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COMPARISON OF FRACTURE TOUGHNESS VALUES OBTAINED USING SEMI-INFINITE ALUMINUM PLATES WITH VALUES OBTAINED USING LABORATORY SIZE SPECIMENS

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TECHNICAL REPORT AFML-TR-69-58

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FOREWORD

This report was prepared by the University of Dayton Research Institute, Dayton, Ohio, under Air Force Contract AF 33(615)-67-C-1262. The contract was initiated under Project No. 7381, "Materials Application," Task No. 738106, "Engineering and Design Data." The program was administered by the Air Force Materials Laboratory, Directorate of Laboratories, Air Force System Command, Wright-Patterson Air Force Base, Ohio. This work was performed under the technical cognizance of Mr. David C. Watson and Mr. Sidney O. Davis.

This report covers preparatory and laboratory work conducted from November 1965 to December 1967 and was released by the author January 1969 for publication. The contractor's report number is UDRI-TR-68-34.

The author wishes to acknowledge the support and technical assistance provided by Mr. G. J. Petrak.

This technical report has been reviewed and is approved.

A. OLEVITCH
Chief, Materials Engineering Branch
Materials Support Division
Air Force Materials Laboratory

ABSTRACT

Fracture toughness values obtained from small laboratory size specimens in four point slow-bend loading were compared with values obtained by Aluminum Company of America (ALCOA) in testing large semi-infinite center notched plate specimens. The plane-strain stress-intensity factors, K_{IC}, determined in this investigation varied from those values obtained by ALCOA by 7% on the positive side and 18% on the negative side. The results, although not conclusive in themselves, tend to substantiate the specimen requirements suggested by Brown and Srawley.

Distribution of this abstract is unlimited.

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SECTION I

INTRODUCTION

The state-of-the-art of fracture mechanics has progressed to such a point that it is currently being considered for application in the design of aircraft. Test methods for plane strain testing have been standardized and the Military Handbook-5 Committee is presently reviewing plane strain data for inclusion in MIL-HDBK-5.

To assist in this effort, Aluminum Company of America (ALCOA) Research Laboratories, under Contract No. AF 33(657)-11155 has generated fracture toughness data on several aluminum alloys by performing tests on large semi-infinite center notched plate specimens. The specimens which were 64" x 20" x 1" were not fatigue cracked. These aluminum plates were evaluated to determine:

1. The suitability of thick materials in certain applications for aircraft.
2. Design values to be used in the selection of the most advantageous alloy for various applications.
3. The comparison of a full section member to a small center notch laboratory size specimen in order to ascertain the merit of the latter.

In view of the increased emphasis on slow bend testing as reflected by the ASTM-E-24 Committee recommendation for a standard test specimen and the obvious economy of using a smaller specimen, the program discussed herein was initiated using the same materials that were tested by ALCOA. The use of the same materials permitted a comparison of the laboratory size slow bend specimens to the large ALCOA specimens.

SECTION II

MATERIAL

ALCOA conducted tests on seven materials: 2020-T651, 2024-T851, 2219-T851, 7001-T75, 7075-T651, 7075-T7351, and 7079-T651. Three lots of each material were processed and fabricated into semi-infinite plates. Each of the lots represented a different production run from a different ingot, the result being a 1-3/8 inch plate. The lots with the exception of alloy 7001 were fabricated and heat treated at the Davenport Works of ALCOA. Alloy 7001 was fabricated to the -W51 temper by ALCOA and aged to the T-75 temper by Harvey Aluminum. In order to simulate actual service conditions, all of the plate to be tested in "full section" was machined from the 1-3/8 inch thickness to a nominal thickness of 1.00 inch, with minimum of 1/8 inch machined from each as-rolled surface. The resulting plates were 64" x 20" x 1". The plates were tested in both the longitudinal and transverse directions (References 4 and 5).

SECTION III

SPECIMENS

After ALCOA had tested the semi-infinite plate specimens the fractured half plates were sent to the Materials Engineering Branch, Materials Support Division, Air Force Materials Laboratory. It was from this material that the slow bend laboratory size specimens tested in this program were removed.

The slow bend specimens shown in Figure 1 were machined from the failed half plates such that the direction of crack propagation of the specimen would be the same as that of the semi-infinite plates. They were fabricated from a region which was a minimum of two inches back from the fracture surface of the half plates in the position illustrated in Figure 2.

The specimens were marked with the following designation:

2020-T651	A
2024-T851	B
2219-T851	C
7001-T75	D
7075-T651	E
7075-T7351	F
7079-T651	G
Lot I	1
Lot II	2
Lot III	3
Longitudinal	L
Transverse	T

An example designation for 2219-T851, Lot II, the transverse direction, and specimen number four would appear as C2T4 on the end of the specimen.

Four specimens of each material, lot, and direction were fabricated. Consequently, a total of 168 specimens were tested.

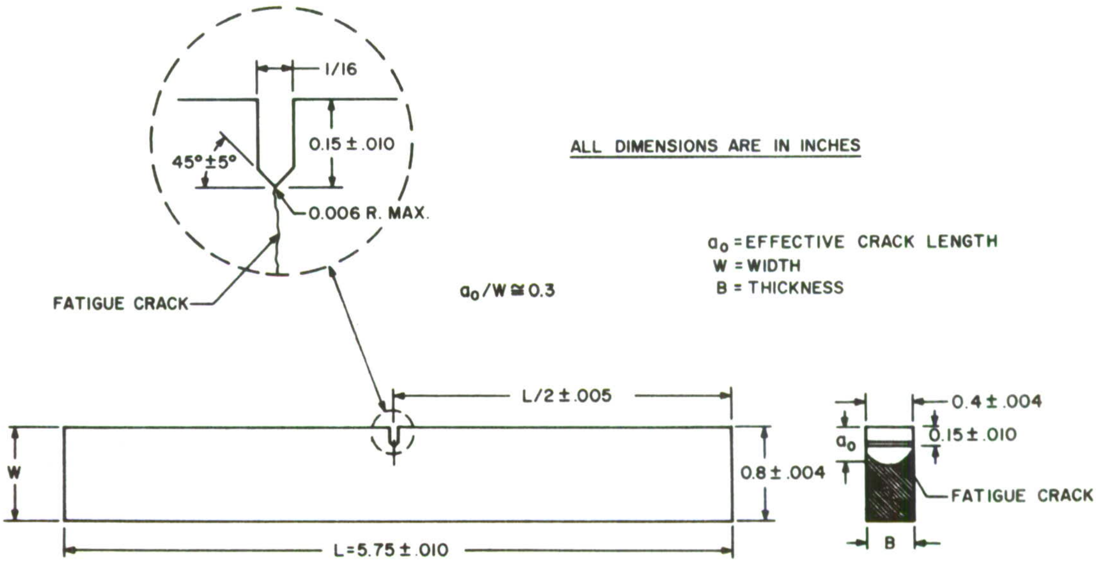


Figure 1. Four Point Loading Slow Bend Specimen Configuration

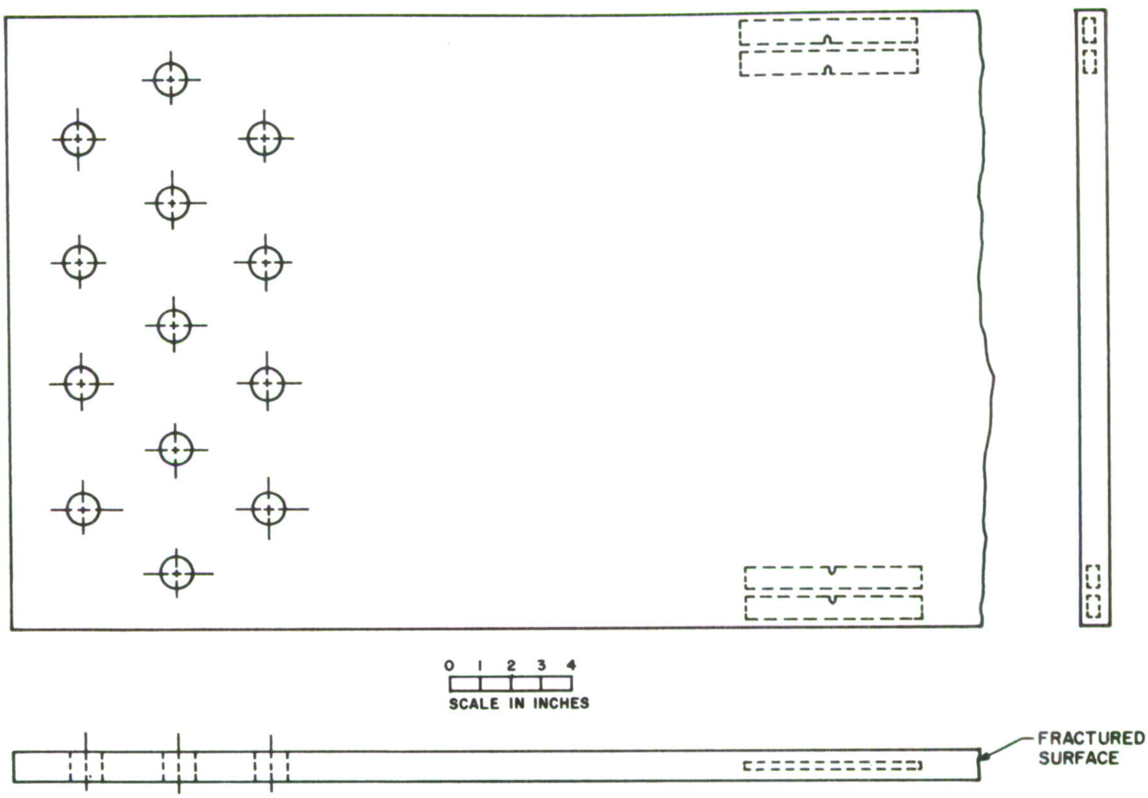


Figure 2. Large Aluminum Plate and Area of Specimen Removal

SECTION IV

TEST EQUIPMENT

Slow bend specimens were fatigue cracked in a Six Ton Schenck Fatigue Machine under axial tension-tension loading at a stress ratio $(R) = \sigma \min / \sigma \max = 1/7$. The maximum stresses used were from 17 to 27 percent of the yield strength computed on the gross section area. A Manlabs Slow Bend Machine, Model SB-750, pictured in Figure 3 was used to load the specimen to failure in four point bending. This model was designed for testing precracked Charpy specimens at low strain rates and at constant head speeds. The four point bend fixture shown in Figure 4, having a major span of five inches and a minor span of 2-1/2 inches, was modified somewhat for this program.

The Leeds and Northrup recorder on the machine was altered to provide load versus deflection measurements. A LVDT-demodulator system sensed the deflection at the center of the bottom side of the specimen and the electrical output of the demodulator was recorded on the X-axis of the recorder shown in Figure 3. Load was recorded on the Y-axis.

The machine also has a force-time integrating system which determines the amount of energy the testing machine provides to the specimen and to the loading fixture. Since the machine operates under constant head speed, the load when integrated with time is proportional to energy. A meter displays the integration in units which equal the work done by the machine when the units are multipled by the correct factors.

SECTION V

PROCEDURE

1. TEST PROCEDURE

All testing on the Manlabs Machine was performed at a head speed of 0.025 inches per minute. All tests were performed at room temperature.

2. DATA REDUCTION PROCEDURE

Fracture toughness results were computed by an IBM 7094 Digital Computer which was programmed as follows:

$$S = a_o/W$$

$$K_{IC} = \frac{3/4\ P(L)\ a_o^{1/2}}{BW^2}\left[1.99 - 2.47(S) + 12.97(S^2) - 23.17(S^3) + 24.80(S^4)\right]$$

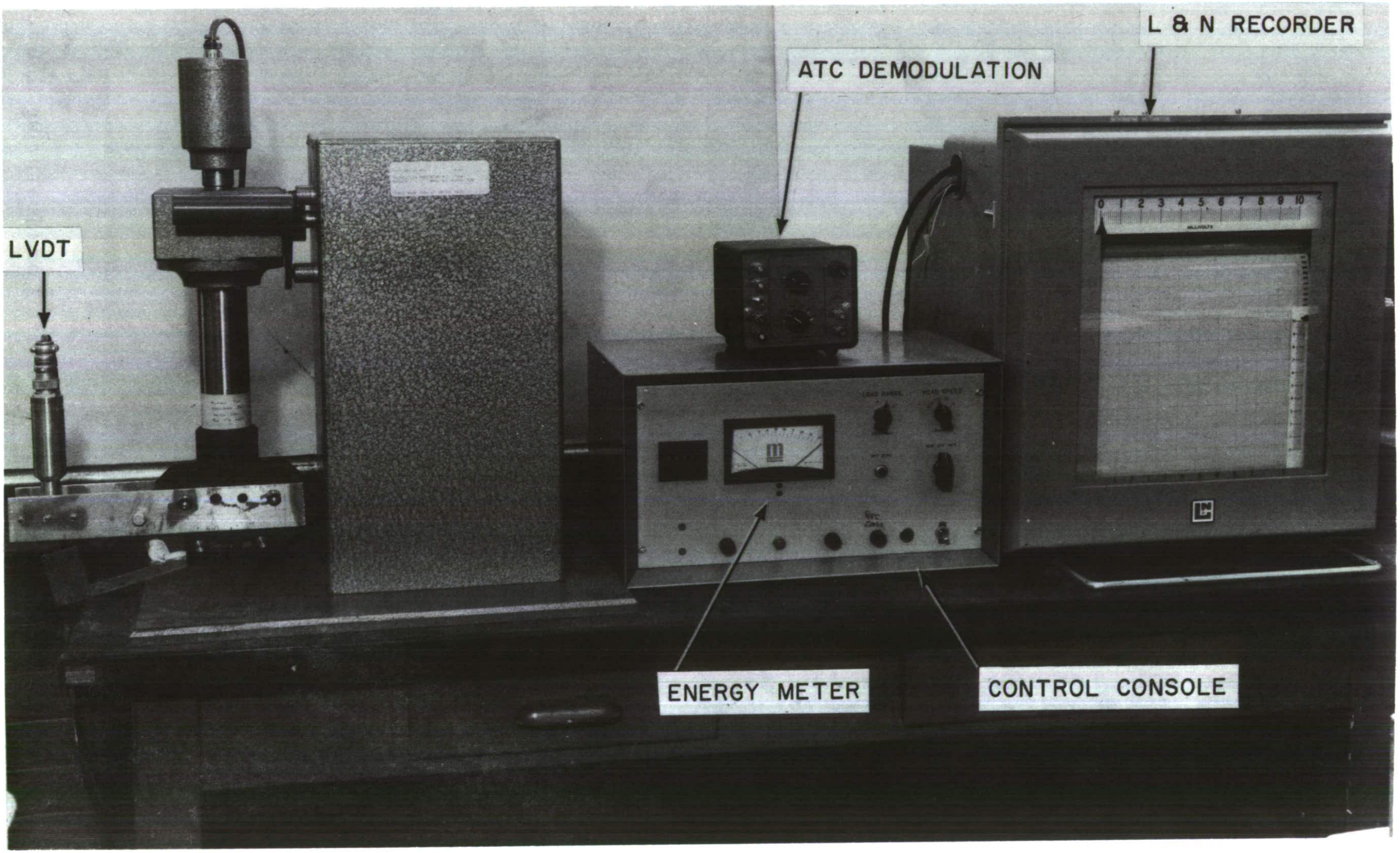


Figure 3. Four Point Slow Bend Testing Equipment

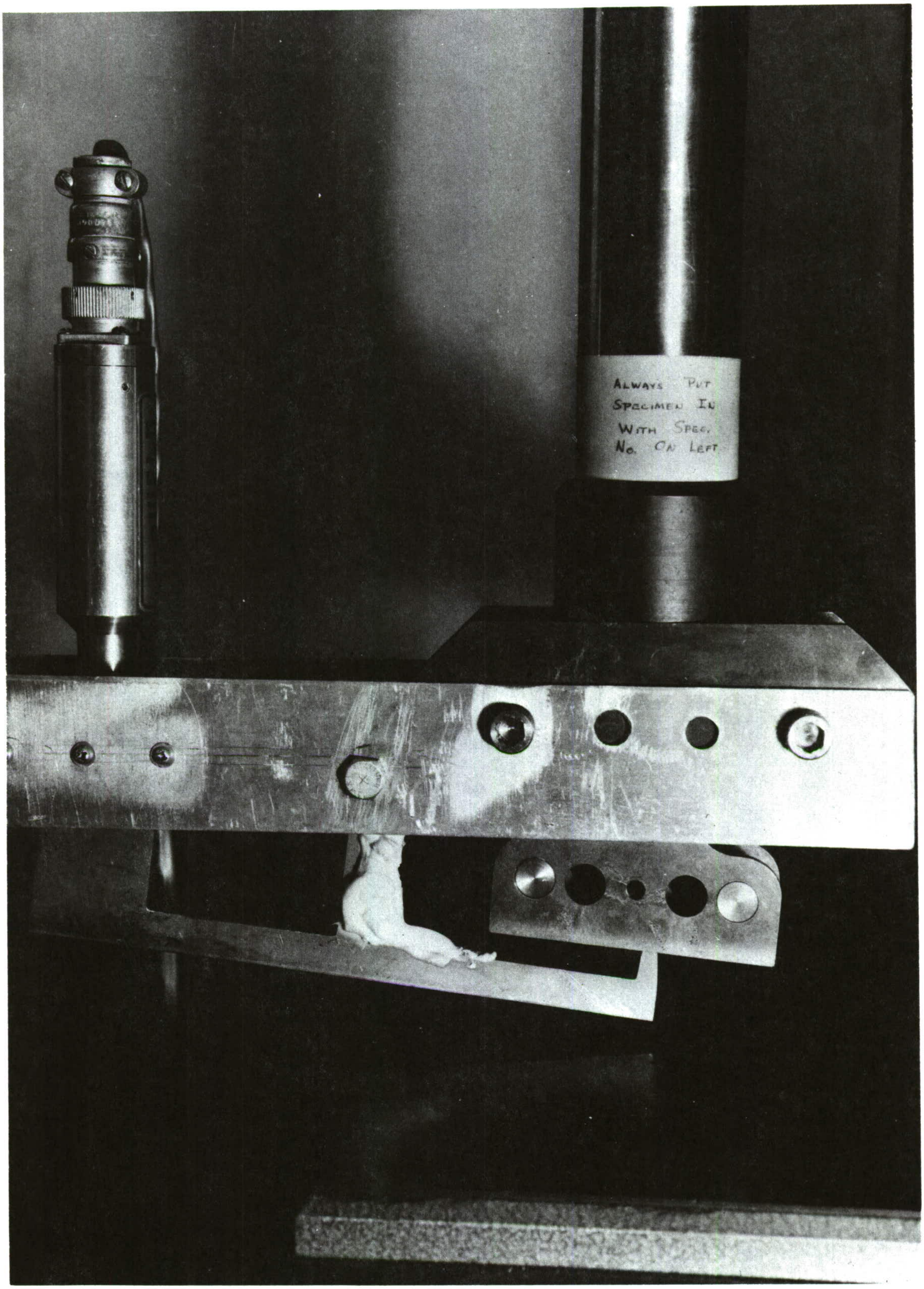


Figure 4. Four Point Slow Bend Test Fixture For Measuring Deflection

$$G_{IC} = (1 - \mu^2)(K_{IC})^2/E$$

$$R_{IY} = [(K_{IC})^2/(YS)^2] \frac{1}{6\pi}$$

$$A = (W - a_o)B$$

$$Q/A = D\,(HS)\,(G)\,(12)/A$$

where
- S = Crack length to width ratio
- a_o = Effective crack length (in)
- W = Width of specimen (in)
- K_{IC} = Stress intensity factor (KSI $\sqrt{IN}$)
- P = Pop-in load by Secant Method (KIPS)
- L = Specimen span (in)
- B = Specimen thickness (in)
- μ = Poisson's ratio
- E = Young's modulus (KSI)
- G_{IC} = Strain energy release rate (in-lb/in^2)
- YS = Yield stress (KSI)
- R_{IY} = Plastic zone radius (in)
- A = Net cross sectional area (in^2)
- Q/A = Machine energy to fracture specimen per unit area (in-lb/in^2)
- D = Load range setting for Manlabs
- HS = Head speed (in/min)
- G = Manlab energy meter reading

Only the fracture toughness values computed from the equations in Reference 3 are tabulated although values were determined from the equations given in both References 3 and 6. Both values are similar but the equations in Reference 3 are more accurate.

SECTION VI

RESULTS

Fatigue cracking data and specimen dimensions are presented in Table I. The crack lengths were determined by post-test measurement on the fracture faces with a 50X toolmakers microscope.

Basic tensile properties were assumed to be the same as those determined by ALCOA during the testing program of the large semi-infinite plates. The only tensile data presented in this report is the yield strength as shown in Table II. For other tensile properties see References 4 and 5.

The fracture toughness values, K_{IC}, for individual specimens, as given in Table II, were tabulated with a computer program. These values, however, were not corrected for plastic zone size. The plastic zone correction would be 0.2 $KSI\sqrt{IN}$ for the lowest toughness specimen (A3T4) and 1.97 $KSI\sqrt{IN}$ for the specimen with the highest toughness (F1L3).

The average plane strain toughness values, K_{IC}, by alloy, lot, and direction are given in Table III with the corresponding values as determined by ALCOA with the large semi-infinite center notched plates given in columns one and four. The ALCOA values are corrected for plastic zone size but the laboratory values are not. The K_{IC} values determined by this investigation are presented in columns two and five. The ALCOA K_{IC} values were obtained from References 4 and 5 and were computed using the Irwin's tangent equation. As a new and more accurate formula has been developed by Forman et al. in the intervening time since the development of the subject data, ALCOA's data were corrected using the new equation. These values are also presented in Table III and are plastic zone corrected.

Individual energy data, Q/A, the energy supplied by the machine to the loading fixture divided by the net uncracked section, are presented in Table IV. All G_{IC} results were computed with the K_{IC} values determined in the laboratory tests. Average values of Q/A versus G_{IC} are found in Figure 5. The ALCOA range and scatter values and the internally developed K_{IC} values are presented as a basis for comparison in Table V.

SECTION VII

DISCUSSION AND ANALYSIS

Plane strain fracture toughness specimens are designed to keep the plastic zone relatively small as compared to the thickness, width, and crack length of the specimen, thus encouraging abrupt pop-in rather than slow crack growth. Linear elastic equations may then be applied as a good approximation. An analysis of the plastic zone radii in Table II illustrates that the materials with the larger radii, 2219-T851 and 7075-T7351, had high percentages of invalid tests because of local yielding at the crack tip. These alloys exhibited slow crack growth, therefore, the plane-strain stress intensity factor at crack initiation, K_{IC}, would not be calculated.

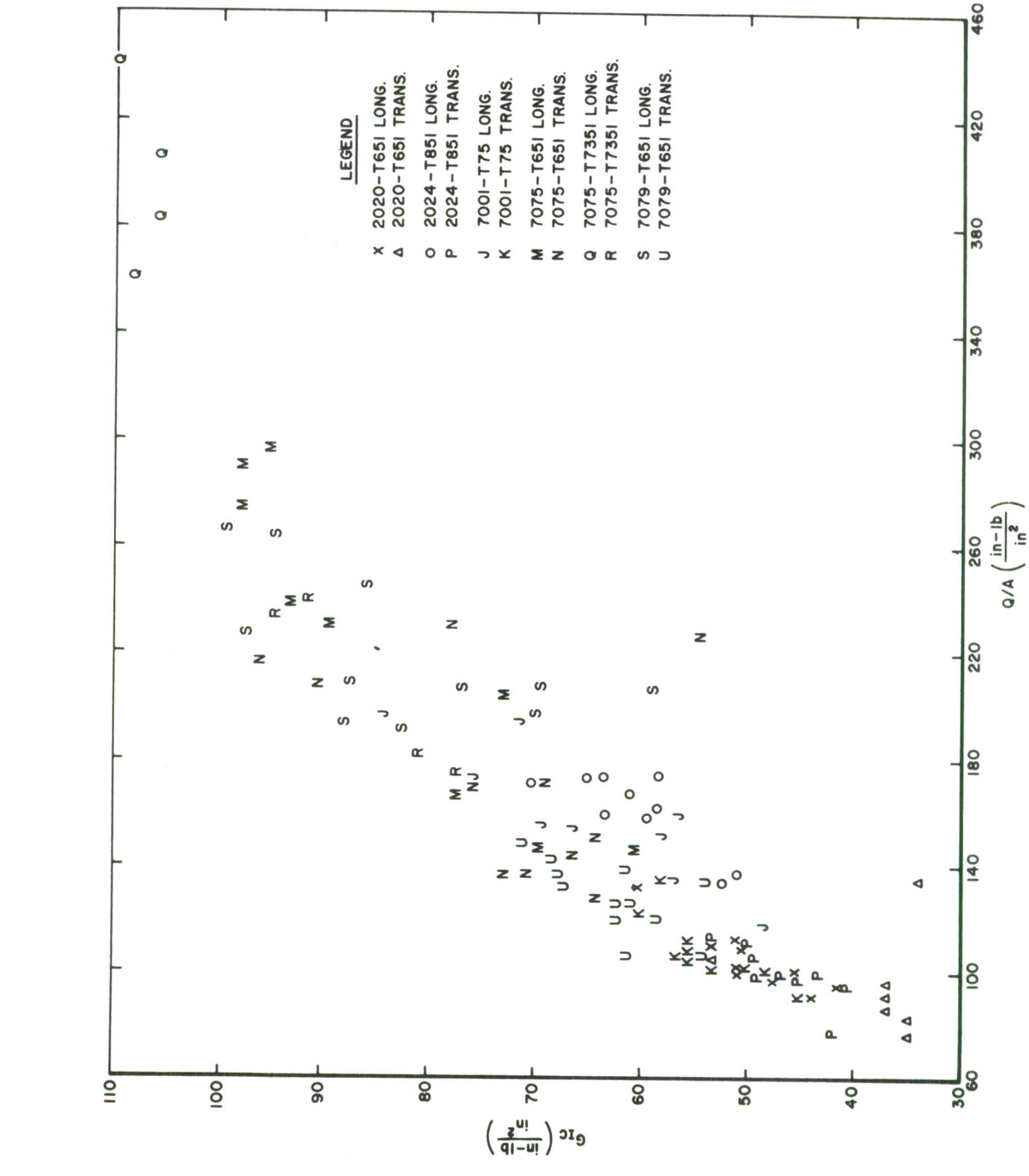


Figure 5. Strain Energy Release Rate Versus Machine Energy to Fracture

The problem now arises as to what specimen dimensions will provide a valid K_{IC} in the materials which did not meet the Secant method requirements (Reference 3). Working limits have to be determined by experimental testing. Since the completion of this test program, Brown and Srawley (Reference 3) recommend using a multiple of $(K_{IC}/YS)^2$, which is proportional to the plastic zone radius. Since K_{IC} could not be adequately determined for alloys 2219-T851 and 7075-T7351, larger specimen dimensions are required to obtain pop-in in these materials.

Knowing that $(K_{IC}/YS)^2$ is a characteristic which is proportional to the dimensions of the fracture toughness specimen, a table (Table VI) can be tabulated based on the following formulae:

$$a_o = X\,(K_{IC}/YS)^2$$

$$B = Y\,(K_{IC}/YS)^2$$

where X = dimensional characteristic of a_o

B = dimensional characteristic of B

The limiting specimen size requirements suggested by Brown and Srawley (Reference 3) are:

$$X = a_o/(K_{IC}/YS)^2 \geq 2.5$$

and

$$Y = B/(K_{IC}/YS)^2 \geq 2.5$$

It has been also recommended in Reference 3 that $a_o/W = 0.5$. Table VI shows that the value of X was low for all alloys except 2020-T651 and the value of Y was low for alloy 7075-T7351 only. Alloy 2219-T851 is not shown in this table because a K_{IC} value could not be obtained by the Secant method for this alloy.

The variation of the laboratory values from those values obtained by ALCOA for full section center-notched specimens as presented in Table III is 10% on the positive side and 11-1/2% on the negative side. As previously stated, Brown and Srawley have set tentative criteria for minimum thickness and crack length. In all but one alloy one or more of these values were violated by the laboratory specimens.

The large negative errors can readily be explained by attributing them to a complete lack of sufficient size in the laboratory size specimens. More recent results published by ALCOA since the completion of Reference 3 indicate the positive errors may be considerably reduced when the original curves from the large semi-infinite plates are evaluated by the methods of Reference 3. See Reference 7. The results in Reference 7 were developed from the original curves obtained during the testing of the semi-infinite plates but analyzed by the secant method. Comparison of these results with the ones obtained in this report shows a maximum positive error of 7%. This error corresponds to 1.4 KSI $\sqrt{IN}$ for the transverse direction of 2020-T651. This value of 1.4 KSI $\sqrt{IN}$, although larger than one would expect on a percentage basis (five percent could be accepted), is still not sufficient to cause the data to be rejected. Also, the new data in Reference 7 makes the negative error considerably larger (minus 18 percent for 7075-T7351 longitudinal) which is what one would expect. Although these results are not conclusive in themselves, they do add weight to the specimen size requirements as presented in Reference 3.

It was proposed by others that a relationship exists between Q/A, the machine energy to fracture per unit area, and G_{IC}. Table IV shows that no correlation can be observed. Srawley and Brown suggested that the specimen be of sufficient size so that fracture occurs at pop-in for the correlation between G_{IC} and Q/A to exist. This would minimize the chances of side boundary plastic regions forming. G_{IC} represents the idealized elastic energy to fracture, whereas Q/A is the total energy to fracture which includes plastic energy, elastic energy, and stored machine energy.

The plotted data points of G_{IC} versus Q/A fall within a wide range as shown in Figure 5. For instance, the data points J for alloy 7001-T75 longitudinal occur within the range of Q/A = 198.14 in-lb/in^2 and Q/A = 119.19 in-lb/in^2. This value of Q/A varies with the amount of energy which is stored in the testing machine and the plastic energy which is used to permanently deform the metal.

Figures 6 and 7 illustrate sketches of the load-deflection curves obtained for the alloys pictured in Figures 8 and 9. Taking into account the load-deflection histories, the plastic zone size, and the average K_{IC} values in Table III, the alloys can be ranked in descending order of toughness as follows: 2219-T851, 7075-T7351, 7075-T651, 7079-T651, 7001-T75, 2024-T851, and 2020-T651.

The fracture face of the individual alloy generally had larger shear lips in the longitudinal direction than in the transverse direction. The longitudinal direction also had larger K_{IC} values than the transverse direction for the same alloy. It can, therefore, be concluded that in different alloys the larger shear lips are associated with the tougher material.

Fracture surfaces of selected specimens are shown in Figures 8 and 9. It can be seen from these pictures that alloys 2219-T851 and 7075-T7351 have the larger shear lips and are the tougher of the alloys. The transverse fracture faces have a more fibrous appearance than the longitudinal directions. Whereas all the longitudinal specimens except 2020-T651 have large plastically distorted regions around the crack front on the specimen surfaces, the transverse specimens displayed very small distortions around the crack front. The more brittle materials, 2020-T651 and 7001-T75, had the smallest shear lips and fractured more catastrophically than the other alloys, as expected.

A chemical composition analysis of a few specimens which did not appear to be representative of that alloy revealed that alloy 7001-T75 had a high magnesium content. The results presented for alloy 7001-T75, therefore, may not represent the normal reaction of this particular alloy to fracture toughness testing.

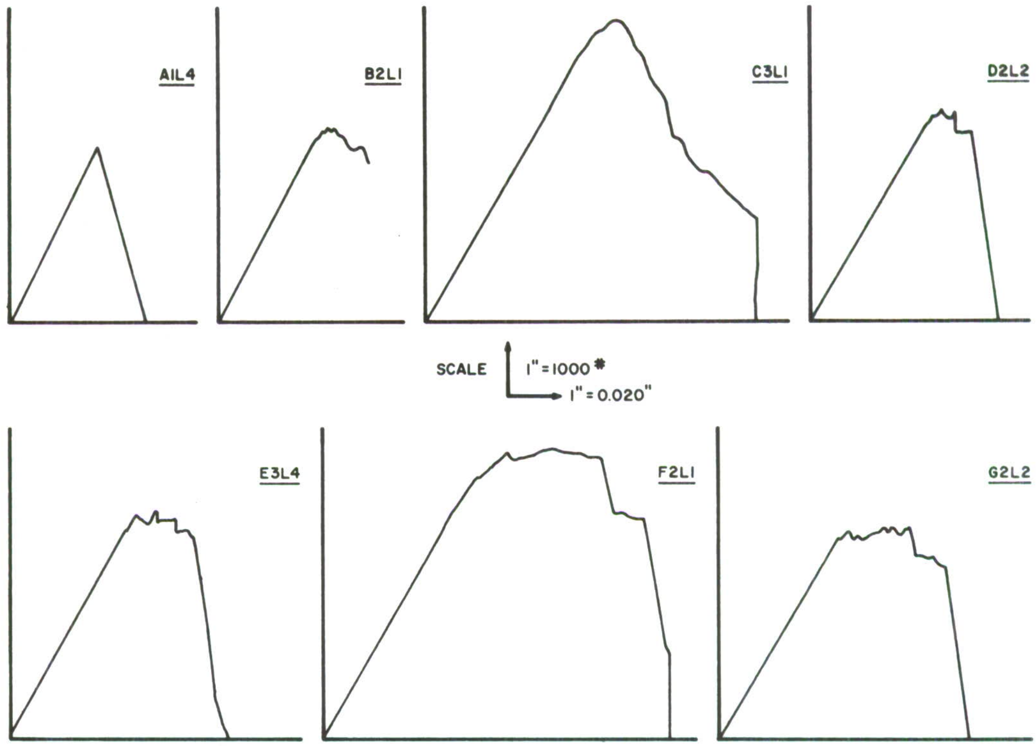


Figure 6. Typical Load-Deflection Curves For Longitudinal Specimen

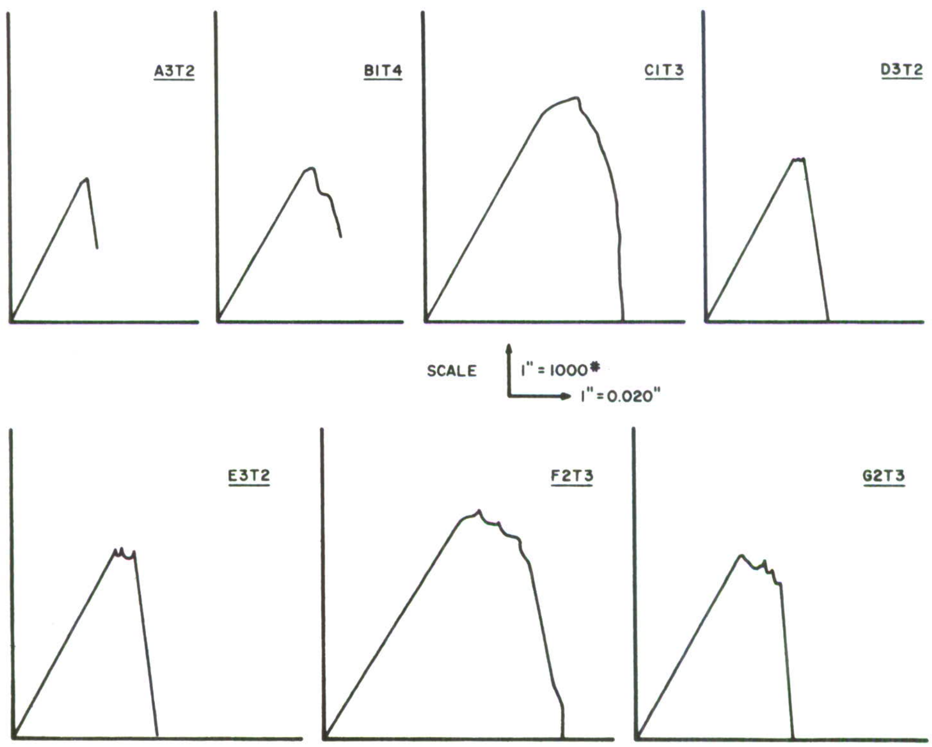


Figure 7. Typical Load-Deflection Curves For Transverse Specimen

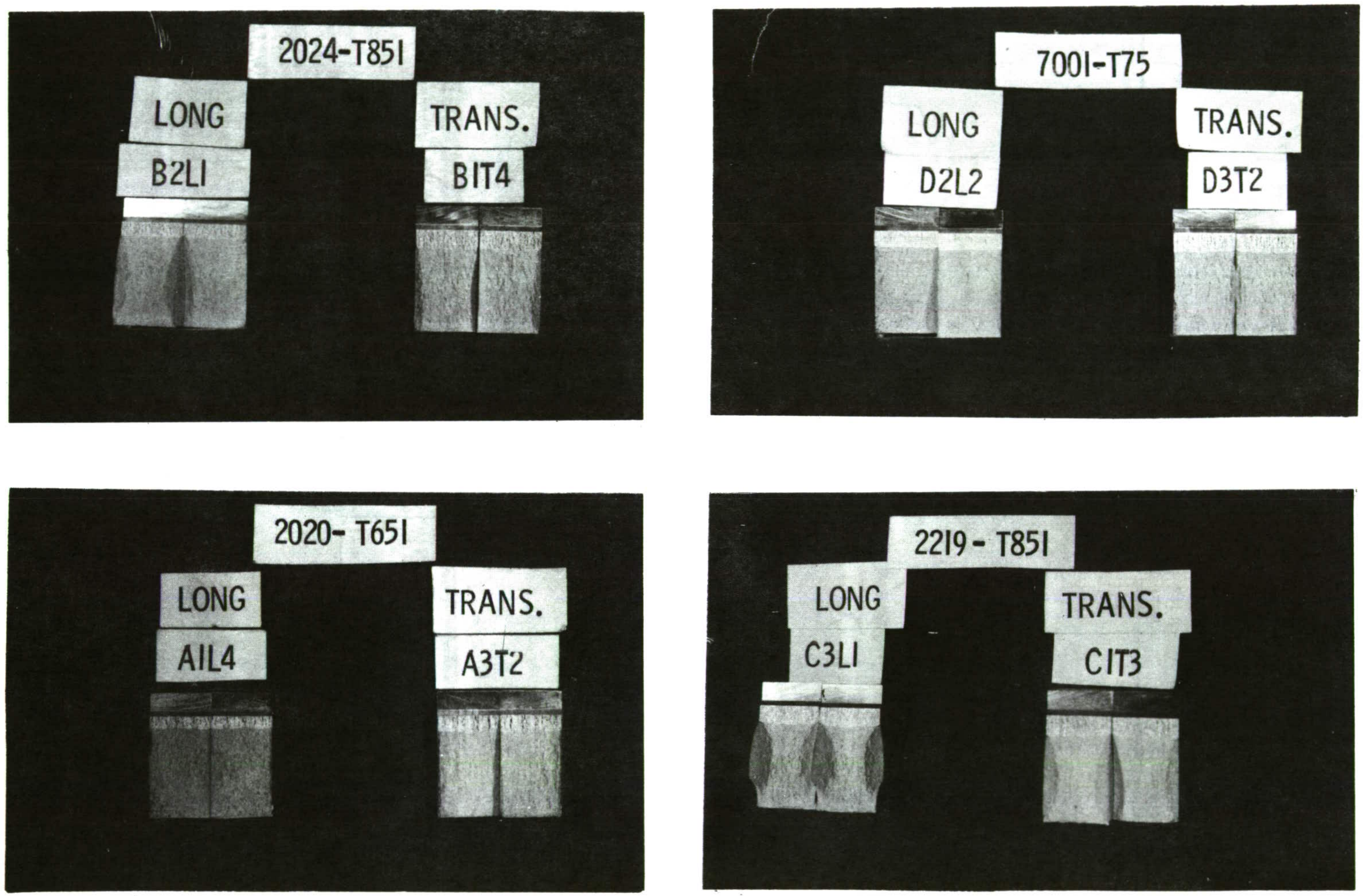
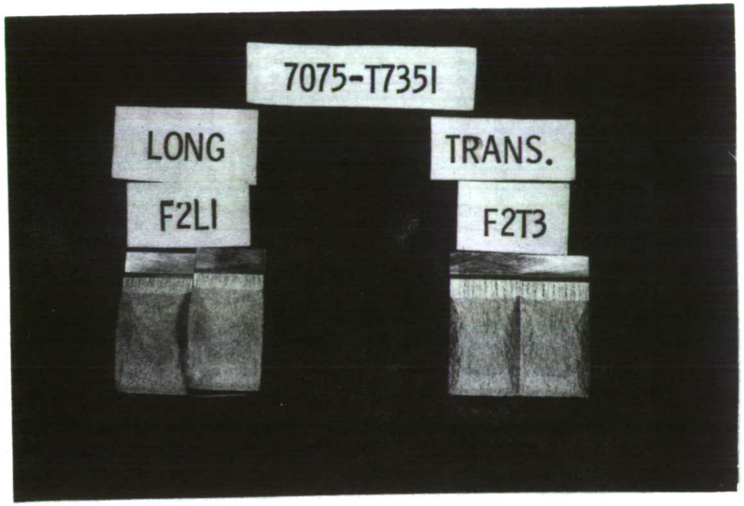


Figure 8. Fracture Surfaces of Representative Specimens



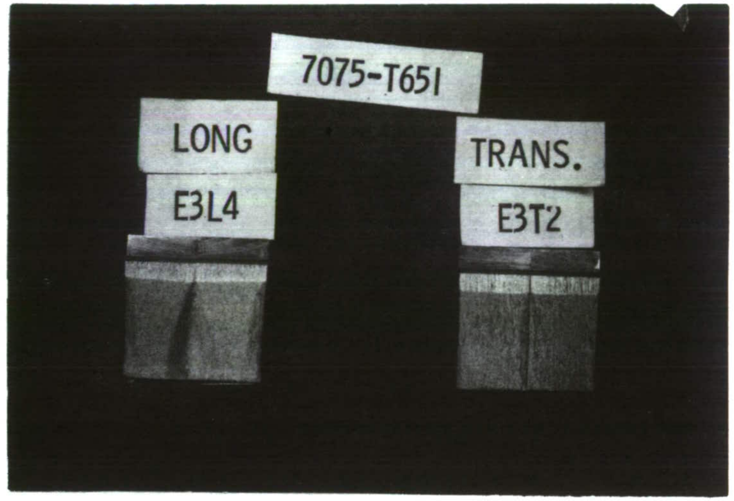


Figure 9. Fracture Surfaces of Representative Specimens

SECTION VIII

CONCLUSIONS

1. The maximum variation of laboratory values from the results originally obtained by ALCOA is plus 10 percent and minus 11-1/2 percent. However, when the original ALCOA data is evaluated by the same method as the data in this test program, the errors are then plus 7 percent and minus 18 percent. These results, although not able to stand by themselves, are an indication that the specimen requirements as presented in Reference 3 are sufficient for valid tests.

2. Machine energy, Q/A, and strain energy release rate, G_{IC}, were not readily correlated.

3. Specimen ranking in descending order of toughness is as follows:

    1) 2219-T851
    2) 7075-T7351
    3) 7075-T651
    4) 7079-T651
    5) 7001-T75
    6) 2024-T851
    7) 2020-T651

SECTION IX

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3. W. F. Brown and J. E. Srawley, "Plain Strain Crack Toughness Testing of High Strength Metallic Materials," ASTM Special Technical Publication No. 410, December 1966.

4. J. G. Kaufman, G. E. Nordmark, and B. W. Lifka, "Fracture Toughness Fatigue and Corrosion Characteristics of 2020-T651, 2024-T851, and 7001-T75 Aluminum Alloys," AFML-TR-66-291.

5. J. G. Kaufman, G. E. Nordmark, and B. W. Lifka, "Fracture Toughness, Fatigue and Corrosion Characteristics of 7075-T651, 7075-T7351, and 7079-T651 Aluminum Alloys," AFML-Tr-65-170, May 1965.

6. "Workshop in Fracture Mechanics," Third Fracture Mechanics Summer Series, Universal Technology Corp., August 7-19, 1966.

7. J. G. Kaufman, F. G. Nelson, Jr., and M. Holt, "Fracture Toughness of Aluminum Alloy Plate," Engineering Fracture Mechanics, August 1968, p. 264.

SECTION X

APPENDIX

TABLE I

Specimen Dimensions and Fatigue Cracking Data
Maximum Load = 3500 lb
Minimum Load = 500 lb
Frequency = 1900 cpm

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	A1L1	.8000	.3998	.2154	33,000
	A1L2	.7996	.3996	.2277	33,100
	A1L3	.7996	.3986	.2282	34,000
	A1L4	.7991	.3990	.2266	32,300
	A2L1	.7998	.3990	.2650	102,600
	A2L2	.7995	.3995	.2477	25,500
	A2L3	.7994	.3982	.2353	28,100
	A2L4	.7994	.3992	.2405	37,700
	A3L1	.7999	.3991	.2647	50,000
	A3L2	.7996	.3996	.2456	90,900
	A3L3	.8003	.3997	.2299	117,800
	A3L4	.8006	.3993	.2249	51,800
2020-T651					
	A1T1	.7987	.3989	Fractured while fatigue cracking	
	A1T2	.7997	.3997	.2180	32,200
	A1T3	.8001	.3985	.2300	31,100
	A1T4	.7999	.3993	.2236	74,800
	A2T1	.8003	.3999	.3053	50,400
	A2T2	.8002	.3997	.2470	32,700
	A2T3	.7998	.3955	.2239	31,400
	A2T4	.7997	.3980	.2293	28,800
	A3T1	.7991	.3991	Fractured while fatigue cracking	
	A3T2	.7990	.3999	.2552	47,700
	A3T3	.7999	.3997	.2384	58,100
	A3T4	.7998	.3993	.2435	66,900

TABLE I, (con't)

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	B1L1	.8000	.3991	.2370	19,200
	B1L2	.7993	.3996	.2537	19,500
	B1L3	.8002	.3981	.2430	23,800
	B1L4	.7998	.3992	.2627	24,700
	B2L1	.8004	.3994	.2163	23,900
	B2L2	.8005	.3999	.2252	17,400
	B2L3	.7995	.3987	.2569	24,800
	B2L4	.7995	.3994	.2593	32,700
	B3L1	.8002	.3997	.2380	24,100
	B3L2	.7996	.3992	.2263	22,800
	B3L3	.8001	.3990	.2439	22,600
	B3L4	.8004	.3997	.2384	21,200
2024-T851					
	B1T1	.8004	.3995	.2922	21,300
	B1T2	.7999	.3992	.2691	17,900
	B1T3	.8001	.3991	.2540	20,700
	B1T4	.8002	.3991	.2676	17,900
	B2T1	.8006	.3996	.2260	17,600
	B2T2	.8002	.3994	.2262	20,500
	B2T3	.7994	.3994	.2364	18,700
	B2T4	.7997	.3998	.2770	28,600
	B3T1	.7997	.3993	.2560	20,500
	B3T2	.8005	.3999	.2467	17,400
	B3T3	.7996	.3985	.2417	17,500
	B3T4	.8000	.3995	.3430	21,100

TABLE I, (con't)

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	C1L1	.8000	.3971	.2990	23,900
	C1L2	.7993	.3988	.2622	24,700
	C1L3	.7995	.3987	.2541	19,000
	C1L4	.7997	.3993	.2714	28,000
	C2L1	.8000	.3997	.2806	26,300
	C2L2	.8001	.4001	.2583	31,700
	C2L3	.8003	.3995	.2797	26,700
	C2L4	.7999	.3995	.2564	23,100
	C3L1	.8000	.3937	.2622	14,500
	C3L2	.7996	.3984	.2750	17,600
	C3L3	.7999	.3990	.2500	21,900
	C3L4	.7994	.3995	.2627	39,100
2219-T851					
	C1T1	.8000	.3987	.3179	31,000
	C1T2	.7994	.3984	.2440	19,600
	C1T3	.7999	.3996	.2640	23,600
	C1T4	.7998	.3990	.2940	27,600
	C2T1	.8989	.3974	.2735	19,000
	C2T2	.7994	.3987	.2845	20,700
	C2T3	.8001	.3994	.2578	24,000
	C2T4	.7987	.3992	.2428	24,300
	C3T1	.7994	.3992	.2595	24,000
	C3T2	.7996	.3995	.2565	24,050
	C3T3	.8003	.3994	.2604	34,800
	C3T4	.8002	.3998	.2627	35,500

TABLE I, (con't)

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	D1L1	.7999	.3992	.2247	21,100
	D1L2	.7998	.3997	.2265	21,900
	D1L3	.8000	.3992	.2272	16,400
	D1L4	.7995	.3992	.2318	17,500
	D2L1	.7997	.3993	.2546	19,100
	D2L2	.8003	.4000	.2485	19,300
	D2L3	.8003	.3993	.2456	15,100
	D2L4	.7998	.3984	.2542	14,400
	D3L1	.7997	.3979	.2465	16,600
	D3L2	.7992	.3993	.2426	17,400
	D3L3	.7998	.3991	.2532	16,200
	D3L4	.8002	.3995	.2599	18,300
7001-T75					
	D1T1	.7999	.3983	.2783	22,700
	D1T2	.8001	.3993	.2334	14,900
	D1T3	.7996	.3994	.2409	15,400
	D1T4	.8000	.3997	.2949	16,700
	D2T1	.8005	.3999	Fractured while fatigue cracking	
	D2T2	.7995	.3997	.2290	39,500
	D2T3	.8001	.3983	.2302	14,000
	D2T4	.7999	.3996	.2542	21,700
	D3T1	.7994	.3993	.2329	14,800
	D3T2	.7990	.3994	.2675	15,500
	D3T3	.8004	.3991	.2885	17,200
	D3T4	.7997	.3996	.2419	20,900

TABLE I, (con't)

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	E1L1	.7995	.3983	.2225	15,800
	E1L2	.7997	.3990	.2437	18,800
	E1L3	.8005	.3978	.2411	29,500
	E1L4	.7999	.3993	.2599	24,400
	E2L1	.7994	.3991	.2404	16,100
	E2L2	.7998	.3995	.2311	13,400
	E2L3	.7989	.3982	.2700	20,600
	E2L4	.7993	.3991	.2654	17,400
	E3L1	.7999	.3992	.2687	17,500
	E3L2	.8002	.3990	.2494	15,600
	E3L3	.7997	.3996	.2428	13,600
	E3L4	.7999	.3998	.2493	17,900
7075-T651					
	E1T1	.7991	.3991	.2509	37,800
	E1T2	.7999	.3992	.2821	20,400
	E1T3	.8006	.3996	.2527	19,600
	E1T4	.8000	.4001	.2814	22,700
	E2T1	.8001	.3997	.2361	15,000
	E2T2	.7999	.3994	.2433	18,500
	E2T3	.8000	.3992	.2045	15,800
	E2T4	.7997	.4001	.2210	16,400
	E3T1	.7995	.3979	.3038	16,700
	E3T2	.7984	.3995	.2501	15,900
	E3T3	.7996	.3996	.2506	13,500
	E3T4	.8002	.3996	.2549	16,900

TABLE I, (con't)

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	F1L1	.7995	.3993	.2343	17,100
	F1L2	.8002	.4001	.2294	17,100
	F1L3	.7993	.3990	.2324	17,300
	F1L4	.7998	.4000	.2345	20,100
	F2L1	.7995	.3992	.2324	20,400
	F2L2	.7990	.3996	.2339	20,500
	F2L3	.7998	.3993	.2403	20,300
	F2L4	.7994	.3991	.2264	19,500
	F3L1	.7994	.3992	.2556	22,700
	F3L2	.7997	.3993	.2415	22,800
	F3L3	.8000	.3986	.2655	25,000
	F3L4	.7998	.3996	.2762	34,700
7075-T7351					
	F1T1	.7990	.3993	.2231	16,200
	F1T2	.8005	.4000	.2806	21,600
	F1T3	.7990	.3996	.2419	26,700
	F1T4	.7998	.4000	.2102	15,800
	F2T1	.7995	.3991	.2431	21,700
	F2T2	.7994	.3997	.2291	15,900
	F2T3	.8008	.3997	.2469	17,500
	F2T4	.7993	.3997	.2540	22,300
	F3T1	.7998	.3979	.2499	20,700
	F3T2	.7995	.3991	.2583	18,600
	F3T3	.7993	.3993	.2474	19,700
	F3T4	.7997	.3991	.2474	20,700

TABLE I, (con't)

Material	Specimen No.	Width (W) (Inch)	Thickness (B) (Inch)	Crack Length(a) (Inch)	Fatigue Cycles
	G1L1	.7998	.3998	.2482	13, 300
	G1L2	.8002	.3995	.2554	13, 100
	G1L3	.8000	.4001	.2243	10, 000
	G1L4	.7997	.3997	.2313	19, 700
	G2L1	.7995	.3993	.2388	13, 000
	G2L2	.7994	.3996	.2317	14, 900
	G2L3	.8004	.3969	.2534	17, 400
	G2L4	.8004	.3990	.2788	18, 700
	G3L1	.7994	.3982	.2910	15, 300
	G3L2	.8005	.4000	.2722	12, 400
	G3L3	.7998	.3986	.2538	10, 900
	G3L4	.7993	.3977	.2545	11, 100
7079-T651					
	G1T1	.7999	.3987	.2280	13, 500
	G1T2	.7999	.3998	.2297	12, 500
	G1T3	.8004	.3992	.2721	13, 800
	G1T4	.7996	.3996	.2520	16, 300
	G2T1	.8004	.3996	.2555	12, 600
	G2T2	.8001	.3997	.2603	12, 500
	G2T3	.7997	.3972	.2485	14, 200
	G2T4	.7994	.3987	.2631	17, 500
	G3T1	.7994	.3996	.2475	15, 900
	G3T2	.7997	.3996	.2601	11, 800
	G3T3	.7997	.3979	.2456	12, 500
	G3T4	.7997	.3991	.2599	14, 600

TABLE II

Individual Fracture Toughness Results

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI$\sqrt{IN}$)	Yield Strength (KSI)	Plastic △ Zone (in x 10^{-3})
	A1L1	1120	+	77.5	--
	A1L2	1740	23.96	77.5	5.0
	A1L3	1640	22.68	77.5	4.5
	A1L4	1680	23.12	77.5	4.7
			Avg. 23.25		
	A2L1	1580	24.52	76.1	5.5
	A2L2	1630	23.94	76.1	5.2
	A2L3	1570	22.24	76.1	4.5
	A2L4	1500	21.55	76.1	4.3
			Avg. 23.06		
	A3L1	NVPI	++	76.3	--
	A3L2	1640	23.91	76.3	5.2
	A3L3	1880	26.02	76.3	6.1
	A3L4	1750	23.84	76.3	5.1
			Avg. 24.59		
2020-T651					
	A1T1	--1	*	78.4	--
	A1T2	--2	***	78.4	--
	A1T3	1400	19.45	78.4	3.2
	A1T4	1800	24.47	78.4	5.1
			Avg. 21.96		
	A2T1	1370	***	77.5	--
	A2T2	1400	20.46	77.5	3.7
	A2T3	1490	20.47	77.5	3.7
	A2T4	1430	19.87	77.5	3.5
			Avg. 20.27		
	A3T1	--1	*	77.4	--
	A3T2	1360	20.46	77.4	3.7
	A3T3	--2	***	77.4	--
	A3T4	1370	19.84	77.4	3.5
			Avg. 20.15		

TABLE II, (con't)

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI$\sqrt{IN}$)	Yield Strength (KSI)	Plastic△ Zone (in x 10^{-3})
	B1L1	1840	26.11	65.8	8.4
	B1L2	1780	26.65	65.8	8.7
	B1L3	1870	27.10	65.8	9.0
	B1L4	1680	25.87	65.8	8.2
		Avg.	26.43		
	B2L1	NVPI	++	66.1	--
	B2L2	1900	25.60	66.1	7.9
	B2L3	1600	24.22	66.1	7.1
	B2L4	NVPI	++	66.1	--
		Avg.	24.91		
	B3L1	1790	25.43	65.6	7.9
	B3L2	1940	26.63	65.6	8.7
	B3L3	NVPI	++	65.6	--
	B3L4	1980	28.07	65.6	9.7
		Avg.	26.71		
2024-T851					
	B1T1	1400	23.62	65.0	7.0
	B1T2	1520	23.87	65.0	7.1
	B1T3	1640	24.55	65.0	7.6
	B1T4	1470	22.97	65.0	6.6
		Avg.	23.75		
	B2T1	1625	22.27	65.5	6.1
	B2T2	NVPI	++	65.5	--
	B2T3	1510	21.40	65.5	5.7
	B2T4	1350	21.78	65.5	5.9
		Avg.	21.82		
	B3T1	1560	23.54	64.4	7.1
	B3T2	NVPI	++	64.4	--
	B3T3	1580	22.53	64.4	6.5
	B3T4	660	+	64.4	--
		Avg.	23.03		

TABLE II, (con't)

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI$\sqrt{IN}$)	Yield Strength (KSI)	Plastic$^{\Delta}$ Zone (in x 10^{-3})
	C1L1	NVPI	++	51.1	--
	C1L2	NVPI	++	51.1	--
	C1L3	NVPI	++	51.1	--
	C1L4	NVPI	++	51.1	--
		Avg.	++		
	C2L1	NVPI	++	50.6	--
	C2L2	NVPI	++	50.6	--
	C2L3	NVPI	++	50.6	--
	C2L4	NVPI	++	50.6	--
		Avg.	++		
	C3L1	NVPI	++	52.0	--
	C3L2	NVPI	++	52.0	--
	C3L3	NVPI	++	52.0	--
	C3L4	NVPI	++	52.0	--
		Avg.	++		
2219-T851					
	C1T1	NVPI	++	50.8	--
	C1T2	NVPI	++	50.8	--
	C1T3	NVPI	++	50.8	--
	C1T4	NVPI	++	50.8	--
		Avg.	++		
	C2T1	NVPI	++	51.2	--
	C2T2	NVPI	++	51.2	--
	C2T3	NVPI	++	51.2	--
	C2T4	NVPI	++	51.2	--
		Avg.	++		
	C3T1	NVPI	++	49.3	--
	C3T2	NVPI	++	49.3	--
	C3T3	NVPI	++	49.3	--
	C3T4	NVPI	++	49.3	--
		Avg.	++		

TABLE II, (con't)

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI $\sqrt{IN}$)	Yield Strength (KSI)	Plastic△ Zone (in x 10^{-3})
	D1L1	2240	++	72.2	--
	D1L2	1840	25.22	72.2	6.4
	D1L3	1860	25.57	72.2	6.7
	D1L4	2090	29.20	72.2	8.7
		Avg.	26.66		
	D2L1	1780	27.31	70.6	7.9
	D2L2	NVPI	++	70.6	--
	D2L3	1740	25.34	70.6	6.8
	D2L4	1640	23.43	70.6	5.8
		Avg.	25.36		
	D3L1	1900	29.65	70.6	8.3
	D3L2	1960	28.36	70.6	8.6
	D3L3	2060	30.79	70.6	10.1
	D3L4	NVPI	++	70.6	--
		Avg.	29.60		
7001-T75					
	D1T1	1540	25.96	71.3	6.5
	D1T2	1820	25.51	71.3	6.8
	D1T3	1740	25.00	71.3	6.5
	D1T4	1480	25.20	71.3	6.6
		Avg.	25.42		
	D2T1	--1	*	69.6	--
	D2T2	1690	23.37	69.6	5.9
	D2T3	NVPI	23.37	69.6	5.9
	D2T4	NVPI	22.45	69.6	5.5
		Avg.	23.06		
	D3T1	1780	24.96	70.6	6.6
	D3T2	1560	24.43	70.6	6.4
	D3T3	1420	23.70	70.6	5.9
	D3T4	1820	26.22	70.6	7.3
		Avg.	24.82		

TABLE II, (con't)

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI$\sqrt{IN}$)	Yield Strength (KSI)	Plastic△ Zone (in x 10^{-3})
	E1L1	NVPI	++	76.6	--
	E1L2	2280	33.08	76.6	9.9
	E1L3	2300	33.12	76.6	9.9
	E1L4	2140	32.64	76.6	9.6
			Avg. 32.75		
	E2L1	NVPI	++	80.3	--
	E2L2	2120	29.51	80.3	7.1
	E2L3	1760	27.88	80.3	6.4
	E2L4	1700	26.21	80.3	5.7
			Avg. 27.87		
	E3L1	NVPI	++	78.5	--
	E3L2	1980	28.62	78.5	7.0
	E3L3	2240	32.36	78.5	9.0
	E3L4	2160	31.74	78.5	8.7
			Avg. 30.91		
7075-T651					
	E1T1	1940	29.14	73.6	8.3
	E1T2	1680	27.50	73.6	7.4
	E1T3	1880	27.95	73.6	7.7
	E1T4	1760	28.67	73.6	8.0
			Avg. 28.32		
	E2T1	2340	32.98	77.4	9.6
	E2T2	2200	31.83	77.4	8.9
	E2T3	2320	29.64	77.4	7.7
	E2T4	2360	31.76	77.4	5.5
			Avg. 31.55		
	E3T1	1520	26.80	76.0	6.6
	E3T2	1640	27.31	76.0	6.9
	E3T3	NVPI	++	76.0	--
	E3T4	1880	24.77	76.0	7.3
			Avg. 26.29		

TABLE II, (con't)

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI$\sqrt{IN}$)	Yield Strength (KSI)	Plastic$^{\triangle}$ Zone (in x 10^{-3})
	F1L1	NVPI	++	64.6	--
	F1L2	2520	34.79	64.6	15.4
	F1L3	2580	36.15	64.6	16.6
	F1L4	NVPI	++	64.6	--
		Avg.	35.47		
	F2L1	2540	35.28	57.5	20.0
	F2L2	NVPI	++	57.5	--
	F2L3	2390	34.41	57.5	19.0
	F2L4	2520	34.63	57.5	19.2
		Avg.	34.78		
	F3L1	NVPI	++	60.6	--
	F3L2	NVPI	++	60.6	--
	F3L3	NVPI	++	60.6	--
	F3L4	2220	35.64	60.6	18.7
		Avg.	35.64		
7075-T7351					
	F1T1	2220	30.20	63.6	11.9
	F1T2	1820	29.54	63.6	11.4
	F1T3	NVPI	++	63.6	--
	F1T4	NVPI	++	63.6	--
		Avg.	29.87		
	F2T1	NVPI	++	54.0	--
	F2T2	NVPI	++	54.0	--
	F2T3	NVPI	++	54.0	--
	F2T4	NVPI	++	54.0	--
		Avg.	++		
	F3T1	2160	32.04	55.1	14.6
	F3T2	2120	32.53	55.1	18.5
	F3T3	NVPI	++	55.1	--
	F3T4	NVPI	++	55.1	--
		Avg.	32.29		

TABLE II, (con't)

Material	Specimen	Pop-In Load (lb)	K_{IC} (KSI$\sqrt{IN}$)	Yield Strength (KSI)	Plastic△ Zone (in x 10^{-3})
	G1L1	2120	32.19	76.1	8.9
	G1L2	2200	33.04	76.1	10.0
	G1L3	2420	32.62	76.1	9.7
	G1L4	2400	33.42	76.1	10.2
			Avg. 32.82		
	G2L1	2060	29.42	74.9	8.2
	G2L2	2000	27.91	74.9	7.4
	G2L3	1880	28.03	74.9	7.4
	G2L4	1940	31.04	74.9	9.3
			Avg. 29.19		
	G3L1	1860	31.46	74.3	9.5
	G3L2	NVPI	++	74.3	--
	G3L3	2068	25.79	74.3	6.4
	G3L4	2020	30.46	74.3	8.9
			Avg. 29.24		
7079-T651					
	G1T1	2040	28.16	72.6	7.9
	G1T2	1900	26.30	72.6	6.9
	G1T3	1740	27.55	72.6	7.6
	G1T4	1780	26.48	72.6	7.0
			Avg. 27.12		
	G2T1	1760	26.42	72.2	7.1
	G2T2	1680	25.62	72.2	6.7
	G2T3	1760	26.05	72.2	6.9
	G2T4	1660	25.70	72.2	6.2
			Avg. 25.95		
	G3T1	1860	27.59	71.3	7.9
	G3T2	1680	26.25	71.3	7.2
	G3T3	1820	24.59	71.3	6.3
	G3T4	1720	27.79	71.3	8.1
			Avg. 26.56		

TABLE II, (con't)

NOTE: NVPI is abbreviation for "No Valid Pop-In."

1 Broke while fatigue cracking.
2 Equipment malfunction.

+ Unreasonably low value
++ No valid pop-in
* Broke while fatigue cracking
** No pop-in detected; very slow crack growth
*** Equipment malfunction

△ The plane strain plastic zone radius, $r_y = 1/6\pi (K_{IC}/YS)^2$, used to compute plastic zone.

TABLE III

Average K_{IC} (KSI$\sqrt{IN}$)

Secant Method
(Srawley & Brown)

Alloy and Temper	Lot	Longitudinal Alcoa+ Spec.	Longitudinal Lab Spec.	Longitudinal Alcoa++ Spec.	Transverse Alcoa+ Spec.	Transverse Lab Spec.	Transverse Alcoa++ Spec.
2020-T651	I	20.6	23.3	21.1	18.2	22.0	18.6
	II	21.3	23.1	21.8	18.9	20.3	19.4
	III	21.4	24.6	21.9	19.6	20.2	20.1
		21.1	23.7	21.6	18.9	20.8	19.4
2024-T851	I	26.5	26.4	27.1	22.0	23.8	22.5
	II	25.3	24.9	25.9	20.9	21.8	21.4
	III	26.6	26.7	27.2	22.2	23.0	22.7
		26.1	26.0	26.7	21.7	22.9	22.2
2219-T851	I	38.6*	--**	39.5	37.5*	--**	38.4
	II	42.2*	--**	43.2	39.2*	--**	40.1
	III	43.5*	--**	44.5	34.5*	--**	35.3
		41.8*	--**	42.4	37.1*	--**	37.9
7001-T75	I	24.4	26.7	25.0	22.8	25.4	23.3
	II	23.3	25.4	23.9	22.6	23.1	23.1
	III	24.5	29.6	25.1	21.3	24.8	21.8
		24.1	27.2	24.7	22.2	24.4	22.7
7075-T651	I	30.4	33.0	31.1	27.0	28.3	27.6
	II	31.0	27.9	31.7	26.1	31.6	26.7
	III	--**	30.9	---	--**	26.3	---
		30.7	30.6	31.4	26.6	28.7	27.2
7075-T7351	I	--**	35.5	---	--**	29.9	---
	II	39.5	34.8	40.4	33.1	--**	33.9
	III	38.4	35.6	39.3	34.8	32.3	35.6
		39.0	35.3	39.9	34.0	31.1	34.8
7079-T651	I	32.2	32.8	33.0	27.0	27.1	27.6
	II	30.1	29.2	30.8	26.8	26.0	27.4
	III	30.2	29.2	30.9	27.0	26.6	27.6
		30.8	30.4	31.6	26.9	26.6	27.5

* Local Yielding at Notch Tips
** No Pop-In Load by Secant Method
\+ Original Alcoa Data
\+\+ Correction of Irwin Tangent Form (Alcoa) to Forman and Kobayashi, Isida, and Mendelson.

TABLE IV

Individual Energy Data

Material	Specimen	Energy/Area (Q/A) (in-lb/in^2)	G_{IC} (in-lb/in^2)
	A1L1	62.89	---
	A1L2	102.81	51.2
	A1L3	101.48	45.8
	A1L4	96.82	47.6
	A2L1	114.22	53.6
	A2L2	100.19	51.1
	A2L3	91.22	44.1
	A2L4	94.50	41.4
	A3L1	106.66	---
	A3L2	112.94	50.9
	A3L3	132.40	60.3
	A3L4	114.45	50.6
2020-T651			
	A1T1	---	---
	A1T2	---	---
	A1T3	134.88	33.7
	A1T4	104.29	53.3
	A2T1	---	---
	A2T2	84.96	37.3
	A2T3	92.75	37.3
	A2T4	83.81	35.2
	A3T1	---	---
	A3T2	85.81	37.3
	A3T3	---	---
	A3T4	77.36	35.1

TABLE IV, (con't)

Material	Specimen	Energy/Area (Q/A) (in-lb/in^2)	G_{IC} (in-lb/in^2)
	B1L1	167.19	60.7
	B1L2	159.45	63.3
	B1L3	172.11	65.4
	B1L4	159.28	59.6
	B2L1	153.54	---
	B2L2	173.33	58.4
	B2L3	135.93	52.3
	B2L4	137.38	51.0
	B3L1	160.37	57.6
	B3L2	175.65	63.2
	B3L3	170.17	---
	B3L4	169.34	70.2
2024-T851			
	B1T1	104.74	49.7
	B1T2	109.61	50.8
	B1T3	106.37	53.7
	B1T4	98.91	47.0
	B2T1	99.46	---
	B2T2	100.13	43.8
	B2T3	93.42	40.8
	B2T4	78.92	42.3
	B3T1	99.60	49.4
	B3T2	99.75	---
	B3T3	98.05	45.2
	B3T4	---	---

TABLE IV, (con't)

Material	Specimen	Energy/Area (Q/A) (in-lb/in^2)	G_{IC} (in-lb/in^2)
	C1L1	286.33	---
	C1L2	277.37	---
	C1L3	256.06	---
	C1L4	253.46	---
	C2L1	341.44	---
	C2L2	355.12	---
	C2L3	350.51	---
	C2L4	360.45	---
	C3L1	---	---
	C3L2	357.89	---
	C3L3	372.66	---
	C3L4	407.72	---
2219-T851			
	C1T1	195.41	---
	C1T2	234.66	---
	C1T3	210.98	---
	C1T4	214.89	---
	C2T1	230.24	---
	C2T2	235.10	---
	C2T3	216.57	---
	C2T4	224.84	---
	C3T1	300.83	---
	C3T2	310.62	---
	C3T3	288.22	---
	C3T4	287.08	---

TABLE IV, (con't)

Material	Specimen	Energy/Area (Q/A) (in-lb/in^2)	G_{IC} (in-lb/in^2)
	D1L1	---	---
	D1L2	159.56	56.7
	D1L3	151.46	58.3
	D1L4	177.01	76.0
	D2L1	154.43	66.5
	D2L2	164.04	---
	D2L3	136.64	57.2
	D2L4	119.19	48.9
	D3L1	157.33	69.3
	D3L2	194.92	71.7
	D3L3	198.14	84.5
	D3L4	176.40	---
7001-T75			
	D1T1	103.45	55.5
	D1T2	133.90	58.0
	D1T3	116.94	55.7
	D1T4	106.19	56.6
	D2T1	---	---
	D2T2	100.36	48.7
	D2T3	112.29	48.7
	D2T4	90.97	44.9
	D3T1	113.00	55.5
	D3T2	103.96	53.2
	D3T3	104.49	50.0
	D3T4	122.32	61.2

TABLE IV, (con't)

Material	Specimen	Energy/Area (Q/A) (in-lb/in^2)	G_{IC} (in-lb/in^2)
	E1L1	283.95	---
	E1L2	288.64	97.5
	E1L3	274.64	97.8
	E1L4	297.47	94.9
	E2L1	139.37	---
	E2L2	164.47	77.6
	E2L3	145.46	69.2
	E2L4	143.16	61.2
	E3L1	189.35	---
	E3L2	204.21	73.0
	E3L3	239.91	93.3
	E3L4	228.25	89.8
7075-T651			
	E1T1	150.67	75.7
	E1T2	150.94	64.4
	E1T3	170.18	69.6
	E1T4	136.55	73.3
	E2T1	217.40	96.9
	E2T2	208.90	90.3
	E2T3	229.12	78.3
	E2T4	226.43	54.7
	E3T1	125.94	64.0
	E3T2	140.68	66.5
	E3T3	132.97	---
	E3T4	134.48	70.8

TABLE IV, (con't)

Material	Specimen	Energy/Area (Q/A) (in-lb/in²)	G_{IC} (in-lb/in²)
	F1L1	362.52	---
	F1L2	388.73	107.9
	F1L3	356.93	116.5
	F1L4	369.10	---
	F2L1	444.04	110.9
	F2L2	411.63	---
	F2L3	383.84	105.5
	F2L4	408.88	106.8
	F3L1	391.48	---
	F3L2	393.45	---
	F3L3	395.34	---
	F3L4	393.44	113.2
7075-T7351			
	F1T1	180.76	81.3
	F1T2	154.30	77.8
	F1T3	167.10	---
	F1T4	178.95	---
	F2T1	228.86	---
	F2T2	228.62	---
	F2T3	229.27	---
	F2T4	220.50	---
	F3T1	239.77	91.5
	F3T2	236.17	94.3
	F3T3	236.76	---
	F3T4	225.38	---

TABLE IV, (con't)

Material	Specimen	Energy/Area (Q/A) (in-lb/in^2)	G_{IC} (in-lb/in^2)
	G1L1	246.33	86.4
	G1L2	227.98	97.3
	G1L3	263.09	94.8
	G1L4	264.62	99.5
	G2L1	206.35	77.1
	G2L2	204.66	69.4
	G2L3	197.03	70.0
	G2L4	211.15	87.8
	G3L1	193.36	88.2
	G3L2	---	---
	G3L3	206.22	59.2
	G3L4	190.86	82.7
7079-T651			
	G1T1	147.35	70.7
	G1T2	139.97	61.6
	G1T3	131.15	67.6
	G1T4	134.19	62.5
	G2T1	119.10	62.2
	G2T2	119.52	58.5
	G2T3	126.06	60.4
	G2T4	114.05	54.7
	G3T1	136.41	67.8
	G3T2	114.98	61.4
	G3T3	136.61	53.9
	G3T4	142.21	68.8

TABLE V

K_{IC} Ranges

Alloy	Direction	Lab K_{IC} Range KSI$\sqrt{IN}$	Lab ΔK_{IC}	Alcoa K_{IC} Range KSI$\sqrt{IN}$	Alcoa ΔK_{IC}
2020-T651	Longitudinal	22.24-24.52	2.28	20.3-22.2	1.90
	Transverse	19.45-20.47	1.02	17.9-20.7	2.80
2024-T851	Longitudinal	24.22-23.07	3.85	24.7-27.2	2.5
	Transverse	21.40-24.55	3.15	20.5-24.0	3.5
7001-T75	Longitudinal	25.22-30.79	5.57	23.1-25.9	2.80
	Transverse	22.45-26.22	3.77	19.4-24.7	5.30
7075-T651	Longitudinal	26.21-33.08	6.87	29.9-32.0	2.1
	Transverse	26.80-32.98	6.18	25.5-27.4	1.9
7075-T7351	Longitudinal	34.41-36.15	1.74	37.5-41.4	3.9
	Transverse	29.54-32.53	2.99	32.4-34.9	2.5
7079-T651	Longitudinal	27.91-33.42	5.51	28.5-33.8	5.3
	Transverse	24.59-28.16	3.57	26.4-27.8	1.4

NOTE: Lab K_{IC} values which were neglected because of their uniqueness:

2020-T651	Long. -21.55, 26.02;	Trans. -24.47
2024-T851	Long. -None;	Trans. -None
7001-T75	Long. -23.43;	Trans. -None
7075-T651	Long. -None;	Trans. -24.77
7075-T7351	Long. -None;	Trans. -None
7079-T651	Long. -25.79;	Trans. -None

TABLE VI

Dimensional Characteristics of Test Specimens

Material	X	Y
2020-T651 Long.	2.79	4.18
2020-T651 Trans.	3.74	5.60
2024-T851 Long.	1.70	2.55
2024-T851 Trans.	2.15	3.22
7001-T75 Long.	1.82	2.73
7001-T75 Trans.	2.23	3.34
7075-T651 Long.	1.76	2.63
7075-T651 Trans.	1.86	2.79
7075-T7351 Long.	0.79	1.19
7075-T7351 Trans.	0.92	1.37
7079-T651 Long.	1.63	2.44
7079-T651 Trans.	1.97	2.95

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13. ABSTRACT

Fracture toughness values obtained from small laboratory size specimens in four point slow-bend loading were compared with values obtained by Aluminum Company of America (ALCOA) in testing large semi-infinite center notched plate specimens. The plane-strain stress-intensity factors, K_{IC}, determined in this investigation varied from those values obtained by ALCOA by 7% on the positive side and 18% on the negative side. The results, although not conclusive in themselves, tend to substantiate the specimen requirements suggested by Brown and Srawley.

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