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Report No. 8926-161

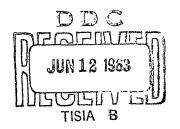
Material - Transparency - Plastic - Plexiglas 55

Static and Fatigue Strength

E. Schiff, J. P. McNelly, W. E. Wise



30 September 1957



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GENERAL DYNAMICS | CONVAIR

MODEL DATE

PAGE REPORT NO.

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Material - Transparency - Plastic - Plexiglas 55

Static and Fatigue Strength

Abstract:

Static tensile and notched tensile, tensile fatigue, crack propagation, edge attachment and shear-out tests were made with biaxially stretched (70% approx.) Plexiglas 55 supplied by the Swedlow Plastics Co., Los Angeles, Calif. The test data resulting from tests at -50, 75 and 195°F are given in tabulations and charts.

Reference: Schiff, E., McNelly, J. P., Wise, W. E., "Plexiglass 55 - Physical Properties -Static and Fatigue Tests, General Dynamics/Convair Report SL 56-164, San Diego, California, 30 September 1957. (Reference attached).

STRUCTURES & MATERIALS LABORATORIES

REPORT 56-164

DATE 30 September 1957

MODEL F-1024

TITLE

REPORT NO. 56-164

PLEXIGLAS 55 - PHYSICAL PROPERTIES

STATIC AND FATIGUE TESTS

MODEL F-102'

CONTRACT NO. AF 33(600)-5942

A DIVISION OF GENERAL DYNAMICS CORPORATION

SAN DIEGO

PRE	PARED BY	E. Schiff	If	GROUP STRUCTURES	S LABORATORIES
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ANALYSIS
PREPARED BY
CHECKED BY
REVISED BY

E. Schiff W. E. Wise

C O N V A I R A DIVISION OF SENERAL BYNABICS CORPORATION SAN DIEGO

PAGE 1
REPORT NO. 56-164
MODEL F-102A
DATE 30 Sept 1957

REPORT NO. 56-164 PLEXIGIAS 55 - PHYSICAL PROPERTIES STATIC AND FATIGUE TESTS MODEL F-102A

REFERENCES:

- (a) Federal Specification LP 406 b, "Plastics, Organic: General Specifications, Test Methods", dated 27 September 1951.
- (b) Convair Specification ZM-8-104, "Specification for Canopy and Windshield Materials Development".

OBJECT:

To determine various physical properties of Plexiglas 55, biaxially stretched approximately 70%, for design information purposes and to provide data for the selection of minimum acceptable properties for a procurement specification.

TEST SPECIMENS:

All stretched test specimens were from a single lot of Plexiglas 55 stretched and furnished by Swedlow Plastics Company. After stretching the material, the vendor subjected it to the same heat cycle as a production F-102A canopy panel. Two shrink-back specimens cut from this sheet and shrunk back gave an average stretch percentage of 66.2. As-cast Plexiglas 55 was also furnished by Swedlow Plastics Company.

Specimen configurations were as follows:

Static tensile tests - The 75°F and 194°F specimens were standard tensile coupons in accordance with Reference (a); the -50°F specimens were modified as shown in Figure 1 to cause failure to occur at the center, since they otherwise often failed at the grips.

Static notched tensile tests - These were made as shown in Figures 2 and 3.

Tensile fatigue tests - The specimen shown in Figure 1 was used at 75°F and 194°F; the -50°F specimens were modified as shown in Figure 4, to cause failure at the center.

<u>Crack propagation tests</u> - Standard 2 inch x 6 inch specimens were used, in accordance with Reference (b). See Figure 14.

Edge attachment tests - Convair 8-07142 specimens were made by Swedlow Plastics Company, per Reference (b). See Figure 5.

Shear-out tests - The specimen is shown in Figure 6.

ANALYSIS
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PAGE 2
REPORT NO. 56-164
MODEL F-102A
DATE 30 Sept 1957

TEST PROCEDURES:

Static tensile tests - Reference (a) was followed, except that the load rate was changed to .02 inch per minute, to more closely approach the estimated load rate in service. Five specimens were run at each of 3 temperatures: 75°F, 194°F and -50°F.

Static notched tensile tests - The same procedure as for unnotched tensile tests was followed. Ten specimens each of stretched and as-cast Plexiglas 55 were tested at 75 F.

Tensile fatigue tests - A Triplett and Barton fatigue machine was used to load the specimens, at a rate of 15 cycles per minute. Four points were obtained on an S-N curve at 194°F. Five specimens were run at 75°F at 7,000 psi for a minimum of 20,000 cycles, and five were run at -50°F at 10,000 psi for a minimum of 20,000 cycles.

Crack propagation tests - Reference (a) was followed, with load rate adjusted to fail the specimen in 3 to 5 minutes. Five specimens were tested at each of 3 temperatures: 75°F, 194°F and -50°F.

Edge attachment tests - A set of holding fixtures simulating the canopy edge attachment were used. This loaded the specimen eccentrically, similar to the way the actual canopy frame loads the plastic panel. Five specimens were tested at each of 3 temperatures: 75°F, 194°F and -50°F.

Shear-out tests - The specimens were loaded in double shear, using a .186 inch diameter pin. All tests were at 75°F. An attempt was made to cause a shear failure, by varying the edge distance.

RESULTS:

Results of all tests are given in Tables I through V, and failed specimens are shown in Figures 8 through 16. The edge attachment specimens all failed initially by shearing the orlon-acrylic impregnate ledge. The 75 F specimens were reloaded after this failure, until complete tensile failure through the Plexiglas occurred.

The shear-out tests were halted after edge distances as low as 1 d failed to produce a shear failure; all specimens failed in tension. Failing loads were as follows:

Specimen	Edge Distance	Ultimate - Lbs.
2570-1	2 d	1520
2574-1	1.5 d	1225
25 7A- 2	1 d	· 750

An S-N curve of tensile fatigue data at 194°F is given in Figure 7.

NOTE:

The test data from which this report was prepared are recorded in Structures Test Laboratory Data Book No. 4005, pages 5 through 9.

ANALYSIS

PREPARED BY E. Schiff CHECKED BY W. E. Wise

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SAN DIEGO

PAGE 3
REPORT NO. 56-164
MODEL F-102A
DATE 30 South

REVISED BY DATE 30 Sept 1957

TABLE INDEX

TABLE NO.	TITLE	PAGE NO.
I	Static Tensile Tests - Stretched Plexiglas 55 - (Swedlow Plastics Company)	4
II	Static Notched Tensile Tests - As-Cast and Stretched Plexiglas 55	i 5
III	Crack Propagation Tests - Stretched Plexiglas 55	6
IA	Edge Attachment Static Tensile Tests - Stretched Plexiglas 55	7
ν.	Tensile Fatigue Test Results - Stretched Plexiglas	55 8

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PAGE REPORT NO. DATE 7 55-164 30 September 1957 55 STRETCHED PLEXIGLAS 5018 5609 4857 5215 4373. 5014 rsd Secondary Failure .lbs. .2710 :2800 2910 2440 3130 2798 plex. adhesive o. *ISG Ultimate. 1763 1989 1918 651 738 832 795 2457 2764 2794 2824 2793 2115 1948 792 3127 STATIC TENSILE TESTS 1953 962 failure was tensile failure $_{
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PAGE 8
REPORT NO. 56-164
DATE 30 September 1957

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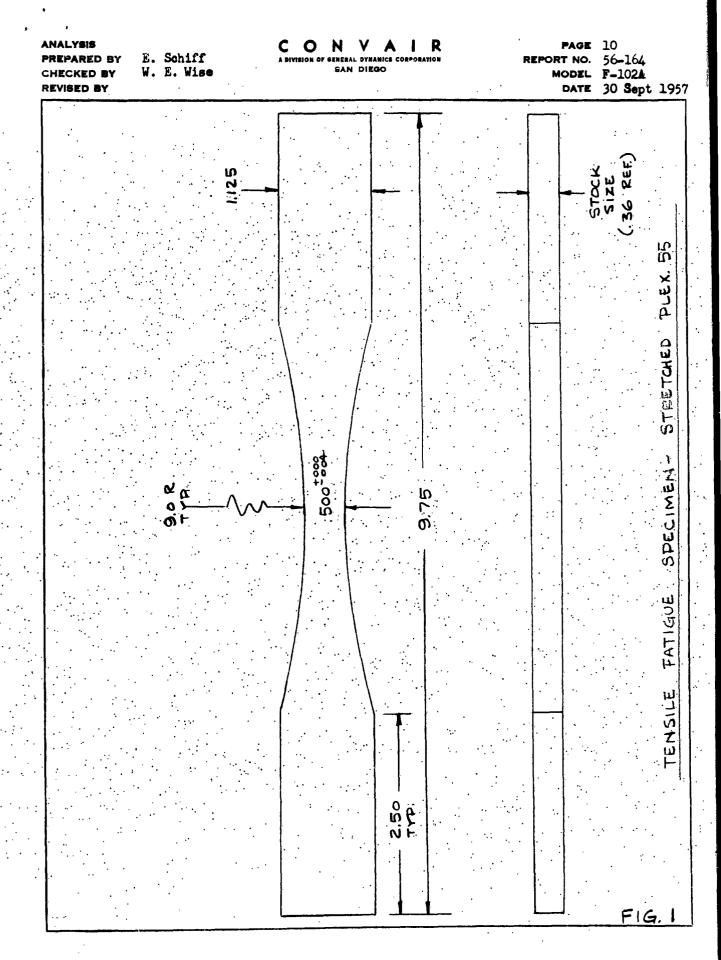
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PAGE 9
REPORT NO. 56-164
MODEL F-102A
DATE 30 Sept 1957

FIGURE INDEX

FIGURE NO.	PHOTO NO.	TITLE	PAGE NO.
1		Tensile Fatigue Specimen - Stretched Plexiglas 55	10
2		Notched Static Tensile Specimen - Stretched Plexiglas 55	11
3		Motched Static Tensile Specimen - As-Cast Plexiglas 55	12
4		Tensile Fatigue Specimen - Stretched Plexiglas 55	13
5		Specimen - Test, Edge Attachment, Canopy Window	14
6		Shear-out Specimen - Stretched Plexiglas 55	15
7		S-N Curve for Stretched Plexiglas 55 - Test Temperature 194°F	16
8	23754	Static Tensile Failure 75°F	17
9	23753	Static Tensile Failure 194°F	18
10	23 7 55	Static Tensile Failure -50°F	19
. 11	23757	Static Notched Tensile Failure - As-Cast Plexiglas 55	20
12	23 75 6	Static Notched Tensile Failure - Stretched Plexiglas 55	21
13	23752	Tensile Fatigue Specimens - Stretched Plexiglas 55	22
14	23760	Crack Propagation Specimens - Stretched Plexiglas 55	23
15	23759	Edge Attachment Specimens - Stretched Plexiglas 55	24
16	23758	Shear-out Specimens - Stretched Plexiglas 55	25



PAGE 11 CONVAIR ANALYSIS REPORT NO. 56-164 MODEL F-102A E. Schiff SAN DIEGO W. E. Wise DATE 30 Sept 1957 REVISED BY PLEX 55 STRETCHED SPECIMEN-TENSILE STATIC NOTCHED

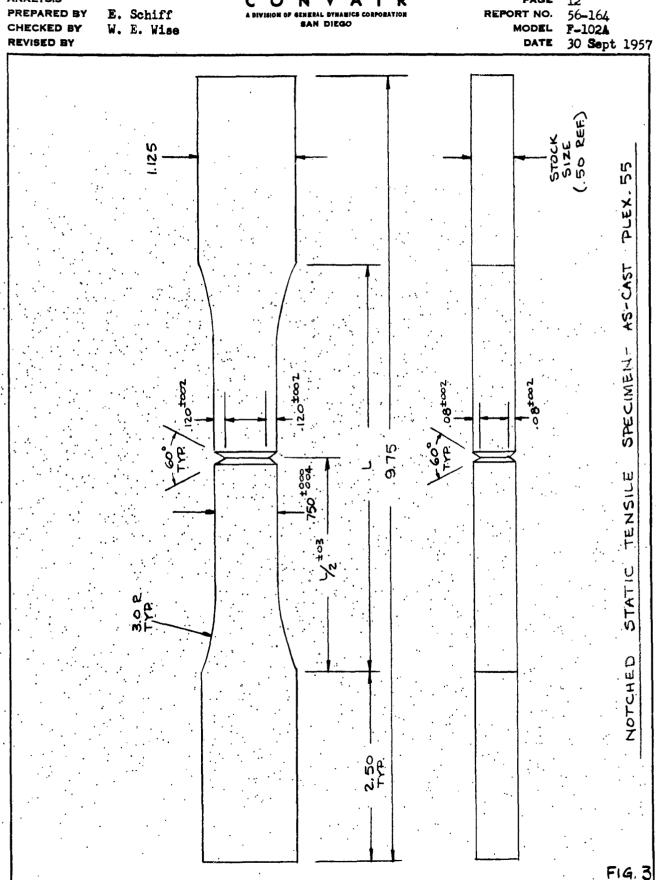
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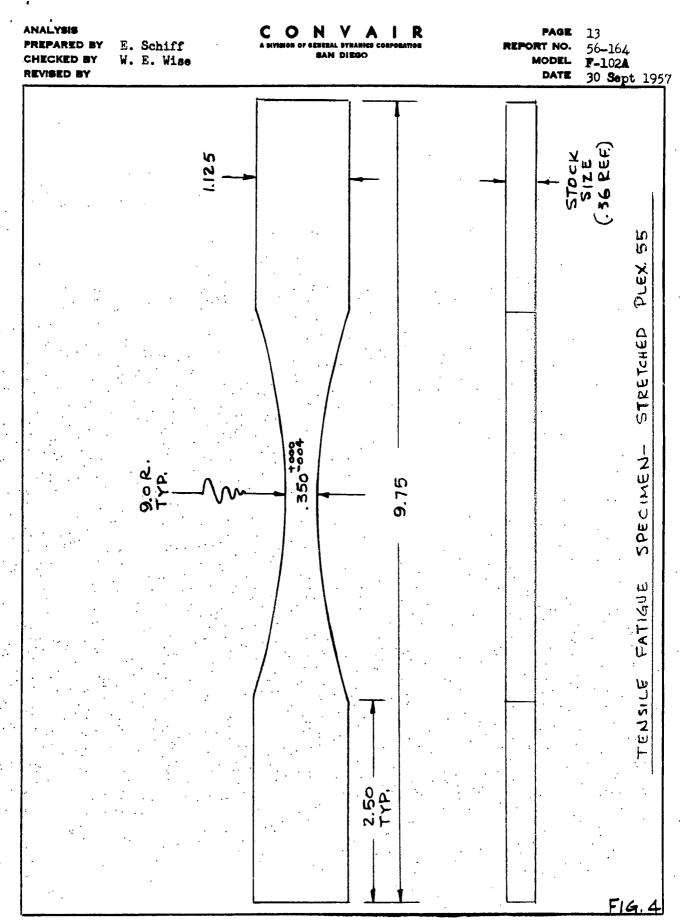
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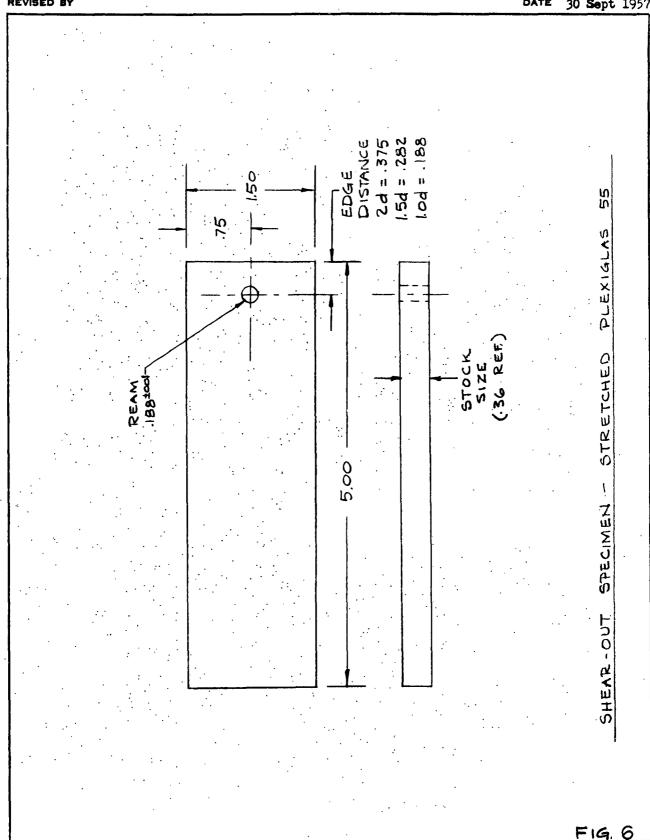


DATE 30 Sept 1957 .28 10 .255 .250 HOLE JIG DRILL CSK 100° X .35 +.03 10.00 1.85 .50 R. .50 2.00 ALL DIMENSIONS TYPICAL EACH END. SPECIMEN - TEST, EDGE ATTACHMENT, CANOPY WINDOW 8-07142 FIG. 5

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PAGE 15
REPORT NO. 56-164
MODEL F-102A
DATE 30 Sept 1957





PAGE 16 REPORT NO. 56-164 DATE 30 Sept 1957 CURVE FOR STRETCHED PLEX, 55 TEST TEMP: 194 11:1 i i la distribu v ٦ -----111 4111 1:1:1: : : : : <u>, : .</u> T 4 : i 3 STRESS - P.S. . x 10-3 F19. 7



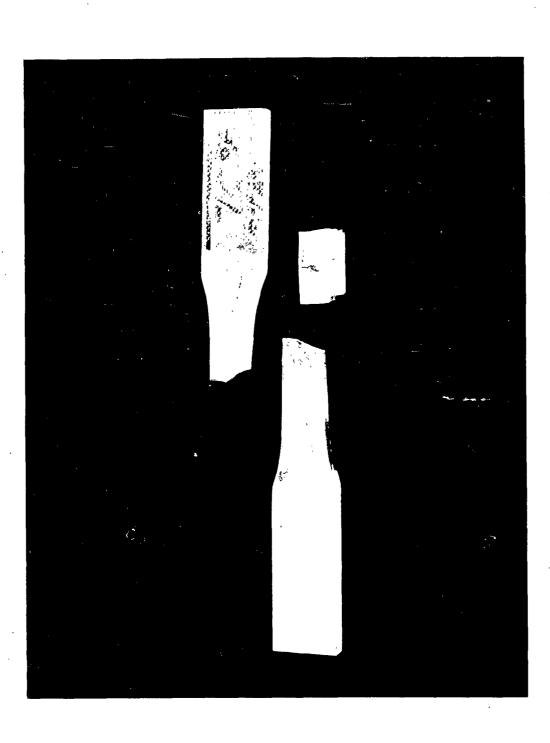
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PAGE 17 56-164 F-102A REPORT NO. MODEL

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STATIC TENSILE FAILURE 75°F Figure 8



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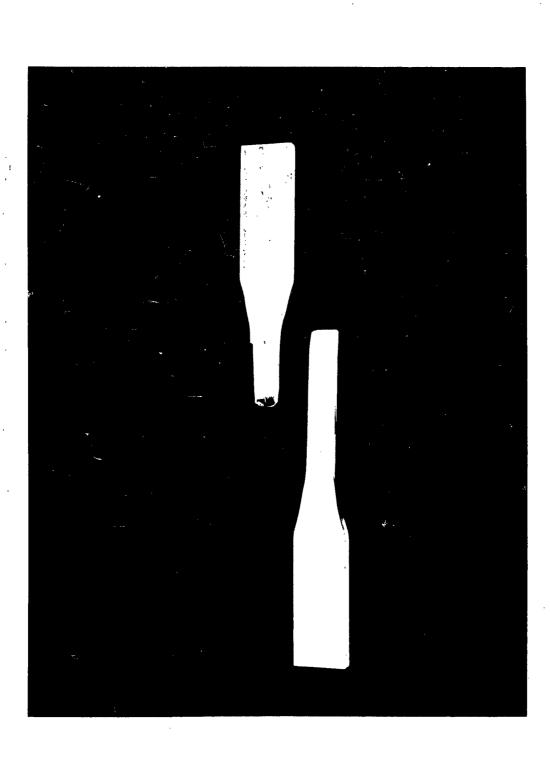
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PAGE 18 REPORT NO. 56-164

MODEL F-102A

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STATIC TENSILE FAILURE 194°F Figure 9



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PAGE 19
REPORT NO. 56-164
MODEL F-102A
DATE 30 Sept 1957

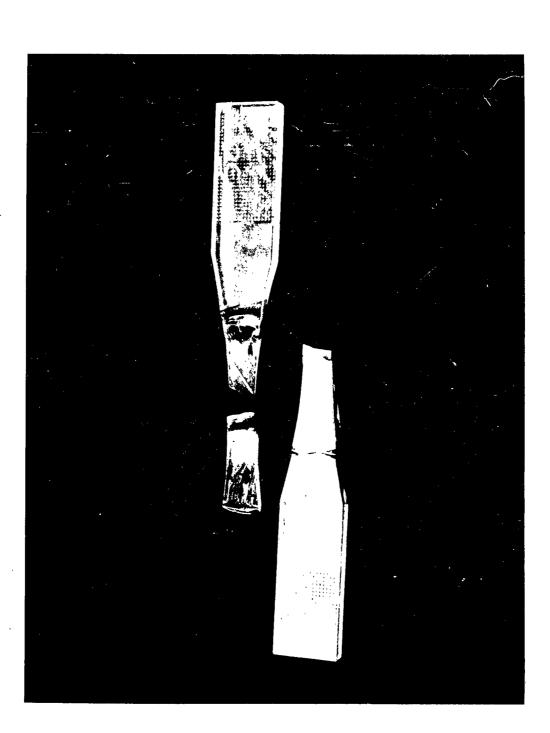


Figure 10 STATIC TENSILE FAILURE -50°F



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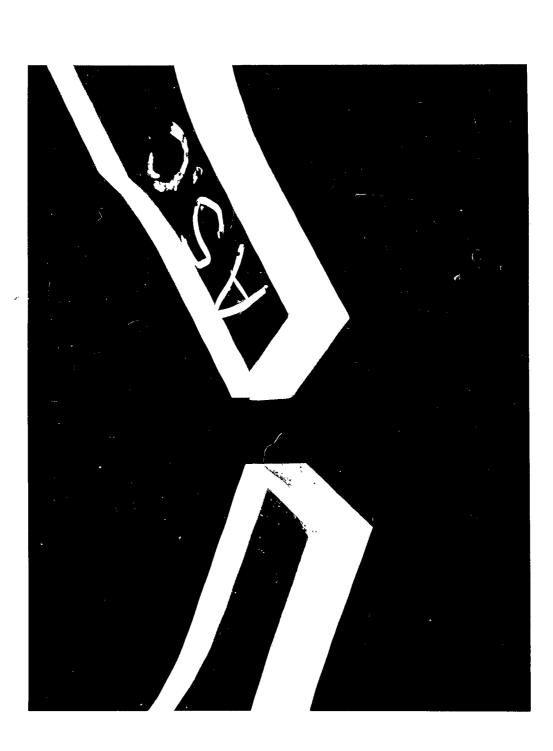
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STATIC NOTCHED TENSILE FAILURE - AS-CAST PLEXIGLAS 55 Figure 11



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PAGE 21 REPORT NO. 56-164 MODEL F-102A

DATE 30 Sept 1957

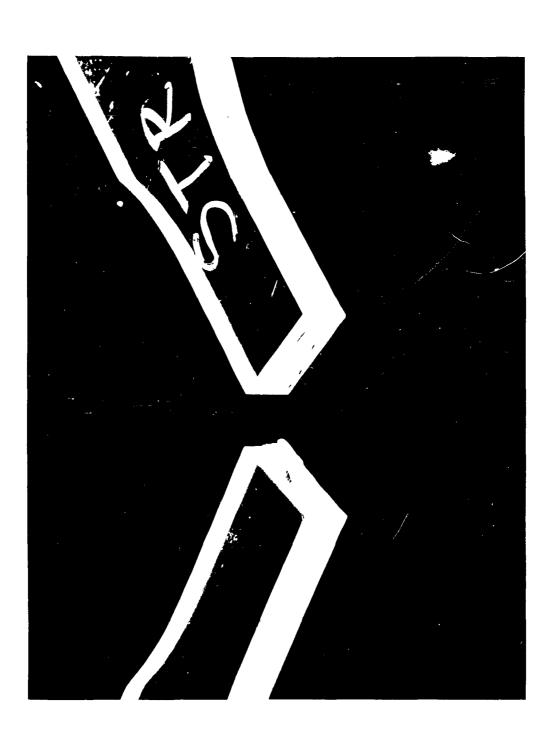


Figure 12 STATIC NOTCHED TENSILE FAILURE - STRETCHED FLEXIGLAS 55



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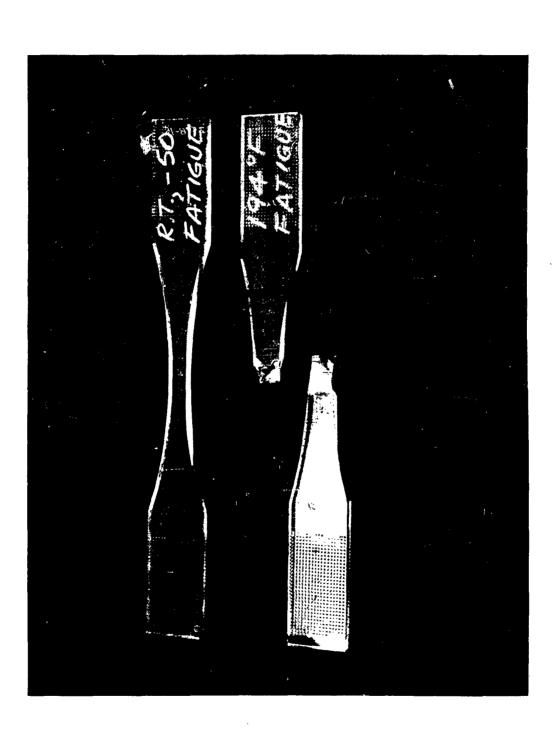
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DATE 30 Sept 1957



gure 13 TENSILE FATIGUE SPECIMENS - STRETCHED PLEXIGLAS 55

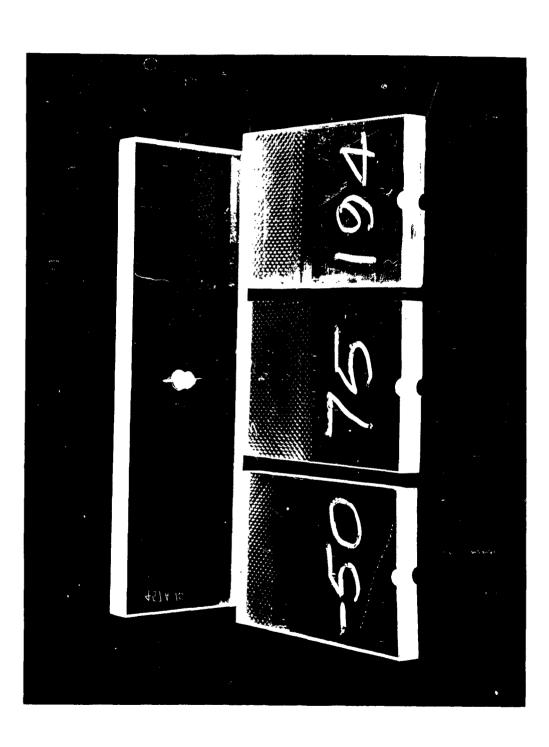
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REPORT NO. 56-164
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CRACK PROPAGATION SPECIMENS - STRETCHED PLEXIGLAS 55 Figure 14

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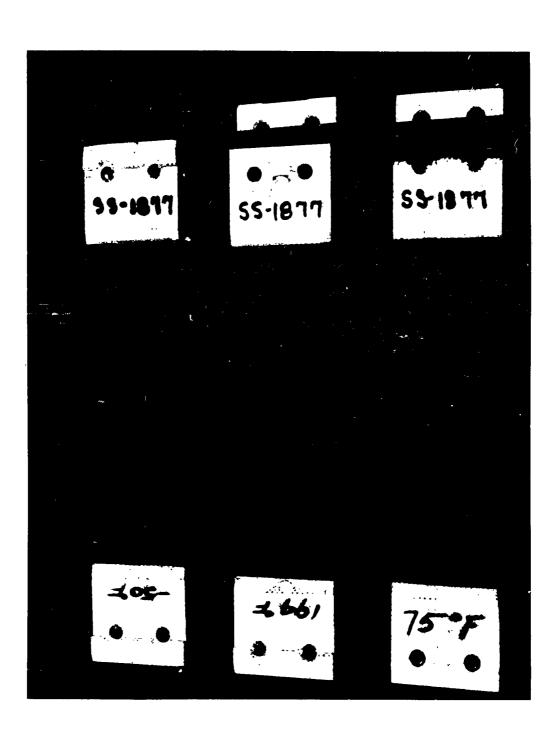


Figure 15 EDGE ATTACHMENT SPECIMENS - STRETCHED PLEXIGLAS 55



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PAGE 25
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Figure 16 SHEAR-OUT SPECIMENS - STRETCHED PLEXIGLAS 55