.1 KSI
(77500.) 0.	.010	.000	.500	16.67
2400.	.015	.000	.515	17.17
17300.	.040	.025	.565	18.83
35000.	.070	.060	.630	21.00
46200.	.115	.110	.725	24.17
55300.	.170	.155	.825	27.50
62300.	.225	.195	.915	30.50
77200.	.255	.245	1.000	33.33
83000.	[illegible]	.280	1.130	37.33
94600.	.340	.365	1.255	41.83
105300.	.470	.460	1.430	47.33
112700.	.555	.540	1.595	53.17
115700.	.660	.645	1.805	60.17
122700.	.765	.750	2.015	67.17
125400.	.855	.835	2.190	73.00
125600.	.975	.935	2.410	80.33
125900.	1.110	1.060	2.665	88.83
343260L3_ X7080T751			T = .4980 IN.	SIP = 8.2 KSI
(165100.) 0.	.000	.000	.500	16.67
4500.	.020	.000	.520	17.33
34400.	.055	.000	.555	18.50
54200.	.110	.000	.610	20.33
70200.	.170	.015	.685	22.83
88700.	.215	.055	.770	25.67
100800.	.240	.120	.860	28.67
107700.	[illegible]	.155	.940	31.33
113600.	.315	.125	1.000	33.33
121500.	.370	.235	1.105	36.83
128700.	.425	.290	1.215	40.50
133300.	[illegible]	.355	1.340	44.67
143100.	.555	.420	1.470	49.00
147900.	.615	.480	1.595	53.17
158400.	.860	.715	2.075	69.17
160900.	1.030	.760	2.190	73.00
162200.	1.010	.830	2.340	78.00
163200.	1.145	.890	2.475	82.50
163300.	1.130	.950	2.520	84.00
343260L5_ X7080T751			T = .4960 IN.	SIP = 8.2 KSI
(77200.) 0.	.000	.000	.500	16.66
3500.	.010	.015	.525	17.49
24200.	.070	.040	.610	20.33
42200.	.125	.095	.720	23.99
56500.	.170	.145	.815	27.16
70000.	.225	.280	.925	30.82
79300.	.260	.240	1.000	33.32
88600.	.330	.300	1.130	37.65
101700.	.410	.375	1.285	42.82
108800.	.470	.435	1.405	46.82
113300.	.535	.495	1.530	50.98
116200.	.615	.575	1.690	56.31
123100.	[illegible]	.665	1.825	60.81
124800.	[illegible]	.700	1.970	65.64
127600.	[illegible]	.765	2.070	69.64
130100.	[illegible]	.825	2.205	73.48
130500.	[illegible]	.865	2.345	78.31
131400.	[illegible]	.940	2.490	82.97
131600.	1.142	.963	2.600	86.64

343260, LONG. MACHINED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
343260L4_ X7080T751			T = .4559 IN.	SIP = 8.2 KSI
(111500.) 0.	.000	.000	.500	16.66
4900.	.000	.015	.515	17.16
17900.	.020	.035	.555	18.49
36000.	.050	.060	.610	20.33
45200.	.080	.080	.660	21.99
54600.	.125	.135	.760	25.32
70900.	.145	.200	.845	[illegible]
81300.	.250	.250	1.000	33.32
91000.	.310	.310	1.120	37.32
100800.	.345	.350	1.275	42.49
109300.	.470	.470	1.440	47.98
117700.	.575	.565	1.635	54.48
122100.	.660	.655	1.815	60.48
124300.	.765	.760	2.015	67.16
128600.	.865	.865	2.160	72.48
130600.	.925	.920	2.345	78.16
131600.	1.010	1.005	2.515	83.81
132200.	1.110	1.100	2.710	90.30
343260L4_ X7080T751			T = .4552 IN.	SIP = 8.1 KSI
(65500.) 0.	.000	.000	.500	16.67
5500.	.025	.015	.540	18.00
24900.	.045	.040	.585	19.50
44700.	.065	.060	.625	20.83
57300.	.140	.135	.775	25.83
60600.	.190	.165	.855	28.50
86500.	.220	.220	.940	31.33
87600.	.280	.270	1.050	35.00
93000.	.325	.315	1.140	38.00
98500.	.375	.370	1.245	41.50
104500.	.425	.420	1.345	44.83
108300.	.500	.485	1.485	49.50
113700.	.575	.565	1.640	54.67
116300.	.735	.720	1.955	65.17
116400.	[illegible]	.850	2.200	73.33
117600.	[illegible]	.943	2.380	79.33
118600.	[illegible]	1.015	2.535	84.50
119100.	1.110	1.100	2.710	90.33

343260, TRANS. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
343260T1_ X7080T751			T = .4996 IN.	SIP = 8.1 KSI
(86700.) 0.	.000	.000	.500	16.67
4100.	.025	.025	.525	17.50
28300.	.045	.035	.620	20.67
43700.	.135	.075	.710	23.67
56600.	.180	.110	.790	26.33
66600.	.225	.170	.895	29.83
75100.	.275	.225	1.000	33.33
88200.	.335	.285	1.120	37.33
93900.	.395	.335	1.230	41.00
101100.	.475	.410	1.385	46.17
107900.	.545	.465	1.550	51.67
113800.	.595	.575	1.740	58.00
117700.	.745	.675	1.920	64.00
120600.	.870	.755	2.125	70.83
122100.	.870	.920	2.290	76.33
123100.	1.101	.870	2.470	82.33
343260_T2 X7080T751			T = .4984 IN.	SIP = 8.2 KSI
(93900.) 0.	.000	.000	.500	16.67
7400.	.055	.025	.580	19.33
35700.	.110	.060	.660	22.00
49600.	.150	.110	.760	25.33
63600.	.200	.155	.855	28.50
73100.	.235	.200	.935	31.17
78400.	.275	.225	1.000	33.33
87300.	.330	.295	1.115	37.17
94000.	.375	.340	1.215	40.50
101600.	[illegible]	.400	1.340	44.67
107400.	[illegible]	.445	1.435	47.83
112700.	[illegible]	.520	1.575	52.50
117500.	[illegible]	.580	1.710	57.00
122600.	.735	.660	1.910	63.67
124300.	[illegible]	.765	2.070	69.00
126600.	[illegible]	.865	2.250	75.00
127600.	[illegible]	.905	2.365	78.83
128100.	[illegible]	.965	2.550	85.00
129200.	1.20	.970	2.690	89.33
343260_T3 X7080T751			T = .4989 IN.	SIP = 8.2 KSI
(-1200.) 0.	.000	.000	.500	16.66
1000.	.010	.010	.520	16.99
29400.	.026	.065	.590	19.66
46300.	.050	.110	.670	22.33
57700.	.105	.155	.760	25.32
68400.	.155	.145	.800	26.66
78400.	.200	.245	.945	31.49
86800.	.220	.280	1.000	33.32
95200.	.275	.320	1.095	36.49
98400.	[illegible]	.395	1.225	40.82
113100.	[illegible]	.445	1.365	45.48
118700.	.455	.510	1.465	48.82
122800.	.510	.570	1.585	52.82
126600.	.535	.625	1.710	56.98
130200.	[illegible]	.695	1.840	61.31
132800.	[illegible]	.760	1.960	65.31
135100.	[illegible]	.830	2.100	69.98
136600.	.965	.900	2.245	74.81
137800.	.920	1.000	2.420	80.64
138400.	.970	1.100	2.570	85.64

343259, LONG. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
343259L1_ X7080T751			T = .7515 IN.	SIP = 8.2 KSI
(-39000.) 0.	.000	.000	.500	16.66
1900.	.010	.000	.510	16.99
39000.	.040	.010	.550	18.33
50700.	.075	.015	.590	19.66
66600.	.110	.045	.655	21.83
79000.	.155	.085	.740	24.66
91500.	.200	.115	.815	27.14
104100.	.230	.145	.875	29.16
120200.	.290	.210	1.000	33.32
132000.	.350	.280	1.130	37.65
141900.	.405	.355	1.260	41.99
145600.	.445	.400	1.345	44.82
148000.	.480	.450	1.430	47.65
152100.	.530	.505	1.535	51.15
155500.	.570	.540	1.610	53.65
157500.	.600	.600	1.700	56.65
159000.	.660	.670	1.830	60.98
161500.	.730	.715	1.945	64.81
164400.	.84	.895	2.235	74.46
165200.	.930	.960	2.390	79.64
165300.	1.250	1.250	3.000	99.97
343259_ L2X70801751			T = .7490 IN.	SIP = 8.2 KSI
76500.) 0.	.000	.000	.500	16.67
3300.	.005	.010	.510	17.00
36010.	.045	.045	.590	19.67
75700.	.100	.085	.685	22.83
102500.	.157	.130	.790	26.33
133300.	.210	.150	.860	28.67
151400.	.265	.235	1.000	33.33
152400.	.270	.235	1.005	33.50
167700.	.335	.290	1.125	37.50
181700.	.415	.375	1.290	43.00
190600.	.425	.440	1.435	47.83
200630.	.477	.455	1.665	55.17
206600.	.705	.625	1.830	61.00
211800.	.660	.695	1.955	65.17
212100.	.670	.745	2.115	70.50
216400.	.965	.810	2.255	75.17
216500.	1.030	.865	2.395	79.83
217000.	1.115	.915	2.530	84.33
343529_ 3X7080T751			T = .7515 IN.	SIP = 8.2 KSI
(175300.) 0.	.000	.000	.500	16.67
4700.	.035	.015	.520	17.33
12700.	.065	.060	.625	20.83
40700.	.115	.110	.725	24.17
65300.	.160	.155	.815	27.17
104500.	.255	.245	1.000	33.33
122800.	.333	.320	1.150	38.33
133300.	.410	.370	1.280	42.67
142900.	.460	.440	1.400	46.67
151100.	.465	.475	1.460	48.67
154700.	.575	.560	1.635	54.50
158200.	.725	.670	1.895	63.17
160900.	.815	.725	2.040	68.00
163100.	.905	.870	2.275	75.83
164400.	.965	.850	2.315	77.17
165500.	1.025	.910	2.435	81.17
165900.	1.125	.960	2.585	86.17

343259, TRANS. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
343529_ I1X7080T751			T = .7455 IN.	SIP = 8.2 KSI
(617800.) 0.	.000	.000	.500	16.67
7100.	.000	.015	.515	17.17
25400.	.030	.035	.565	18.83
52600.	.055	.070	.625	20.83
78100.	.115	.115	.730	24.33
97400.	.165	.165	.830	27.67
112300.	.200	.200	.900	30.00
129900.	.250	.250	1.000	33.33
141200.	.315	.305	1.120	37.33
156500.	.400	.345	1.245	41.49
162900.	.460	.445	1.405	46.83
166100.	.525	.500	1.525	50.83
174900.	.654	.630	1.780	59.33
179500.	.715	.690	1.905	63.50
181600.	.790	.725	2.015	67.17
184100.	.875	.805	2.180	72.67
185500.	1.020	.890	2.410	80.33
343529_ I2X7080T751			T = .7502 IN.	SIP = 8.2 KSI
(877600.) 0.	.000	.000	.500	16.66
1300.	.015	.010	.525	17.49
40900.	.172	.155	.825	27.49
74600.	.165	.140	.795	26.49
90850.	.215	.205	.920	30.66
96400.	.245	.255	1.000	33.32
107850.	.315	.290	1.105	36.82
118500.	.375	.370	1.245	41.49
126500.	.417	.400	1.315	43.82
132000.	.460	.465	1.425	47.49
134700.	.555	.520	1.575	52.49
139800.	.615	.610	1.725	57.49
143400.	.705	.685	1.890	62.98
145330.	.775	.765	2.040	67.98
146600.	.835	.810	2.140	71.31
147600.	.44	.945	2.255	75.14
148100.	[illegible]	.930	2.410	80.31
148500.	1.060	1.000	2.560	85.30
343529_ I3X7080T751			T = .7528 IN.	SIP = 8.2 KSI
(13200.) 0.	.000	.000	.500	16.47
5800.	.015	.030	.535	17.64
34300.	.061	.065	.626	20.54
47700.	.111	.105	.715	23.94
57500.	.167	.160	.820	27.24
71200.	.21	.210	.920	30.64
85500.	.251	.250	1.000	33.34
91500.	.310	.300	1.110	37.01
100200.	.370	.355	1.225	40.45
98400.	.415	.415	1.350	45.07
114500.	.465	.475	1.440	48.06
119500.	.575	.540	1.615	53.45
122300.	.640	.600	1.740	58.02
125700.	.710	.64	1.850	61.66
129500.	.790	.730	2.020	67.34
129000.	.850	.775	2.140	71.34
131200.	.975	.855	2.275	75.84
131700.	.985	.890	2.375	79.19
132200.	[illegible]	.940	2.520	84.13

Notes

343260 - 1/2-in. thick plate.
343259 - 1-5/8-in. thick plate.
Cycles - Number of cycles of crack propagation. Figures in parenthesis indicate cycles to initial crack - see text for method of determination.
Fatigue Crack Length - measured on specimen surface.
Total Notch Length - 0.50-in. long machined notch plus fatigue cracks.
Percent Cracked - Total notch length expressed as percent of gross width.
T - specimen thickness, in.

Approved for Public Release

Contrails

CRACK PROPAGATION FOR CENTER-NOTCHED FATIGUE SPECIMENS

Constant Load Tests, Maximum Gross Stress in Cycle = 8.2 ksi, Stress Ratio = 1/3
7178-T651 Plate

340457. LONG. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
340457_3L2_7178T651			T = .5016 IN. SIP = 8.2 KSI	
(1480400.) 0.	.000	.000	.500	16.67
1430.	.015	.000	.515	17.17
53100.	.085	.000	.585	19.50
85400.	.180	.000	.680	22.67
105200.	.320	.000	.820	27.33
114900.	.400	.000	.900	30.00
125900.	.500	.000	1.000	33.33
132600.	.585	.000	1.085	36.17
141200.	.695	.000	1.195	39.83
144500.	.755	.065	1.320	44.00
146800.	.815	.135	1.450	48.33
149000.	.875	.205	1.580	52.67
150800.	.935	.265	1.700	56.67
152500.	1.055	.315	1.870	62.33
340457_3L3_7178T651			T = .5012 IN. SIP = 8.2 KSI	
(1122100.) 0.	.000	.000	.500	16.67
15000.	.000	.115	.615	20.50
25500.	.000	.195	.695	23.17
35900.	.000	.275	.775	25.83
43000.	.000	.335	.835	27.83
51400.	.000	.410	.910	30.33
59700.	.000	.480	.980	32.67
61100.	.000	.500	1.000	33.33
69500.	.110	.600	1.210	40.33
73400.	.205	.685	1.390	46.33
77500.	.300	.775	1.575	52.50
80900.	.380	.875	1.755	58.50
82000.	.420	.940	1.860	62.00

340457. LONG. MACHINED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
340457_3L4_7178T651			T = .4595 IN. SIP = 8.2 KSI	
(386100.) 0.	.000	.000	.500	16.67
12000.	.105	.000	.605	20.17
24900.	.230	.000	.730	24.34
30800.	.270	.000	.770	25.69
35200.	.320	.000	.820	27.34
39500.	.370	.000	.870	29.01
42900.	.415	.000	.915	30.51
45000.	.450	.000	.950	31.68
49000.	.500	.000	1.000	33.34
51900.	.555	.055	1.110	37.01
54700.	.610	.135	1.245	41.51
56900.	.665	.190	1.355	45.18
58500.	.725	.245	1.470	49.02
60300.	.815	.310	1.625	54.18
61500.	.885	.365	1.750	58.35
62100.	1.005	.415	1.920	64.02
340457_3L5_7178T651			T = .4596 IN. SIP = 8.2 KSI	
(663500.) 0.	.000	.000	.500	16.67
4900.	.030	.020	.550	18.33
16000.	.060	.055	.615	20.50
23500.	.090	.080	.670	22.33
29100.	.155	.120	.775	25.83
33900.	.215	.185	.900	30.00
35500.	.270	.230	1.000	33.33
40100.	.350	.330	1.180	39.33
43200.	.445	.410	1.355	45.17
45700.	.525	.500	1.525	50.83
47900.	.630	.595	1.725	57.50
49600.	.745	.695	1.940	64.67
50100.	.825	.765	2.090	69.67
50200.	.840	.780	2.120	70.67

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
340457_3T1_7178T651			T = .5016 IN. SIP = 8.2 KSI	
(441500.) 0.	.000	.000	.500	16.67
9200.	.040	.000	.540	18.00
28600.	.130	.000	.630	21.00
51600.	.230	.000	.730	24.33
74500.	.365	.000	.865	28.83
87100.	.455	.045	1.000	33.33
92900.	.500	.110	1.110	37.00
99100.	.575	.185	1.260	42.00
103200.	.640	.260	1.400	46.67
107300.	.730	.335	1.565	52.17
109700.	.825	.405	1.730	57.67
110700.	.875	.435	1.810	60.33
340457_3T2_7178T651			T = .5020 IN. SIP = 8.2 KSI	
(5994800.) 0.	.000	.000	.500	16.67
13900.	.125	.000	.625	20.83
21400.	.185	.000	.685	22.83
27300.	.245	.000	.745	24.83
32700.	.290	.000	.790	26.33
38600.	.345	.000	.845	28.17
44600.	.415	.000	.915	30.50
48700.	.465	.000	.965	32.17
50900.	.500	.000	1.000	33.33
55400.	.560	.000	1.060	35.33
58700.	.615	.000	1.115	37.17
62000.	.685	.030	1.215	40.50
63900.	.735	.110	1.345	44.83
65500.	.795	.175	1.470	49.00
67000.	.880	.245	1.625	54.17
68000.	.960	.295	1.755	58.50
340457_3T3_7178T651			T = .5018 IN. SIP = 8.2 KSI	
(1247400.) 0.	.000	.000	.500	16.67
4600.	.040	.000	.540	18.00
23500.	.080	.000	.580	19.33
34000.	.165	.000	.665	22.17
49200.	.265	.000	.765	25.50
58300.	.335	.020	.855	28.50
61900.	.375	.045	.920	30.67
66000.	.415	.085	1.000	33.33
70800.	.475	.155	1.130	37.67
74500.	.515	.210	1.225	40.83
77200.	.570	.250	1.320	44.00
79900.	.615	.305	1.420	47.33
82100.	.680	.360	1.540	51.33
83700.	.730	.395	1.625	54.17
85100.	.800	.450	1.750	58.33
85400.	.815	.465	1.780	59.33

340450. LONG. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
340450_1L1_7178T651			T = .7504 IN. SIP = 8.2 KSI	
(919100.) 0.	.000	.000	.500	16.68
10000.	.000	.020	.520	17.34
28000.	.000	.055	.555	18.51
52900.	.000	.105	.605	20.18
67300.	.000	.160	.660	22.01
81300.	.000	.265	.765	25.52
93700.	.000	.355	.855	28.52
102800.	.035	.435	.970	32.35
104400.	.045	.455	1.000	33.36
109900.	.115	.525	1.140	38.03
113800.	.145	.590	1.235	41.19
115900.	.240	.635	1.375	45.86
119200.	.320	.700	1.520	50.70
121700.	.390	.800	1.690	56.37
123800.	.470	.935	1.905	63.54
340450_1L2_7178T651			T = .7420 IN. SIP = 8.2 KSI	
(148700.) 0.	.000	.000	.500	16.68
1800.	.020	.000	.520	17.34
18500.	.050	.040	.590	19.68
32900.	.120	.075	.695	23.18
48800.	.260	.185	.945	31.52
51400.	.285	.215	1.000	33.36
54000.	.305	.240	1.045	34.86
60600.	.375	.320	1.195	39.86
65400.	.440	.385	1.325	44.20
68400.	.485	.420	1.405	46.86
72500.	.550	.505	1.555	51.87
75500.	.580	.560	1.640	54.70
77800.	.670	.620	1.790	59.71
80000.	.765	.695	1.960	65.38
81200.	.845	.790	2.135	71.21
81500.	.860	.800	2.160	72.05

340450. TRANS. ROLLED SURFACES

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
340450_2T1_7178T651			T = .7518 IN. SIP = 8.2 KSI	
(581200.) 0.	.000	.000	.500	16.67
4000.	.000	.030	.530	17.67
24100.	.000	.075	.575	19.17
35600.	.000	.145	.645	21.51
47400.	.005	.220	.725	24.17
53000.	.060	.255	.815	27.18
62400.	.155	.345	1.000	33.34
66600.	.240	.400	1.140	38.01
73200.	.305	.480	1.285	42.85
77000.	.375	.550	1.425	47.52
80400.	.430	.600	1.530	51.02
83400.	.510	.695	1.705	56.85
85200.	.570	.790	1.860	62.02
85300.	.580	.820	1.900	63.35
340450_2T2_7178T651			T = .7420 IN. SIP = 8.2 KSI	
(864100.) 0.	.000	.000	.500	16.68
11500.	.070	.000	.570	19.01
28500.	.170	.000	.670	22.35
41900.	.253	.000	.753	25.12
53400.	.320	.000	.820	27.3[illegible]
62800.	.395	.000	.895	29.[illegible]
72800.	.490	.010	1.000	33.3[illegible]
81500.	.545	.110	1.205	40.1[illegible]
85200.	.660	.190	1.340	44.7[illegible]
88000.	.735	.240	1.475	49.[illegible]
90100.	.815	.290	1.605	53.[illegible]
91000.	.905	.340	1.745	58.[illegible]
91600.	.920	.350	1.770	59.0[illegible]
340450_2T3_7178T651			T = .7518 IN. SIP = 8.2 KSI	
(528000.) 0.	.000	.000	.500	16.66
22400.	.000	.030	.530	17.68
40100.	.000	.075	.575	19.18
84600.	.000	.110	.610	20.35
110900.	.000	.175	.675	22.51
117400.	.035	.220	.755	25.18
127100.	.080	.265	.845	28.19
134100.	.135	.320	.955	31.85
137100.	.155	.345	1.000	33.36
146600.	.275	.440	1.215	40.53
151500.	.355	.515	1.370	45.70
154700.	.425	.560	1.485	49.53
157800.	.495	.635	1.630	54.37
161500.	.655	.775	1.930	64.38
161620.	.665	.785	1.950	65.04
161600.	.670	.790	1.960	65.38

Notes

340457 - 1/2-in. thick plate
340450 - 1-3/8-in. thick plate
Cycles - Number of cycles of crack propagation. Figures in parenthesis indicate cycles to initial crack - see text for method of determination.
Fatigue Crack Length - measured on specimen surface.
Total Notch Length - 0.50-in. long machined notch plus fatigue cracks.
Percent Cracked - Total notch length expressed as percent of gross width.
T - specimen thickness, in.

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CRACK PROPAGATION FOR CENTER-NOTCHED FATIGUE SPECIMENS

Constant Load Tests, Maximum Gross Stress in Cycle = 8.2 ksi, Stress Ratio = +1/3
7075-T6510 Extrusions

340637, LONG., EXTRUDED SURFACES

340637_L1 7075T6510 SIP = 8.2 KSI, T = .6661 IN.

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(92500.) 0.	.000	.000	.500	16.64
2700.	.007	.015	.515	17.14
16400.	.020	.045	.565	18.81
33100.	.065	.080	.645	21.47
42700.	.095	.105	.700	23.30
51100.	.115	.150	.765	25.47
59900.	.190	.230	.920	30.63
65700.	.235	.265	1.000	33.29
70400.	.280	.315	1.095	36.45
80000.	.370	.400	1.270	42.28
85000.	.445	.470	1.415	47.10
90300.	.515	.535	1.550	51.60
94200.	.590	.615	1.705	56.76
97200.	.655	.690	1.845	61.42
99300.	.725	.745	1.970	65.58
100700.	.780	.805	2.085	69.41
101500.	.850	.870	2.220	73.90
101900.	.875	.900	2.275	75.73

340637_L2 7075T6510 SIP = 8.2 KSI, T = .6660 IN.

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(111800.) 0.	.000	.000	.500	16.63
4900.	.015	.000	.515	17.13
16200.	.040	.000	.540	17.96
25500.	.070	.000	.570	18.96
40000.	.130	.000	.630	20.96
51800.	.225	.000	.725	24.12
62900.	.305	.000	.805	26.78
67900.	.385	.020	.905	30.11
74000.	.445	.055	1.000	33.27
78900.	.505	.085	1.090	36.26
82300.	.560	.140	1.200	39.92
85000.	.605	.190	1.295	43.08
88700.	.670	.275	1.445	48.07
91300.	.760	.350	1.610	53.56
93200.	.855	.410	1.765	58.72
94700.	1.000	.470	1.970	65.54
95100.	1.110	.490	2.100	69.86

340637_L3 7075T6510 SIP = 8.2 KSI, T = .6620 IN.

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(78200.) 0.	.000	.000	.500	16.63
4100.	.020	.000	.520	17.30
16400.	.050	.000	.550	18.30
24600.	.090	.015	.605	20.13
38200.	.140	.035	.695	23.12
49300.	.250	.060	.810	26.95
55600.	.305	.085	.890	29.61
61500.	.350	.125	.975	32.44
63000.	.365	.135	1.000	33.27
68300.	.410	.210	1.120	37.26
72400.	.450	.245	1.195	39.75
76300.	.510	.300	1.310	43.58
79400.	.570	.355	1.425	47.41
83700.	.635	.415	1.550	51.56
87300.	.715	.470	1.685	56.05
90100.	.800	.540	1.840	61.21
91600.	.865	.585	1.950	64.87
92900.	.955	.635	2.090	69.53
93400.	1.010	.675	2.185	72.69

340637, LONG., MACHINED SURFACES

340637_L4 7075T6510 SIP = 8.2 KSI, T = .6274 IN.

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(108900.) 0.	.000	.000	.500	16.64
11800.	.030	.025	.555	18.48
24300.	.065	.050	.615	20.47
35300.	.090	.075	.665	22.14
44300.	.115	.110	.725	24.13
49500.	.170	.140	.810	26.96
53500.	.200	.200	.900	29.96
57600.	.250	.250	1.000	33.29
62100.	.310	.310	1.120	37.28
65900.	.370	.370	1.240	41.28
69900.	.435	.440	1.375	45.77
72600.	.490	.505	1.495	49.77
74800.	.555	.570	1.625	54.09
76800.	.615	.635	1.750	58.25
78100.	.695	.695	1.890	62.92
79000.	.740	.775	2.015	67.08
79900.	.790	.825	2.115	70.41
80700.	.860	.950	2.310	76.90

340637_L5 7075T6510 SIP = 8.2 KSI, T = .6264 IN.

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(148900.) 0.	.000	.000	.500	16.64
5500.	.000	.010	.510	16.97
17800.	.000	.030	.530	17.64
28400.	.000	.050	.550	18.30
40000.	.035	.105	.640	21.30
48000.	.070	.160	.730	24.29
55500.	.095	.210	.805	26.79
61100.	.160	.250	.910	30.29
65200.	.215	.285	1.000	33.28
69900.	.280	.335	1.115	37.10
74200.	.340	.400	1.240	41.26
78000.	.415	.450	1.365	45.42
81600.	.505	.525	1.530	50.92
84700.	.595	.590	1.685	56.07
87000.	.680	.680	1.860	61.90
88900.	.760	.760	2.020	67.22
90000.	.845	.830	2.175	72.38
90700.	.905	.895	2.300	76.54

340637, TRANS., EXTRUDED SURFACES

340637_T1 7075T6510 SIP = 8.2 KSI, T = .5004 IN.

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(11700.) 0.	.000	.000	.500	16.64
1300.	.000	.015	.515	17.14
22200.	.000	.120	.620	20.64
35600.	.020	.175	.695	23.14
43400.	.065	.230	.795	26.46
51700.	.130	.310	.940	31.29
53900.	.170	.330	1.000	33.29
54900.	.185	.345	1.030	34.29
59000.	.235	.390	1.125	37.45
63600.	.300	.460	1.260	41.94
69600.	.440	.580	1.520	50.60
72700.	.525	.705	1.730	57.59
73900.	.585	.750	1.835	61.09
75100.	.640	.825	1.965	65.41
76100.	.720	.900	2.120	70.57
76800.	.760	.950	2.210	73.57

340637T2 7075T6510 SIP = 8.2 KSI, T = .4994 IN.

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(222200.) 0.	.000	.000	.500	16.64
3000.	.015	.000	.515	17.14
34300.	.060	.000	.560	18.64
54800.	.125	.000	.625	20.80
66200.	.180	.000	.680	22.63
80200.	.260	.000	.760	25.29
95800.	.360	.000	.860	28.62
111900.	.480	.020	1.000	33.28
119000.	.575	.115	1.190	39.60
124000.	.655	.180	1.335	44.43
126800.	.720	.230	1.450	48.25
129400.	.805	.275	1.580	52.58
131900.	.890	.335	1.725	57.40
133300.	.980	.370	1.850	61.56
133300.	1.240	1.240	2.980	99.17

340637T3 7075T6510 SIP = 8.2 KSI, T = .4996 IN.

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(95900.) 0.	.000	.000	.500	16.65
2200.	.020	.000	.520	17.32
9200.	.050	.015	.565	18.81
16800.	.095	.035	.630	20.98
23300.	.155	.075	.730	24.31
27500.	.195	.110	.805	26.81
34800.	.240	.165	.905	30.14
39700.	.295	.205	1.000	33.30
44600.	.355	.255	1.110	36.96
49200.	.430	.305	1.235	41.13
53300.	.500	.365	1.365	45.45
56600.	.580	.425	1.505	50.12
59300.	.655	.470	1.625	54.11
60900.	.725	.520	1.745	58.11
62400.	.800	.570	1.870	62.27
63700.	.895	.630	2.025	67.43
63900.	.935	.640	2.075	69.10
63900.	1.240	1.740	2.980	99.23

340619, LONG., EXTRUDED SURFACES

340619_SL1 7075T6510 SIP = 8.2 KSI, T = .7519 IN.

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(124500.) 0.	.000	.000	.500	16.66
3700.	.000	.020	.520	17.32
20700.	.000	.065	.565	18.82
45900.	.015	.115	.630	20.99
59300.	.050	.185	.735	24.48
70800.	.085	.250	.835	27.81
79300.	.130	.295	.925	30.81
82200.	.175	.330	1.000	33.31
87000.	.220	.370	1.090	36.31
93000.	.285	.435	1.220	40.64
99500.	.345	.505	1.350	44.97
102500.	.405	.505	1.410	46.97
105900.	.465	.615	1.580	52.63
109200.	.505	.670	1.675	55.80
112200.	.570	.745	1.815	60.46
115400.	.670	.875	2.045	68.12
116500.	.735	.955	2.190	72.95
117200.	.765	1.050	2.315	77.12

340619_SL2 7075T6510 SIP = 8.2 KSI, T = .7508 IN.

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(108900.) 0.	.000	.000	.500	16.64
4600.	.000	.020	.520	17.30
28300.	.025	.070	.595	19.80
40100.	.055	.095	.650	21.63
52600.	.085	.125	.710	23.63
69600.	.130	.200	.830	27.62
78800.	.165	.270	.935	31.11
81600.	.200	.300	1.000	33.28
82500.	.215	.305	1.020	33.94
85500.	.250	.340	1.090	36.27
91200.	.315	.400	1.215	40.43
95700.	.390	.465	1.355	45.09
99300.	.455	.530	1.485	49.42
102900.	.535	.595	1.630	54.24
106600.	.625	.680	1.805	60.07
108900.	.705	.755	1.960	65.22
110100.	.775	.815	2.090	69.55
110900.	.835	.890	2.225	74.04
111500.	.895	.960	2.355	78.37
111800.	.960	1.030	2.490	82.86

340619, LONG., T/4, MACHINED

340619_ML 7075T6510 SIP = 8.2 KSI, T = .7514 IN.

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(144200.) 0.	[illegible]	.000	.500	16.65
3800.	.025	.025	.550	18.32
17800.	[illegible]	.055	.650	21.65
27700.	.140	.140	.780	25.97
35300.	.195	.190	.885	29.47
42200.	.245	.240	.985	32.80
47800.	.255	.245	1.000	33.30
49900.	.295	.295	1.090	36.30
53600.	.340	.335	1.175	39.13
56500.	[illegible]	.345	1.280	42.62
63200.	[illegible]	.440	1.360	45.29
68100.	[illegible]	.520	1.550	51.62
71300.	[illegible]	.560	1.675	55.78
74100.	[illegible]	.645	1.805	60.11
76500.	.730	.715	1.945	64.77
78600.	[illegible]	.770	2.070	68.93
79900.	.860	.840	2.200	73.26
81100.	[illegible]	.910	2.345	[illegible]
82000.	1.045	1.025	2.570	85.58

Notes

340637 - 11/16 x 16-in. extruded panel.
340619 - 3-1/2 x 7-1/2-in. extruded bar
Cycles - Number of cycles of crack propagation. Figures in parenthesis indicate cycles to initial crack - see text for method of determination.
Fatigue Crack Length - measured on specimen surface.
Total Notch Length - 0.50-in. long machined notch plus fatigue cracks.
Percent Cracked - Total notch length expressed as percent of gross width.
T - specimen thickness, in.

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Contrails

CRACK PROPAGATION FOR CENTER-NOTCHED FATIGUE SPECIMENS

Constant Load Tests, Maximum Gross Stress in Cycle - 8.2 ksi, Stress Ratio = 1/3
7075-T73510 Extrusions

340639, LONG, EXTRUDED SURFACES

340639_L1 7075T73510 — T = .4622 IN., SIP = 8.2 KSI

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(63000.) 0.	.000	.000	.500	16.66
4700.	.000	.015	.515	17.16
19500.	.000	.035	.535	17.80
42500.	.025	.100	.625	20.80
57000.	.050	.150	.700	23.29
69500.	.105	.195	.800	26.62
79500.	.160	.240	.900	29.95
89200.	.205	.295	1.000	33.28
104400.	.290	.380	1.170	38.94
111300.	.345	.430	1.275	42.43
117400.	.395	.485	1.380	45.92
122300.	.435	.545	1.480	49.25
127400.	.505	.605	1.610	53.58
131500.	.565	.675	1.740	57.90
135000.	.635	.755	1.890	62.90
137900.	.700	.855	2.055	68.39
140000.	.770	.965	2.235	74.38
141400.	.845	1.120	2.465	82.03

340639_L2 7075T73510 — T = .4613 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(74900.) 0.	.000	.000	.500	16.66
1300.	.000	.010	.510	16.99
17700.	.020	.030	.550	18.32
30100.	.065	.040	.605	20.15
45700.	.130	.095	.725	24.15
60000.	.180	.145	.825	27.48
70900.	.225	.180	.905	30.15
80600.	.280	.220	1.000	33.31
90600.	.335	.270	1.105	36.81
99000.	.395	.315	1.210	40.31
109000.	.475	.380	1.355	45.14
117100.	.570	.450	1.520	50.63
123000.	.670	.530	1.700	56.63
128400.	.770	.605	1.875	62.46
131300.	.855	.665	2.020	67.29
132600.	.920	.710	2.130	70.95
133900.	1.000	.745	2.245	74.78
134800.	1.110	.800	2.410	80.28
135000.	1.145	.805	2.450	81.61

340639_L3 7075T73510 — T = .4422 IN., SIP = 8.1 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(66300.) 0.	.000	.000	.500	16.67
4400.	.010	.005	.515	17.17
21300.	.030	.025	.555	18.51
34800.	.045	.060	.605	20.17
49300.	.080	.110	.690	23.01
62900.	.135	.160	.795	26.51
74100.	.185	.210	.895	29.84
85100.	.235	.265	1.000	33.34
95600.	.290	.320	1.110	37.01
106600.	.350	.375	1.225	40.85
114500.	.440	.455	1.395	46.52
122700.	.525	.540	1.565	52.18
127500.	.605	.610	1.715	57.19
131600.	.670	.685	1.855	61.85
134500.	.760	.755	2.015	67.19
136400.	.835	.835	2.170	72.36
138100.	.920	.905	2.325	77.53
139000.	1.005	.975	2.480	82.69
139400.	1.115	1.040	2.655	88.53

340639, LONG, MACHINED SURFACES

340639_L4 7075T73510 — T = .4274 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(100200.) 0.	.000	.000	.500	16.65
6300.	.010	.005	.515	17.15
23000.	.025	.025	.550	18.32
42100.	.045	.050	.595	19.81
60500.	.065	.070	.635	21.15
77200.	.095	.120	.715	23.81
90400.	.140	.170	.810	26.97
100500.	.200	.220	.920	30.64
105100.	.245	.255	1.000	33.30
117900.	.300	.310	1.110	36.96
125500.	.355	.365	1.220	40.63
133900.	.430	.435	1.365	45.45
140700.	.505	.510	1.515	50.45
147000.	.600	.605	1.705	56.78
149800.	.665	.665	1.830	60.94
153800.	.755	.755	2.010	66.93
155600.	.815	.810	2.125	70.76
156900.	.875	.870	2.245	74.76
157900.	.930	.920	2.350	78.26
159300.	1.090	1.035	2.625	87.41

340639_L5 7075T73510 — T = .4193 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(53600.) 0.	.000	.000	.500	16.65
2900.	.000	.010	.510	16.98
19400.	.015	.030	.545	18.15
34300.	.040	.055	.595	19.81
49200.	.085	.080	.665	22.14
59600.	.140	.125	.765	25.47
71500.	.205	.185	.890	29.64
80400.	.260	.240	1.000	33.30
90300.	.325	.310	1.135	37.80
99100.	.400	.375	1.275	42.46
106600.	.470	.450	1.420	47.29
111900.	.535	.515	1.550	51.62
116800.	.610	.590	1.700	56.61
120300.	.680	.655	1.835	61.11
123300.	.750	.735	1.985	66.10
125200.	.825	.795	2.120	70.60
126900.	.905	.865	2.270	75.59
127800.	.955	.925	2.380	79.25
128300.	1.015	.975	2.490	82.92
128900.	1.105	1.020	2.625	87.41

340639, TRANS, EXTRUDED SURFACES

340639T1 7075T73510 — T = .4988 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(85300.) 0.	.000	.000	.500	16.65
1600.	.015	.000	.515	17.15
12800.	.030	.040	.570	18.98
27900.	.070	.080	.650	21.65
37900.	.120	.130	.750	24.98
46000.	.150	.170	.820	27.31
56000.	.195	.200	.895	29.80
65700.	.245	.255	1.000	33.30
75700.	.300	.310	1.110	36.96
84900.	.375	.380	1.255	41.79
91900.	.450	.450	1.400	46.62
97400.	.515	.505	1.520	50.62
100800.	.565	.555	1.620	53.95
104500.	.640	.640	1.780	59.27
108200.	.755	.740	1.995	66.43
109800.	.815	.800	2.115	70.43
111000.	.905	.890	2.295	76.42
111900.	.995	.980	2.475	82.42
112000.	1.060	1.020	2.580	85.91
112600.	1.240	1.240	2.980	99.23

340639T2 7075T73510 — T = .5018 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(77500.) 0.	.000	.000	.500	16.64
4700.	.000	.020	.520	17.31
19400.	.020	.050	.570	18.97
33700.	.040	.090	.630	20.97
45600.	.100	.130	.730*	24.30
59200.	.150	.185	.835	27.80
69500.	.210	.235	.945	31.46
74300.	.240	.260	1.000	33.29
83600.	.295	.320	1.115	37.12
90000.	.350	.380	1.230	40.95
101600.	.485	.500	1.485	49.43
106200.	.545	.570	1.615	53.76
109900.	.615	.640	1.755	58.42
112500.	.680	.700	1.880	62.58
116200.	.825	.845	2.170	72.24
117100.	.885	.910	2.295	76.40
117700.	.945	.975	2.420	80.56
118100.	1.000	1.060	2.560	85.22
118100.	1.240	1.240	2.980	99.20

340639T3 7075T73510 — T = .4974 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(68700.) 0.	.000	.000	.500	16.67
2400.	.020	.000	.520	17.33
33000.	.095	.015	.610	20.33
49900.	.150	.055	.705	23.50
64400.	.210	.115	.825	27.50
77500.	.255	.165	.920	30.67
85500.	.300	.200	1.000	33.33
96600.	.370	.265	1.135	37.83
105900.	.440	.325	1.265	42.17
112900.	.510	.380	1.390	46.33
117000.	.570	.430	1.500	50.00
125100.	.715	.520	1.735	57.83
127600.	.775	.570	1.845	61.50
129700.	.870	.620	1.990	66.33
131300.	.955	.680	2.135	71.17
132200.	1.035	.715	2.250	75.00
132500.	1.090	.730	2.320	77.33
132600.	1.240	1.240	2.980	99.33

340620, LONG, EXTRUDED SURFACES

340620SL1 7075T73510 — T = .75[illegible] IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(86100.) 0.	[illegible]	.000	.500	16.66
5000.	[illegible]	.020	.530	17.66
22500.	.010	.090	.600	19.99
33100.	.045	.120	.665	22.15
41700.	.080	.150	.730	24.32
55000.	.145	.205	.850	28.31
63600.	.195	.245	.940	31.32
70200.	.215	.285	1.000	33.31
80000.	.275	.340	1.115	37.14
88300.	.345	.400	1.245	41.47
96700.	.420	.475	1.395	46.47
102500.	.490	.540	1.530	50.97
106900.	.555	.610	1.665	55.46
111400.	.650	.695	1.845	61.46
115100.	.750	.800	2.050	68.29
117500.	.860	.900	2.260	75.28
118900.	.955	1.005	2.460	81.95
119500.	1.020	1.090	2.610	86.94
119600.	1.035	1.115	2.650	88.27

340620SL2 7075T73510 — T = .7506 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(132000.) 0.	.000	.000	.500	16.66
7000.	.015	.005	.520	17.32
17500.	.030	.020	.550	18.32
29700.	.045	.040	.585	19.49
44100.	.080	.090	.670	22.32
52100.	.130	.150	.780	25.98
72200.	.185	.195	.880	29.31
83200.	.245	.255	1.000	33.31
92500.	.305	.310	1.115	37.14
102500.	.395	.400	1.295	43.14
110300.	.470	.480	1.450	48.30
116500.	.555	.540	1.615	53.80
121300.	.650	.660	1.810	60.29
124600.	.745	.745	1.990	66.29
126200.	.800	.805	2.105	70.12
127900.	.895	.885	2.270	75.62
128900.	.950	.970	2.420	80.61
129800.	1.060	1.090	2.650	88.27

340620, TRANS., T/4, MACHINED

340620_ML 7075T73510 — T = .7524 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(93600.) 0.	[illegible]	.000	.500	16.66
[illegible]	[illegible]	.020	.520	17.32
14600.	[illegible]	.040	.560	18.65
29800.	.070	.095	.665	22.15
44000.	[illegible]	.140	.775	25.82
61000.	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	.255	1.000	33.31
[illegible]	[illegible]	.330	1.135	37.81
96900.	[illegible]	[illegible]	1.265	42.14
103900.	[illegible]	.455	1.405	[illegible]
110700.	[illegible]	.535	1.565	52.13
115200.	[illegible]	.615	1.715	57.13
119000.	[illegible]	[illegible]	[illegible]	[illegible]
122000.	[illegible]	.765	[illegible]	[illegible]
124100.	[illegible]	[illegible]	[illegible]	[illegible]
125500.	[illegible]	.915	[illegible]	[illegible]
126600.	[illegible]	1.000	[illegible]	[illegible]
127200.	[illegible]	1.475	[illegible]	[illegible]

Notes

340639 - 11/16 x 15-in. extruded panel.
340620 - 3-1/2 x 7-1/2-in. extruded bar.
Cycles - Number of cycles of crack propagation. Figures in parenthesis indicate cycles to initial crack - see text for method of determination.
Fatigue Crack Length-measured on specimen surface.
Total Notch Length - 0.50-in. long machined notch plus fatigue cracks.
Percent Cracked - Total notch length expressed as percent of gross width.
T - specimen thickness, in.

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Contrails

CRACK PROPAGATION FOR CENTER-NOTCHED FATIGUE SPECIMENS
Constant Load Tests, Maximum Gross Stress in Cycle = 8.2 ksi, Stress Ratio = 1/3
X7080-T7E42 Extrusions

340730, LONG. EXTRUDED SURFACES

340730L1 X7080T6E42 — T = .4512 IN., SIP = 8.2 KSI

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(113600.) 0.	.000	.000	.500	16.65
2600.	.015	.000	.515	17.15
9600.	.035	.025	.560	18.65
23100.	.070	.070	.640	21.31
36400.	.125	.120	.745	24.81
46700.	.180	.165	.845	28.14
54900.	.230	.195	.925	30.80
59700.	.270	.230	1.000	33.30
67000.	.330	.290	1.120	37.30
75900.	.400	.360	1.260	41.96
84900.	.485	.445	1.430	47.62
92200.	.580	.545	1.625	54.11
97200.	.665	.625	1.790	59.61
101200.	.745	.705	1.950	64.94
105800.	1.050	.880	2.430	80.92
106100.	1.145	.915	2.560	85.25

340730L2 X7080T6E42 — T = .4543 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(106700.) 0.	.000	.000	.500	16.65
3900.	.010	.010	.520	17.32
16900.	.030	.035	.565	18.81
42900.	.065	.060	.625	20.81
66400.	.130	.115	.745	24.81
71900.	.185	.185	.870	28.97
84600.	.250	.250	1.000	33.30
95300.	.320	.325	1.145	38.13
105300.	.395	.410	1.305	43.46
113700.	.475	.490	1.465	48.78
120300.	.580	.590	1.670	55.61
126300.	.705	.690	1.895	63.10
129700.	.805	.805	2.110	70.26
132300.	.930	.915	2.345	78.09
133900.	1.080	1.055	2.635	87.75
133900.	1.085	1.060	2.645	88.08

340730L3 X7080T6E42 — T = .4526 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(66500.) 0.	.000	.000	.500	16.66
5400.	.025	.000	.525	17.49
21100.	.050	.020	.570	18.99
33300.	.090	.040	.630	20.99
43200.	.125	.070	.695	23.15
52600.	.170	.115	.785	26.15
60400.	.200	.155	.855	28.48
73000.	.280	.220	1.000	33.31
84900.	.345	.285	1.130	37.64
93500.	.425	.360	1.285	42.80
100000.	.490	.435	1.425	47.47
107900.	.590	.515	1.605	53.46
112300.	.670	.595	1.765	58.79
117700.	.805	.715	2.020	67.29
120700.	.935	.825	2.260	75.28
122000.	1.050	.895	2.445	81.45
122300.	1.125	.930	2.555	85.11

340730, LONG. MACHINED SURFACES

340730L4 X7080T7E42 — T = .6245 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(74500.) 0.	.000	.000	.500	16.66
4500.	.015	.010	.525	17.49
24900.	.040	.035	.575	19.15
44900.	.075	.090	.665	22.15
62500.	.170	.170	.840	27.98
69900.	.205	.200	.905	30.15
78500.	.260	.240	1.000	33.31
91400.	.345	.325	1.170	38.97
100300.	.425	.405	1.330	44.30
107900.	.505	.470	1.475	49.13
112900.	.585	.535	1.620	53.96
116200.	.635	.605	1.740	57.96
119900.	.725	.685	1.910	63.62
123500.	.870	.740	2.110	70.29
129900.	.995	.925	2.420	80.61
126600.	1.130	.990	2.620	87.24

340730L5 X7080T7E42 — T = .6240 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(81800.) 0.	.000	.000	.500	16.65
3200.	.020	.000	.520	17.32
24200.	.085	.000	.585	19.48
42200.	.160	.015	.675	22.48
56700.	.240	.045	.785	26.14
68700.	.295	.105	.900	29.97
77200.	.340	.160	1.000	33.30
85200.	.415	.220	1.135	37.80
97200.	.510	.310	1.320	43.96
106200.	.600	.395	1.495	49.79
111100.	.690	.465	1.655	55.11
116600.	.815	.560	1.875	62.44
115800.	.930	.650	2.080	69.26
121400.	1.020	.685	2.205	73.43
122400.	1.160	.770	2.430	80.92

340730, TRANS. EXTRUDED SURFACES

340730T1 X7080T6E42 — T = .5586 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(59300.) 0.	.000	.000	.500	16.66
10100.	.030	.015	.545	18.16
39400.	.075	.045	.620	20.66
53700.	.120	.080	.700	23.33
70600.	.160	.110	.770	25.66
80100.	.220	.130	.850	28.32
88500.	.275	.165	.940	31.32
97100.	.315	.185	1.000	33.32
100900.	.395	.250	1.145	38.15
105600.	.440	.290	1.230	40.99
109400.	.495	.335	1.330	44.32
112400.	.550	.355	1.405	46.82
116100.	.615	.410	1.525	50.82
118500.	.680	.440	1.620	53.98
120700.	.725	.495	1.720	57.31
122300.	.800	.515	1.815	60.48
123800.	.880	.560	1.940	64.65
125100.	.950	.595	2.045	68.14
126300.	1.110	.650	2.260	75.31
126300.	1.250	1.250	3.000	99.97

340730T2 X7080T6E42 — T = .6567 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(44800.) 0.	.000	.000	.500	16.67
10800.	.020	.020	.540	18.00
27500.	.055	.055	.610	20.33
44500.	.085	.085	.670	22.33
57400.	.110	.115	.725	24.17
72000.	.145	.150	.795	26.50
83700.	.190	.200	.890	29.67
92000.	.245	.255	1.000	33.33
98600.	.300	.310	1.110	37.00
103400.	.350	.345	1.195	39.83
109300.	.425	.415	1.340	44.67
113600.	.490	.465	1.455	48.50
117500.	.560	.515	1.575	52.50
121600.	.630	.590	1.720	57.33
123600.	.720	.645	1.865	62.17
125400.	.785	.705	1.990	66.33
127300.	.875	.760	2.135	71.17
129000.	.995	.820	2.305	76.83
129900.	1.070	.850	2.420	80.67
129900.	1.240	1.240	2.980	99.33

340730T3 X7080T6E42 — T = .6588 IN., SIP = 8.3 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(51800.) 0.	.000	.000	.500	16.67
4900.	.015	.020	.535	17.83
26900.	.075	.060	.635	21.17
32200.	.100	.095	.695	23.17
35900.	.125	.100	.725	24.17
56400.	.150	.105	.755	25.17
63400.	.210	.150	.860	28.67
75400.	.280	.200	.980	32.67
76400.	.290	.210	1.000	33.33
82300.	.340	.265	1.105	36.83
87600.	.395	.320	1.215	40.50
91100.	.450	.355	1.305	43.50
94100.	.495	.400	1.395	46.50
97200.	.560	.435	1.495	49.83
99800.	.640	.485	1.625	54.17
102400.	.695	.535	1.730	57.67
104200.	.760	.590	1.850	61.67
106200.	.840	.645	1.985	66.17
107700.	.930	.700	2.130	71.00
108500.	1.040	.750	2.290	76.33
108600.	1.095	.760	2.345	78.17
109600.	1.240	1.240	2.980	99.33

340732, LONG. EXTRUDED SURFACES

340732SL1 X7080T7E42 — T = .7502 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(112500.) 0.	.000	.000	.500	16.66
1500.	.000	.015	.515	17.16
17500.	.015	.055	.570	18.99
36000.	.095	.125	.720	23.99
49600.	.145	.180	.825	27.49
58600.	.195	.220	.915	30.48
65700.	.235	.265	1.000	33.31
74700.	.310	.340	1.150	38.31
86100.	.360	.410	1.290	42.97
97100.	.525	.555	1.580	52.63
103100.	.655	.680	1.835	61.13
105200.	.715	.740	1.955	65.12
107100.	.775	.815	2.090	69.62
108900.	.860	.915	2.275	75.78
110000.	.950	1.000	2.450	81.61
110700.	1.050	1.140	2.690	89.61

340732SL2 X7080T7E42 — T = .7519 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(95800.) 0.	.000	.000	.500	16.66
1900.	.000	.020	.520	17.32
12100.	.020	.035	.555	18.49
22300.	.065	.065	.630	20.99
37100.	.115	.120	.735	24.48
49600.	.165	.185	.850	28.31
57900.	.220	.230	.950	31.65
60100.	.240	.260	1.000	33.31
66800.	.285	.300	1.085	36.14
72500.	.340	.340	1.180	39.31
79300.	.410	.420	1.330	44.30
85400.	.480	.500	1.480	49.30
90700.	.565	.585	1.650	54.96
95100.	.660	.690	1.850	61.63
98600.	.765	.795	2.060	68.62
100400.	.875	.895	2.270	75.62
102200.	.990	1.010	2.500	83.28
103800.	1.080	1.130	2.710	90.27

340732, LONG., T/2, MACHINED

340732ML X7080T7E42 — T = .7[illegible] IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(87200.) 0.	.000	.000	.500	16.66
7200.	[illegible]	.020	.520	17.32
26000.	.020	.055	.575	19.1[illegible]
34100.	.045	.095	.640	21.32
46100.	.100	.175	.775	26.[illegible]
55000.	.155	.190	.845	28.[illegible]
64100.	.195	.215	[illegible]	[illegible]
75100.	.235	.265	1.000	33.31
83400.	.285	.315	1.100	36.64
92000.	.340	.375	1.215	40.47
101400.	.420	.450	1.370	45.6[illegible]
108400.	.510	.535	[illegible]	51.[illegible]
114600.	.545	.630	1.725	57.46
117300.	.660	.685	1.845	61.[illegible]
119800.	.725	.740	1.965	65.[illegible]
121600.	.795	.830	2.125	70.[illegible]
122800.	.875	.905	2.28[illegible]	7[illegible]
123600.	.930	.965	2.395	79.7[illegible]
124500.	.940	1.050	2.540	84.61
124900.	1.020	1.120	2.640	87.94

Notes

340730 - 11/16 x 16-in. extruded panel.
307732 - 3-1/2 x 7-1/2-in. extruded bar.
Cycles - Number of cycles of crack propagation. Figures in parenthesis indicate cycles to initial crack - see text for method of determination.
Fatigue Crack Length - measured on specimen surface.
Total Notch Length - 0.50-in. long machined notch plus fatigue cracks.
Percent Cracked - Total notch length expressed as percent of gross width.
T - specimen thickness, in.

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CRACK PROPAGATION FOR CENTER-NOTCHED FATIGUE SPECIMENS

Constant Load Tests, Maximum Gross Stress in Cycle = 8.2 ksi, Stress Ratio = 1/3
7178-T6510 Extrusions

340616, LONG. EXTRUDED SURFACES

340616_L1_7178T6510 — T = .6598 IN., SIP = 8.2 KSI

CYCLES	FATIGUE CRACK LENGTH (IN.) AVG. LEFT	FATIGUE CRACK LENGTH (IN.) AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(134100.) 0.	.000	.000	.500	16.64
2500.	.000	.030	.530	17.64
26300.	.045	.085	.630	20.97
34100.	.070	.140	.710	23.63
44700.	.110	.205	.815	27.12
53500.	.185	.270	.965	32.11
55400.	.215	.285	1.000	33.28
59500.	.255	.320	1.075	35.77
67700.	.355	.405	1.260	41.93
72600.	.430	.470	1.400	46.59
76600.	.505	.535	1.540	51.25
80300.	.595	.605	1.700	56.57
82600.	.675	.675	1.850	61.56
84200.	.775	.830	2.105	70.05

340616_L2_7178T6510 — T = .6594 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(88700.) 0.	.000	.000	.500	16.64
9900.	.000	.020	.520	17.30
35800.	.000	.060	.560	18.64
40300.	.000	.110	.610	20.30
71900.	.025	.170	.695	23.13
79000.	.085	.225	.810	26.96
84200.	.155	.285	.940	31.28
89300.	.185	.315	1.000	33.28
91200.	.200	.325	1.025	34.11
97300.	.260	.390	1.150	38.27
102800.	.325	.460	1.285	42.76
108600.	.400	.530	1.430	47.59
112500.	.455	.580	1.535	51.08
115400.	.510	.625	1.635	54.41
119600.	.610	.765	1.875	62.40
120800.	.650	.825	1.975	65.72
121000.	.665	.850	2.015	67.05

340616_L3_7178T6510 — T = .6587 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(94900.) 0.	.000	.000	.500	16.64
100.	.015	.000	.515	17.14
29600.	.070	.010	.580	19.30
44900.	.125	.045	.670	22.30
54900.	.185	.080	.765	25.46
65300.	.255	.105	.860	28.62
70900.	.295	.145	.940	31.28
74500.	.325	.175	1.000	33.28
78000.	.370	.215	1.085	36.11
83900.	.415	.280	1.195	39.77
91100.	.505	.370	1.375	45.76
95700.	.580	.435	1.515	50.42
99700.	.645	.505	1.650	54.91
102500.	.750	.600	1.850	61.56
103900.	.815	.690	2.005	66.72
104400.	.880	.760	2.140	71.21

340616, LONG. MACHINED SURFACES

340616_L4_7178T6510 — T = .4224 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(141400.) 0.	.000	.000	.500	16.67
3600.	.030	.000	.530	17.67
23500.	.075	.000	.575	19.17
39400.	.170	.000	.670	22.33
49800.	.230	.000	.730	24.33
61400.	.315	.000	.815	27.17
65500.	.345	.015	.860	28.67
73100.	.395	.045	.940	31.33
78000.	.440	.060	1.000	33.33
84700.	.530	.135	1.165	38.83
90400.	.635	.235	1.370	45.67
93100.	.685	.270	1.455	48.50
96900.	.790	.370	1.660	55.33
99300.	.900	.440	1.840	61.33
99700.	.945	.455	1.900	63.33

340616_L5_7178T6510 — T = .6174 IN., SIP = 8.3 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(197500.) 0.	.000	.000	.500	16.65
2600.	.000	.030	.530	17.65
16700.	.000	.090	.590	19.65
26800.	.035	.150	.685	22.81
37300.	.080	.215	.795	26.47
44000.	.105	.270	.875	29.14
49900.	.180	.320	1.000	33.30
58500.	.265	.375	1.140	37.96
64700.	.325	.465	1.290	42.96
69200.	.400	.515	1.415	47.12
72300.	.455	.575	1.530	50.95
75300.	.515	.640	1.655	55.11
77700.	.585	.705	1.790	59.61
79200.	.645	.790	1.925	64.10
79500.	.690	.830	2.020	67.27

340616, TRANS. EXTRUDED SURFACES

340616I1_7178T6510 — T = .5019 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(15000.) 0.	.000	.000	.500	16.64
1900.	.015	.000	.515	17.14
13900.	.100	.000	.600	19.97
22100.	.165	.000	.665	22.14
31600.	.240	.000	.740	24.63
39800.	.320	.000	.820	27.30
46700.	.375	.000	.875	29.13
55900.	.435	.000	.935	31.13
61600.	.500	.000	1.000	33.29
68600.	.570	.000	1.070	35.62
72200.	.620	.000	1.120	37.28
76300.	.680	.000	1.180	39.28
79200.	.745	.035	1.280	42.61
82000.	.815	.075	1.390	46.27
83200.	.860	.095	1.455	48.44

340616I2_7178T6510 — T = .4999 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(122300.) 0.	.000	.000	.500	16.65
2300.	.010	.000	.510	16.98
10400.	.025	.000	.525	17.48
20400.	.060	.000	.560	18.65
27000.	.100	.000	.600	19.98
36800.	.150	.000	.650	21.65
47100.	.210	.000	.710	23.64
59300.	.275	.000	.775	25.81
70100.	.325	.000	.825	27.47
81500.	.410	.000	.910	30.30
87000.	.445	.055	1.000	33.30
93900.	.515	.135	1.150	38.30
99500.	.585	.175	1.260	41.96
109100.	.810	.280	1.590	52.95
109300.	1.250	1.250	3.000	99.90

340616I3_7178T6510 — T = .4988 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(227200.) 0.	.000	.000	.500	16.64
7900.	.035	.000	.535	17.81
18900.	.095	.000	.595	19.81
31300.	.145	.000	.645	21.47
48500.	.235	.000	.735	24.47
58000.	.280	.000	.780	25.97
68900.	.345	.000	.845	28.13
76900.	.395	.000	.895	29.79
82000.	.435	.000	.935	31.13
91600.	.500	.000	1.000	33.29
97900.	.555	.000	1.055	35.12
102300.	.600	.000	1.100	36.62
105600.	.640	.020	1.160	38.62
108800.	.685	.075	1.260	41.94
111600.	.735	.125	1.360	45.27
113800.	.775	.175	1.450	49.27
115700.	.850	.215	1.565	52.10
116700.	.895	.240	1.635	54.43
116800.	.905	.250	1.655	55.09
116800.	1.250	1.250	3.000	99.87

340635, LONG. EXTRUDED SURFACES

340635_SL1_7178T6510 — T = .7497 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(1344000.) 0.	.000	.000	.500	16.65
3100.	.000	.015	.515	17.15
24000.	.025	.050	.575	19.15
44100.	.065	.090	.655	21.81
60400.	.110	.130	.740	24.64
69300.	.175	.185	.860	28.64
77800.	.245	.255	1.000	33.30
82500.	.295	.295	1.090	36.30
88700.	.350	.355	1.205	40.13
96400.	.460	.450	1.410	46.95
104000.	.650	.540	1.690	56.28
105900.	.745	.665	1.910	63.60
106900.	.810	.700	2.010	66.93

340635_SL2_7178T6510 — T = .7500 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(149700.) 0.	.000	.000	.500	16.66
6000.	.025	.000	.525	17.49
20200.	.085	.000	.585	19.49
31000.	.130	.000	.630	20.99
45300.	.195	.015	.710	23.65
54600.	.235	.045	.780	25.98
63100.	.290	.080	.870	28.98
70100.	.340	.145	.985	32.81
71100.	.340	.160	1.000	33.31
76900.	.405	.220	1.125	37.48
82200.	.460	.280	1.240	41.31
86500.	.515	.325	1.340	44.64
90000.	.570	.385	1.455	48.47
92700.	.620	.435	1.555	51.80
95000.	.690	.490	1.680	55.96
96200.	.755	.535	1.790	59.63
97300.	.830	.590	1.920	63.96
97800.	.885	.600	1.985	66.12

340635, LONG., T/2, MACHINED

340635_ML_7178T6510 — T = .7498 IN., SIP = 8.2 KSI

CYCLES	AVG. LEFT	AVG. RIGHT	TOTAL NOTCH LENGTH (IN.)	PERCENT CRACKED
(132800.) 0.	.000	.000	.500	16.67
5000.	.000	.020	.520	17.33
31600.	.000	.065	.565	18.83
50500.	.000	.130	.630	21.00
61400.	.000	.175	.675	22.50
86600.	.035	.245	.780	26.00
92400.	.150	.245	.895	29.83
101000.	.145	.355	1.000	33.33
110200.	.210	.400	1.110	37.00
121300.	.300	.505	1.305	43.50
124400.	.380	.565	1.445	48.17
131000.	.445	.635	1.580	52.67
134400.	.510	.695	1.705	56.83
136900.	.570	.765	1.835	61.17
139000.	.640	.850	1.990	66.33
140000.	.625	.905	2.030	67.67
140300.	.720	1.005	2.225	74.17

Notes

340616 - 11/16 x 18-in. extruded panel
340635 - 3-1/2 x 7-1/2-in. extruded bar
Cycles - Number of cycles of crack propagation. Figures in parenthesis indicate cycle to initial crack - see text for method of determination.
Fatigue Crack Length - measured on specimen surface.
Total Notch Length - 0.50-in. long machined notch plus fatigue cracks.
Percent Cracked - Total notch length expressed as percent of gross width.
T - specimen thickness, in.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Aluminum						
7075-T6510						
7075-T73510						
X7080-T751						
7178-T651						
Plate						
Extruded Shapes						
Tensile Properties						
Plane-Strain Fracture Toughness						
Axial-Stress Fatigue						
Fatigue Crack Propagation						
Exfoliation						
Stress-Corrosion Cracking						

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13. ABSTRACT
The tensile properties, plane-strain fracture toughness (K_{Ic}), axial-stress fatigue properties and fatigue-crack propagation rates, and the resistance to exfoliation and stress-corrosion cracking, have been determined for several aluminum alloys. Two thicknesses of X7080-T7E41(T751) and 7178-T651 plate, and two thicknesses of 7075-T6510, 7075-T73510, X7080-T7E42(T7510) and 7178-T6510 extruded shapes, have been evaluated.

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