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LTV AEROSPACE CORP DALLAS TEX VOUGHT SYSTEMS DIV
S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM, VOLUME 1.(U)

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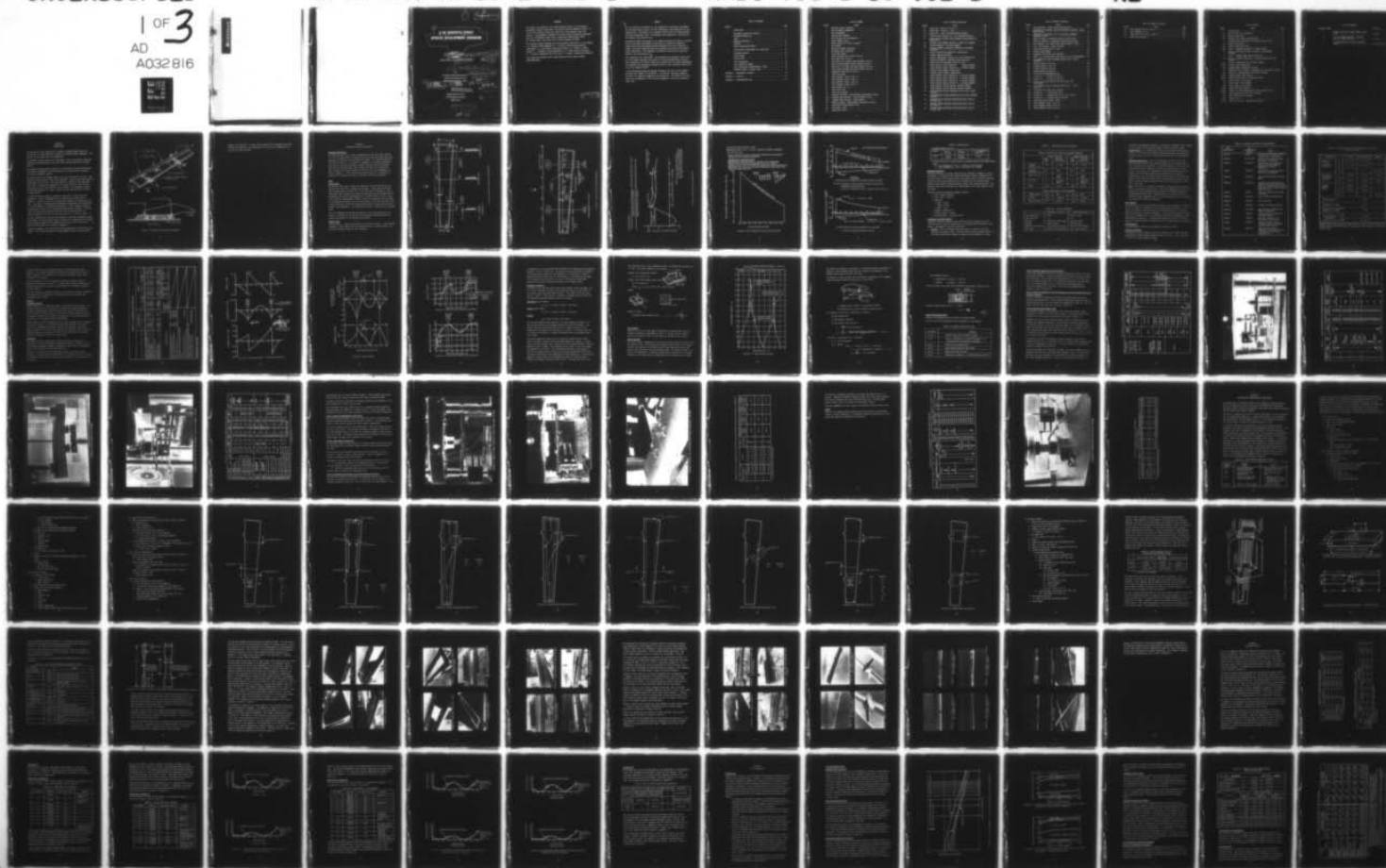
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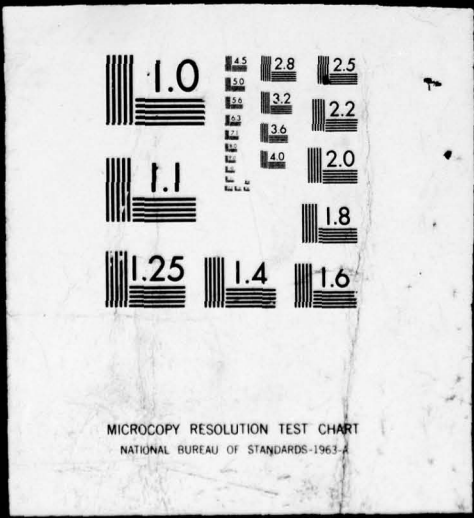


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**S-3A GRAPHITE/EPOXY
SPOILER DEVELOPMENT PROGRAM.**

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FOREWORD

This report was prepared by the Vought Systems Division of LTV Aerospace Corporation, Dallas, Texas under the terms of contract N62269-73-C-0610. It is the final technical report and covers all work completed under this contract. The program is sponsored by the Air Vehicle Technology Department, Naval Air Development Center (NADC), Warminster, Pennsylvania, 18974. Mr. Anthony Manno, code 30331 is the Project Engineer for NADC.

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SUMMARY

The S-3A spoiler is designed as a cost competitive lightweight replacement for the metal spoiler, and is fit and functionally interchangeable with the existing part. The spoiler is of sandwich construction with graphite/epoxy faces and non-metallic core. The component was assembled by co-curing the wet laminate faces and HRP core.

Structural analysis and design of the composite spoiler was based on existing criteria and load requirements as specified for production components. Design verification and manufacturing development tests were conducted to predict structural capability and solve manufacturing problems encountered during fabrication. The component is deflection critical and sizing was based on this consideration.

Five components were fabricated. The manufacturing development article was cut into element specimens and tested to evaluate manufacturing processes. Three components were static tested, and successfully met design requirements. One component was successfully fatigue tested to four lifetimes without failure of any composite parts.

A cost monitoring system was employed throughout the span of the program and each cost element was identified. A cost matrix and graph comparing the metal and composite components was constructed. Cost data for the composite was extrapolated to 200 units and compared to actual and projected metal cost.

TABLE OF CONTENTS

SECTION	PAGE
1 INTRODUCTION	1
2 ENGINEERING DESIGN AND ANALYSIS	4
COMPONENT DESCRIPTION	4
LOADS	4
MATERIALS SELECTION	10
ANALYSIS.	15
DESIGN VERIFICATION TESTS	24
3 MANUFACTURING DEVELOPMENT AND FABRICATION	41
4 COMPONENT TESTING	69
STATIC TESTS.	71
FATIGUE TEST.	77
5 COST COMPARISONS.	78
COST MONITORING SYSTEM.	79
COST COMPARISONS GRAPHITE/EPOXY - METAL	82
PROGRESS CURVES - FACTORY LABOR	85
APPENDIX A - ENGINEERING DRAWINGS	89
APPENDIX B - TESTING.	107
APPENDIX C - MANUFACTURING PLAN	177

LIST OF FIGURES

FIGURE	TITLE	PAGE
1	COMPOSITE SPOILER ASSEMBLY.	2
2	SPOILER GENERAL DIMENSIONS.	5
3	SKIN ARRANGEMENT.	6
4	SPOILER HINGE MOMENTS	7
5	UNIT SPOILER LOAD DISTRIBUTIONS	8
6	DESIGN RUNNING LOADS.	9
7	SHEAR, MOMENT AND TORSION DIAGRAMS.	17
8	SKIN STRESS	18
9	SPOILER STIFFNESS COMPARISON.	19
10	DEFLECTED SHAPE COMPARISON.	19
11	CORE SHEAR STRESS	22
12	INSERT SPECIMEN TEST FIXTURE (TR-135)	27
13	CORE SHEAR TEST (TR-140).	29
14	TEST SET-UP FOR FLEXURAL BEAM SPECIMENS (TR-141).	30
15	HINGE FITTING/SANDWICH PANEL SPECIMEN (TR-142).	33
16	TEST SET-UP FOR PANEL WITH EDGE CLOSEOUT (TR-147)	34
17	FAILED TEST SPECIMEN WITH EDGE CLOSEOUT (TR-147).	35
18	COMPRESSIVE TEST SET-UP (TR-150).	39
19	LOWER SKIN LAYUP	45
20	EDGE DOUBLERS (PLIES 10 AND 11)	46
21	EDGE DOUBLERS (PLIES 12 AND 13)	47
22	EDGE DOUBLERS (PLIES 14 AND 15)	48
23	EDGE DOUBLERS (PLIES 16 AND 17)	49
24	EDGE DOUBLER (PLY 18)	50
25	UPPER SKIN LAYUP.	51
26	UPPER SKIN DOUBLERS	52
27	SPECIMEN LOCATIONS - MANUFACTURING DEVELOPMENT SPOILER.	55
28A	FLEXURAL BEAM SPECIMEN - LOADING METHOD SPOILER	56
28B	FLEXURAL BEAM SPECIMEN - CONFIGURATION.	56
29	TENSILE COUPONS - MANUFACTURING DEVELOPMENT SPOILER	58
30	GLASS/EPOXY SPOILER MOLDING TOOL.	60
31	SKIN LAYUP GUIDE	60
32	LOWER SKIN PLY NO. 1	60

LIST OF FIGURES (Continued)

FIGURE	TITLE	PAGE
33	LOWER SKIN - LAYUP OF PLY NO. 6	60
34	LOWER SKIN - PLYS NO. 7 AND 8	61
35	LOWER SKIN - LAYUP COMPLETE-TEMPLATE TRIMMED.	61
36	PICTURE FRAME DOUBLER, PLY 14 ON TRANSFER TEMPLATE.	61
37	LOWER SKIN AND PICTURE FRAME DOUBLERS AFTER TRANSFER TO MOLDING TOOL.	61
38	MACHINED CORE SEGMENTS APPLIED TO LOWER SKIN ASSEMBLY	62
39	VACUUM DEBULKING OF SPOILER ASSEMBLY.	62
40	SPOILER ASSEMBLY, DEBULKING COMPLETE-TAB STIFFENERS INSTALLED	62
41	BAGGING PREPARATION-BLEEDER PLY INSTALLATION.	62
42	PROCESS CONTROL SPECIMENS	64
43	BAGGING PREPARATION, PARTIAL CAUL PLATE INSTALLATION.	64
44	BAGGING PREPARATION, PRESSURE BLOCKS INSTALLED.	64
45	BAGGED PART AND SPECIMENS, READY FOR CURE	64
46	UPPER SURFACE, STATIC ARTICLE NO. 1, SPOILER ASSEMBLY	65
47	LOWER SURFACE, STATIC ARTICLE NO. 1, SPOILER ASSEMBLY	65
48	INBOARD HINGE ASSEMBLY INSTALLATION	65
49	OUTBOARD HINGE ASSEMBLY INSTALLATION	65
50	LOWER SURFACE, STATIC ARTICLE NO. 2, SPOILER ASSEMBLY	66
51	UPPER SURFACE, STATIC ARTICLE NO. 2, SPOILER ASSEMBLY	66
52	LOWER SURFACE, STATIC ARTICLE NO. 3, SPOILER ASSEMBLY	66
53	UPPER SURFACE, STATIC ARTICLE NO. 3, SPOILER ASSEMBLY	66
54	LOWER SURFACE, FATIGUE ARTICLE, SPOILER ASSEMBLY.	67
55	UPPER SURFACE, FATIGUE ARTICLE, SPOILER ASSEMBLY.	67
56	GRAPHITE/EPOXY SPOILER INSTALLED ON S-3A WING, CLOSED POSITION.	67
57	GRAPHITE/EPOXY SPOILER INSTALLED ON S-3A WING, EXTENDED POSITION.	67
58	MEASURED VERSUS PREDICTED DEFLECTIONS-STATIC TEST #1 AT 150% DLL	73
59	MEASURED VERSUS PREDICTED DEFLECTIONS-STATIC TEST #2 AT 150% DLL	75
60	MEASURED VERSUS PREDICTED DEFLECTIONS-STATIC TEST #3 AT 150% DLL	76

LIST OF FIGURES (Continued)

FIGURE	TITLE	PAGE
61	COST COMPARISON - METAL VERSUS GRAPHITE/EPOXY	80
62	PERCENTAGE OF RECURRING COST FOR FUNCTIONAL ELEMENTS - SHEET METAL SPOILER	81
63	PERCENTAGE OF RECURRING COST FOR FUNCTIONAL ELEMENTS - COMPOSITE SPOILER	81
64	EFFECT OF LABOR ON COMPOSITE SPOILER SELLING PRICE.	87
65	EFFECT OF MATERIAL ON COMPOSITE SPOILER SELLING PRICE	87
A-1	CORE ASSEMBLY - S3A OUTER PANEL LOWER SPOILER (4 SHTS).	90
A-2	FLAP - S3A SPOILER - LOWER (11 SHTS).	94
A-3	OUTER SKIN BONDING MOLD (2 SHTS).	105
B-1	SPOILER HINGE MOMENTS	111
B-2	DEFLECTION AND STRAIN GAGE LOCATIONS.	112
B-3	LOWER L. H. SPOILER STATIC TEST SET UP AND LOAD REQUIREMENTS.	113
B-4	S-3A COMPOSITE SPOILER SPANWISE RUNNING LOAD - STATIC CONDITION	114
B-5	SPOILER LOADED AT 150% DLL.	118
B-6	SPOILER LOADED AT 177% DLL.	119
B-7	SPOILER LOADED AT 260% DLL.	120
B-8	SPOILER LOADED AT 300% DLL.	121
B-9	STATIC TEST INSTRUMENTATION KEY	122
B-10	SPOILER NO. 2 - FAILURE AT 360% DLL	131
B-11	SPOILER NO. 3 - FAILURE AT 375% DLL	142
B-12	LOWER L.H. SPOILER FATIGUE TEST SET-UP AND LOAD REQUIREMENTS	155
B-13	S3A COMPOSITE SPOILER SPANWISE RUNNING LOAD - FATIGUE CONDITION	157
B-14	DEFLECTION AND STRAIN GAGE LOCATION	158
B-15	SPOILER NO. 4 - FATIGUE TEST SET-UP	162
B-16	SPOILER NO. 4 - DELAMINATIONS (POST 4,800 CYCLES)	163
B-17	SPOILER NO. 4 - OUTBOARD FITTING FAILURE	164
C-1	LOWER SKIN LAYUP (PLIES 1 THRU 9)	181
C-2	EDGE DOUBLERS (PLIES 10 AND 11)	182
C-3	EDGE DOUBLERS (PLIES 12 AND 13)	183
C-4	EDGE DOUBLERS (PLIES 14 AND 15)	184

LIST OF FIGURES (Continued)

FIGURE	TITLE	PAGE
C-5	EDGE DOUBLERS (PLIES 16 AND 17)	185
C-6	EDGE DOUBLERS (PLY 18)	186
C-7	UPPER SKIN LAYUP (PLIES 1 THRU 9)	187
C-8	INNER SKIN DOUBLERS	188

LIST OF TABLES

TABLE	TITLE	PAGE
I	FATIGUE LOADS	10
II	QUALIFICATION DATA COMPARISON	11
III	PROCESS COMPARISON.	11
IV	MATERIALS AND PROCESS SPECIFICATIONS.	13
V	UNIDIRECTIONAL PROPERTIES OF 5209/T300 GRAPHITE EPOXY	14
VI	MATERIAL ALLOWABLES	16
VII	DESIGN VERIFICATION TESTS	24
VIII	TR-135 - STRENGTH EVALUATION OF POTTED INSERTS.	26
IX	TR-140 - VERIFICATION TEST OF SANDWICH CORE/GRAPHITE LAMINATE.	28
X	TR-141 - FLEXURAL BEAM SPECIMEN TEST DATA	31
XI	TR-147 - STRENGTH EVALUATION OF SANDWICH PANELS WITH EDGE CLOSEOUT.	36
XII	TR-150 - COMPRESSION TEST SPECIMEN RESULTS.	38
XIII	SPOILER WEIGHT COMPARISONS.	40
XIV	MANUFACTURING DEVELOPMENT SPECIMENS	41
XV	PROCESS CONTROL SPECIMENS - MANUFACTURING DEVELOPMENT SPOILER	54
XVI	TEST DATA - MANUFACTURING DEVELOPMENT SPECIMEN.	57
XVII	PROCESS CONTROL TEST RESULTS.	70
XVIII	ACTUAL SPOILER WEIGHT VS PREDICTED WEIGHT	70
XIX	STATIC TEST #1 RUN SEQUENCE	71
XX	STATIC TEST #2 RUN SEQUENCE	72
XXI	STATIC TEST #3 RUN SEQUENCE	74
XXII	FATIGUE TEST-RUN SEQUENCE	77
XXIII	FORMAT FOR COST REPORTING-METAL VERSUS COMPOSITE PART	83
XXIV	COST COMPARISON OF FIRST FIVE SPOILERS.	84
B-I	TEST LOADS AND HINGE MOMENTS.	115
B-II	FATIGUE LOAD.	156
B-III	FATIGUE TEST DATA - STRAIN AND DEFLECTION	161

LIST OF REFERENCES

REFERENCE NUMBER		REPORT NO.
1	CONTROL SYSTEM AND CONTROL SURFACE LOADS (S-3A)	LR 24691
2	S-3A WING CONTROL SURFACES - INTERNAL LOADS AND STRESS ANALYSIS.	LR 24597
3	S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM.	2-53443/3R-3139

SECTION 1
INTRODUCTION

The objective of this program was to develop a graphite/epoxy lower S-3A spoiler that is fully qualified to replace the existing metal component. The spoiler is both weight and cost competitive.

Five graphite epoxy spoilers were fabricated. One was sectioned to evaluate processes and manufacturing, three were static tested, and one was fatigue tested.

The program included material selection, verification testing, manufacturing and tooling development, structural analysis, and design effort necessary to develop a composite spoiler.

The S-3A spoilers are surfaces hinged off of the rear spar of the wing. They function as roll control devices and speedbrakes. Each wing has four spoilers, three upper and one lower. The lower spoiler is located on the wing underside, and is a simple beam supported by two hinge fittings. The spoiler is positioned by a push rod attached to each fitting. Its planform is quadrilateral approximately 85" long, 8" wide at the outboard end and 15" wide at the inboard end.

A composite spoiler assembly, composed of only four (4) basic parts was designed as a direct replacement for the existing lower metal spoiler assembly. A series of tests were defined and conducted for design verification. Four types of manufacturing development subcomponents were fabricated to check on details of component producibility. Then a complete component was produced to check out the tooling and manufacturing processes. Finally, four test articles were produced for static and fatigue testing. The complete assembly, including the trailing edge seal, is shown in Figure 1.

The four completed test spoilers were shipped to Naval Air Development Center for testing. The three static tests to failure were satisfactorily concluded and the fatigue tests were run successfully exceeding design requirements. Test reports from the NADC are included in Appendix B.

During the program a cost monitoring system was employed to monitor each cost element. The system consisted of an alpha-numeric code by which each cost

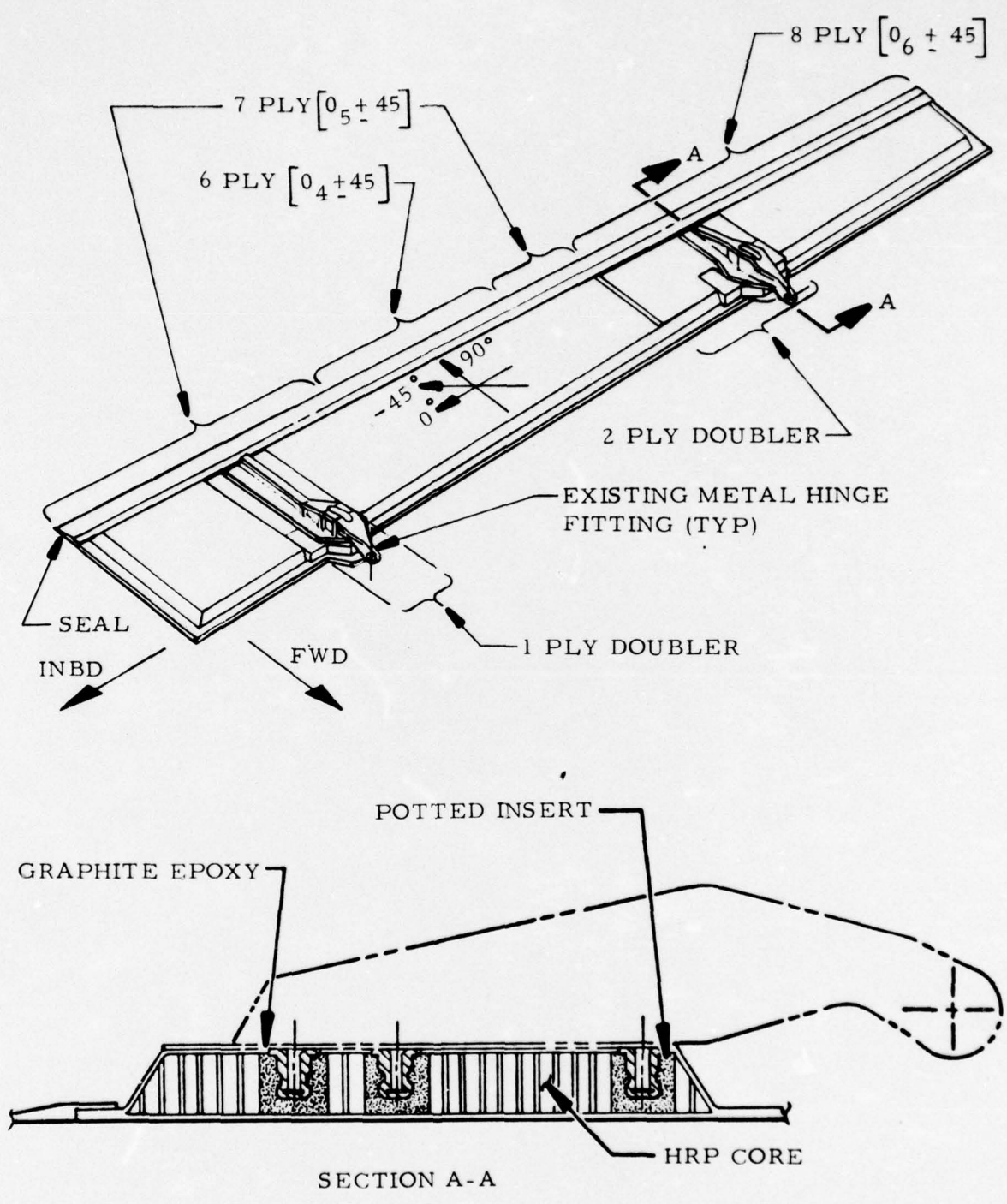


FIGURE 1 COMPOSITE SPOILER ASSEMBLY

element was identified. As costs were incurred on each component they were recorded and compiled, then extrapolated to 200 units for comparison with the costs of metal spoilers.

SECTION 2
ENGINEERING DESIGN AND ANALYSIS

COMPONENT DESCRIPTION

The composite spoiler is a direct replacement for the lower metal spoiler. It fits in the same space, is hinged off the existing outer panel rear spar supports, and utilizes the same actuation system. The general dimensions are shown in Figure 2. The spoiler is composed of two contoured graphite/epoxy skins of variable thickness, a glass reinforced plastic honeycomb core, and two existing metal hinge fittings attached with fourteen (14) bolts threaded into inserts potted in the core. The skin arrangement is shown in Figure 3. A new trailing edge seal design will be required for production utilization, but was not necessary for the test articles.

LOADS

Static Loads

The applied loads used to design the composite S-3A lower spoiler are the same as those used for the current metal design. These loads are derived from Lockheed Report LR 24691 (Ref. 1) and are shown in Figures 4, 5 and 6. Additional loads resulting from control system friction are accounted for by multiplying all closing hinge moments by a friction factor of 1.24. Axial loads resulting from support structure strain are eliminated from the design by incorporating free-play into the hinge design. Side loads applied to the spoiler hinges are a result of push rod positioning, spoiler slope and $\pm 3^\circ$ of assumed rod misalignment. All resulting side load is reacted at the outboard hinge.

Both the triangular and uniform distributions of airload are used in the design. The spoiler is critical for the triangular distribution and the hinges are critical for the uniform distribution.

Fatigue Loads

Fatigue loads, as defined in Reference 2, are shown in Table I. The spectrum represents 13,000 flight hours (one lifetime) with no scatter factor. One spoiler was fatigue tested to four lifetimes.

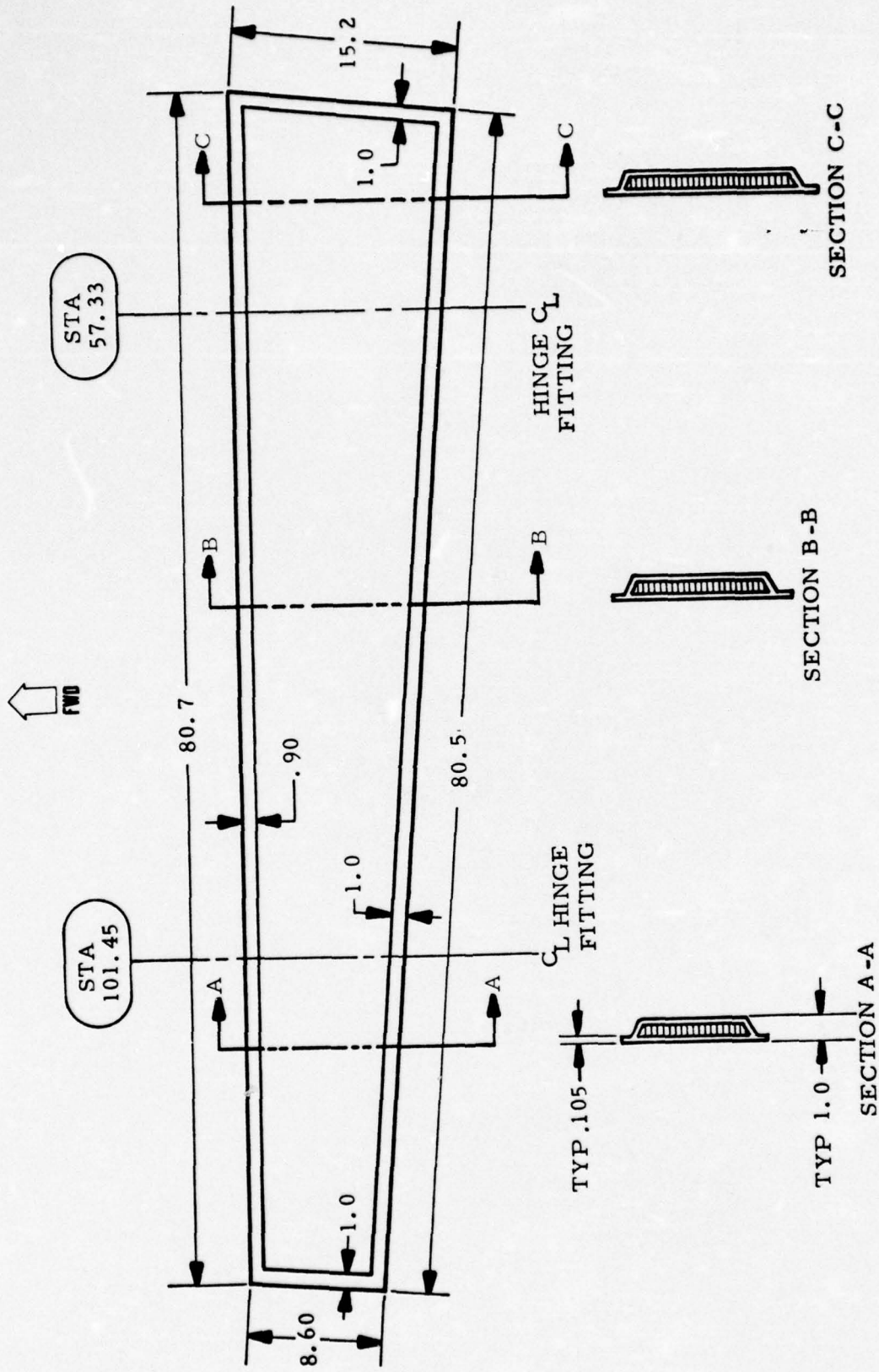


FIGURE 2 SPOILER GENERAL DIMENSIONS

LOWER SPOILER

- OPERATING HINGE MOMENT (AIRLOAD LESS FRICTION) WITH SERVO OUTPUT AT 2850 PSI
- - - BLOWBACK HINGE MOMENT (AIRLOAD PLUS FRICTION) WITH SERVO OUTPUT AT 3000 PSI

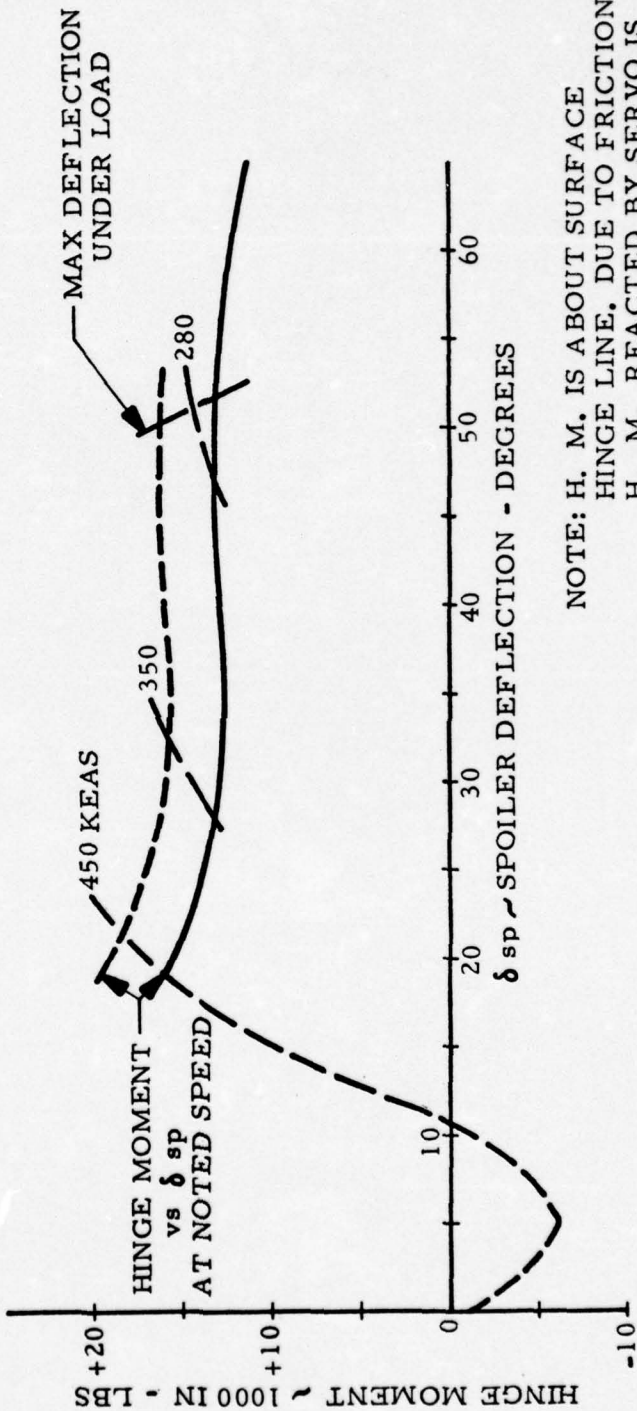


FIGURE 4 SPOILER HINGE MOMENTS

UNIT SPANWISE RUNNING LOAD
 DISTRIBUTIONS FOR A TOTAL SURFACE HINGE MOMENT
 OF 1000 IN - LBS.

FOR CLOSING LOADS IN THE OPEN POSITION OR OPENING
 LOADS IN THE CLOSED POSITION.

CHORDWISE DISTRIBUTIONS

USE BOTH A UNIFORM AND A TRIANGULAR PRESSURE
 DISTRIBUTION PER SKETCHES BELOW FOR CLOSING
 LOADS. FOR FLAPS UP OPENING LOADS USE THE TRIANGULAR
 DISTRIBUTION. FOR FLAPS DOWN OPENING LOADS USE THE
 UNIFORM DISTRIBUTION

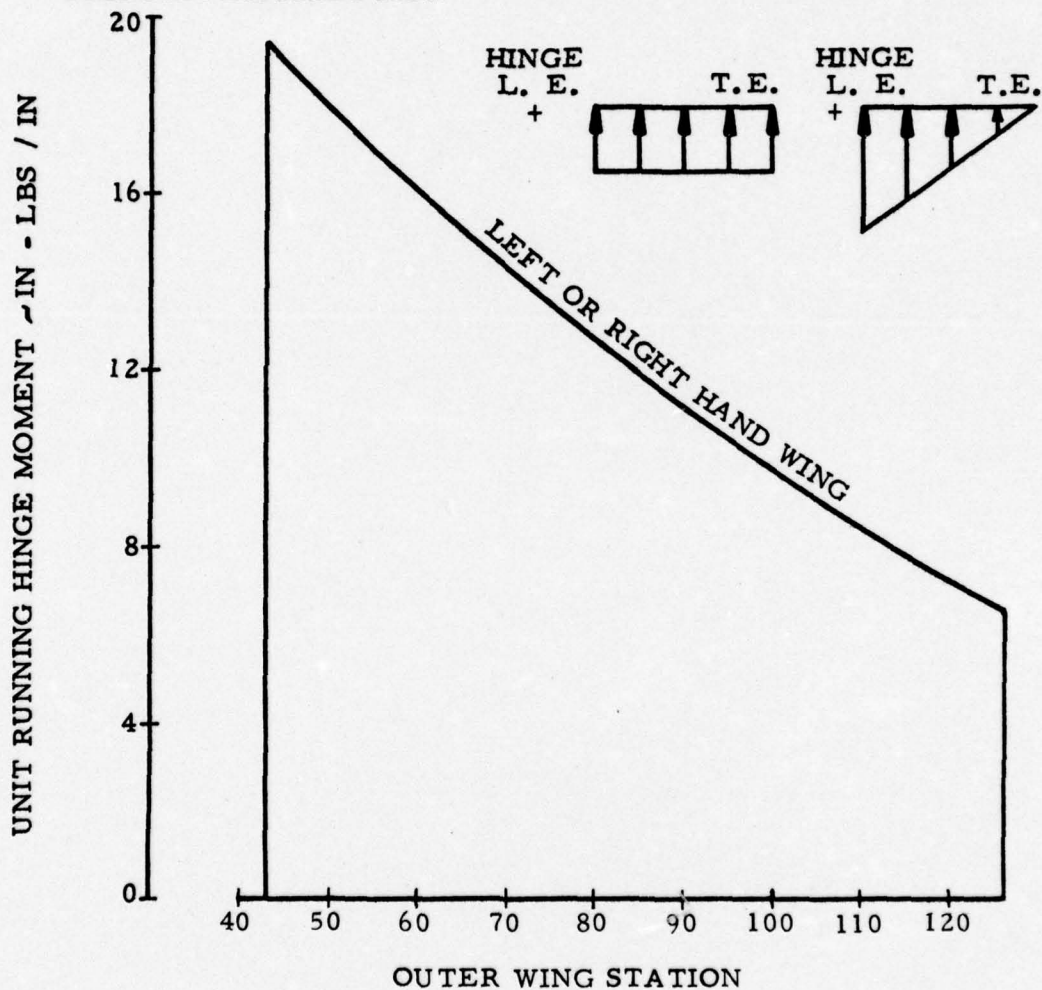
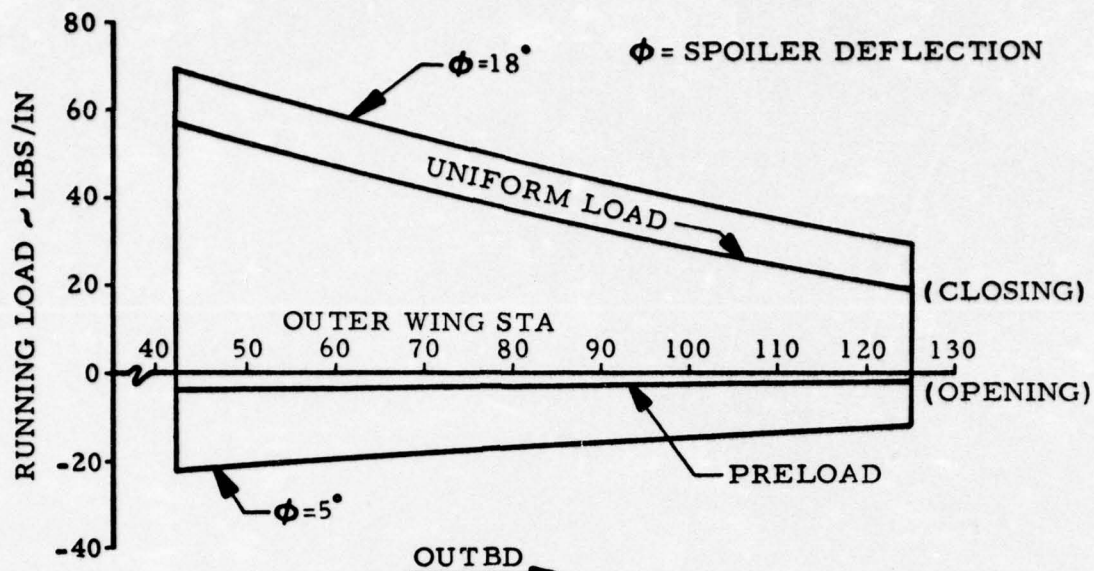


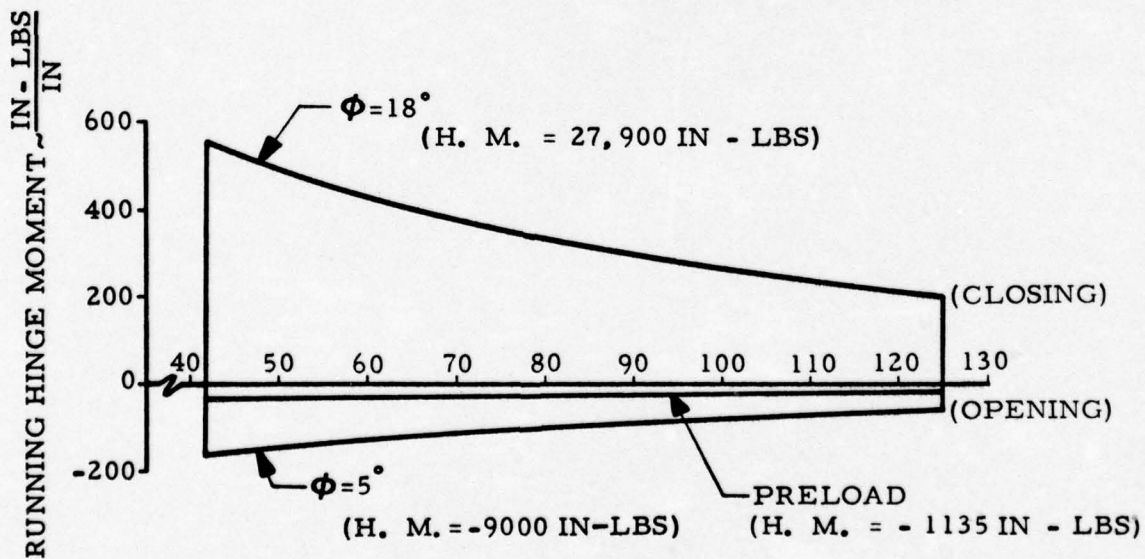
FIGURE 5 UNIT SPOILER LOAD DISTRIBUTIONS



LOWER SPOILER DESIGN LOADS [ULTIMATE LOAD]

NOTES: RUNNING LOADS DERIVED FROM TRIANGULAR PRESSURE DISTRIBUTION.

RATIO OF UNIFORM LOAD / TRIANGULAR LOAD = .76



LOWER SPOILER HINGE MOMENTS (ULTIMATE)

FIGURE 6 DESIGN RUNNING LOADS

TABLE I FATIGUE LOADS

SPOILER SPECTRUM (REF. 2)

SURFACE	MIN H. M. (IN-LBS)	MAX H. M. (IN-LBS)	NO. OF OCCURRENCES/ 13,000 HRS
LOWER	-6,000 -7,080*	+12,000 +14,160*	20,000

* Includes increase in loads because of outboard upper spoiler deactivation

NOTES:

- 1) SIGN CONVENTION, POS. H. M. TENDS TO CLOSE SPOILERS
- 2) ONE OCCURRENCE IS: MIN H. M. TO MAX H. M. TO ZERO

MATERIALS SELECTION

Materials selected for spoiler fabrication are required to operate in a 180F environment. Co-curing at 260F during manufacture requires compatibility of the cure cycles of the graphite/epoxy, film adhesive and core splice material. Adhesive used for insert potting and the sealant used for honeycomb edge protection and faying surface protection require room temperature cures. The phenolic resin which stabilizes the beveled edges of the core requires a 350F oven cure.

Materials required for spoiler assembly include:

- o G_R/E - Narmco 5209/T300
- o Core - HRP - 5.5#/ft³
- o Adhesives
 - Film - M1113
 - Paste - EA 901
 - Foam - FM 37
- o Sealant - ProSeal 890
- o Phenolic Resin - SC 1008
- o Threaded Insert - Shur-Lok SL 607

Evaluation and Qualification

Comparative data for Narmco 5209 and 5208 are shown in Tables II and III. This data was the basis for selection of the Narmco 5209/T300 graphite epoxy system. Advantages of the 5209 system are:

1. Modulus - the low viscosity 5209 resin system is suited to the well aligned T300 graphite fiber. With the better packing characteristics of the T300, higher fiber volumes are possible and consequently a higher

TABLE II QUALIFICATION DATA COMPARISON

PHYSICAL PROPERTIES OF UNCURED IMPREGNATED MATERIAL				
	NARMCO 5209/T300		NARMCO 5208/T300	
	TEST BATCH	REQUIRED (207-81-410/1)	TEST BATCH	REQUIRED (207-8-410/2)
Volatile Content, % wt.	.50	1.7 max	.90	1.7 max
Non-fiber Content, % wt.	43.8	41 \pm 4	42.6	41 \pm 4
Resin Flow, %	23	10-24 @250 F	20.2	10-24 @350 F
Gel Time	17	5-20 min @250 F	37	25-45 min @325 F
Tack	pass	30 min	pass	30 min
PHYSICAL PROPERTIES OF CURED LAMINATE				
Void Content	pass	NDT	pass	NDT
Density	1.53	1.56 \pm .02	1.55	1.56 \pm .02
Fiber Volume %	65.5	62. \pm 4.	73.0	62. \pm 4.

TABLE III PROCESS COMPARISON

	5209 (260 F Cure)	5208 (360 F Cure)
Cure temperature	260 F	350 F - 400 F
Cure Time, Hrs	1.5	4.0
Tooling	Aluminum or Fiber glass	Aluminum/Steel
Warpage	Lower Warpage	Higher Warpage
Adhesive Performance	High Peel and Strength	Low Peel and Strength
Co-curing	No over curing problem	Over curing problem

0° tensile and compressive modulus is available at comparable shear values. The 90° tensile and compressive modulus values are slightly lower.

2. Processability - cure temperature (260F) is lower than the 5208 system (350F). This causes less tool/part expansion problems, less heat up and cool down time, lower cost tooling materials and less tool fabrication costs.
3. Adhesive Compatibility - One of the advantages of using a 260F cure graphite/epoxy system is the concurrent capability of co-curing with a 260F cure adhesive as compared to a 350F cure adhesive. The M-1113 260F cure generates shear strengths of 5000-6000 psi and T-peel of 40-60 lbs/in. While tests at VSD demonstrate that 260F cure adhesives may be co-cured with 350F cure graphite epoxy laminates for 2-3 hours at temperature, it has been found that the shear strength of the 260F cure adhesive drops from the normal 5000-6000 range down to the 2000 to 3000 range. The best available adhesive system for spoiler usage is M-1113 with a 260F cure.
4. Cost - Since cost is a primary consideration, trade offs must consider cost of processing, see Table III. Lower cure temperatures lead to lower production costs, increased production rates with existing equipment, and decreased tooling costs. Almost double the production can be put through the same autoclave with a 1.5 hr. cure cycle as can be put through at 4 hours with a 360F cure material.

Core Material

The selection of the core was governed largely by the requirement to minimize the use of metals in conjunction with the graphite/epoxy materials. This avoids the problem of galvanic reactions and corrosion which are common to aircraft components in naval environments. The core used is Hexcel HRP glass core which is compatible with the materials and process requirements of the graphite/epoxy being used. A constant core density of 5.5#/ft³ is used to reduce the required number of splices from five to three splices per assembly.

Specifications

All specifications used on this program are listed in Table IV.

Material Allowables

Unidirectional lamina strength and elastic properties for NARMCO 5209/T300 intermediate strength graphite/epoxy are shown in Table V. These data were the basis of initial component design.

TABLE IV MATERIALS AND PROCESS SPECIFICATIONS

TYPE SPECIFICATION	VSD SPECIFICATION NUMBER	TITLE
Process	208-8-3	Graphite Tape and Sheet, Resin Impregnated for Hand Layup
Material	207-8-410/1	Graphite Fiber Tape and Sheet. Epoxy Resin Impregnated
Material	207-8-415	Film Adhesive and Primer for Bonding Precured Composite Laminate and Sandwich Structures
General	207-8-410	Graphite Fiber Tape and Sheet. Epoxy Resin Impregnated
Material	207-8-417	Core Filling Compound, Two Part Paste
Material	207-8-408	Adhesive System for Bonding of Aluminum-to-Aluminum and Aluminum Faces to Non-Perforated, Aluminum Honeycomb Core for 180°F Service (Type III only)
Process	CVA8-51	Aluminum, Cleaning and Etching for Bonding
Material	207-8-411	Core, Honeycomb non-metallic
Material	CVA8-405	Epoxy Adhesives
Process	CVA8-206	Bonding with Epoxy Adhesives
Material	CVA-6-579	Heat Resistant Sealant, 250°F Service Temperature
Process	CVA6-177	Sealing Compounds Preparation and Application of
Process	CVA8-39	Metalite, Fabrilite, and Wood Parts, Protection of
Process	208-8-12	Bonding of Metal-to-Metal and Metal Faces to Honeycomb Core for 180° Service
Process	208-7-18	Epoxy Reinforced Solid Laminates and Laminate Facings for Sandwich Construction, Fabrication of

TABLE V UNIDIRECTIONAL PROPERTIES OF 5209/T300
GRAPHITE EPOXY

PROPERTY		TENSION	COMPRESSION	SHEAR
MODULUS OF ELASTICITY (LBS/IN ²)	E ₁	19.0 × 10 ⁶	19.0 × 10 ⁶	—
	E ₂	1.5 × 10 ⁶	1.5 × 10 ⁶	—
	G ₁₂	—	—	0.7 × 10 ⁶
ULTIMATE STRENGTH (LBS/IN ²)	F ₁	170,000	170,000	10,000
	F ₂	8,000	25,000	10,000
STRAIN LIMIT (IN/IN)	e ₁	0.00895	0.00895	—
	e ₂	0.00532	0.01660	—
	γ ₁₂	—	—	0.01420
DENSITY ρ (#/IN ³)			0.058	
POISSON' RATIO μ			0.210	
INTERLAMINAR SHEAR STRESS F _{isu} (#/IN ²)			13,000	
COEFFICIENT OF EXPANSION (MICRO-IN/IN/°F)	α ₁	0.3 × 10 ⁶		
	α ₂	14.4 × 10 ⁶		

PROPERTIES FROM TABLE V WERE USED IN CONJUNCTION WITH POINT STRESS COMPUTER ROUTINES TO DEVELOP THE GENERAL MATERIAL PROPERTIES

Values are shown as B-basis allowables where a sufficient data base is available. The B-basis allowables are defined as the value above which at least 90 percent of the population of values are expected to fall, with a confidence of 95 percent.

Design allowables for other non-metallic materials including core and adhesives are presented in Table VI. Strength data are from sources such as industry specifications, military specifications, R&D programs, and prior in-house testing.

For final design and structural analysis of the critical sections, allowables were modified where verification or qualification tests indicated this information did not apply.

ANALYSIS

Structural Analysis

Stress analysis of the composite spoiler is presented in this section. The analysis covers the critical areas of the plank, and includes analysis of the graphite/epoxy faces, the HRP honeycomb core, and the potted inserts used to attach the hinge fittings. The critical loading conditions, shown in Figures 4 through 6, were used for the analysis. The spoiler surface is critical for the triangular airload distribution.

Shear, moment and torsion diagrams for the simply supported spoiler surface, are shown in Figure 7. The laminate bending and torsional stress shown in Figure 8 was calculated using beam theory and hand methods of analysis. Margins-of-safety for the critical sections were calculated using a computer analysis program. The program is a point stress analysis of a laminated orthotropic structure subject to in-plane loads.

Deflection

The spoiler cavity is restricted in depth and little cross section is available to provide the required structural stiffness. Stiffness is critical because an excessive amount of deflection would result in unacceptable gaps when the spoiler is in the open position.

Figure 9 is a comparison of the calculated graphite and metal spoiler stiffness. Outboard of hinge Station 101.45 the graphite spoiler is stiffer. The increase helps reduce the critical tip deflection at the outboard end of the spoiler.

TABLE VI - MATERIALS ALLOWABLES

	COMPRESSIVE			SHEAR					
	STRENGTH Psi	MODULUS Ksi	HEXCELL HONEYCOMB CORE	L. DIR.			W. DIR.		
				STRENGTH Psi	MODULUS Ksi	STRENGTH Psi	MODULUS Ksi	STRENGTH Psi	MODULUS Ksi
HRP 3/16 - 4.0 #/FT ³ VENDOR DATA (VSD 207-8-411)	370 (370)	57		212 (180)*	11.5 (10.0)	110 (94)*	5.0 (5.0)		
HRP 3/16 - 5.5 #/FT ³ VENDOR DATA (VSD 207-8-411)	600 (600)	95		350 (293)*	19.5 12.6	190 (150)*	8.5 (6.8)		
INSERTS SL607									
				TENSION	VENDOR DATA			TEST DATA	
FILM ADHESIVE (M1113)	-67°	4500 PSI		-	900 LBS.		1210 LBS.		
MIN AVE SHEAR STRENGTH	75°F	4500 PSI		-	905 LBS.		N/A		
PER VSD 207-8-415	+ 180°F	3400 PSI		-	150 IN/LBS.		280 LBS.		
CORE SPLICE ADHESIVE (FOAM)									
FM 37									
CORE SHEAR STRENGTH		650 PSI							
PER VSD 207-8-408, (TYPE III)									
INSERT POTTING ADHESIVE (EA 901)									
SHEAR STRENGTH PER									
VSD 207-8-405, (TYPE VI)									

@ 75°F 2500 Psi

* Adjusted for core depth

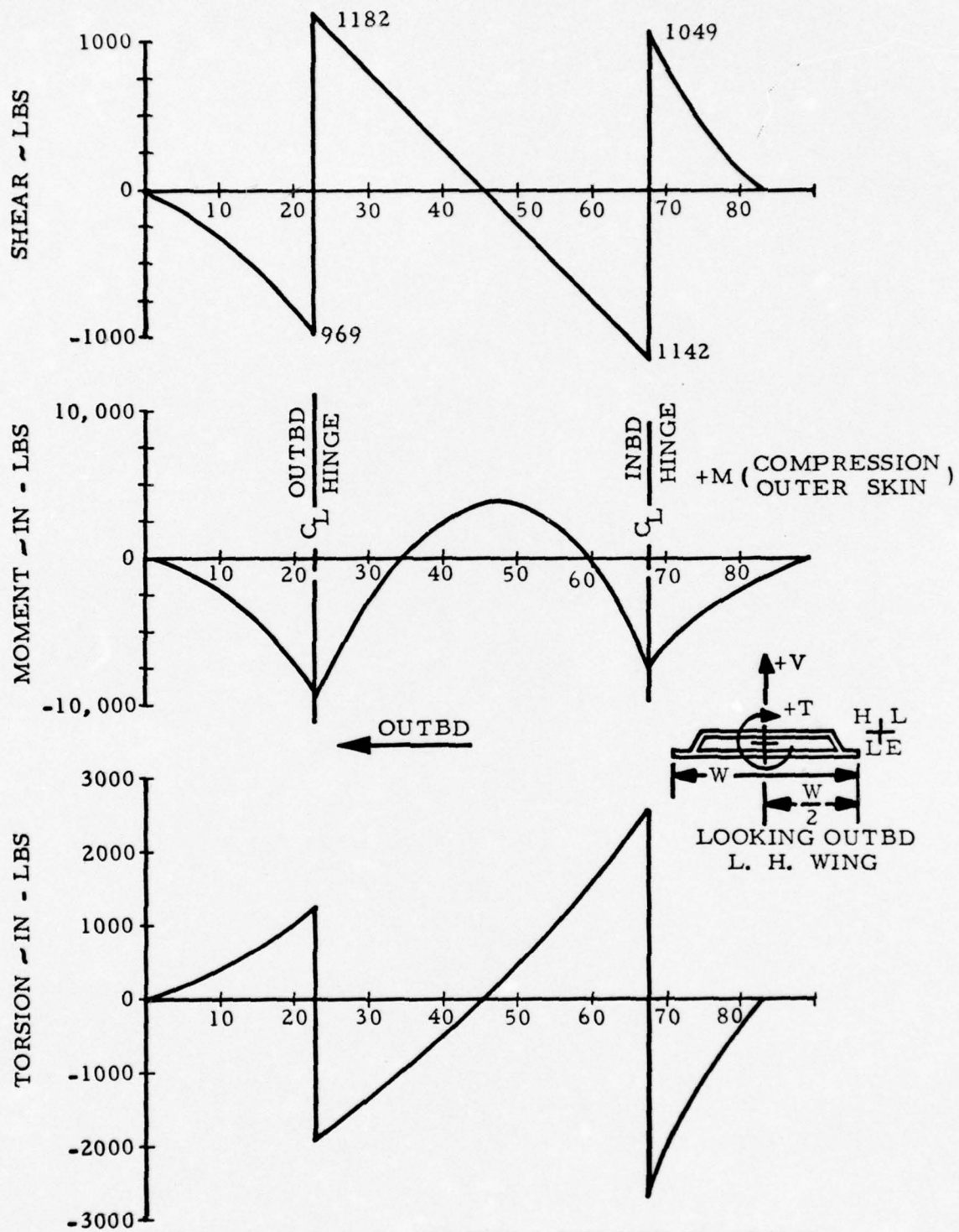


FIGURE 7 SHEAR MOMENT & TORSION DIAGRAMS

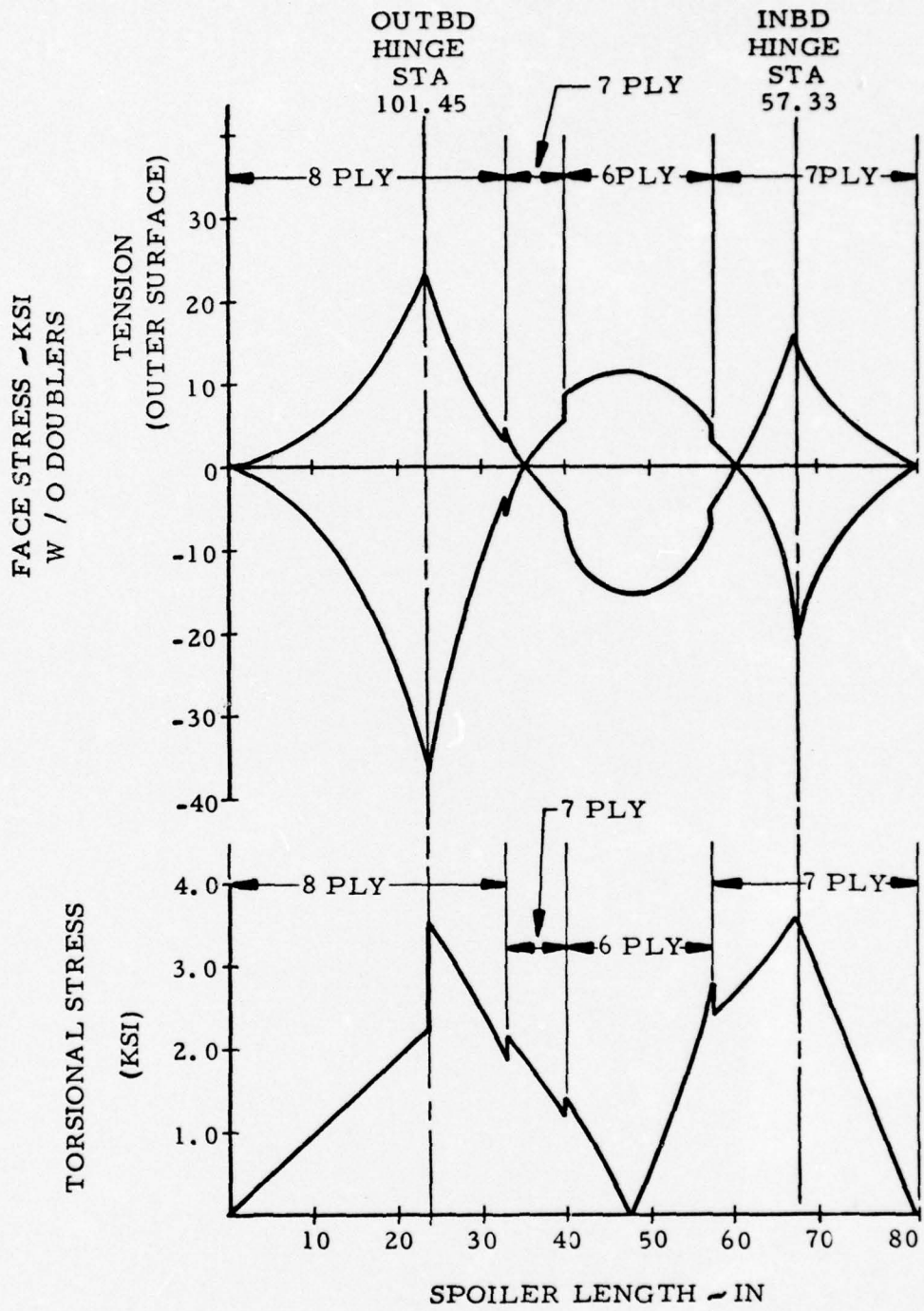


FIGURE 8 SKIN STRESS

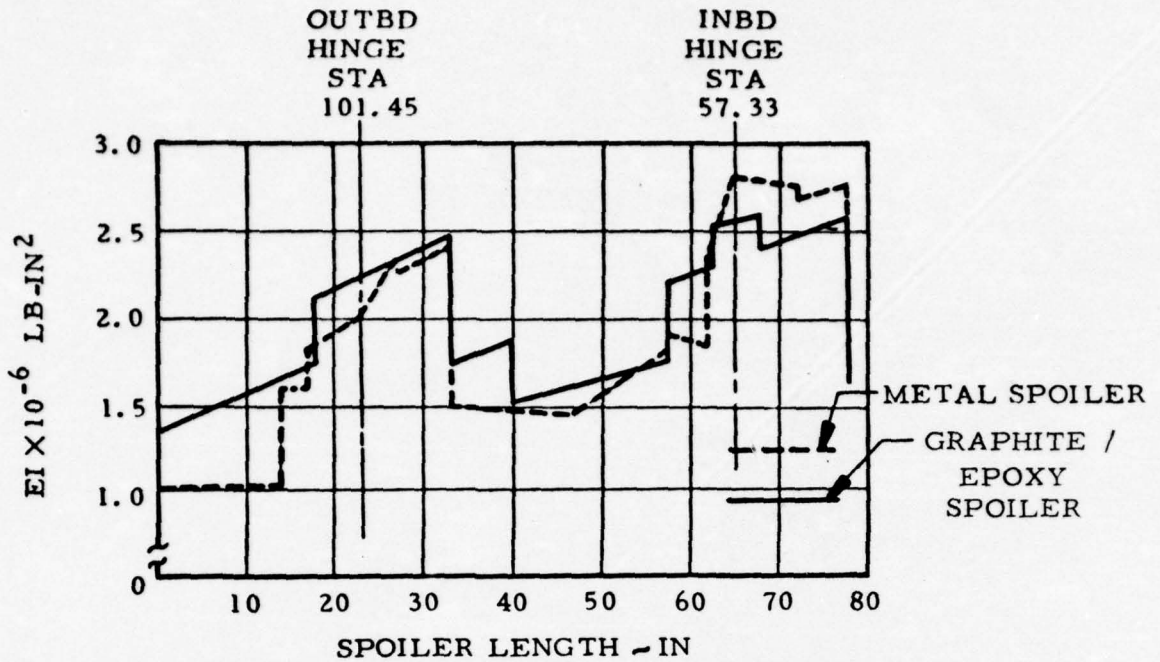


FIGURE 9 SPOILER STIFFNESS COMPARISON

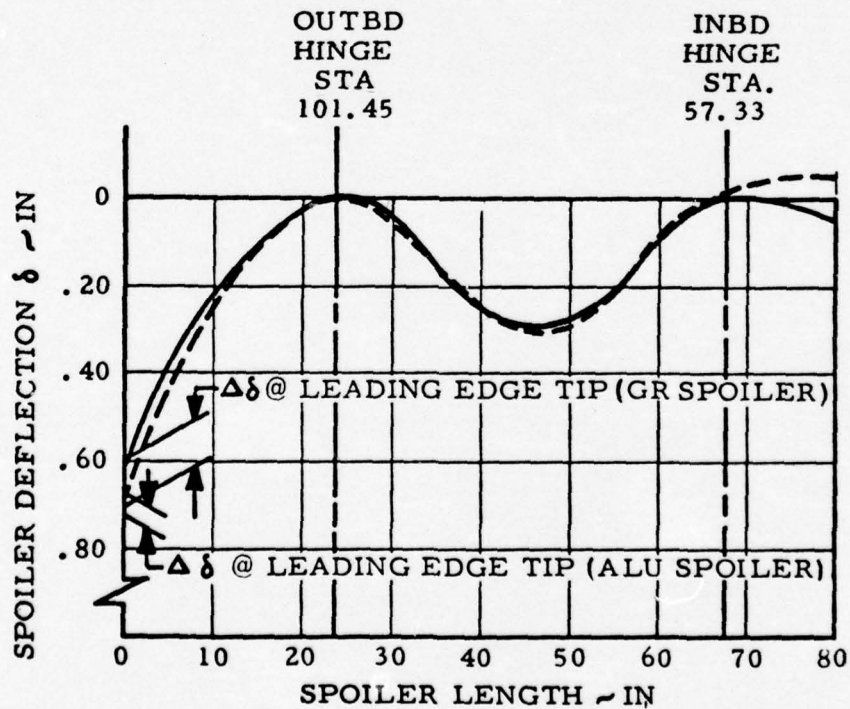


FIGURE 10 DEFLECTED SHAPE COMPARISON

A comparison of the calculated deflected shape of the aluminum and the graphite spoilers is shown in Figure 10. The modulus of elasticity used to calculate the spoiler section properties was reduced by 17.5 percent as a result of design verification tests (see TR 150 discussion). The reduction was based on the minimum value obtained in the test. The values are considered conservative and actual measured deflections were slightly lower.

Analysis of Laminate

Two checks at the critical point, outer hinge Station 101.45 were made. The first check considered the basic cross section without the local effect of the insert cutouts and added local doublers. The stress levels are those shown in Figure 8. This stress is converted to running load for input into the laminated structural analysis routine as follows:

Compression inner surface

$$N_x = f_c t = (36,800) (0.040) = 1472 \text{ lb/in.}$$

Tension outer surface

$$N_x = f_t t = (22,425) (0.040) = 897 \text{ lb/in.}$$

Torsion

$$N_{xy} = (3550) (0.040) = 142 \text{ lb/in.}$$

The combined loading effect, results in a minimum margin-of-safety of .97 for the inner skin and 1.05 margin-of-safety for the outer surface. The margin-of-safety calculations were based on a limiting strain of .007 compared to the design value from Table V of .00895. The reduced value was used based on the results of design verification tests as discussed under TR 141 data.

The second analysis at Station 101.45, where the highest bending stress occurs, considers laminate cutout and added doubler ply effects. As shown below, the same running load is applied as in the previous analysis except an additional load is added. This accounts for the effect of the out-of-plane load applied at the insert. The relationship between the out-of-plane "P" load to the in-plane load is based on strain gage information derived from the design verification tests summarized in TR 135 discussion. The calculated margins of safety using the VSD program was based on a limiting strain acquired from design verification test TR 141. The beam test results show

that limiting strain, which includes the loss of strength for the cutout, to be .0055. The detail analysis is as follows:

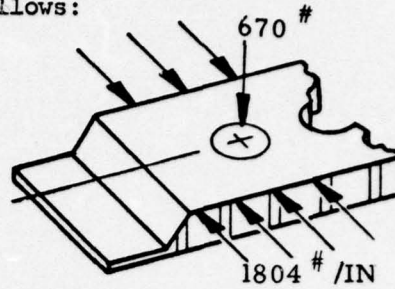
Running Load (Compressive Bending)

$$N_x = 1472 \text{ lb/in. ULT}$$

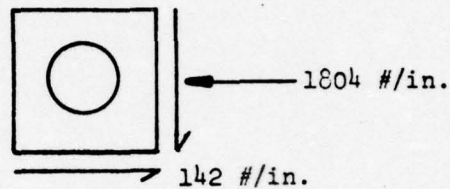
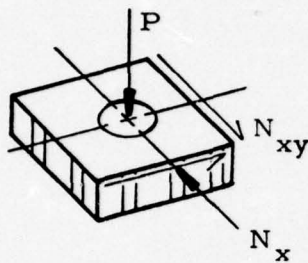
Running Load (out-of-plane insert load)

$$N'_x = 332 \text{ lb/in ULT}$$

$$\text{Total } N_{x_T} = N_x + N'_x = 1472 + 332 = 1804 \text{ lb/in ULT}$$



Element



Margin of Safety

(Allowable Strain Based on Test)

M. S. =

.76

Core Analysis

Figure 11 is a plot of core applied shear versus allowable shear based on minimum specification requirement of Table V. The peak stress shown is based on an effective width of 4.50 inches in the area of the inserts.

Insert Analysis

The spoiler plank is supported by two hinge fittings located at Station 101.45 and Station 57.33. The fittings which transmit spoiler loads to the support structure are mounted to the spoiler plank through fasteners bolted into inserts which are potted into the honeycomb core. The principle loads on the inserts are compression. Loads are conservatively considered to be reacted entirely by the inserts and are transmitted into the honeycomb core through

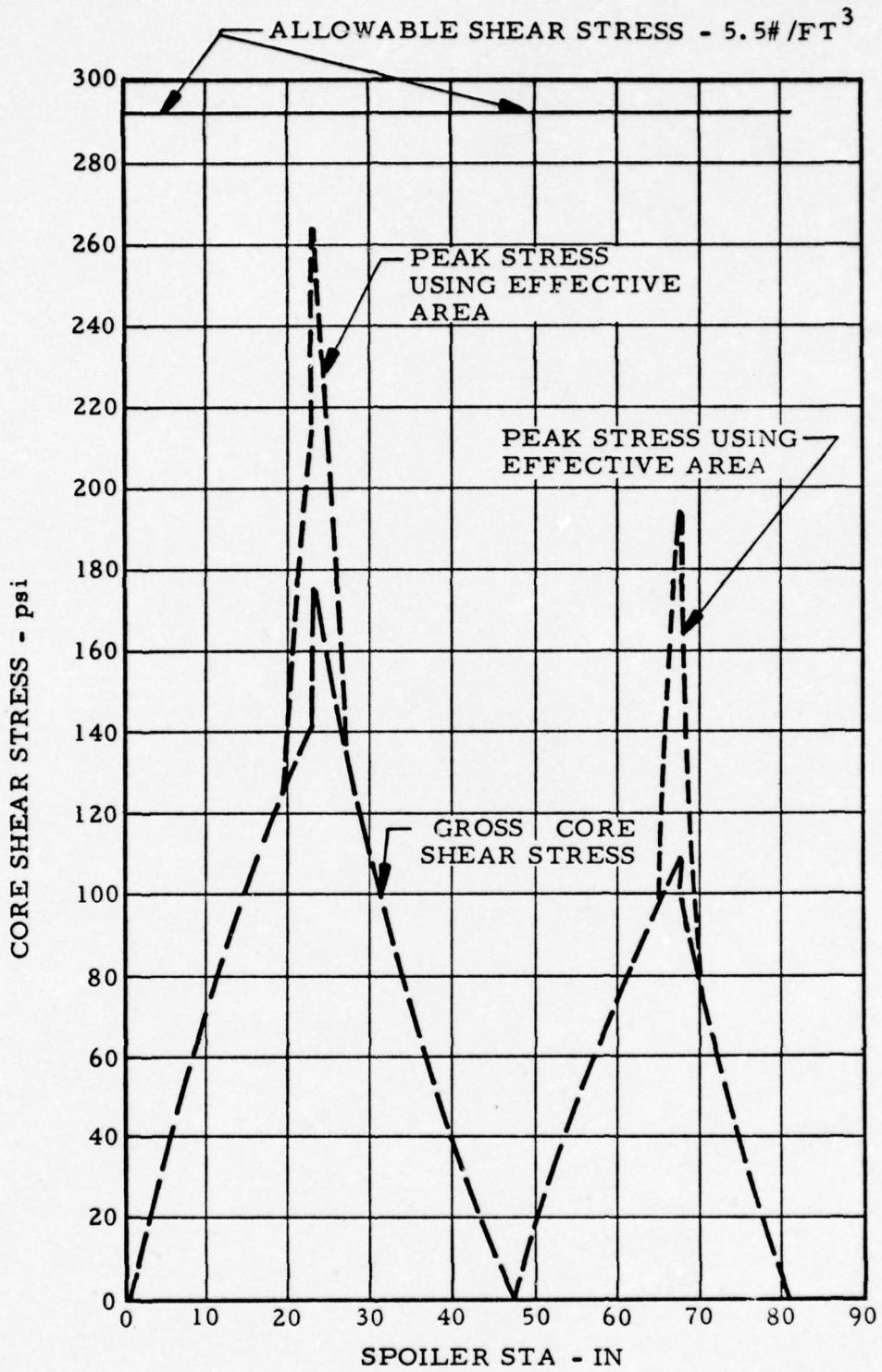
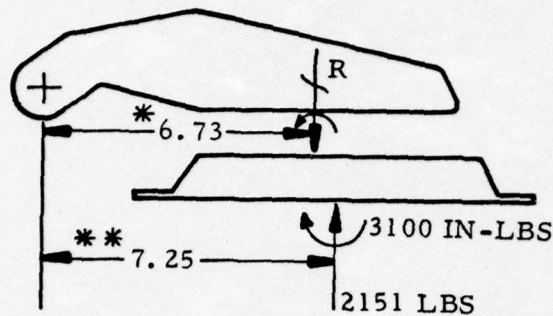


FIGURE 11 CORE SHEAR STRESS

the potting (see page 24 for analysis). The margin-of-safety calculation is based on a load allowable taken from test results; the allowable is the minimum value obtained from the test data.

The spoiler to hinge fastener load distribution calculation at the outboard hinge (triangular airload distribution) is shown below:



* Distance from C_L hinge to bolt pattern centroid

** Distance from C_L hinge to center of cross section

The maximum bolt load has 3 components as follows:

P_1 from normal loads

P_2 from moments chordwise

P_3 from moments from side load

$$P_1 = \frac{2151}{6} = 358 \text{ lbs/fastener}$$

$$P_2 = \frac{M_c}{\sum \rho^2} = \frac{[3100 - 2151(7.25 - 6.73)] 2.57}{10.66} = 478 \text{ lbs}$$

This load is distributed over 2 fasteners

$$P_2 = 239 \text{ lbs/fastener}$$

$$P_3 = \frac{M}{h} \text{ side}$$

$$\text{Where } M = 260 \text{ lbs} \times 1.26'' = 328 \text{ in-lbs}$$

$$h = 1.50 \text{ in effective at 3 location} = 4.5 \text{ in}$$

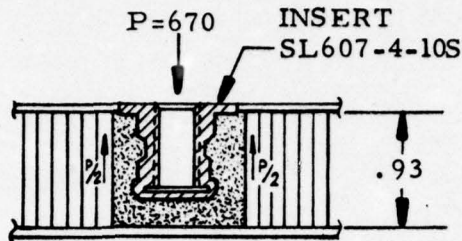
$$P_3 = \frac{328}{4.5} = 73 \text{ lbs/fastener}$$

Total fastener load is:

$$P \text{ compression} = P_1 + P_2 + P_3 = 670 \text{ lbs}$$

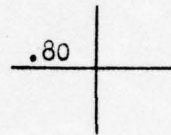
$$P \text{ tension} = P_1 - P_2 + P_3 = 192 \text{ lbs}$$

A check for local core shear stress adjacent to the insert is made as shown.



Allowable Stress based on test $P = 1210\#$

$$M. S. = \frac{1210}{670} - 1$$



DESIGN VERIFICATION TESTS

A series of subcomponent tests verified the spoiler design.

Table VII lists the subcomponent tests performed for this program.

TABLE VII - DESIGN VERIFICATION TESTS

TR NUMBER	SUBJECT
TR-135	STRENGTH EVALUATION OF POTTED INSERTS
TR-140	TENSION, COMPRESSION AND SHEAR PROPERTIES OF HRP CORE/GRAPHITE FACED SANDWICH STRUCTURE
TR-141	SANDWICH BEAM FLEXURE TESTS
TR-142	HINGE FITTING/SANDWICH PANEL TESTS
TR-147	PANEL EDGE CLOSE OUT TEST
TR-150	COMPRESSION PROPERTIES - CO-CURED SANDWICH SPECIMENS

TR-135 Strength Evaluation of Potted Inserts

Tension and compression strengths of potted inserts were tested in 4.00 inch rectangular specimens. Torsional strengths were tested in 2.00 inch rectangular specimens. All specimens were fabricated with a 5.5 #/ft³ HRP core and 7 ply graphite/epoxy faces. The inserts were potted in the same manner as in the spoiler assembly in both fixed and self-aligning versions. Table VIII summarizes the test data. The tension and compression test fixture is shown in Figure 12.

TR-140 Tension, Compression and Shear Properties of HRP Core/Graphite Faced Sandwich Structure

Flatwise tension and compression and short beam shear tests were run to determine the properties of a basic sandwich construction using HRP core and graphite/epoxy faces. The test results are summarized in Table IX. The test fixture for the core shear test is shown in Figure 13.

TR-141 Sandwich Beam Flexure Tests

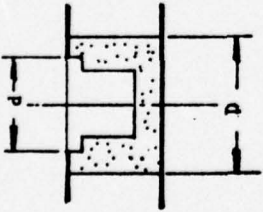
The flexural strength of the spoiler at the inboard and outboard hinge locations was verified with and without inserts. Two series of tests were conducted with a four point loading system as shown in Figure 14.

Specimens IWO, OWO, OW and IW were initially tested to evaluate basic ply strength and component capability in the inboard and outboard hinge area. All specimens failed in the area of maximum moment (on the compression face) except two specimens that failed outside the test area. Specimens failed at lower longitudinal strains than predicted using allowables of Table V. Loss of capability was attributed to local dimpling between cells when the laminate was co-cured to the core.

To determine the effect of dimpling on tensile strength, eight tension specimens (IW01-1 thru -4 and IW02-1 thru -4) were cut from the laminate skins of flex beam specimens IW01 and IW02. As shown in Table X, no significant strength or modulus loss was noted.

After an additional ply of material was added to the basic component skin to compensate for the loss of stiffness from dimpling, fifteen (15) additional specimens (BIW, BOW, and BOWO) were fabricated and tested to evaluate the full scale component capability. Three of the specimens (BOWO-1 thru -3)

TABLE VIII TR-135 STRENGTH EVALUATION OF POTTED INSERTS

TENSION/COMPRESSION	FASTENER TYPE	FINAL DIMENSIONS	FACE SHEET	CORE TYPE	SPECIMEN NO.	FAILING LOAD	DESIGN LOADS	DESCRIPTION OF FAILURE	
 <p>FAB PROCEDURES #1 UPPER CO-CURED LOWER PRE-CURED</p> <p>#2 UPPER CO-CURED LOWER CO-CURED</p>	Self-align	d=.749-.755 D=.999-1.005	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft ³	1	1315 lb	670#	COMPRESSION	
		2	1325		670#	COMPRESSION			
		3	1180		670#	COMPRESSION			
		1	1255		670#	COMPRESSION			
		2	1525		670#	COMPRESSION			
		3	1575		670#	COMPRESSION			
	Fixed	d=.499-.504 D=.749-.754	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft ³	1	1180	670#	COMPRESSION	
		2	1455		192#	TENSION			
		3	1425		670#	COMPRESSION			
		1	1450		670#	COMPRESSION			
		2	1350		670#	COMPRESSION			
		3	1210		192#	TENSION			
TORSION	Self-align	d=.687-.693 D=.937-.943	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft ³	1	500	70 IN-LBS	TORSION	
		2			450	70 IN-LBS	TORSION		
		3			1465	70 IN-LBS	TORSION		
		1			1330	70 IN-LBS	TORSION		
		2			1115	70 IN-LBS	TORSION		
		3			1320	70 IN-LBS	TORSION		
	Fixed	d=.749-.755 D=.999-1.005	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft ³	HRP 3/16 cell 5.5 #/ft ³	1	260 IN-LB	70 IN-LBS	TORSION
		2				220	70 IN-LBS	TORSION	
		3				240	70 IN-LBS	TORSION	
		1				340	70 IN-LBS	TORSION	
		2				320	70 IN-LBS	TORSION	
		3				280	70 IN-LBS	TORSION	
Self-align	d=.687-.693 D=.937-.943	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft ³	HRP 3/16 cell 5.5 #/ft ³	1	180	70 IN-LBS	TORSION	
	2				200	70 IN-LBS	TORSION		
Fixed	d=.562-.567 D=.812-.817	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft ³	HRP 3/16 cell 5.5 #/ft ³	1	200	70 IN-LBS	TORSION	
	2				260	70 IN-LBS	TORSION		

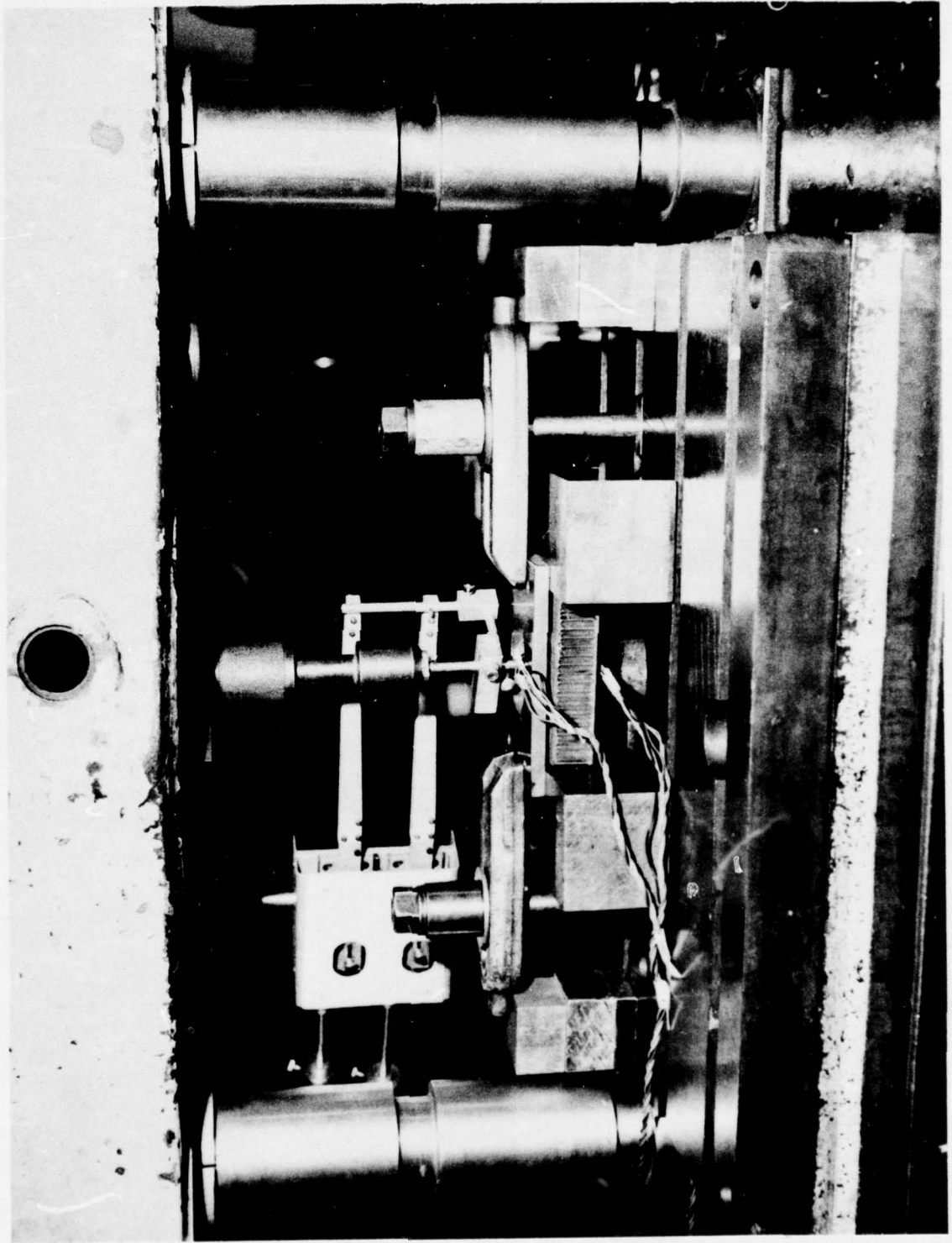


FIGURE 12 INSERT SPEC IMEN TEST FIXTURE (TR-135)

TABLE IX TR-140 VERIFICATION TEST OF SANDWICH CORE/GRAPHITE LAMINATE

SPECIMEN NO.	FACE SHEET	CORE TYPE	FAB PROCEDURE	FAILING LOAD (LB)	FAILING STRESS (PSI)	DESIGN STRESS (PSI)	DESCRIPTION OF FAILURE	REMARKS
1	6 Ply 5209	HRP 3/16 Cell 4.0 #/ft ³	Co-Cure	3940	985	NOT APPLICABLE	Flatwise Tension	
2				3370	842			
3				3900	975			
4				3330	832			
5				3260	815			
6								
1	6 Ply 5209	HRP 3/16 Cell 5.5 #/ft ³	Co-Cure	4000	1000	1000	Compression of core	
2				4200	1050			
3				3865	966			
4				4040	1010			
5				4115	1028			
6								
1	6 Ply 5209	HRP 3/16 Cell 4.0 #/ft ³	Co-Cure	1405	350	370	Core Shear	Core in L Dir.
2				1852	463			
3				1738	434			
1				3170	790			
2				3235	809			
3				2900	724			
1	6 Ply 5209	HRP 3/16 Cell 4.0 #/ft	Co-Cure	1380	232	180	Core Shear	Core in W Dir.
2				1418	239			
3				1308	220			
1				803	135			
2				799	135			
3				806	135			
1	6 Ply 5209	HRP 3/16 Cell 5.5 #/ft ³	Co-Cure	2100	353	293	Core Shear	Core in L Dir.
2				2155	362			
3				2090	351			
1				1400	235			
2				1400	235			
3				1352	227			

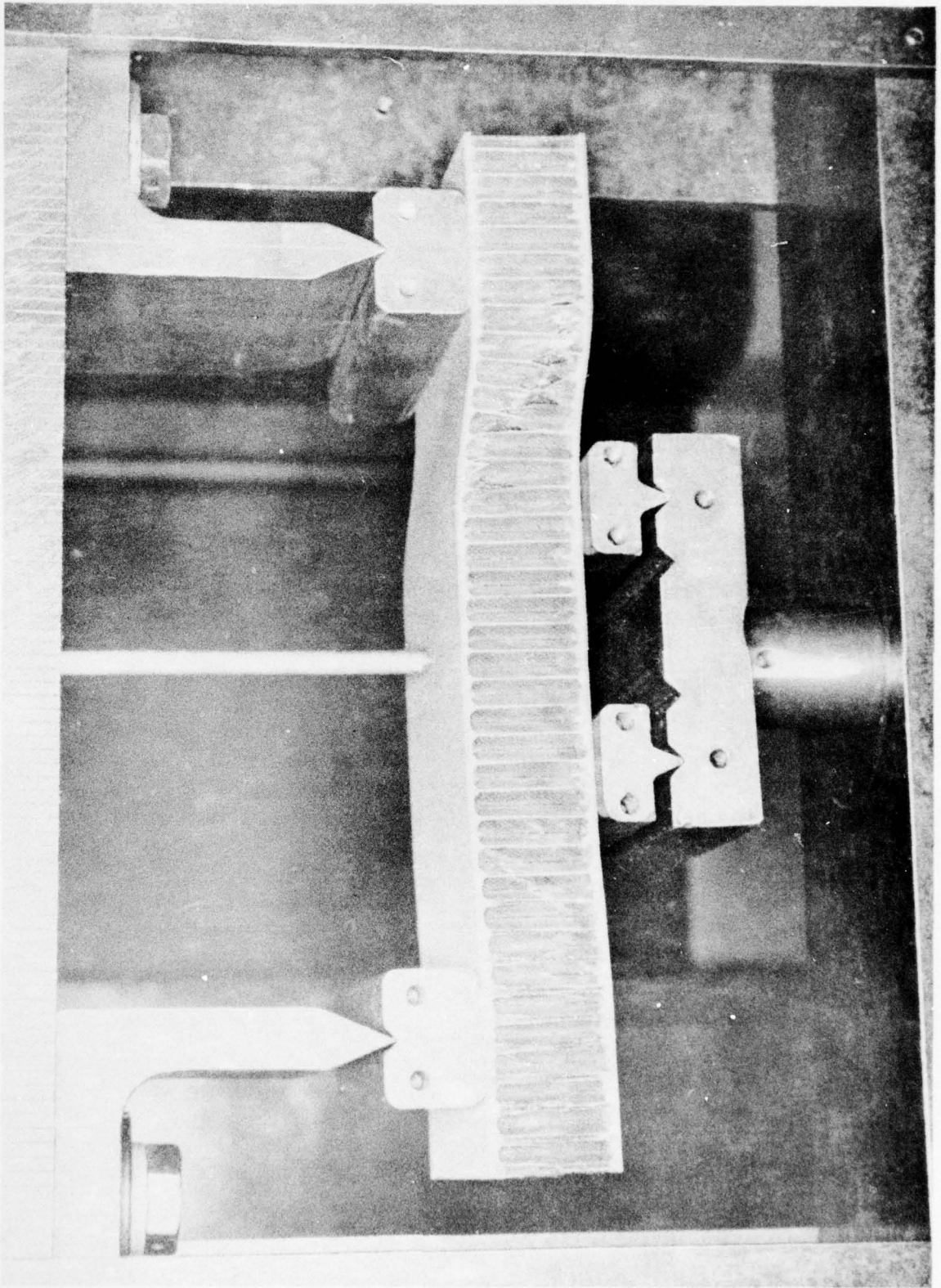


FIGURE 13 CORE SHEAR TEST (TR-140)

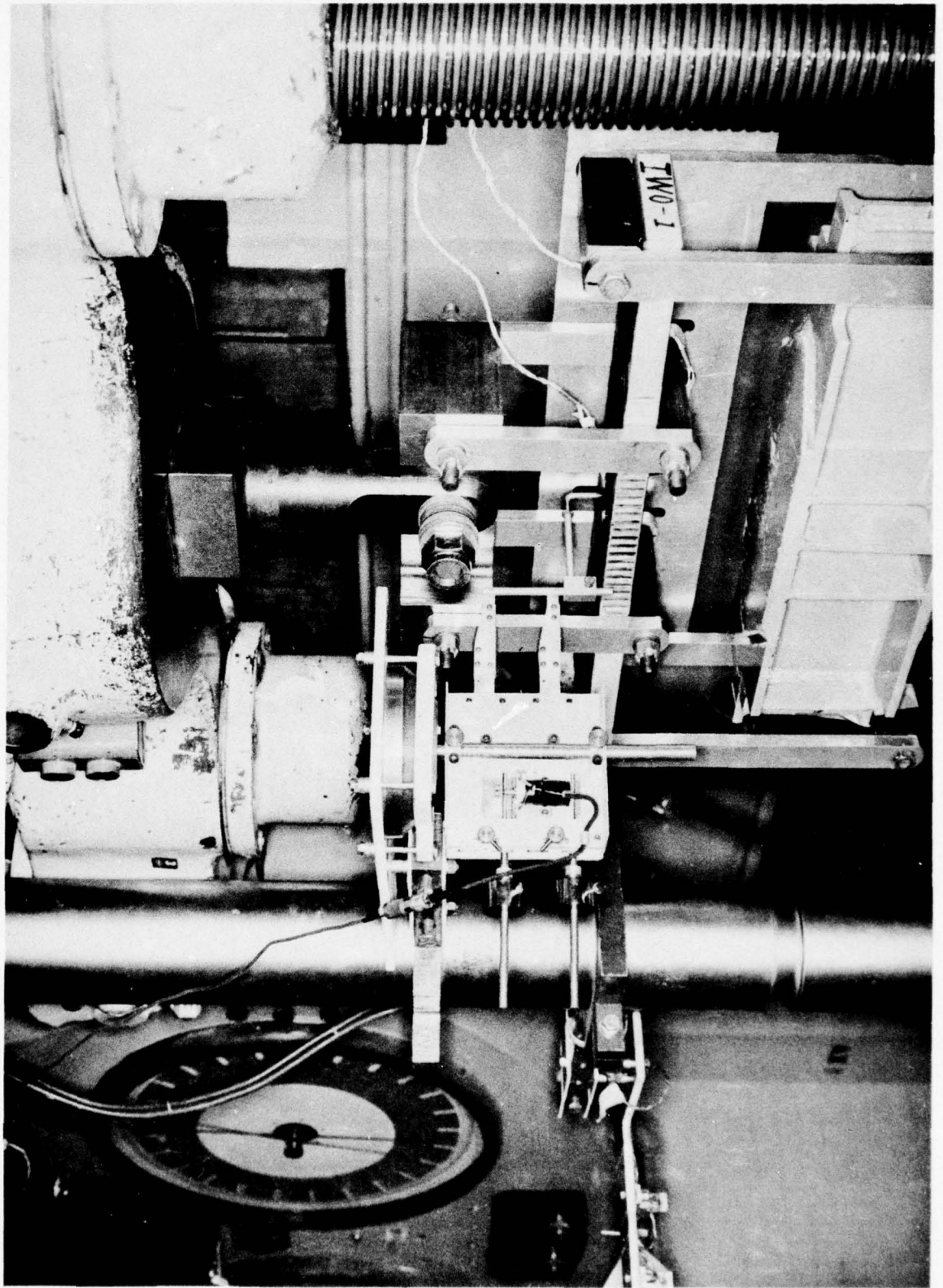


FIGURE 14 TEST SET-UP FOR FLEXURAL BEAM SPECIMENS (TR-141)

TABLE X TRI141 FLEXURAL BEAM SPECIMEN TEST DATA

SPEC. NO.	FACE (PLY)	LAYUP	FAB METHOD	NO. INSERTS	PREDICTED FAILING LOAD (LBS)	ACTUAL FAILING LOAD (LBS)	ε MAX IN/IN COMPRESSION	GROSS STRESS (3) KSI	NET STRESS (3) KSI	E × 10 ⁶ (PSI)	FAILURE			
IMO 1	6 UPPER	0 ₂ +45,0 ₂	WET LAYUP - CO-CURED	NONE	4608	3275	.00793	82.2	-	MC (4)	UPPER FACE COMPRESSION			
IMO 2	6 LOWER					3415	.00678	85.7	-	MC				
IMO 3	6 LOWER					3460	.00901	86.8	-	13.8				
OMO 1	7 UPPER	0 ₂ +45,0 ₂ -45,0 ₂		WET LAYUP - CO-CURED	NONE	5719	4150	.00656	95.4	-	15.3	CORE COMPRESSION		
OMO 2	7 LOWER						4305	.00707	98.9	-	14.9			
OMO 3	7 LOWER	4260			.00697	97.9	-	13.9	UPPER FACE COMPRESSION					
OM 6	9 UPPER	0 ₂ +45,0 ₂ -45,0 ₂			WET LAYUP - CO-CURED	FOUR	2406	4130	NA (2)	75.5	100.7	MC	CORE COMPRESSION	
OM 2	7 LOWER							4450	.00549	81.4	108.5	MC		
OM 5	7 LOWER							3845	NA	70.3	93.7	MC		
OM 4	7 LOWER							3820	NA	69.8	93.2	MC		
OM 1	7 UPPER	0 ₂ +45,0 ₂ -45,0 ₂				WET LAYUP - CO-CURED	FOUR	2015	2580	.00382	59.5	79.2	MC	CORE COMPRESSION
OM 3	9 LOWER								3300	.00490	76.0	101.4	MC	
IM 1	7 UPPER	0 ₂ +45,0 ₂ -45,0 ₂	WET LAYUP - CO-CURED				TWO	2015	2815	.00513	66.8	76.3	MC	CORE COMPRESSION
IM 2	6 LOWER								3340	.00673	79.3	90.6	MC	
IM 3	6 LOWER	3415					.00678	81.1	92.7	MC				
IMO1-1	tension specimens cut from laminate skin of IMO1	tension specimens cut from laminate skin of IMO2		WET LAYUP - CO-CURED			NONE	5092	4440	(tension)	104.6	-	MC	TENSION
IMO1-2	4850								.0085	112.6	-	MC		
IMO1-3	4720								.01013	114.1	-	MC		
IMO1-4	4060				.00963				114.1	-	12.9			
IMO2-1	8 UPPER	0 ₃ +45,0 ₂ -45,0 ₂			WET LAYUP - CO-CURED		NONE	4826	3350	(tension)	83.3	-	MC	UPPER FACE COMPRESSION
IMO2-2	4656								.00775	115.0	-	MC		
IMO2-3	5057								.00995	112.1	-	12.5		
IMO2-4	5370					.01010			112.1	-	11.7			
IMU-1	8 UPPER					2900			.00407	66.1	75.5	MC		
IMU-2	7 LOWER		3470			.00616			79.1	90.4	14.48			
IMU-3	7 LOWER	3005	NA			68.5	78.3	MC						
IMU-4	7 LOWER	3020	NA			68.8	78.6	MC						
IMU-5	7 LOWER	2740	NA	62.4		71.3	MC							
IMU-6	7 LOWER	3180	NA	72.5		82.9	MC							
BOM-1	10 UPPER	0 ₄ +45,0 ₂ -45,0 ₂	WET LAYUP - CO-CURED	FOUR		5500	3825	.004476	63.5	84.7	15.8	UPPER FACE COMPRESSION		
BOM-2	8 LOWER						3315	NA	55.1	73.5	MC			
BOM-3	8 LOWER				3750		NA	62.3	83.1	MC				
BOM-4	8 LOWER				3735		NA	62.0	82.0	MC				
BOM-5	8 LOWER				3950		.004768	65.6	87.5	15.8				
BOM-6	8 LOWER				4110		NA	68.3	91.0	MC				
BOMO-1	7 UPPER	0 ₂ +45,0 ₂ -45,0 ₂		WET LAYUP - CO-CURED	NONE	6066	5945	NA	136.6	-	MC	UPPER FACE COMPRESSION		
BOMO-2	7 LOWER						5415	NA	124.4	-	MC			
BOMO-3	7 LOWER						6540	NA	150.3	-	MC			
BFOM-1	10 UPPER	0 ₄ +45,0 ₂ -45,0 ₂			WET LAYUP - CO-CURED	FOUR	Cycled from 13.6 KSI to -6.8 KSI Design 40,000 cycles (2 lives)	2,320,000 cycles +					UPPER FACE COMPRESSION	
BFOM-2	8 LOWER							2,532,000 cycles +						
BFOM-3	8 LOWER	0 ₂ -45,0 ₂ +45,0 ₂												7,801,000 cycles +

(1) UPPER FACE IN COMPRESSION (2) NA = NOT AVAILABLE, NO GAGE (3) UPPER FACE STRESS BASED ON LOAD (4) MC = NOT CALCULATED PLY THICKNESS OF .0050

had pre-cured skin to reduce laminate dimpling. These specimens show higher failing loads and failing stresses that are close to predicted values.

Specimens BIW and BOW indicated that adequate capability was available in full scale components to sustain design loads.

Three specimens were built (BFOW-1 thru -3) to evaluate fatigue capability. These specimens show capability of sustaining 100 + lives, indicating a high probability that the full scale component would meet the fatigue requirements.

TR-142 Hinge Fitting/Sandwich Panel Tests

Both tension and compression loads were applied to three (3) spoiler planks through a simulated hinge fitting as shown in Figure 15. The specimens were tested to limit load in tension and failing load in compression.

Two of the specimens failed on the tension face. Stress level based on load was 100.9 and 96.2 KSI. Both failures occurred at the edge of the fitting. The third specimen failed in the core at a laminate flexural stress, based on load, of 97.5 KSI. The higher failing stress was attributed to a local load redistribution because of the presence of the fitting.

TR-147 Panel Edge Closeout Test

The flexural strength characteristics of a typical sandwich panel with closeout edge members and an eight ply upper and lower surface was determined by this test.

Three specimens were fabricated and static tested to failure as shown in Figure 16. Figure 17 shows a failed specimen. Table XI summarizes the specimen configurations and test results.

Examination of the test data and the failed specimens revealed two things.

- (1) All specimens failed in the compression face at a lower value than was predicted. This is attributed to face dimpling.
- (2) Laminate edge member shear stress was low, indicating that the vertical load is reacted by the honeycomb core.

TR-150 Compression Properties of Co-Cured Sandwich Specimens

This test was conducted to determine the compressive modulus when the wet laminate is co-cured to the HRP core. It was found that the modulus of the co-cured specimen was from 12.5 to 17.5% lower than the design modulus. Thus,

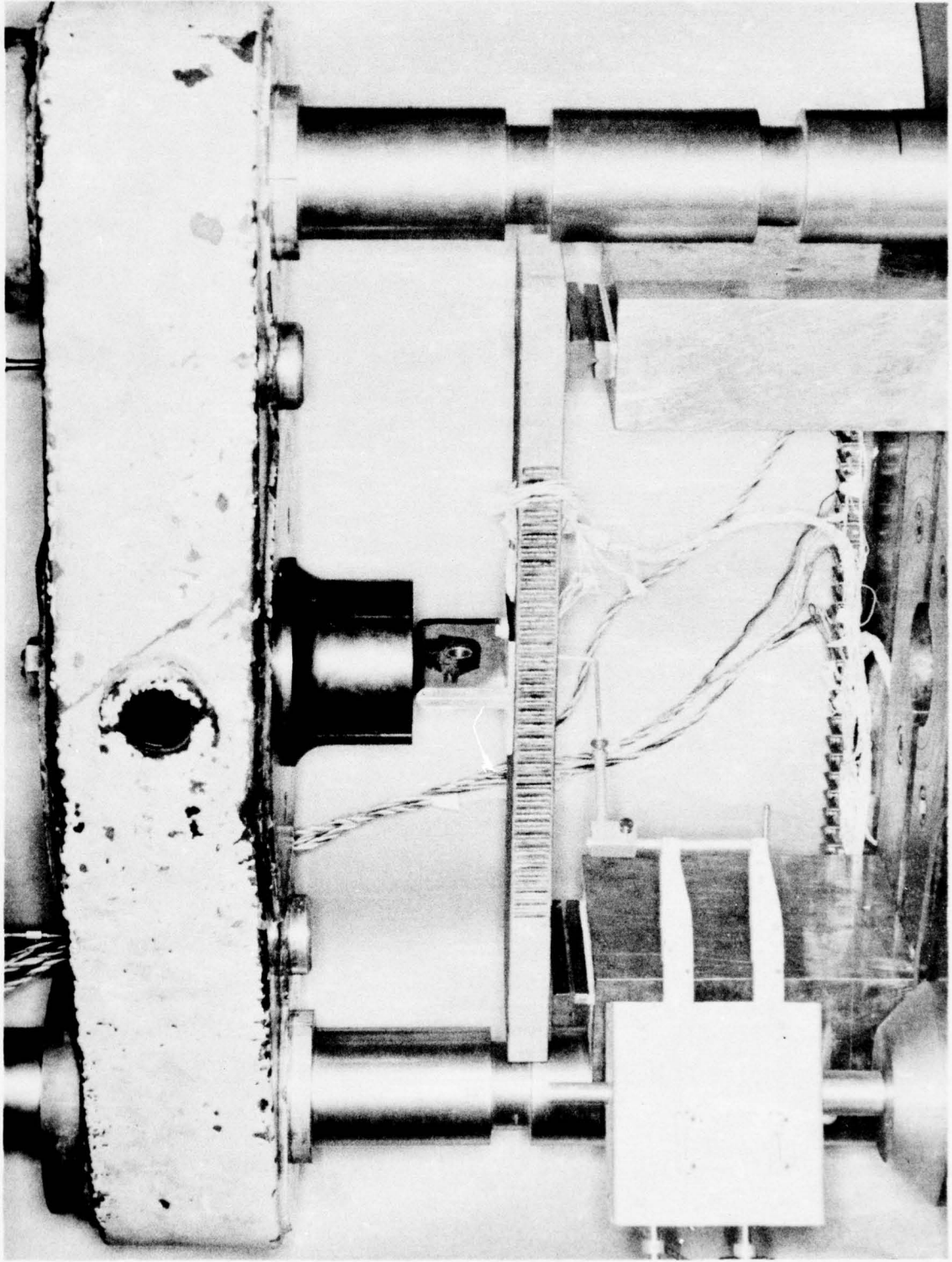


FIGURE 15 HINGE FITTING / SANDWICH PANEL SPECIMEN (TR-142)

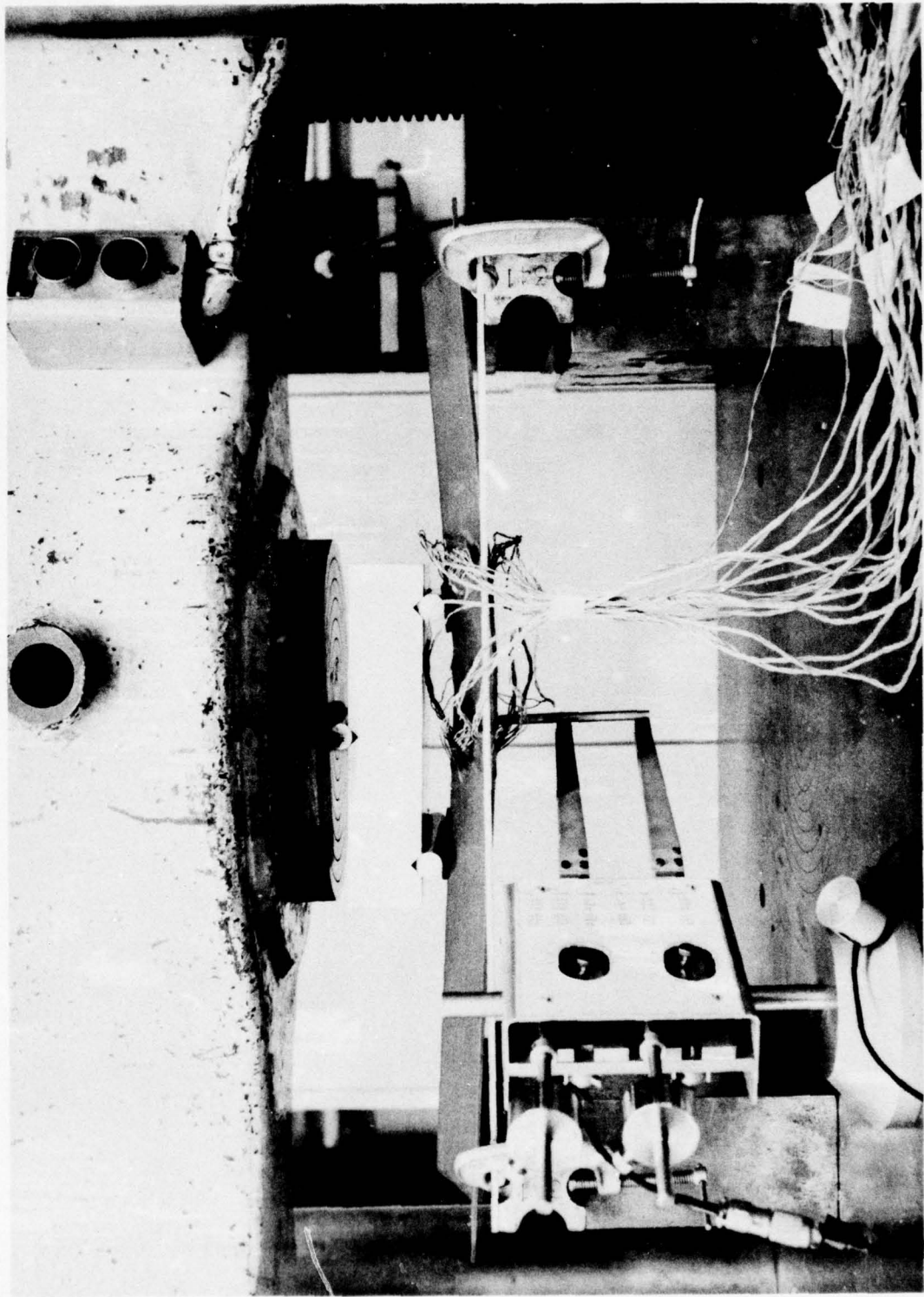


FIGURE 16 TEST SET-UP FOR PANEL WITH EDGE CLOSEOUT (TR-147)

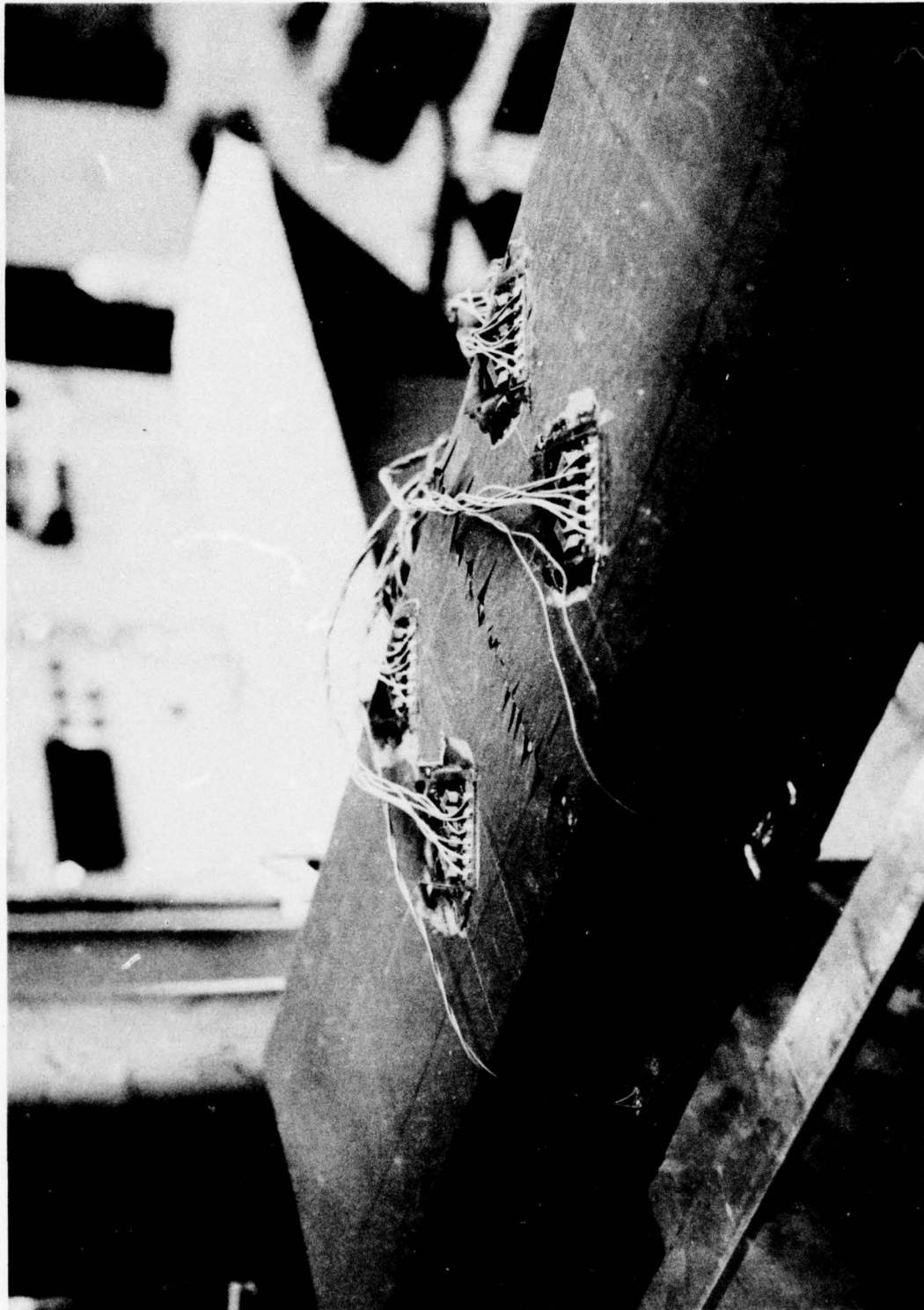


FIGURE 17 FAILED TEST SPECIMEN WITH EDGE CLOSEOUTS (TR-147)

TABLE XI TRI47 STRENGTH EVALUATION OF SANDWICH PANELS WITH EDGE CLOSEOUT

SPEC. NO.	FACE (1) (PLY)	LAYUP	FAB. METHOD	PREDICTED FAILING LOAD (LBS.)	ACTUAL FAILING LOAD (LBS.)	GROSS STRESS TENSION (KSI)	GROSS STRESS COMP. (KSI)
1	8 UPPER	0 ₂ , -45, 0 ₂ , +45, 0 ₂	CO-CURED	6200	5165	51.6	88.9
	8 LOWER	0 ₂ , +45, 0 ₂ , -45, 0 ₂					
2	8 UPPER	0 ₂ , -45, 0 ₂ , +45, 0 ₂	WET LAYUP - CO-CURED	6200	4540	45.3	78.1
	8 LOWER	0 ₂ , +45, 0 ₂ , -45, 0 ₂					
3	8 UPPER	0 ₂ , -45, 0 ₂ , +45, 0 ₂	WET LAYUP - CO-CURED	6200	5075	50.7	87.3
	8 LOWER	0 ₂ , +45, 0 ₂ , -45, 0 ₂					

(1) UPPER FACE IN COMPRESSION

an extra ply of material was added to the upper and lower faces of the spoiler. Suspecting laminated dimpling between cell walls, other specimens were run with precured (and thus pre-stabilized) core. Testing showed modulus values equal to or greater than the design values.

Table XII summarizes the test results, and Figure 18 shows the test set up.

Weight

Based on the completed design drawings and data available from production sources, a weight comparison of the graphite composite spoiler and the metal design was made and is presented in Table XIII.

TABLE XII TR 150 COMPRESSION TEST SPECIMEN RESULTS

SPECIMEN	FACE (PLY)	ORIENTATION	MAT'L	CORE TYPE	FAB PROCEDURE	FAILING LOAD (LB)	F ^{cu} DESIGN PSI	FAILING STRESS PSI	E _c x 10 ⁶ TEST PSI	E _c x 10 ⁶ DESIGN PSI	FAILURE
5A	5	0, ±45, 0 ₂		HRP	CO-CURE	6035	110,000	60,350	10.40	12.6	
5B	5			3/16 Cell		6010		60,010	11.40		
5C	5			4.0#/Ft ³		4980		49,800	13.20		
6A	6	0 ₂ , ±45, 0 ₂				7540	122,600	62,833	13.72	13.7	
6B	6					8120		67,667	13.90		
6C	6					7620		63,500	15.00		
7A	7	0 ₂ , ±45, 0, -45, 0				7140	129,600	51,000	12.70	14.5	
7B						9490		67,785	13.30		
7C					CO-CURE	8470		60,500	12.50		
7D					Stabilized	11060		78,810	15.07		
7E					CORE	13120		93,686	14.69		
7F					Pre-cured	13020		92,800	14.47		
7G					Faces	12920		91,598	15.53		
7H						14120		100,455	14.47		
7I	7		5209 - 1300			11670		82,778	15.12		

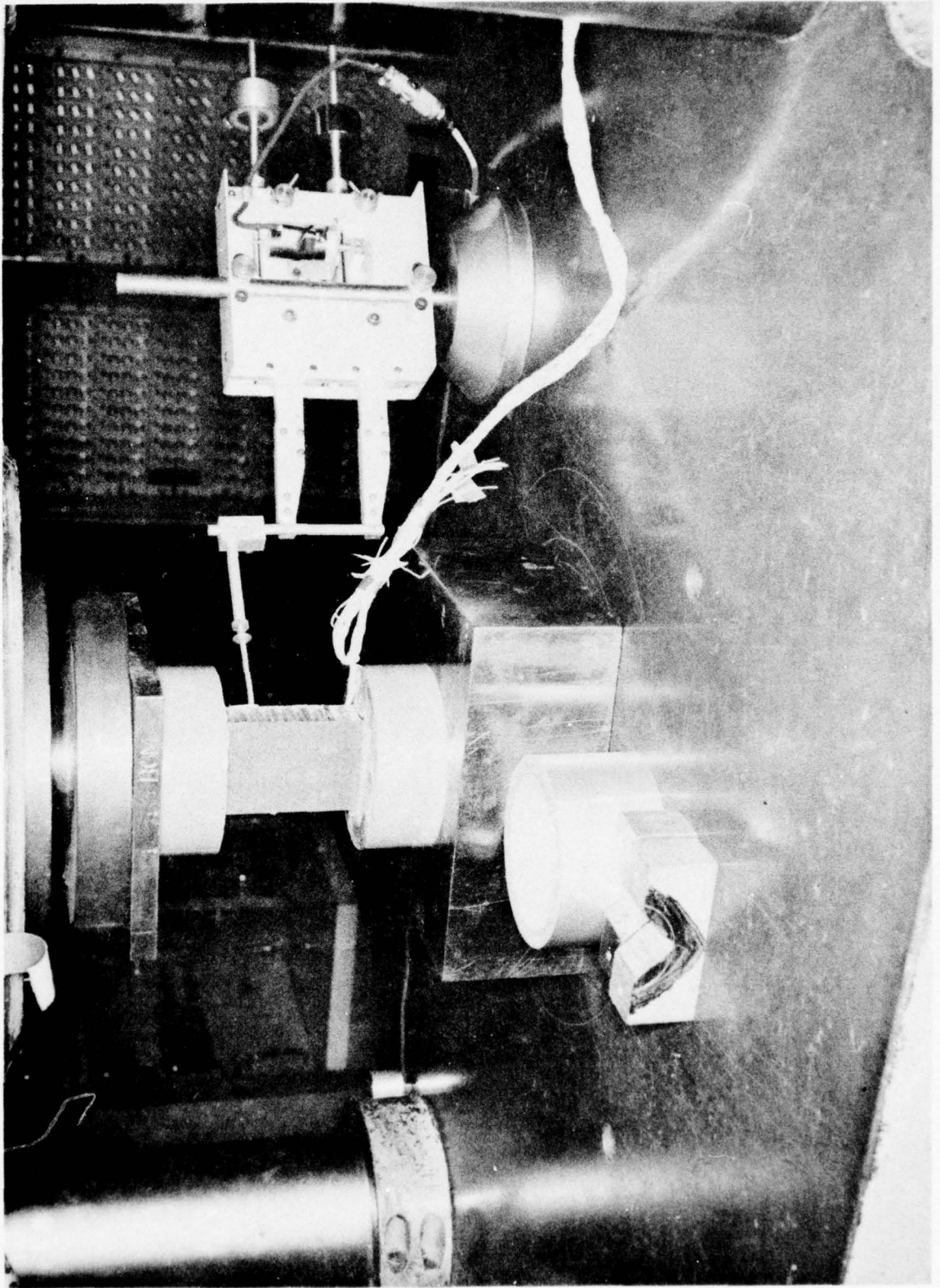


FIGURE 18 COMPRESSIVE TEST SET-UP (TR-150)

TABLE XIII SPOILER WEIGHT COMPARISON
(WEIGHT IN POUNDS)

COMPONENT	METAL	CALC. COMP. WT.	ACTUAL COMPONENT WEIGHT					
			MFG. DEV.	STATIC NO. 1	STATIC NO. 2	STATIC NO. 3	FATIGUE	
SPOILER PLANK	12.70	8.40	8.43	8.31	8.34	—	—	
% SAVINGS	—	33.86	33.62	34.57	34.33	—	—	
FINISHED SPOILER*	16.69	12.28	—	11.59	11.65	12.09	12.05	
% SAVINGS	—	26.42	—	30.56	30.20	27.56	27.80	
			AVERAGE % WEIGHT SAVINGS= 29.03 %					

* INCLUDES HINGES, SEALS, HARDWARE

SECTION 3
MANUFACTURING DEVELOPMENT AND FABRICATION

The manufacturing development portion of the program has covered tooling, a spoiler manufacturing plan and fabrication of manufacturing development specimens, design verification specimens, three static test spoiler assemblies, and one fatigue test spoiler assembly.

Two types of templates were used for spoiler fabrication, (1) mylar templates, and (2) aluminum trim templates. A glass epoxy molding tool was designed and fabricated for spoiler assembly and cure. Tab stiffener sub-assemblies were cured using a .38 thick flat aluminum plate as a tool.

To establish techniques for fabrication of the four deliverable spoiler assemblies four types of manufacturing development specimens were made. Three specimens were made to determine the best method for lightning protection screen attachment to the spoiler lower skin. Six specimens were manufactured to establish a satisfactory method for honeycomb core edge stabilization in order to resist core collapse due to autoclave cure pressure. Two specimens were made to be used as standard defect specimens for ultrasonic immersion testing as well as determination of the correct resin bleeder material to be used between the tool and the spoiler. The fourth specimen represented the outboard end of the spoiler with one hinge tab and edge closeouts on all four sides. This specimen rendered proof of tooling concept prior to lay-up and cure of the manufacturing development spoiler. Table XIV summarizes the results of the manufacturing development specimens.

TABLE XIV - MANUFACTURING DEVELOPMENT SPECIMENS

SPECIMEN NUMBER	REQUIRED DATA	RESULTS
MDS-1	Lightning protection screen attachment	Layer of adhesive between screen and lower skin
MDS-2	Honeycomb core edge stabilization	350F curing phenolic resin
MDS-3	NDT data & lower resin bleeder requirements	1. Minimum detectable delamination = .50 dia 2. With screen and resin bleeder required
MDS-4	Proof of tooling concept	Concept satisfactory

A spoiler subassembly was fabricated as confirmation of the manufacturing planning, checkout of the molding tool and processing parameters. No final assembly operations were carried out for this article, i.e., no hinge assemblies or trailing edge seal were installed. Provisions for these items were included by installation of the threaded inserts and drilling and countersinking the seal attach holes. Fabrication of the manufacturing development article was in accordance with the following fabrication sequence.

I. Core Stabilization

- A. Machine core segments to size
- B. Sand .125 R per engineering drawing
- C. Machine lower bevels
- D. Clean core
 - 1. Solvent flush
 - 2. Dry (1 hr. @ R.T.)
 - 3. Wrap in clean Kraft paper
- E. Stabilize core
 - 1. Stabilize periphery of core by dipping in SC 1008 phenolic resin
 - 2. Cure in oven (350F - 1 hr.)
 - 3. Wrap in clean Kraft paper

II. Tab Stiffener Assembly (Separate Operation)

- A. Prepare tool (flat plate) for bonding
 - 1. Solvent clean
 - 2. Apply release coating
- B. From broadgoods
 - 1. Lay up one (10 inch x 7 inch) 4 ply laminate (per 78-002553)
 - 2. Trim one piece HRP core, 5 x 7 inches
 - a. Saw 7 inch edges at 30° bevel
 - b. Clean core
 - (1) Solvent flush
 - (2) Dry (1 hr. @ R. T.)
 - (3) Wrap in clean Kraft paper

3. Trim film adhesive, specification 207-8-415, type II, grade 10 to match laminate
 - a. Apply adhesive
 - b. Remove backing film
4. Apply core to adhesive per engineering drawing
- C. Prepare for cure (specification 208-8-3), apply:
 1. Peel ply
 2. Separator film
 3. Bleeder
 4. Vacuum bleeder
 5. Breather
 6. Bagging film
- D. Autoclave cure
 1. Door close to door open - 4 hrs.
- E. Debag
- F. Machine -22 and -23 (78-002553) from stock produced by B thru E above.
- G. Clean -22 and -23
 1. Solvent clean
 2. Dry (160F for 1 hr.)
 3. Wrap in clean Kraft paper

III. Lower Skin Assembly

- A. Prepare tool for bonding
 1. Solvent clean
 2. Apply release film
 3. Apply peel ply
- B. Template trim 120 mesh screen to size
- C. Clean screen (CVA 8-51, Method II)
 1. Vapor degrease
 2. Rinse
 3. Alkaline clean
 4. Rinse
 5. Acid clean
 6. Rinse
 7. Protect (paper wrap)
 8. After cleaning handle screen only when using cotton gloves

- D. Apply screen in molding tool
 - E. Apply film adhesive, specification 207-8-415, type II, grade 10
 - 1. Template trim
 - 2. Place on assembly
 - 3. Remove backing film
 - F. Hand lay up lower skin (Ref Figure 19)
 - 1. Trim plies number 1 thru 9 (one template)
 - 2. Place lower skin on tool (use transfer template)
 - a. Remove mylar backing
 - G. From broadgoods (38 inches x 90 inches - 45° orientation)
 - 1. Trim ply numbers 10 thru 18 (17 templates) (Ref Figures 20 thru 24)
 - 2. Apply plies, in proper sequence, on tool
 - a. Remove Mylar backing
- IV. Lower Skin/Core Subassembly
- A. Apply film adhesive, specification 207-8-415, type II, grade 10, to lower skin to core faying surface
 - 1. Remove backing film
 - B. Place core segments onto lower skin
 - 1. Use adhesive foam specification 207-8-408, type III, for core splice (2 places)
 - C. Apply film adhesive, specification 207-8-415, type II, grade 10 to upper surface of core
 - 1. Remove backing film
- V. Upper Skin Assembly
- A. Hand lay up upper skin (Ref Figure 25)
 - 1. Trim ply numbers 1 thru 9 (one template)
 - 2. Trim plies for upper skin doublers (three templates)
 - 3. Apply to tool (use transfer template) butt joint corners per engineering drawing 78-002553
 - 4. Apply upper skin doubler ply stack on upper skin (use transfer templates) (Ref Figure 26)
 - 5. Protect from contamination

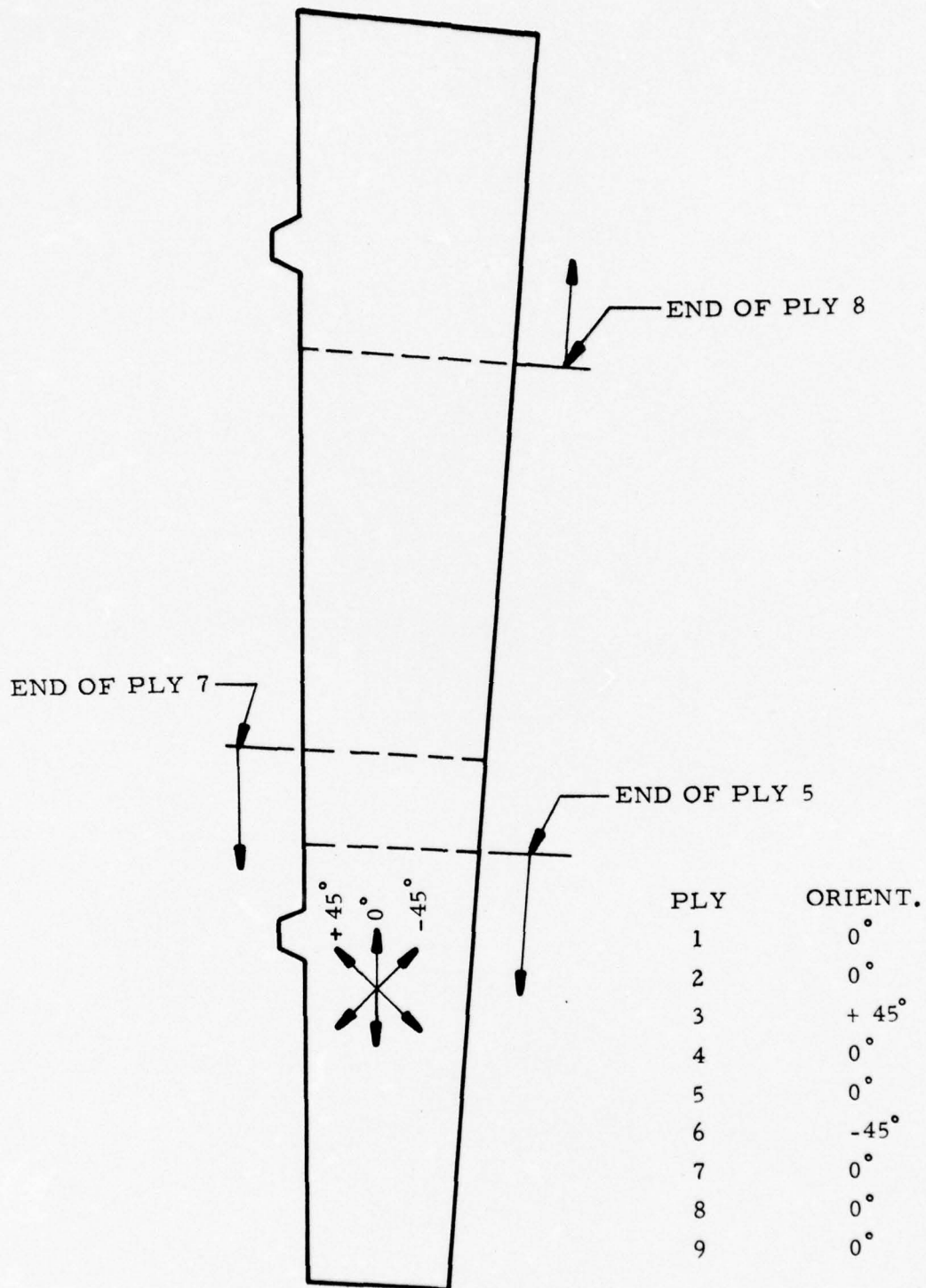
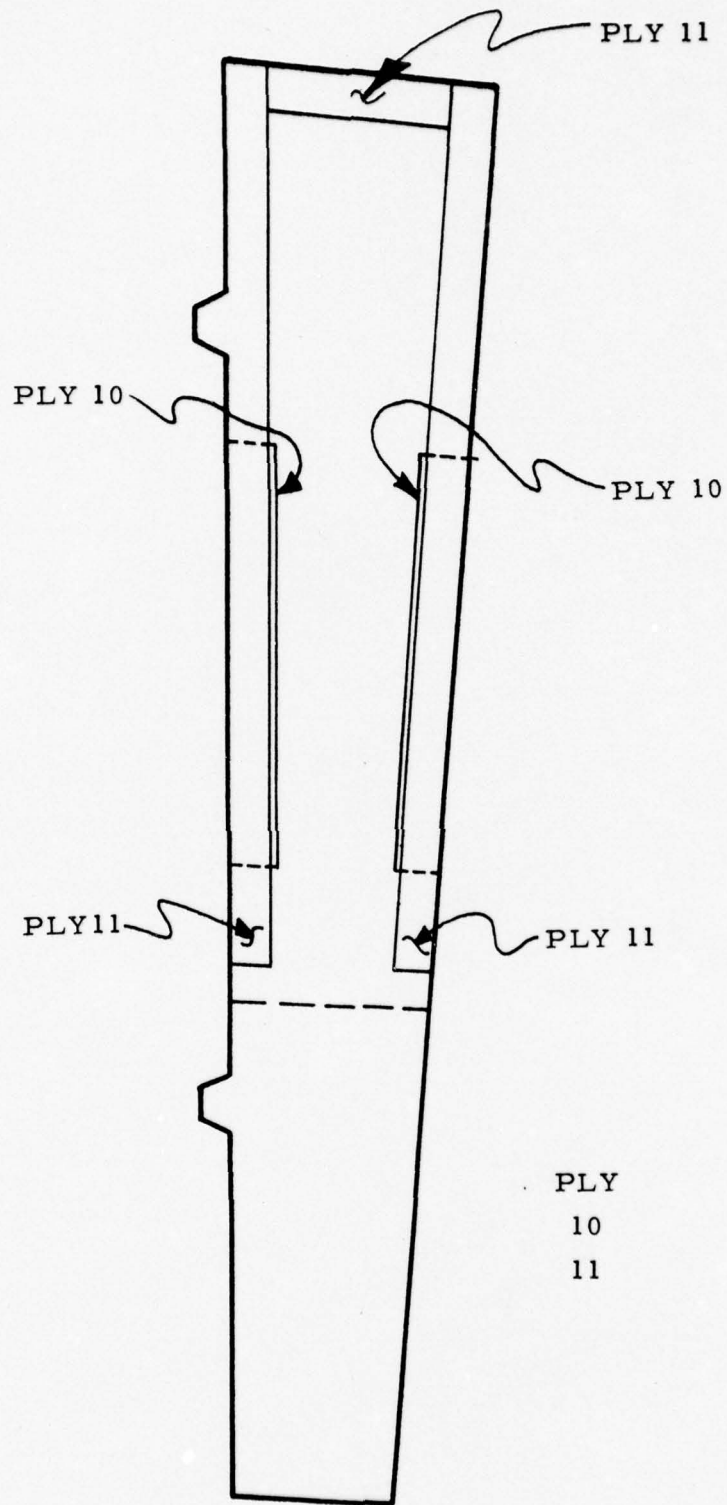


FIGURE 19 LOWER SKIN LAY-UP



PLY	ORIENT.
10	+45°
11	-45°

FIGURE 20 EDGE DOUBLERS (PLIES 10 & 11)

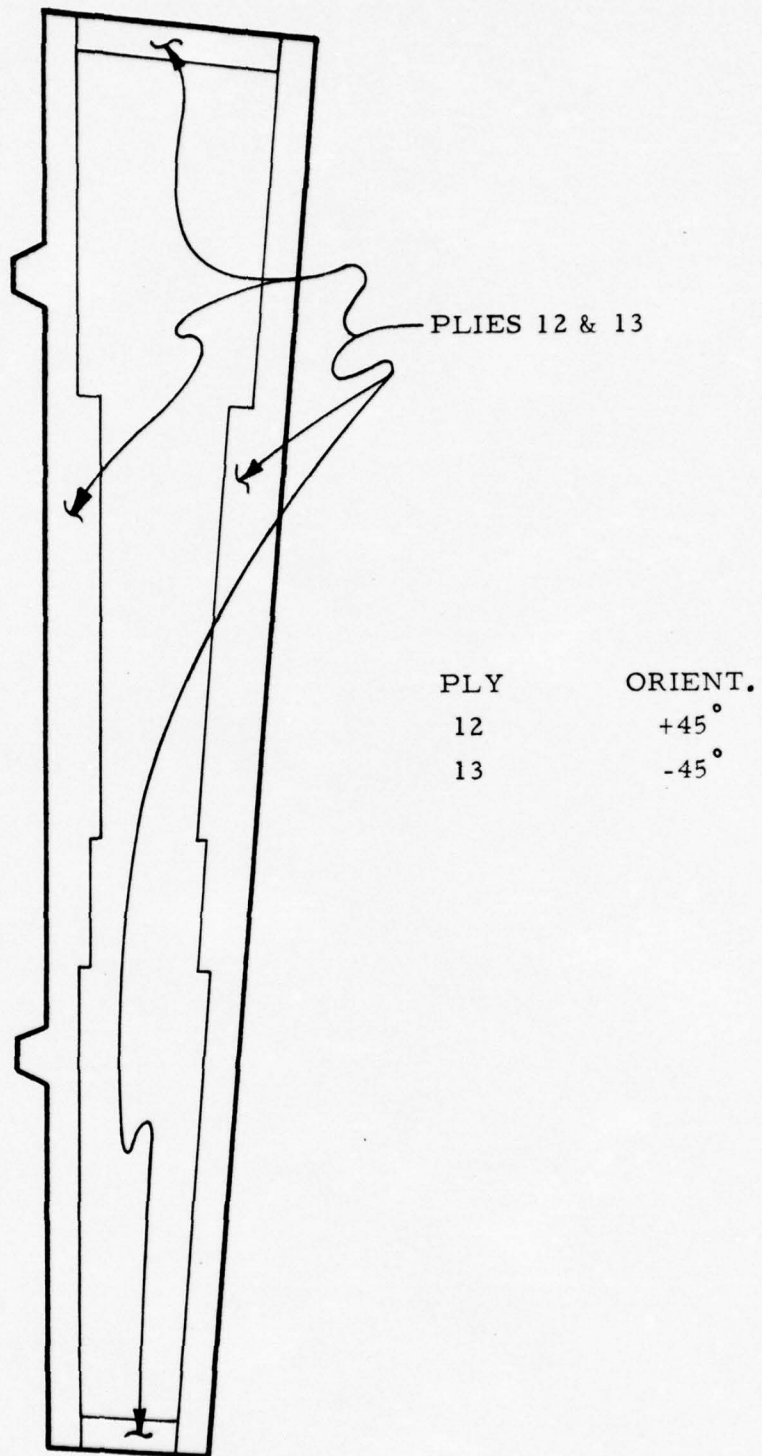


FIGURE 21 EDGE DOUBLERS (PLIES 12 & 13)

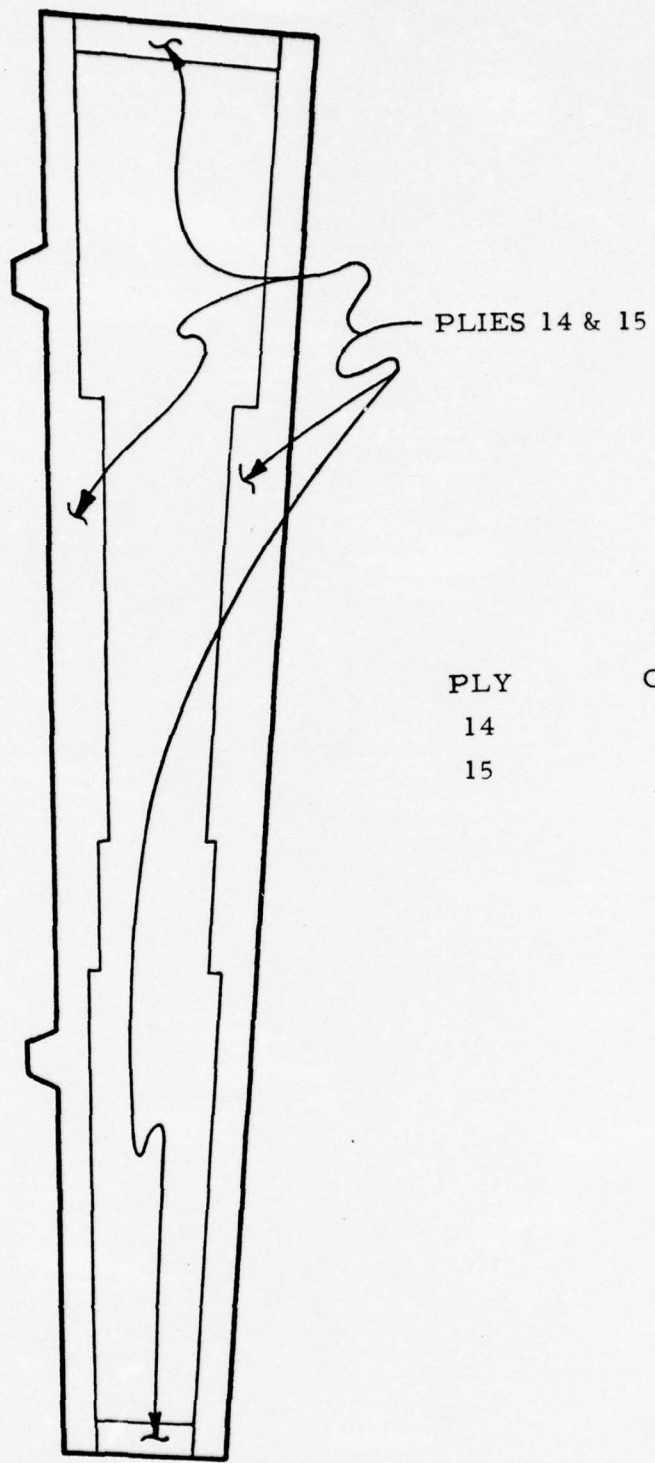


FIGURE 22 EDGE DOUBLERS (PLIES 14 & 15)

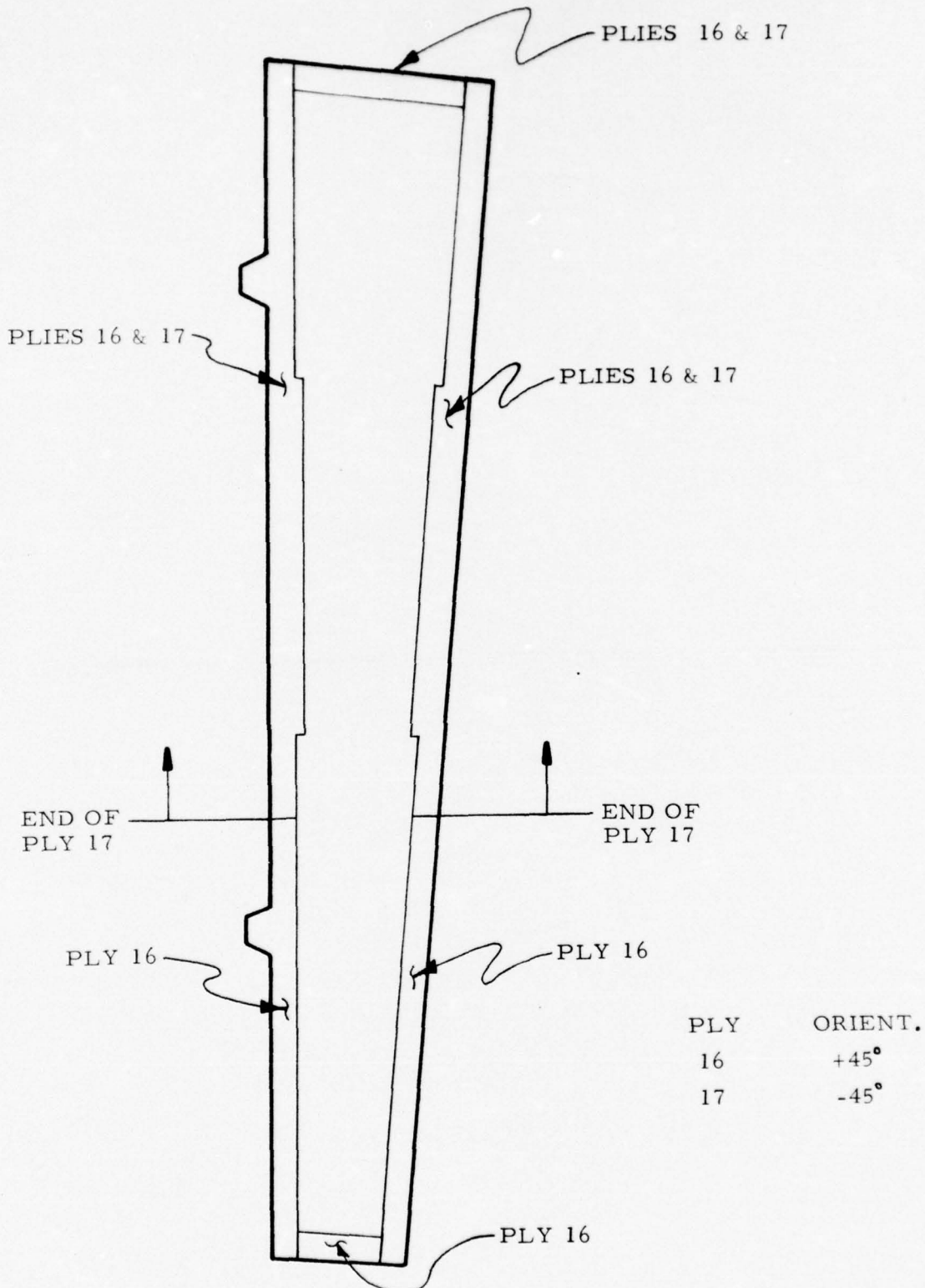


FIGURE 23 EDGE DOUBLERS (PLIES 16 & 17)

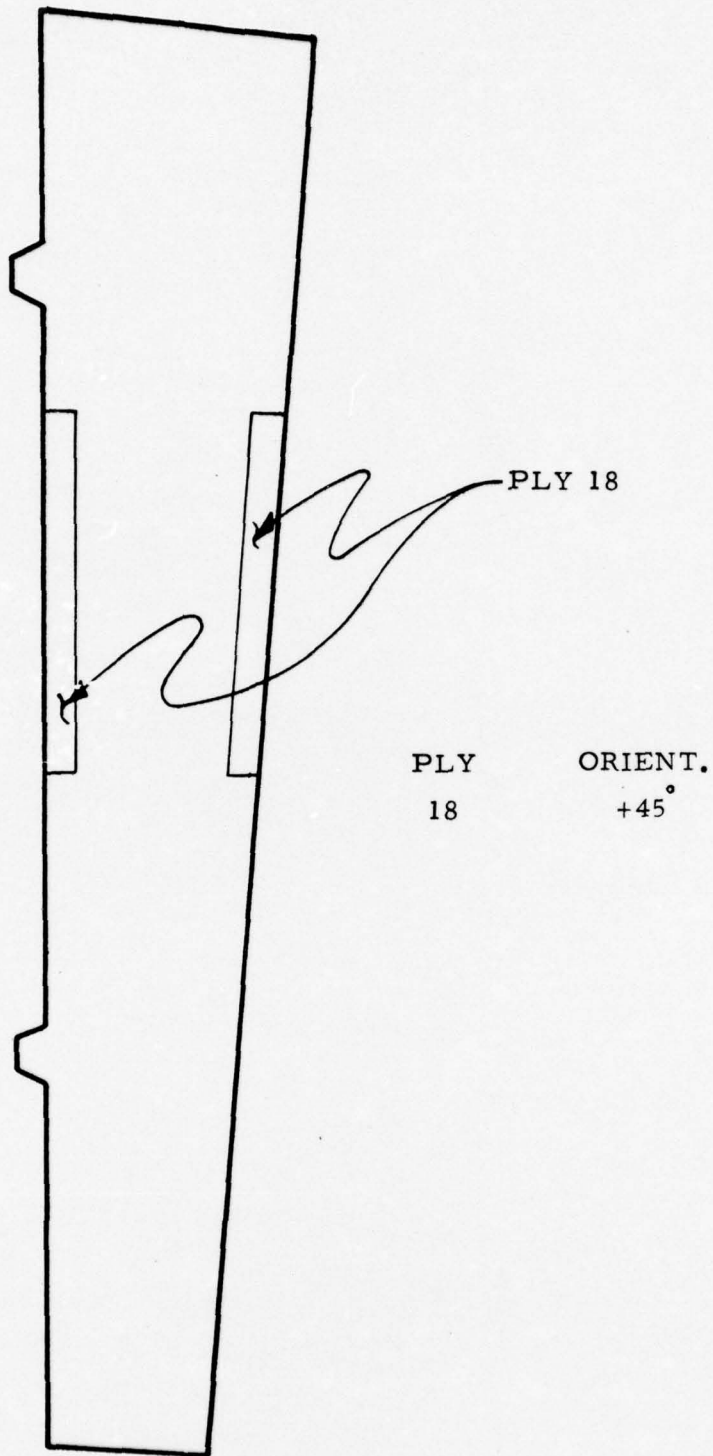


FIGURE 24 EDGE DOUBLERS (PLY 18)

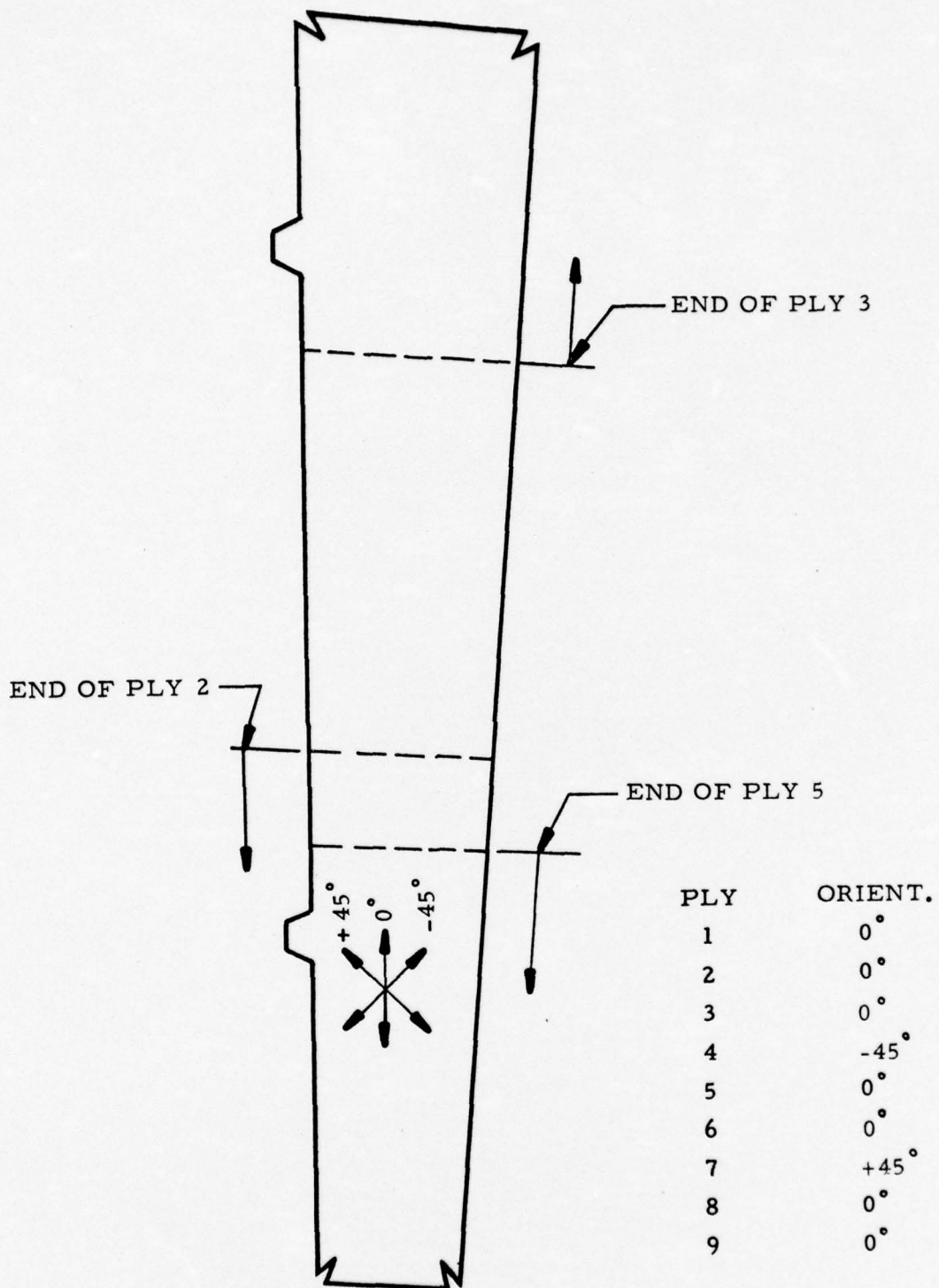


FIGURE 25 UPPER SKIN LAY-UP

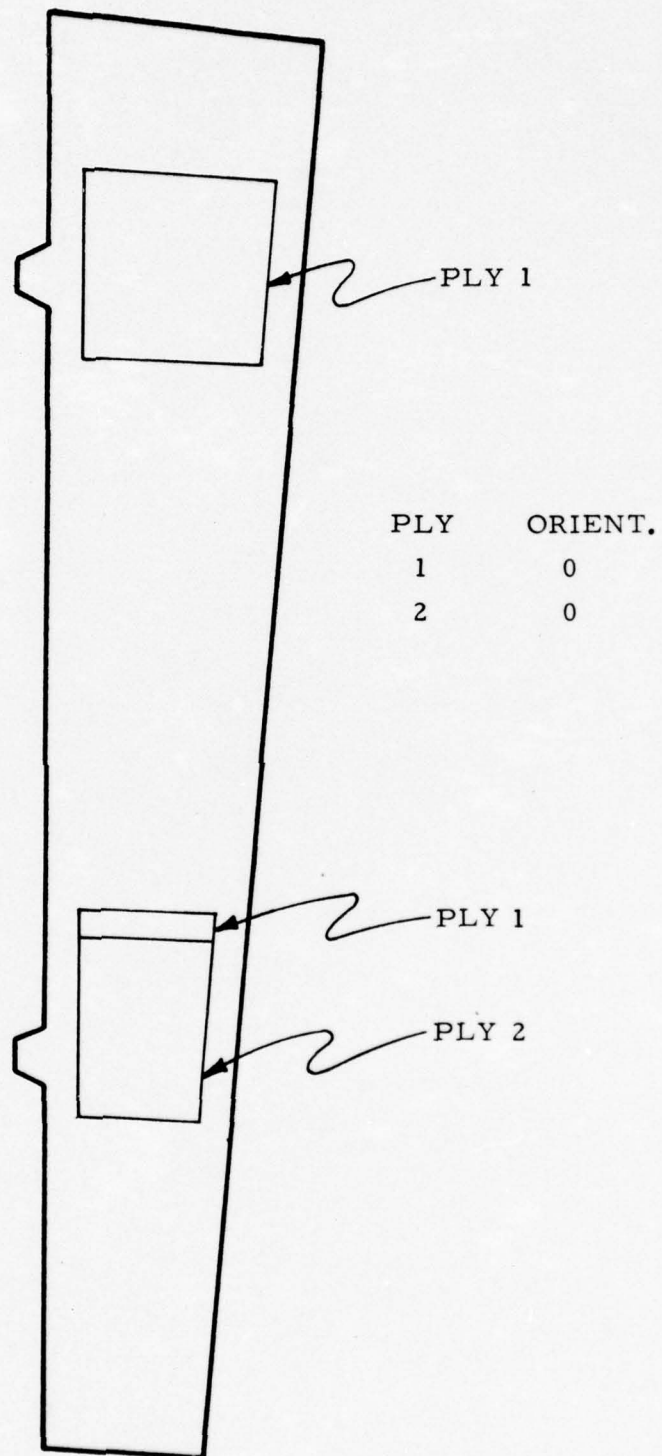


FIGURE 26 UPPER SKIN DOUBLERS

VI. Spoiler Assembly

- A. Apply film adhesive, specification 207-8-415, type II, grade 10, to -22 and -23 (reference Item II)
- B. Position -22 and -23 on assembly
- C. Prepare for cure, specification 208-8-3
 - 1. Similar to item II.C.1 thru 6
- D. Autoclave cure
 - 1. Door close to door open - 4 hrs.
- E. Debag
- F. Rough trim (remove excess resin and molding flash)
- G. NDT(24 -36 hrs. turn around)
- H. Machine to final size (leave tooling tab at each end)
- I. Install hinge inserts
 - 1. Using production hinges and shims
 - a. Load hinges and spoiler in assembly tool
 - b. Pilot holes in spoiler (inner skin only)
 - c. Install inserts
 - (1) .5 diameter hole in spoiler inner skin
 - (2) Under cut core
 - (3) Clean core
 - (a) Solvent flush
 - (b) Dry (160F for 1 hr.)
 - (4) Using paste adhesive, specification CVA 8-405, type VI
 - (a) Mix adhesive
 - (b) Fill cavity (1/2 full)
 - (c) Install inserts
 - (d) Fill cavity
 - (e) Cure (8 hrs. @ R. T.)
 - d. Using sealant, specification CAV 6-579, seal
 - (1) Seal edges of -22 and -23
- J. Seal Attach Provisions
 - 1. Drill 66 holes per engineering drawing
- K. Final Inspect

Process control specimens were made for the manufacturing development article. These specimens are fabricated at the same time, with the same materials, and under the same procedures as the spoiler. These provided a baseline for future process control specimens and give an idea of the quality of the material and procedures. In this case two extra sets of process control specimens were fabricated. One set was made with a bonded aluminum screen. The second set was made with scrim cloth between the specimen and the screen so that the screen could be removed after curing. The purpose of these specimens was to check the weakening effect due to bleed off of resin into the screen. This bleed off of resin raises the fiber volume and therefore it was expected that the screen would decrease the short beam shear strength and increase the modulus. Results concur with prediction as can be seen in Table XV.

TABLE XV - PROCESS CONTROL SPECIMENS -
MANUFACTURING DEVELOPMENT SPOILER

	PEEL PLY BOTH SIDES	SCREEN WITH SCRIM CLOTH	WITH BONDED SCREEN
f_{sa}	13,666 *	12,511	11,063
F	231,469	228,091	280,846
E	18.03×10^6	21.21×10^6	26.11×10^6

* All values are averages

The spoiler was then cut into three basic types of specimens. These consisted of flexural beam specimens, tensile specimens, and potted insert specimens. Three flexural beam specimens, twelve (12) tensile specimens, six (6) from the upper skin and six (6) from the lower skin, and two (2) potted insert specimens were fabricated from the full scale component. These were cut from the spoiler as shown in Figure 27.

The three flexural beam specimens were four point loaded as shown in Figure 28A. The load concentrations made it necessary to neck down specimens A & B as shown in Figure 28B. This necking down of the specimen assured that the beam would fail in flexure. Specimen C could not be necked down because of the potted inserts. This beam was prepared in order to test the weakening effect of the potted inserts. The general area of the inserts was strengthened with

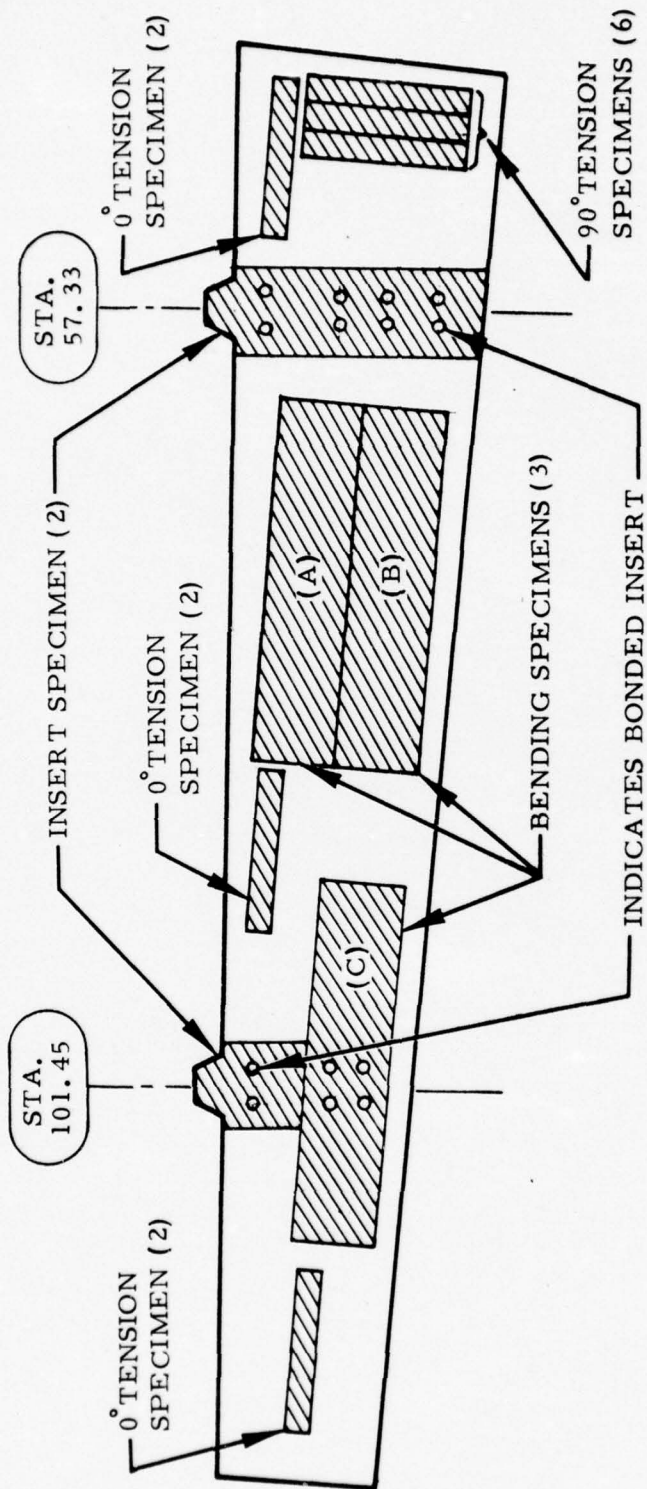
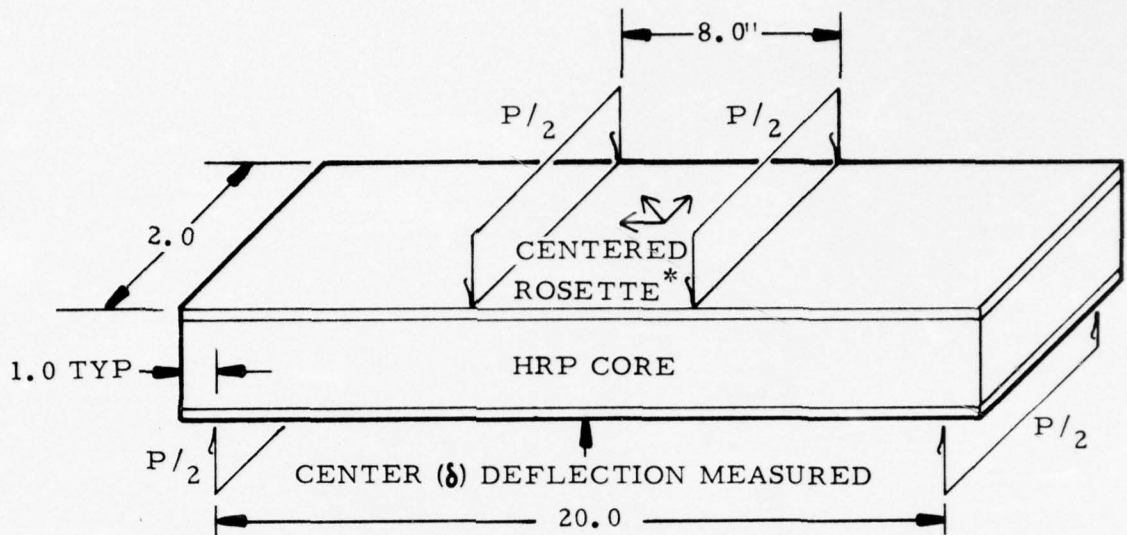


FIGURE 27 SPECIMEN LOCATIONS - MANUFACTURING DEVELOPMENT SPOILER



* INSTALL ROSETTE ON ONE SPECIMEN, UPPER & LOWER SURFACE
 FIGURE 28A FLEXURAL BEAM SPECIMEN - LOADING METHOD

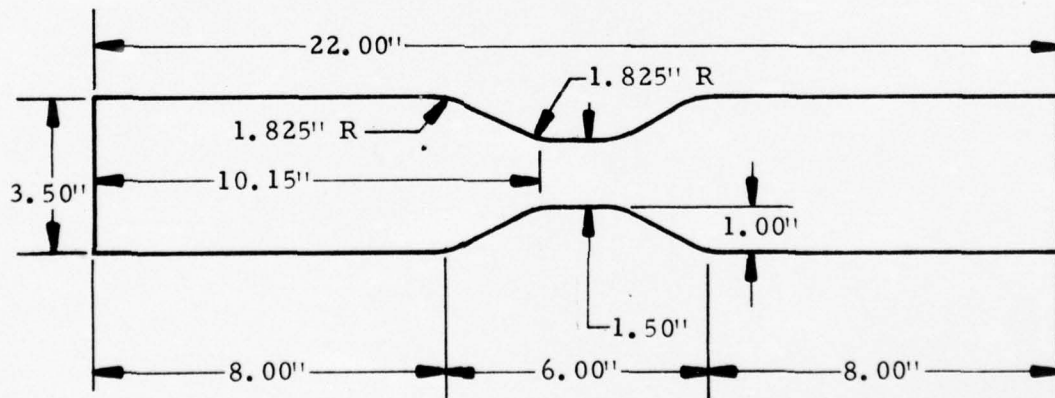


FIGURE 28B FLEXURAL BEAM SPECIMEN - CONFIGURATION

a two ply doubler as shown in Figure 3. In order to insure that the beam would fail in flexure the core was removed and replaced with potting up to a point 0.5 inch inside of the load concentrations.

The twelve tensile specimens consisted of six (6) upper skin coupons and six (6) lower skin coupons with the core removed. They were fashioned for testing as shown in Figure 29.

The results of tests on the manufacturing development article are shown in Table XVI.

TABLE XVI - TEST DATA-MANUFACTURING DEVELOPMENT SPECIMEN

SPECIMEN		REMARKS
Flex Specimens	Load	
B	780#	Failed in necked down area
A	1065#	Failed in necked down area
C	3970#	Failed at edge of doubler outboard of outboard hinge
Inserts	Load	All values except compression 3 were to 115%
Tension-1,2,3	221#	No failure
Compression-1,2	771#	No failure
Compression 3	1805#	Failure
Torque 1,2,3	70 in-lb	No failure
Tensile	F_{tu}	Loads shown are averages
A	105,330	0°, w/o screen bonded tab failure
B	88,870	0°, w screen; failed center (test section)
C	13,670	90°, w/o screen; failed edge of bonded grip end
D	11,930	90°, w screen; failed edge of bonded grip end

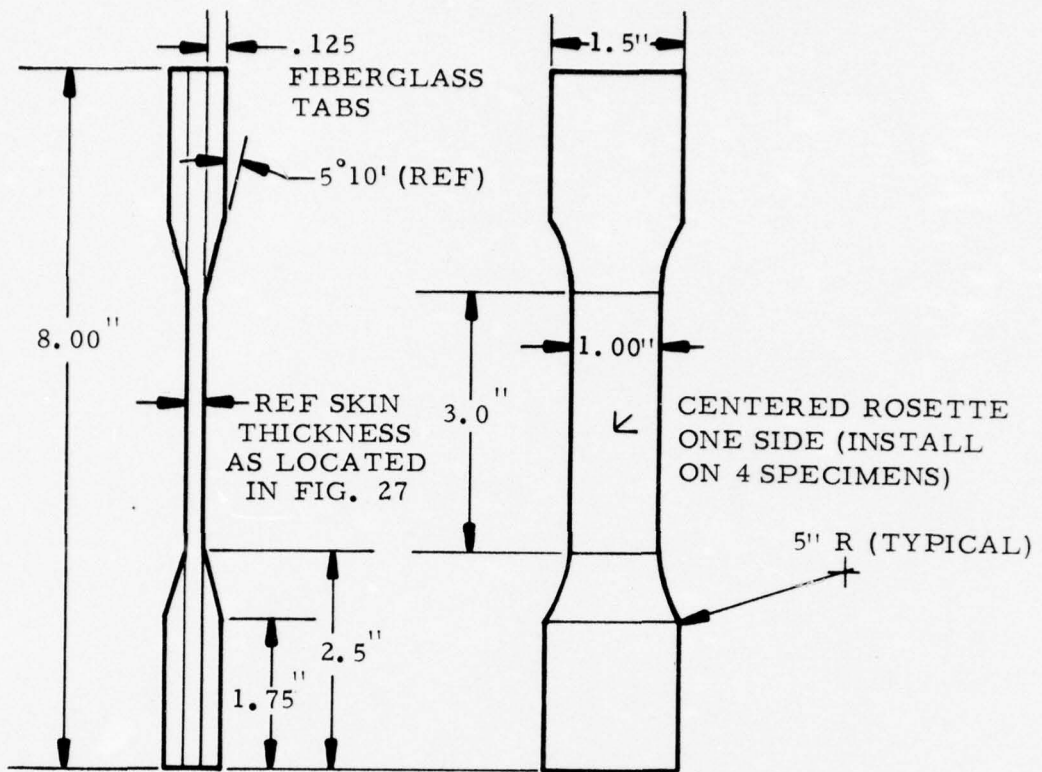


FIGURE 29 TENSILE COUPONS - MANUFACTURING DEVELOPMENT SPOILER

As can be seen in Figure 27 one of the flex specimens was cut across the outboard hinge area and included four inserts. This specimen had a 10 ply upper and an 8 ply lower surface. The other two flex specimens had 6 ply upper and lower surfaces. The specimen with the inserts failed along the edge of doubler on the outboard side. The other two failed in the necked down section, at the edge of the radius.

The inserts were tested to 115% of design limit load as verification of predicted strength. One of the compression specimens was tested to failure to get an idea of actual strength and margin of safety. It tested to 1805 lbs or 270% of design limit load.

There is an aluminum screen used for lightning strike protection on one side of the spoiler. Therefore, half of the tensile specimens were tested with a screen and half without. The screen, as shown by tests on the process control specimens, had a weakening effect on the specimens.

Four spoiler assemblies were fabricated for testing at NADC. The first three articles are for static testing while the fourth is a fatigue article. Static test articles 1 and 2 were fabricated in the same manner as the manufacturing development article. Static article 3 and the fatigue article were manufactured in accordance with the revised manufacturing plan as described in Appendix C. The change allows direct layup of the edge doublers, deleting the use of doubler transfer templates.

The glass epoxy molding tool has the edge of part (EOP) outline and two tooling hole locations scribed lightly on the OML surface. Two removable tooling pins were utilized to key all mylar templates to the EOP outline. Figure 30 shows the molding tool with tooling pins attached by double faced tape. To provide a surface for lay-up of the skins for the spoiler an outline of the spoiler, which includes .38 trim on all sides, was drawn on a polyethylene sheet. This surface shown in Figure 31 also included a table of ply numbers and orientations. A sheet of nylon film was taped to the table and the lower skin was hand layed-up ply on ply. Ply Number 1 is shown in Figure 32. Figure 33 shows partial completion of ply number 6. Partial plies Numbers 7 and 8 are shown in Figure 34. The complete, template trimmed lower skin is shown in Figure 35. A single sheet of 45° orientation broad goods was prepared. Metal templates were used to trim the picture frame doublers to size. The lower skin and doubler plies were transferred to the tool by utilizing mylar transfer templates. Figure 36 shows doubler ply number 14 on the transfer template. The complete lower skin/picture frame subassembly, after vacuum debulking is shown in Figure 37.

Film adhesive is applied to the lower surface of the previously machined and cleaned honeycomb core segments. Foam adhesive is applied to the ends of the center core segment. Starting with one of the end segments the core is applied to the skin/doubler subassembly. This stage of manufacture is shown in Figure 38. Film adhesive is now attached to the upper and sloped edges of the core. The protective film is left in place during the lay-up and trim of the upper skin assembly. This lay-up process is accomplished in a similar manner to that employed in the fabrication of the lower skin. Transfer to the tool is again accomplished by transfer template. The upper skin requires draping and trimming at each corner. Vacuum debulking is again used after the upper skin application as shown in Figure 39.

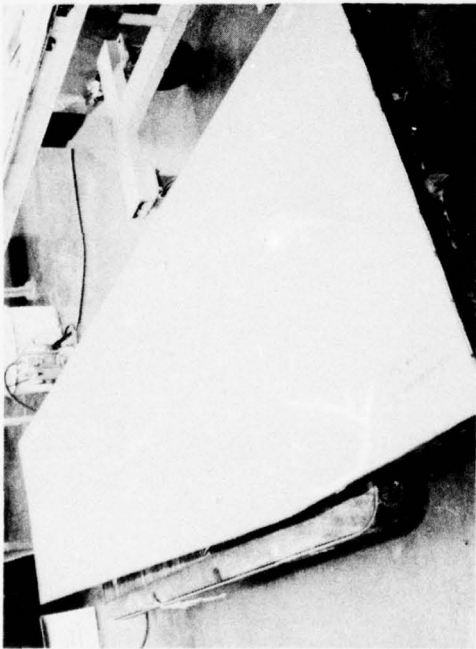


FIGURE 30: GLASS/EPOXY SPOILER MOLDING TOOL

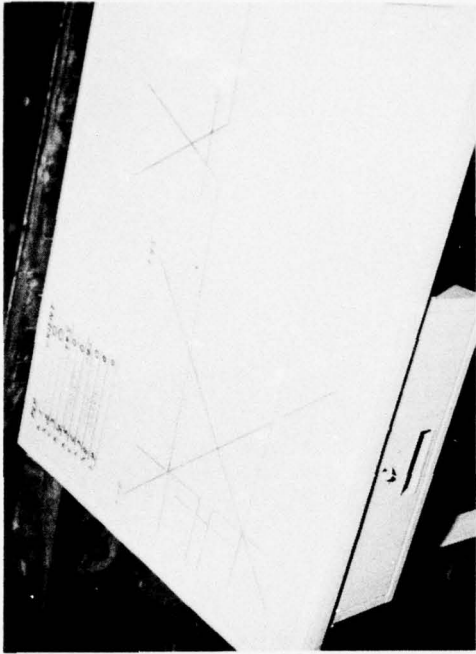


FIGURE 31: SKIN LAY-UP GUIDE

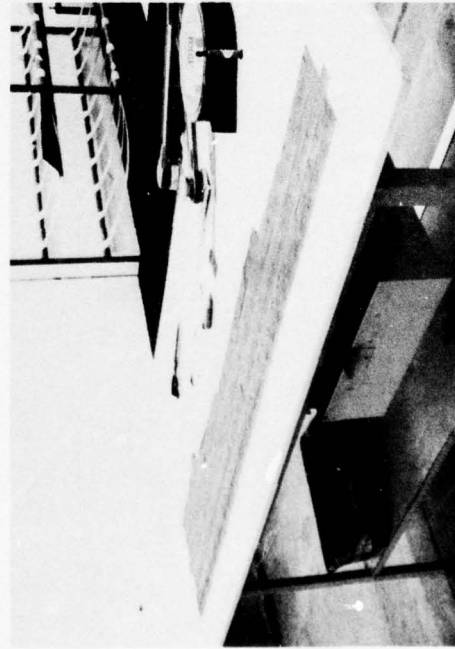


FIGURE 32: LOWER SKIN PLY NO. 1



FIGURE 33: LOWER SKIN, LAY-UP OF PLY NO. 6



FIGURE 34: LOWER SKIN, PLYS NO. 7 AND 8

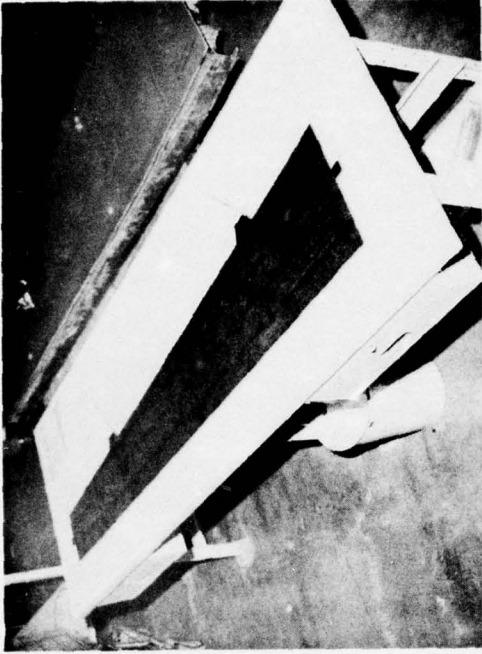


FIGURE 35: LOWER SKIN, LAY-UP COMPLETE, TEMPLATE TRIMMED

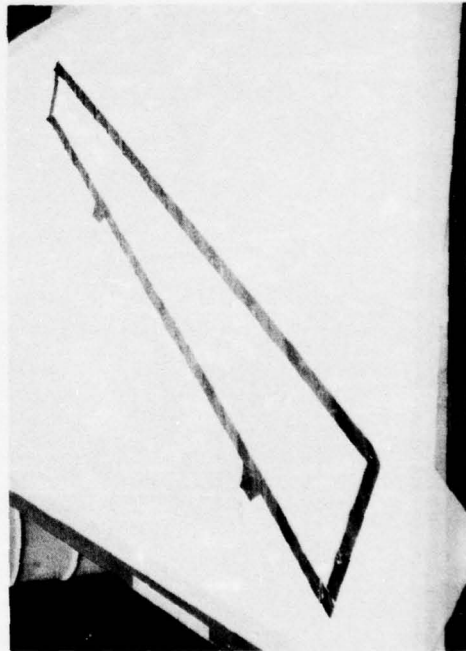


FIGURE 36: PICTURE FRAME DOUBLER, PLY 14, ON TRANSFER TEMPLATE

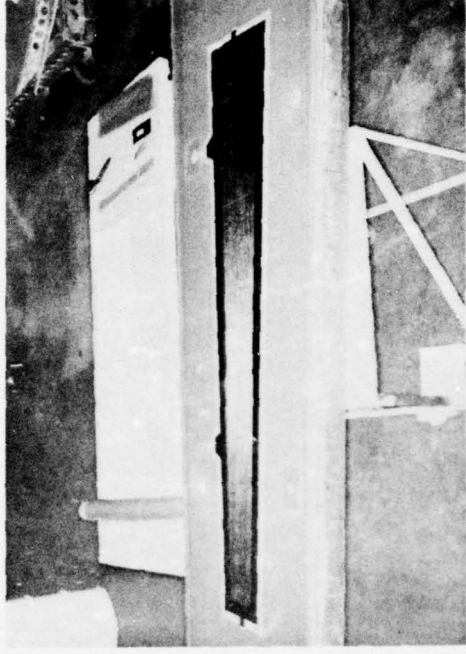


FIGURE 37: LOWER SKIN AND PICTURE FRAME DOUBLERS AFTER TRANSFER TO MOLDING TOOL

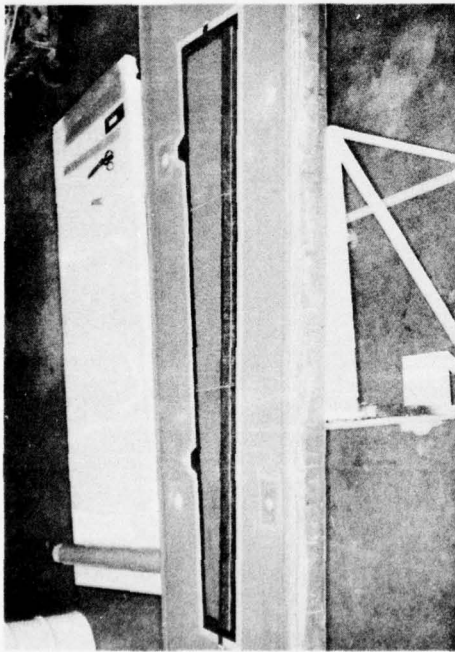


FIGURE 38: MACHINED CORE SEGMENTS APPLIED TO LOWER SKIN ASSEMBLY

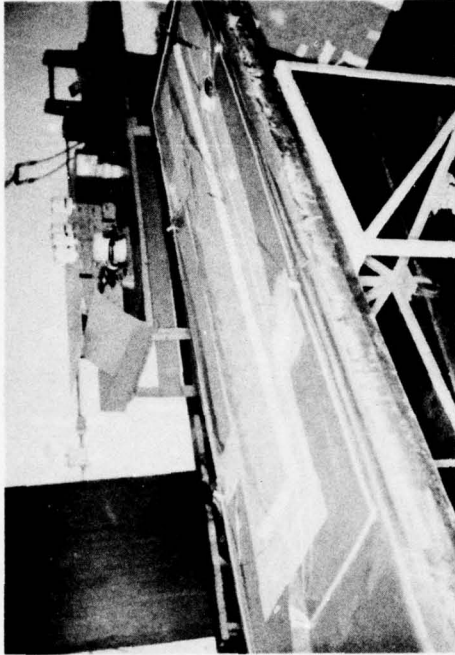


FIGURE 39: VACUUM DEBULKING OF SPOILER ASSEMBLY



FIGURE 40: SPOILER ASSEMBLY, DEBULKING COMPLETE, TAB STIFFENERS INSTALLED

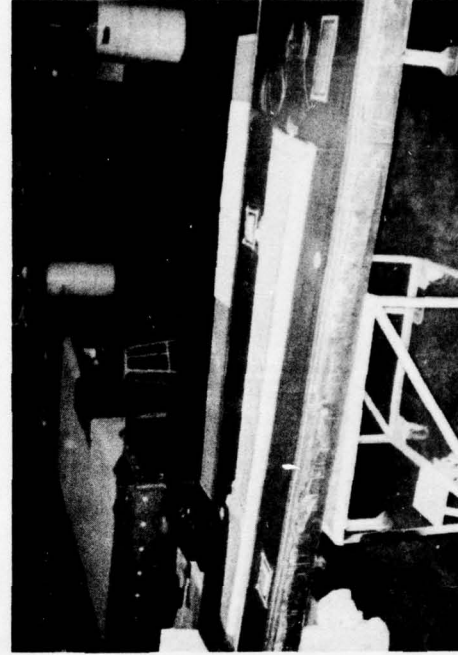


FIGURE 41: BAGGING PREPARATION, BLEEDER PLY INSTALLATION

The precured tab stiffeners are template located on the spoiler assembly, after application of film adhesive to the core to spoiler faying surface. Figure 40 shows these tab stiffeners in place, as well as the Corprene dam in place around the spoiler. Peel ply, teflon coated glass fabric, and resin bleeder material, as shown in Figure 41, are secured to the part.

Two process control specimens are required, per specification 208-8-3. P/C 1 is a sixteen ply unidirectional laminate, from which flexure and short beam specimens are made. Both P/C 1 and P/C 2 are shown in Figure 42. P/C 2 is a sandwich specimen with seven ply alternate 0° and 90° oriented skins. Flatwise tensile specimens are fabricated from this sandwich. Both specimens are cured under the vacuum blanket covering the spoiler assembly.

Figures 43 and 44 show the caul plate and pressure block installation prior to bagging. The caul plates are 0.020 aluminum alloy. The 30° sloping surface of the spoiler utilizes two angles with a 0.008 slip sheet under the angles at the joints. The pressure blocks are wooden strips which fit the caul angles on two sides and slope upward from the tool surface.

Figure 45 shows the tool, spoiler assembly and process control specimens after the completion of the bagging operation, but prior to cure. Four thermocouples were employed during the cure of each spoiler assembly. A thermocouple is located in each of the tooling tabs. While one is located in the solid laminate process control specimen, the other is located in the lower skin of the sandwich process control specimen.

Figures 46 and 47 show the upper and lower surfaces of static article Number 1. Close-up views of the hinge installation and tab stiffener sealant application is depicted in Figures 48 and 49.

Views of the upper and lower surfaces of static articles 2 and 3 and the fatigue article are shown in Figures 50 thru 55.

To verify spoiler final assembly one of the spoilers was attached to a S-3A wing assembly. The actuation system was operated and no signs of unusual operation or system malfunction was noted. Figures 56 and 57 show this installation.



FIGURE 42: PROCESS CONTROL SPECIMENS

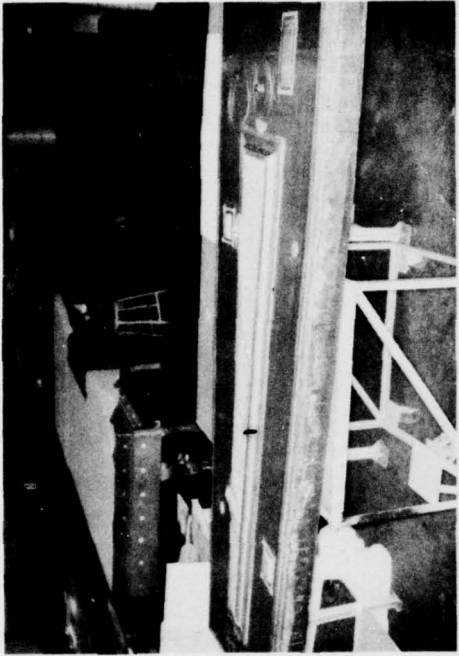


FIGURE 43: BAGGING PREPARATION, PARTIAL CAULK PLATE INSTALLATION

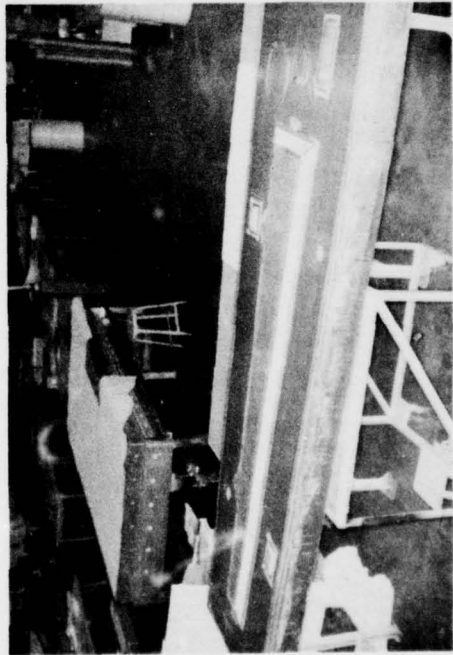


FIGURE 44: BAGGING PREPARATION, PRESSURE BLOCKS INSTALLED

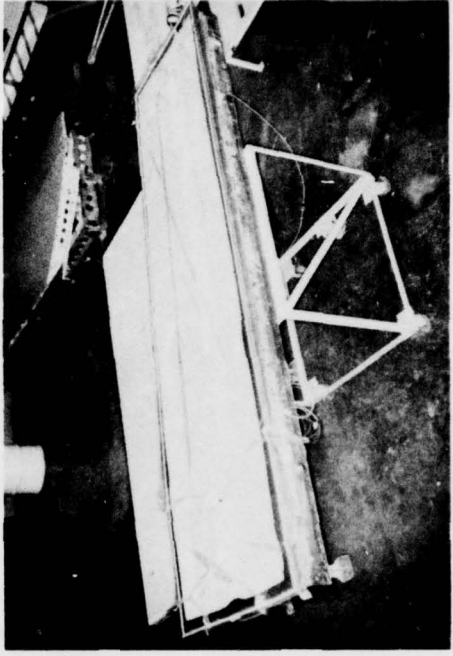


FIGURE 45: BAGGED PART AND SPECIMENS, READY FOR CURE

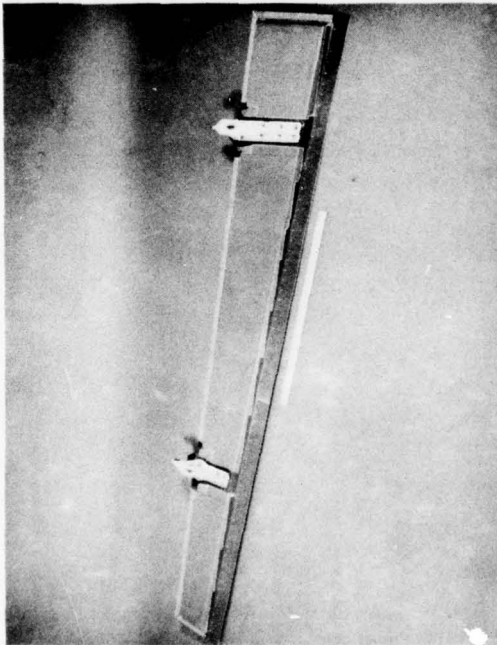


FIGURE 46: UPPER SURFACE, STATIC ARTICLE NO. 1, SPOILER ASSEMBLY

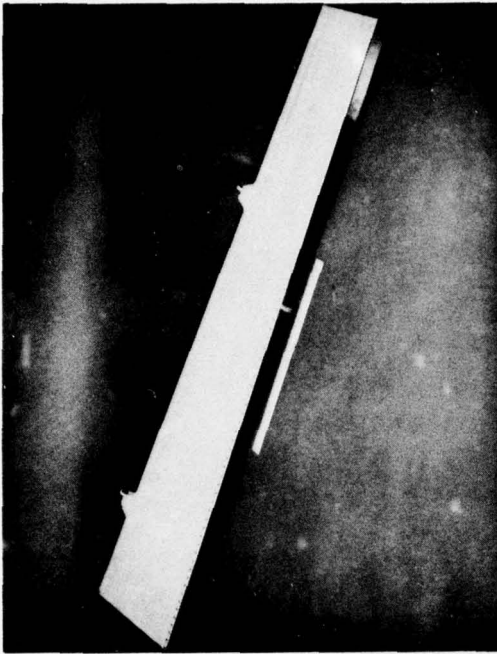


FIGURE 47: LOWER SURFACE, STATIC ARTICLE NO. 1 SPOILER ASSEMBLY



FIGURE 48: INBOARD HINGE ASSEMBLY INSTALLATION,

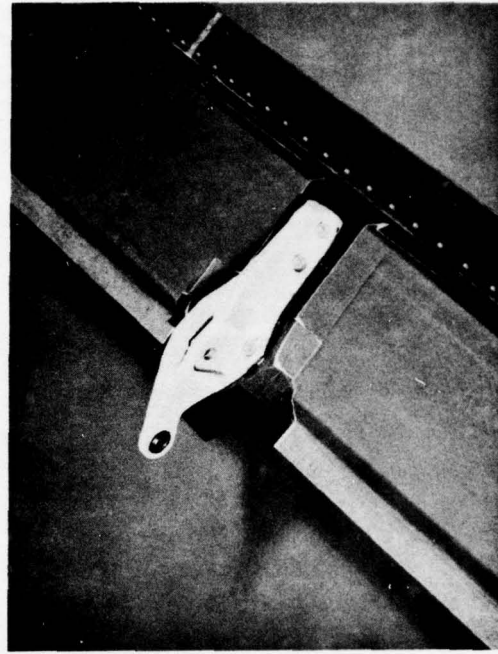


FIGURE 49: OUTBOARD HINGE ASSEMBLY INSTALLATION

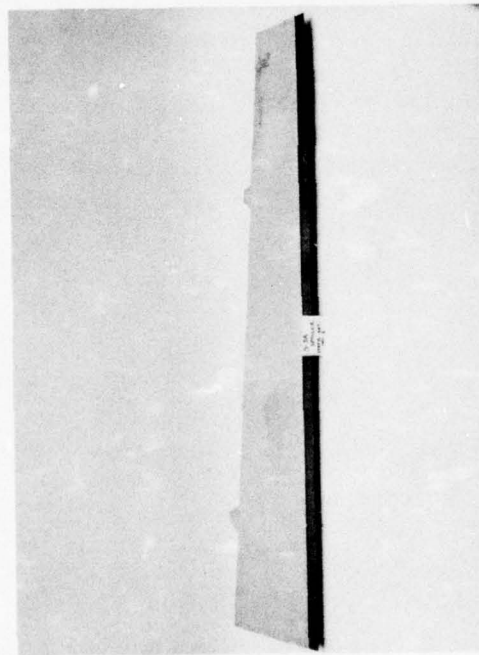


FIGURE 50: LOWER SURFACE, STATIC ARTICLE
NO. 2, SPOILER ASSEMBLY

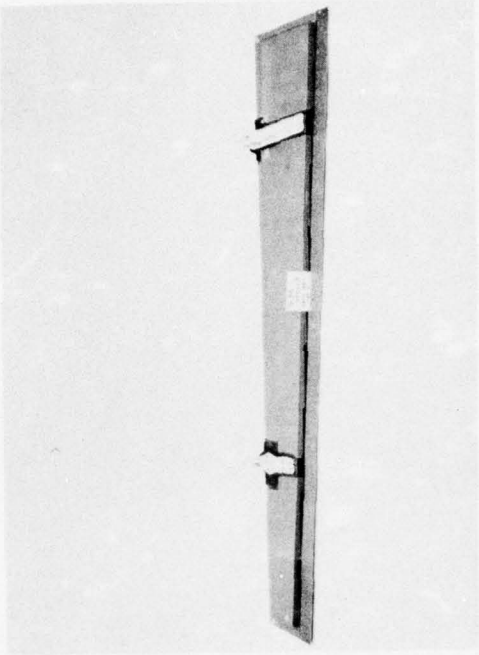


FIGURE 51: UPPER SURFACE, STATIC ARTICLE
NO. 2, SPOILER ASSEMBLY

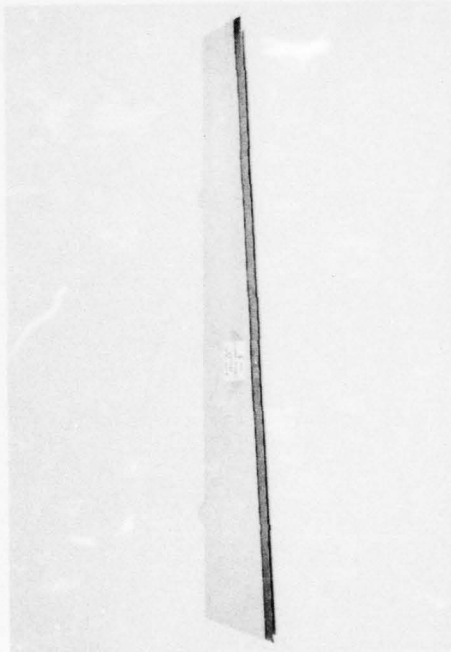


FIGURE 52: LOWER SURFACE, STATIC ARTICLE
NO. 3, SPOILER ASSEMBLY

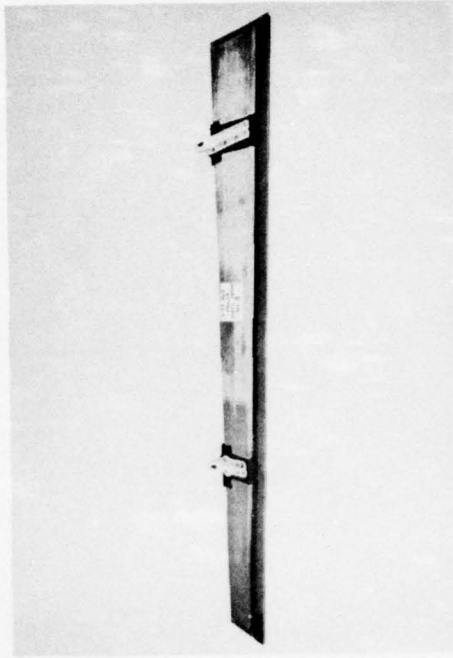


FIGURE 53: UPPER SURFACE, STATIC TEST ARTICLE
NO. 3, SPOILER ASSEMBLY

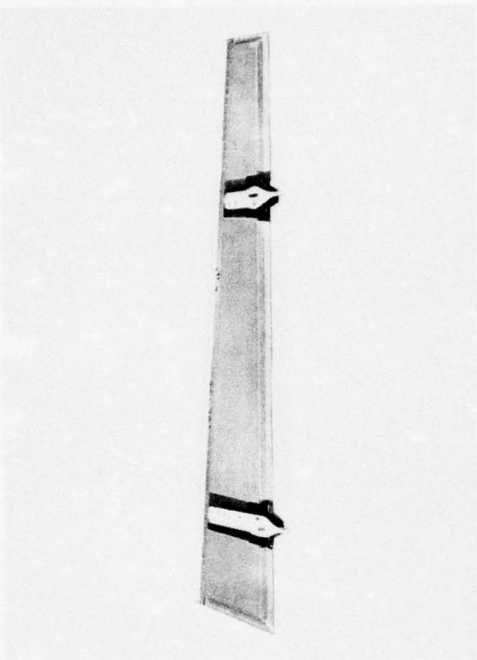


FIGURE 55: UPPER SURFACE, FATIGUE ARTICLE,
SPOILER ASSEMBLY

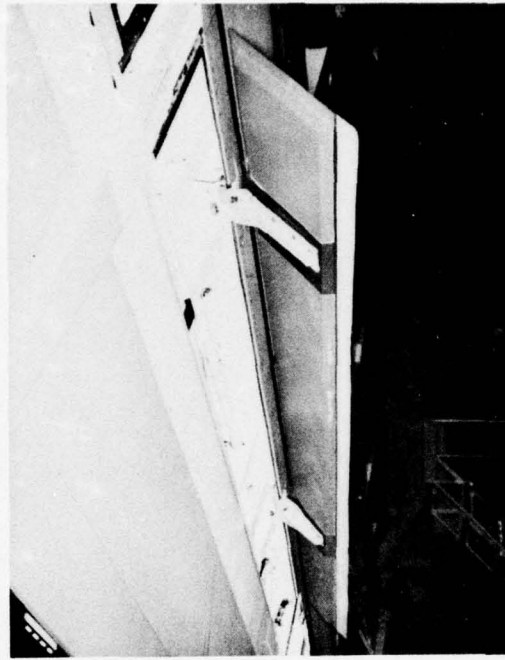


FIGURE 57: GRAPHITE/EPOXY SPOILER INSTALLED
ON S-3A WING, EXTENDED POSITION

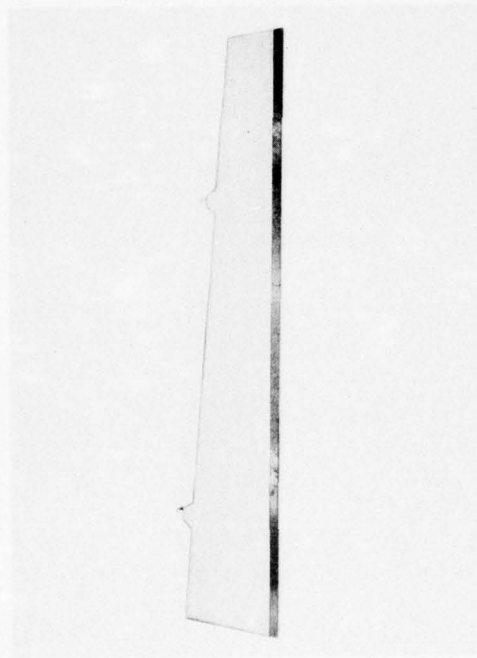


FIGURE 54: LOWER SURFACE, FATIGUE ARTICLE,
SPOILER ASSEMBLY



FIGURE 56: GRAPHITE/EPOXY SPOILER INSTALLED
ON S-3A WING, CLOSED POSITION

During the fabrication of static article Number 3 and the fatigue article the fabrication sequence was altered slightly to eliminate the usage of the picture frame doubler transfer templates for assembly. This change reduced the man hour requirements for spoiler fabrication. This change is reflected in the Revised Manufacturing Plan as shown in Appendix C.

SECTION 4
COMPONENT TESTING

All of the component testing was conducted by the Naval Air Development Center at Warminster, Pennsylvania under the direction of Mr. A. Manno. Test results and data were supplied to VSD for incorporation into this report. The full scale component tests conducted under the contract include three static tests and a fatigue test as defined in the test plans. The static test plan, report number 2-53440/3R-10108 included in Appendix B defines test loads and conditions. The fatigue test plan, report number 2-53440/3R-10109 is also included in Appendix B.

Two types of process control specimens were fabricated per process specifications during each spoiler assembly cure. One specimen consisted of a 16 ply unidirectional solid laminate which was cut into three zero degree flexure and three shear specimens for testing. The second specimen was a honeycomb sandwich panel with the same core as the spoiler and seven ply skins oriented 0, 90, 0, 90, 0, 90, 0. This was cut into three 2" x 2", flatwise tensile specimens. The test results on these specimens are compared to the manufacturing development components control specimens in Table XVII, and indicate no deficiencies in manufacturing process control. Table XVIII gives the actual weight versus the predicted weight of the finished test components.

The static test articles were loaded as defined in the Static Test Plan shown in Appendix B, and evaluated for strength and stiffness, to verify the design capability of the spoilers. Stresses and deflections were measured by five rosette gauges and twelve deflectometers on each spoiler.

Although the closing condition is the critical condition, the opening condition was tested to substantiate the spoiler performance for tension loads in the areas of the hinges. Each test checked three data points for the closing condition (150% DLL, 177% DLL, and failure), and one data point for the opening condition. The requirement for sustaining 177% of DLL as a check point in testing resulted from an S-3A operational change which deactivates the upper outer spoilers and increases the loading on the remaining spoilers.

TABLE XVII - PROCESS CONTROL TEST RESULTS

ARTICLE	FLATWISE TENSION	FLEXURE	MODULUS 10 ⁶	SHORT BEAM SHEAR
Static No. 1	1070*	258,923	18.60	13,065
Static No. 2	958	215,780	17.47	13,787
Static No. 3	1022	230,961	18.10	13,501
Fatigue Article	892	234,166	20.04	14,121
M. D. Article	1061	231,469	18.03	13,366

* All Values Average

TABLE XVIII - ACTUAL SPOILER WEIGHT VS. PREDICTED WEIGHT

ELEMENT	PREDICTED WEIGHT	ACTUAL WEIGHT			FATIGUE
		STATIC NO. 1	STATIC NO. 2	STATIC NO. 3	
Spoiler	8.40	8.31	8.34	**	**
Spoiler* With Fittings	12.28	11.59	11.65	12.09	12.05

* Fittings Include Hinges, Seals, Hardware

** Not Weighed

STATIC TESTS

As required per contract, three static test articles were fabricated according to the drawings of Appendix A, and the materials and process specifications of Table IV. These components were shipped to NADC where the actual testing was accomplished.

Static Test - Spoiler #1

The test report for static spoiler number 1 is presented in Appendix B. The spoiler was loaded thru the test sequence shown in Table XIX.

TABLE XIX - STATIC TEST #1 RUN SEQUENCE

RUN NUMBER	CONDITION	MAX LOAD (% DLL)	REMARKS
1	Opening	40	Check loading fixture
1a	Closing	40	Check loading fixture
2	Opening	100	
3	Opening	115	
4	Closing	100	
5	Closing	150	
6	Closing	177	
7	Closing	230	
7a	Closing	290	Failure at 300% DLL before gages could be read

The critical strains and deflections were checked after each run and showed acceptable correlation with the predicted values. The deflection at the outboard tip was less than that of the metal spoiler at the same load. Loading was applied in increments until failure. Failure occurred suddenly at 300 percent DLL, at the edge of the outboard doubler. There were no preliminary audible indications of failure.

Strain measured at the gauge located nearest to the point of failure, when extrapolated to the point of failure, was .00430. Using this value in the

point stress analysis routine, discussed in Section 2, results in close agreement with test results at 300% DLL. The calculated failure occurred at the same point as on the flexural beam specimen cut from the manufacturing development article. When the measured strain was extrapolated to the area of the outboard hinge, the strain was .0061. This value, being higher than predicted by previous tests (TR-141, Table X), indicates that local load redistribution because of the hinge pad reduces the local stress.

Measured deflections show close agreement with the predicted values, and are within 10% of the predicted values at 150% DLL. A comparison of measured and predicted leading edge and trailing edge deflections for Static Test Article number one (1) are shown in Figure 58.

Static Test - Spoiler #2

The test report for static spoiler number 2 is presented in Appendix B. The second test series is given in Table XX.

TABLE XX - STATIC TEST #2-RUN SEQUENCE

RUN NUMBER	CONDITION	MAX LOAD (% DLL)	REMARKS
1	Opening	40	Check run
2	Opening	115	
3	Opening	150	
4	Closing	40	Check run
4a	Closing	40	Check run
5	Closing	100	
5a	Closing	100	Check run
6	Closing	150	
7	Closing	177	Lost tension pads (reworked)
7a	Closing	80	Discontinued due to pad unbonding
7b	Closing	177	Retest run #7
8	Closing	240	
9	Closing	350	Failure at 360% DLL before gages were read.

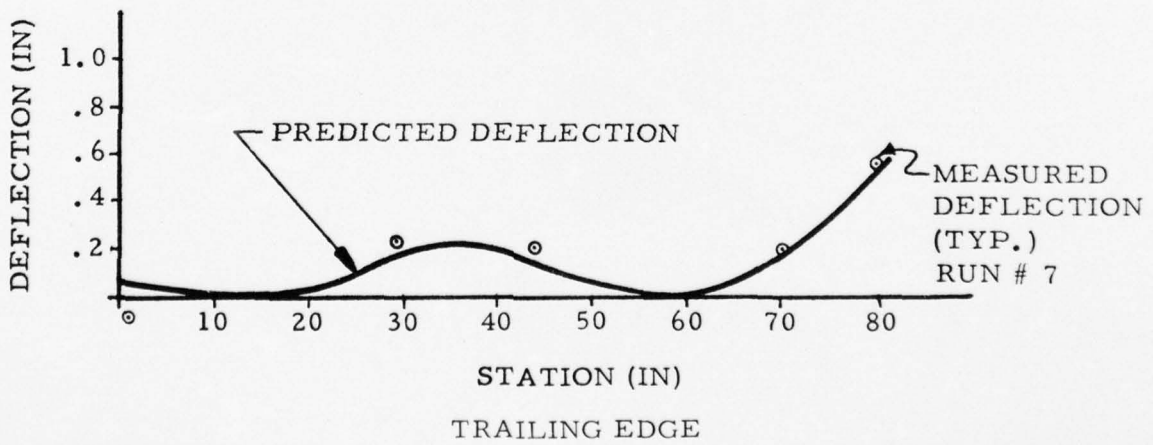
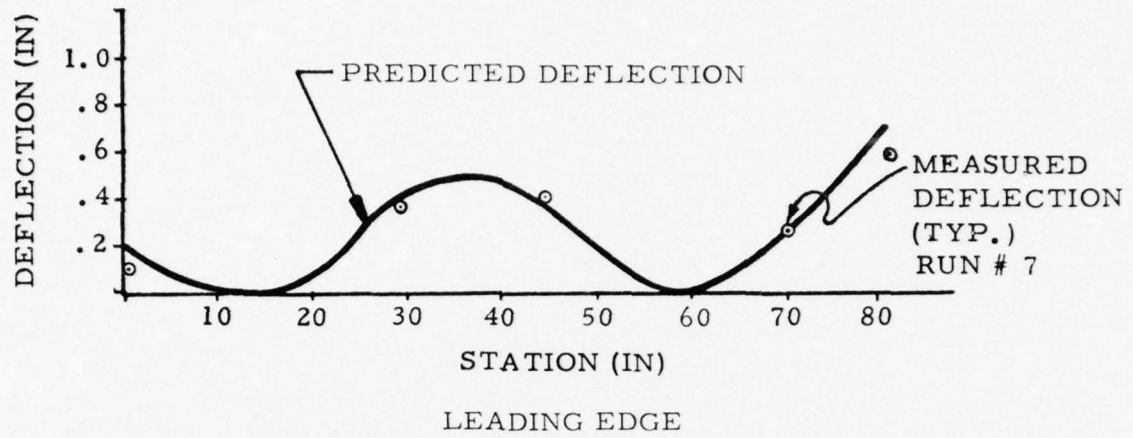


FIGURE 58 MEASURED VERSUS PREDICTED DEFLECTIONS
 STATIC TEST #1 AT 150% DLL

Failure on this spoiler occurred at the same location as in the first spoiler test. All data and measurements taken indicate similarity to test data taken during test number 1. The leading and trailing edge deflected shapes are plotted and compared to the predicted shapes for 150% DLL as shown in Figure 59.

Static Test - Spoiler #3

The test report for static spoiler number 3 is presented in Appendix B. The run sequence for this test is given in Table XXI.

TABLE XXI - STATIC TEST #3 - RUN SEQUENCE

RUN NUMBER	CONDITION	MAX LOAD (% DLL)	REMARKS
1	Opening	40	Check run
2	Opening	115	
3	Opening	150	
4	Closing	40	Check run
5	Closing	100	
6	Closing	150	
7	Closing	177	
8	Closing	160	Lost pads (reworked)
8a	Closing	100	recalibration check
8b	Closing	240	
9	Closing	340	Lost pad - test fixture problems
9a	Closing	160	Test fixture problem
9b	Closing	260	Lost pad (reworked)
9c	Closing	370	Failed at 375% DLL while loading

Failure on the third spoiler occurred in approximately the same location as the first and second spoilers. The recorded data was showing the same similarity as achieved in prior tests. The leading and trailing edge deflected shapes for spoiler number 3 are plotted and compared to predicted shapes for 150% DLL in Figure 60.

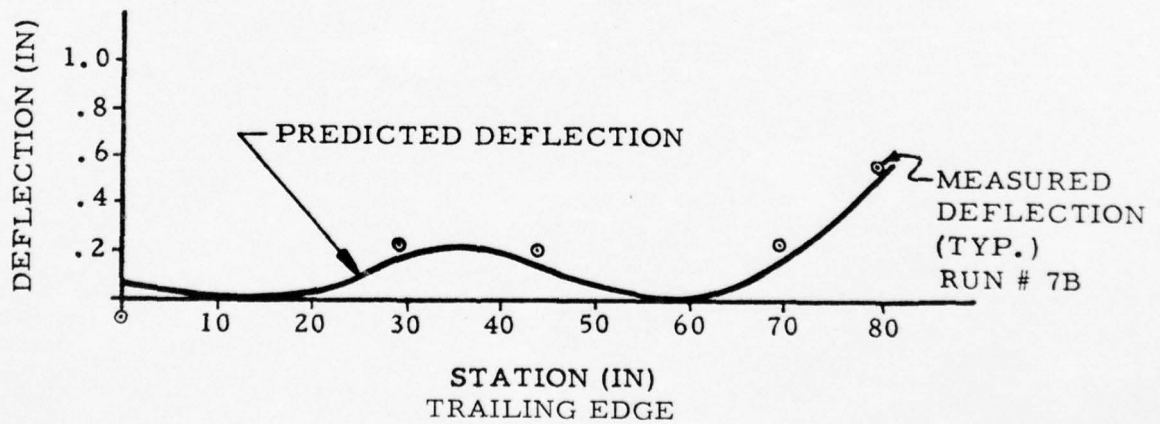
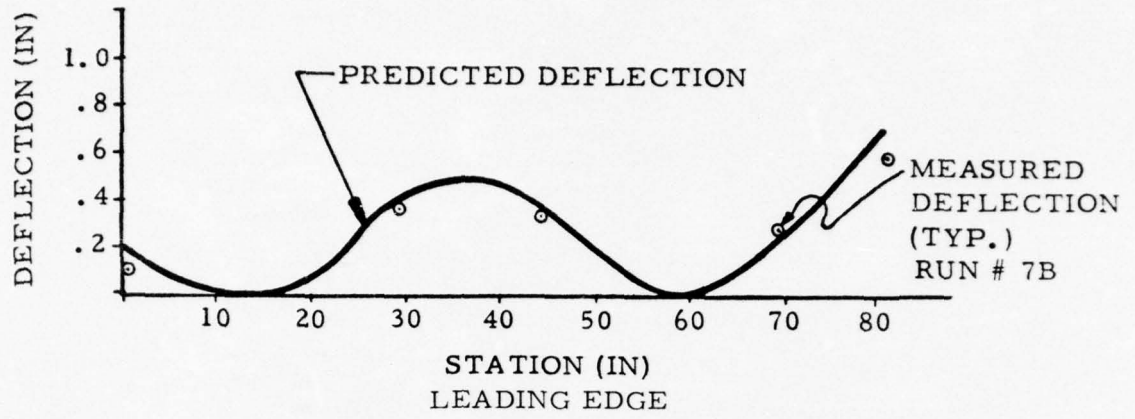


FIGURE 59 MEASURED VERSUS PREDICTED DEFLECTIONS -
 STATIC TEST #2 AT 150% DLL

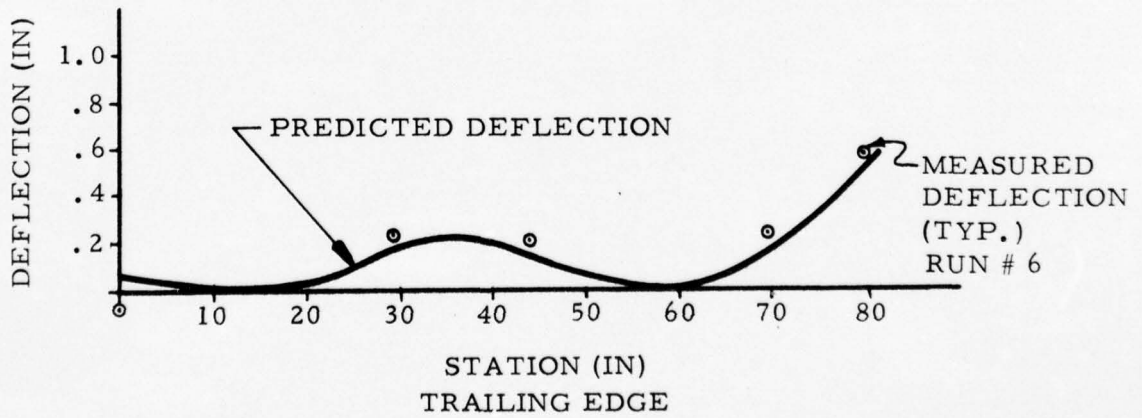
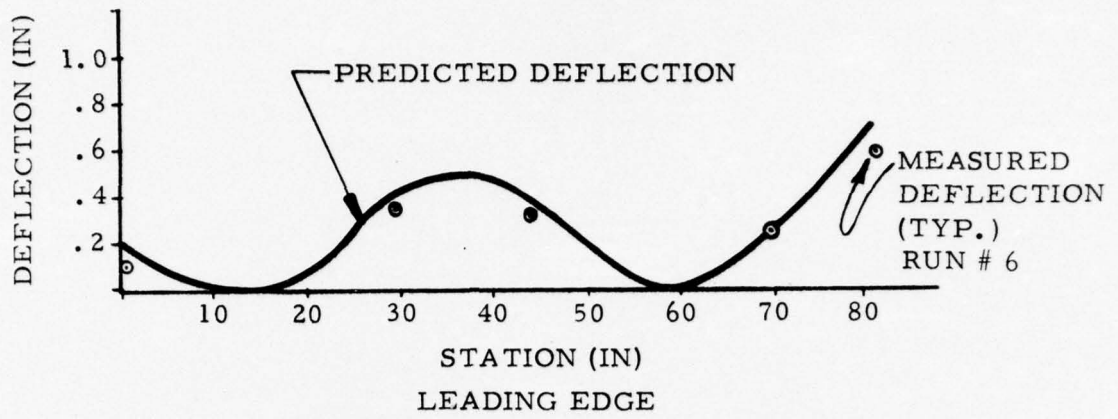


FIGURE 60 MEASURED VERSUS PREDICTED DEFLECTIONS -
 STATIC TEST #3 AT 150% DLL

FATIGUE TEST

One fatigue test article was fabricated in the same manner as the preceding static test components and delivered to NADC for life testing. After successful completion of the required cyclic testing as defined in the test plan additional testing was performed. Table XXII shows the test sequence used. The fatigue test report is presented in Appendix B.

TABLE XXII FATIGUE TEST-RUN SEQUENCE

CONDITION	OPENING LOAD	CLOSING LOAD	LIFETIMES	REMARKS
FATIGUE SPECTRUM	SEE FATIGUE TEST PLAN IN APPENDIX B	SEE FATIGUE TEST PLAN IN APPENDIX B	2	NO DAMAGE
FATIGUE SPECTRUM	150% DLL	177% DLL	2	REPLACED SOME METAL PARTS
STATIC TEST	—	330% DLL	—	FAILURE

The critical strains and deflections were monitored during the fatigue design requirements test and no significant changes were observed. Upon the completion of the fatigue design requirements tests, the test loads were modified to 150% DLL for opening loads and 177% DLL for closing loads and the fatigue test rerun. Damage did occur to both the graphite and metal parts during this modified testing. Details of the damage incurred are in the Fatigue Test Results Report in Appendix B.

After completing the fatigue tests, a static test to failure was accomplished. Failure occurred at 330% DLL; the fracture was similar to the previous static tests. The location of the failure was approximately four inches outboard of the outboard hinge fitting. There was no audible warning prior to failure.

SECTION 5
COST COMPARISONS

INTRODUCTION

Graphite epoxy material is a new material with desirable engineering characteristics for aerospace design. However, a new material not only must have the desired engineering properties, but also must be cost competitive or have lower cost when comparing components fabricated with the new material to metallic components. One of the objectives of this contract was to demonstrate that a graphite epoxy spoiler could be fabricated for lower cost than the semi-monocoque metal spoiler for the production quantity planned. The ground rules by which the cost comparison data was collected are as follows:

- o The graphite epoxy spoiler assembly is interchangeable with the aluminum alloy spoiler assembly - physically and characteristically. The graphite epoxy spoiler can replace a metal spoiler on the airplane without any modification to the aircraft.
- o The hinges for the graphite spoiler are identical to the hinges on the metal spoiler except the attaching bolt holes will be a larger diameter.
- o The cost comparison between the graphite epoxy spoiler and metal spoiler will use the S3A production lots, rates and quantities. Thus, the metal spoiler will be "actuals" for the quantity produced through 1 July 1974 and will insure identical production program.
- o The cost comparison will use constant dollars. The direct labor rates and overheads will be constant during the production period as will the cost of material.
- o The direct labor rates and overheads are calendar 1975 averages as negotiated with Naval Plant Representative Office, Dallas, Texas.
- o The average cost curve for the sheet metal spoiler is based upon the actual cost of the first 53 ship sets of spoiler produced by 1 July 1974. The costs were obtained from VSD's standard cost tracking system. The cost for the remaining spoilers to the 200 unit is predicated from the progress curve determined from these first 53 sets.
- o The cost for the graphite epoxy spoiler will be an estimate for 200 production articles. The estimate was made after the five developmental spoilers had been produced.

COST MONITORING SYSTEM

Standard Cost Monitoring

The cost monitoring system at VSD is designed to fulfill the reporting requirement for Cost Schedule Control Systems Criteria (CSCS). Under this system, the tasks are divided into contractual line items which have cost reporting functions and a Work Breakdown Structure (WBS) per MIL-STD-881. The WBS is further broken down to 5th and 6th levels to provide VSD with details for adequate control. The cost monitoring system which accumulates the desired cost is an Alpha-Numeric code which identifies the contract and WBS level. In addition, each departmental function such as engineering, tooling, materials, manufacturing and quality is identified for each WBS element. The functional cost can be identified for any WBS item which has been coded.

Sheet Metal Spoiler Costs

The sheet metal spoiler is fabricated under a WBS code. The code is for a ship set of spoilers and contains the contract number, line item and departmental functional notation. The charges by departmental elements have been accumulated for fifty-three ship sets of metal spoilers completed by 1 July 1974. The cost for the metal spoiler which is being replaced by the composite spoiler has been estimated by the responsible departments (Manufacturing Controls - Factory, Materials for direct materials, etc.) from the actual data accumulated by WBS code.

The techniques employed by each department are varied, but historically have produced consistent results; therefore, the cost for the metal spoiler is a "best cost estimate" possible from actual data of multiple spoiler components. The estimates were then dollarized in constant 1975 dollars and used to develop the curve in Figure 61.

Sheet Metal Spoiler Cost Drivers

The cost contributors for the sheet metal spoilers are factory labor, raw materials, quality assurance, sustaining tooling, and sustaining engineering. Figure 62 indicates the percentage for each of these elements as a function of quantity of articles. As noted, the primary cost driver is factory labor with raw materials a strong second. Analysis of data shown in Figure 62 indicates that an increase in material cost requires a large decrease in factory labor to maintain cost competitiveness. The cost for the composite

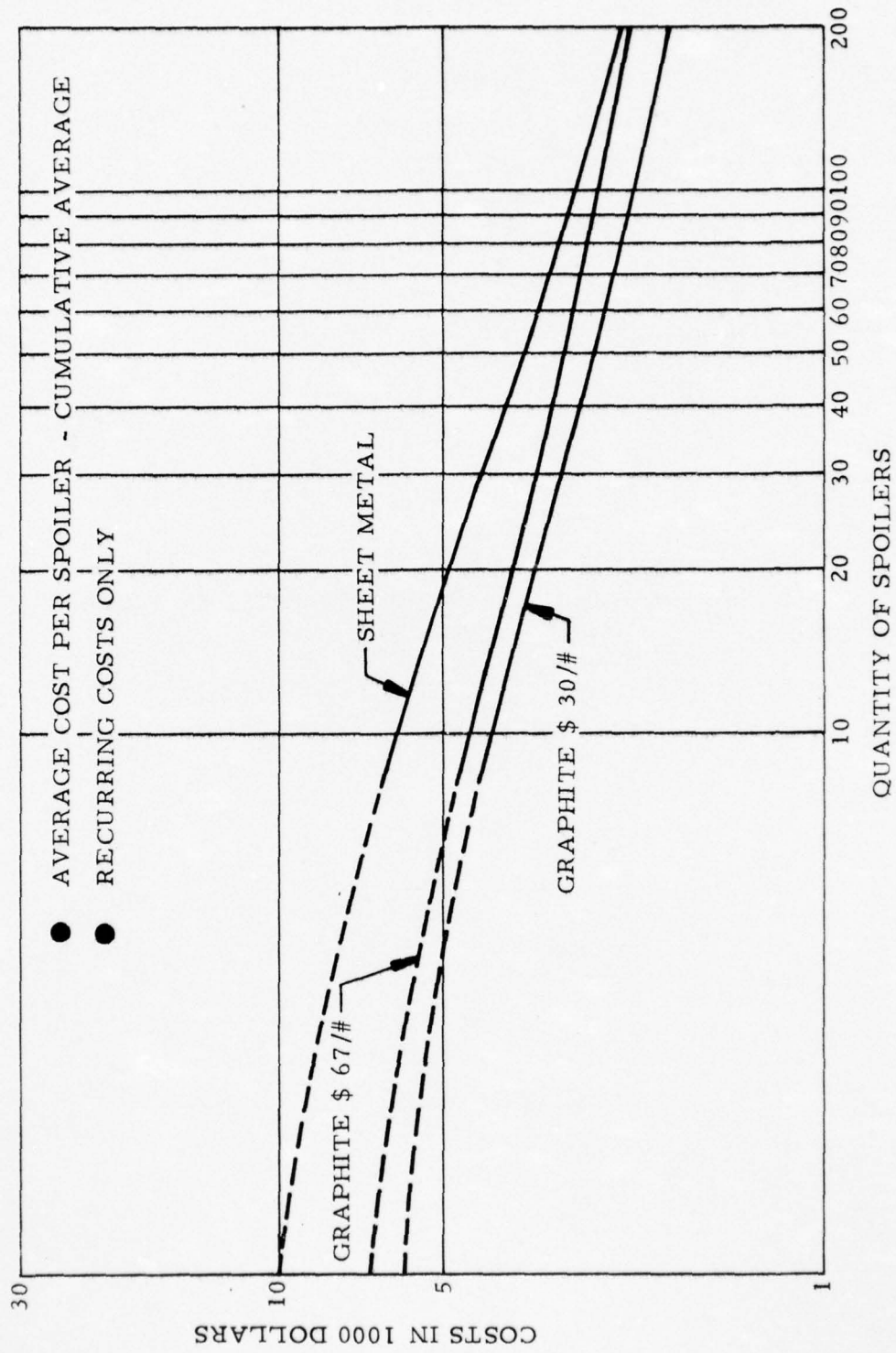


FIGURE 61 COST COMPARISON - METAL VERSUS GRAPHITE / EPOXY SPOILER

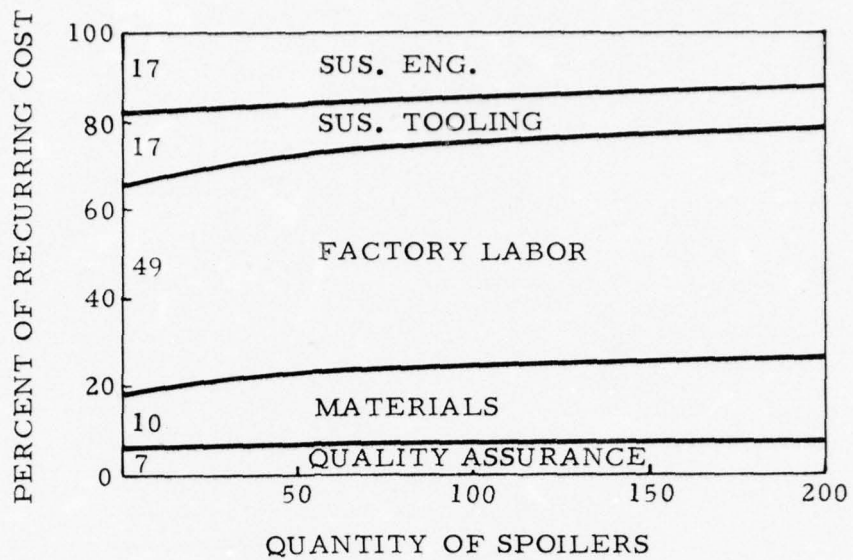


FIGURE 62 PERCENTAGE OF RECURRING COST FOR FUNCTIONAL ELEMENTS - SHEET METAL SPOILERS

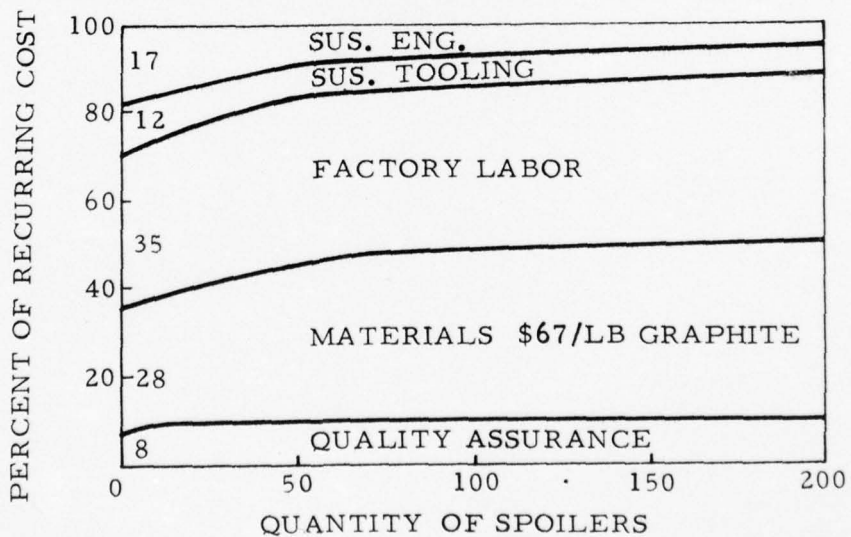


FIGURE 63 PERCENTAGE OF RECURRING COST FOR FUNCTIONAL ELEMENTS - COMPOSITE SPOILER

spoiler reflects a decrease in factory labor, an increase in raw material cost, and shows this spoiler to be cost competitive with the sheet metal spoiler.

Composite Spoiler Costs

The costs for the composite spoiler were estimated after the five developmental spoilers were fabricated. The first five spoilers were used to develop and qualify the process as well as gain some production experience. The departmental estimates were dollarized in constant 1975 dollars and the recurring cost for 200 spoilers is shown in Figure 61.

The cost for the graphite epoxy material for the basic estimate was \$67 per pound. A separate cost estimate was made using an estimate of \$30 per pound for graphite epoxy. This estimate is also shown for reference on Figure 61.

Composite Spoiler Cost Drivers

The cost contributors for the composite spoilers are factory labor, raw materials, quality assurance, sustaining tooling, and sustaining engineering. Figure 63 illustrates the percentages for each of these elements as a function of the quantity of articles. Factory labor is the primary cost driver in the beginning but is replaced by raw materials as the quantity increases. The reason for the reversal of the roles is the progress curve for labor is steeper (faster rate) than the progress curve for materials. The high cost of graphite raw material requires a savings in manhours to offset the material cost delta. Quality requirements for graphite/epoxy structures is more than metal structure for the reasons shown: (1) additional receiving inspection to insure raw material compliance to specification, (2) revalidation testing after 90 days to prolong material shelf life, and (3) the additional quality requirements for bonded structure. With additional experience, the cost for quality assurance will decrease in percentage and approach the requirements of the metallic structure.

COST COMPARISONS GRAPHITE/EPOXY-METAL

Production Program Cost Comparison

The cumulative average cost for the functional elements which comprise the total recurring costs are compared at quantities of 8, 101, and 200 units in Table XXIII. Costs of the sheet metal spoilers are projected from the first 53 ship sets costs and the graphite spoiler costs are projected from the five articles fabricated for this study.

TABLE XXIII - FORMAT FOR COST REPORTING - METAL
VERSUS COMPOSITE PART

Part Number <u>1281384-101</u>		Nomenclature <u>Spoiler</u>				
Nonrecurring		Metal		Composite		
Design Engineering		\$118,486		\$128,104		
Basic Tooling		90,898		63,905		
Total Nonrecurring Costs		\$209,384		\$192,009		
X	Quantity of Spoilers					
	8		101		200	
	Sheet Metal	Composite	Sheet Metal	Com-Posite	Sheet Metal	Composite
Sustaining Engineering	\$ 1,092	\$ 819	\$ 405	\$ 167	\$ 282	\$ 123
Sustaining Tooling	1,089	572	287	190	211	135
Materials	639	1,300	491	992	456	922
Manufacturing	3,209	1,681	1,463	965	1,262	856
Quality Assurance	497	393	189	257	153	240
Average Recurring	\$ 6,526	\$ 4,765	\$2,832	\$2,571	\$2,364	\$2,276
Average Nonrecurring	26,173	24,001	2,073	1,901	1,047	960
Total Manufacturing Cost	\$32,699	\$28,766	\$4,905	\$4,471	\$3,411	\$3,236

Developmental Cost Comparison

The initial five composite spoilers were used to develop and qualify the production process. A cost tracking system was conducted during the development phase to compare the cost of the composite spoiler to the cost of the initial five metal spoilers. This comparison is made in Table XXIV using the labor rates for the development spoiler to establish a common time frame.

Progress Curves

The progress curve or learning curve is applicable on all non-automated production lines. The initial component has the highest cost since the personnel are not familiar with the details of the component, the production process, or the tools. After the first operation is complete, the operators gain confidence and begin to reduce the manhours required to complete the

TABLE XXIV - COST COMPARISON OF FIRST FIVE SPOILERS

FUNCTIONAL COST ELEMENTS	S-3A COMPOSITE SPOILERS 5 DEVELOPMENTAL SPOILERS					S-3A METAL SPOILERS INITIAL 5 SPOILERS					
	Non recurring	Unit No.				Non recurring	Unit No.				
		1	2	3	4		5	1	2	3	4
Engineering Manhours Departmental Costs (\$)	6,118 111,321	40 712	42 748	32 571	32 571	28 500	86 1,565	72 1,308	60 1,092	46 836	48 873
Manufacturing Engr. Manhours Departmental Costs (\$)	2,294 44,988	40 766	46 881	40 766	36 690	31 594	78 1,513	68 1,320	68 1,320	44 854	58 1,126
Manufacturing Manhours Departmental Costs (\$)	* 1,721 33,108	143 2751	126 2423	106 2038	107 2058	92 1769	290 5,512	245 4,656	220 4,181	205 3896	185 3516
Quality Assurance Manhours Departmental Costs (\$)	310 7,020	35 793	38 861	31 702	32 725	31 702	50 1,136	45 1,024	43 979	41 932	39 887
Materials Manhours Direct Materials (\$) Departmental Costs (\$)	31 6,303 7,511	5 1147 1357	6 1212 1446	6 1272 1446	6 1212 1446	6 1212 1446	3 571 681	3 571 681	3 571 681	3 571 681	3 571 681
Manufacturing Costs (\$)	203,948	6379	6359	5523	5490	5011	10,407	8989	8253	7199	7083

NOTES: Nonrecurring costs here do not match those shown in Table XXIII for the following reasons:

1. Labor and overhead rates for the first five composite spoilers shown in this table are actuals accumulated during the current contract (For comparison purposes the five metal spoilers were calculated using the same rates). The labor and overhead rates for projected quantities of metal and composite spoilers in Table XXIII are projected 1975 labor and overhead rates.
 2. "One time" only costs for materials and process development are included in the nonrecurring costs for the five composite spoilers. This is not included in the projected nonrecurring costs in the Table XXIII.
- * Cost of test specimens is included in composite nonrecurring; is not in metal nonrecurring

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S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM, VOLUME 1.(U)

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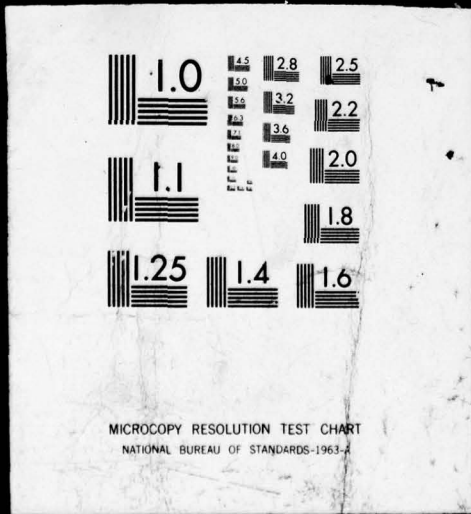


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required processes. In addition, the production lot sizes may increase which permits amortizing the tool setup time over more articles and further reduce the time per part. In any event, the reduction of time with each succeeding article has been described as learning curves, or progress curves. Factory labor is measured by progress curves, and raw materials are purchased to a curve which is usually the result of purchases of large quantities of materials and reduced packaging. The learning curves for these important cost drivers are further explained in succeeding paragraphs.

PROGRESS CURVES

Factory Labor

Factory labor is a key cost contributor as noted in Figures 62 and 63. The initial components require more manhours than subsequent units. The degree of improvement is a function of the skills of the craftsman, familiarity with the manufacturing process, number of operations - by hand and by machine, design complexity, producibility changes to reduce factory labor, lot sizes, production rate, and similar factors.

The factory labor progress curve for the sheet metal spoiler approximates an 84% slope and is predicated upon the data acquired during the fabrication of the first 53 sets. An 84% learning factor reflects less improvement than the 80% which would normally be expected for a sheet metal assembly. This is primarily due to the complex sheet metal assembly which has many detail parts and is difficult to assemble. The complexity of the assembly does not lend itself to efficient production procedures.

The factory labor progress curve for the graphite assembly is on an 87% slope. This is based upon the data from the fabrication of the first five graphite spoilers. This slower progress rate is in a large part due to factors inherent in the bonding process, which do not lend themselves to a decrease in cycle time. These include the lay-up, bagging and autoclave operations. Lay-up and bagging (applying the vacuum barrier materials to the mold) are hand operations and the curing cycle is a fixed time element.

Raw Materials

The progress curve for both the sheet metal and composite raw materials is 92%. This 92% curve is historical for aluminum structure at VSD, and the same curve was selected for graphite epoxy. Material costs are constant

for the first five graphite spoilers because the material was procured in one buy. Cost decrease will be reflected in succeeding lots as the quantity of material procured is increased. The curve for graphite may become a steeper curve as additional manufacturing capacity is added by the raw material fabricators. However, since the estimate was made using constant 1975 dollars, the 92% progress curve was employed.

Trade Studies

Several trade studies were conducted to determine the impact on cost for the composite spoiler. Since factory labor and raw material are the primary cost contributors for 200 units, these factors were analyzed to determine the impact on manufacturing cost for 200 articles should the other cost elements remain constant.

The study for factory labor with all other cost elements constant is graphically shown by Figure 64. Basically, an increase or decrease of 10% in factory labor will change the manufacturing cost for the composite spoiler by +3.8%.

The study for raw material with all other cost elements constant is graphically shown on Figure 65. An increase or decrease in cost of raw materials by 10% will result in a change of the manufacturing cost for the composite spoiler by + 4.1%.

Composite Raw Material

The effect of a changing total material cost has been described previously. However, a study was conducted to determine the impact of changing the cost of graphite epoxy. For the basic study, graphite epoxy raw material cost was priced to VSD at \$67 per pound. Since demand and production capacity are expected to increase, the manufacturers of graphite/epoxy materials are projecting significant price reductions. A material cost of \$30 per pound was selected for the graphite/epoxy cost; the cost for the remaining materials were kept constant. As a result, the raw material was reduced by approximately 35%. This reduction in raw material will reduce the cost for 200 spoilers by 14%. The cost curve for composite spoiler with \$30 per pound graphite epoxy material is shown on Figure 61.

Core Material

The core for the spoilers is Hexcel's "HRP" core. This core was selected to

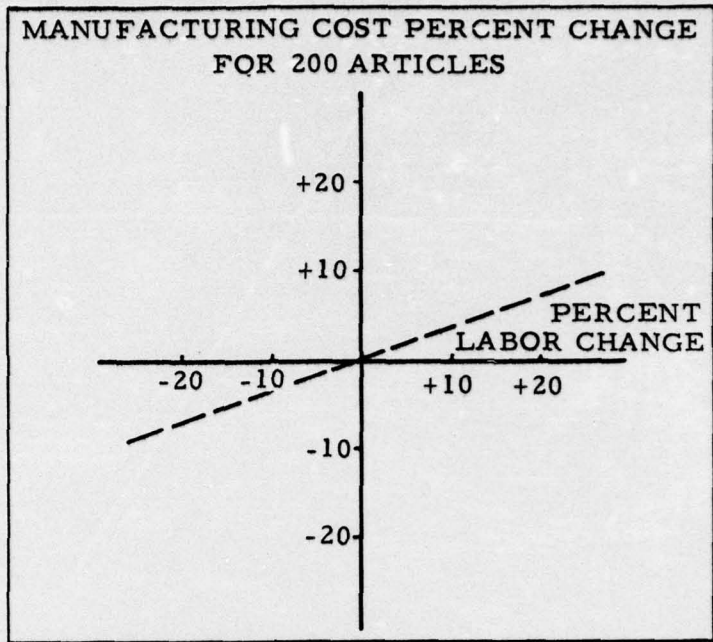


FIGURE 64 EFFECT OF LABOR ON
COMPOSITE SPOILER MANUFACTURING COST

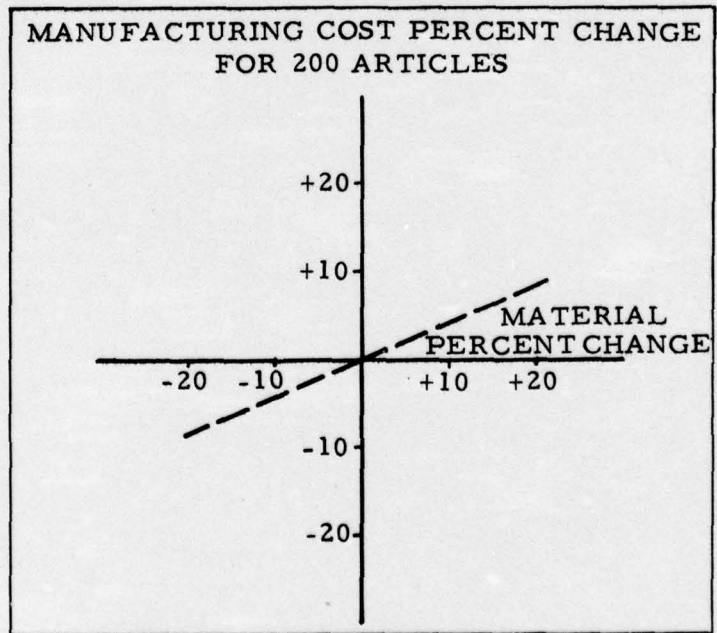


FIGURE 65 EFFECT OF MATERIAL ON
COMPOSITE SPOILER MANUFACTURING COST

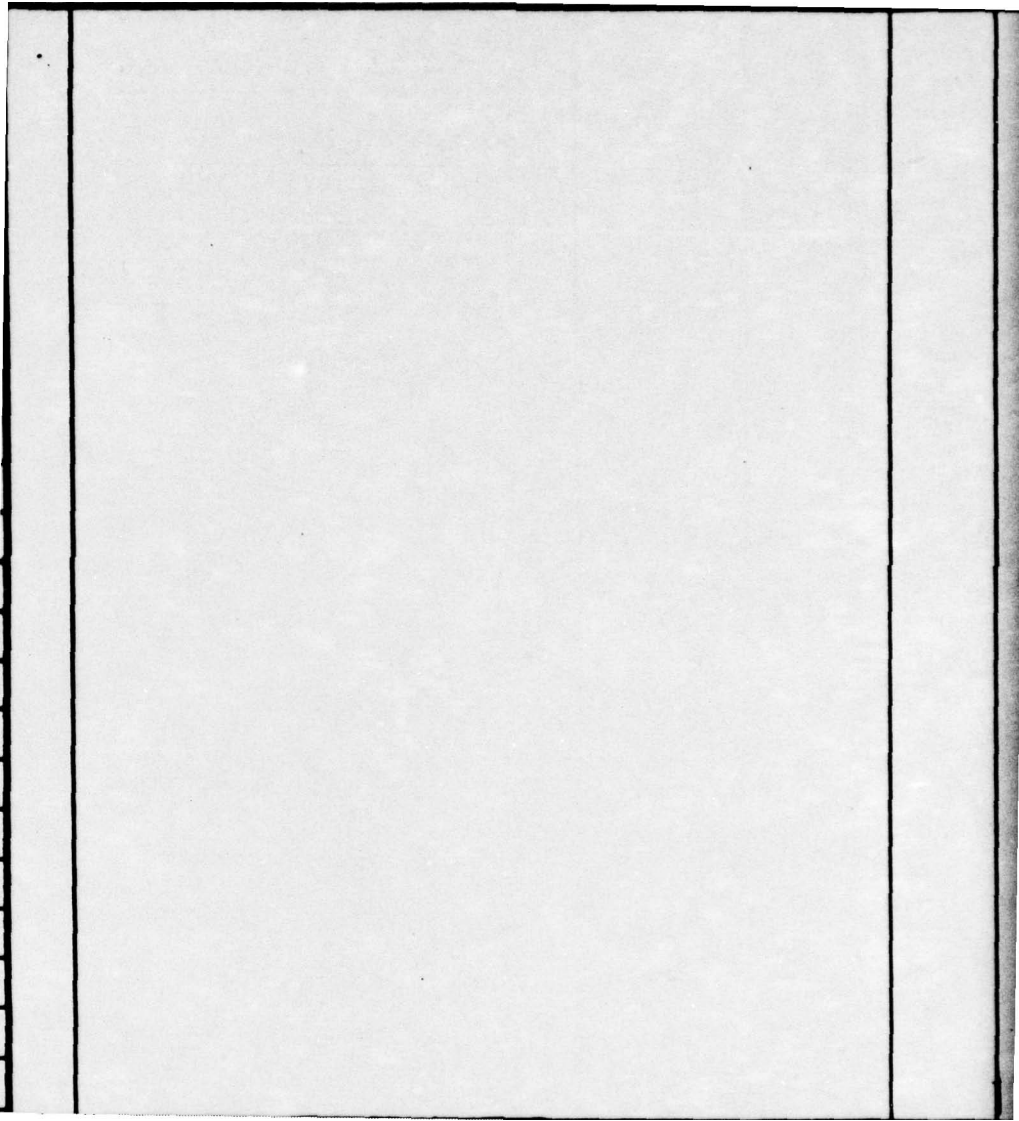
eliminate the corrosion interface with the graphite/epoxy; however, the "HRP" core is more costly than aluminum alloy core. A study was made to determine the initial cost savings possible for 200 spoilers if the aluminum core had been specified. The material cost would be 11% less when aluminum alloy core is specified. The 11% reduction in material costs for 200 articles will reduce the manufacturing cost approximately 4.5%.

APPENDIX A

ENGINEERING DRAWINGS

This appendix contains the following S-3A composite spoiler drawings and the tool drawings from which the parts were fabricated.

- o 78-002553 - Flap S-3A Spoiler Lower Outer Panel Advanced Composites
- o 78-002554 - Core Assembly S-3A Outer Panel Lower Spoiler Advanced Composites
- o S/N 405011 - 082 - 78-002553 Bonding Mold



RLSE AUTH 10261.2

A
REMOVED -3, -4, -5, -6
REVISED & RENUMBERED NOTES.
REMOVED ALL 4.0" CORE
REVISED STOCK SIZE & WT. OF -2
ADDED NOTES 6&7
ADDED M3

DWG BY:
S.E. Wood
GROUP
S.E. Wood
STR.
MFG/R40
BLOSSER
PROJ.
S.E. Wood

FIGURE A-1
CORE ASSEMBLY
S-3A OUTER PANEL LOWER SPOILER
PAGE 1 OF 4



BW Staff	9-27-70
BLOSSER	20 SEPT 73
S.E. Wood	9/20/73

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LTV AEROSPACE CORPORATION
P O BOX 5907 DALLAS, TEXAS 75222

NOTES:

1. HONEYCOMB CORE $\frac{3}{16}$ - 5.5" CVA207-8-411 CLASS I, TYPE I GR
2. CORE SPLICE FOAM ADHESIVE VSD 207-8-408 TYPE I
3. FOR CONTOURS SEE 78-002553
4. CORE SPLICE APPLY & CURE VSD 207-8-408 (TYPE III) FC
5. TOLERANCE ON CORE THICKNESS $\pm .008$, ON TRIM $\pm .03$, (
6. DIP PERIPHERY EDGES OF CORE IN SC1008 PHE
7. PHENOLIC RESIN SC1008 MONSANTO CHEMICAL

CONTR NO.

N62269-73-C-0610

VOUGHT AERONAUT
A Division of LTV Aero
P.O. BOX 5907 - DALL

ASSI, TYPE I GRADE 5.5
-8-408 TYPE III

B-408 (TYPE III) FOAM PER VSD 208-8-12
TRIM $\pm .03$, ON ANGLES $\pm 30^\circ$

SC 1008 PHENOLIC RESIN PER 208-7-18
D CHEMICAL CO. SEATTLE, WASH.

QTY REQD PER DASH NUMBER										ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
											AR		PHENOLIC RES
											AR		CORE SPLICE FILM ADHES
												-2	CORE
												-1	CORE AS

LIST OF MATERIAL

	PHENOLIC RESIN			M3		~
	CORE SPLICE FILM ADHESIVE			M2		.07
	CORE	.93x12.0x85.0		M1		1.93 A
	CORE ASSY					2.00 A
NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE			UNIT WT	REV SYM
MATERIAL						

18

17

16

15

14

DWRS
STA
1100

F

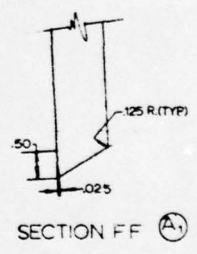
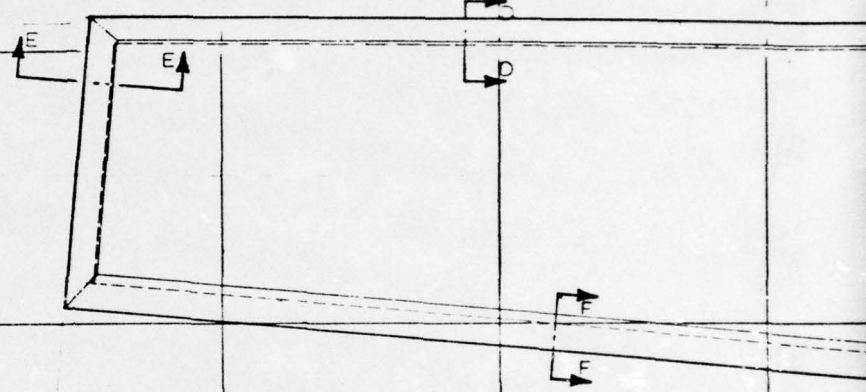
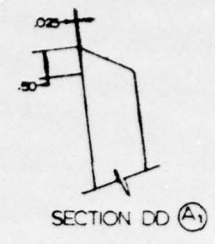
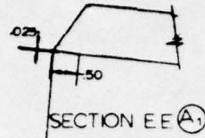
E

D

C

B

A



14

13

12

11

10

9

2

OWRS
STA
110.0

OWRS
STA
100.00

OWRS
STA
90.00

1.E6

C

B

1.A5 B

CORE

80378 78-C02554

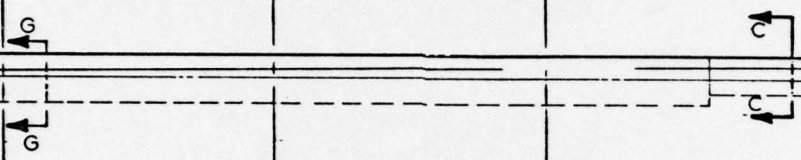
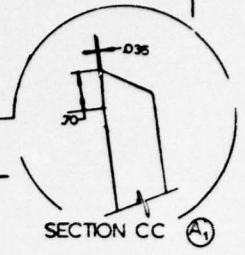
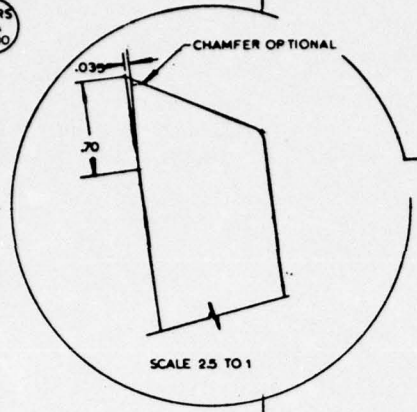
8 1

3

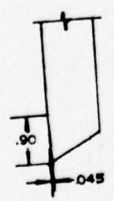
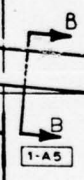
OWRS STA 80.00

OWRS STA 70.00

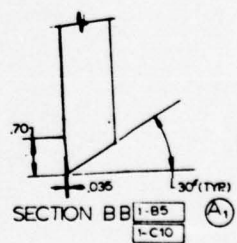
OWRS STA 60.00



CORE SPLICE PERMITTED THIS AREA ONLY BETWEEN
OWRS STA 65.0 TO OWRS STA 95.0 (A1)



SECTION GG (A1)
1-C8
1-E8 ROTATED 180°



5

REVISIONS				REVISIONS			
ZONE	LTR	DESCRIPTION	DATE	APPROVED	ZONE	LTR	DESCRIPTION
							RELEASE AUTHORITY 10261
	A	RELEASE AUTHORITY 10261 & 1. REVISED FOLLOWING SECTION DIMENSIONS: SECTION (NOW) (WAS) AA 035x70 045x100 BB 035x70 045x100 CC 035x70 045x100 DD 025x50 035x70 EE 025x50 035x70 FF 025x50 035x70 GG 045x90 055x120 2. CORRECTED PLAN VIEW TO AGREE WITH SECTION CHANGES. 3. REMOVED 3-4-5-6 FROM FID 4. ADDED CORE SPLICE NOTE TO FID					DWG BY GROUP DATE MFG. R&C DRAWN PROJ. OFF.
	BB						
	B	RELEASE AUTHORITY 10261 & 1. REVISED PERIPHERAL TYP OF -1 & 2 CORE 2. ADDED .75 NOTE & TYP*					DRAWN BY DATE GROUP DATE MFG. R&C DRAWN PROJ. OFF.
	BT						
	DI						

F
E
D
C
B
A

FIGURE A-1 (CONT'D) PAGE 4 OF 4

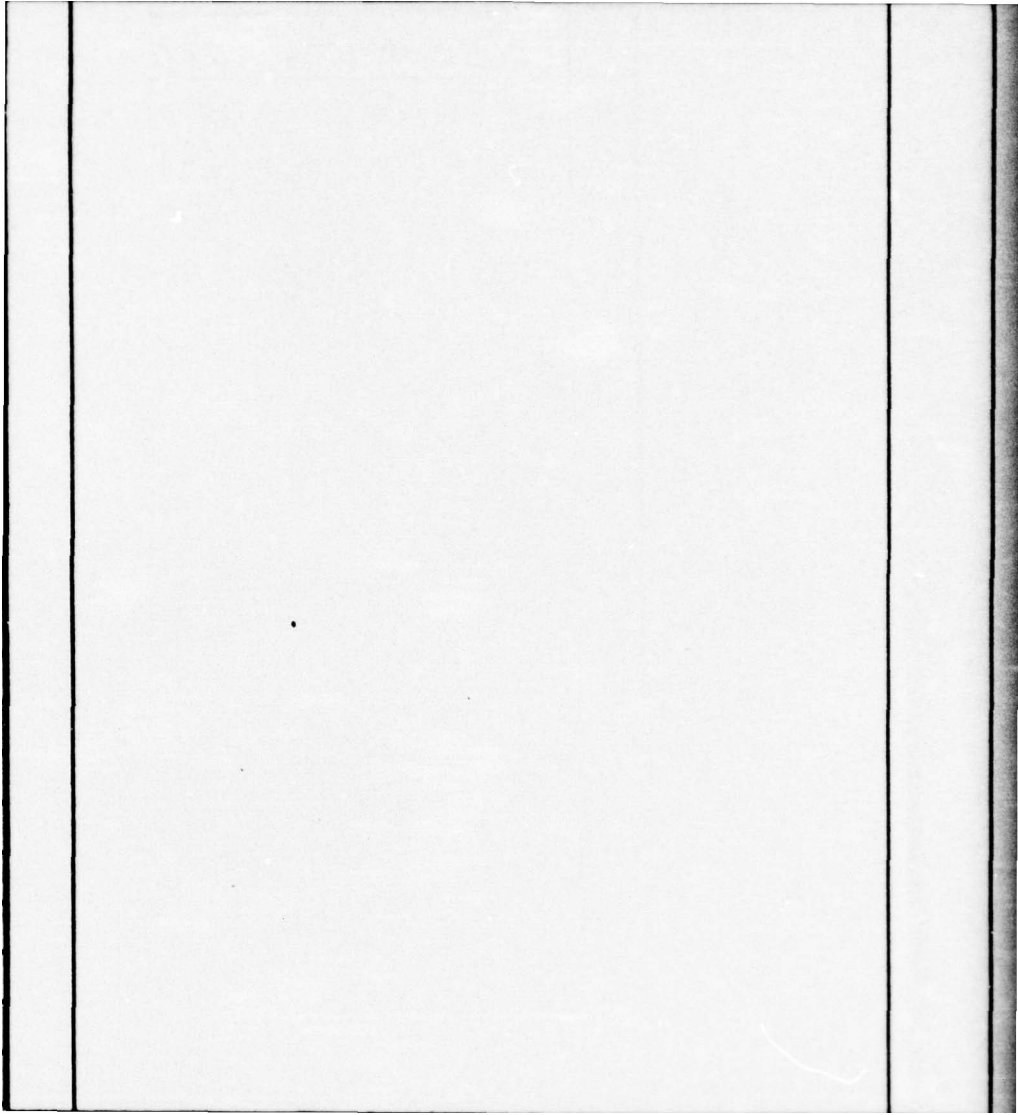
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	



48300 BT

REVISION STATUS OF SHEETS UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. DIMENSIONED FEATURES ARE UNLESS OTHERWISE SPECIFIED. LINEAR .010 .030 HOLE .03 .030 X - .03 TO FRAMES FOR UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE FROM CENTER LINE OF DIMENSIONED FEATURES. DIMENSION GROUP NAME: COMPOSITES		CONTR NO. PREPARED: J MADON N 073 CHECKED: J MADON N 073 GROUP: J MADON N 073 STAFF: J MADON N 073 PROJ. ENGR: J MADON N 073	SEE SEPARATE PARTS LIST CORE ASSY S-3A O P LWR SPOILER ADVANCED COMPOSITES SIZE: J 80378 CODE ORIENT NO: 78-002554 DRAWING NO: 78-002554 SCALE: FULL REV. DATE: B SHEET: 1
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	---------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

035
AA (A)



RLSE AUTH 10261.2

A. RELEASE AUTHORITY 10261.4
SHT.4 REVISED WT. ON -1,-3,-4,-5,-7,-8,-9,-10,-11
" MATL SIZE ON -5,-7,-8,-9,-10,-11
SHEET 3 ADDED NOTE 24

DWG BY
J.E. MADORIN
GICU
J.E. Madorin
S-3A Spoiler Lwr.
MFG RLD
BLOSSER
PROJ.
J.E. Madorin

FIGURE A-2
FLAP
S-3A SPOILER LOWER
PAGE 1 OF 11



MFG. 1412	BLOSSER	20 SEPT 73
PROJ ENGR	J.E. Madorin	9/20/73
STR DSGN	J.E. Madorin	9/19/73
GROUP	MADORIN	9/19/73
CHK/BY	J.E. Madorin	9/19/73
DRAWN BY	MADORIN	9/19/73
ENGRG UNIT NO.	2-51640	

VOUGHT AERONAUTICS DIVISION
LTV AEROSPACE CORPORATION
P O BOX 5907 DALLAS, TEXAS 75222

FLAP
S-3A SPOILER LWR. O.P.
ADVANCED COMPOSITES

1. L.H. PART ONLY SHOWN
2. GRAPHITE FILAMENT TAPE EPOXY RESIN IMPREGNATED VSD
3. FILM ADHESIVE VSD 207-8-415 TYPE II GRADE 10 (REQUEST ME
THIS PROGRAM
4. HONEYCOMB CORE 3/16 - 5.5* CVA 207-8-411 CLASS 1 TYPE I GRADE
5. SEALANT CVA 6-579
6. EPOXY ADHESIVE CVA 8-405 TYPE VI
- 7.
8. ALUMINUM SCREEN 5052-0 120 MESH (.004 WIRE DIA.) M
FROM PACIFIC WIRE WORKS INC.
9. PROCESS COMPOSITE EPOXY RESIN IMPREGNATED MATL PER
10. APPLY VSD 207-8-415 TYPE II GRADE 10 PER VSD 208-8-
- 11.
12. POT INSERTS WITH CVA 8-405 TYPE VI PER CVA 8-260
13. APPLY FAYING SURFACE SEAL (CVA 6-579) PER CVA 6-177(I)
14. COAT EXPOSED HONEYCOMB WITH CVA 6-579 SEALANT PER
15. CLEAN SCREEN PER CVA 8-51 METHOD II PRIOR TO LAYUP
16. APPLY FILLER TO EXTERIOR SURFACE PER LCP 78-2055
EPOXY FILLER EPS 37.7250. (IF REQD. FOR SMOOTHING
17. APPLY ANTI-STATIC COATING (CONDUCTIVE MATL EPS 3
37.7272) TO EXTERIOR SURFACE PER PB 78-529 AND ONE
MIL-C-23377 EPOXY PRIMER PER PB 78-509.
18. NDT INSPECT FOR STRUCTURAL SOUNDNESS.
19. MAKE FROM MIL-P-15035 LAMINATED PLASTIC TY
20. CPC PAGE 10 B 8 HUCK MFG. CO. DETROIT MICHIGAN.

UNATED VSD 207-8-410/1
 (REQUEST METAL BOND M-III 3 FOR
 THIS PROGRAM)
 TYPE I GRADE 5.5

WIRE DIA.) MAY BE PURCHASED

D MATL PER VSD 208-8-3
 SD 208-8-3

8-260

A6-177(i)

EALANT PER CVA 8-39(i)

R. TO LAYUP

LCP 78-2059 TYPE I UTILIZING
 SMOOTHNESS)

MATL EPS 37.7270, 37.7274,

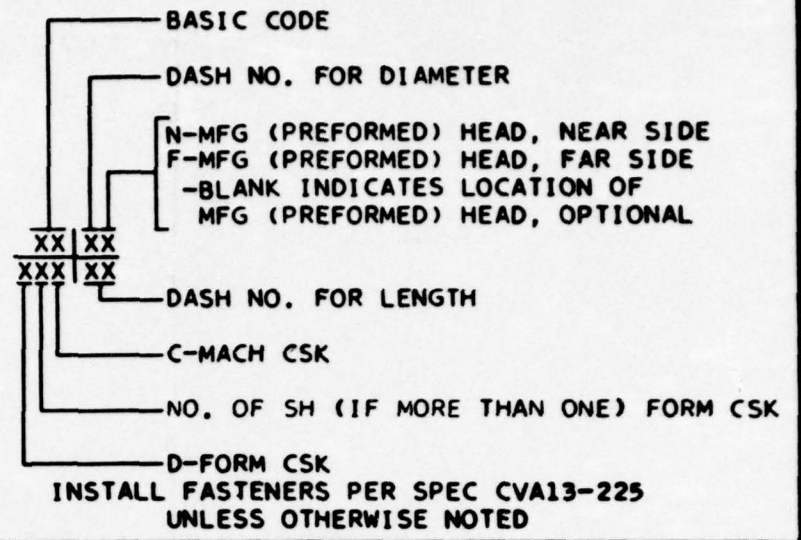
S AND ONE COAT OF
 509.

ESS.

PLASTIC TYPE FBG

MICHIGAN.

NAS 523 RIVET CODE



BASIC CODES

FIGURE A-2 (CONT'D) PAGE 2 OF 11

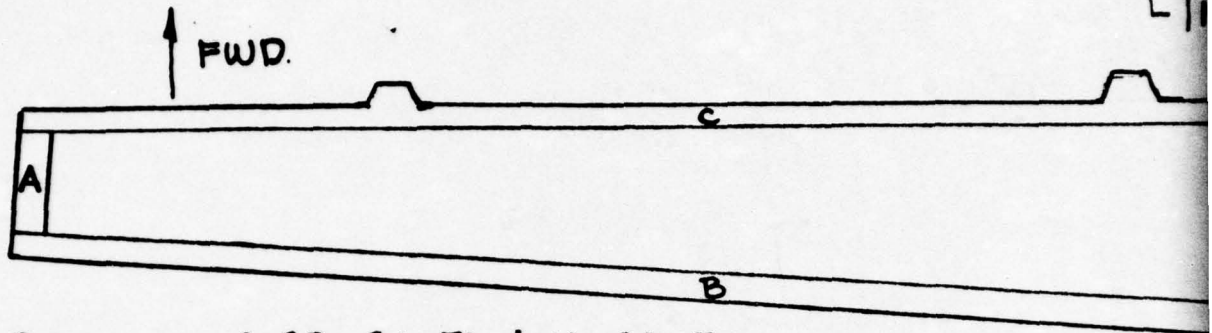
CONTRACT NUMBER

LTV VOUGHT AERONAUTICS DIVISION
 LING-TEMCO-VOUGHT, INC. P.O. BOX 5907 DALLAS, TEXAS 75222

CODE IDENT NO. 80378	SIZE B	PL78-002553	
SCALE NONE	REV SYM	A 95	SHEET 2

21. PLY NUMBER IDENTIFICATION CODE

EXAMPLE :



22. SHUR-LOK CORP SANTA ANA, CALIF.

23. AFTER INSTL. TOUCH UP PER PB 78-510 (IF REQD.)

24. THE FOLLOWING PARTS ENCLOSED IN () ARE IDENTICAL IN C

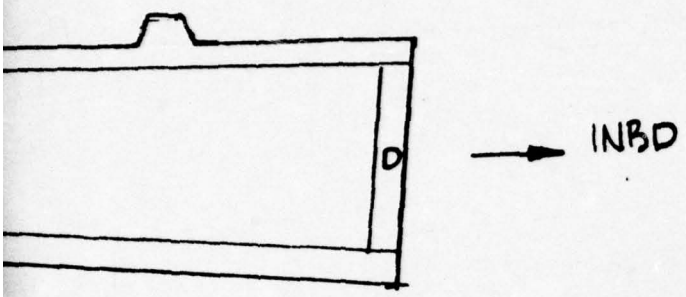
- | | | |
|----------|----------|-----------|
| (-8P12A) | (-9P10B) | (-10P12D) |
| (-8P13A) | (-9P11B) | (-10P13D) |
| (-8P14A) | (-9P12B) | (-10P14D) |
| (-8P15A) | (-9P13B) | (-10P15D) |
| | (-9P14B) | (-10P16D) |
| | (-9P15B) | (-10P17D) |

CONTR NO.

N2269-73-C-0610

VOUGHT AERON
A Division of LTV
P.O. BOX 5907 - E

BASIC PART NO.
 AREA OF DWG WHERE PART LOCATED
 5 P 10 B
 INDIVIDUAL PLY IDENT. NO.



IDENTICAL IN OUTLINE AND DIFFER ONLY IN PLY ORIENTATION.

- P 12 D) (-11 P 10 C)
- P 13 D) (-11 P 11 C)
- P 14 D) (-11 P 12 C)
- P 15 D) (-11 P 13 C)
- P 16 D) (-11 P 14 C)
- P 17 D) (-11 P 15 C)

					1					4-A6		-14	CORE OUTBD	
						1				4-C6		-13	CORE INBD	
									1	2-B7		-12	SEAL	
									1	2-E12		-11	DOUBLER	
									1	2-B18		-10	DOUBLER	
									1	2-B9		-9	DOUBLER	
									1	2-D1		-8	DOUBLER	
									1	2-B5		-7	SKIN LWR	
												-6	UNASSIGN	
							1			1-B8		-5	SKIN UP	
									1	1-B8		-4	SKIN ASSY	
									1	2-B12		-3	SKIN ASSY	
												-2	UNASSIGN	
										1-B8		-1	FLAP ASSY	
						-23	-22	-4	-3	-1	ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
QTY REQD PER DASH NUMBER														

LIST OF MATERIAL

USED ON	QTY REQD FINAL ASSY	NEXT ASSY	FROM	THRU	MATERIAL	SPECIFICATION
	TEST ONLY.				M1 NOTE 2	
					M2 NOTE 19	
					M3 NOTE 4	
					M4 NOTE 8	
					M5 NOTE 3	
					M6 NOTE 5	
					M7 NOTE 6	
					M9 NOTE 16	

2

CORE OUTBD ACT	.93x5.8x3.2	M3			.01	
CORE INBD ACT	.93x5.8x3.2	M3			.01	
SEAL	.20x2.2x85.0	M2			1.27	
DOUBLER	870 IN ²	M1			.25	A
DOUBLER	112 IN ²	M1			.01	A
DOUBLER	740 IN ²	M1			.21	A
DOUBLER	58 IN ²	M1			.02	A
SKIN LWR	6100 IN ²	M1	21		1.76	A
UNASSIGNED						
SKIN UPR	7200 IN ²	M1			2.10	A
SKIN ASSY UPR					2.19	A
SKIN ASSY LWR					2.50	A
UNASSIGNED						
FLAP ASSY			FI	16,17,18	12.27	A
NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE			UNIT WT	REV SYM	

MATERIAL

SPECIFICATION	PROTECTIVE FINISH				
	FI	NOTE 17			
			CONTRACT NUMBER N62269-73-C-0610		
VOUGHT AERONAUTICS DIVISION LTV AEROSPACE CORPORATION P O BOX 5907 DALLAS, TEXAS 75222					
CODE IDENT NO. 80378		SIZE B	PL 78-002553		
SCALE NONE	REV SYM	A 97	SHEET	4	

2

TAB ASSY OUTBD			18	.02	
TAB ASSY INBD			18	.02	
SCREEN		M4	8, 15, 16	.25	
DOUBLER INBD ACT	120 IN ²	MI		.04	
DOUBLER OUTBD ACT	172 IN ²	MI		.05	
SHIM INBD ACT	.062 x 2.6 x 9.4		23	MIL-5-22499 COMPI TYPE I	.05
SHIM OUTBD ACT	.062 x 3.0 x 5.8		23	MIL-5-22499 COMPI TYPE I	.03
SKIN OUTBD TAB	26 IN ²	MI			.01
SKIN INBD TAB	26 IN ²	MI			.01

NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE	UNIT WT	REV SYM
-----------------------------	------------------	---------	---------

SPECIFICATION		PROTECTIVE FINISH							
<p style="text-align: center;">CONTRACT NUMBER N2269-73-C-0610</p> <p style="text-align: center;">VOUGHT AERONAUTICS DIVISION LTV AEROSPACE CORPORATION P O BOX 5907 DALLAS TEXAS 75222</p> <table border="1" style="width: 100%;"> <tr> <td style="width: 50%;"> CODE IDENT NO. 80378 </td> <td style="width: 10%;"> SIZE B </td> <td style="width: 40%;"> PL 78-002553 </td> </tr> <tr> <td>SCALE NONE</td> <td>REV SYM</td> <td>A 98</td> </tr> </table>				CODE IDENT NO. 80378	SIZE B	PL 78-002553	SCALE NONE	REV SYM	A 98
CODE IDENT NO. 80378	SIZE B	PL 78-002553							
SCALE NONE	REV SYM	A 98							
		SHEET	5						

FIGURE A-2 (CONT'D) PAGE 5 OF 11

FILM ADHESIVE		M5			.70	
RIVET				20	.03	
INSERT					.11	
BOLTS					.18	
HINGE				15	.94	
HINGE				15	1.46	
CORE ASSY					2.00	A

NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE	UNIT WT	REV SYM
-----------------------------	------------------	---------	---------

MATERIAL	
SPECIFICATION	PROTECTIVE FINISH
CONTRACT NUMBER N62269-73-C-0610	
VOUGHT AERONAUTICS DIVISION LTV AEROSPACE CORPORATION P O BOX 5907 DALLAS TEXAS 75222	
CODE IDENT NO. 80378	SIZE B
SCALE NONE	REV SYM A 99
	SHEET 6

FIGURE A-2 (CONT'D) PAGE 6 OF 11

								EPOXY FILLER
-23	-22	-4	-3	-1	ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
DASH NUMBER								

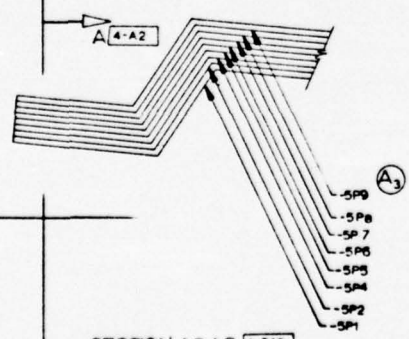
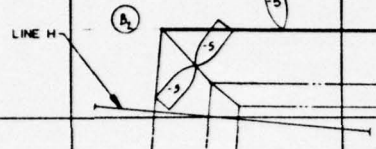
F
E
D
C
B
A

OWRS STA 12000

OWRS STA 11000

OWRS BL 0.00

OWRS BL 15.00



SECTION AC AC 1-D18
SECTION OF -5 ONLY (NO SCALE)

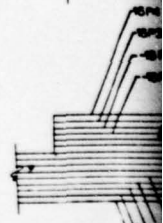
M 78-002554 CORE B1

A3

1-A14 AB

-19

-15



SECTION AB AB 1-DM
SECTION OF UPR SKIN & DOUBLERS ONLY (NO SCALE)



2

OWRS STA 101.45
OWRS STA 100.00
128508-101 HNGE
OWRS STA 101.450
OWRS BL. 1.100
OWRS WL. -3.029

OWRS STA 80.00

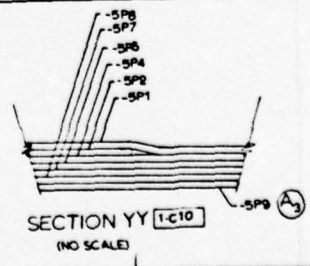
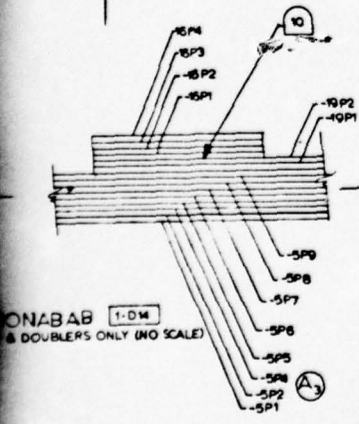
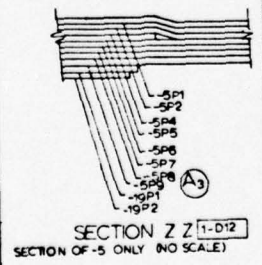
OWRS STA 80.00

M 78-002454 CORE (B)

(19) DOUBLER OUTB ACT



NA56304U3 BOLTS(6 RECD)



CODE IDENT NO	DRAWING NO	LN	BT
80378	78-002454	B	1

3

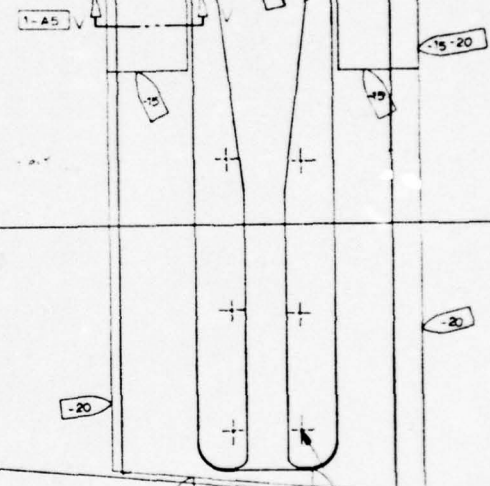
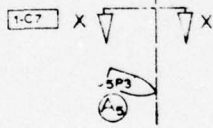
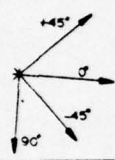
OWRS STA 80.00

OWRS STA 70.00

OWRS STA 60.00

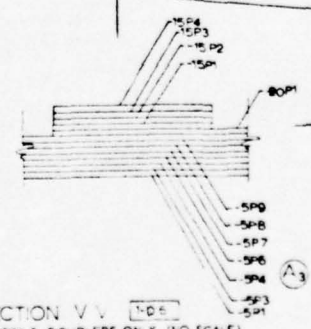
OWRS STA 57.33

1281907-101 HINGE
OWRS STA 57.330
OWRS BL 1.100
OWRS WL -3.628

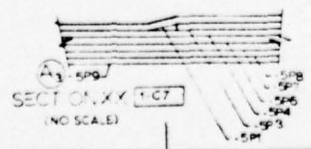


12

- 1 FLAP ASSY
- 4 SKIN ASSY
- 5 SKIN



NA56304U3B0



SECTION V-V
SECTION UPR SKN & DOUBLERS ONLY (NO SCALE)

4

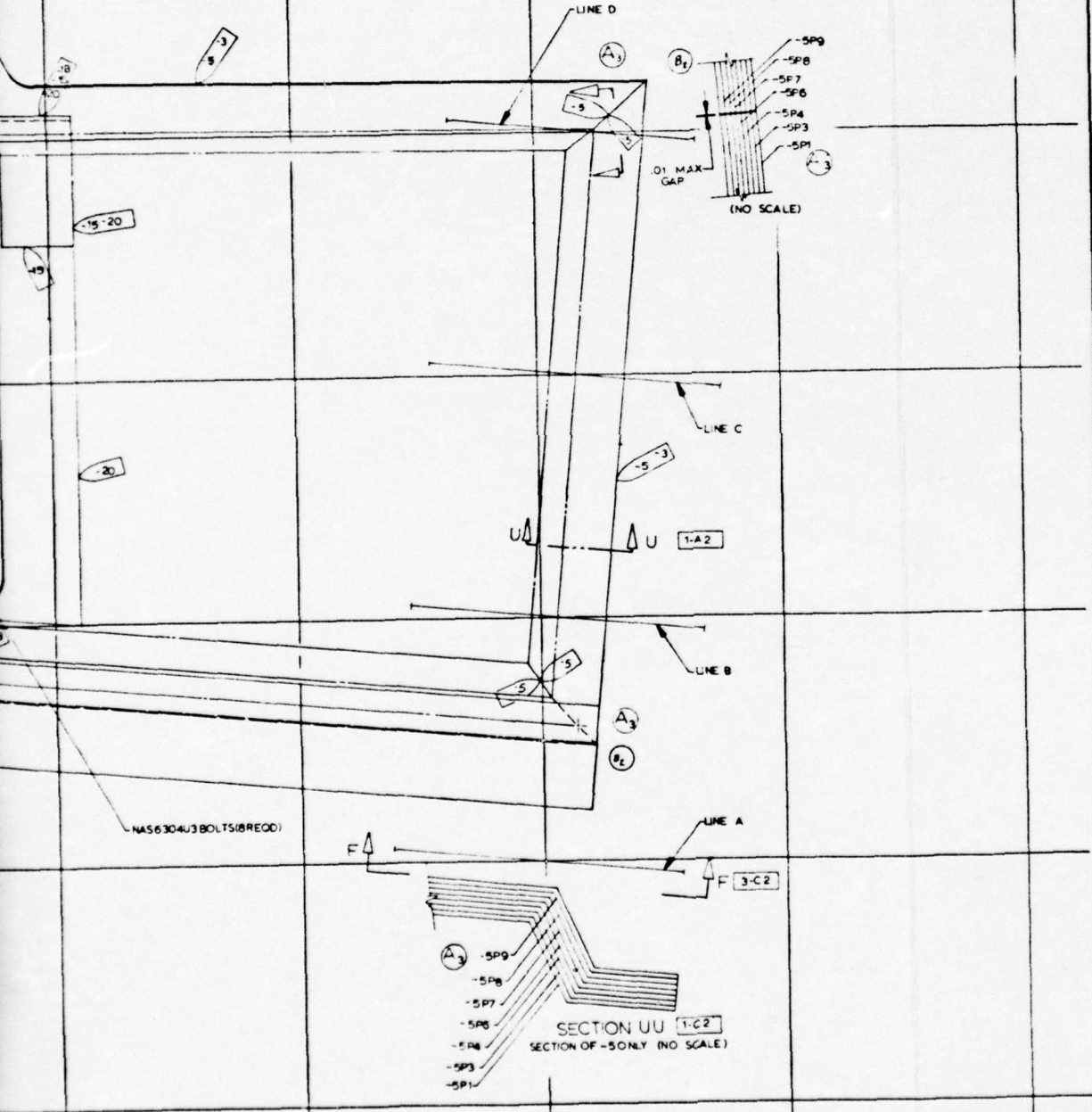
12 0007-101 HINGE
 OWRS STA 57.330
 OWRS BL 1.100
 OWRS WL -3.628

OWRS STA 50.00

PLY ORIENTATION CHART

		PLY LAYUP NUMBER								
		1	2	3	4	5	6	7	8	9
P	-5	1	2	3	4	5	6	7	8	9
A	-5	1	2	3	4	5	6	7	8	9
B	-5	1	2	3	4	5	6	7	8	9
C	-5	1	2	3	4	5	6	7	8	9
D	-5	1	2	3	4	5	6	7	8	9
E	-5	1	2	3	4	5	6	7	8	9
F	-5	1	2	3	4	5	6	7	8	9
G	-5	1	2	3	4	5	6	7	8	9
H	-5	1	2	3	4	5	6	7	8	9
I	-5	1	2	3	4	5	6	7	8	9
J	-5	1	2	3	4	5	6	7	8	9
K	-5	1	2	3	4	5	6	7	8	9
L	-5	1	2	3	4	5	6	7	8	9
M	-5	1	2	3	4	5	6	7	8	9
N	-5	1	2	3	4	5	6	7	8	9
O	-5	1	2	3	4	5	6	7	8	9
P	-5	1	2	3	4	5	6	7	8	9

OWRS STA 40.00



SHEET

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INDICATE REFERENCE CALLOUT OF DASH NO OF THIS DRAWING

INDICATE GENERAL NOTE ON SEPARATE PARTS LIST

INDICATE DIMENSION WE SEPARATE PARTS LIST

INDICATE REFERENCE CALLOUT OF DASH NO OF THIS DRAWING

INDICATE DIMENSION WE SEPARATE PARTS LIST

INDICATE REFERENCE CALLOUT OF DASH NO OF THIS DRAWING

INDICATE DIMENSION WE SEPARATE PARTS LIST

80378 78-002553 B 1

5

REV. NO.	DESCRIPTION	DATE	APPROVED
A	RELEASE AUTHORITY 102613 1. ADDED A. OF PLY NUMBERED -SP6 2. RENUMBERED FOLLOWING PARTS: (NEW) (WAS) -SP7 -SP6 -SP8 -SP7 -SP9 -SP8 3. CHANGED ALL VIEWS AND SECTIONS TO REFLECT THE ABOVE CHANGES		DWG BY G. M. [Signature] CHKD BY [Signature] DATE 11/14/78 MFG. REQ. D. [Signature] PROJ. [Signature]
2F	4. REVISED PLY ORIENTATION CHART TO REFLECT NEW AND REIDENTIFIED PLY NUMBERS		
3C	5. INCORPORATED EO 102613		
B	RELEASE AUTHORITY 102616 1. ADDED "M. 78-002554 CORE" 2. REVISED CORNER TRIM OF -5		DWG BY G. M. [Signature] CHKD BY [Signature] DATE 11/14/78 MFG. REQ. D. [Signature] PROJ. [Signature]

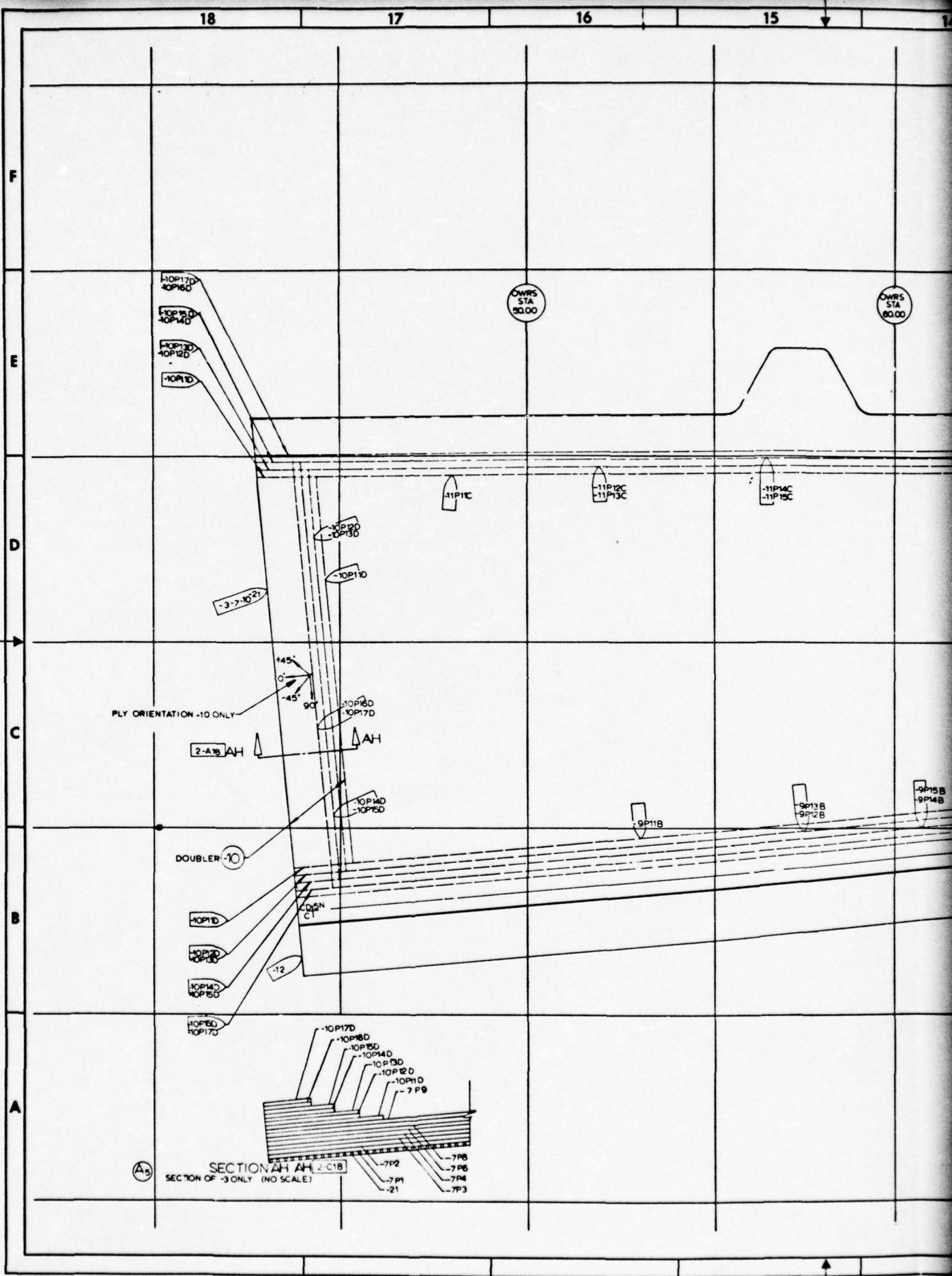
F
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FIGURE A-2 (CONT'D) PAGE 8 OF 11



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INDICATE DIMENSIONS <input type="checkbox"/> INDICATE REFERENCE CALLOUT OF DASH NO. OF THIS DRAWING <input checked="" type="checkbox"/> INDICATE GENERAL NOTE ON SEPARATE PARTS LIST <input type="checkbox"/> INDICATE LIMITATION REV. SEPARATE PARTS LIST	DIMENSIONED FEATURES ARE ANGULAR XXX - 1/2 XXX - 1/4 XXX - 1/8 TOLERANCES FOR UNDIMENSIONED PARTS ARE: OUTLINE .0015 DIMENSIONS .0015 HOLE DIA. .0015 HOLE POS. .0015	DATE OF PREPARED CHECKED GROUP STATUS PROJ. ENG.	SET SEPARATE PARTS LIST YOUNGT AIRCRAFT COMPANY 175 BROADWAY, NEW YORK, N.Y. 10038 PEAR S-3A SPOILER LWR OP ADVANCED COMPOSITES USE LOCAL IDENTIFICATION J 80378 78-002553 SCALE REV. 11/78 SHEET 1 OF 4
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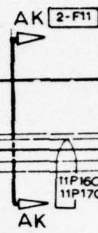
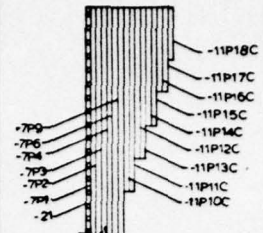
DWRS STA 80.00

DWRS STA 70.00

DWRS STA 80.00

11 DOUBLER

SECTION AK-AK [2-E11]
(NO SCALE)

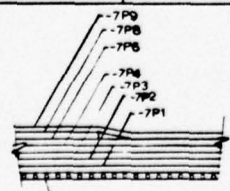


AG [2-A13]

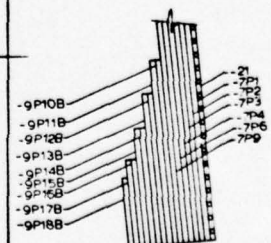


VIEW BB
LOOKING UP AT LOWER

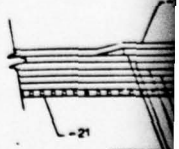
3 SKIN ASSY LWR



SECTION AG AG [2-C13]
(NO SCALE)



SECTION AJ-AJ [2-B11]
(NO SCALE)



SECTION AF AF [2-C9]
(NO SCALE)

CODE BOOK# NO DRAWING NO L/W IN
80378 78-002553 A 2

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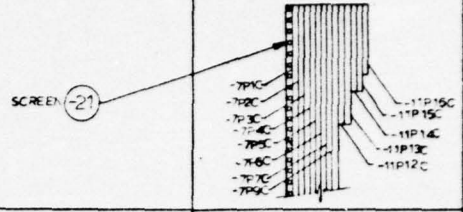
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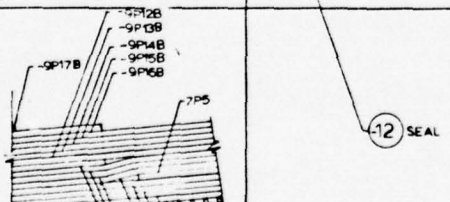
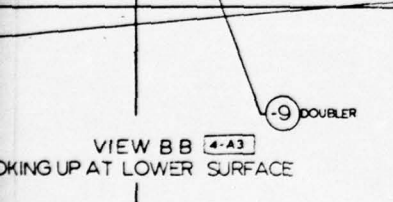
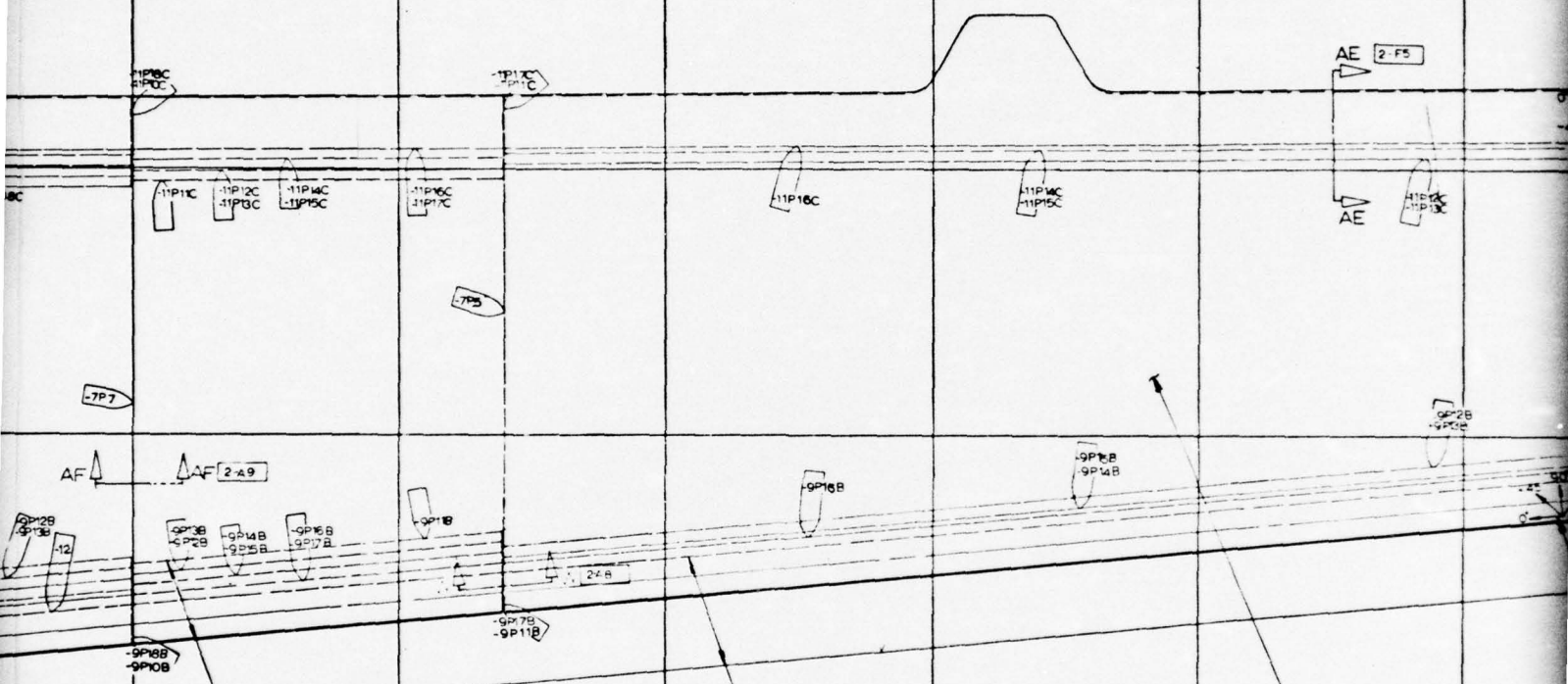


OWRS STA 90.00

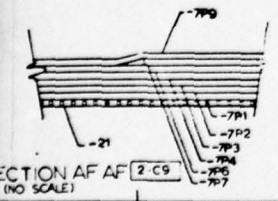
OWRS STA 100.00

SECTION AE AE 2-E-5
SECTION OF -3 ONLY (NO SCALE)

OWRS STA 110.00



9 SKIN LOWER



SECTION W W 2-C-8
SECTION OF -3 ONLY (NO SCALE)

SECTION AF AF 2-C-9
(NO SCALE)

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1

PLY ORIENTATION CHART

PART NO.	PLY LAYUP NUMBER																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
-7	0°	0°	45°	0°	0°	45°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°
-8												45°	45°	45°	45°	45°	45°	45°
-9												45°	45°	45°	45°	45°	45°	45°
-10												45°	45°	45°	45°	45°	45°	45°
-11												45°	45°	45°	45°	45°	45°	45°

- 11P15C
- 11P15C
- 11P14E
- 11P13C
- 11P12C

E 2-E5 (SCALE)

E 2-F5

H1P13C

GAP 2B

SKIN LOWER

PLY ORIENTATION -11 ONLY



PLY ORIENTATION -9 ONLY



ADL
 -BP15A
 -BP15A
 -BP15A
 -BP13A
 -BP12A

AD 2-A1

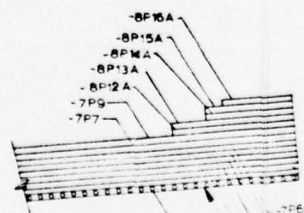
PLY ORIENTATION -8 ONLY

-8 DOUBLER

TRIM OF -7, -8-21

CUT ON C 66 REQD 65 EQUAL SPACES

-BP15A
 -BP15A
 -BP14A
 -BP13A
 -BP12A



SECTION A-A (NO SCALE)

-7P6
 -7P5
 -7P4
 -7P3
 -7P2
 -7P1

CODE IDENT NO: 80378 DRAWING NO: 78-002553 LTR: 4 SH: 2

NO.	REVISION	DATE
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REVISION STARTS ON SHEET

IMPORTANT: SURVEY
 -XXX INDICATE DIFFERENCE CALCULATED BY THIS DRAWING
 X INDICATES GENERAL FACTS OF SEPARATE PARTS LIST
 INDICATES LIMITATION SEE SEPARATE PARTS LIST

TOLERANCES FOR UNLESS OTHERWISE SPECIFIED ARE:
 DIMENSIONS IN INCHES .005
 DIMENSIONS IN MILLIMETERS .10

5

REV. LTR		DESCRIPTION		DATE	APPROVED	INITIALS
			RELEASE AUTHORITY 1028-#			
			1 ADDED A OF PLY NUMBERED -7P4 TO THE LOWER SKIN			
			2 RENUMBERED FOLLOWING PARTS:			
			(WAS) (NOW)			
			-7P4 -7P5			
			-7P5 -7P6			
			-7P7 -7P8			
			-7P8 -7P9			
			3 DELETED FOLLOWING PARTS:			
			-8P7A -8P7B -9P5E -9P5B -10P1E			
			-10P1B -11P7C -11P9C			
			4 REVISED TRIM OF DOUBLER PLES TO DROP OFF TWO EVERY 20 INSTEAD OF ONE EVERY 10			
			5 CHANGED ALL VIEWS AND SECTIONS TO REFLECT THE ABOVE CHANGES			
	2F		6 REVISED BY ORIENTATION CHART TO REFLECT ABOVE CHANGES			
	2F		7 INCORPORATED E 0102613 WITH CHANGES TO REFLECT NEW AND RENUMBERED PARTS			
			8 ADDED PLY ORIENTATION SYMBOL FOR DOUBLERS B 9 10 11			
			9 ADDED SECTIONS A1 & A2			

F
E
D
C
B
A

FIGURE A-2 (CONT'D) PAGE 9 OF 11



NONSTANDARD SYMBOLS		SEE SEPARATE PARTS LIST	
-XXX	INDICATES REFERENCE CALLOUT OR DASH NO OF THIS DRAWING	VOUGHT AERONAUTICS COMPANY	170 AIRSPACE CORPORATE DR
X	INDICATES GENERAL NOTE IN SEPARATE PARTS LIST	P.O. BOX 1001, DAL, TEXAS 75210	
○	INDICATES DIMENSIONS SEE SEPARATE PARTS LIST	FLAP S3A SPOILER LWR OF ADVANCED COMPOSITES	
		SIZE: 100% IDENT NO: 1000000000	
		J 80378 78-002553	
		SCALE F	REV LTR 2 SHEET 2

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PLY ORIENTATION - B ONLY

DOUBLER

OF -7 - 4 2



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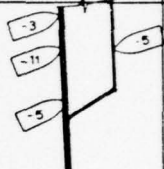
SECTION

3-D15

G

HV

G

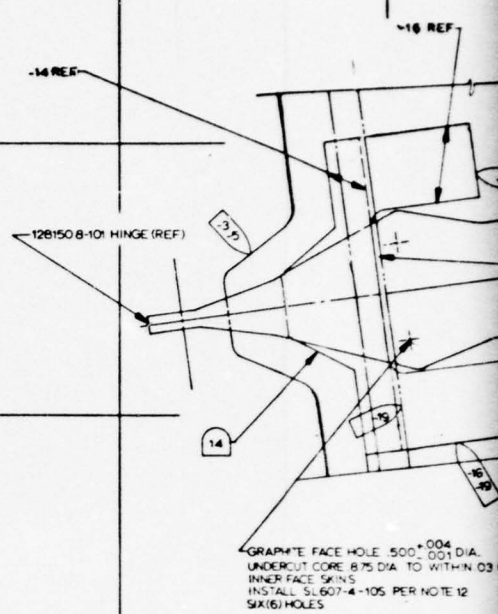
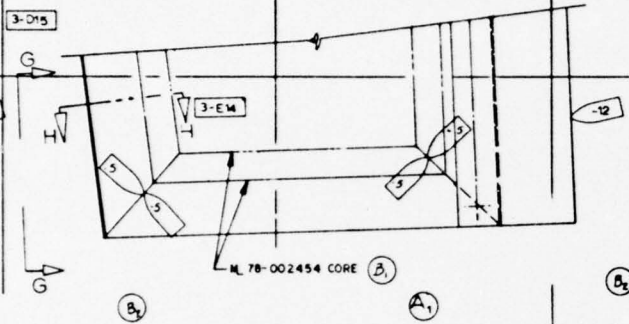
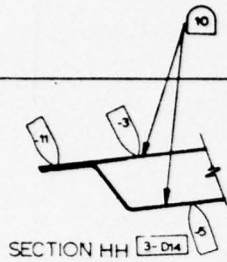


VIEW GG 3-D14

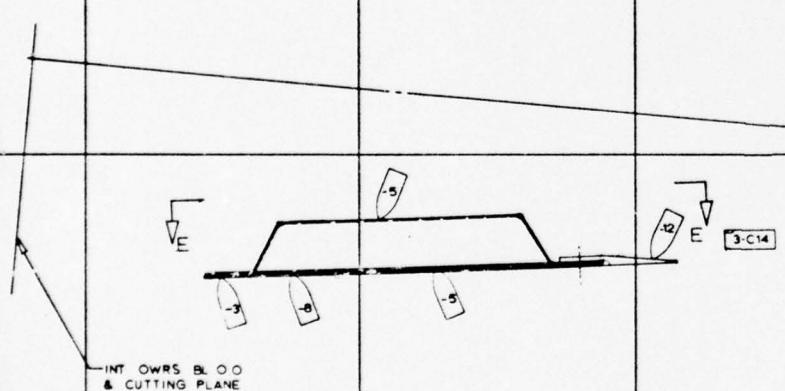


INT OWRS

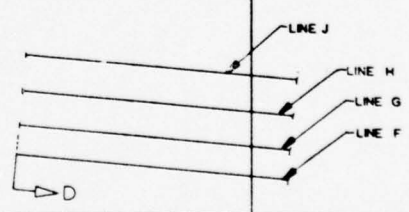
& CUTTING



VIEW E E 3-B'2

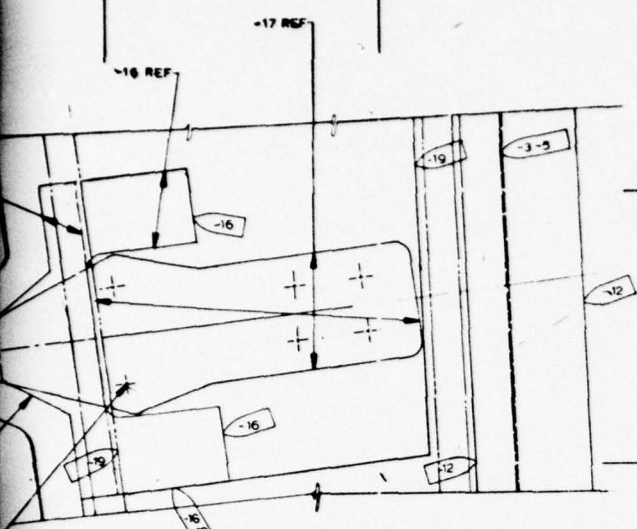


VIEW D D 3-A13

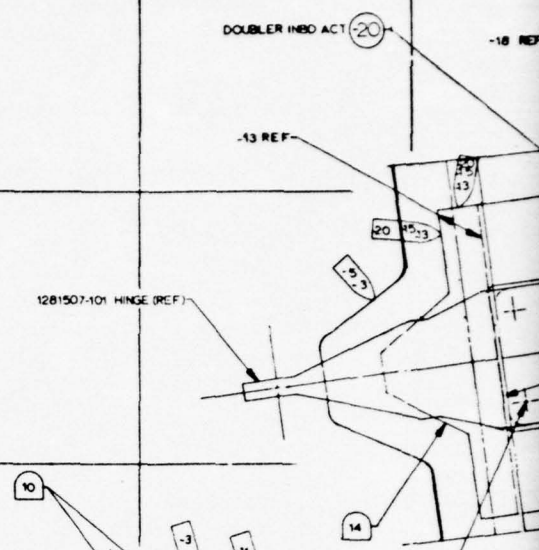


VIEW DD 3-C11

VIEW C C 1-D17
STRUCTURE OMITTED FOR CLARITY

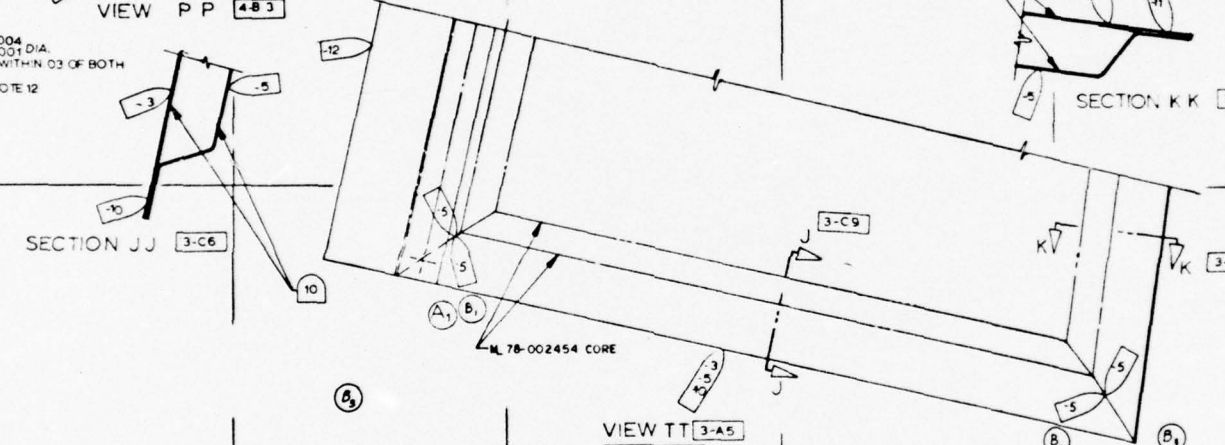


VIEW P P 4-8-3

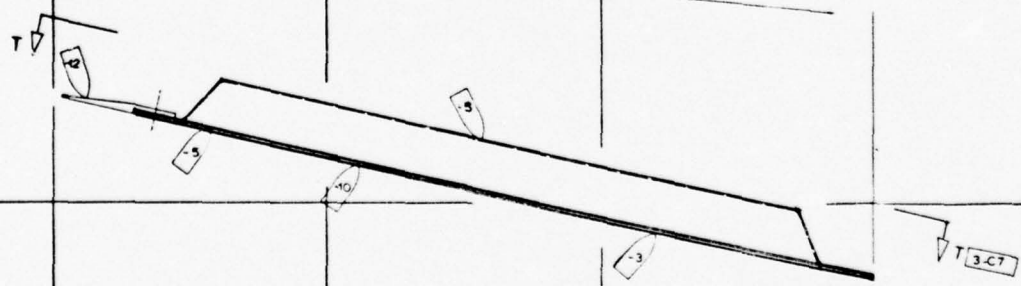


SECTION K K 3-C5

WHITE FACE HOLE .500 ± .004 DIA.
 CUT CORE .875 DIA TO WITHIN .03 OF BOTH
 FACE SKINS
 ALL SL607-4-105 PER NOTE 12
 HOLES

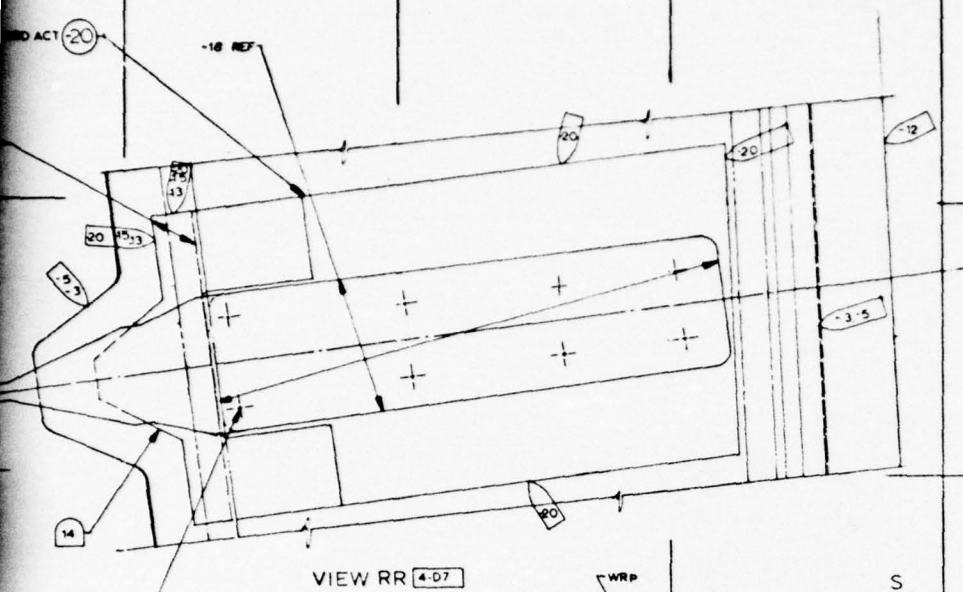


VIEW T T 3-A5



VIEW S S 3-C2

GRAPHITE FACE HOLES
 UNDER CUT CORE B
 BOTH INNER FACE B
 INSTALL SL607-4-105
 EIGHT (8) HOLES



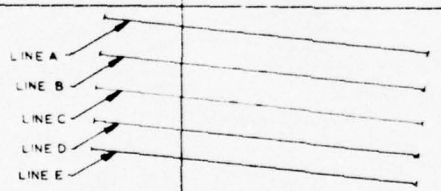
VIEW RR 4-D7

3-C5

GRAPHITE FACE HOLE .500^{+0.004} DIA.
 INNER RADIUS .001 DIA.
 BOTH INNER FACE SPINS
 INSTALL 4-607-4-10S PER NOTE 12
 EIGHT (8) HOLES

3-D5

A1



VIEW FF 1-A2
 STRUCTURE OMITTED
 FOR CLARITY

CODE IDENT NO. DRAWING NO. LTR SH
 80378 78-00265-2 B 3

REVISION STATUS OF SHEETS	
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NONSTANDARD SYMBOLS		DIMENSIONS	
—XXX	INDICATES REFERENCE CALL-OUT OF DASH NO. OF THIS DRAWING	XXX.X	DIMENSIONS FEATURES AND ANGLES
X	INDICATES GENERAL NOTE ON SEPARATE PART LIST	XXX.X	4 OF 8
⊘	INDICATES LIMITATION OR SEPARATE PART LIST	XXX.X	TOLERANCES FOR UNDIMENSIONED FEATURES ARE UNLESS OTHERWISE SPECIFIED FROM DIMENSIONS OR SEE NOTE ON DIMENSIONS FRAME COMPOSITE

5

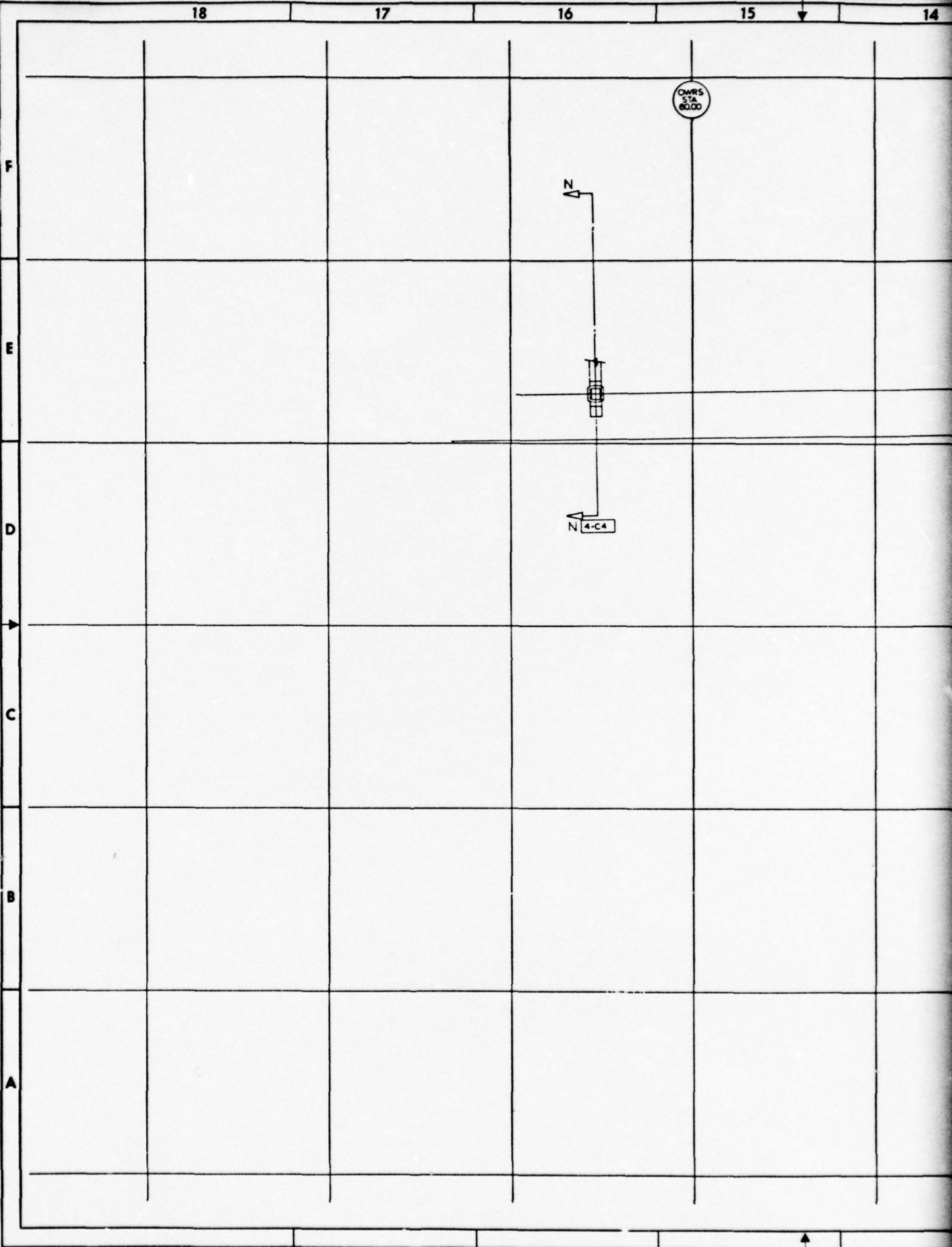
REVISIONS		DATE	APPROVED
1	RELEASE AUTHORITY 102414 1 REVISED VIEW TO REFLECT ADDITIONAL PLIES AND REIDENTIFIED PLIES		APPROVED BY: [Signature] DATE: [Blank]
2	RELEASE AUTHORITY 102414 1 REVISED CORNER TRIM OF 'S' & ADDED 'M' OF 16-002556 CORE 2 REMOVED TRIM OF -SP1 -SP2 -SP3 -SP4 -SP5 -SP6 -SP8 3 REMOVED TRIM OF -SP1 -SP2 -SP3 -SP5 -SP7 -SP8		APPROVED BY: [Signature] DATE: [Blank]

FIGURE A-2 (CONT'D) PAGE 10 OF 11

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REVISION STATUS OF SHEETS NONSTANDARD SYMBOLS INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING INDICATES GENERAL NOTE ON SEPARATE PARTS LIST INDICATES LIMITATION SEE SEPARATE PARTS LIST		DIMENSIONS IN PARENTHESES ARE TOLERANCES FOR UNDIMENSIONED FEATURES ARE OUTLINE ± .03 ANGLES ± .3 FROM CENTERLINE OF SLOPED LINE DIMENSIONS IN SQUARE PARENTHESES ARE COMPOSITES		CHECKED: [Signature] DRAWN: [Signature] STRESS: [Signature] PROJ ENGR: [Signature]		SEE SEPARATE PARTS LIST YOUNG AIRCRAFT COMPANY 175 WEST 10TH AVENUE DENVER, COLORADO 80202 FLAP S-3A SPOILER LWR OP ADVANCED COMPOSITES J 80378 79-002FR3 SCALE: 1/8" = 1" SHEET 3	
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	---------------------------------------------------------------------------------------------	--	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--



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OWRS
SIA
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N 4-C4

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OWRS
STA
7000

OWRS
STA
8000

OWRS
STA
9000

VIEW LL 4-E1
ROTATED CCW 90
STRUCTURE OMITTED FOR CLARITY

DESIGN NO. 80378 DRAWING NO. 78-002553

REV. A 4

OWRS STA 10.00

OWRS STA 10.00

M

M 4-A5

R 3-D3

WRP & CUTTING PLANE

1281507 HINGE (REF)

SKIN INBD TAB -15

-18 SHIM INBD. ACT.

14

-13 CORE INBD. ACT.

OWRS STA 5.00

-22 TAB ASSY INBD.

78-002554 (REF)

SECTION MM

OWRS STA 10.00

SKIN OUTBD TAB -16

WRP & CUTTING PLANE

1281508 101 HINGE REF

-17 SHIM OUTBD. ACT.

14

-14 CORE OUTBD. ACT.

78-002554

SECTION MM 4-D7

-23 TAB ASSY OUTBD.

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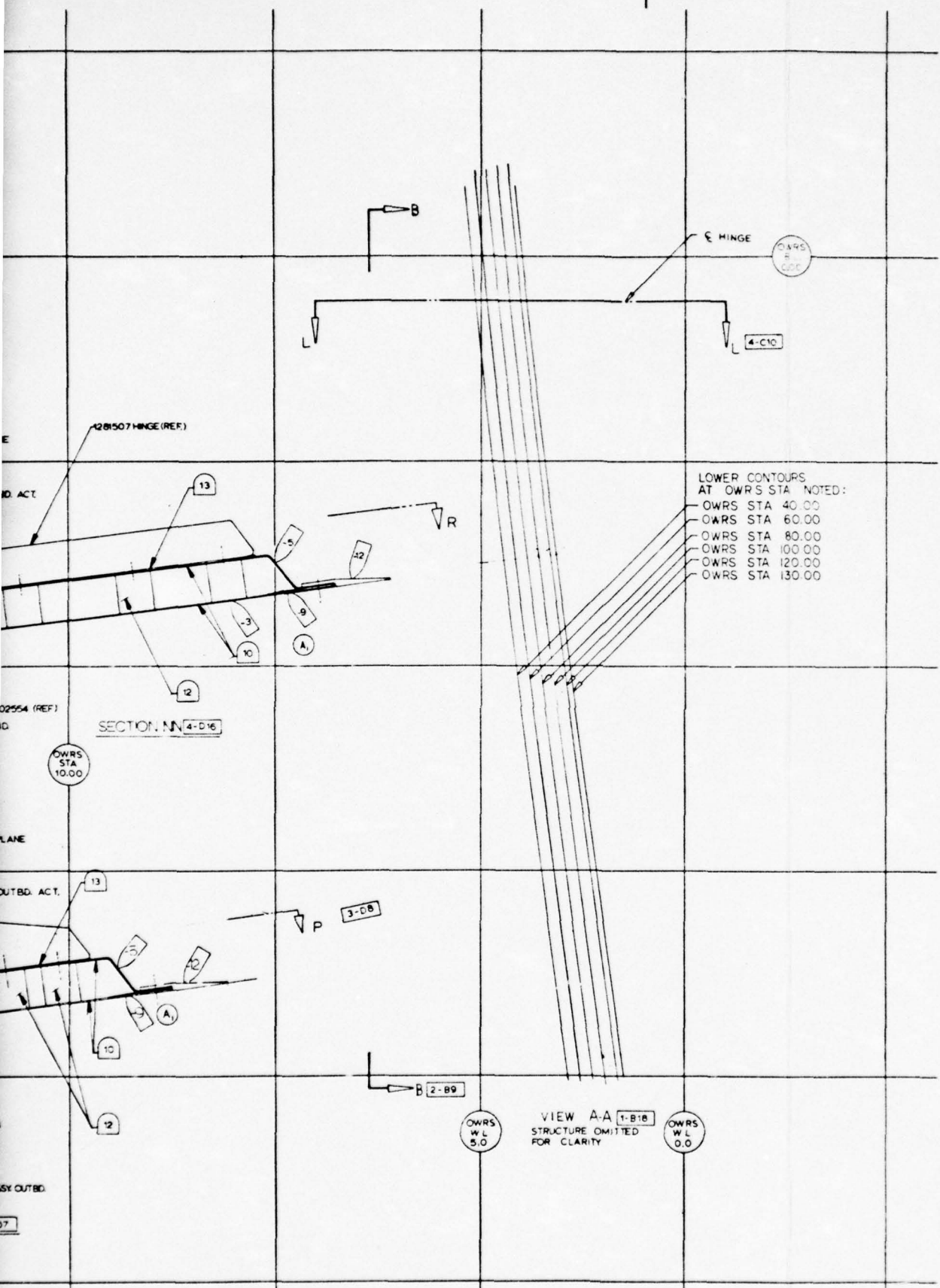
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ZONE LTR DESCRIPTION SHEET NO



- LOWER CONTOURS
AT OWRS STA NOTED:
- OWRS STA 40.00
 - OWRS STA 60.00
 - OWRS STA 80.00
 - OWRS STA 100.00
 - OWRS STA 120.00
 - OWRS STA 130.00

SECTION, N-N 4-D-16

VIEW A-A 1-B-18
STRUCTURE OMITTED
FOR CLARITY

CODE IDENT NO DRAWING NO LTR BR

80378 74-002553 A 4

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NONSTANDARD SYMBOL	INDICATES REFERENCE CALCULATION OF DIMEN NO OF THIS DRAWING	INDICATES DIMENSIONAL FEATURES ARE ANGULAR DIMENSIONAL TOLERANCE
(Symbol)	(Symbol)	(Symbol)
(Symbol)	(Symbol)	(Symbol)
(Symbol)	(Symbol)	(Symbol)

S

REVISIONS				REVISIONS			
ZONE	DATE	DESCRIPTION	APPROVED	ZONE	DATE	DESCRIPTION	APPROVED
A		RELEASE AUTHORITY 10241 & REVISED M. OF CORE IN SECT N-A & M-M TO AGREE WITH SHEET 1					

FIGURE A-2 (CONT'D) PAGE 11 OF 11

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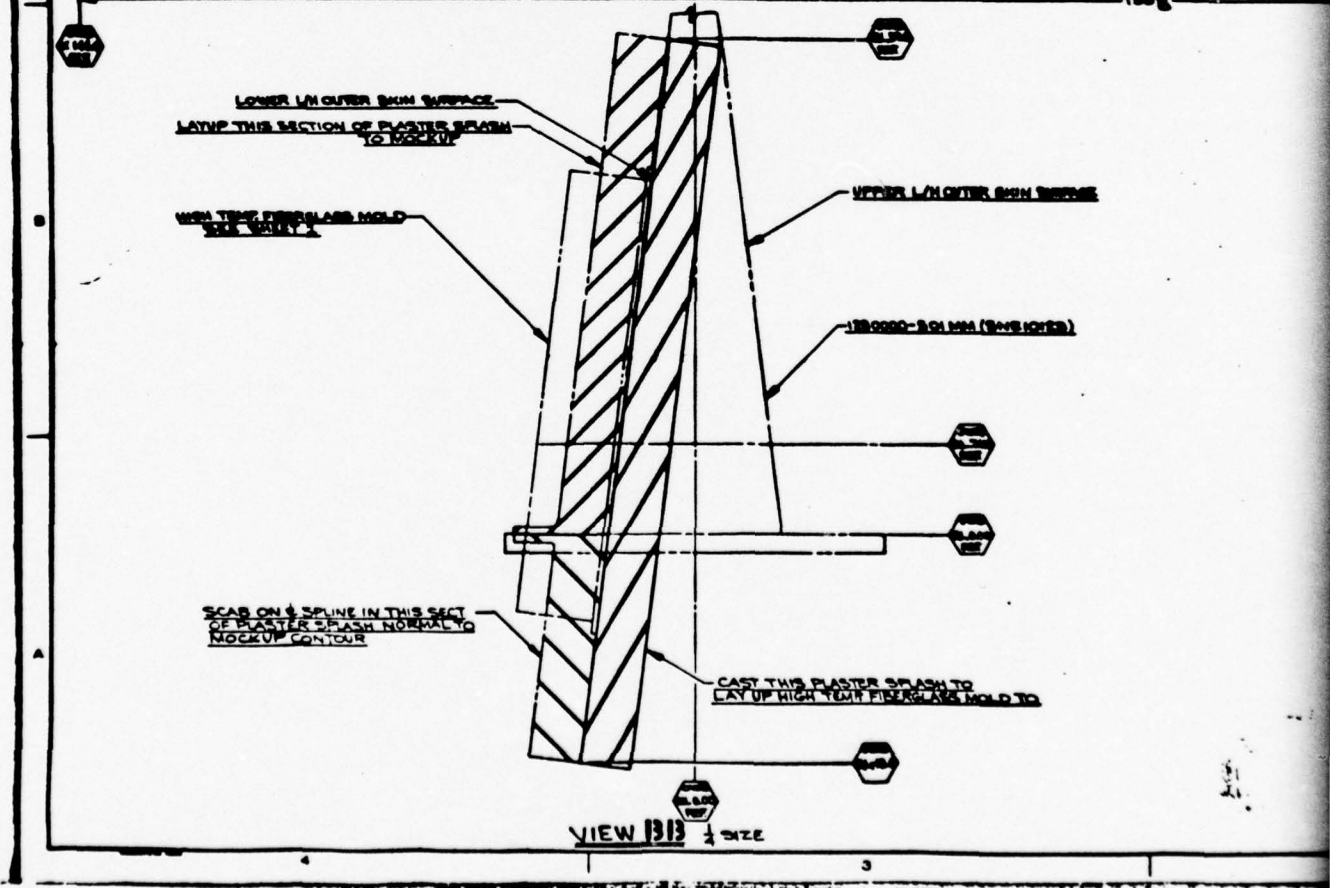
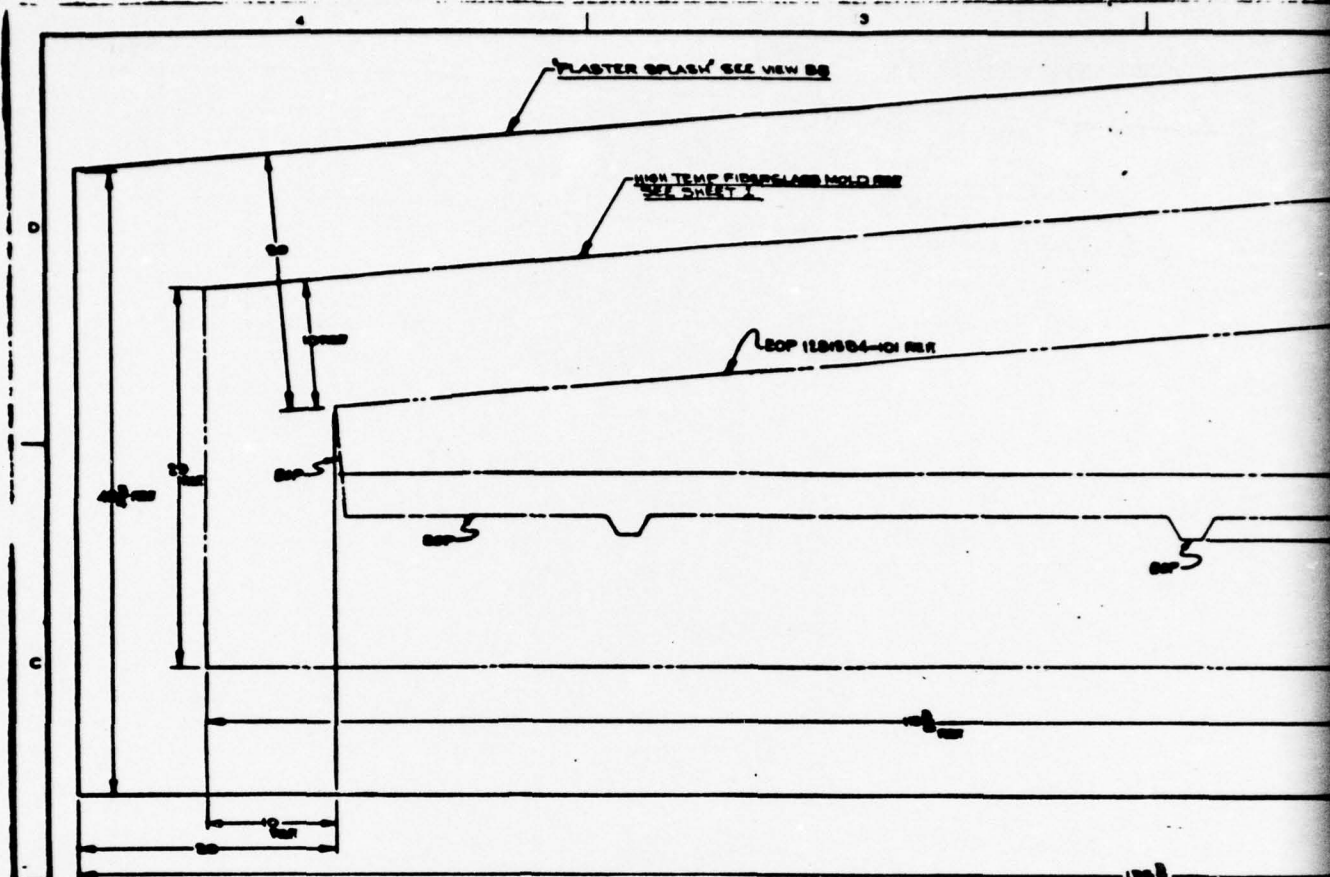


<p>INDICATE REFERENCE CALLOUT OF DASH NO OF THIS DRAWING</p> <p>INDICATE GENERAL NOTE ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p>	<p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p>	<p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p>	<p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p>	<p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p> <p>INDICATE DIMENSIONS ON SEPARATE PARTS LIST</p>
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FLAP

S-3A SPYER WR OP

J 80378 74-002553



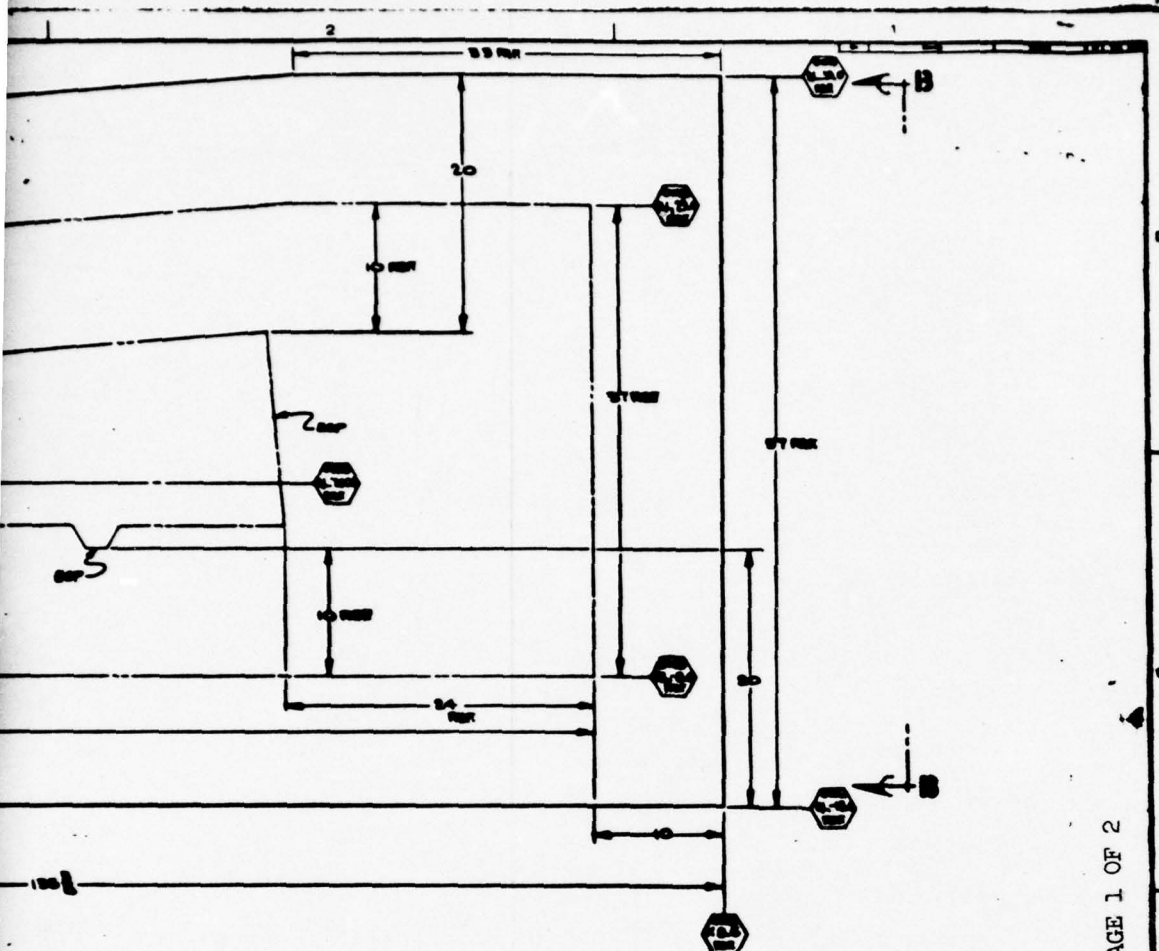
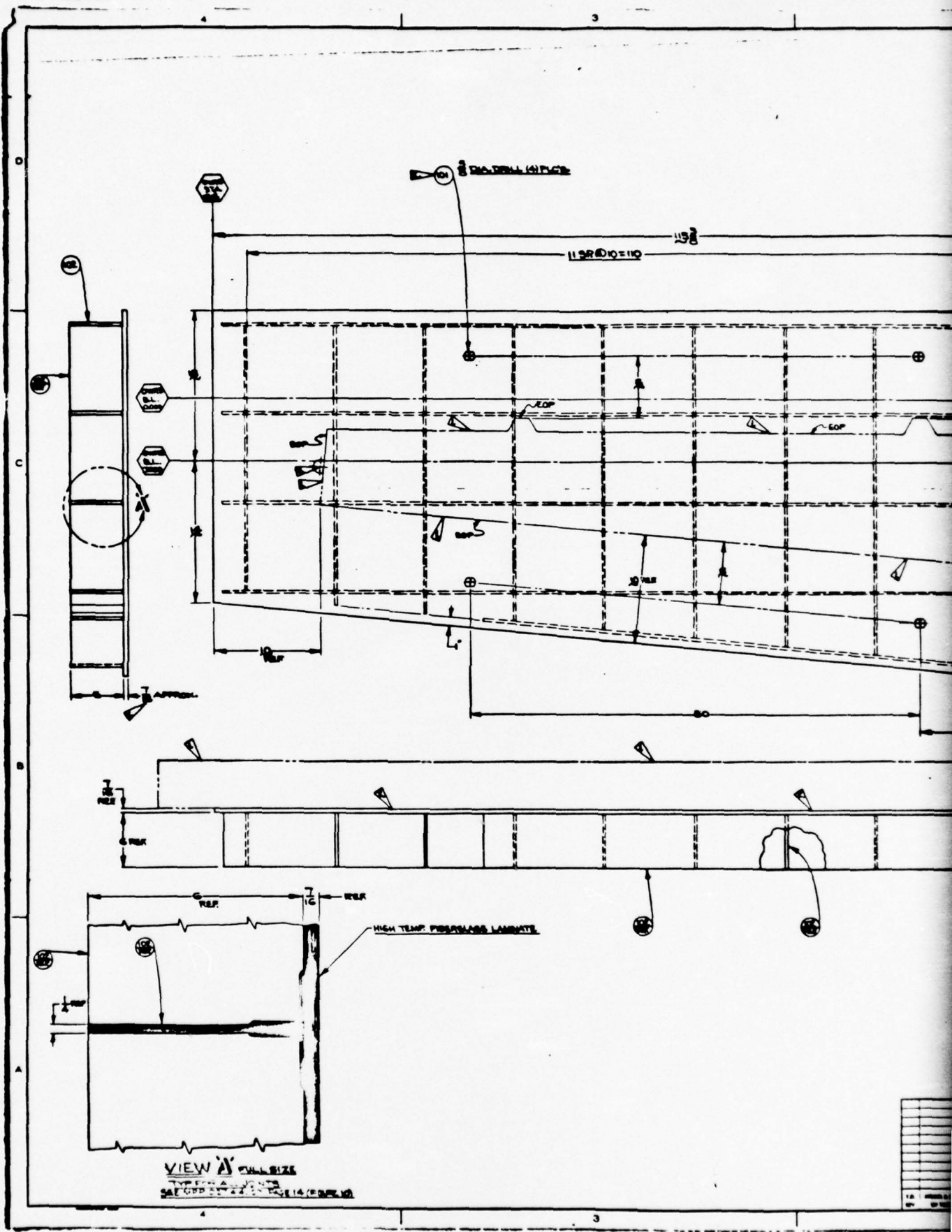


FIGURE A-3 OUTER SKIN BONDING MOLD PAGE 1 OF 2

LAST METAL CLASSIFIED USED	
DATE	BY
APPROVED	DESIGNED
DATE	BY
MASON B-34	
VOUGHT AERONAUTICS	
2	US NAVY SN 405011-082



APPENDIX B

This Appendix contains the documentation relating to the component testing under this contract and presents the following information.

- A) Static Test Plan - Report No. 2-53440/3R-10108
Rev A, 2/27/74
- B) Summary Report #1 Static Test dtd 30 May 1974
- C) Selected Strain gage information - Static Test #1
Run #3, #5, #6, and #7 (7 pages)
- D) Summary Report #2 Static Test
- E) Selected Strain gage information - Static Test #2
Run #3, #6, #7B, and #9 (9 pages)
- F) Summary Report #3 Static Test
- G) Selected strain gage information - Static Test #3
Run #3, #6, #7, and #9C (9 pages)
- H) Fatigue Test Plan - Report No. 2-53440/3R-10109
Rev A, 6/17/74
- I) Summary Report - Fatigue Test

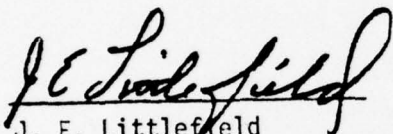
12 Dec. 1973

Static Test Plan S-3A
Composite Spoiler

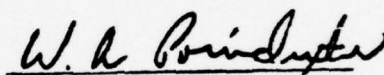
Prepared Under
Contract N62269-73-C-0610

BY
Vought Systems Division
LTV Aerospace Corporation
FOR
Naval Air Development Center
Warminster, Pa.

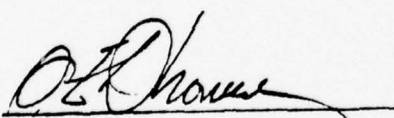
PREPARED BY:


J. E. Littlefield
Engineer Specialist - Structures

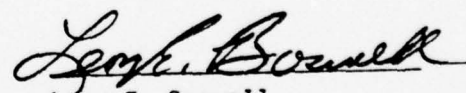
APPROVED BY:


W. A. Poindexter
Supervisor, Structures Tech.

REVIEWED BY:


O. E. Dhonau
Senior Specialist - Structures Tech.

APPROVED BY:


Leon E. Boswell
Supervisor, Structures

STATIC TEST PLAN S3A ADVANCED COMPOSITES SPOILER

PURPOSE:

The purpose of this test is to verify the design capability of the lower left hand graphite/epoxy spoiler for the S-3A aircraft. Three spoilers will be tested to failure by the method described in the following paragraphs.

DESCRIPTION OF TEST:

Two (2) load conditions will be investigated; the opening load (tension on lower surface) and the closing (failing) load (compression on lower surface). The opening load will be 115% of design limit and failing (closing) load will be 150% of design limit based on data provided in Figure B-1. Test data will be acquired from five (5) rosette strain gages and eighteen (18) deflection devices as shown in Figure B-2.

REQUIREMENT:

This test plan is required per contract N62269-73-C-0610.

TEST SPECIMEN:

The test specimen will consist of a graphite S3A lower spoiler assembly as defined by DWG78-002553 Flap S3A Spoiler, LWR. O.P. Advanced Composite. The specimen will be supported at the actuator hinge fitting thru the mounting holes provided as shown in Figure B-3.

TEST CONDITIONS:

Maximum spoiler hinge moments occur as a function of surface rotation and air-speed as given in Figure B-1. Table B-I gives the hinge moments and positions for the spoiler static test opening and closing condition. Spoiler spanwise unit running hinge moment curves are presented in Figure B-4.

TEST SETUP:

The specimens will be installed in the Test jig as shown in Figure B-2 and B-3. Air loads on the spoiler will be simulated by applying test loads through tension pads. Figure B-3 shows location of pads and applied load at each location, at maximum test loads.

TEST PROCEDURES:

Loads will be applied in increments of no greater than 20 percent design limit load to 100 percent limit load, and in increments of no greater than 10 percent design limit load from 100 to 150 percent design limit load. The structure will be loaded to 115% of design limit opening load (tension) and to failure for the closing load (compression).

Strains will be reduced and plotted during static tests as a check on predicted stress values. Deflection data will be checked during all tests. If a change in deflection rate or strain rate occurs, the above loading increments may be altered to obtain sufficiently small subsequent increments to determine if this change is linear or curvilinear.

MEASUREMENT OF STRUCTURAL DEFLECTIONS:

Structural deflections at spoiler and jig support points will be measured primarily by displacement devices supported by independent structures. The accuracy will be ±.02 inches deflection or better.

METHODS OF LOAD APPLICATION:

All loads will be applied to simulate as nearly as practicable the actual loads on the test article. The loads will be introduced into the structure in such a manner that secondary stresses will not be induced at load application points due to structural deflections during tests.

Loads will be transmitted by rubber backed tension pads bonded to the surfaces. The applied static test loads will be supplied to pads by means of hydraulic jacks.

LOWER SPOILER

- OPERATING HINGE MOMENT (AIRLOAD LESS FRICTION) WITH SERVO OUTPUT AT 2850 PSI
- - - BLOWBACK HINGE MOMENT (AIRLOAD PLUS FRICTION) WITH SERVO OUTPUT AT 3000 PSI

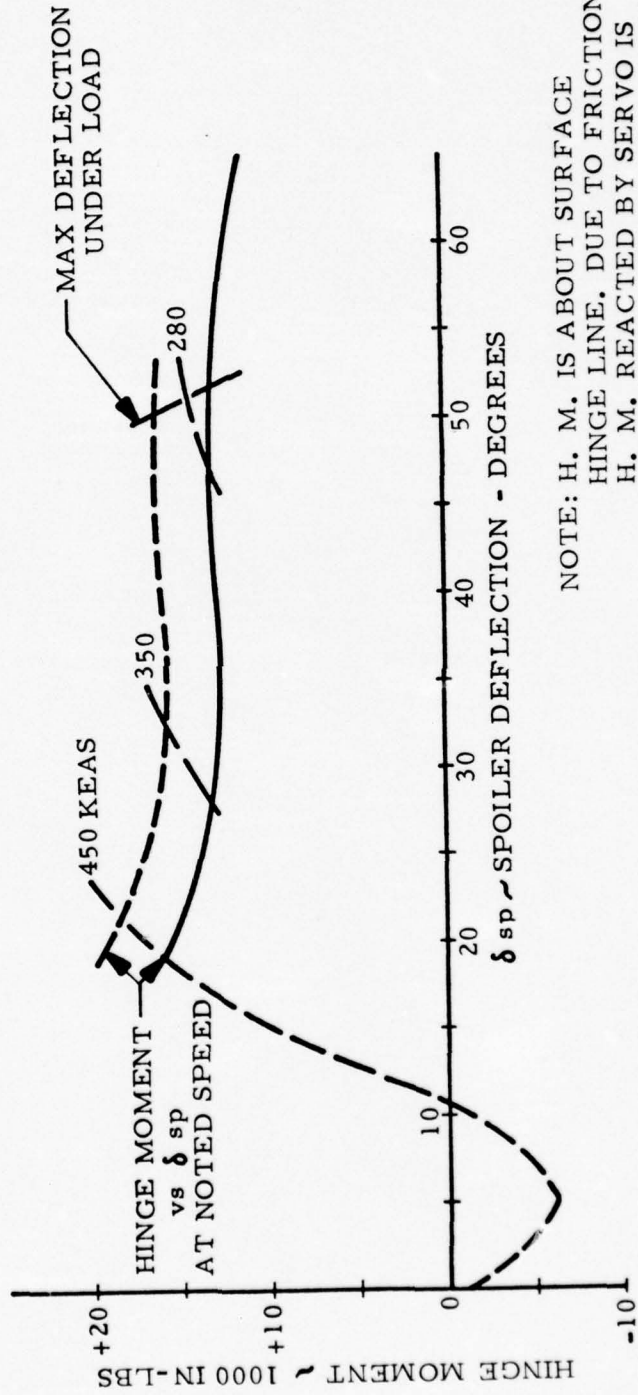


FIGURE B-1 SPOILER HINGE MOMENTS

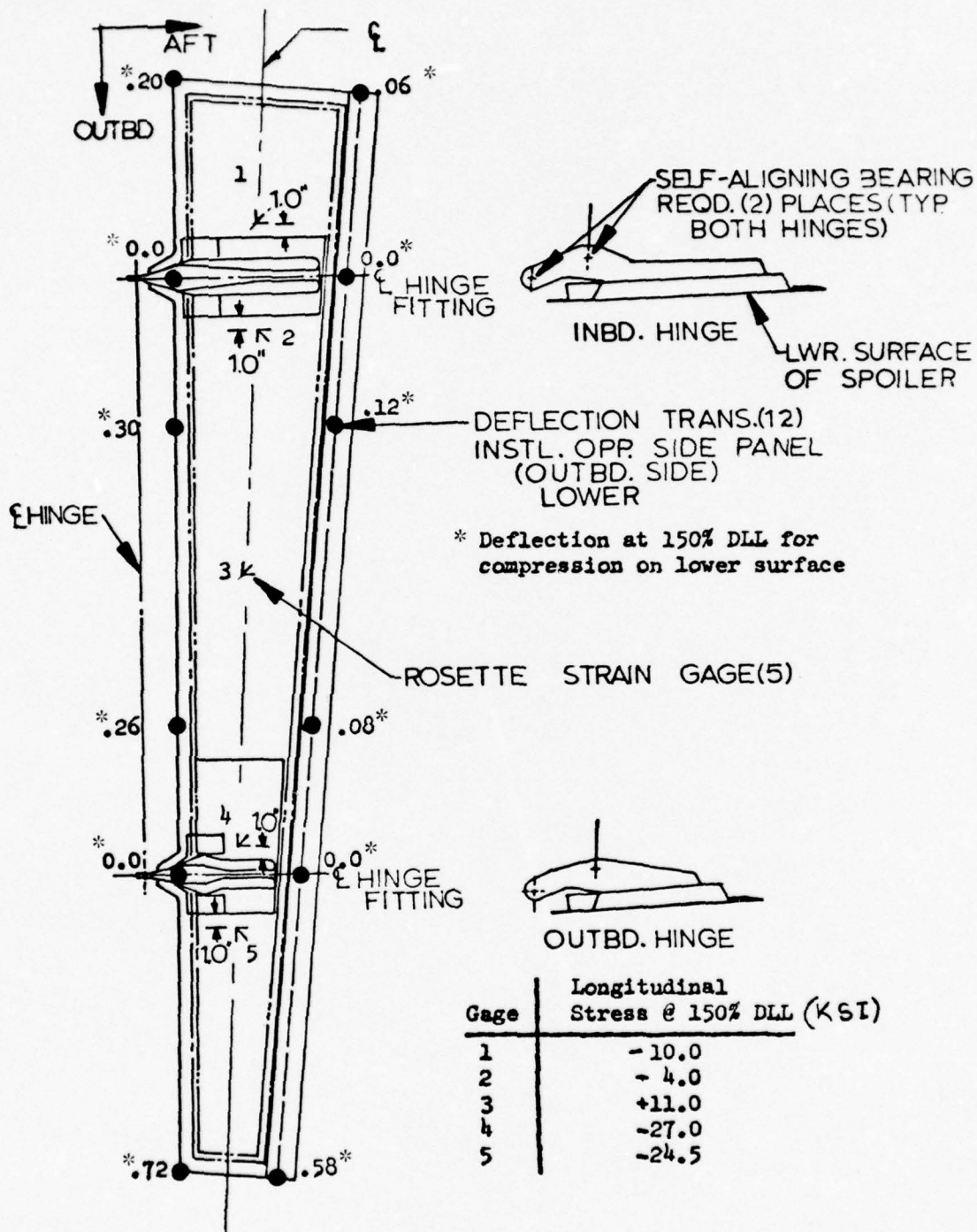
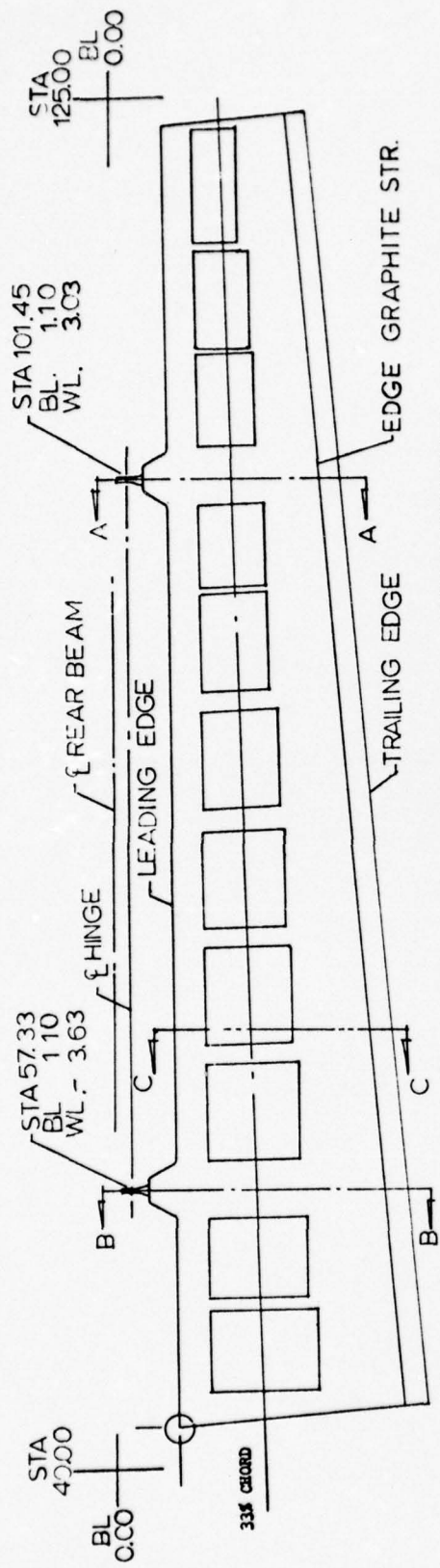
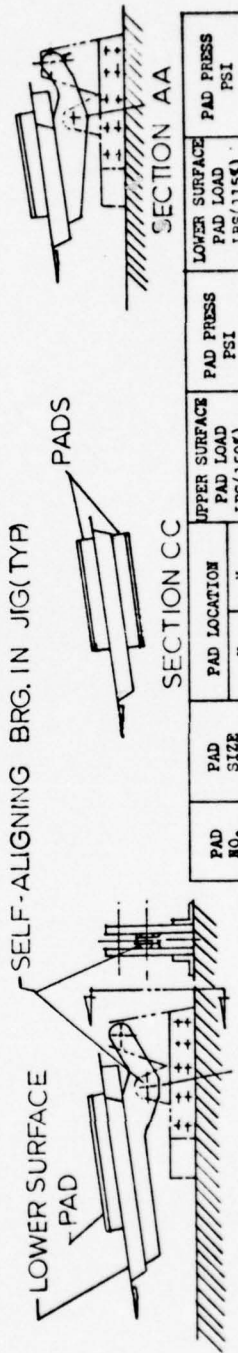


FIGURE B-2 DEFLECTION AND STRAIN GAGE LOCATIONS



LOWER SPOILER (LOOKING AT OUTER SURFACE)



PAD NO.	PAD SIZE	PAD LOCATION		UPPER SURFACE PAD LOAD LBS.(150%)	PAD PRESS PSI	LOWER SURFACE PAD LOAD LBS.(115%)	PAD PRESS PSI
		X	Y				
1	5 x 6.4	7.38	8.20	540	16.9	133	4.16
2	5 x 6.2	12.90	7.80	424	13.7	104	3.37
3	6 x 5.8	22.32	7.45	420	12.1	104	2.98
4	6 x 5.3	29.56	6.90	420	13.2	104	3.27
5	6 x 4.9	36.79	6.50	380	12.9	94	3.19
6	6 x 4.6	44.03	6.20	380	13.8	94	3.41
7	6 x 4.3	51.26	5.80	350	13.5	87	3.37
8	5.3 x 4.0	57.00	5.68	270	12.74	67	3.16
9	5.6 x 3.6	66.50	5.15	250	12.40	62	3.07
10	6 x 3.1	72.97	4.70	312	16.8	77	4.13
11	5.8 x 2.8	79.25	4.33	312	19.2	77	4.74

- NOTES:
1. Pads located || and | to spoiler leading edge.
 2. Measurements are positive otbd and aft.
 3. All measurements are to be made on skin outside surface.
 4. Pad pulloffs are to be located at the geometric center of each pad.
 5. Pad pulloffs located on spoiler 33% chord (for engineering reference only).
 6. Loads shown are maximum.

spad locations are given by locating the aft-otbd corner of pads. X & Y are measured || and | to spoiler leading edge beginning at fwd-inbnd surface corner.

FIGURE B-3 LOWER L. H. SPOILER STATIC TEST SET-UP AND LOAD REQUIREMENTS

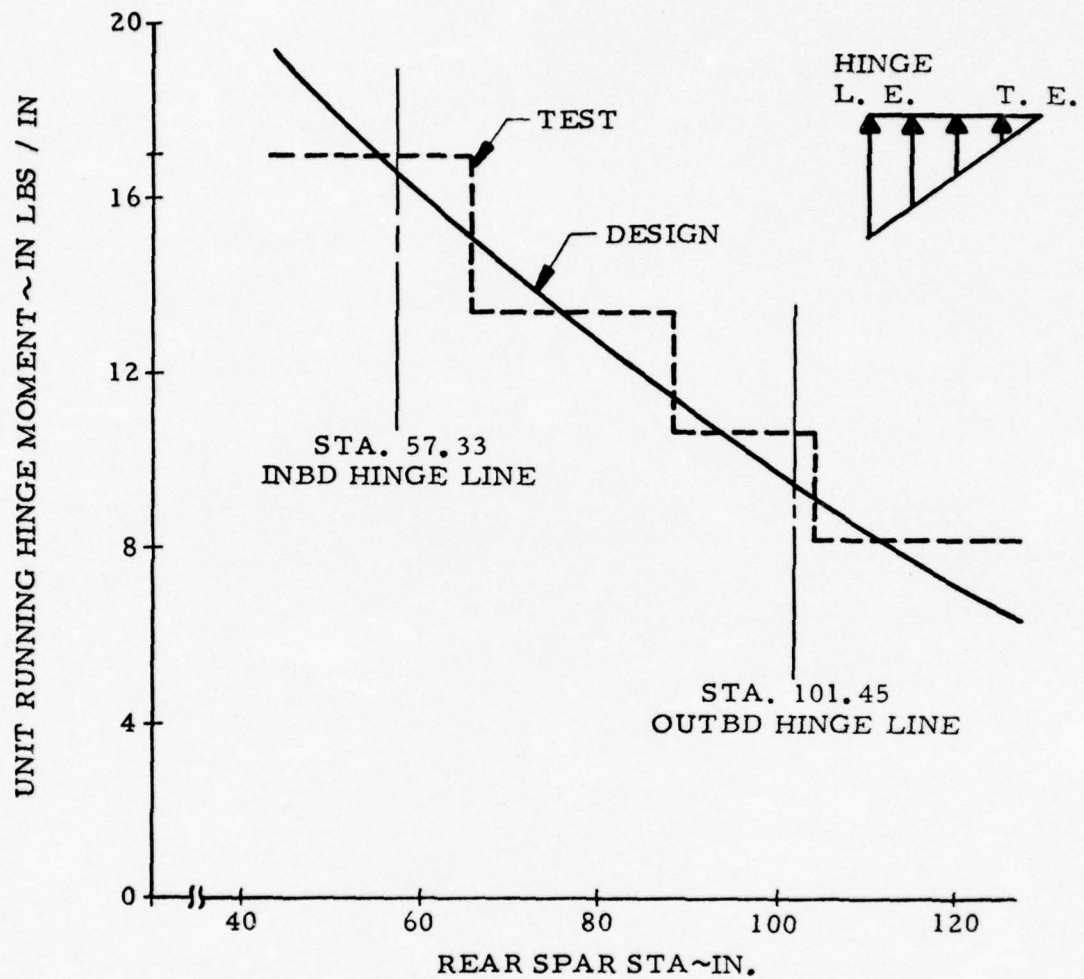


FIGURE B-4 S-3A COMPOSITE SPOILER SPANWISE
 RUNNING LOAD FOR A TOTAL SURFACE
 HINGE MOMENT OF 1000 IN - LBS APPLIED
 (STATIC CONDITION)

TABLE B-I TEST LOADS AND HINGE MOMENTS

PAD LOAD CONDITION	SPOILER POSITION	AIR SPEED	TEST LOAD (LB)	TEST H.M. (IN-LB*)	% (LIMIT)
COMPRESSION	18°	450 KN	4,058	27,900	150
TENSION	5°	450 KN	1,003	6,900	115

*Limit Hinge moment obtained from figure B-1 and increased 24% due to system friction.

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARRMINSTER, PENNSYLVANIA 18974

3033
30 May 1974

SUMMARY REPORT ON STATIC TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 1

- Ref: (a) LTV Report 2-53443/3R-3139, "S-3A Graphite/Epoxy Spoiler Development Program," dtd Jan 1974
(b) LTV Report 2-53440/3R-10108, "Static Test Plan S-3A Composite Spoiler," Revised 27 Feb 1974
- Figure: B-5 Photograph No. CAD-18382-4-74--Spoiler loaded at 150 percent DLL
B-6 Photograph No. CAD-18384-4-74--Spoiler loaded at 177 percent DLL
B-7 Photograph No. CAD-18380-4-74--Spoiler loaded at 260 percent DLL
B-8 Photograph No. CAD-18386-B-4-74-- Failure of spoiler at 300 percent DLL

1. The spoiler consists of a graphite/epoxy (G/E) outer skin, a glass-reinforced-plastic honeycomb core, a pan-shaped G/E inner skin, and two production metal hinge fittings attached to the inner surface through inserts in the core. The overall dimensions are 30.7 inches by 15.2 inches inboard tapering to 8.6 inches outboard. A detailed description of the construction is given in reference (a).

2. The spoiler was tested statically in two conditions--the opening condition and the closing condition. Although the closing condition is the critical condition, the opening condition was run to substantiate the spoiler performance for tension loads in the areas of the hinges. The test loads are shown in reference (b). The loading sequence was as follows:

- a. Apply 40 percent design limit load (DLL) in opening and closing conditions to check set-up.
- b. Apply 100 percent DLL opening load and check test-theory correlation.
- c. Apply 115 percent DLL opening load and check test-theory correlation.
- d. Apply 100 percent DLL closing load and check test-theory correlation.

e. Apply 150 percent DLL closing load and check test-theory correlation.

f. Apply 177 percent DLL closing load and check test-theory correlation.

g. Apply closing load to failure.

Loads were applied in 20 percent increments up to 100 percent DLL and thereafter, in 10 percent increments. The run to 177 percent DLL was to obtain data for possible new load criteria resulting from button-down of the upper outboard spoiler.

3. The spoiler was installed in the test fixture at the hinges. The distributed airloads were introduced into the structure using tension pads bonded to the surface. The loads for the opening condition were applied to the outer surface (up in the subsequent photographs); loads for the closing condition were applied to the inner surface (down in the subsequent photographs).

4. The spoiler was loaded through the test sequence of paragraph 2 uneventfully. The critical strains and deflections were checked after each run and showed acceptable correlation with the predicted values. The deflection at the outboard tip was less than that of the metal spoiler at the same load. Figures B-5, B-6, and B-7 show the spoiler deflection for the closing condition at several load levels. Loading was continued in 10 percent increments until failure. Failure occurred suddenly at 300 percent DLL with no prior audible sound emanations. Failure occurred at the edge of a doubler outboard of the outboard hinge fitting. The failure is shown in figure B-8.

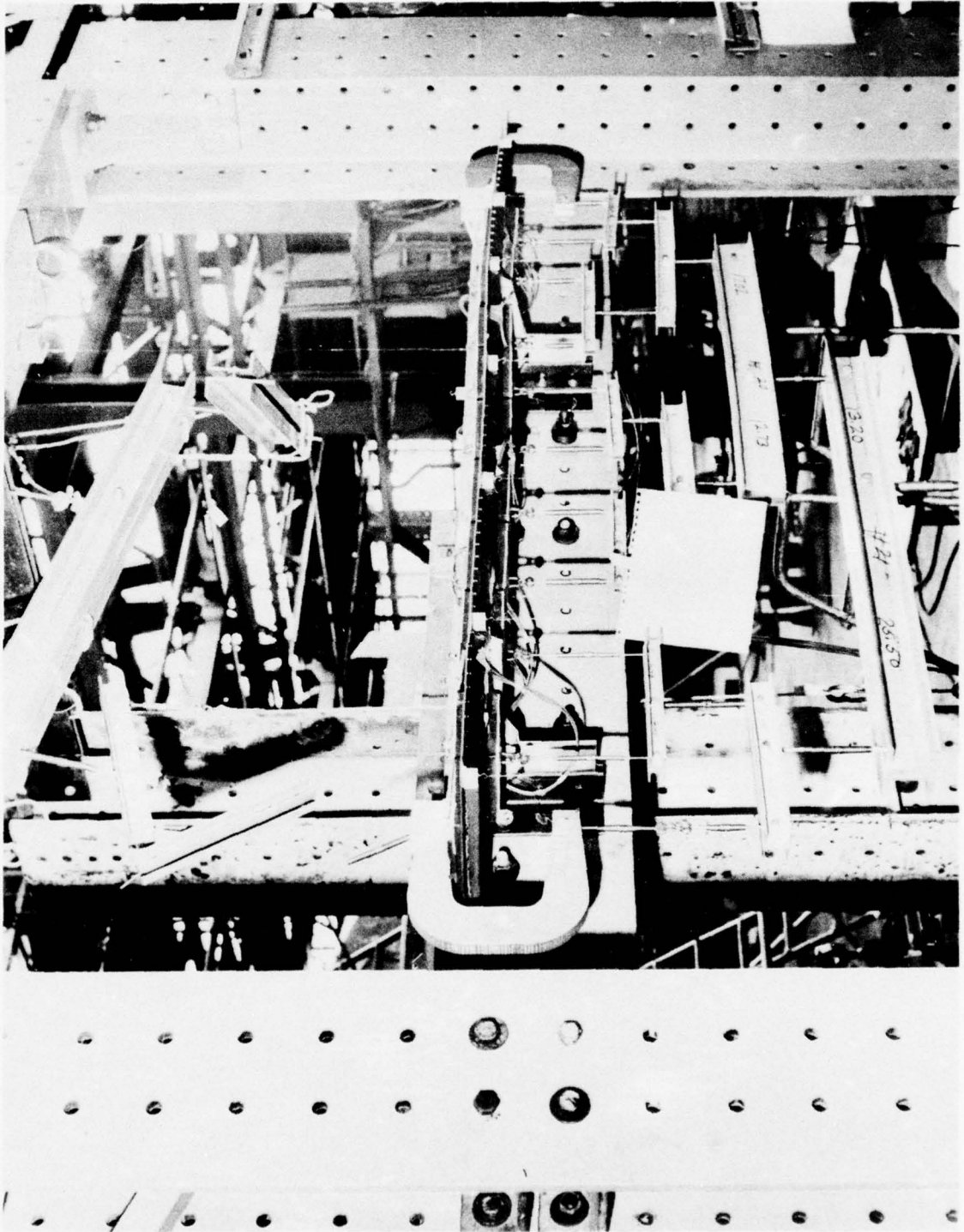


FIGURE B-5 SPOILER LOADED AT 150 PERCENT DLL

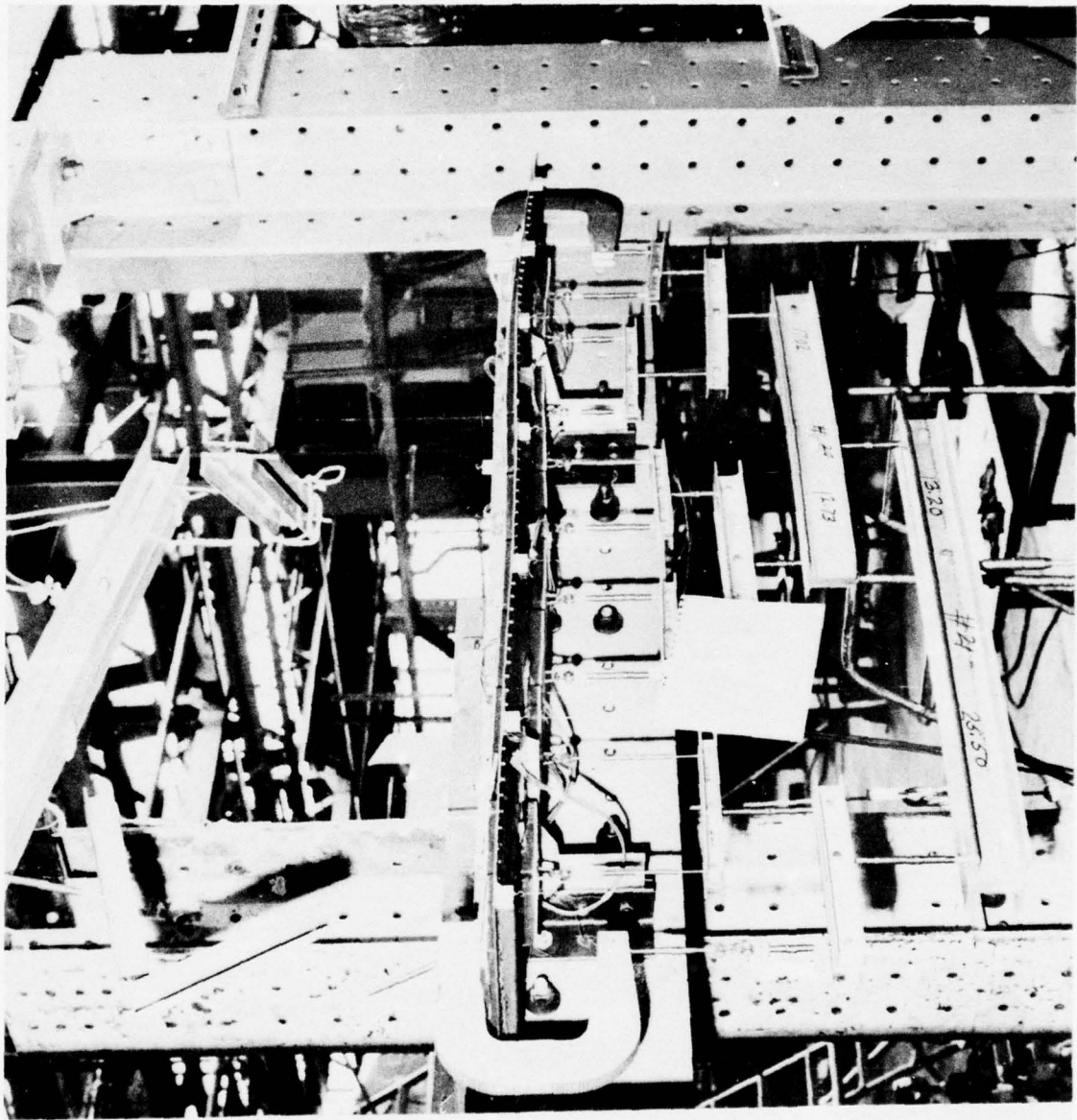


FIGURE B-6 SPOILER LOADED AT 177 PERCENT DLL

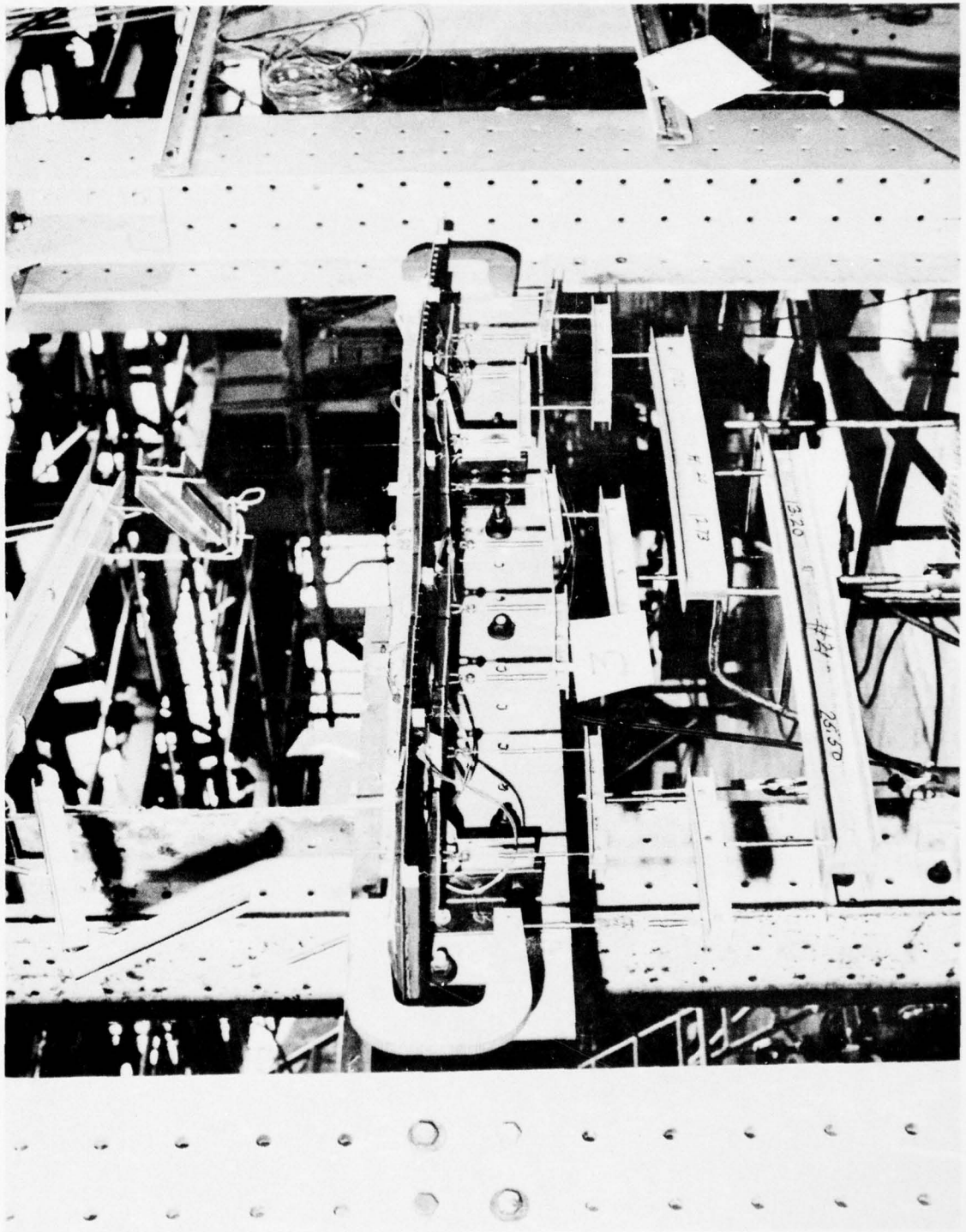


FIGURE B-7 SPOILER LOADED AT 260 PERCENT DLL

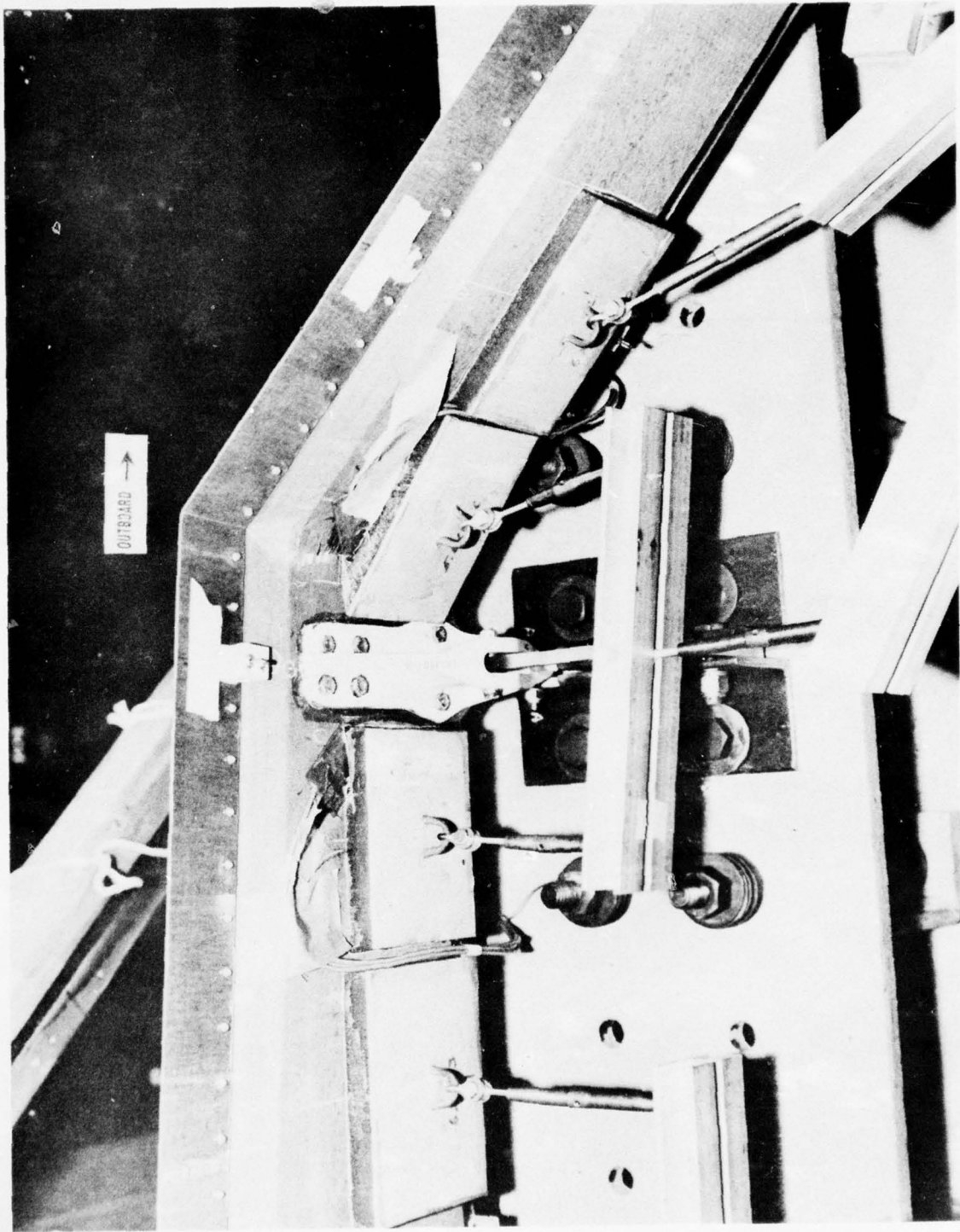
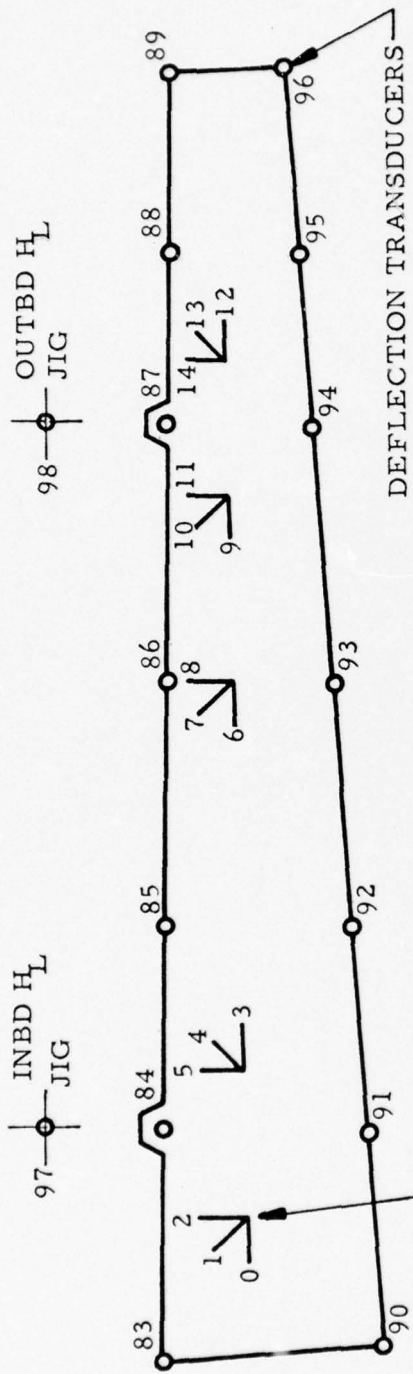


FIGURE B-8 SPOILER FAILED AT 300 PERCENT DLL



STRAIN GAGES

RECORDING CHANNEL	GAGE LEG
000	0
001	1
002	2
003	3
004	4
005	5
006	6
007	7
008	8
009	9
010	10
011	11
012	12
013	13
014	14

DEFLECTION TRANSDUCERS

RECORDING CHANNEL	TRANSDUCER
083	83
084	84
085	85
086	86
087	87
088	88
089	89
090	90
091	91
092	92
093	93
094	94
095	95
096	96
097	97
098	98

FIGURE B-9 STATIC TEST INSTRUMENTATION KEY

STATIC TEST #1
 RUN NO. 3 115% DLL OPENING LOAD 4/8/74

0%	40%	80%	115%
099 -02256 0	099 -04224 0	099 -03343 0	099 -04499 0
098 -00093 0	098 -00099 0	098 -00109 0	098 -00114 0
097 -00229 0	097 -00228 0	097 -00233 0	097 -00241 0
096 +00012 0	096 +00003 0	096 +00131 0	096 +00179 0
095 +00016 0	095 +00044 0	095 +00081 0	095 +00114 0
094 +00006 0	094 +00083 0	094 +00103 0	094 +00120 0
093 -00102 0	093 -00007 0	093 -00034 0	093 +00009 0
092 -00111 0	092 -00005 0	092 -00021 0	092 +00021 0
091 +00011 0	091 +00040 0	091 +00079 0	091 +00105 0
090 -00070 0	090 -00040 0	090 -00004 0	090 +00026 0
089 -00084 0	089 -00027 0	089 +00026 0	089 +00072 0
088 -00165 0	088 -00145 0	088 -00122 0	088 -00102 0
087 -00119 0	087 -00121 0	087 -00120 0	087 -00132 0
086 -00006 0	086 +00025 0	086 +00052 0	086 +00082 0
085 -00129 0	085 -00107 0	085 -00075 0	085 -00050 0
084 -00355 0	084 -00310 0	084 -00217 0	084 -00225 0
083 -00109 0	083 -00103 0	083 -00092 0	083 -00082 0
082 500000 0	082 500000 0	082 500000 0	082 500000 0
081 500000 0	081 500000 0	081 500000 0	081 500000 0
080 500000 0	080 500000 0	080 500000 0	080 500000 0
019 500000 0	019 500000 0	019 500000 0	019 500000 0
018 500000 0	018 500000 0	018 500000 0	018 500000 0
017 500000 0	017 500000 0	017 500000 0	017 500000 0
016 500000 0	016 500000 0	016 500000 0	016 500000 0
015 500000 0	015 500000 0	015 500000 0	015 500000 0
014 -00015 0	014 -00077 0	014 -00134 0	014 -00189 0
013 +00015 0	013 +00053 0	013 +00132 0	013 +00147 0
012 +00037 0	012 +00180 0	012 +00319 0	012 +00449 0
011 +00005 0	011 -00000 0	011 -00005 0	011 -00008 0
010 -00009 0	010 +00016 0	010 +00037 0	010 +00057 0
009 +00021 0	009 +00122 0	009 +00218 0	009 +00310 0
008 +00008 0	008 +00024 0	008 +00044 0	008 +00053 0
007 -00029 0	007 -00056 0	007 -00083 0	007 -00100 0
006 -00045 0	006 -00137 0	006 -00231 0	006 -00318 0
005 -00002 0	005 -00012 0	005 -00023 0	005 -00031 0
004 +00003 0	004 -00003 0	004 -00012 0	004 -00019 0
003 -00001 0	003 +00043 0	003 +00081 0	003 +00119 0
002 -00001 0	002 -00024 0	002 -00037 0	002 -00054 0
001 -00000 0	001 -00014 0	001 -00019 0	001 -00025 0
000 +00003 0	000 +00030 0	000 +00090 0	000 +00141 0
000 131734 0	000 131734 0	000 131734 0	000 131734 0
000 131734 0	000 131734 0	000 131734 0	000 131734 0

STATIC TEST #1
 RUN NO. 5 150% DLL CLOSING LOAD 4/9/74

0%			40%			80%		
099	-002000	0	099	-014226	0	099	-011229	0
098	-001951	0	098	-003147	0	098	-000145	0
097	-001900	0	097	-000199	0	097	-000192	0
096	-000089	0	096	-000244	0	096	-000430	0
095	-000086	0	095	-000167	0	095	-000270	0
094	+000955	0	094	+000912	0	094	+000554	0
093	-000252	0	093	-000356	0	093	-000472	0
092	-000259	0	092	-000374	0	092	-000504	0
091	+000929	0	091	+000846	0	091	+000750	0
090	+000961	0	090	+000885	0	090	+000801	0
089	-000156	0	089	-000300	0	089	-000470	0
088	-000220	0	088	-000282	0	088	-000362	0
087	-000089	0	087	-000088	0	087	-000080	0
086	-000001	0	086	-000154	0	086	-000260	0
085	-000211	0	085	-000298	0	085	-000397	0
084	-000395	0	084	-000082	0	084	-000082	0
083	-000211	0	083	-000540	0	083	-000570	0
082	5000000	0	082	5000000	0	082	5000000	0
081	5000000	0	081	5000000	0	081	5000000	0
080	5000000	0	080	5000000	0	080	5000000	0
019	5000000	0	019	5000000	0	019	5000000	0
018	5000000	0	018	5000000	0	018	5000000	0
017	5000000	0	017	5000000	0	017	5000000	0
016	5000000	0	016	5000000	0	016	5000000	0
015	5000000	0	015	5000000	0	015	5000000	0
014	+000003	0	014	+000175	0	014	+000056	0
013	+000007	0	013	-000145	0	013	-000311	0
012	-000001	0	012	-000440	0	012	-000919	0
011	+000004	0	011	+000010	0	011	+000014	0
010	-000002	0	010	-000085	0	010	-000174	0
009	+000004	0	009	-000318	0	009	-000663	0
008	+000005	0	008	-000051	0	008	-000116	0
007	+000002	0	007	+000073	0	007	+000155	0
006	-000000	0	006	+000275	0	006	+000573	0
005	+000002	0	005	+000028	0	005	+000050	0
004	-000002	0	004	+000025	0	004	+000047	0
003	+000001	0	003	-000124	0	003	-000257	0
002	+000006	0	002	+000055	0	002	+000101	0
001	+000003	0	001	+000015	0	001	+000026	0
000	-000006	0	000	-000147	0	000	-000309	0
00-	110000	-	00-	110052	-	00-	110000	-
000	0	0	000	0	0	000	0	0

STATIC TEST #1
 RUN NO. 5 150% DLL CLOSING LOAD 4/9/74
 (CONT.)

120%		150%			
099	-00574	0	099	-01007	0
098	-00137	0	098	-00127	0
097	-00185	0	097	-00180	0
096	-00616	0	096	-00763	0
095	-00373	0	095	-00459	0
094	+00003	0	094	+00758	0
093	-00599	0	093	-00688	0
092	-00040	0	092	-00754	0
091	+00004	0	091	+00593	0
090	+00719	0	090	+00653	0
089	-00041	0	089	-00767	0
088	-00439	0	088	-00494	0
087	-00068	0	087	-00057	0
086	-00304	0	086	-00447	0
085	-00496	0	085	-00577	0
084	-00002	0	084	-00049	0
083	-00594	0	083	-00616	0
082	500000	0	082	500000	0
081	500000	0	081	500000	0
080	500000	0	080	500000	0
079	500000	0	079	500000	0
078	500000	0	078	500000	0
077	500000	0	077	500000	0
076	500000	0	076	500000	0
075	500000	0	075	500000	0
074	+00530	0	074	+00660	0
073	-00485	0	073	-00620	0
072	-01406	0	072	-01798	0
071	+00019	0	071	+00020	0
070	-00262	0	070	-00331	0
069	-01012	0	069	-01276	0
068	-00180	0	068	-00244	0
067	+00237	0	067	+00297	0
066	+00075	0	066	+01100	0
065	+00066	0	065	+00074	0
064	+00009	0	064	+00087	0
063	-00386	0	063	-00484	0
062	+00141	0	062	+00168	0
061	+00043	0	061	+00094	0
060	-00469	0	060	-00590	0
059	-111243	-	059	-111009	-
058	-00120	0	058	-00100	0

STATIC TEST #
 RUN NO. 6 177% DLL CLOSING LOAD 4/9/74

0%	40%	80%
099 -12713 0	099 -03762 0	099 -04117 0
098 -00170 0	098 -00160 0	098 -00157 0
097 -00240 0	097 -00242 0	097 -00233 0
096 -00136 0	096 -00292 0	096 -00467 0
095 -00123 0	095 -00206 0	095 -00299 0
094 +00720 0	094 +00086 0	094 +00042 0
093 -00290 0	093 -00389 0	093 -00373 0
092 -00001 0	092 -00412 0	092 -00233 0
091 +00025 0	091 +00757 0	091 +00075 0
090 +00010 0	090 +00052 0	090 +00775 0
089 -00212 0	089 -00340 0	089 -00505 0
088 -00250 0	088 -00015 0	088 -00304 0
087 -00100 0	087 -00104 0	087 -00090 0
086 -00100 0	086 -00185 0	086 -00200 0
085 -00201 0	085 -00329 0	085 -00420 0
084 -00111 0	084 -00102 0	084 -00039 0
083 -00001 0	083 -00070 0	083 -00000 0
082 500000 0	082 500000 0	082 500000 0
081 500000 0	081 500000 0	081 500000 0
080 500000 0	080 500000 0	080 500000 0
079 500000 0	079 500000 0	079 500000 0
078 500000 0	078 500000 0	078 500000 0
077 500000 0	077 500000 0	077 500000 0
076 500000 0	076 500000 0	076 500000 0
075 500000 0	075 500000 0	075 500000 0
074 -00001 0	074 +00173 0	074 +00332 0
073 +00001 0	073 -00149 0	073 -00313 0
072 -00003 0	072 -00444 0	072 -00922 0
071 +00004 0	071 +00010 0	071 +00014 0
070 -00004 0	070 -00086 0	070 -00175 0
069 -00002 0	069 -00316 0	069 -00061 0
068 +00003 0	068 -00054 0	068 -00119 0
067 +00001 0	067 +00075 0	067 +00158 0
066 -00003 0	066 +00270 0	066 +00580 0
065 -00003 0	065 +00026 0	065 +00040 0
064 +00000 0	064 +00029 0	064 +00051 0
063 -00000 0	063 -00123 0	063 -00200 0
062 +00004 0	062 +00049 0	062 +00070 0
061 -00000 0	061 +00012 0	061 +00020 0
060 -00001 0	060 -00140 0	060 -00300 0
059 -141000 0	059 -141000 0	059 -141000 0
058 -141000 0	058 -141000 0	058 -141000 0

STATIC TEST #1
 RUN NO. 6 177% DLL CLOSING LOAD 4/9/74
 (CONT.)

120%			150%			177%		
099	-02153	0	099	500000	0	099	-03435	0
098	-03122	0	098	-00125	0	098	-04119	0
097	-00209	0	097	-00202	0	097	-00197	0
096	-00039	0	096	-00763	0	096	-00900	0
095	-00302	0	095	-04459	0	095	-00534	0
094	+00596	0	094	+00558	0	094	+01519	0
093	-00002	0	093	-00722	0	093	-00773	0
092	-00052	0	092	-00745	0	092	-00351	0
091	+00000	0	091	+00554	0	091	+00472	0
090	+00705	0	090	+00055	0	090	+00596	0
089	-00051	0	089	-00793	0	089	-00095	0
088	-00448	0	088	-00503	0	088	-00552	0
087	-00061	0	087	-00094	0	087	-00046	0
086	-00308	0	086	-00455	0	086	-00528	0
085	-00522	0	085	-00065	0	085	-00056	0
084	-00066	0	084	-00008	0	084	-00040	0
083	-00004	0	083	-00021	0	083	-00041	0
082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0
079	500000	0	079	500000	0	079	500000	0
078	500000	0	078	500000	0	078	500000	0
077	500000	0	077	500000	0	077	500000	0
076	500000	0	076	500000	0	076	500000	0
075	500000	0	075	500000	0	075	500000	0
074	500000	0	074	500000	0	074	500000	0
073	500000	0	073	500000	0	073	500000	0
072	500000	0	072	500000	0	072	500000	0
071	500000	0	071	500000	0	071	500000	0
070	500000	0	070	500000	0	070	500000	0
069	+00525	0	069	+00054	0	069	+00765	0
068	-00491	0	068	-00025	0	068	-00749	0
067	-01406	0	067	-01774	0	067	-03103	0
066	+00017	0	066	+00019	0	066	+00014	0
065	-00265	0	065	-00333	0	065	-00095	0
064	-01011	0	064	-01277	0	064	-01513	0
063	-00191	0	063	-00249	0	063	-00332	0
062	+00239	0	062	+00297	0	062	+00347	0
061	+00082	0	061	+01107	0	061	+01312	0
060	+00060	0	060	+00071	0	060	+00079	0
059	+00072	0	059	+00089	0	059	+00107	0
058	-00384	0	058	-00483	0	058	-00567	0
057	+00136	0	057	+00164	0	057	+00180	0
056	+00042	0	056	+00053	0	056	+00061	0
055	-00405	0	055	-00584	0	055	-00090	0
054	-00550	0	054	-00731	0	054	-00229	0

STATIC TEST #1

RUN NO. 7 CLOSING CONDITION TO FAILURE 4/9/74

0%		100%		150%		200%	
099	-001613 0	099	-004007 0	099	-002003 0	099	-004003 0
098	-001100 0	098	-001107 0	098	-001200 0	098	-001100 0
097	-002229 0	097	-002210 0	097	-002004 0	097	-001900 0
096	-001009 0	096	-000700 0	096	-000700 0	096	-001009 0
095	-001400 0	095	-001003 0	095	-001000 0	095	-001000 0
094	+000000 0	094	+000002 0	094	+000000 0	094	+000400 0
093	-000000 0	093	-000000 0	093	-000000 0	093	-000000 0
092	-000000 0	092	-000000 0	092	-000000 0	092	-000000 0
091	+000000 0	091	+000000 0	091	+000000 0	091	+000000 0
090	+000000 0	090	+000000 0	090	+000000 0	090	+000000 0
089	-000000 0	089	-000000 0	089	-000000 0	089	-000000 0
088	-000000 0	088	-000000 0	088	-000000 0	088	-000000 0
087	-000000 0	087	-000000 0	087	-000000 0	087	-000000 0
086	-000000 0	086	-000000 0	086	-000000 0	086	-000000 0
085	-000000 0	085	-000000 0	085	-000000 0	085	-000000 0
084	-000000 0	084	-000000 0	084	-000000 0	084	-000000 0
083	-000000 0	083	-000000 0	083	-000000 0	083	-000000 0
082	000000 0	082	000000 0	082	000000 0	082	000000 0
081	000000 0	081	000000 0	081	000000 0	081	000000 0
080	000000 0	080	000000 0	080	000000 0	080	000000 0
019	000000 0	019	000000 0	019	000000 0	019	000000 0
018	000000 0	018	000000 0	018	000000 0	018	000000 0
017	000000 0	017	000000 0	017	000000 0	017	000000 0
016	000000 0	016	000000 0	016	000000 0	016	000000 0
015	000000 0	015	000000 0	015	000000 0	015	000000 0
014	+000000 0	014	+000000 0	014	+000000 0	014	+000000 0
013	-000000 0	013	-000000 0	013	-000000 0	013	-000000 0
012	-000000 0	012	-000000 0	012	-000000 0	012	-000000 0
011	-000000 0	011	-000000 0	011	-000000 0	011	-000000 0
010	-000000 0	010	-000000 0	010	-000000 0	010	-000000 0
009	-000000 0	009	-000000 0	009	-000000 0	009	-000000 0
008	+000000 0	008	+000000 0	008	+000000 0	008	+000000 0
007	-000000 0	007	-000000 0	007	-000000 0	007	-000000 0
006	+000000 0	006	+000000 0	006	+000000 0	006	+000000 0
005	-000000 0	005	-000000 0	005	-000000 0	005	-000000 0
004	+000000 0	004	+000000 0	004	+000000 0	004	+000000 0
003	-000000 0	003	-000000 0	003	-000000 0	003	-000000 0
002	-000000 0	002	-000000 0	002	-000000 0	002	-000000 0
001	-000000 0	001	-000000 0	001	-000000 0	001	-000000 0
000	-000000 0	000	-000000 0	000	-000000 0	000	-000000 0
000	150000 0	000	150000 0	000	150000 0	000	150000 0
000	000000 0	000	000000 0	000	000000 0	000	000000 0

STATIC TEST #1
 RUN NO. 7 CLOSING CONDITION TO FAILURE 4/9/74
 (CONT.)

240%			280%			290%		
099	-00107	0	099	-00107	0	099	-01287	0
098	-00170	0	098	-00001	0	098	-00001	0
097	-00100	0	097	-00101	0	097	-00169	0
096	-01210	0	096	-01449	0	096	-01401	0
095	-00708	0	095	-00000	0	095	-00012	0
094	+00417	0	094	+00007	0	094	+00000	0
093	-00079	0	093	-01104	0	093	-01100	0
092	-01000	0	092	-01271	0	092	-01200	0
091	+00011	0	091	+00102	0	091	+00000	0
090	+00443	0	090	+00000	0	090	+00000	0
089	-01174	0	089	-01000	0	089	-01000	0
088	-00002	0	088	-00779	0	088	-00700	0
087	-00018	0	087	+00000	0	087	+00001	0
086	-00707	0	086	-00047	0	086	-00000	0
085	-00023	0	085	-00007	0	085	-00042	0
084	-00004	0	084	+00029	0	084	+00020	0
083	-00000	0	083	-00000	0	083	-00007	0
082	00000	0	082	00000	0	082	00000	0
081	00000	0	081	00000	0	081	00000	0
080	00000	0	080	00000	0	080	00000	0
079	00000	0	079	00000	0	079	00000	0
078	00000	0	078	00000	0	078	00000	0
077	00000	0	077	00000	0	077	00000	0
076	00000	0	076	00000	0	076	00000	0
075	00000	0	075	00000	0	075	00000	0
074	+01009	0	074	+01194	0	074	+01100	0
073	-01000	0	073	-01007	0	073	-01000	0
072	-00000	0	072	-00007	0	072	-00000	0
071	-00000	0	071	-00001	0	071	-00000	0
070	-00001	0	070	-00000	0	070	-00000	0
069	-00000	0	069	-00000	0	069	-00000	0
068	-00000	0	068	-00000	0	068	-00000	0
067	+00000	0	067	+00000	0	067	+00000	0
066	+01700	0	066	+02100	0	066	+02000	0
065	+00001	0	065	+00100	0	065	+00000	0
064	+00149	0	064	+00100	0	064	+00100	0
063	-00707	0	063	-00000	0	063	-00000	0
062	+00002	0	062	+00000	0	062	+00000	0
061	+00000	0	061	+00000	0	061	+00000	0
060	-00000	0	060	-01141	0	060	-01100	0
059	-00000	0	059	-00000	0	059	-00000	0
058	-00000	0	058	-00000	0	058	-00000	0
057	-00000	0	057	-00000	0	057	-00000	0

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PA. 18974

3033

SUMMARY REPORT ON STATIC TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 2

- Ref: (a) LTV Report 2-53440/3R-10108, "Static Test Plan S-3A Composite Spoiler", Revised 27 Feb 1974
(b) NAVAIRDEVCCEN ltr report "Summary Report on Static Test Results for the S-3A Graphite Spoiler Number 1" dtd 30 May 1974

Figure B-10 Photograph No. CAD-19396-7-74--Failure of Spoiler at 360 percent DLL.

1. The spoiler was tested statically in two conditions -- the opening condition and the closing condition as described in reference (a). The loading sequence was the same as that for spoiler 1, described in reference (b) except that the spoiler was loaded to a maximum load of 150 percent limit load rather than the designated 115 percent limit load for the opening load condition.
2. The spoiler was installed in the test fixture at the hinges as described in reference (b). The spoiler was loaded successfully to 150 percent DLL in the opening condition without incident. While loading to 177 percent DLL in the closing condition, several tension pads unbonded from the spoiler. To prevent similar occurrences, "C" clamps were installed on the spoiler to transfer the applied loads from the inner surface to the outer surface. Loading was continued to failure. Failure occurred suddenly at 360 percent DLL with no noticeable sound emissions prior to failure. Failure occurred just outboard of the outboard hinge fitting as shown in Figure B-10.

Enclosure (1)

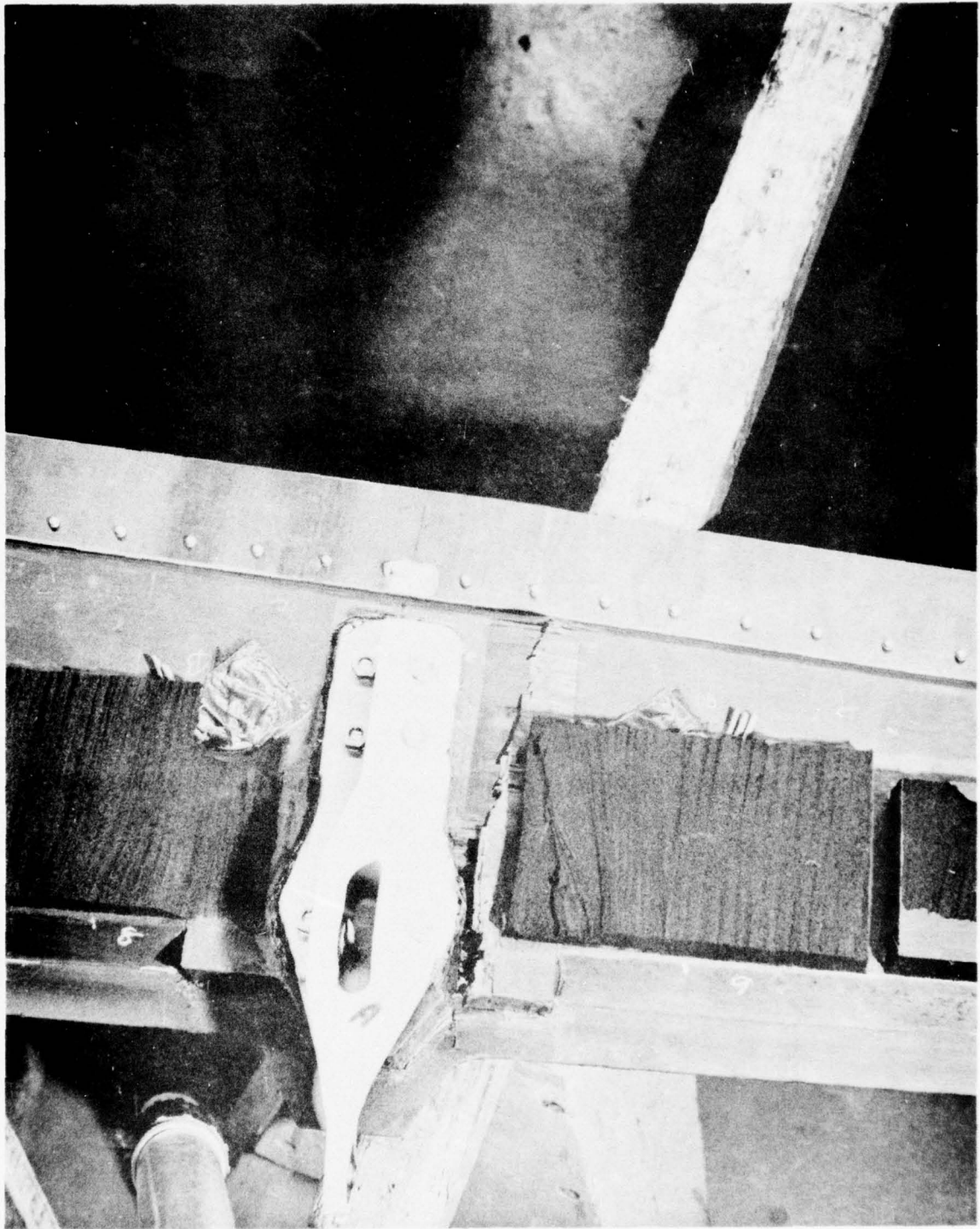


FIGURE B-10 SPOILER NO. 2 --- FAILURE AT 360 PERCENT DLL

STATIC TEST #2
 RUN NO. 3 150% DLL OPENING LOAD

0%			40%			80%		
099	-02091	0	099	-03133	x	099	-02104	0
098	-00243	0	098	-00301	k	098	-00387	0
097	-01263	0	097	-03134	k	097	-04001	0
096	-01369	0	096	-03045	k	096	-05060	0
095	-00283	0	095	-00410	k	095	-00591	0
094	-00031	0	094	-14972	k	094	-18494	0
093	+00035	0	093	+00295	k	093	+00219	0
092	-00040	0	092	-00034	k	092	-00056	0
091	-00097	0	091	-00060	k	091	-00068	0
090	-00180	0	090	-00272	k	090	-00371	0
089	-00097	0	089	-00114	k	089	-00179	0
088	-00277	0	088	-00281	k	088	-00310	0
087	-00063	0	087	-00155	k	087	-00263	0
086	-00241	0	086	-00477	k	086	-00724	0
085	-00144	0	085	-00115	0	085	-00085	0
084	-00105	0	084	-00091	0	084	-00083	0
083	-00250	0	083	-00411	0	083	-00589	0
082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	-00034	0
080	200000	0	080	200000	0	080	200000	0
019	-00020	0	019	-00019	0	019	-00020	0
018	+00001	0	018	-00000	0	018	-00002	0
017	+00011	0	017	+00011	0	017	+00010	0
016	+00005	0	016	+00005	0	016	+00003	0
015	500000	0	015	500000	0	015	500000	0
014	-00005	0	014	-000067	0	014	-00123	0
013	+00001	0	013	+00045	0	013	+00078	0
012	-00002	0	012	+00153	0	012	+00282	0
011	-00001	0	011	-00015	0	011	-00032	0
010	-00001	0	010	+00034	0	010	+00055	0
009	-00004	0	009	+00119	0	009	+00216	0
008	+00002	0	008	+00026	0	008	+00038	0
007	-00000	0	007	-00016	0	007	-00037	0
006	-00001	0	006	-00095	0	006	-00183	0
005	+00005	0	005	-00003	0	005	-00015	0
004	-00001	0	004	-00005	0	004	-00014	0
003	+00001	0	003	+00043	0	003	+00077	0
002	-00004	0	002	-00021	0	002	-00041	0
001	-00003	0	001	-00003	0	001	-00013	0
000	+00000	0	000	+00055	0	000	+00098	0
00-	090/52	-	00-	090911	-	00-	091009	0
000	000000	0	000	000040	0			

STATIC TEST #2
 RUN NO. 3 150% DLL OPENING LOAD
 (CONT.)

120%	150%
099 -02543 0	099 -01728 0
098 -00491 0	098 -00503 0
097 -07357 0	097 -10486 0
096 -06968 0	096 -09271 0
095 -00000 0	095 -01007 0
094 -21782 0	094 -23901 0
093 +00357 0	093 +00616 0
092 -00089 0	092 +00030 0
091 -00092 0	091 +00001 0
090 -00008 0	090 -00082 0
089 -00297 0	089 -00372 0
088 -00351 0	088 -00423 0
087 -00451 0	087 -00007 0
086 -01038 0	086 -01484 0
085 -00085 0	085 -00017 0
084 -00066 0	084 -00010 0
083 -00799 0	083 -01068 0
082 200000 0	082 200000 0
081 500000 0	081 500000 0
080 200000 0	080 200000 0
019 -00023 0	019 -00023 0
018 -00005 0	018 -00002 0
017 +00007 0	017 +00007 0
016 +00000 0	016 -00001 0
015 500000 0	015 500000 0
014 -00189 0	014 -00239 0
013 +00120 0	013 +00151 0
012 +00440 0	012 +00550 0
011 -00053 0	011 -00063 0
010 +00081 0	010 +00100 0
009 +00335 0	009 +00419 0
008 +00057 0	008 +00068 0
007 -00065 0	007 -00083 0
006 -00288 0	006 -00362 0
005 -00027 0	005 -00035 0
004 -00017 0	004 -00021 0
003 +00119 0	003 +00151 0
002 -00064 0	002 -00076 0
001 -00020 0	001 -00025 0
000 +00156 0	000 +00196 0
000 001123 0	000 001227 0

STATIC TEST #2
 RUN NO. 6 150% DLL CLOSING LOAD

0%		40%		80%	
099	-000004	099	-000704	099	+000099
098	-000113	098	-001008	098	-000110
097	-000024	097	-000319	097	-000306
096	-000080	096	-000237	096	-000399
095	-000131	095	-000211	095	-000286
094	+000071	094	+000048	094	+000020
093	-000139	093	-000219	093	-000299
092	-000193	092	-000292	092	-000398
091	-000120	091	-000174	091	-000227
090	-000140	090	-000196	090	-000249
089	-000178	089	-000327	089	-000489
088	-000335	088	-000403	088	-000408
087	-000093	087	-000095	087	-000090
086	-000210	086	-000292	086	-000360
085	-000190	085	-000270	085	-000368
084	-000111	084	-000104	084	-000094
083	+000019	083	+000007	083	-000010
082	2000000	082	5000000	082	+12730
081	-000120	081	-200243	081	-14023
080	-14143	080	-18037	080	-14082
019	-000054	019	-000055	019	-000054
018	-000020	018	-000030	018	-000029
017	+000007	017	+000006	017	+000007
016	-000013	016	-000015	016	-000014
015	5000000	015	5000000	015	5000000
014	+000006	014	+000193	014	+000300
013	-000003	013	-000143	013	-000294
012	+000003	012	-000469	012	-000960
011	-000001	011	+000035	011	+000070
010	+000002	010	-000118	010	-000245
009	-000006	009	-000367	009	-000741
008	+000004	008	-000072	008	-000154
007	-000008	007	+000039	007	+000080
006	-000010	006	+000277	006	+00079
005	+000000	005	+000031	005	+000052
004	-000003	004	+000014	004	+000034
003	-000006	003	-000131	003	-000208
002	+000009	002	+000067	002	+000126
001	-000000	001	+000010	001	+000024
000	+000006	000	-000101	000	-000335
000	1000000	000	1000438	000	1000010
000	0000000	000	0000040	000	0000080

STATIC TEST #2
 RUN NO. 6 150% DLL CLOSING LOAD
 (CONT.)

120%			150%		
099	-02528	0	099	-02795	0
098	-00113	0	098	-00116	0
097	-00305	0	097	-00304	0
096	-00594	0	096	-00714	0
095	-00376	0	095	-00444	0
094	-00020	0	094	-00046	0
093	-00403	0	093	-00486	0
092	-00516	0	092	-00606	0
091	-00305	0	091	-00354	0
090	-00315	0	090	-00361	0
089	-00660	0	089	-00780	0
088	-00544	0	088	-00599	0
087	-00095	0	087	-00087	0
086	-00466	0	086	-00533	0
085	-00469	0	085	-00545	0
084	-00084	0	084	-00082	0
083	-00033	0	083	-00041	0
082	500000	0	082	500000	0
081	-15974	0	081	-23365	0
080	-18129	0	080	-22772	0
019	-00055	0	019	-00055	0
018	-00029	0	018	-00029	0
017	+00007	0	017	+00005	0
016	-00014	0	016	-00014	0
015	500000	0	015	500000	0
014	+00572	0	014	+00697	0
013	-00463	0	013	-00587	0
012	-01491	0	012	-01857	0
011	+00184	0	011	+00126	0
010	-00379	0	010	-00470	0
009	-01144	0	009	-01421	0
008	-00253	0	008	-00325	0
007	+00132	0	007	+00160	0
006	+00908	0	006	+01135	0
005	+00071	0	005	+00080	0
004	+00060	0	004	+00080	0
003	-00387	0	003	-00472	0
002	+00185	0	002	+00227	0
001	+00036	0	001	+00042	0
000	-00524	0	000	-00654	0
100	300028	0	000	100003	-
			000	000150	0

STATIC TEST #2
 RUN NO. 7B 177% DLL CLOSING LOAD

0%	40%	80%
099 -003767	099 +00986	099 +01542
098 -00103	098 -00103	098 -00100
097 -00253	097 -00258	097 -00257
096 -00057	096 -00203	096 -00384
095 -00108	095 -00177	095 -00266
094 +00092	094 +00067	094 +00038
093 -00246	093 -00320	093 -00416
092 -00235	092 -00320	092 -00434
091 -00355	091 -00407	091 -00474
090 -00039	090 -00086	090 -00147
089 -00190	089 -00324	089 -00492
088 +00090	088 +00041	088 -00027
087 -00080	087 -00081	087 -00074
086 -00350	086 -00410	086 -00495
085 -00284	085 -00351	085 -00447
084 -00150	084 -00145	084 -00134
083 -00083	083 -00085	083 -00105
082 500000	082 500000	082 500000
081 -01054	081 -00251	081 -00439
080 -00693	080 -00204	080 -00616
019 -00040	019 -00046	019 -00047
018 -00020	018 -00020	018 -00021
017 +00004	017 +00003	017 +00003
016 -00008	016 -00008	016 -00008
015 500000	015 500000	015 500000
014 -00000	014 +00173	014 +00373
013 +00005	013 -00124	013 -00279
012 +00003	012 -00423	012 -00942
011 +00003	011 +00038	011 +00075
010 +00002	010 -00098	010 -00222
009 +00000	009 -00332	009 -00720
008 +00001	008 -00065	008 -00152
007 +00002	007 +00046	007 +00102
006 +00001	006 +00262	006 +00387
005 +00003	005 +00023	005 +00043
004 -00001	004 +00020	004 +00045
003 -00002	003 -00116	003 -00249
002 +00003	002 +00044	002 +00099
001 -00000	001 +00008	001 +00020
000 -00001	000 -00151	000 -00337
00- 135845	00- 140002	00- 140723
000 000135	000 000040	000 000080

STATIC TEST #2
 RUN NO. 7B 177% DLL CLOSING LOAD
 (CONT.)

120%		150%		177%	
099	-000310	099	-01071	099	-00340
098	-000093	098	-00098	098	-00091
097	-00247	097	-00247	097	-00241
096	-00260	096	-00097	096	-00013
095	-00353	095	-00413	095	-00472
094	+00010	094	-00021	094	-00044
093	-00502	093	-00077	093	-00642
092	-00549	092	-00037	092	-00709
091	-00533	091	-00585	091	-00025
090	-00200	090	-00238	090	-00276
089	-00647	089	-00771	089	-00079
088	-00096	088	-00153	088	-00197
087	-00067	087	-00064	087	-00057
086	-00581	086	-00053	086	-00710
085	-00540	085	-00021	085	-00088
084	-00121	084	-00119	084	-00108
083	-00117	083	-00124	083	-00134
082	500000	082	500000	082	500000
081	-00682	081	-12377	081	-14433
080	-04835	080	-11537	080	-12888
019	-00046	019	-00046	019	-00045
018	-00021	018	-00020	018	-00021
017	+00004	017	+00003	017	+00003
016	-00009	016	-00008	016	-00008
015	500000	015	500000	015	500000
014	+00554	014	+00690	014	+00005
013	-00432	013	-00553	013	-00664
012	-01436	012	-01815	012	-02156
011	+00109	011	+00133	011	+00152
010	-00340	010	-00428	010	-00510
009	-01108	009	-01397	009	-01657
008	-00244	008	-00315	008	-00383
007	+00154	007	+00193	007	+00226
006	+00899	006	+01141	006	+01355
005	+00060	005	+00072	005	+00083
004	+00069	004	+00090	004	+00107
003	-00309	003	-00459	003	-00538
002	+00150	002	+00189	002	+00221
001	+00033	001	+00041	001	+00048
000	-00515	000	-00648	000	-00768
00-	140932	00-	141013	00-	141131
000	000170	000	000150	000	000177

STATIC TEST #2
 RUN NO. 9 CLOSING CONDITION TO FAILURE

0%	40%	80%	120%
099 +00246 0	099 +02717 0	099 -003312 0	099 -01278 0
098 -000084 0	098 -000083 0	098 -000081 0	098 -000079 0
097 -000249 0	097 -000246 0	097 -000249 0	097 -000242 0
096 -000075 0	096 -000216 0	096 -000391 0	096 -000072 0
095 -000116 0	095 -000183 0	095 -000264 0	095 -000346 0
094 +000067 0	094 +000043 0	094 +000020 0	094 -000016 0
093 -000255 0	093 -000328 0	093 -000420 0	093 -000019 0
092 -000251 0	092 -000341 0	092 -000448 0	092 -000063 0
091 -000366 0	091 -000411 0	091 -000478 0	091 -000036 0
090 -000049 0	090 -000100 0	090 -000151 0	090 -000204 0
089 -000175 0	089 -000311 0	089 -000471 0	089 -000627 0
088 -000253 0	088 -000320 0	088 -000381 0	088 -000448 0
087 -000065 0	087 -000054 0	087 -000059 0	087 -000051 0
086 -000336 0	086 -000409 0	086 -000484 0	086 -000571 0
085 -000278 0	085 -000331 0	085 -000434 0	085 -000333 0
084 -000129 0	084 -000129 0	084 -000119 0	084 -000107 0
083 -000050 0	083 -000072 0	083 -000082 0	083 -000095 0
082 5000000 0	082 +12310 0	082 +09397 0	082 +13034 0
081 +000750 0	081 -02718 0	081 -01414 0	081 -11338 0
080 +000112 0	080 -04123 0	080 -04009 0	080 -07897 0
019 -000026 0	019 -000027 0	019 -000027 0	019 -000026 0
018 -000016 0	018 -000014 0	018 -000014 0	018 -000014 0
017 +000031 0	017 +000031 0	017 +000032 0	017 +000032 0
016 +000019 0	016 +000020 0	016 +000021 0	016 +000021 0
015 5000000 0	015 5000000 0	015 5000000 0	015 5000000 0
014 +000039 0	014 +000211 0	014 +000401 0	014 +000004 0
013 +000033 0	013 -000091 0	013 -000239 0	013 -000394 0
012 +000047 0	012 -000377 0	012 -000874 0	012 -01373 0
011 -000002 0	011 +000041 0	011 +000077 0	011 +000109 0
010 +000042 0	010 -000046 0	010 -000168 0	010 -000281 0
009 +000032 0	009 -000292 0	009 -000672 0	009 -01053 0
008 +000015 0	008 -000051 0	008 -000137 0	008 -000228 0
007 +000042 0	007 +000089 0	007 +000144 0	007 +000196 0
006 +000061 0	006 +000329 0	006 +000644 0	006 +000962 0
005 +000011 0	005 +000035 0	005 +000055 0	005 +000071 0
004 +000033 0	004 +000056 0	004 +000080 0	004 +000107 0
003 +000055 0	003 -000059 0	003 -000183 0	003 -000304 0
002 +000018 0	002 +000062 0	002 +000112 0	002 +000164 0
001 +000035 0	001 +000043 0	001 +000055 0	001 +000066 0
000 +000050 0	000 -000099 0	000 -000277 0	000 -000453 0
00- 100117 -	000 000000 0	00- 102400 -	00- 102444 -
000 000000 0		000 000000 0	000 000120 0

STATIC TEST #2
 RUN NO. 9 CLOSING CONDITION TO FAILURE
 (CONT.)

160%			200%			240%		
099	+00000	0	099	-04225	0	099	-03417	0
098	-00074	0	098	-00070	0	098	-00050	0
097	-00236	0	097	-00230	0	097	-00225	0
096	-00741	0	096	-00920	0	096	-01096	0
095	-00435	0	095	-00012	0	095	-00097	0
094	-00047	0	094	-00080	0	094	-00100	0
093	-00611	0	093	-00706	0	093	-00795	0
092	-00673	0	092	-00783	0	092	-00897	0
091	-00099	0	091	-00060	0	091	-00710	0
090	-00254	0	090	-00302	0	090	-00349	0
089	-00792	0	089	-00945	0	089	-01115	0
088	-00008	0	088	-00085	0	088	-00055	0
087	-00042	0	087	-00035	0	087	-00031	0
086	-00062	0	086	-00750	0	086	-00045	0
085	-00034	0	085	-00734	0	085	-00030	0
084	-00102	0	084	-00080	0	084	-00079	0
083	-00107	0	083	-00114	0	083	-00121	0
082	+10072	0	082	+13678	0	082	+11250	0
081	-00887	0	081	-10022	0	081	-10086	0
080	-00813	0	080	-07574	0	080	-07944	0
019	-00027	0	019	-00026	0	019	-00026	0
018	-00013	0	018	-00013	0	018	-00013	0
017	+00031	0	017	+00031	0	017	+00032	0
016	+00021	0	016	+00021	0	016	+00020	0
015	500000	0	015	500000	0	015	500000	0
014	+00762	0	014	+00932	0	014	+01100	0
013	-00057	0	013	-00723	0	013	-00902	0
012	-01079	0	012	-02383	0	012	-02904	0
011	+00139	0	011	+00163	0	011	+00184	0
010	-00400	0	010	-00018	0	010	-00044	0
009	-01440	0	009	-01825	0	009	-02221	0
008	-00327	0	008	-00431	0	008	-00541	0
007	+00248	0	007	+00290	0	007	+00344	0
006	+01285	0	006	+01003	0	006	+01927	0
005	+00086	0	005	+00100	0	005	+00111	0
004	+00136	0	004	+00165	0	004	+00193	0
003	-00420	0	003	-00039	0	003	-00057	0
002	+00213	0	002	+00258	0	002	+00303	0
001	+00075	0	001	+00085	0	001	+00092	0
000	-00031	0	000	-00006	0	000	-00056	0
00-	102528	-	00-	102012	-	00-	102053	-
000	000100	0	000	000200	0	000	000240	0

STATIC TEST #2
 RUN NO. 9 CLOSING CONDITION TO FAILURE
 (CONT.)

280%			320%			350%		
099	+00272	0	099	-01606	0	099	+02377	0
098	-00064	0	098	-00006	0	098	-00049	0
097	-00222	0	097	-00221	0	097	-00200	0
096	-01269	0	096	-01461	0	096	-01094	0
095	-00091	0	095	-00779	0	095	-00054	0
094	-00148	0	094	-00189	0	094	-00220	0
093	-00905	0	093	-01005	0	093	-01002	0
092	-01023	0	092	-01141	0	092	-01243	0
091	-00789	0	091	-00853	0	091	-00922	0
090	-00411	0	090	-00468	0	090	-00512	0
089	-01270	0	089	-01441	0	089	-01069	0
088	-00720	0	088	-00800	0	088	-00064	0
087	-00016	0	087	-00003	0	087	+00000	0
086	-00940	0	086	-01004	0	086	-01004	0
085	-00945	0	085	-01049	0	085	-01101	0
084	-00071	0	084	-00002	0	084	-00004	0
083	-00100	0	083	-00100	0	083	-00103	0
082	+10740	0	082	+06000	0	082	+10024	0
081	-09007	0	081	-11961	0	081	-14000	0
080	-06070	0	080	-09070	0	080	-10014	0
019	-00025	0	019	-00025	0	019	-00025	0
018	-00013	0	018	-00013	0	018	-00014	0
017	+00032	0	017	+00032	0	017	+00033	0
016	+00021	0	016	+00022	0	016	+00021	0
015	500000	0	015	500000	0	015	500000	0
014	+01256	0	014	+01094	0	014	+01498	0
013	-01091	0	013	-01203	0	013	-01447	0
012	-03420	0	012	-03920	0	012	-04000	0
011	+00197	0	011	+00194	0	011	+00184	0
010	-00766	0	010	-00885	0	010	-00900	0
009	-02011	0	009	-02977	0	009	-03272	0
008	-00055	0	008	-00760	0	008	-00062	0
007	+00087	0	007	+00420	0	007	+00440	0
006	+02244	0	006	+02044	0	006	+02787	0
005	+00116	0	005	+00110	0	005	+00107	0
004	+00220	0	004	+00240	0	004	+00201	0
003	-00773	0	003	-00881	0	003	-00968	0
002	+00346	0	002	+00301	0	002	+00408	0
001	+00099	0	001	+00102	0	001	+00105	0
000	-01766	0	000	-01037	0	000	-01479	0
00-	102706	-	00-	102047	-	00-	102902	-
000	000200	0	000	000320	0	000	000350	0

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PA. 18974

3033

SUMMARY REPORT ON STATIC TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 3

- Ref: (a) LTV Report 2-53440/3R-10108, "Static Test Plan S-3A Composite Spoiler", Revised 27 Feb 1974
(b) NAVAIRDEVCECEN ltr report "Summary Report on Static Test Results for the S-3A Graphite Spoiler Number 1, dtd 30 May 1974

Figure B-11 Photograph No. CAD-20807-12-74--Failure of Spoiler at 375 percent DLL.

1. The spoiler was tested statically in two conditions -- the opening condition and the closing condition as described in reference (a). The loading sequence was the same as that for spoiler 1, described in reference (b) except that the spoiler was loaded to a maximum load of 150 percent limit load rather than the designated 115 percent limit load for the opening load condition.
2. The spoiler was installed in the test fixture at the hinges as described in reference (b). The spoiler was loaded 150 percent DLL in the opening condition without incident. While loading to 170 percent DLL in the closing condition, a tension pad unbonded. A "C" clamp was installed to transfer the applied load from the inner surface to the outer surface. Loading was continued to 350 percent DLL at which point another tension pad unbonded. It was decided to install "C" clamps on all tension pads to prevent similar occurrences. Loading was continued to failure at 375 percent DLL with no noticeable sound emissions prior to failure. Failure occurred at the edge of the doubler outboard of the outboard hinge fitting. The failure is shown in Figure B-11.

Enclosure (2)

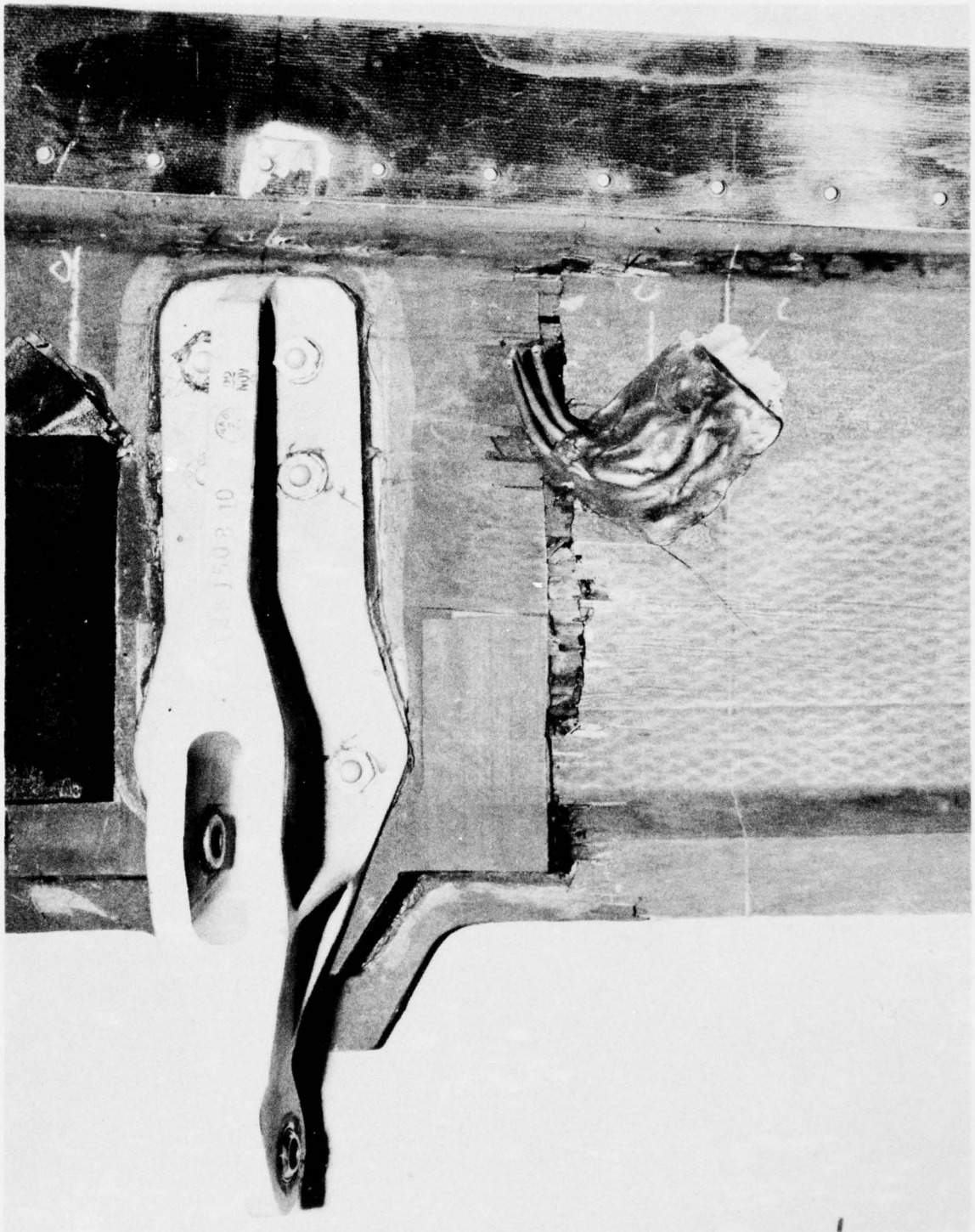


FIGURE B-11 SPOILER NO. 3 --- FAILURE AT 375 PERCENT DLL

STATIC TEST #3
 RUN NO. 3 150% DLL OPENING LOAD

0%			40%			80%		
099	+070006	0	099	+06168	0	099	+06703	0
098	-000032	0	098	-000011	0	098	-000015	0
097	-000014	0	097	-000003	0	097	-000004	0
096	-000011	0	096	+000053	0	096	+000099	0
095	-000014	0	095	+000019	0	095	+000042	0
094	-000013	0	094	+000003	0	094	+000012	0
093	+000000	0	093	+000035	0	093	+000060	0
092	+000014	0	092	+000043	0	092	+000070	0
091	-000000	0	091	+000015	0	091	+000030	0
090	+000002	0	090	+000023	0	090	+000047	0
089	-000047	0	089	+000034	0	089	+000079	0
088	-000007	0	088	+000025	0	088	+000042	0
087	-000021	0	087	-000002	0	087	-000006	0
086	-000002	0	086	+000029	0	086	+000047	0
085	-000019	0	085	+000020	0	085	+000043	0
084	-000006	0	084	+000003	0	084	+000001	0
083	-000009	0	083	+000004	0	083	+000006	0
082	2000000	0	082	2000000	0	082	2000000	0
081	2000000	0	081	2000000	0	081	2000000	0
080	2000000	0	080	2000000	0	080	2000000	0
019	+000046	0	019	+000044	0	019	+000044	0
018	+000033	0	018	+000031	0	018	+000031	0
017	+000047	0	017	+000043	0	017	+000044	0
016	+000065	0	016	+000061	0	016	+000062	0
015	5000000	0	015	5000000	0	015	5000000	0
014	+000006	0	014	-000057	0	014	-00107	0
013	+000004	0	013	+000043	0	013	+000079	0
012	+000013	0	012	+00150	0	012	+00279	0
011	+000012	0	011	-000014	0	011	-000029	0
010	+000004	0	010	+000020	0	010	+000030	0
009	+000006	0	009	+00113	0	009	+00200	0
008	+000010	0	008	+000025	0	008	+000038	0
007	+000006	0	007	-000018	0	007	-000035	0
006	-000012	0	006	-00101	0	006	-00170	0
005	+000013	0	005	-000003	0	005	-000013	0
004	+000003	0	004	-000006	0	004	-000013	0
003	+000009	0	003	+000047	0	003	+000001	0
002	+000004	0	002	-000021	0	002	-000039	0
001	+000009	0	001	-000001	0	001	-000005	0
000	+000010	0	000	+000058	0	000	+00100	0
00-	004038	-	00-	003035	-	00-	003916	-
000	0000133	0	000	0000133	0	000	0000133	0

STATIC TEST #3
 RUN NO. 3 150% DLL OPENING LOAD
 (CONT.)

120%	150%
099 +07000 0	099 +00045 0
098 -00020 0	098 -00021 0
097 -00011 0	097 -00012 0
096 +00160 0	096 +00200 0
095 +00070 0	095 +00092 0
094 +00010 0	094 +00027 0
093 +00088 0	093 +00108 0
092 +00111 0	092 +00143 0
091 +00056 0	091 +00079 0
090 +00260 0	090 +00094 0
089 +00130 0	089 +00167 0
088 +00065 0	088 +00082 0
087 -00012 0	087 -00019 0
086 +00060 0	086 +00084 0
085 +00067 0	085 +00080 0
084 -00006 0	084 -00011 0
083 +00011 0	083 +00016 0
082 200000 0	082 200000 0
081 200000 0	081 200000 0
080 200000 0	080 200000 0
019 +00044 0	019 +00044 0
018 +00030 0	018 +00032 0
017 +00044 0	017 +00045 0
016 +00061 0	016 +00062 0
015 500000 0	015 500000 0
014 -00165 0	014 -00206 0
013 +00122 0	013 +00140 0
012 +00421 0	012 +00018 0
011 -00045 0	011 -00050 0
010 +00054 0	010 +00065 0
009 +00315 0	009 +00386 0
008 +00051 0	008 +00059 0
007 -00059 0	007 -00076 0
006 -00265 0	006 -00320 0
005 -00023 0	005 -00033 0
004 -00018 0	004 -00025 0
003 +00121 0	003 +00150 0
002 -00060 0	002 -00073 0
001 -00011 0	001 -00015 0
000 +00140 0	000 +00101 0
000 -00400 0	000 +00101 0
000 000133 0	000 000133 0

STATIC TEST #3
 RUN NO. 6 150% DLL CLOSING LOAD

	0%	40%	80%
099	+08293 0	099 +08482 0	099 +08508 0
098	+08285 0	098 +08005 0	098 +08008 0
097	+08026 0	097 +08028 0	097 +08033 0
096	-08006 0	096 -08155 0	096 -08334 0
095	-08007 0	095 -08075 0	095 -08156 0
094	+08004 0	094 -08025 0	094 -08059 0
093	-08006 0	093 -08082 0	093 -08179 0
092	+08011 0	092 -08089 0	092 -08212 0
091	-08024 0	091 -08098 0	091 -08167 0
090	+08016 0	090 -08060 0	090 -08142 0
089	-08069 0	089 -08197 0	089 -08321 0
088	-08083 0	088 -08056 0	088 -08124 0
087	-08084 0	087 -08083 0	087 +08000 0
086	+08010 0	086 -08052 0	086 -08127 0
085	-08021 0	085 -08087 0	085 -08174 0
084	+08031 0	084 +08034 0	084 +08047 0
083	-08005 0	083 -08016 0	083 -08030 0
082	208000 0	082 208000 0	082 208000 0
081	208000 0	081 208000 0	081 208000 0
080	208000 0	080 208000 0	080 208000 0
019	+08022 0	019 +08024 0	019 +08027 0
018	+08013 0	018 +08015 0	018 +08014 0
017	+08046 0	017 +08049 0	017 +08052 0
016	+08073 0	016 +08074 0	016 +08073 0
015	508000 0	015 508000 0	015 508000 0
014	+08012 0	014 +08172 0	014 +08346 0
013	+08005 0	013 -08119 0	013 -08264 0
012	-08015 0	012 -08414 0	012 -08870 0
011	+08026 0	011 +08053 0	011 +08086 0
010	-08015 0	010 -08074 0	010 -08160 0
009	-08015 0	009 -08313 0	009 -08070 0
008	+08003 0	008 -08047 0	008 -08113 0
007	+08003 0	007 +08052 0	007 +08104 0
006	+08020 0	006 +08269 0	006 +08349 0
005	+08007 0	005 +08039 0	005 +08069 0
004	+08024 0	004 +08053 0	004 +08089 0
003	-08007 0	003 -08116 0	003 -08236 0
002	+08008 0	002 +08064 0	002 +08120 0
001	+08005 0	001 +08017 0	001 +08027 0
000	-08004 0	000 -08138 0	000 -08290 0
000	208132 0	000 208135 0	000 208143 0

STATIC TEST #3
 RUN NO. 6 150% DLL CLOSING LOAD
 (CONT.)

120%			150%		
099	+09676	0	099	+09005	0
098	+00011	0	098	+00017	0
097	+00033	0	097	+00040	0
096	-00012	0	096	-00051	0
095	-00246	0	095	-00309	0
094	-00094	0	094	-00121	0
093	-00283	0	093	-00357	0
092	-00330	0	092	-00416	0
091	-00236	0	091	-00287	0
090	-00212	0	090	-00258	0
089	-00016	0	089	-00037	0
088	-00188	0	088	-00237	0
087	+00012	0	087	+00022	0
086	-00209	0	086	-00268	0
085	-00272	0	085	-00340	0
084	+00057	0	084	+00004	0
083	-00042	0	083	-00048	0
082	200000	0	082	200000	0
081	200000	0	081	200000	0
080	200000	0	080	200000	0
019	+00029	0	019	+00026	0
018	+00017	0	018	+00017	0
017	+00053	0	017	+00052	0
016	+00072	0	016	+00075	0
015	500000	0	015	500000	0
014	+00017	0	014	+00032	0
013	-00423	0	013	-00543	0
012	-01343	0	012	-01682	0
011	+00117	0	011	+00131	0
010	-00234	0	010	-00282	0
009	-01031	0	009	-01280	0
008	-00190	0	008	-00250	0
007	+00168	0	007	+00213	0
006	+00845	0	006	+01059	0
005	+00094	0	005	+00188	0
004	+00123	0	004	+00146	0
003	-00356	0	003	-00438	0
002	+00174	0	002	+00208	0
001	+00039	0	001	+00045	0
000	-00445	0	000	-00374	0
00-	213406	-			
000	000133	0			

STATIC TEST #3
 RUN NO. 7 177% DLL CLOSING LOAD

0%	40%	80%
099 +00408 0	099 +00075 0	099 +02000 0
098 +00070 0	098 +00070 0	098 +00066 0
097 +00077 0	097 +00078 0	097 +00076 0
096 +00035 0	096 -00116 0	096 -00302 0
095 +00032 0	095 -00039 0	095 -00124 0
094 +00038 0	094 +00013 0	094 -00027 0
093 +00000 0	093 -00081 0	093 -00180 0
092 -00000 0	092 -00092 0	092 -00212 0
091 -00013 0	091 -00070 0	091 -00153 0
090 +00044 0	090 -00032 0	090 -00114 0
089 +00034 0	089 -00112 0	089 -00274 0
088 +00026 0	088 -00007 0	088 -00077 0
087 +00078 0	087 +00072 0	087 +00074 0
086 +00059 0	086 -00007 0	086 -00007 0
085 +00059 0	085 -00013 0	085 -00116 0
084 +00075 0	084 +00075 0	084 +00081 0
083 +00072 0	083 +00054 0	083 +00031 0
082 200000 0	082 200000 0	082 200000 0
081 200000 0	081 200000 0	081 200000 0
080 200000 0	080 200000 0	080 200000 0
019 -00002 0	019 -00004 0	019 -00002 0
018 -00017 0	018 -00016 0	018 -00015 0
017 +00021 0	017 +00022 0	017 +00023 0
016 +00045 0	016 +00046 0	016 +00046 0
015 500000 0	015 500000 0	015 500000 0
014 -00009 0	014 +00152 0	014 +00026 0
013 -00041 0	013 -00170 0	013 -00015 0
012 -00020 0	012 -00430 0	012 -00088 0
011 -00010 0	011 +00029 0	011 +00061 0
010 -00028 0	010 -00079 0	010 -00159 0
009 -00020 0	009 -00020 0	009 -00072 0
008 -00019 0	008 -00072 0	008 -00108 0
007 -00019 0	007 +00031 0	007 +00085 0
006 +00024 0	006 +00269 0	006 +00049 0
005 -00015 0	005 +00017 0	005 +00047 0
004 +00004 0	004 +00034 0	004 +00070 0
003 +00008 0	003 -00108 0	003 -00228 0
002 +00003 0	002 +00065 0	002 +00120 0
001 +00006 0	001 +00019 0	001 +00030 0
000 +00001 0	000 -00107 0	000 -00291 0
00- 004227 -	00- 004349 -	00- 004435 -
000 000133 0	000 000133 0	000 000133 0

STATIC TEST #3
 RUN NO. 7 177% DLL CLOSING LOAD
 (CONT.)

120%			150%			177%		
099	+00102	0	099	+00400	0	099	+01091	0
098	+00066	0	098	+00065	0	098	+00055	0
097	+00077	0	097	+00077	0	097	+00078	0
096	-00468	0	096	-00616	0	096	-00742	0
095	-00209	0	095	-00279	0	095	-00342	0
094	-00063	0	094	-00097	0	094	-00130	0
093	-00276	0	093	-00356	0	093	-00419	0
092	-00325	0	092	-00413	0	092	-00492	0
091	-00224	0	091	-00272	0	091	-00318	0
090	-00183	0	090	-00233	0	090	-00280	0
089	-00443	0	089	-00579	0	089	-00702	0
088	-00143	0	088	-00199	0	088	-00253	0
087	+00076	0	087	+00074	0	087	+00072	0
086	-00169	0	086	-00238	0	086	-00301	0
085	-00210	0	085	-00290	0	085	-00370	0
084	+00080	0	084	+00093	0	084	+00097	0
083	+00015	0	083	+00004	0	083	-00010	0
082	2000000	0	082	2000000	0	082	2000000	0
081	2000000	0	081	2000000	0	081	2000000	0
080	2000000	0	080	2000000	0	080	2000000	0
019	+00001	0	019	+00003	0	019	+00006	0
018	-00014	0	018	-00012	0	018	-00009	0
017	+00023	0	017	+00025	0	017	+00028	0
016	+00046	0	016	+00048	0	016	+00051	0
015	5000000	0	015	5000000	0	015	5000000	0
014	+00490	0	014	+00611	0	014	+00715	0
013	-00466	0	013	-00588	0	013	-00700	0
012	-01342	0	012	-01693	0	012	-02006	0
011	+00089	0	011	+00110	0	011	+00128	0
010	-00240	0	010	-00300	0	010	-00346	0
009	-01023	0	009	-01296	0	009	-01531	0
008	-00213	0	008	-00270	0	008	-00325	0
007	+00142	0	007	+00187	0	007	+00230	0
006	+00025	0	006	+01041	0	006	+01238	0
005	+00071	0	005	+00086	0	005	+00094	0
004	+00103	0	004	+00129	0	004	+00148	0
003	-00344	0	003	-00433	0	003	-00511	0
002	+00172	0	002	+00212	0	002	+00246	0
001	+00040	0	001	+00040	0	001	+00056	0
000	-00440	0	000	-00555	0	000	-00658	0
000	004535	0	000	008031	0	000	004833	0

AD-A032 816

LTV AEROSPACE CORP DALLAS TEX VOUGHT SYSTEMS DIV
S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM, VOLUME 1.(U)

F/G 1/3

AUG 74 O E DHONAU, E G BLOSSER
2-53443/4R-3172-VOL-1

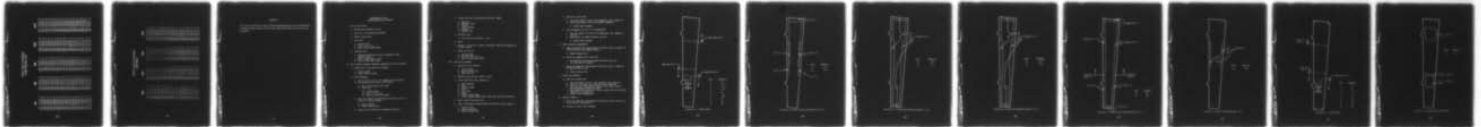
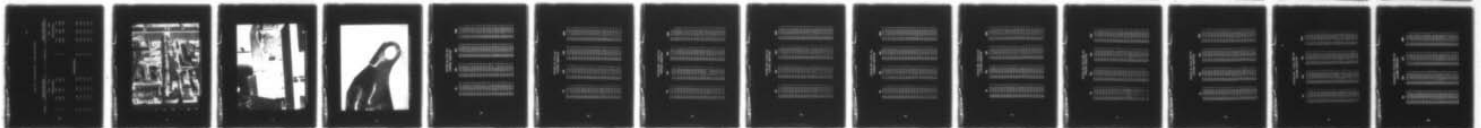
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UNCLASSIFIED

NADC-75141-30-VOL-1

NL

3 OF 3
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END

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1 - 77

OF 3
32816

STATIC TEST #3
 RUN NO. 9C CLOSING CONDITION TO FAILURE

0%		40%		80%		120%	
099	+04243	099	+00184	099	+00040	099	+00062
098	+00016	098	-00000	098	-00000	098	+00000
097	+00010	097	-00008	097	-00009	097	+00002
096	+00008	096	-00202	096	-00071	096	-00061
095	+00013	095	-00003	095	-00166	095	-00252
094	+00007	094	-00042	094	-00078	094	-00115
093	+00012	093	-00094	093	-00188	093	-00291
092	+00006	092	-00120	092	-00236	092	-00360
091	+00016	091	-00072	091	-00140	091	-00213
090	+00009	090	-00090	090	-00159	090	-00231
089	+00012	089	-00102	089	-00034	089	-00014
088	+00017	088	-00060	088	-00132	088	-00205
087	+00010	087	-00007	087	+00001	087	+00010
086	+00020	086	-00074	086	-00149	086	-00234
085	+00016	085	-00080	085	-00178	085	-00202
084	+00010	084	+00007	084	+00014	084	+00027
083	+00006	083	-00029	083	-00040	083	-00049
082	200000	082	200000	082	200000	082	200000
081	200000	081	200000	081	200000	081	200000
080	200000	080	200000	080	200000	080	200000
019	+00010	019	+00016	019	+00015	019	+00010
018	+00013	018	+00021	018	+00020	018	+00020
017	+00015	017	+00021	017	+00021	017	+00020
016	+00040	016	+00045	016	+00044	016	+00044
015	500000	015	500000	015	500000	015	500000
014	+00004	014	+00150	014	+00029	014	+00008
013	+00001	013	-00130	013	-00276	013	-00442
012	+00006	012	-00403	012	-00043	012	-01036
011	+00000	011	+00003	011	+00035	011	+00006
010	+00007	010	-00054	010	-00100	010	-00171
009	+00006	009	-00300	009	-00023	009	-00097
008	+00007	008	-00053	008	-00121	008	-00202
007	+00010	007	+00053	007	+00111	007	+00176
006	+00008	006	+00259	006	+00034	006	+00042
005	+00000	005	+00025	005	+00002	005	+00077
004	+00003	004	+00031	004	+00003	004	+00101
003	+00009	003	-00117	003	-00231	003	-00058
002	+00004	002	+00003	002	+00114	002	+00168
001	+00005	001	+00012	001	+00022	001	+00030
000	-00000	000	-00137	000	-00203	000	-00148
00-	024618	00-	020013	00-	020028	00-	020053
000	000000	000	000000	000	000000	000	000000

STATIC TEST #3
 RUN NO. 9C CLOSING CONDITION TO FAILURE
 (CONT.)

160%		200%		240%		280%	
099	+000003 0	099	+000090	099	+000425 0	099	+000080 0
098	+000004 0	098	+000009	098	+000015 0	098	+000012 0
097	+000006 0	097	+000014	097	+000022 0	097	+000022 0
096	-000114 0	096	-000001	096	-000060 0	096	-000246 0
095	-000320 0	095	-000415	095	-000409 0	095	-000502 0
094	-000145 0	094	-000104	094	-000215 0	094	-000255 0
093	-000376 0	093	-000403	093	-000570 0	093	-000600 0
092	-000462 0	092	-000500	092	-000690 0	092	-000818 0
091	-000270 0	091	-000344	091	-000403 0	091	-000472 0
090	-000204 0	090	-000350	090	-000405 0	090	-000457 0
089	-000059 0	089	-000031	089	-000004 0	089	-000159 0
088	-000259 0	088	-000334	088	-000394 0	088	-000460 0
087	+000020 0	087	+000028	087	+000030 0	087	+000048 0
086	-000303 0	086	-000395	086	-000472 0	086	-000560 0
085	-000362 0	085	-000463	085	-000556 0	085	-000672 0
084	+000038 0	084	+000045	084	+000056 0	084	+000064 0
083	-000055 0	083	-000064	083	-000068 0	083	+000055 0
082	2000000 0	082	2000000 0	082	2000000 0	082	-000061 0
081	2000000 0	081	2000000 0	081	2000000 0	081	-000002 0
080	2000000 0	080	2000000 0	080	2000000 0	080	2000000 0
019	+000010 0	019	+000016	019	+000016 0	019	+000016 0
018	+000020 0	018	+000020	018	+000020 0	018	+000021 0
017	+000020 0	017	+000020	017	+000021 0	017	+000020 0
016	+000045 0	016	+000044	016	+000045 0	016	+000045 0
015	5000000 0	015	5000000 0	015	5000000 0	015	5000000 0
014	+000050 0	014	+000026	014	+000071 0	014	+000130 0
013	-000507 0	013	-000770	013	-000939 0	013	-001149 0
012	-001700 0	012	-002274	012	-002736 0	012	-003279 0
011	+000090 0	011	+000114	011	+000128 0	011	+000140 0
010	-000241 0	010	-000327	010	-000403 0	010	-000488 0
009	-001320 0	009	-001723	009	-002075 0	009	-002491 0
008	-000270 0	008	-000360	008	-000457 0	008	-000560 0
007	+000231 0	007	+000293	007	+000346 0	007	+000400 0
006	+001104 0	006	+001419	006	+001698 0	006	+002024 0
005	+000090 0	005	+000111	005	+000116 0	005	+000121 0
004	+000132 0	004	+000171	004	+000190 0	004	+000236 0
003	-000403 0	003	-000591	003	-000704 0	003	-000830 0
002	+000213 0	002	+000265	002	+000333 0	002	+000409 0
001	+000038 0	001	+000047	001	+000053 0	001	+000059 0
000	-000507 0	000	-000700	000	-000900 0	000	-001179 0
00-	020011 -	00-	020026 -	00-	020056 -	00-	030044 -
000	000000 0	000	000000 0	000	000000 0	000	000000 0

STATIC TEST #3
 RUN NO. 9C CLOSING CONDITION TO FAILURE
 (CONT.)

320%	350%	370%
099 +00401 0	099 +00011 0	099 +00448 0
098 +00016 0	098 +00016 0	098 +00017 0
097 +00029 0	097 +00000 0	097 +00029 0
096 -01307 0	096 -01390 0	096 -01390 0
095 -00606 0	095 -00720 0	095 -00741 0
094 -00287 0	094 -00015 0	094 -00004 0
093 -00767 0	093 -00769 0	093 -00770 0
092 -00920 0	092 -01009 0	092 -01008 0
091 -00527 0	091 -00076 0	091 -00011 0
090 -00406 0	090 -00405 0	090 -00406 0
089 -01277 0	089 -01281 0	089 -01281 0
088 -00001 0	088 -00006 0	088 -00008 0
087 +00006 0	087 +00001 0	087 +00000 0
086 -00048 0	086 -00714 0	086 -00740 0
085 -00770 0	085 -00040 0	085 -00005 0
084 +00075 0	084 +00003 0	084 +00000 0
083 -00001 0	083 -00003 0	083 -00006 0
082 200000 0	082 200000 0	082 200000 0
081 200000 0	081 200000 0	081 200000 0
080 200000 0	080 200000 0	080 200000 0
019 +00016 0	019 +00017 0	019 +00017 0
018 +00022 0	018 +00022 0	018 +00022 0
017 +00021 0	017 +00021 0	017 +00021 0
016 +00046 0	016 +00045 0	016 +00046 0
015 500000 0	015 500000 0	015 500000 0
014 +01202 0	014 +01067 0	014 +01414 0
013 -01332 0	013 -01480 0	013 -01004 0
012 -00724 0	012 -04092 0	012 -04209 0
011 +00146 0	011 +00100 0	011 +00148 0
010 -00046 0	010 -00012 0	010 -00047 0
009 -02023 0	009 -00098 0	009 -00220 0
008 -00006 0	008 -00743 0	008 -00783 0
007 +00436 0	007 +00409 0	007 +00483 0
006 +02294 0	006 +02012 0	006 +02021 0
005 +00124 0	005 +00126 0	005 +00123 0
004 +00277 0	004 +00007 0	004 +00021 0
003 -00929 0	003 -01011 0	003 -01048 0
002 +00307 0	002 +00416 0	002 +00430 0
001 +00060 0	001 +00062 0	001 +00062 0
000 -01222 0	000 -01340 0	000 -01397 0
00- 030206 -	00- 030248 -	00- 030011 -
000 000000 0	000 000000 0	000 000000 0

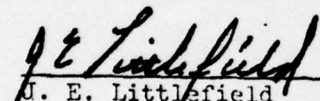
17 June 1974

Fatigue Test Plan S-3A
Composite Spoiler

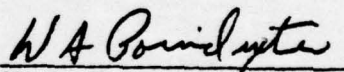
Prepared Under
Contract N62269-73-C-0610

BY
Vought Systems Division
LTV Aerospace Corporation
FOR
Naval Air Development Center
Warminster, Pa.

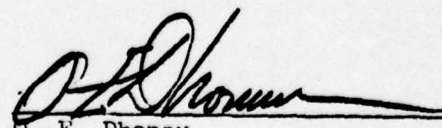
PREPARED BY:


U. E. Littlefield
Engineer Specialist - Structures

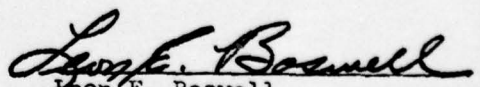
APPROVED BY:


W. A. Poindexter
Supervisor, Structures Tech.

REVIEWED BY:


U. E. Dhonau
Senior Specialist - Structures Tech.

APPROVED BY:


Leon E. Boswell
Supervisor, Structures

FATIGUE TEST PLAN S-3A ADVANCED COMPOSITE
SPOILER

PURPOSE:

The purpose of this test is to verify the fatigue capability of the graphite/epoxy spoiler for the S-3A aircraft.

DESCRIPTION OF TEST:

The specimen will be cyclic tested.

REQUIREMENT:

This test plan is required per contract N62269-73-C-0610.

TEST SPECIMEN:

The test specimen will consist of a graphite S-3A lower spoiler assembly as described in Dwg. 78-002553; Flap - S-3A Spoiler, LWR. O.P. Advanced Composite. The specimen will be supported at the actuator hinge fittings thru mounting holes, as shown in Figure B-10.

TEST CONDITIONS:

Spoiler hinge moments occur as a function of surface rotation and air speed. Table B-II gives maximum and minimum cyclic hinge moment for the fatigue test. Spanwise unit running hinge moment curves are presented in Figure B-11.

TEST SETUP:

The specimen will be installed in the test jig as shown in Figure B-10. Air loads on the spoiler will be simulated by applying test loads through tension pads. Figure B-10 shows location of pads and applied load at each.

TEST PROCEDURE:

The spoiler fatigue spectrum is given in Table B-II. A cycle of load is from zero load to minimum load to maximum load to zero. Loads are given as airload hinge moments. The specimen will be tested to two lifetimes. Continuous recording of applied loads is required. Test data will be acquired from three (3) rosette strain gages and twelve (12) deflection devices as shown in Figure B-12.

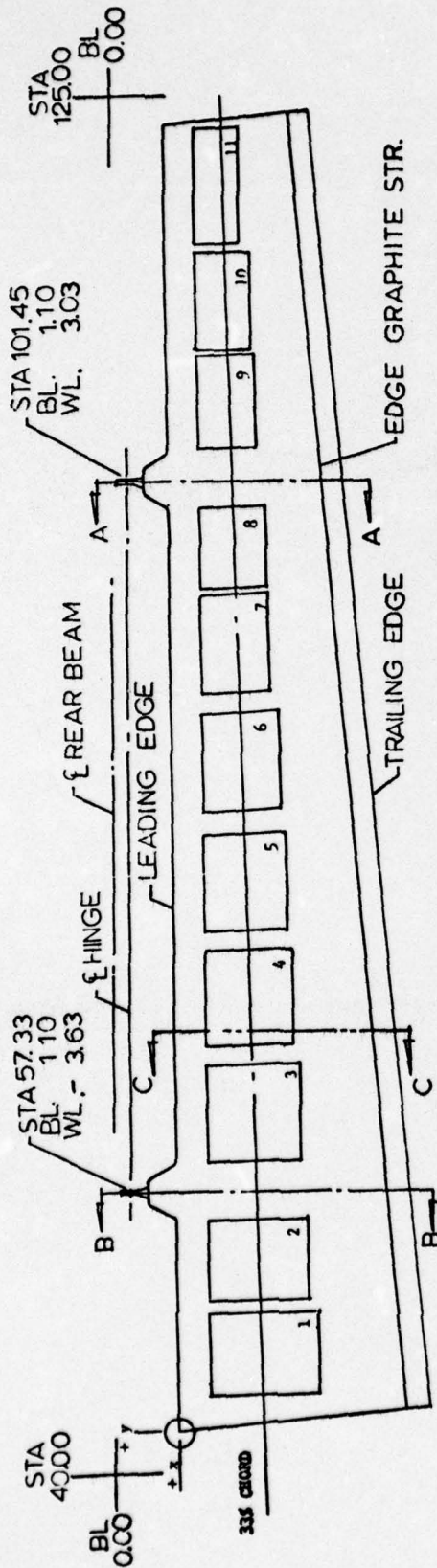
Strains will be reduced and plotted at end of each $1/4$ life as a check on predicted stress values. Deflection data will also be checked. If a change in deflection rate or strain rate occurs, a check of structure for permanent set will be made.

METHOD OF LOAD APPLICATION:

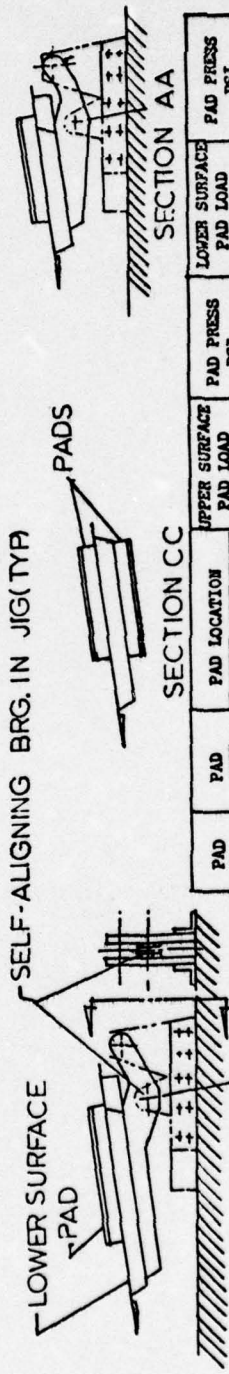
All loads will be applied to simulate as nearly as practicable the actual loads on the test article. Loads will be applied by rubber backed tension pads bonded to the surface. The test loads will be supplied to pads by means of hydraulic jacks.

MEASUREMENT OF STRUCTURAL DEFLECTIONS:

Structural deflections at spoiler and jig support points will be measured primarily by displacement devices supported by independent structures. The accuracy will be ± 0.02 inches deflection or better.



LOWER SPOILER (LOOKING AT OUTER SURFACE)



PAD NO.	PAD SIZE	PAD LOCATION		UPPER SURFACE PAD LOAD (TENSION)	PAD PRESS PSI	LOWER SURFACE PAD LOAD (TENSION)	PAD PRESS PSI
		X	Y				
1	5 x 6.4	7.38	8.20	274	8.56	137	4.28
2	5 x 6.2	12.90	7.80	215	6.94	108	3.48
3	6 x 5.8	22.32	7.45	213	6.12	107	3.07
4	6 x 5.3	29.56	6.90	213	6.70	107	3.36
5	6 x 4.9	36.79	6.50	193	6.56	96	3.26
6	6 x 4.6	44.03	6.20	193	7.00	96	3.48
7	6 x 4.3	51.26	5.80	178	6.46	89	3.45
8	5.3 x 4.0	57.00	5.68	137	6.30	69	3.25
9	5.6 x 3.6	66.50	5.15	127	8.50	63	3.12
10	6 x 3.1	72.97	4.70	158	9.73	79	4.25
11	5.8 x 2.8	79.25	4.32	158	8.50	79	4.36

- NOTES:
- Pads located \parallel and \perp to spoiler leading edge.
 - Measurements are positive otbd and aft.
 - All measurements are to be made on skin outside surface.
 - Pad pulloffs are to be located at the geometric center of each pad.
 - Pad pulloffs located on spoiler 335 chord (for engineering reference only).
 - Loads shown are maximum.

spad locations are given by locating the aft-otbd corner of pads.
X & Y are measured \parallel and \perp to spoiler leading edge beginning at fwd-labd surface corner.

FIGURE B-12 LOWER L. H. SPOILER FATIGUE TEST SET-UP AND LOAD REQUIREMENTS

TABLE B-II FATIGUE LOAD

CONDITION	CYCLES/LIFE	TEST LOAD (LB)	TEST H.M. (IN-LB)
COMPRESSION UPPER SURFACE	20,000 **	2059*	14,160 (Maximum) *
TENSION UPPER SURFACE		-1030*	-7,080 (Minimum) *

* includes 1.18 increase in loads because of outboard upper spoiler
deactivation- ECP 128

**one lifetime

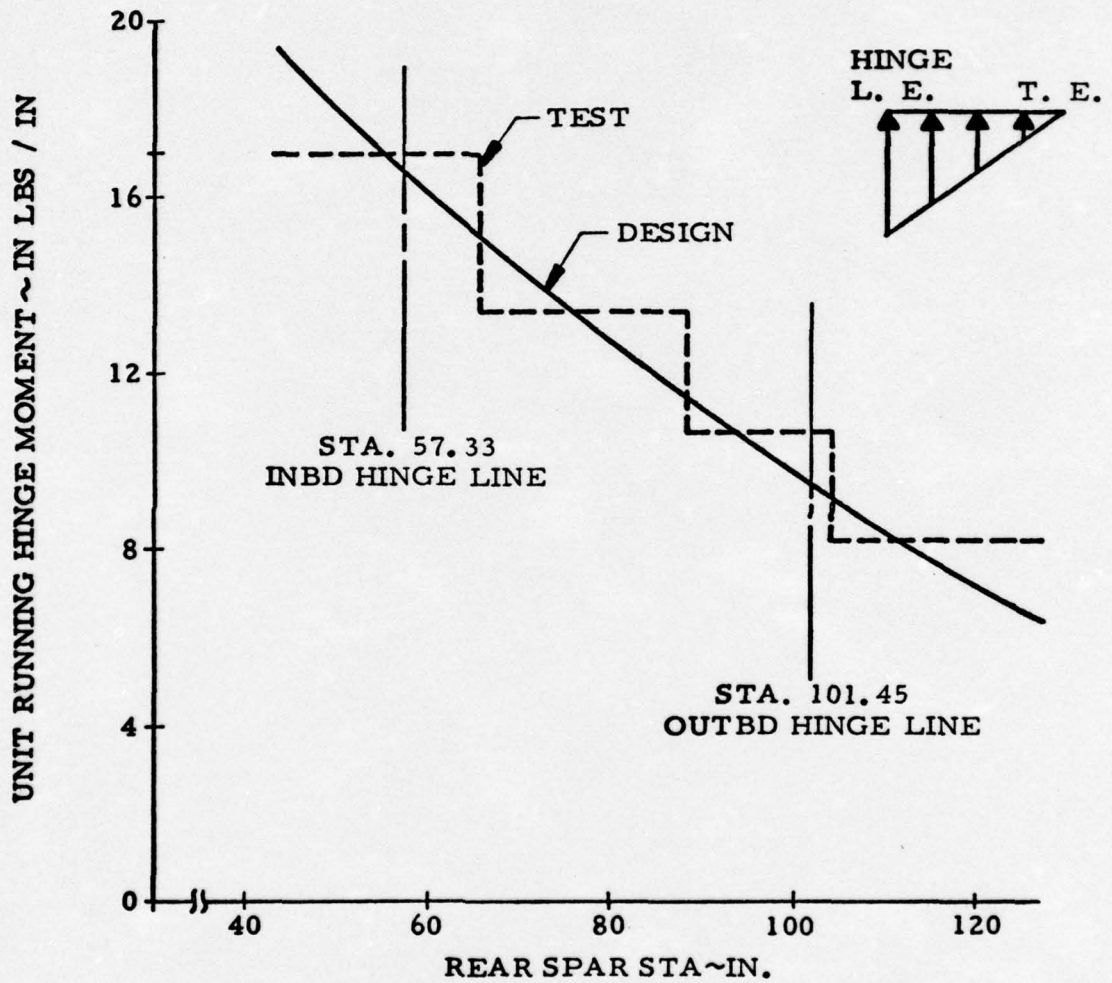


FIGURE B-13 S-3A COMPOSITE SPOILER SPANWISE
 RUNNING LOAD FOR A TOTAL SURFACE
 HINGE MOMENT OF 1000 IN - LBS APPLIED
 (FATIGUE CONDITION)

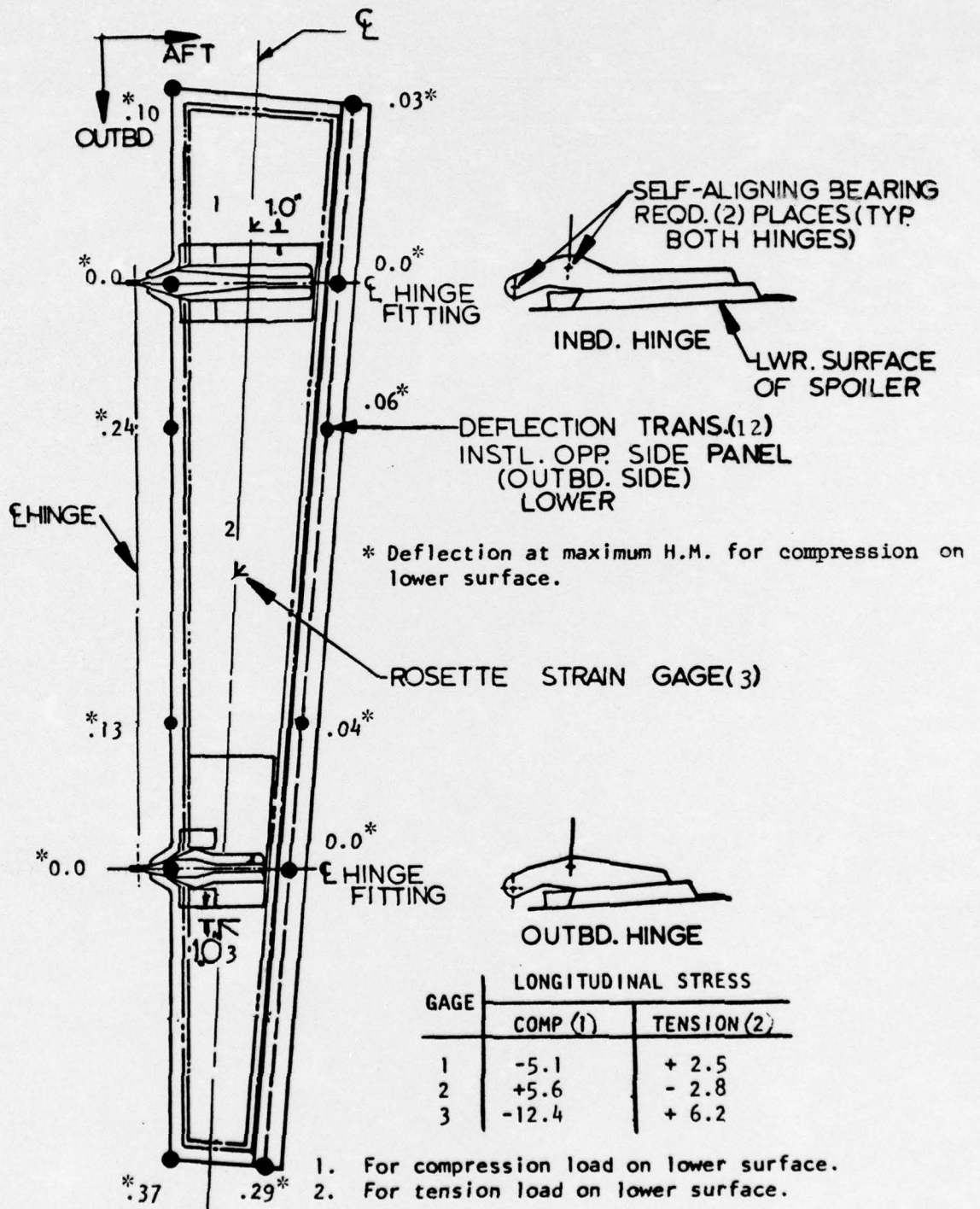


FIGURE B-14 DEFLECTION AND STRAIN GAGE LOCATION

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PA. 18974

3033

SUMMARY REPORT ON FATIGUE TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 4

Ref: (a) LTV Report No. 2-53440/3R-10109 "Fatigue Test Plan S-3A Composite Spoiler", Revised 17 Jun 1974
(b) NAVAIRDEVCEEN ltr report "Summary Report on Static Test Results for the S-3A Graphite Spoiler Number 1" dtd 30 May 1974

Table: (1) Fatigue Test Data -- Strain and Deflection

Figure B-15 Photograph No. CAD 20806-12-74-Test Set-up
Figure B-16 Photograph No. CAD 20805-12-74-Delamination Observed After 4800 Cycles
Figure B-17 Photograph No. CAD 20732-12-74-Outboard Fittings Failure
Figure (4) Photograph No. CAD 20829-12-74-Failure of Spoiler at 330 Percent DLL (Not Included in this Appendix)

1. The fatigue test was performed as described in reference (a). Loading consisted of constant amplitude cycling at the fatigue design loads shown in reference (a) for both the opening and closing conditions. Strain and deflection data were recorded periodically, and areas around the hinges were inspected at the same time with the Navy Ultrasonic Flow Detector AM/GSM 238. The spoiler sustained two equivalent lifetimes (40,000 cycles) of cyclic loading with no detectable damage. Strain and deflection data were monitored during the fatigue test and data for locations of interest are presented in Table III. The data indicated no significant changes in strain or deflection during the fatigue test.

2. Having satisfied the design requirements for fatigue with no detectable damage to the spoiler, the loads were increased to 150 percent DLL for the opening condition and 177 percent DLL for the closing condition and cycling was continued for an additional 40,000 cycles. The test setup was modified slightly after 4800 cycles to prevent unbonding of the tension pads and allow access to the areas around the hinges for ultrasonic inspection. With this modification, the applied loads were transferred from tension through the pads to compression on the opposite surface through aluminum channels shown in Figure B-15. During inspection at 4800 cycles, a slight delamination about 1.5 inches long was detected about 7 inches outboard of the outboard fitting shown in Figure B-16. Delamination appeared to be confined to the outer layer and did not increase in length during subsequent cycling.

Enclosure (3)

3. At approximately 22,000 cycles, failure of the inboard fitting occurred as shown in Figure B-17. The fitting was removed and replaced with the fitting from spoiler 3 and cycling was continued to 40,000 cycles without further incident. The data indicated no significant changes in strain or deflection during cycling at the higher loads as shown in Table III.

4. Static test to failure was accomplished after completion of the fatigue test. The spoiler was loaded in the closing condition in 20 percent DLL increments to 200 percent then in 10 percent increments to 330 percent DLL when failure suddenly occurred with no noticeable sound emissions prior to failure. The failure occurred approximately 4 inches outboard of the outboard hinge fitting as shown in Figure 4.

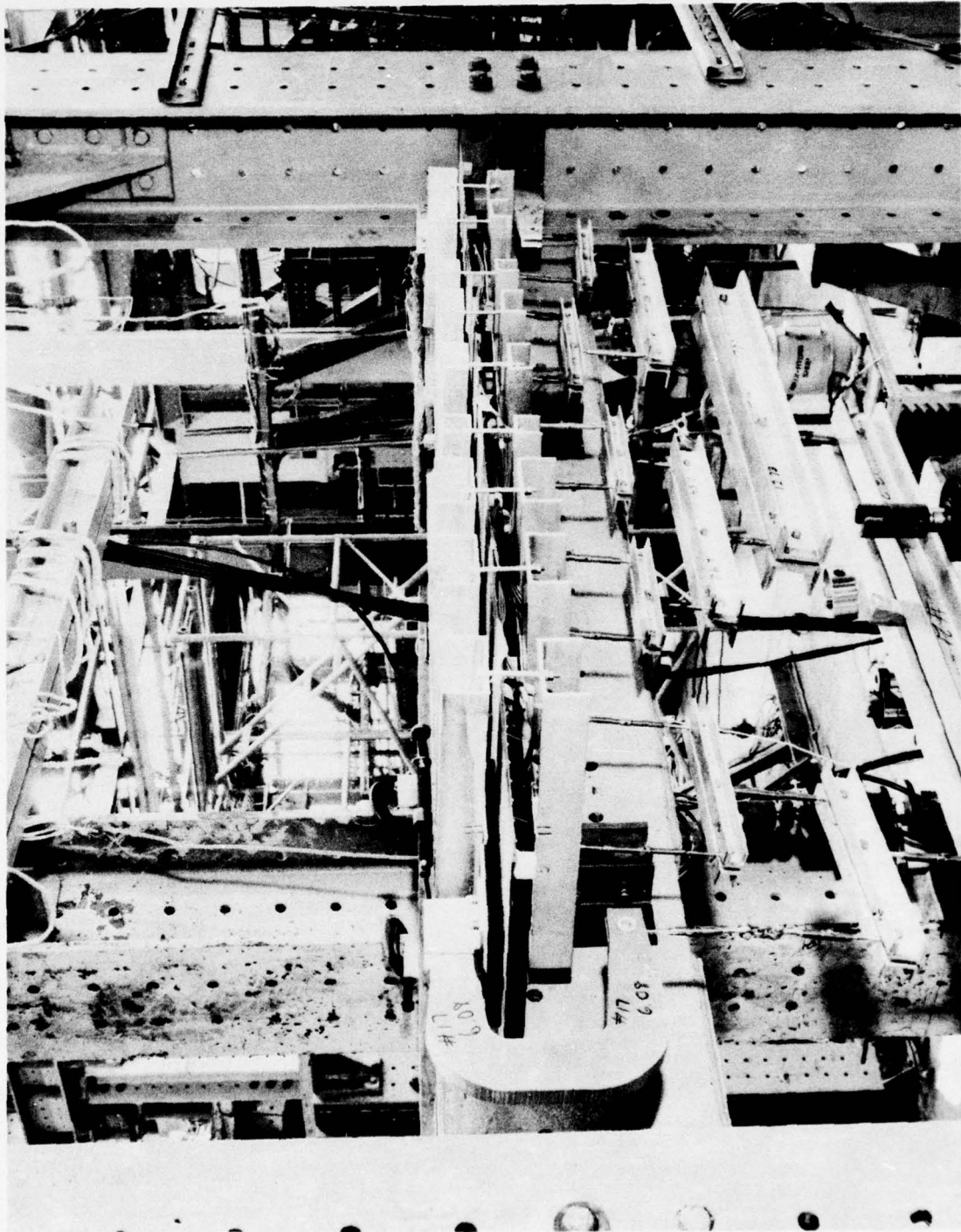


FIGURE B-15 SPOILER NO. 4 --- FATIGUE TEST SET-UP

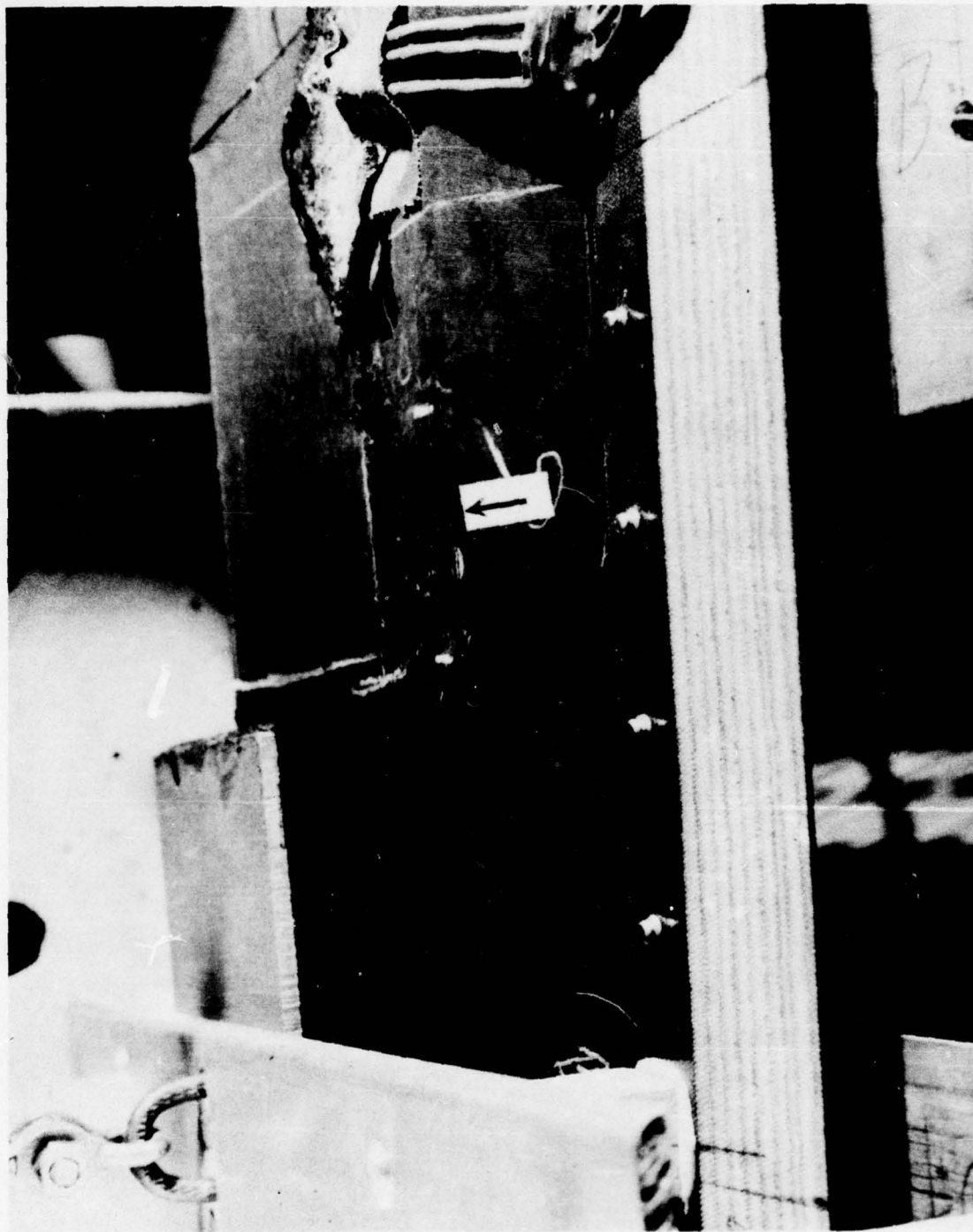


FIGURE B-16 SPOILER NO. 4 --- DELAMINATIONS (POST 4,800 CYCLES)



FIGURE B-17 SPOILER NO. 4 --- OUTBOARD FITTING FAILURE

FATIGUE 1st CYCLE DLL
OPENING CONDITION

0%	20%	60%	100%
099 -10245 0	099 -14228 0	099 -12041 0	099 -11749 0
098 -00025 0	098 -00020 0	098 -00020 0	098 -00020 0
097 -00017 0	097 -00020 0	097 -00018 0	097 -00017 0
096 +00016 0	096 +00042 0	096 +000148 0	096 +000220 0
095 -00025 0	095 -00040 0	095 +00031 0	095 +00033 0
094 -00028 0	094 -00021 0	094 +00030 0	094 +00030 0
093 -00220 0	093 -00197 0	093 -00116 0	093 -00059 0
092 -00174 0	092 -00138 0	092 -00047 0	092 +00011 0
091 -00083 0	091 -00053 0	091 +00028 0	091 +00030 0
090 -00054 0	090 -00020 0	090 +00025 0	090 +00037 0
089 -00005 0	089 +00000 0	089 +00004 0	089 +000124 0
088 -00000 0	088 -00001 0	088 +00039 0	088 +000078 0
087 -00010 0	087 -00020 0	087 -00043 0	087 -00004 0
086 -00040 0	086 -00030 0	086 +00012 0	086 +00048 0
085 -00020 0	085 -00012 0	085 +00018 0	085 +00043 0
084 -00073 0	084 -00074 0	084 -00097 0	084 -00106 0
083 +00025 0	083 +00009 0	083 +00040 0	083 +00039 0
082 +12405 0	082 +13272 0	082 500000 0	082 500000 0
081 500000 0	081 +00015 0	081 +01106 0	081 +00044 0
080 500000 0	080 -100 0	080 -14712 0	080 -09794 0
079 200000 0	079 20001 0	079 200000 0	079 200000 0
078 +00002 0	078 -00039 0	078 -00113 0	078 -00187 0
077 -00005 0	077 +00015 0	077 +00007 0	077 +000119 0
076 -00011 0	076 +00073 0	076 +00243 0	076 +000414 0
075 -00005 0	075 +00004 0	075 +00018 0	075 +00029 0
074 -00009 0	074 -00019 0	074 -00008 0	074 -000107 0
073 +00010 0	073 -00044 0	073 -00153 0	073 -00258 0
072 +00004 0	072 -00008 0	072 -00030 0	072 -00049 0
071 -00003 0	071 -00005 0	071 -00010 0	071 -00019 0
070 -00000 0	070 +00020 0	070 +00000 0	070 +00039 0

FATIGUE 1st CYCLE DLL
CLOSING CONDITION

	0%	20%	60%	100%
099	-14923	-13493	099	-12201
098	-00025	-00032	098	-00034
097	-00015	-00015	097	-00010
096	+00002	-00074	096	-00203
095	-00074	-00112	095	-00184
094	-00058	-00077	094	-00114
093	-00254	-00346	093	-00383
092	-00205	-00268	092	-00301
091	-00114	-00163	091	-00230
090	-00084	-00136	090	-00198
089	-00001	-00049	089	-00134
088	-00017	-00041	088	-00093
087	-00008	-00014	087	+00004
086	-00002	-00006	086	-00163
085	-00029	-00053	085	-00102
084	-00007	-00061	084	-00051
083	-00012	-00017	083	-00048
082	+13791	+15408	082	00000
081	00000	+04572	081	+00033
080	00000	-13910	080	-10900
079	00000	20000	079	20000
078	-00018	+00067	078	+00223
077	+00000	-00050	077	-00150
076	+00024	-00165	076	-00227
075	-00000	-00026	075	-00066
074	-00010	+00012	074	+00071
073	+00002	+00109	073	+00334
072	-00001	+00021	072	+00059
071	-00000	-00002	071	+00007
070	+00002	-00002	070	-00104
069	-17340		069	-17340
068	-00035		068	-00035
067	-00007		067	+00006
066	-00040		066	-00230
065	-00240		065	-00149
064	-00146		064	-00045
063	-00401		063	-00052
062	-00454		062	00000
061	-00208		061	+00006
060	-00258		060	-00143
059	-00218		059	+00006
058	-00143		058	-00143
057	+00006		057	+00006
056	-00230		056	-00230
055	-00149		055	-00149
054	-00045		054	-00045
053	-00052		053	-00052
052	00000		052	00000
051	+00006		051	+00006
050	-00312		050	-00312

FATIGUE 20K CYCLES DLL
OPENING CONDITION

0%	20%	60%	100%
099 -12447 0	099 -12842 0	099 -1/285 0	099 -1/471 0
098 -00000 0	098 -00013 0	098 -00012 0	098 -00013 0
097 -00007 0	097 -00011 0	097 -00013 0	097 -00011 0
096 -00003 0	096 +00018 0	096 +00007 0	096 +00016 0
095 +00003 0	095 +00018 0	095 +00053 0	095 +00086 0
094 -00012 0	094 +00008 0	094 +00018 0	094 +00031 0
093 -00007 0	093 -00014 0	093 +00043 0	093 +00077 0
092 -00006 0	093 -00000 0	092 +00044 0	092 +00086 0
091 -00002 0	092 -00001 0	091 +00031 0	091 +00050 0
090 +00003 0	091 +00002 0	090 +00031 0	090 +00055 0
089 -00002 0	089 +00000 0	089 +00059 0	089 +00097 0
088 -00003 0	088 +00003 0	088 +00027 0	088 +00052 0
087 +00000 0	087 -00001 0	087 -00010 0	087 -00021 0
086 -00000 0	086 -00003 0	086 +00022 0	086 +00048 0
085 +00000 0	085 -00006 0	085 +90008 0	085 +00027 0
084 -00000 0	084 -00010 0	084 -00014 0	084 -00022 0
083 -00005 0	083 -00006 0	083 -00006 0	083 -00003 0
082 20000 0	082 50000 0	082 50000 0	082 50000 0
081 20000 0	081 50000 0	081 +01200 0	081 +00033 0
080 20000 0	080 +01119 0	080 -1/160 0	080 -20182 0
089 20000 0	089 20000 0	089 20000 0	089 20000 0
088 +00002 0	088 -00033 0	088 -00104 0	088 -00172 0
087 -00007 0	087 +00014 0	087 +00063 0	087 +00107 0
086 -00010 0	086 +00007 0	086 +00233 0	086 +00389 0
085 +00001 0	085 +00007 0	085 +00019 0	085 +00031 0
084 -00000 0	084 -00024 0	084 -00077 0	084 -00114 0
083 +00002 0	083 -00004 0	083 -00150 0	083 -00249 0
082 -00004 0	082 -00015 0	082 -00035 0	082 -00056 0
081 -00007 0	081 -00010 0	081 -00023 0	081 -00030 0
080 +00002 0	080 +00027 0	080 +00080 0	080 +00141 0

FATIGUE 20K CYCLES DLL
CLOSING CONDITION

	0%	20%	60%	100%
099	-12016 0	-15664 0	-20197 0	-16875 0
098	-00015 0	-00015 0	-00011 0	-00014 0
097	-00015 0	-00016 0	-00009 0	-00014 0
096	-00015 0	-00088 0	-00224 0	-00354 0
095	-00086 0	-00048 0	-00111 0	-00175 0
094	-00019 0	-00038 0	-00068 0	-00093 0
093	-00018 0	-00056 0	-00128 0	-00197 0
092	-00017 0	-00067 0	-00158 0	-00231 0
091	-00011 0	-00032 0	-00085 0	-00132 0
090	-00015 0	-00033 0	-00084 0	-00123 0
089	-00012 0	-00060 0	-00154 0	-00233 0
088	-00010 0	-00042 0	-00092 0	-00137 0
087	-00017 0	-00017 0	-00010 0	-00088 0
086	-00018 0	-00053 0	-00117 0	-00178 0
085	-00011 0	-00033 0	-00079 0	-00125 0
084	-00016 0	-00018 0	-00011 0	-00011 0
083	-00011 0	-00011 0	-00025 0	-00035 0
082	00000 0	00000 0	00000 0	00000 0
081	00000 0	+11/47 0	+05213 0	+04090 0
080	-10004 0	-00016 0	-21056 0	-21037 0
079	00000 0	00000 0	00000 0	00000 0
078	+00004 0	+00088 0	+00237 0	+00390 0
077	-00011 0	-00066 0	-00172 0	-00279 0
076	-00010 0	-00195 0	-00502 0	-00925 0
075	-00002 0	-00020 0	-00059 0	-00104 0
074	-00017 0	+00027 0	+00093 0	+00150 0
073	-00002 0	+00106 0	+00322 0	+00543 0
072	-00006 0	+00016 0	+00055 0	+00090 0
071	-00007 0	-00003 0	+00009 0	+00021 0
070	-00001 0	-00062 0	-00193 0	-00321 0

FATIGUE 40K CYCLES DLL
OPENING CONDITION

	0%	20%	60%	100%
099	-19420	-19204	-19900	-21122
098	-00017	-00020	-00026	-00027
097	+00010	+00003	+00003	+00002
096	-00018	-00004	+00005	+00002
095	-00030	-00020	+00005	+00004
094	-00021	-00025	+00019	+00020
093	-00050	-00039	+00000	+00040
092	-00050	-00055	+00002	+00030
091	-00075	-00061	+00008	+00030
090	-00040	-00026	-00007	-00008
089	+00000	+00000	-00007	+00020
088	-00020	-00020	+00004	+00020
087	+00032	+00026	+00005	+00029
086	-00044	+00026	+00022	+00005
085	-00010	-00045	-00015	+00012
084	-00020	-00017	+00000	+00040
083	-00012	-00030	-00030	-00039
082	500000	-00018	-00017	-00013
081	500000	500000	500000	500000
080	500000	500000	500000	500000
009	200000	200000	200000	200000
008	-00004	-00042	-00113	-00100
007	+00003	+00027	+00075	+00126
006	-00006	+00001	+00240	+00406
005	-00001	+00004	+00016	+00031
004	-00007	-00027	-00006	-00123
003	+00000	-00047	-00149	-00255
002	+00001	-00006	-00020	-00040
001	-00003	-00005	-00017	-00026
000	+00007	+00030	+00092	+00149

FATIGUE 40K CYCLES DLL
CLOSING CONDITION

0%	20%	60%	100%
099 -1/353 0	099 -109/6 0	099 -1/309 0	099 -15/45 0
098 -00027 0	098 -00028 0	098 -00029 0	098 -00020 0
097 +00001 0	097 -00002 0	097 -00004 0	097 -00002 0
096 -00017 0	096 -00095 0	096 -00227 0	096 -00032 0
095 +/99/1 0	095 -00070 0	095 -00134 0	095 -00192 0
094 -00018 0	094 -00039 0	094 -00069 0	094 -00091 0
093 -00045 0	093 -00086 0	093 00015/ 0	093 -00223 0
092 -00058 0	092 -00112 0	092 -00194 0	092 -00272 0
091 -00005 0	091 -00092 0	091 -00134 0	091 -00175 0
090 -00028 0	090 -00055 0	090 -00100 0	090 -00136 0
089 +00009 0	089 -00072 0	089 -00102 0	089 -00030 0
088 -00031 0	088 -00063 0	088 -00112 0	088 -00160 0
087 +00009 0	087 +00003 0	087 +00012 0	087 +00017 0
086 -00048 0	086 -00086 0	086 -00146 0	086 -00206 0
085 -00013 0	085 -00054 0	085 -00126 0	085 -00197 0
084 -00041 0	084 -00090 0	084 -00037 0	084 -00028 0
083 -00021 0	083 -00026 0	083 -00039 0	083 -00043 0
082 00000 0	082 00000 0	082 00000 0	082 00000 0
081 00000 0	081 00000 0	081 00000 0	081 00000 0
080 00000 0	080 00000 0	080 00000 0	080 00000 0
079 20000 0	079 20000 0	079 20000 0	079 20000 0
078 -00006 0	078 +00001 0	078 +00230 0	078 +00009 0
077 +00003 0	077 -00055 0	077 -00156 0	077 -00257 0
076 -00004 0	076 -00204 0	076 -00571 0	076 -00934 0
075 -00002 0	075 -00024 0	075 -00066 0	075 -00110 0
074 -00013 0	074 +00024 0	074 +00090 0	074 +00154 0
073 -00002 0	073 +00121 0	073 +00341 0	073 +00500 0
072 +00000 0	072 +00021 0	072 +00050 0	072 +00093 0
071 -00005 0	071 +00004 0	071 +00013 0	071 +00024 0
070 +00007 0	070 -00004 0	070 -00012 0	070 -00030 0

FATIGUE 1st CYCLE 150% DLL
OPENING CONDITION

	0%	20%	60%	100%
099	-10011	-20046	099	-20177
098	-00017	-00026	098	-00024
097	+00040	+00052	097	+00023
096	-00017	+00023	096	+00133
095	-00030	-00013	095	+00051
094	-00010	-00011	094	+00025
093	-00071	-00052	093	+00006
092	-00096	-00074	092	+00001
091	-00112	-00103	091	-00061
090	-00055	-00044	090	-00008
089	+00050	+00071	089	+00138
088	-00026	-00018	088	+00017
087	+00059	+00047	087	+00028
086	-00044	-00039	086	-00003
085	-00004	-00008	085	+00031
084	-00027	-00030	084	-00040
083	-00018	-00010	083	-00018
082	500000	500000	082	500000
081	500000	500000	081	500000
080	500000	500000	080	500000
009	200000	200000	009	200000
008	+00002	-00046	008	-00136
007	+00005	+00038	007	+00102
006	-00001	+00111	006	+00013
005	+00003	+00011	005	+00028
004	+00004	-00019	004	-00007
003	+00001	-00005	003	-00194
002	+00007	-00005	002	-00029
001	-00002	-00000	001	-00021
000	500000	+00041	000	+00114

FATIGUE 1st CYCLE 177% DLL
CLOSING CONDITION

	0%	20%	60%	100%
099	-14012 0	-06900 0	-12002 0	-20961 0
098	-00020 0	+00022 0	+00011 0	+00000 0
097	+00017 0	+00057 0	+00050 0	+00033 0
096	-00001 0	-00110 0	-00420 0	-00737 0
095	-00017 0	-00051 0	-00209 0	-00363 0
094	-00013 0	-00011 0	-00000 0	-00157 0
093	-00057 0	-00101 0	-00279 0	-00465 0
092	-00077 0	-00130 0	-00334 0	-00563 0
091	-00096 0	-00123 0	-00220 0	-00379 0
090	-00040 0	-00053 0	-00154 0	-00303 0
089	+00024 0	-00050 0	-00055 0	-00042 0
088	-00026 0	-00046 0	-00105 0	-00293 0
087	+00012 0	+00026 0	+00026 0	+00059 0
086	-00050 0	-00079 0	-00231 0	-00394 0
085	-00012 0	-00054 0	-00210 0	-00406 0
084	-00041 0	-00006 0	+00011 0	+00013 0
083	-00015 0	+00004 0	-00034 0	+00007 0
082	00000 0	00000 0	00000 0	00000 0
081	00000 0	00000 0	00000 0	00000 0
080	00000 0	00000 0	00000 0	00000 0
079	00000 0	00000 0	00000 0	00000 0
078	-00002 0	+00177 0	+00335 0	+00007 0
077	+00009 0	-00106 0	-00349 0	-00012 0
076	+00010 0	-00404 0	-01270 0	-02147 0
075	+00005 0	-00043 0	-00140 0	-00276 0
074	-00004 0	+00078 0	+00230 0	+00342 0
073	-00005 0	+00240 0	+00770 0	+01300 0
072	+00011 0	+00020 0	+00140 0	+00210 0
071	-00002 0	+00013 0	+00030 0	+00057 0
070	+00005 0	-00140 0	-00439 0	-00730 0

FATIGUE 25K CYCLES 150% DLL
OPENING CONDITION

	0%	20%	60%	100%
099	+002109 0	-0/009 0	099 -04457 0	099 -04252 0
098	-000014 0	-000020 0	098 -000020 0	098 -000026 0
097	-000013 0	-000014 0	097 -000018 0	097 -000022 0
096	+000000 0	+000040 0	096 +000107 0	096 +000109 0
095	-000011 0	-000002 0	095 +000026 0	095 +000029 0
094	-000007 0	-000007 0	094 +000002 0	094 +000015 0
093	+000005 0	+000010 0	093 +000049 0	093 +000091 0
092	-000006 0	+000010 0	092 +000055 0	092 +000101 0
091	-000002 0	-000000 0	091 +000033 0	091 +000057 0
090	-000000 0	-000001 0	090 +000030 0	090 +000067 0
089	-000006 0	+000022 0	089 +000001 0	089 +000138 0
088	+000001 0	-000001 0	088 +000027 0	088 +000049 0
087	+000005 0	-000006 0	087 -000003 0	087 -000013 0
086	+000005 0	+000013 0	086 +000052 0	086 +000077 0
085	+000014 0	+000011 0	085 +000047 0	085 +000081 0
084	-000006 0	-000006 0	084 -000010 0	084 -000019 0
083	+000009 0	+000011 0	083 +000005 0	083 +000015 0
082	200000 0	200000 0	082 200000 0	082 200000 0
081	200000 0	200000 0	081 200000 0	081 200000 0
080	200000 0	20 000 0	080 200000 0	080 20 000 0
079	200000 0	200000 0	079 200000 0	079 20 000 0
078	-000006 0	-000006 0	078 -000142 0	078 -000225 0
077	+000000 0	+000007 0	077 +000005 0	077 +000140 0
076	-000003 0	+000110 0	076 +000312 0	076 +000502 0
075	-000006 0	+000004 0	075 +000025 0	075 +000041 0
074	-000001 0	-000022 0	074 -000000 0	074 -000096 0
073	+000005 0	-000070 0	073 -000204 0	073 -000331 0
072	+000000 0	-000000 0	072 -000002 0	072 -000050 0
071	-000000 0	-000005 0	071 -000013 0	071 -000019 0
070	+000010 0	+000040 0	070 +000120 0	070 +000187 0

FATIGUE 25K CYCLES 177% DLL
CLOSING CONDITION

	0%	20%	60%	100%	
099	-09473	099	-04930	099	-04930
098	-00025	098	-00026	098	-00026
097	-00043	097	-00020	097	-00020
096	-00022	096	-00130	096	-00420
095	-00017	095	-00091	095	-00223
094	-00012	094	-00041	094	-00091
093	-00002	093	-00093	093	-00250
092	-00009	092	-00112	092	-00300
091	-00003	091	-00070	091	-00189
090	-00005	090	-00073	090	-00172
089	-00011	089	-00155	089	-00410
088	-00006	088	-00069	088	-00167
087	-00016	087	-00016	087	-00000
086	-00003	086	-00079	086	-00229
085	-00005	085	-00076	085	-00243
084	-00017	084	-00014	084	-00002
083	-00004	083	-00029	083	-00020
082	-00004	082	-00000	082	-00000
081	-00004	081	-00000	081	-00000
080	-00000	080	-00000	080	-00000
079	-00000	079	-00000	079	-00000
078	-00011	078	-00011	078	-00016
077	-00006	077	-00120	077	-00366
076	-00005	076	-00432	076	-01200
075	-00000	075	-00053	075	-00150
074	-00000	074	-00074	074	-00217
073	-00004	073	-00027	073	-00002
072	-00009	072	-00053	072	-00134
071	-00001	071	-00016	071	-00044
070	-00001	070	-00010	070	-00070
069	-00001	069	-00010	069	-00095

STATIC TEST TO FAILURE
AFTER FATIGUE TEST

10%	40%	80%	120%	160%
099 -02002 0	099 -03001 0	099 -04001 0	099 -04/24 0	099 -0JY37 0
098 -00014 0	098 -00028 0	098 -00021 0	098 -00018 0	098 -00013 0
097 +00007 0	097 -00002 0	097 +00005 0	097 +00014 0	097 +00010 0
096 +00007 0	096 -00212 0	096 -00008 0	096 -00032 0	096 -00001 0
095 -00015 0	095 -00117 0	095 -00030 0	095 -00074 0	095 -00047 0
094 +00002 0	094 -00040 0	094 -00070 0	094 -00103 0	094 -00120 0
093 +00001 0	093 -00129 0	093 -00216 0	093 -00030 0	093 -00091 0
092 -00010 0	092 -00145 0	092 -00240 0	092 -00051 0	092 -00040 0
091 -00004 0	091 -00004 0	091 -00106 0	091 -00211 0	091 -00267 0
090 -00004 0	090 -00003 0	090 -00407 0	090 -00004 0	090 -00055 0
089 +00004 0	089 -00202 0	089 -00056 0	089 -00096 0	089 -00042 0
088 -00000 0	088 -00007 0	088 -00100 0	088 -00209 0	088 -00273 0
087 -00012 0	087 -00019 0	087 -00021 0	087 -00022 0	087 -00023 0
086 -00002 0	086 -00107 0	086 -00190 0	086 -00273 0	086 -00053 0
085 -00001 0	085 -00113 0	085 -00204 0	085 -00294 0	085 -00094 0
084 -00005 0	084 -00010 0	084 -00013 0	084 -00003 0	084 -00000 0
083 -00007 0	083 -00004 0	083 -00000 0	083 -00070 0	083 -00071 0
082 20000 0	082 20000 0	082 20000 0	082 20000 0	082 20000 0
081 20000 0	081 20000 0	081 20000 0	081 20000 0	081 20000 0
080 20000 0	080 20000 0	080 20000 0	080 20000 0	080 20000 0
089 20000 0	089 20000 0	089 20000 0	089 20000 0	089 20000 0
088 +00004 0	088 +00247 0	088 +00400 0	088 +00047 0	088 +00020 0
087 +00009 0	087 -00109 0	087 -00000 0	087 -00040 0	087 -00095 0
086 +00007 0	086 -00002 0	086 -01044 0	086 -01044 0	086 -02010 0
085 +00006 0	085 -00008 0	085 -00113 0	085 -00177 0	085 -00244 0
084 +00000 0	084 +00000 0	084 +00100 0	084 +00252 0	084 +00030 0
083 -00010 0	083 +00024 0	083 +00010 0	083 +00022 0	083 +01200 0
082 +00000 0	082 +00002 0	082 +00107 0	082 +00105 0	082 +00197 0
081 -00000 0	081 +00010 0	081 +00002 0	081 +00042 0	081 +00005 0
080/-00000 0	080/-00000 0	080 -00040 0	080 -00000 0	080 -00000 0

STATIC TEST TO FAILURE
CONTINUED

	200%	240%	280%	320%
099	-00024	099 -00022	099 -04/90	099 -00007
098	-00011	098 -00016	098 -00000	098 -00005
097	+00014	097 +00017	097 +00000	097 +00022
096	-00020	096 -00016	096 -01043	096 -01183
095	-00424	095 -00201	095 -00000	095 -00057
094	-00160	094 -00169	094 -00252	094 -00220
093	-00400	093 -00274	093 -00707	093 -00067
092	-00201	092 -00060	092 -00077	092 -00072
091	-00330	091 -00384	091 -00200	091 -00446
090	-00003	090 -00023	090 -00754	090 -00703
089	-00003	089 -00041	089 -01241	089 -01093
088	-00333	088 -00090	088 -00305	088 -00426
087	-00024	087 -00012	087 +00020	087 -00005
086	-00444	086 -00222	086 -00096	086 -00013
085	-00485	085 -00280	085 -00709	085 -00078
084	+00010	084 +00021	084 +00033	084 +00024
083	-00002	083 -00009	083 -00092	083 -00090
082	200000	082 200000	082 200000	082 200000
081	200000	081 200000	081 200000	081 200000
080	200000	080 200000	080 200000	080 200000
079	200000	079 200000	079 200000	079 200000
078	+01010	078 +01193	078 +01252	078 +01064
077	-00726	077 -00023	077 -01276	077 -01098
076	-02219	076 -00009	076 -00092	076 -00304
075	-00311	075 -00384	075 -00248	075 -00462
074	+00410	074 +00485	074 +00023	074 +00256
073	+01202	073 +01793	073 +02372	073 +02087
072	+00202	072 +00274	072 +00314	072 +00298
071	+00073	071 +00087	071 +00102	071 +00090
070	-00017	070 -00072	070 -01274	070 -01126

APPENDIX C

This section contains the final revised manufacturing plan for the fabrication of graphite/epoxy spoilers for the lower left hand surface of the S-3A outer wing panel.

MANUFACTURING PLAN
GRAPHITE/EPOXY S-3A SPOILER

- I. Core Stabilization
 - A. Machine core segments to size
 - B. Sand .125 R per engineering drawing
 - C. Machine lower bevels
 - D. Clean core
 - 1. Solvent flush
 - 2. Dry (1 hr. @ R.T.)
 - 3. Wrap in clean Kraft paper
 - E. Stabilize core
 - 1. Stabilize periphery of core by dipping SC 1008 phenolic resin
 - 2. Cure in oven (350F - 1 hr.)
 - 3. Wrap in clean Kraft paper
- II. Tab Stiffener Assembly (Separate Operation) For Four Spoilers
 - A. Prepare tool (flat plate) for bonding
 - 1. Solvent clean
 - 2. Apply release coating
 - B. From broadgoods
 - 1. Lay up one (10 x 26) 4 ply laminate (per 78-002553)
 - 2. Trim one piece HRP core, 5 x 26 inches
 - a. Saw 26 inch edges at 30° bevel
 - b. Clean core
 - (1) Solvent flush
 - (2) Dry (1 hr. @ R.T.)
 - (3) Wrap in clean Kraft paper
 - 3. Trim film adhesive, specification 207-8-115, type II, grade 10 to match laminate
 - a. Apply adhesive
 - b. Remove backing film
 - 4. Apply core to adhesive per engineering drawing

C. Prepare for cure (specification 208-8-3), apply:

1. Peel ply
2. Separator film
3. Bleeder
4. Vacuum bleeder
5. Breather
6. Bagging film

D. Autoclave cure

1. Door close to door open - 4 hrs.

E. Debag

F. Machine - 22 and 23, (4 each) (78-002553) from stock produced by B thru E above.

G. Clean -22 and -23

1. Solvent clean
2. Dry (160F for 1 hr.)
3. Wrap in clean Kraft paper

III. Lower Skin Assembly

A. Prepare tool for bonding

1. Solvent clean
2. Apply release film
3. Apply peel ply

B. Template trim 120 mesh screen to size

C. Clean screen (CVA 8-51, Method II)

1. Vapor degrease
2. Rinse
3. Alkaline clean
4. Rinse
5. Acid clean
6. Rinse
7. Protect (paper wrap)
8. After cleaning handle screen only when using cotton gloves

D. Apply screen in molding tool

E. Apply film adhesive, specification 207-8-415, type II, grade 10

1. Template trim
2. Place on assembly
3. Remove backing film

F. Hand lay up lower skin

1. Trim plies number 1 thru 9 (one template) (Ref. Figure C1)
2. Place lower skin on tool (use transfer template)
 - a. Remove mylar backing

G. From broadgoods (38 x 90 - 45° orientation)

1. Trim ply numbers 10 thru 18 (17 templates) (Ref. Figures C2 thru C6)
2. Apply plies, in proper sequence, on tool
 - a. Remove Mylar backing

IV. Lower Skin/Core Subassembly

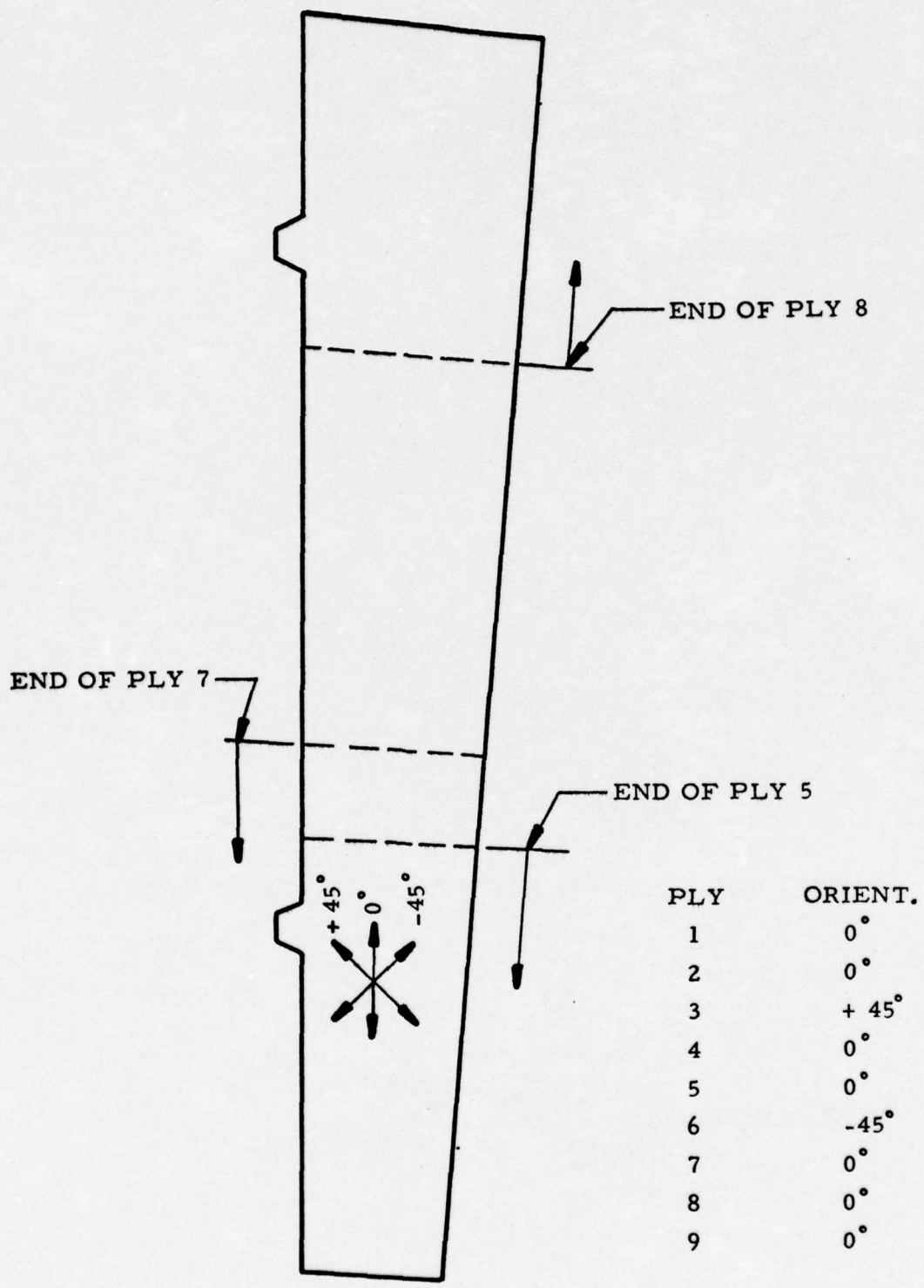
- A. Apply film adhesives, specification 207-8-415, type II, grade 10, to lower skin to core faying surface
 1. Remove backing film
- B. Place core segments onto lower skin
 1. Use adhesive foam specification 207-8-408, type III, for core splice (2 places)
- C. Apply film adhesive, specification 207-8-415, type II, grade 10 to upper surface of core
 1. Remove backing film

V. Upper Skin Assembly

- A. Hand lay up upper skin
 1. Trim ply numbers 1 thru 9 (one template) (Ref Figure C7)
 2. Trim plies for upper skin doublers (three templates)
 3. Apply to tool (use transfer template) butt joint corners per engineering drawing 78-002553
 4. Apply upper skin doubler ply stack on upper skin (use transfer template) (Ref Figure C8)
 5. Protect from contamination

VI. Spoiler Assembly

- A. Apply film adhesive, specification 207-8-415, type II, grade 10, to -22 and -23 (reference II)
- B. Position -22 and -23 on assembly



PLY	ORIENT.
1	0°
2	0°
3	+ 45°
4	0°
5	0°
6	-45°
7	0°
8	0°
9	0°

FIGURE C-1 LOWER SKIN

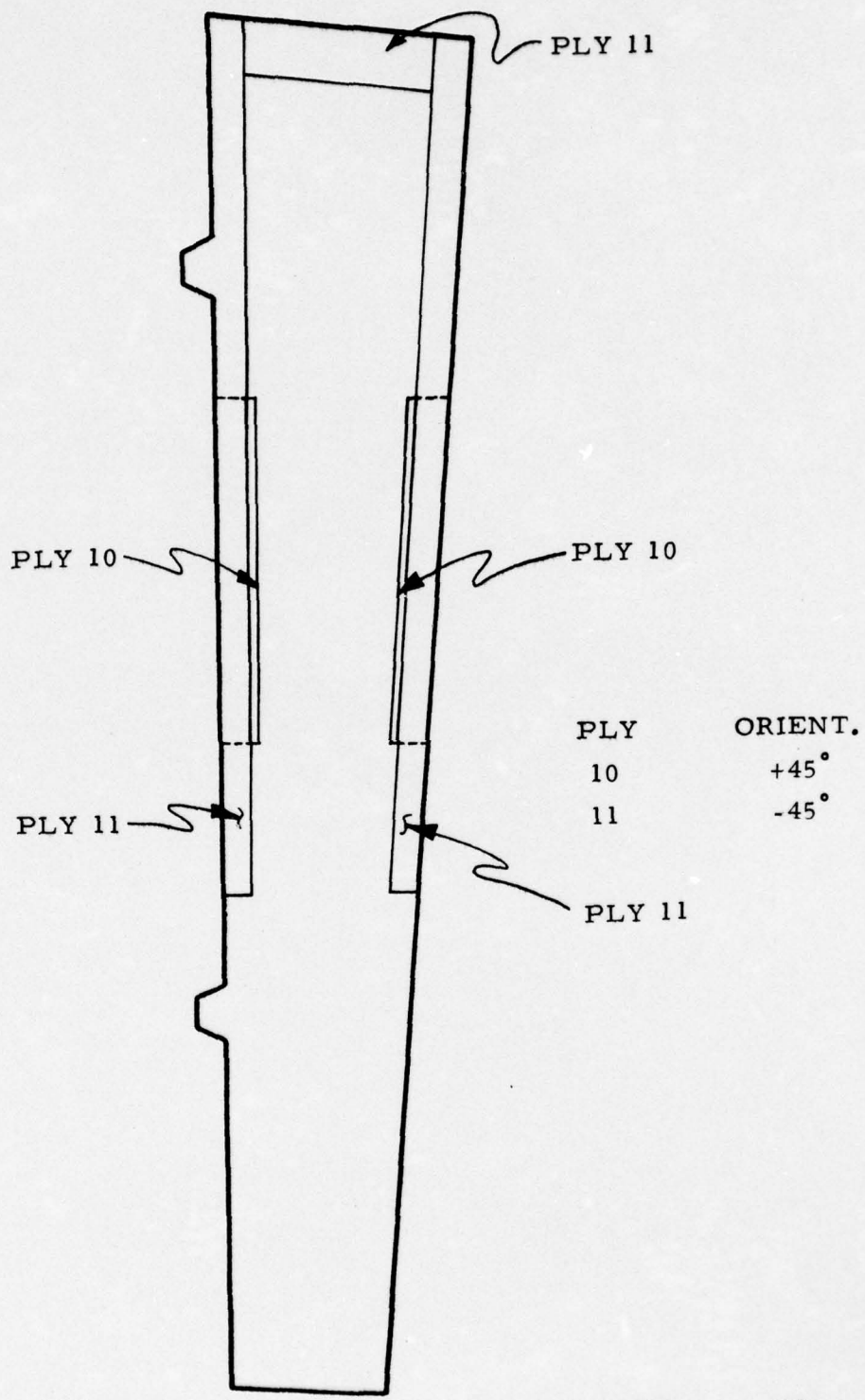


FIGURE C-2 EDGE DOUBLERS (PLIES 10 & 11)

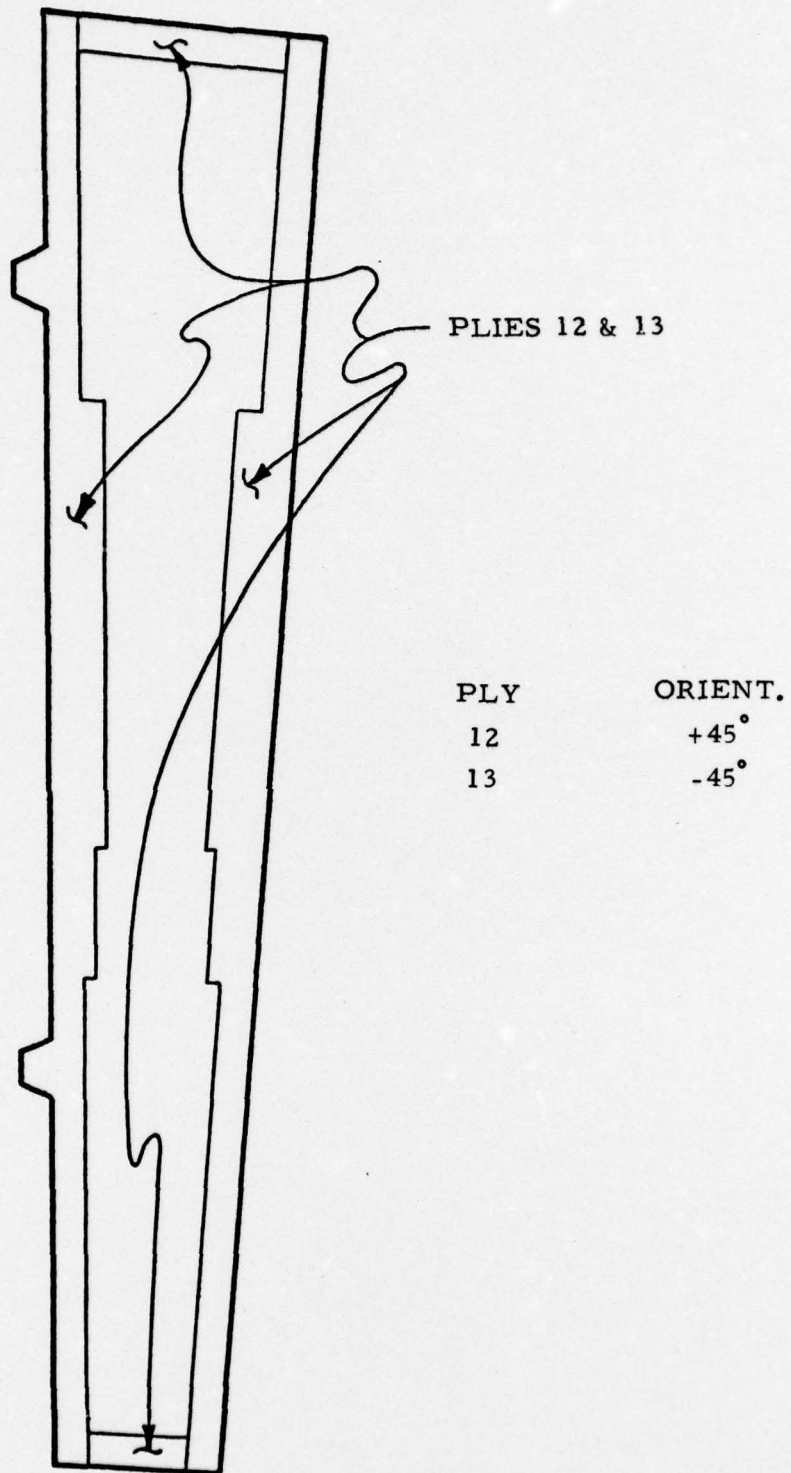


FIGURE C-3 EDGE DOUBLERS (PLIES 12 & 13)

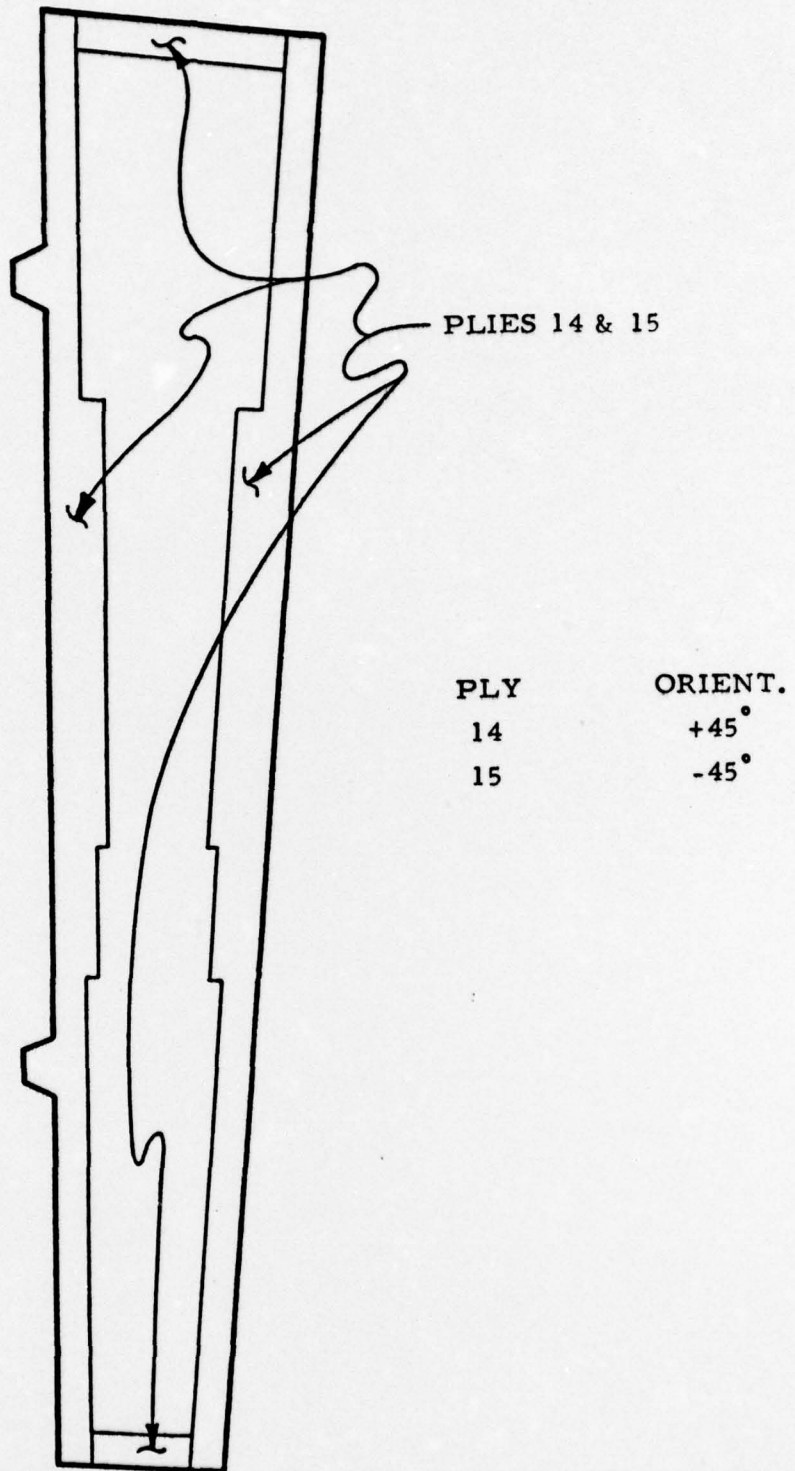


FIGURE C-4 EDGE DOUBLERS (PLIES 14 & 15)

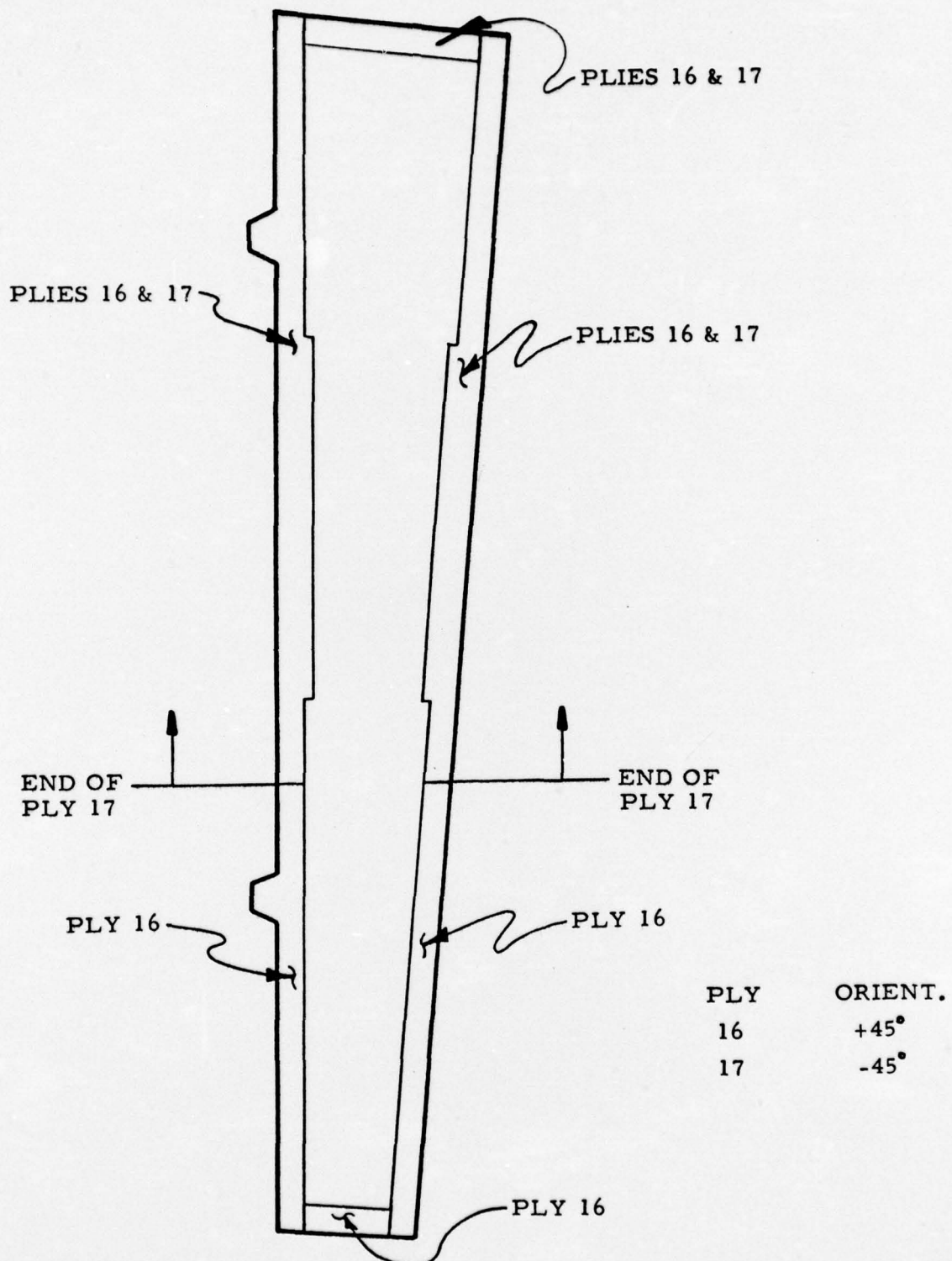


FIGURE C-5 EDGE DOUBLERS (PLIES 16 & 17)

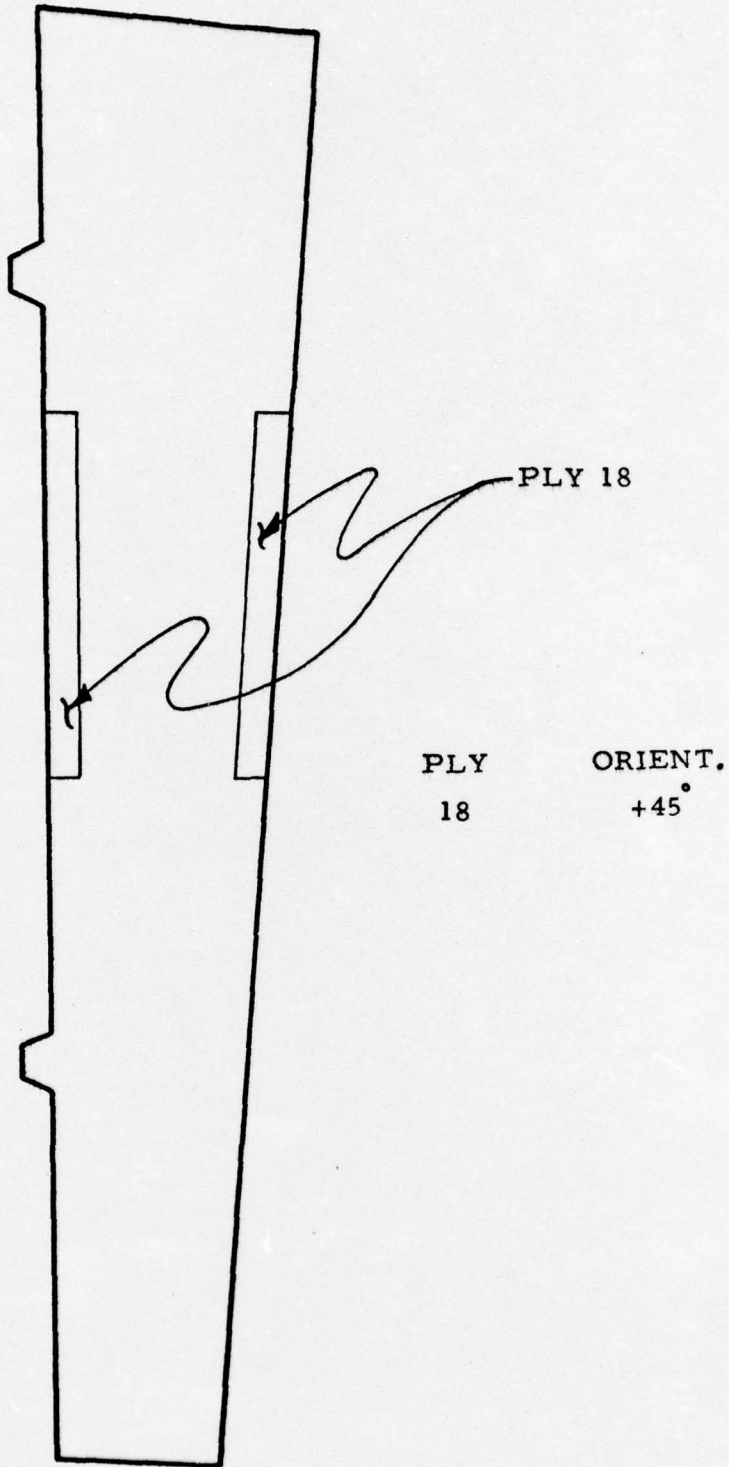


FIGURE C-6 EDGE DOUBLERS (PLY 18)

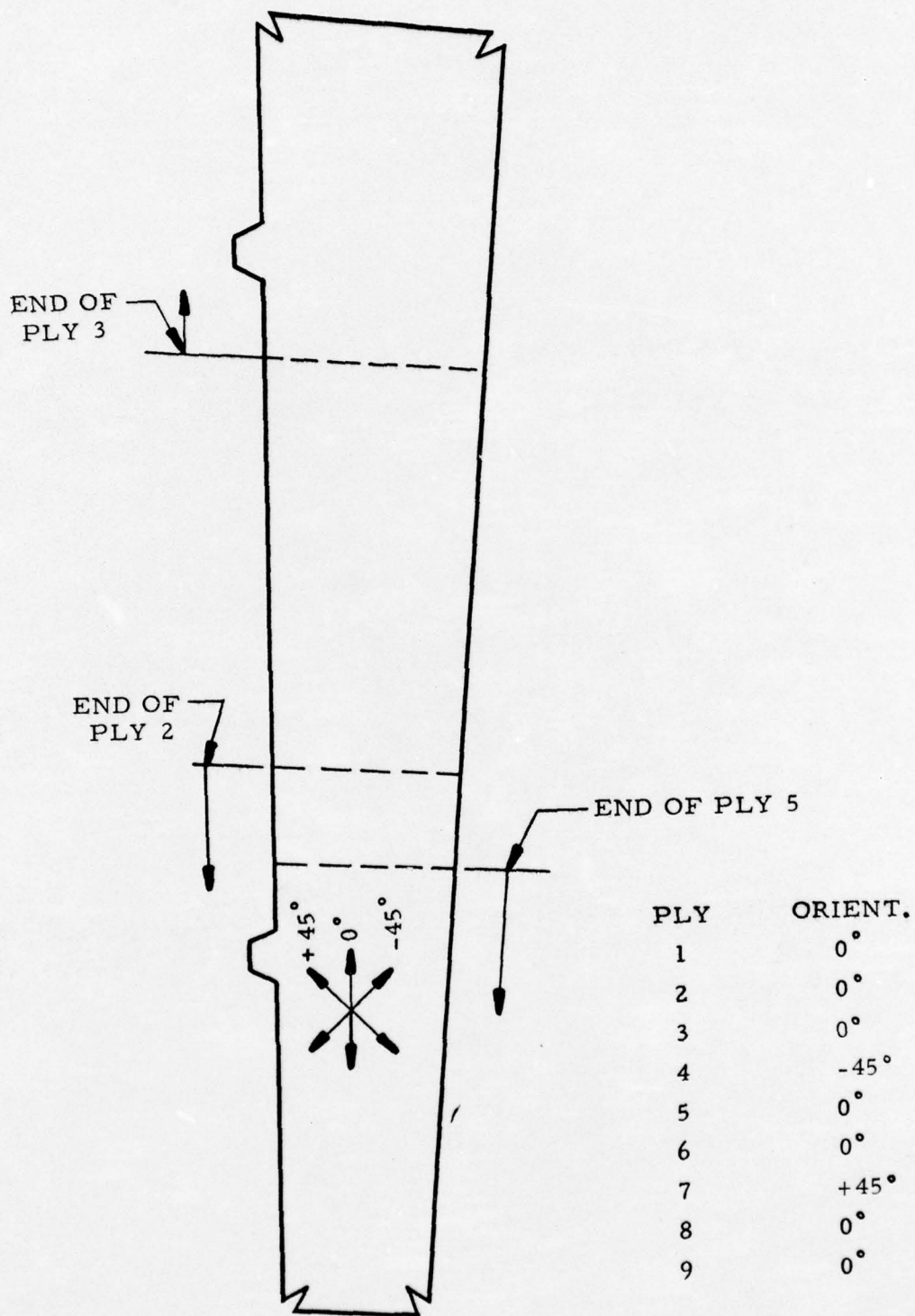


FIGURE C-7 UPPER SKIN

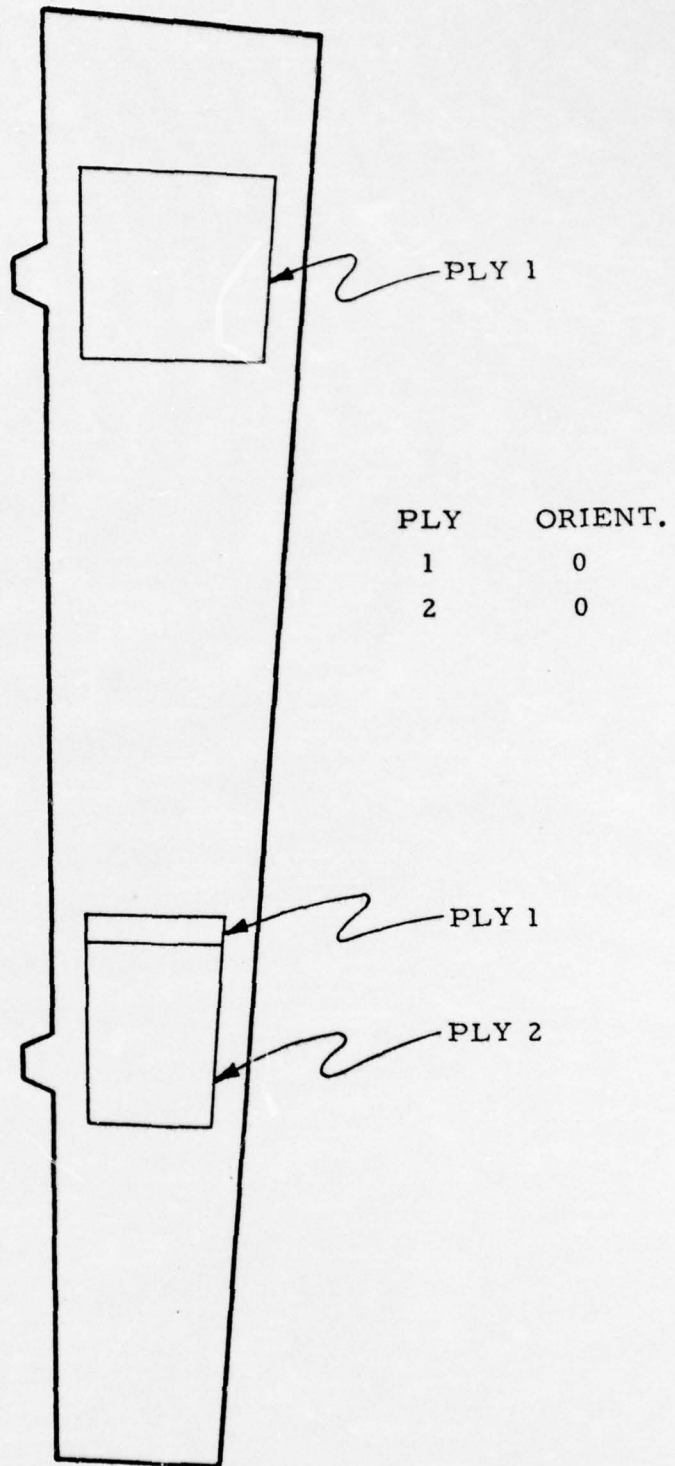


FIGURE C-8 INNER SKIN DOUBLERS

- C. Prepare for cure, specification 208-8-3
 - 1. Similar to item II.C.1 thru 6
- D. Autoclave cure
 - 1. Door close to door open - 4 hrs.
- E. Debag
- F. Rough trim (remove excess resin and molding flash)
- G. NDT (24 - 36 hrs. turn around)
- H. Machine to final size (leave tooling tab at each end)
- I. Install hinges
 - 1. Using production hinges and shims
 - a. Load hinges and spoiler in assembly tool
 - b. Pilot holes in hinges and spoiler (inner skin only)
 - c. Drill hinge bolt holes in hinges
 - d. Install inserts
 - (1) .5 diameter hole in spoiler inner skin
 - (2) Under cut core
 - (3) Clean core
 - (a) Solvent flush
 - (b) Dry (160F for 1 hr.)
 - (4) Using paste adhesive, specification CVA 8-405, type VI
 - (a) Mix adhesive
 - (b) Fill cavity (1/2 full)
 - (c) Install inserts
 - (d) Fill cavity
 - (e) Cure (8 hrs. @ R.T.)
 - e. Using sealant, specification CVA 6-579, seal
 - (1) Seal edges of -22 and -23
 - (2) Faying surfaces of hinges and shims
 - f. Install and torque hinge attach bolts

J. Install seal

1. Drill 66 holes per engineering drawing
2. Attach seal with 100V5D rivets

K. Finish per 78-002553

L. Final Inspect

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Structural analysis and design of the composite spoiler was based on existing criteria and load requirements as specified for production components. Design verification and manufacturing development tests were conducted to predict structural capability and solve manufacturing problems encountered during fabrication. The component is deflection critical and sizing was based on this construction.

Five components were fabricated. The manufacturing development article was cut into element specimens and tested to evaluate manufacturing processes. Three components were static tested, and successfully met design requirements. One component was successfully fatigue tested to two lifetimes without failure.

A cost monitoring system was employed throughout the span of the program and each cost element was identified. A cost matrix and graph comparing the metal and composite components was constructed. Cost data for the composite was extrapolated to 200 units and compared to actual and projected metal cost.

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