ACEE-03-PR-9642

(NASA-CR-172780) ADVANCED COMPOSITE VERTICAL STABILIZER FOR DC-10 TRANSPORT AIRCRAFT Quarterly Technical Progress Report, 25 Sep. - 31 Dec. 1978 (Douglas Aircraft Co., Inc.) 200 p HC A09/MF A01 N83-31595

G3/05 Unclas 10831

ADVANCED COMPOSITE VERTICAL STABILIZER FOR DC-10 TRANSPORT AIRCRAFT

CONTRACT NAS1-14869

SEVENTH QUARTERLY TECHNICAL PROGRESS REPORT
25 SEPTEMBER 1978 THROUGH 31 DECEMBER 1978

DOUGLAS AIRCRAFT COMPANY

MCDONNELL DOUGLAS CORPORATION

Douglas Aircraft Company
Contract NAS1-14869

ACEE-03-PR-9642

ACEE-03-PR-9642
22 JANUARY 1979

DRL ITEM NUMBER 005

SEVENTH QUARTERLY TECHNICAL PROGRESS REPORT
25 SEPTEMBER THROUGH 31 DECEMBER 1978

ADVANCED COMPOSITE VERTICAL STABILIZER FOR DC-10 TRANSPORT AIRCRAFT

PREPARED FOR LANGLEY RESEARCH CENTER
CONTRACT NAS1-14869

Douglas Aircraft Company
Contract NAS1-14869

ORIGINAL PAGE IS
OF POOR QUALITY

ACEE-03-PR-9642

DRL Item Number 005

SEVENTH QUARTERLY TECHNICAL PROGRESS REPORT

25 September through 31 December 1978

Prepared by: ______________________
C. O. Stephens
Engineering Supervisor
DC-10 Composite Vertical Stabilizer

Approved by: ______________________
G. M. Lehman
Project Manager
DC-10 Composite Vertical Stabilizer

Approved by: ______________________
D. G. Smillie
Project Manager
Composite Primary Structures

Approved by: ______________________
M. Stone, Director
Design Engineering
Structures

Approved by: ______________________
M. Klotzsche
Program Manager, ACEE

FOREWORD

This report was prepared by the Douglas Aircraft Company, McDonnell Douglas Corporation, Long Beach, California, under Contract NAS1-14869. It is the seventh quarterly technical progress report covering work performed between 25 September 1978 and 31 December 1978. The program is sponsored by the National Aeronautics and Space Administration, Langley Research Center (NASA-LRC). Mr. Marvin B. Dow is the Project Manager for NASA-LRC.

The following Douglas personnel were the principal contributors to the program during the reporting period: G. M. Lehman, Project Manager; C. O. Stephens, Engineering Supervisor; A. V. Hawley, Structural Design; J. O. Sutton, Stress and Loads Analysis; P. W. Scott, Weight Analysis; M. M. Platte, Cost Analysis; H. M. Toellner, Materials and Producibility Engineering; B. Lyon and M. Nagaoka, Manufacturing Engineering; R. B. Anderson, Engineering Test Supervisor; R. G. Wolfe, Structural Testing, and G. J. Cassell, Lightning Panel Testing.

PRECEDING PAGE BLANK NOT FILMED

SUMMARY

Structural design, tooling, fabrication, and test activities are reported for a program to develop an advanced composite vertical stabilizer (CVS) for the DC-10 Commercial Transport Aircraft. Structural design details are described and the status of structural and weight analyses are reported. A structural weight reduction of 21.7 percent is currently predicted. Test results are discussed for sine-wave stiffened shear webs containing cutouts representative of the CVS spar webs and for lightning current transfer and restrike tests on a panel representative of the CVS skins. Results are presented for mechanical property and fracture mechanics tests to substantiate design allowable stresses. Current status is reported for tooling, fabrication, and quality assurance activities on rudder fittings, skin panel, and spar verification test components. Recurring manufacturing cost projections for the CVS structural configuration indicate that a cost cross-over point with the conventional metal stabilizer will be achieved after production of 32 CVS units. Selected engineering drawings and supplemental mechanical properties data are included in appendices.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF TABLES

SECTION 1
INTRODUCTION

The overall objective of this program is to accelerate the use of advanced composite structures by developing technology and processes for early progressive introduction of composite structures into production commercial transport aircraft. Key steps in accomplishing this objective are: (1) to develop low-cost design and manufacturing approaches which will produce a cost competitive structure, and (2) to initiate commercial airline service of a mid-sized composite primary structure, the DC-10 composite vertical stabilizer (CVS).

The Work Breakdown Structure (WBS) for the program is presently organized in eight major tasks as follows:

1. Preliminary Design
2. Detail Design
3. Manufacturing Process Development
4. Composite Structure Fabrication
5. Subassembly, Subsystem, and Other Fabrication
6. Assembly
7. Verification Testing
8. Contract Management and Plans Development

In Task 1, the Preliminary Design Synthesis culminated in selection of a four-spar, multi-rib structural configuration similar in geometry to the existing baseline metal stabilizer for structural interchangeability. The composite skin panels between spars and ribs will be stiffened by honeycomb sandwich construction for minimum weight and cost purposes, and the skin panels will be mechanically attached to the spar-rib substructure to enhance detail part fabrication, assembly, inspection, and maintenance access. The selected design concepts are presently being verified through testing of the concept and joint development component.

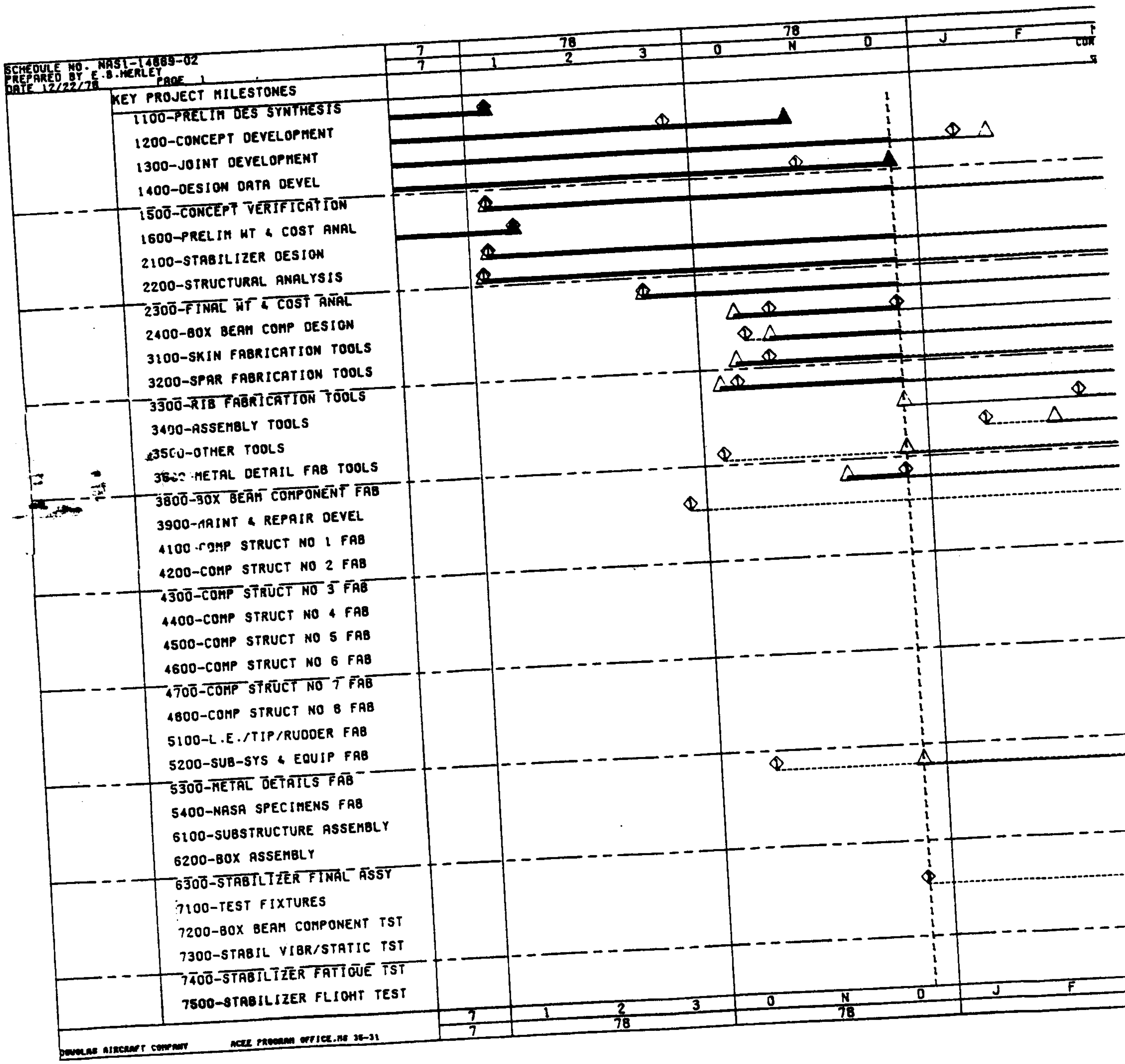
In Tasks 2 and 3, currently active, the structural detailed arrangements, tooling, and manufacturing processes are being developed through engineering and tooling design for the full-size CVS and through experimental development and testing of structural components representative of critical design features. The final development component will be a box-beam approximately eight feet long representing the lower portion of the CVS. The ribs, spar segments, and skin panels of this component will be fabricated and assembled using the full-scale tools for the CVS and will serve as a tooling and processing verification component as well as a structural test component.

Following completion of the box-beam tests, eight stabilizer units will be constructed in a serial production mode in Tasks 4 through 6. The first two of these units will be used in Task 7, Verification Tests, for the ground-based static and repeated load tests. The third unit will be flight-tested as part of the Federal Aviation Agency (FAA) certification testing and, together with the remaining five units, will be introduced into commercial airline service after receipt of FAA certification. Task 8 includes program management functions and the formulation of the plans necessary for development, certification by the FAA, and in-service inspection and maintenance of the CVS.

This report describes work accomplished during the seventh quarterly period of the program. Work continued on structural design and analysis; weight and cost analysis; and tooling, fabrication, and test of the structural development components and specimens. Detail design of the composite structure was continued and tool design was initiated. Overall schedule status is summarized in Figure 1.

The activities during the quarterly period are described under the headings Detail Design, Concept Development Components, Joint Development Components, Mechanical Property Testing, Design Verification Test Components, Tool Design, Cost Analysis, and Quality Assurance. Engineering drawings of the composite skin panels and selected spar and rib assemblies are included in the appendices.

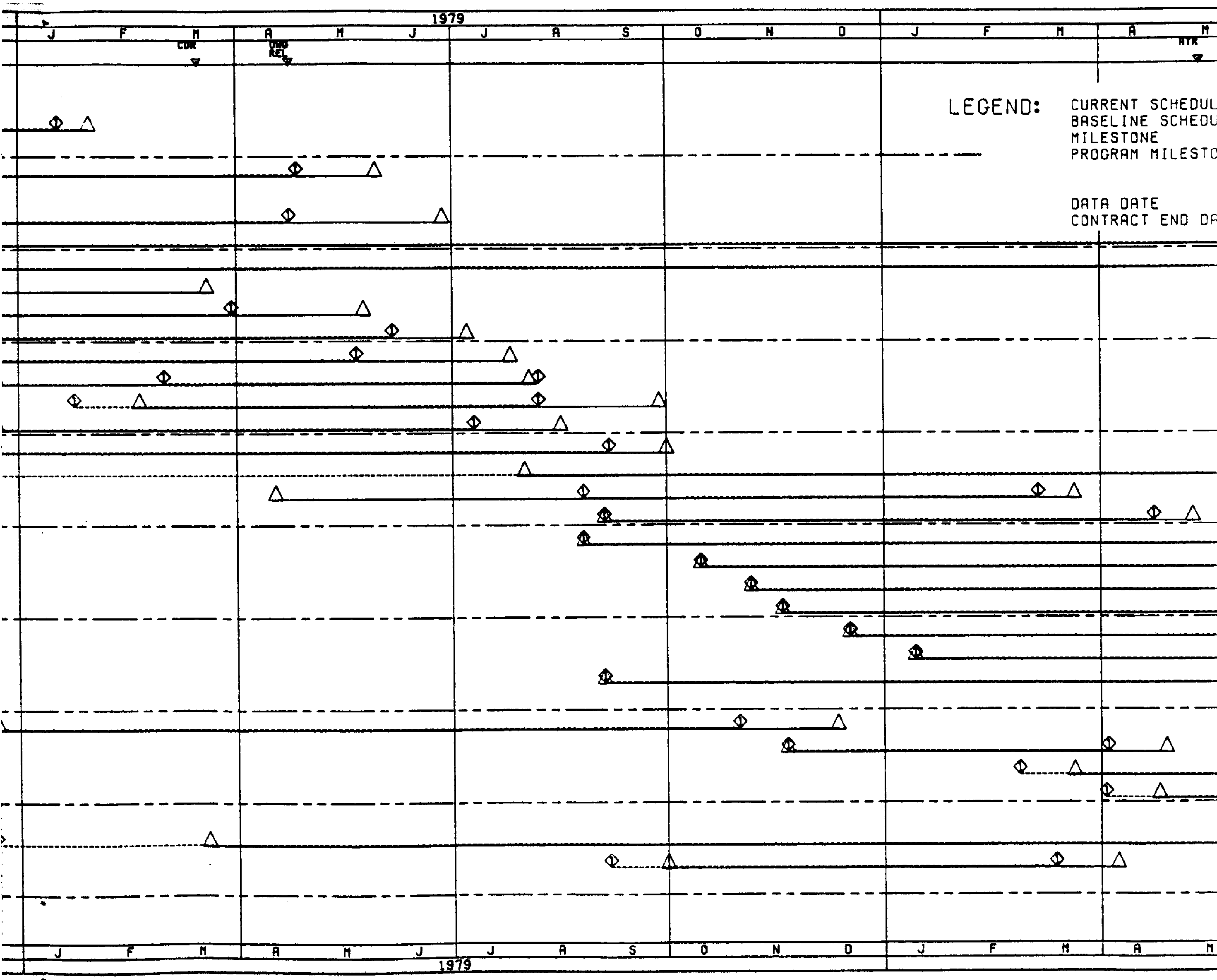
ORIGINAL PAGE IS
OF POOR QUALITY

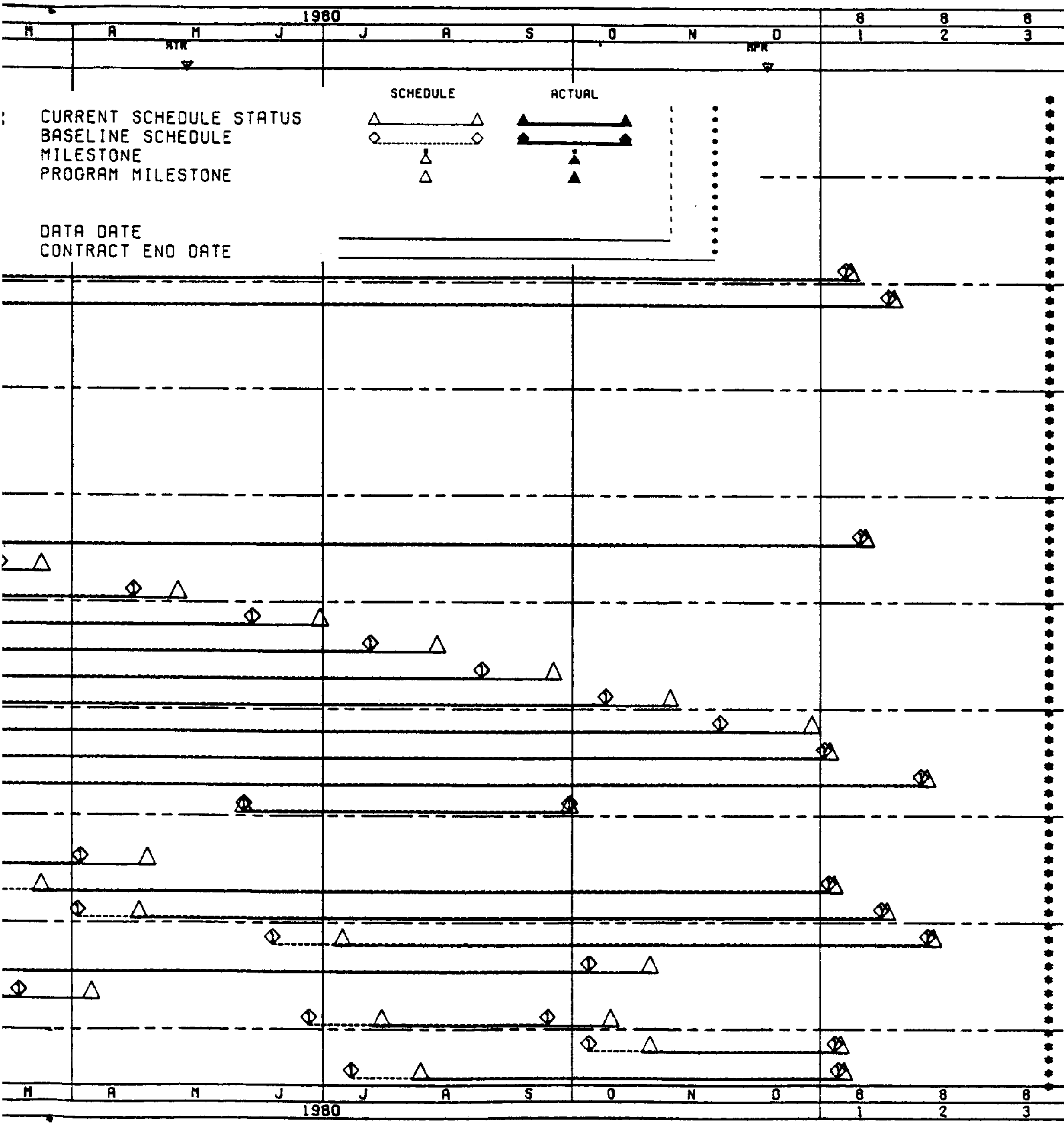


FOLDOUT FRAME

Dougla
Contra

ORIGINAL PAGE IS
OF POOR QUALITY





EARLY START	EARLY FINISH
29MAR77	27JAN78
27APR77	09NOV78
04MAY77	31JAN79
01SEP77	21DEC78
23JAN78	30MAY79
04MAY77	24FEB78
23JAN78	27JUN79
16JAN78	13MAY81
28JUL78	17NOV81
16OCT78	19MAR79
31OCT78	25MAY79
16OCT78	06JUL79
09OCT78	26JUL79
22DEC78	02AUG79
19FEB79	28SEP79
22DEC78	16AUG79
28NOV78	01OCT79
01AUG79	17JUL81
17APR79	20MAR80
04SEP79	09MAY80
27AUG79	30JUN80
15OCT79	12AUG80
05NOV79	24SEP80
19NOV79	06NOV80
17DEC79	29DEC80
14JAN80	10FEB81
04SEP79	12APR82
02JUN80	30SEP80
22DEC78	12DEC79
21NOV79	28APR80
20MAR80	03MAR81
25APR80	20OCT81
08JUL80	10MAY82
19MAR79	30OCT80
01OCT79	07APR80
22JUL80	15OCT80
30OCT80	01APR81
05AUG80	15APR81

FOLDOUT FRAME

FIGURE 1. SUMMARY SCHEDULE

Douglas Aircraft Company
Contract NAS1-14869

ACEE-03-PR-9642

The measurement values in this report are expressed in the International System of Units (SI) and also U.S. Customary Units in some cases. U.S. Customary Units were used for the principal measurements and calculations.

SECTION 2
DETAIL DESIGN

Detail design of the CVS continued with engineering drawing preparation, concurrent structural analysis, and updating of the weight status report based on released engineering drawings.

DESIGN DEVELOPMENT

A CVS drawing list consisting of 89 detail, assembly, and installation drawings was completed and drawing numbers were assigned. Twenty-six of the required drawings are identical to or require only minor modifications to existing DC-10 drawings. Twenty-seven of the required drawings are new drawings of conventional metal details. The remaining 36 are new drawings defining the advanced composite structural elements.

The spar and rib locations of the existing metal stabilizer were retained in the CVS for interchangeability with the fixed-fin structure and the rudder system. The locations and drawing numbers of the major composite structural elements are shown in Figure 2. With the exception of the two uppermost ribs which were identified in the vertical stabilizer coordinate system (subscript V), the rib stations were identified in the forward rudder coordinate system (subscript FR). Engineering drawings of the skin panel assemblies, the substructure assembly, and typical rib and spar installations are included in Appendix A. Design features of the major composite structural elements are described in the balance of this section.

Skin Panels

Left and right-hand skin panels will each be made as a single molded honeycomb sandwich assembly. Spar and rib cap laminates will be included within the sandwich as shown in Figure 3. To maintain structural continuity at spar and rib cap intersections, the caps will be laid up with graphite unidirectional tape in a pseudo-isotropic pattern. The spaces between the caps will be filled by Nomex 4.0 pcf honeycomb core, 0.30 thick with a

ORIGINAL PAGE IS
OF POOR QUALITY

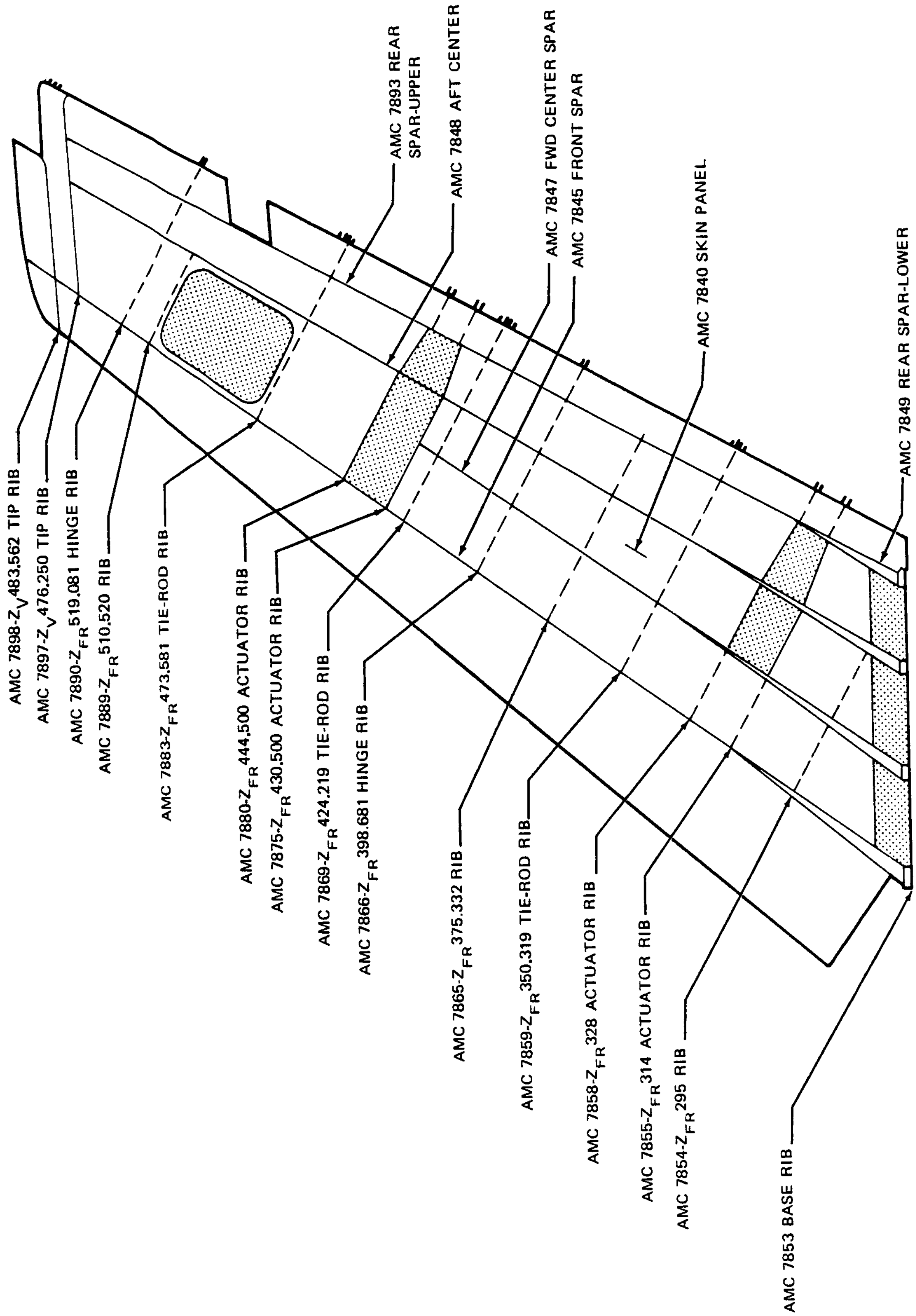


FIGURE 2. DC-10 COMPOSITE VERTICAL STABILIZER STRUCTURAL COMPONENTS AND DRAWING NUMBERS

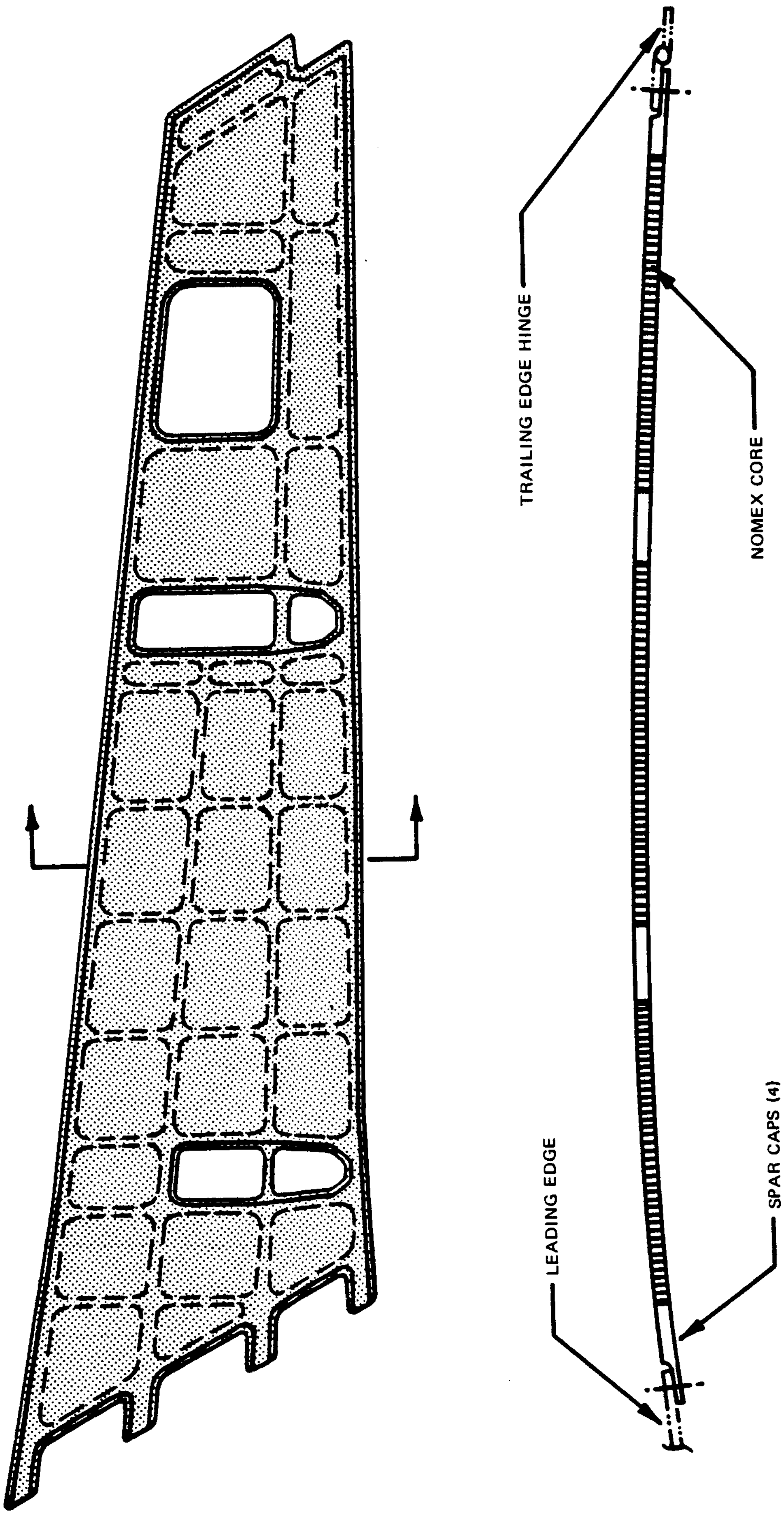


FIGURE 3. SKIN PANEL ASSEMBLY

1/8 inch cell size. Syntactic foam will be used around the periphery of the core to stabilize the edges and to provide a transition region between the solid cap laminates and the thin sandwich facings. The gaps between the core edges and the surrounding laminates will be filled with foaming adhesive to ensure good shear connections at the interfaces.

The sandwich facing material will consist of graphite bi-weave cloth layers in a ±45° orientation with respect to the box axis. Near the root-end, some additional 0/90° layers will be added to help align the CVS box axis with the lower vertical stabilizer box axis. FM 300 K adhesive will be placed between the facings and the core, and the whole assembly will be cured in a single autoclave operation. Recesses for leading and trailing-edges and for access panels will be molded net, and the panel edges will be machined as the final fabrication operation.

Spar Assemblies

The four spar assemblies will have several design features in common. Each spar will have a pair of titanium fittings bonded within the graphite/epoxy at the root-end. The entire load of the stabilizer will be transferred into the lower vertical stabilizer through these fittings and their associated attach bolts. A detail view of the fitting installation is shown in Figure 4, and a more general view of the root-end of a typical spar in Figure 5.

Each titanium fitting will be basically a "tee" section where each of the three legs will be tapered to a narrow edge at the upper end, interfacing with the composite spar cap in a scarf joint. This joint will be co-cured and adhesively bonded during the autoclave cycle in which the entire spar assembly is cured. A secondary load path, capable of transferring design limit load, will be provided by means of mechanical fasteners. The cross-sectional area of the spar caps will be reduced rapidly away from the root-end as the load is transferred into the skin caps.

ORIGINAL PAGE IS
OF POOR QUALITY

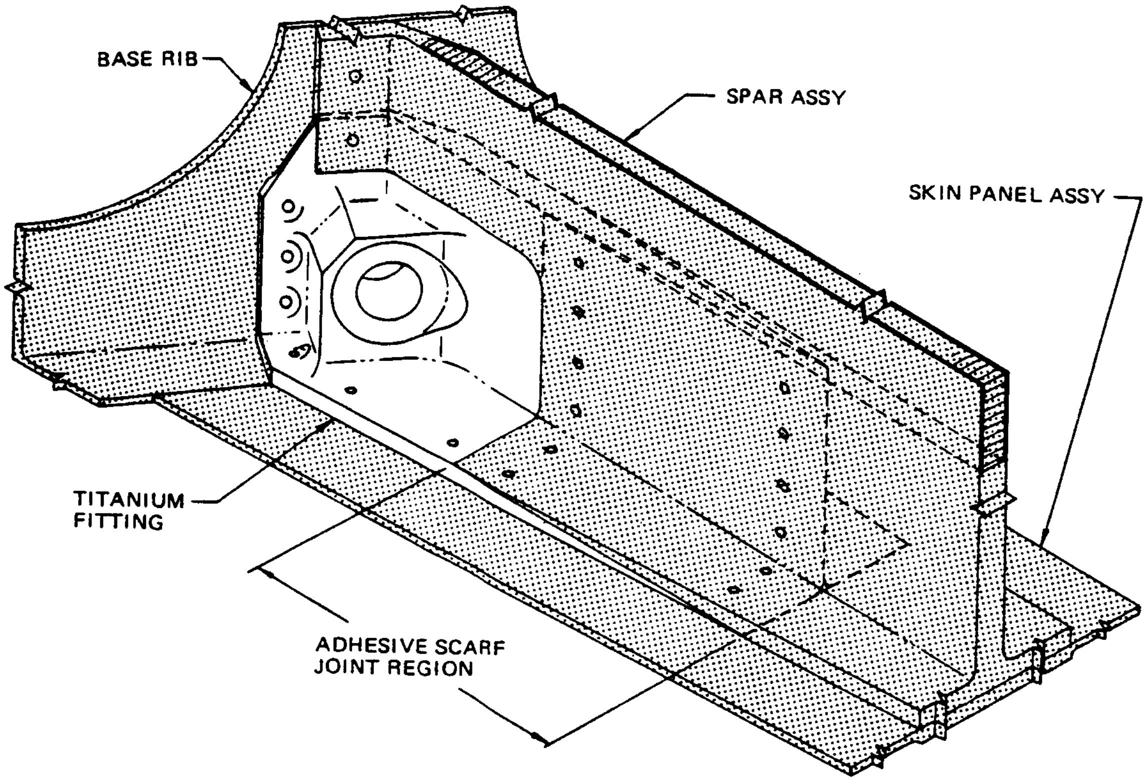


FIGURE 4. SPAR-ROOT FITTING SPLICE-JOINT DETAILS

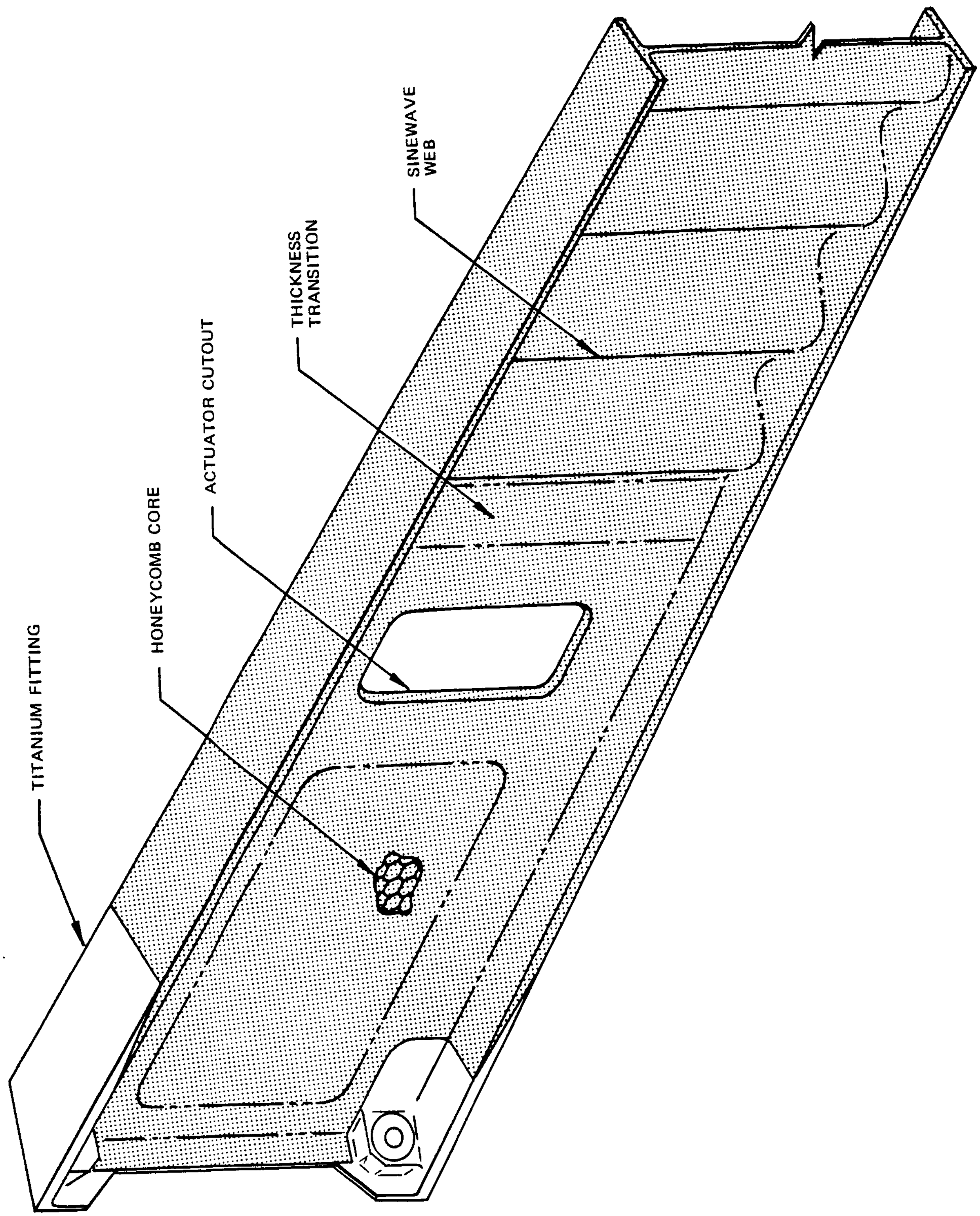


FIGURE 5. TYPICAL SPAR ASSEMBLY

Localized honeycomb sandwich stiffening will be used near the root-end to stabilize the shear web against buckling. In most other regions of the substructure, sine-wave webs will be used to provide stabilization as shown in Figure 5.

The sine-wave geometry is more properly described as intersecting circular arcs. A single wave geometry was selected for use throughout the entire substructure to reduce tool machining costs. This type of stiffening has been found to offer many advantages in cost and weight studies. Some of the weight advantage will be lost in reinforcing access holes and in mounting brackets and clips for rudder attachments and systems installations.

Plain holes in sine-wave webs were found to be inefficient because of the out-of-plane forces around the periphery of the hole. During the test program, a reinforced hole configuration was successfully developed in which a 0.50 inch wide flange was incorporated at the edge of the hole. The required doubler material around the holes was determined from test and analysis. The required local web thickness enabled the panel to remain flat in the region of the hole as shown in Figure 6.

In the lower segment of the front spar, the number of reinforced holes became so extensive that plain thick laminates with unreinforced holes were used with some cost saving and little weight penalty. Each of the three longer spars was divided into upper and lower segments to facilitate fabrication. The lower spar portion is shorter in each case but contains the thicker laminates and the titanium fittings. The upper portion will be primarily of sine-wave construction.

At the mounting stations for the rudder hydraulic actuators, cut-outs will be provided in the rear and aft center spar webs as shown in Figure 5. These cutouts will be plain holes in the thick laminate material.

BASIC WEB THICKNESS		DOUBLER THICKNESS		R_o	R_i	h
LAYERS	CM (IN.)	LAYERS	CM (IN.)	CM (IN.)	CM (IN.)	CM (IN.)
2	0.066 (0.026)	7	0.231 (0.091)	12.06 (4.75)	9.14 (3.60)	1.27 (0.50)
3	0.099 (0.039)	8	0.264 (0.104)	15.24 (6.00)	10.67 (4.20)	1.27 (0.50)
4	0.132 (0.052)	9	0.297 (0.117)	17.78 (7.00)	11.94 (4.70)	1.27 (0.50)
5	0.165 (0.065)	10	0.330 (0.130)	15.88 (6.25)	10.92 (4.30)	1.59 (0.62)

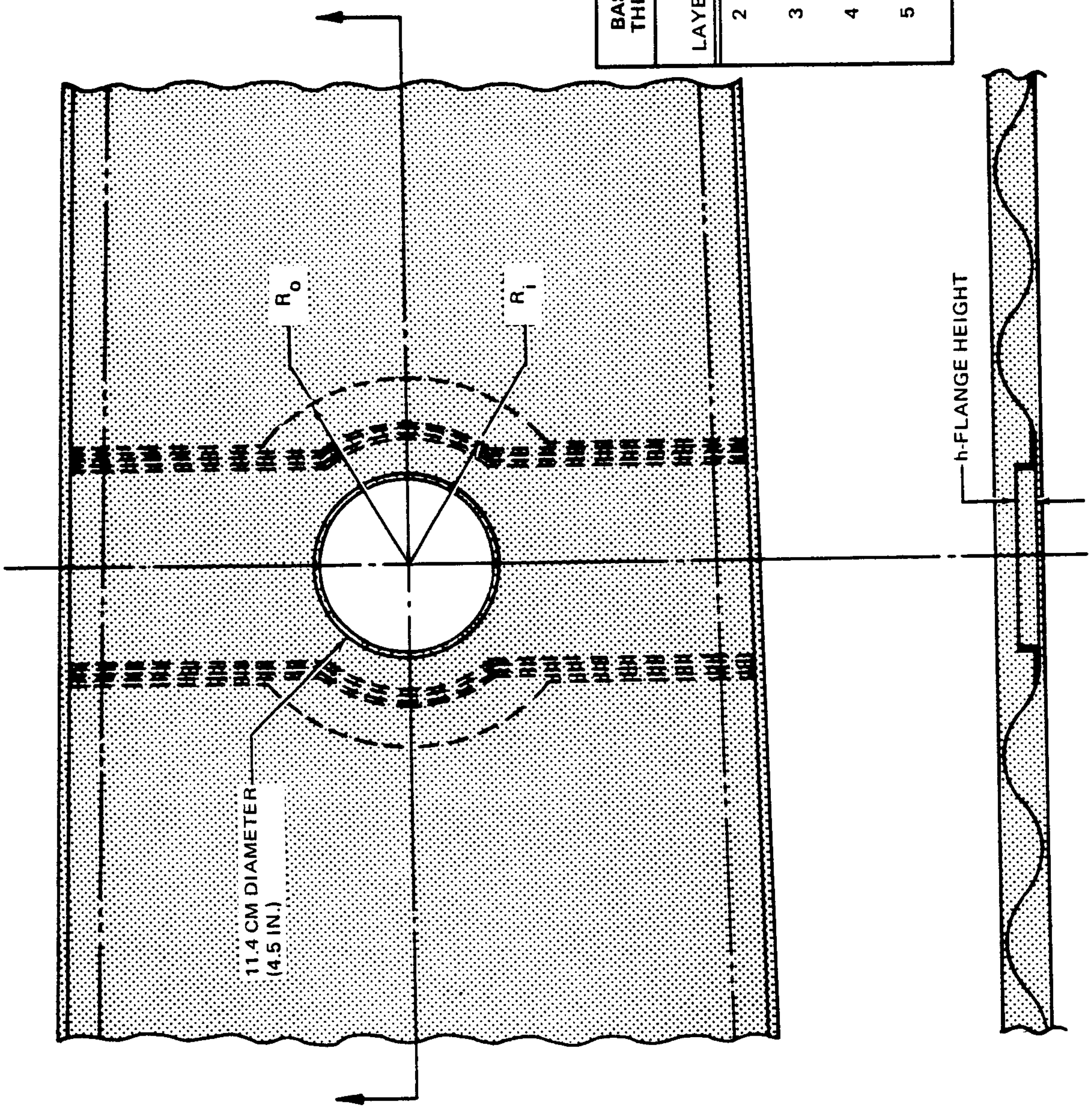


FIGURE 6. TYPICAL HOLE REINFORCEMENT IN SINEWAVE WEB

Where aluminum fittings attach to the graphite-epoxy structure, an interfacing layer of fiberglass will be cocured on the face of the laminate to alleviate galvanic corrosion effects. For smaller clips, the fiberglass will be attached by secondary bonding.

Provisions will be made for access into each bay of the substructure by means of 4.5 inch diameter access holes. This internal access will assist in initial fabrication and inspection and in subsequent inspection and repair.

Base Rib

The base rib will consist of two thick laminate segments joined at the rib center-line as shown in Figure 7. Since the adjacent rib in the lower vertical is capable of transmitting the re-distributing shear loads, the web of the base rib will be largely removed by three oval holes. The remaining material will provide load paths between the root attach bolts, and the skin and spar panels. The base rib edges will be flanged for attachment of the titanium spar fittings and the skin access panels. Projections at the aft end of the rib will support the hinged trailing-edge panels.

Rib 295

This rib is typical of the three ribs which do not incorporate rudder support fittings. The simple sine-wave webs without holes, Figure 8, are representative of many rib segments throughout the substructure. The skin edges of the webs will be reinforced and flanged to form "tee" section caps for attachment to the skin panels. Drainage holes will be provided in the valleys of the sine-waves to prevent standing water from accumulating.

Actuator Ribs

Actuator ribs are located at stations Z_{FR} = 314.000, 328.000, 430.500, and 444.500. The rib at station 314, illustrated in Figure 9, is typical of this group. The web construction will be similar to that of Rib 295 except that in this case, an access hole will be provided in the center segment. A cover-plate over this hole will prevent loose objects from falling into the bay below during hydraulic actuator maintenance.

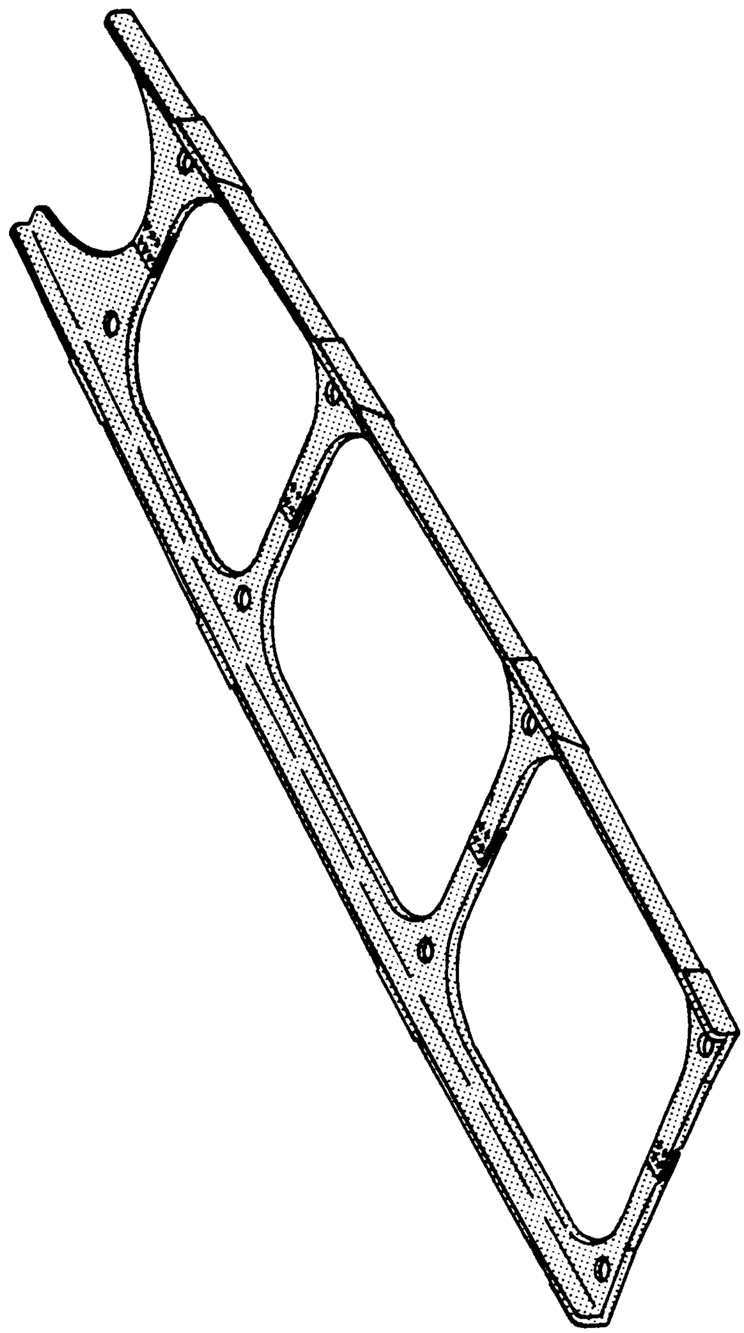


FIGURE 7. BASE RIB ASSEMBLY

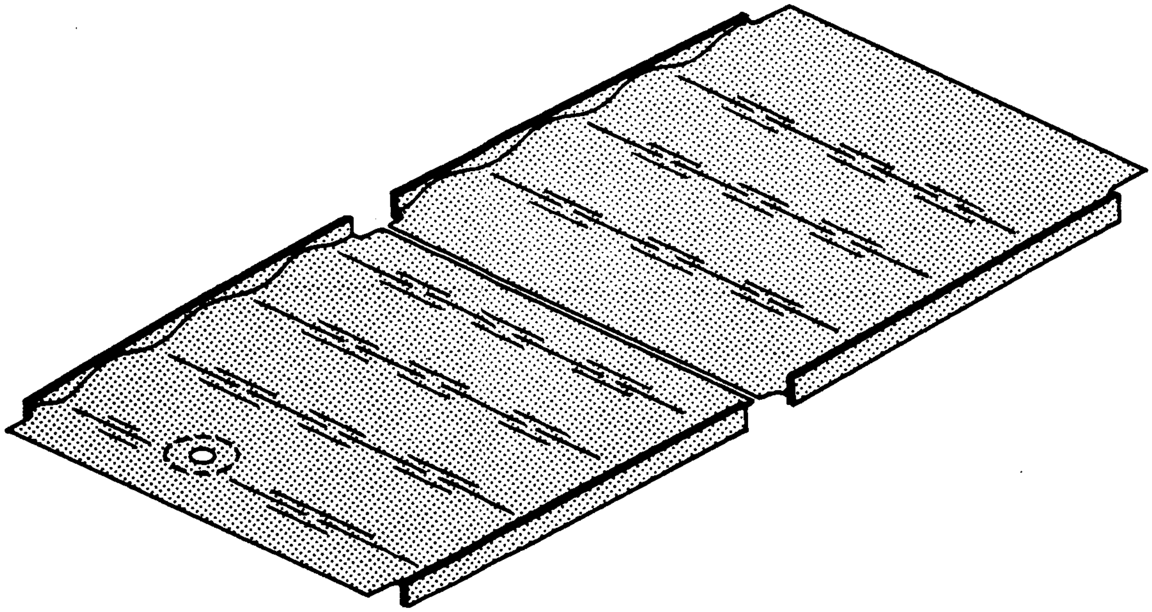


FIGURE 8. RIB STATION 295 COMPOSITE MOLDINGS

ORIGINAL PAGE IS
OF POOR QUALITY

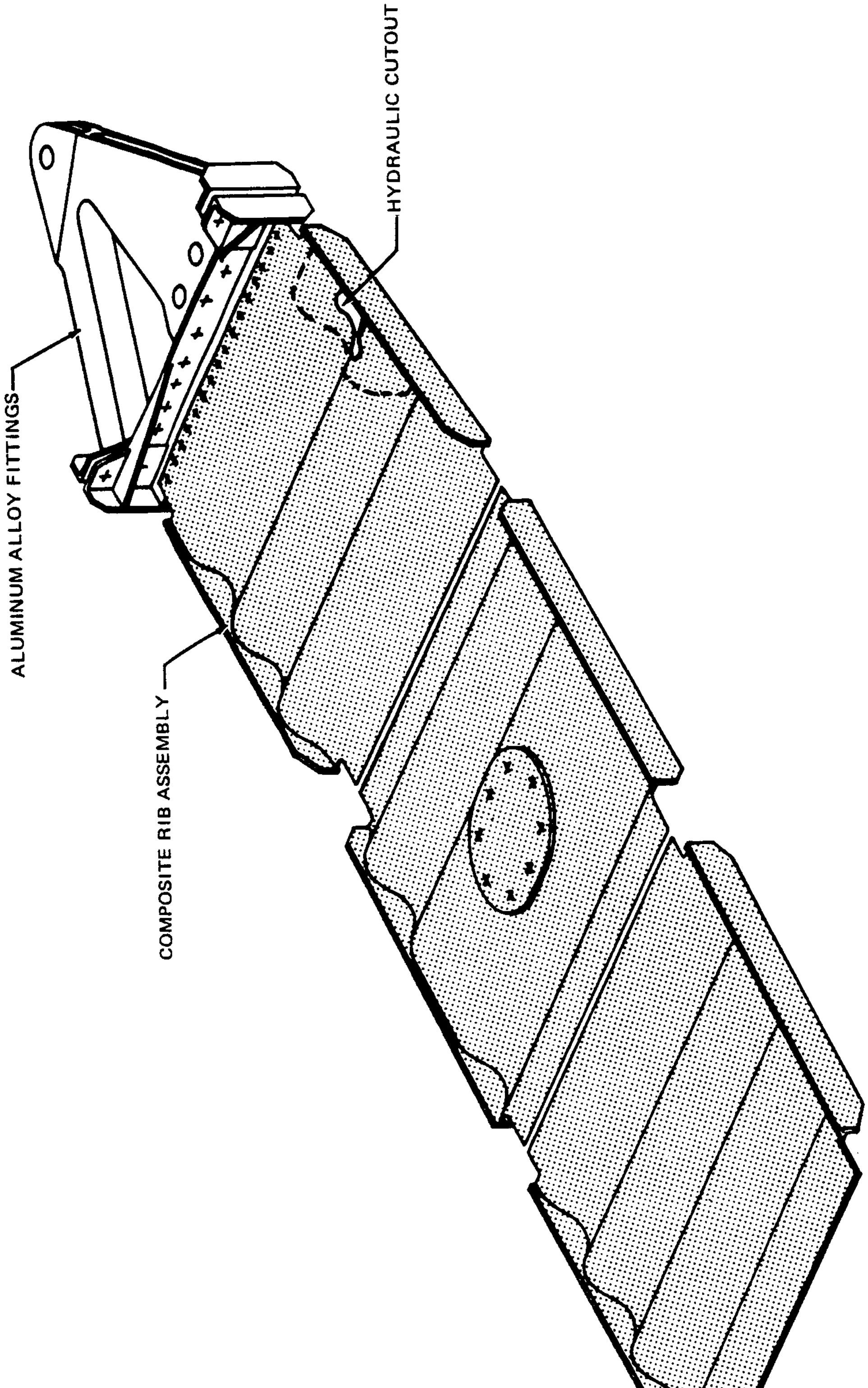


FIGURE 9. ACTUATOR RIB 314 ASSEMBLY

The aluminum alloy actuator bracket will locate the rudder hinge point and the mounting provisions for the rudder hydraulic actuator trunnion. The actuator bracket differs only slightly from the bracket used on the metal stabilizer. Separate fittings, forward and aft of the rear spar, will transfer the rudder loads into the composite box structure. The shear webs at this fitting interface, and at the front spar, will be reinforced with doubler layers to accommodate loads from the rudder and from the control quadrant mounting on the front spar. This particular rib will also incorporate an oval cutout for hydraulic piping.

Tie-Rod Ribs

Tie-rod ribs are located at stations Z_{FR} = 350.319, 424.219, 473.581, and in the tip region. These ribs differ from the actuator ribs in the manner in which the tie-rod brackets transfer loads into the composite box-structure. A typical fitting arrangement is shown in Figure 10. Fail-safe requirements make dual load paths necessary and hence two fittings run along the rib caps at each skin panel. Since it is not convenient to attach a sine-wave web to the face of one of these fittings, a thin honeycomb sandwich panel will be used in this rib segment.

At the upper tie-rod station, a separate structural sub-assembly will be added to the box-structure as shown in Figure 11. This complex region will provide fail-safe load paths for loads arising from the rudder balance weights. Seven existing metal fittings will be contained within this sub-assembly, including the brackets for two hinges and two tie-rod attachments.

Plain Hinge Ribs

The ribs located at station Z_{FR} = 398.681 and 519.081 support simple hinge brackets. Since the rudder loads are smaller at these ribs than at actuator or tie-rod ribs, the load transfer to the composite box structure will be accomplished by simple fittings mounted on the aft side of the rear spar as shown in Figure 12.

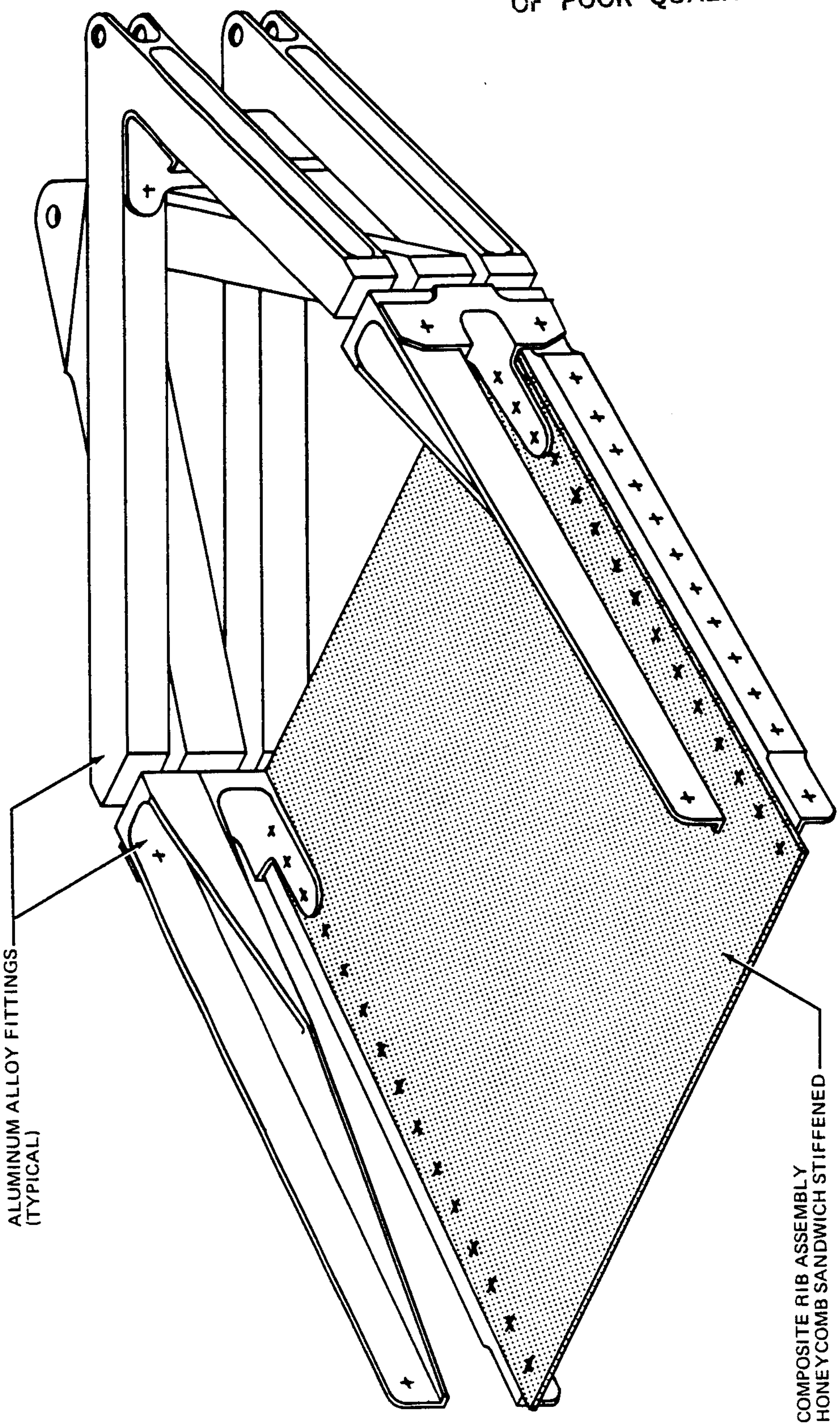


FIGURE 10. TIE-ROD RIB FITTINGS CONFIGURATION

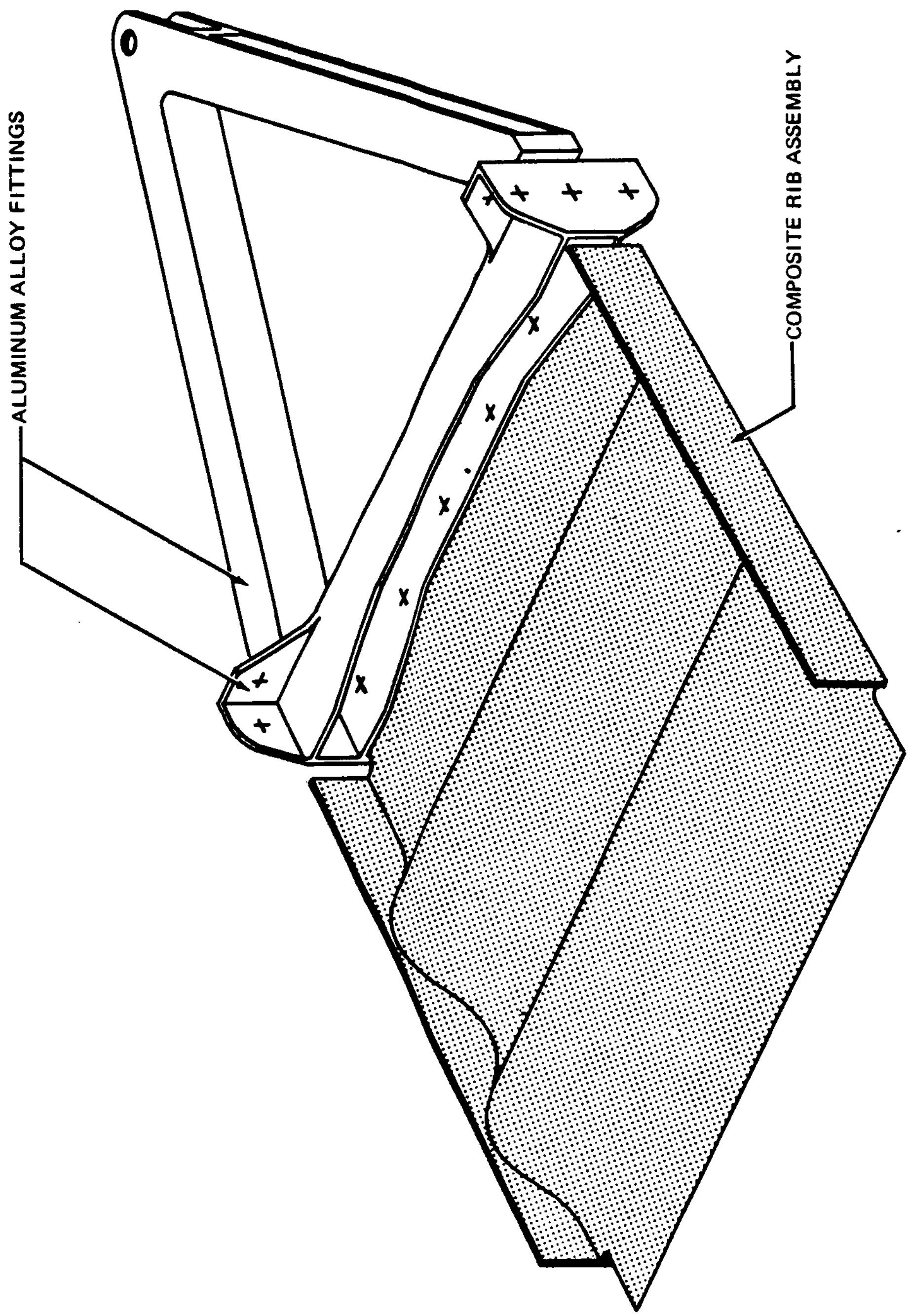


FIGURE 11. HINGE RIB FITTINGS CONFIGURATION

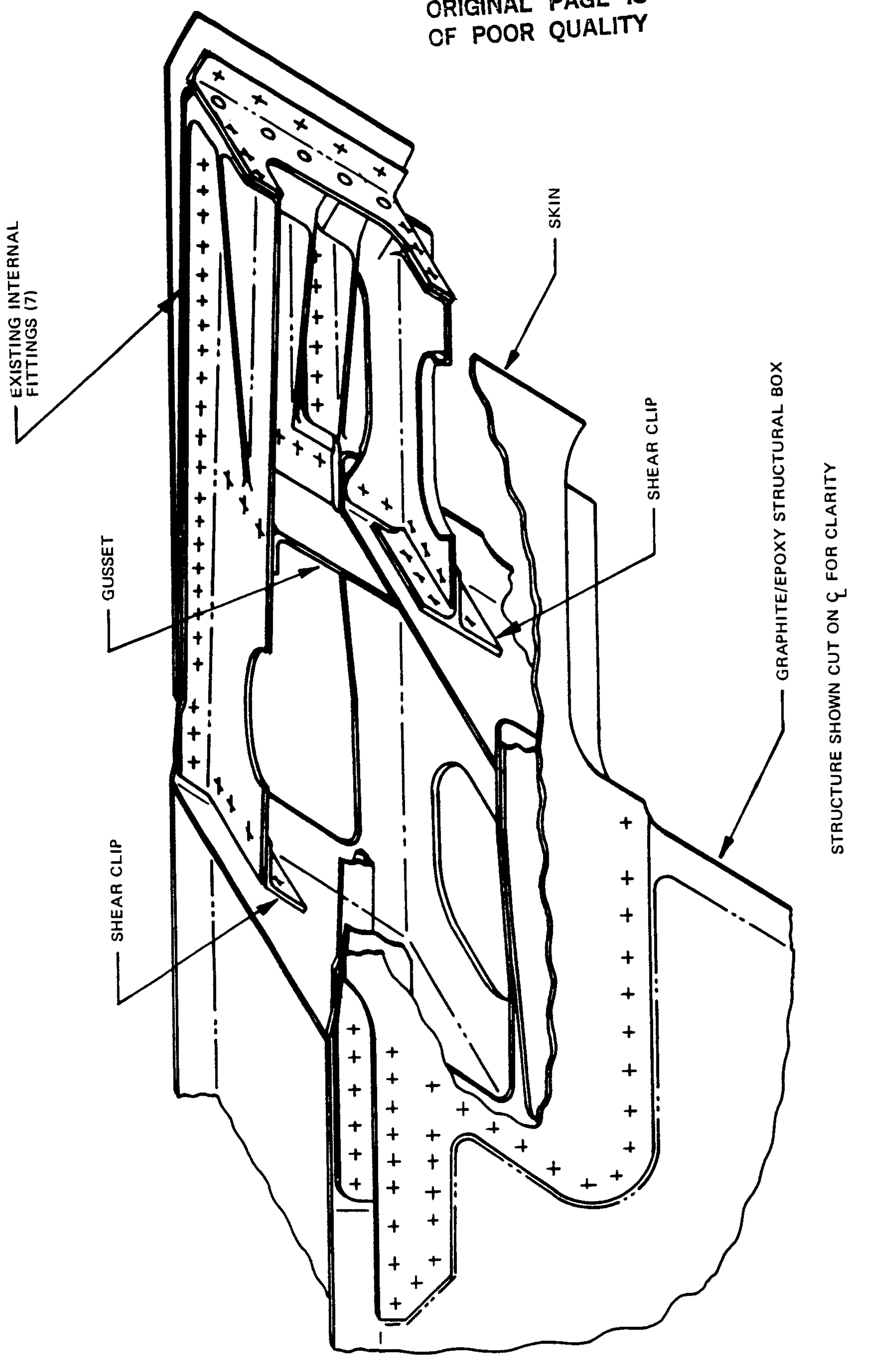


FIGURE 12. UPPER HINGE SUPPORT ASSEMBLY

Substructure Assembly

The spar and rib assemblies will be joined to form a substructure assembly as shown in Figure 13. The attachment at the intersecting corners will be effected by graphite-epoxy angles which will be co-cured and adhesively bonded in place.

Box Assembly

The skin panels will be attached to the substructure assembly with titanium bolts in accordance with normal DC-10 fastener usage policy. Nut-plates and channels will be used in all places where access does not permit the installation of nuts.

Access Doors

Access doors for the root-attach and actuator regions will be simple sandwich panels as shown in Figure 14. The basic construction will follow skin panel practice. The panel will be thick enough to sustain shear, compression, and lateral pressure loads without buckling. Solid laminate material will be used at the edges where the doors bolt to the skin panels.

Trailing Edge Panels

The design concept for the graphite-epoxy trailing-edge panels is shown in Figure 15. This type of composite panel has already been developed and several panels are presently in regular DC-10 airline service. The CVS panels will be hinged at the forward edges to permit opening for maintenance. The hinge-line was moved slightly aft in comparison with the metal stabilizer. When closed, the panels will be attached to supports mounted to the rudder hinge brackets or to the box skin panels.

Systems Installation

Mounting brackets and clips will be provided for installation of the hydraulic, control, electrical, and avionics systems. The avionics VOR/localizer antennas contained in the tip and door panels will be retained without change. To maintain satisfactory avionics performance, the outside surface of

ORIGINAL PAGE IS
OF POOR QUALITY

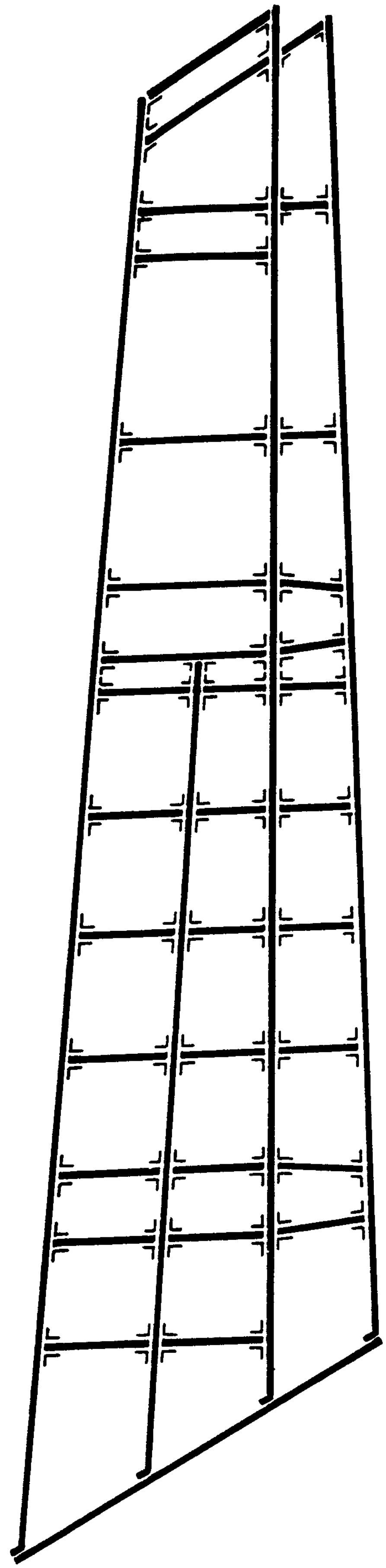


FIGURE 13. SUBSTRUCTURE ASSEMBLY

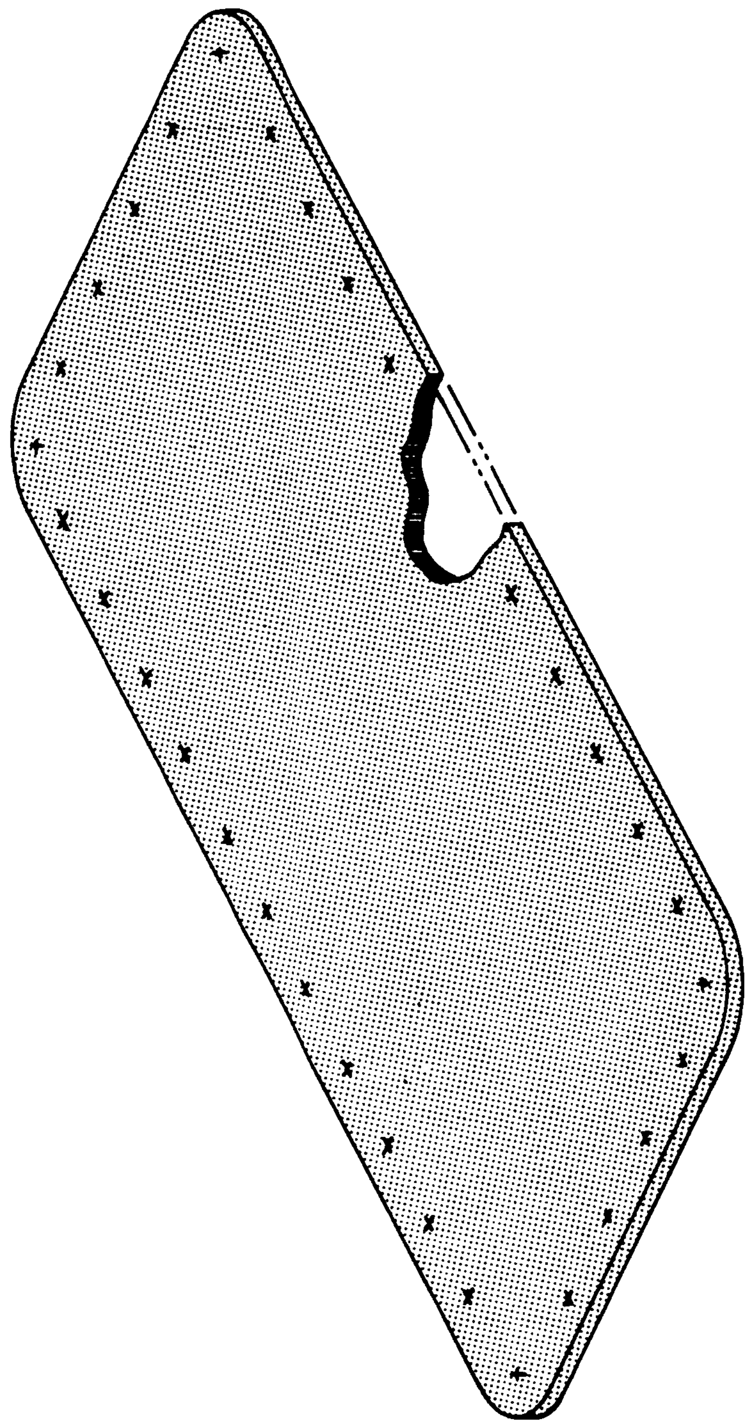


FIGURE 14. TYPICAL ACCESS DOOR ASSEMBLY

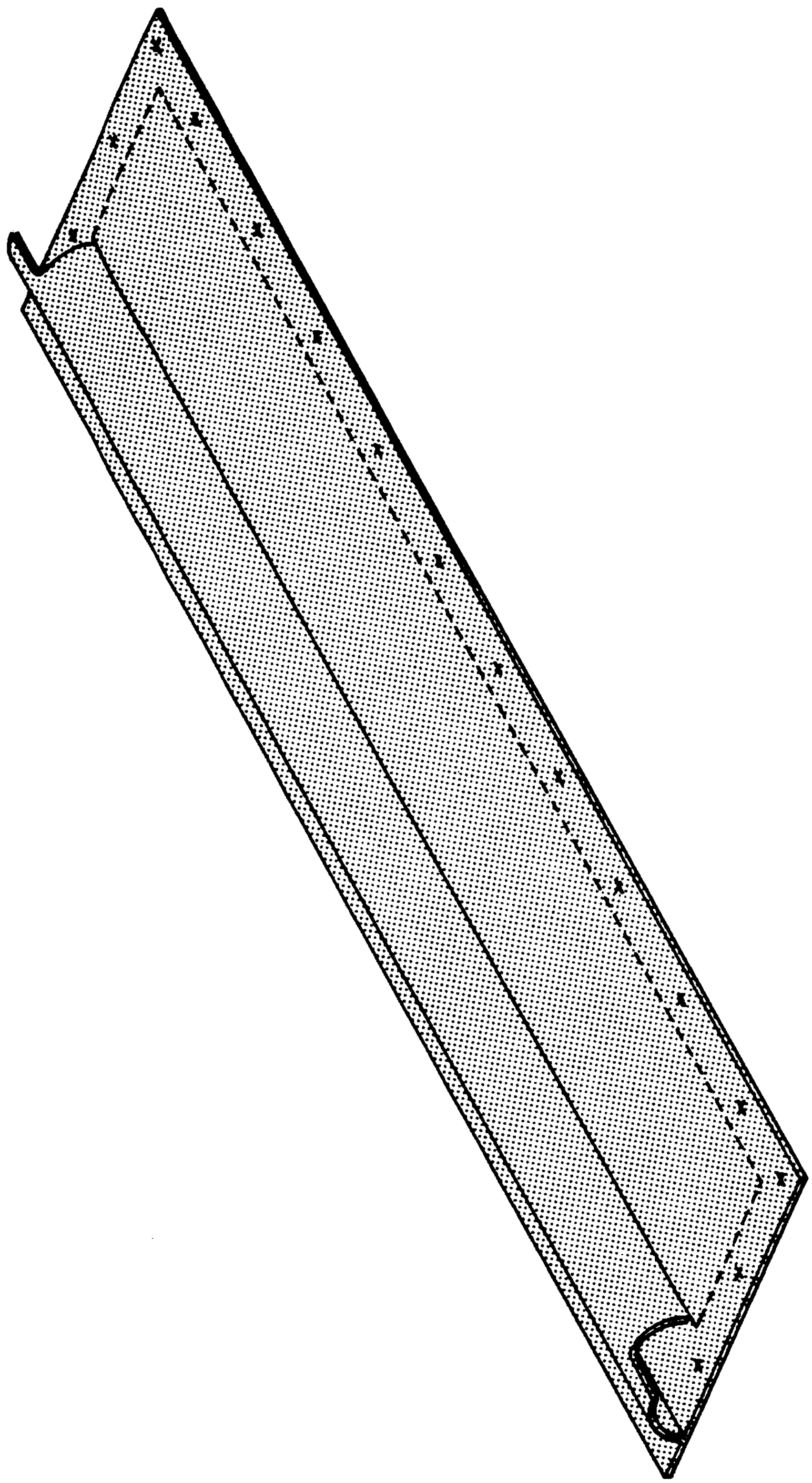


FIGURE 15. TYPICAL TRAILING-EDGE PANEL ASSEMBLY

the graphite-epoxy skin panel and the inside surfaces of the antenna bay will be flame sprayed with a 5-mil aluminum coating. The exterior aluminum surface will also provide protection against the lightning travelling-stroke phenomena. Direct lightning paths will be provided across the tip, and down the metal leading-edge and rudder assemblies.

Special care will be taken to ensure electrical continuity across panel joints and at access doors. This continuity will be achieved at the access door by coating the inner rather than the outer surface of the door with the aluminum spray. Electrical continuity to the leading-edge will require local removal of the paint finish. The metal will then be specially treated to avoid galvanic corrosion.

Drawing Release Status

A total of 28 new drawings were released during the reporting period, and changes were made to four existing drawings to adapt them to the composite stabilizer configuration. Slightly more than 50 percent of the total required drawing effort has been completed. Released drawings are listed below.

AMC 7840	Skin Panel Assembly
AMC 7844	Substructure Assembly
AMC 7845	Front Spar Assembly
AMC 7846	Front Spar Attach Fitting
AMC 7847	Forward Center Spar Assembly
AMC 7848	Aft Center Spar Assembly
AMC 7849	Lower Rear Spar Assembly
AMC 7850	Hinge Support Fitting
AMC 7851	Cant Rib Cap Fitting
AMC 7852	Forward Center Spar Attach Fitting
AMC 7853	Base Rib Installation
AMC 7854	Z_{FR} 295 Rib Installation
AMC 7856	Hinge Bracket Assembly
AMC 7857	Hinge Support Fitting

AMC 7859	Z_{FR} 350 Rib Installation
AMC 7862	Rib Cap Fitting
AMC 7863	Rib Cap Fitting
AMC 7865	Z_{FR} 375 Rib Installation
AMC 7869	Z_{FR} 424 Rib Installation
AMC 7871	Hinge Support Fitting
AMC 7872	Rib Cap Fitting
AMC 7873	Rib Cap Fitting
AMC 7878	Rear Spar Attach Fitting
AMC 7882	Aft Center Spar Attach Fitting
AMC 7892	Hinge Support Fitting
AMC 7893	Upper Rear Spar Assembly
S00202	Laminated Graphite-Epoxy Angle
S00203	Laminated Graphite-Epoxy Angle

The appropriate changes have been made to the following existing hinge and tie-rod bracket assemblies: AMC 7029, 7031, 7073 and 7074.

Drawing preparation is continuing on the remaining ribs and their associated fittings, on the access door assemblies, and on the trailing-edge installation.

STRUCTURAL ANALYSIS

The structural analysis effort has been devoted to completion of the NASTRAN internal loads analysis, derivation of test conditions for the Z5943454 box-beam verification test component, and strength analysis in conjunction with the engineering drawing release activities.

The NASTRAN model for the final internal loads analysis is illustrated in Figure 16. The rudder modules are complete and operational. The lower vertical stabilizer and aft fuselage module is complete and operational. This latter module will be also used to establish the support flexibilities for the Z5943454 box-beam verification test component. Physical and material properties for the upper stabilizer module are approximately 30 percent complete.

The fatigue loading spectrum for the Z5943454 box-beam component has been completed. The identical spectrum will be used on the Z5943452 spar root splice specimens. The spectrum is based on that used on the DC-10 aft-fuselage full-scale fatigue test with the loads modified to reflect the latest external and internal load distributions as developed for this program (Reference 1). The completed test spectrum load exceedance chart is shown in Figure 17. The gust exceedance theoretical line was plotted directly from the DC-10 aft fuselage test report, Reference 2, and the maneuver line was obtained from References 3 and 4.

The analysis method for flanged access holes was substantiated during the reporting period by successful testing of the Z5943434 sine-wave shear-web component (see Section 3 of this report). The analysis method was described in the prior quarterly Progress Report, Reference 5, Appendix B. Accordingly, standard access hole doubler arrangements were formulated for each sine-wave laminate patterns of interest. The doublers are capable of transmitting the maximum shear-flow in the most critical panel of each pattern, (see Figure 6).

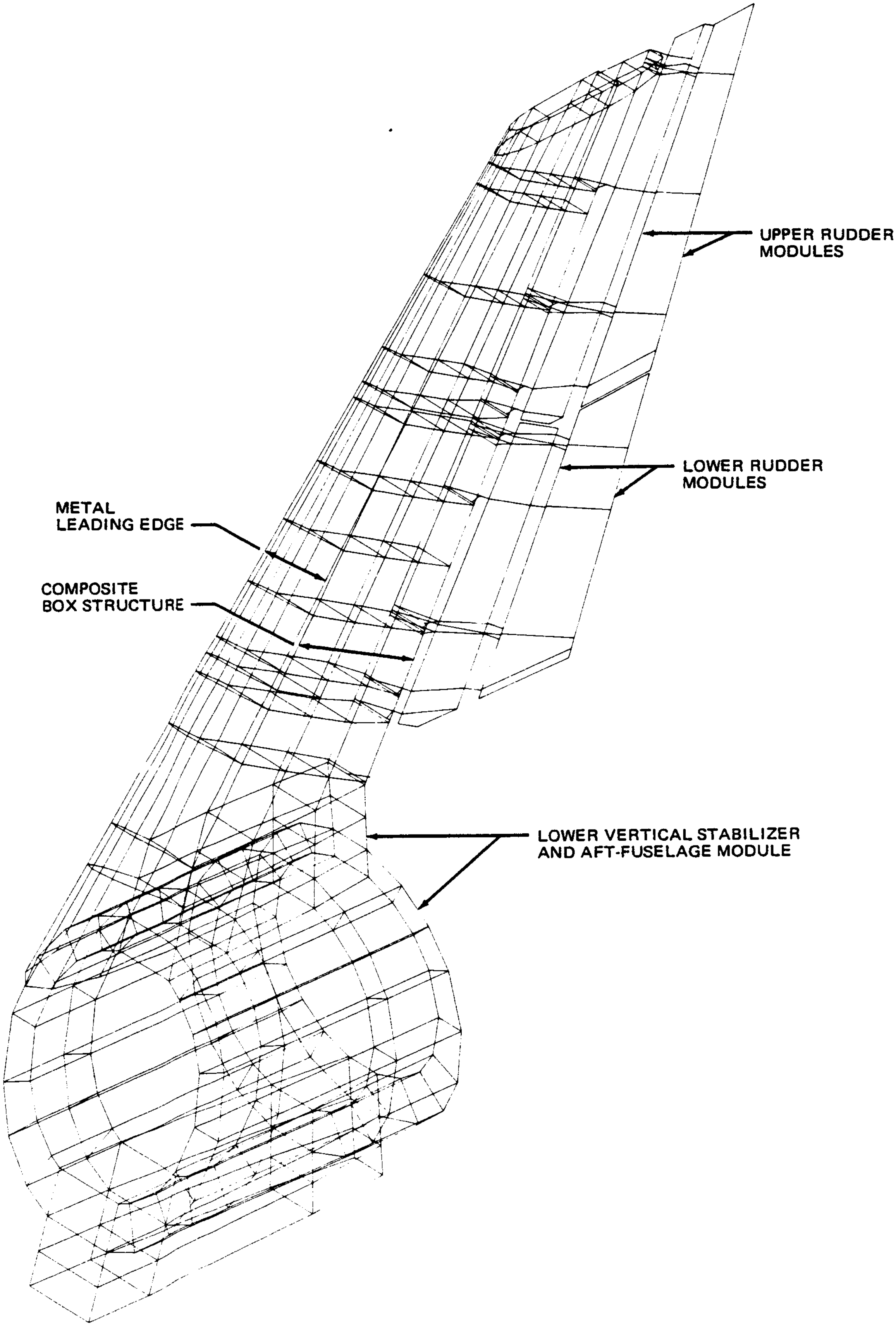


FIGURE 16. NASTRAN MODEL FOR THE COMPOSITE VERTICAL STABILIZER

ORIGINAL PAGE IS
OF POOR QUALITY

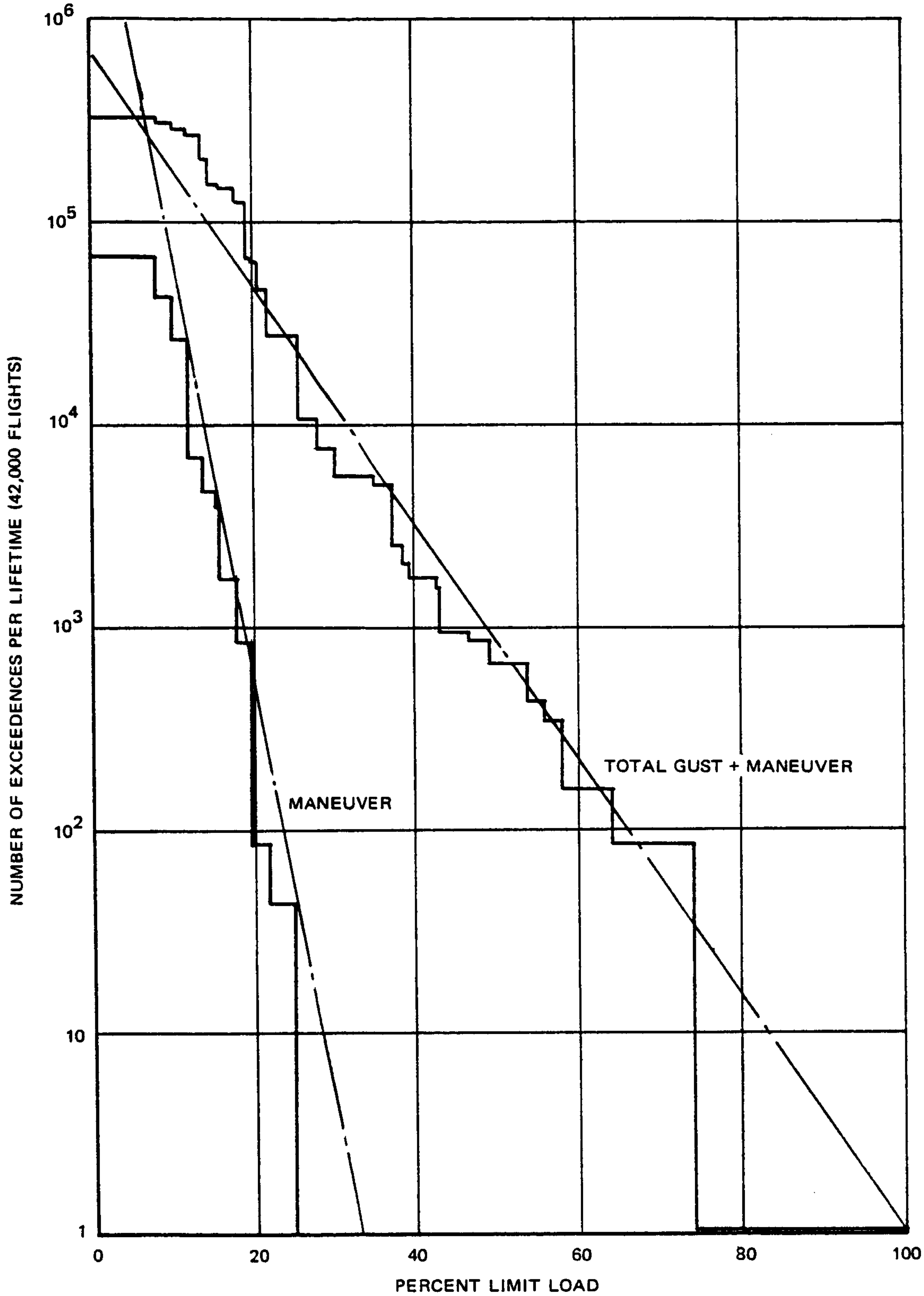


FIGURE 17. FATIGUE TEST LOAD EXCEEDENCE SPECTRUM FOR Z5943452 AND Z5943454 COMPONENTS

Analysis of designed components is proceeding concurrently with the engineering drawing release activity. A summary of analyses completed during the reporting period is presented in Table 1.

WEIGHT STATUS

The predicted weight of the composite stablizer was revised based on calculated weights for engineering drawings released to date. The revised weight comparisons are shown in Table 2. The current predicted weight saving is 21.7 percent.

A weight change summary for the current reporting period is shown in Table 3. A net weight increase of 0.2 kilograms (0.5 pounds), primarily in shear webs, resulted from recalculation of weights based on the released drawing configurations. The CVS weight distribution by material is summarized in Table 4. A weight-time history for the composite stabilizer is shown in Figure 18.

TABLE 1

SUMMARY OF CRITICAL MARGINS-OF-SAFETY
FOR DC-10 COMPOSITE VERTICAL STABILIZER COMPONENTS

AMC DRAWING NUMBER	PART DESCRIPTION	MINIMUM MARGIN-OF-SAFETY	CRITICAL MODE
7840	SKIN PANEL ASSEMBLY	0.15	SHEAR-COMPRESSION INTERACTION
7845 7847 7848 7849	FRONT SPAR ASSEMBLY FORWARD CENTER SPAR ASSEMBLY AFT CENTER SPAR ASSEMBLY REAR SPAR ASSEMBLY	0.52	SHEAR STRESS IN ADHESIVE BOND-LINE AT INTERFACE BETWEEN TITANIUM FITTING AND COMPOSITE SPAR CAP – INCLUDES 133-PERCENT FITTING FACTOR
7850	FITTING – STA Z_{FR} 316 HINGE	0.92	TENSION
7851	FITTING – STA Z_{FR} 316 CANT-RIB CAP	0.07 0.01	BENDING THERMAL BOLT LOAD BEARING
7853	BASE RIB INSTALLATION	0.07	BOLT BEARING
7854	STA Z_{FR} 295 RIB INSTALLATION	0.07	WEB SHEAR AT CUTOUT
7856	BRACKET – STA Z_{FR} 316 AND 325 HINGE	OK	STRUCTURALLY IDENTICAL TO EXISTING DC-10 PART, AMC 7031
7857	FITTING – STA Z_{FR} 351 HINGE	0.24	TENSION
7859	STA Z_{FR} 350 RIB INSTALLATION	0.02	BOLT BEARING
7862	FITTING – STA Z_{FR} 351 RIB CAP	0.12	BOLT BEARING
7863	FITTING – STA Z_{FR} 351 RIB CAP	0.02	BOLT BEARING
7871	FITTING – STA Z_{FR} 423 HINGE	0.24	TENSION
7872	FITTING – STA Z_{FR} 423 RIB CAP	0.02	BOLT BEARING
7873	FITTING – STA Z_{FR} 423 RIB CAP	0.12	BOLT BEARING

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 2
PRELIMINARY WEIGHT COMPARISONS
COMPOSITE VERTICAL STABILIZER

ITEM	COMPOSITE STABILIZER				METAL STABILIZER	
	PREVIOUS ESTIMATE		LATEST ESTIMATE			
	KILOGRAMS	POUNDS	KILOGRAMS	POUNDS	KILOGRAMS	POUNDS
SPAR CAPS	140.5	309.7	132.7	292.6	158.4	349.2
INTERSPAR SKIN PANELS	64.3	141.8	48.3	106.5	87.5	192.8
SPAR WEBS	40.6	89.5	52.9	116.6	62.4	137.6
INTERSPAR RIBS	51.8	114.2	63.5	140.0	67.9	149.6
ACCESS DOORS	16.6	36.6	16.6	36.6	18.5	40.7
MISCELLANEOUS STRUCTURE	13.4	29.5	13.4	29.5	28.7	63.3
GROWTH/CONTINGENCY	4.5	10.0	4.5	10.0	—	—
BOX STRUCTURE	331.7	731.3	331.9	731.8	423.3	933.2
TRAILING-EDGE SKIN AND RIBS	25.3	55.7	25.3	55.7	32.7	72.1
TOTAL — BOX AND TRAILING EDGE	357.0	787.0	357.2	787.5	456.0	1005.3
WEIGHT REDUCTION	99.0	218.3	98.8	217.8	—	—
PERCENT REDUCTION	21.7	21.7	21.7	21.7	—	—

TABLE 3

WEIGHT CHANGE SUMMARY
COMPOSITE VERTICAL STABILIZER

ITEM	WEIGHT CHANGE KILOGRAMS	WEIGHT CHANGE POUNDS
SPAR CAPS		
RELEASE OF PRODUCTION DRAWINGS REFLECT CURRENT WEIGHTS	−7.8	−17.1
INTERSPAR SKIN PANELS		
DELETION OF ANTENNA PANEL FASTENERS (2.4 LB). ESTIMATED WEIGHT FOR PANEL HAS BEEN REPLACED BY COMPOSITE PANEL CORE (HONEYCOMB).	−16.0	−35.3
RELEASE OF SKIN PANEL DRAWING REFLECTS THE CURRENT WEIGHT. IN ADDITION, TRANSFER OF SOME SKIN PANEL TO INTERSPAR RIB WHERE APPLICABLE.		
SPAR WEBS		
RELEASE OF SPAR WEB PRODUCTION DRAWINGS REFLECT CURRENT WEIGHT	+12.3	+27.1
INTERSPAR RIBS		
PARTIAL RELEASE OF PRODUCTION DRAWINGS PROVIDES CURRENT DESIGN AND WEIGHTS FOR RIBS	+11.7	+25.8
TOTAL WEIGHT CHANGE	+0.2	+0.5

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 4

WEIGHT DISTRIBUTION BY MATERIAL
COMPOSITE VERTICAL STABILIZER

ITEM	MATERIAL WEIGHT																	
	GRAPHITE-EPOXY		TITANIUM		ADHESIVE		NOMEX HONEYCOMB		SYNTACTIC FOAM		ALUMINUM		STEEL		FASTENERS		EXTERIOR FINISH		TOTAL	
	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB	KG	LB
SPAR CAPS	88.6	195.4	39.9	88.0											4.2	9.2			132.7	292.6
SKIN PANELS	26.2	57.7			6.6	14.6	5.3	11.6	2.3	5.1	7.9*	17.5*							48.3	106.5
SPAR WEBS	51.6	113.7			0.3	0.6	0.7	1.5	0.4	0.8									52.9	116.6
RIBS	52.0	114.7			0.2	0.5	0.1	0.2	0.1	0.2	7.3	16.2			3.7	8.2			63.5	140.0
ACCESS DOORS	10.5	23.1			1.1	2.5	0.5	1.2	0.4	0.9	1.6*	3.5*			2.4	5.4			16.6	36.6
MISCELLANEOUS STRUCTURE	4.6	10.1			0.6	1.3					4.2	9.3	1.5	3.2	0.2	0.4	2.4	5.2	13.4	29.5
GROWTH/ CONTINGENCY																			**	**
BOX SUBTOTAL	233.5	514.7	39.9	88.0	8.8	19.5	6.6	14.5	3.2	7.0	21.0	46.5	1.5	3.2	10.5	23.2	2.4	5.2	327.4	721.8
TRAILING EDGE	13.8	30.4			0.4	0.8	0.1	0.3	0.3	0.6	8.2	18.0	0.7	1.6	1.5	3.3	0.3	0.7	25.3	55.7
TOTAL WEIGHT	247.3	545.1	39.9	88.0	9.2	20.3	6.7	14.8	3.5	7.6	29.2	64.5	2.2	4.8	12.0	26.5	2.7	5.9	352.7	777.5

*ALUMINUM SPRAY COATING
**GROWTH/CONTINGENCY ALLOWANCE OF 10 POUNDS NOT INCLUDED

ORIGINAL PAGE IS
OF POOR QUALITY

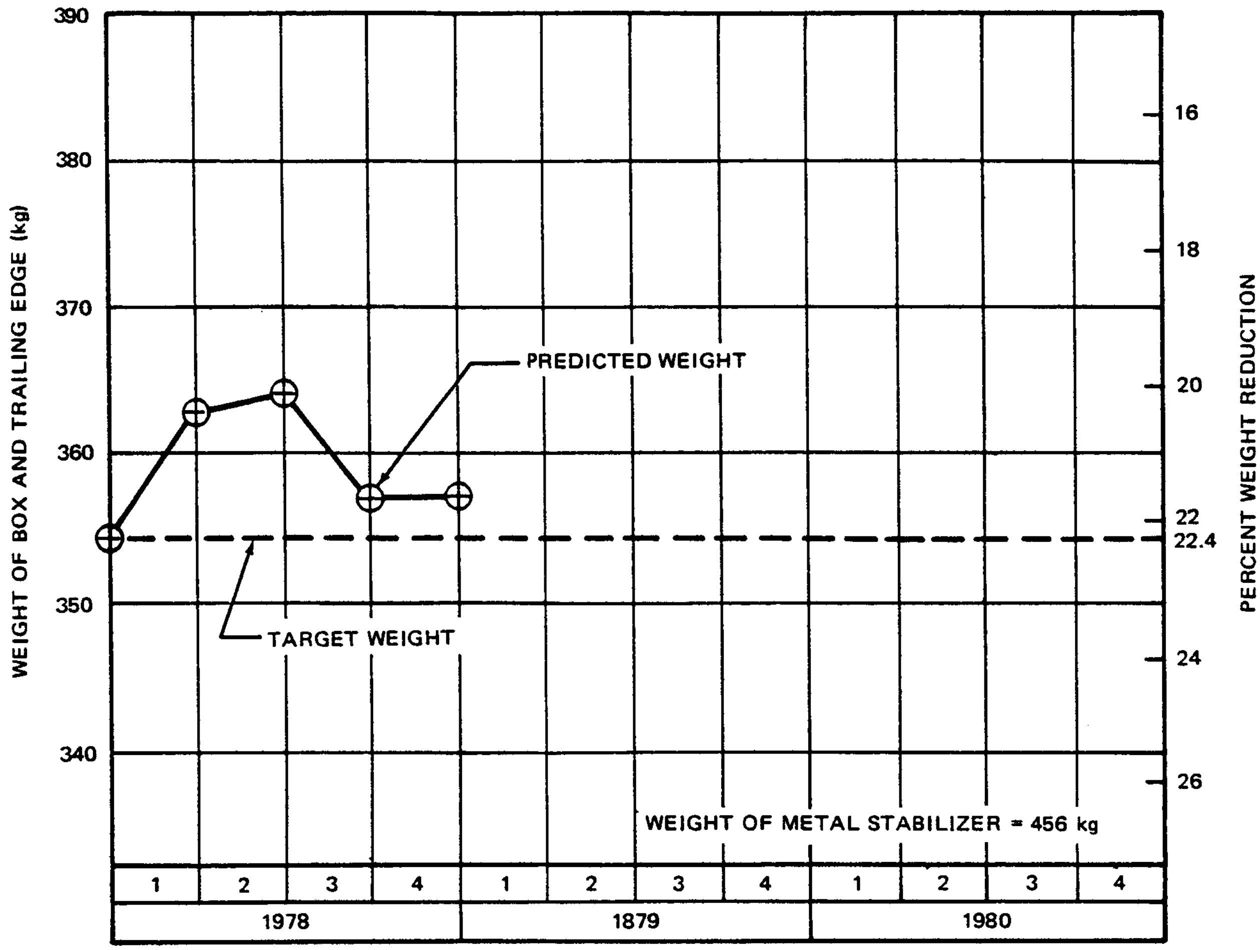


FIGURE 18. COMPOSITE VERTICAL STABILIZER WEIGHT TREND

SECTION 3
CONCEPT DEVELOPMENT COMPONENTS

The concept development component testing for the program was completed during the reporting period with completion of the Z5943434 sine-wave spar-web test and the Z3943451 lightning protection system tests. Previously completed tests in this component group included stiffened compression and shear panel tests (References 5 through 8) a honeycomb stiffened spar-web test (References 5 and 8), and galvanic effects tests (Reference 5).

Test setups and results of the sine-wave spar-web and lightning protection system tests are described in this section.

SPAR-WEB COMPONENT

The Z5943434 sine-wave shear web component was redesigned and remade as a result of previous test component failure (see Reference 5). The redesign provided for two flat areas in the web for incorporation of 11.4 cm (4.5 inch) diameter access openings. The component included one access opening having flanged edges as shown in Figure 19. The other flat area in the specimen web was left blank to permit subsequent test evaluation of an unflanged cutout, see Figure 20.

The testing was accomplished in two steps. The first test subjected the component to ultimate design shear loading (600 pounds per inch) in the web. Load was applied to the component as a simply supported beam as shown in Figure 19. The component successfully sustained the loading without failure. The maximum tensile strain in the flange of the cutout was 2495 microinches per inch at 152 percent test limit load (TLL).

The component was removed from the test fixture and a circular opening cut in the blank web (Figure 21). The component was re-installed in the test fixture and the test loading sequence repeated. The web failed at the unflanged cutout at 104 percent TLL (420 pounds per inch). Failure resulted from

PRECEDING PAGE BLANK NOT FILMED

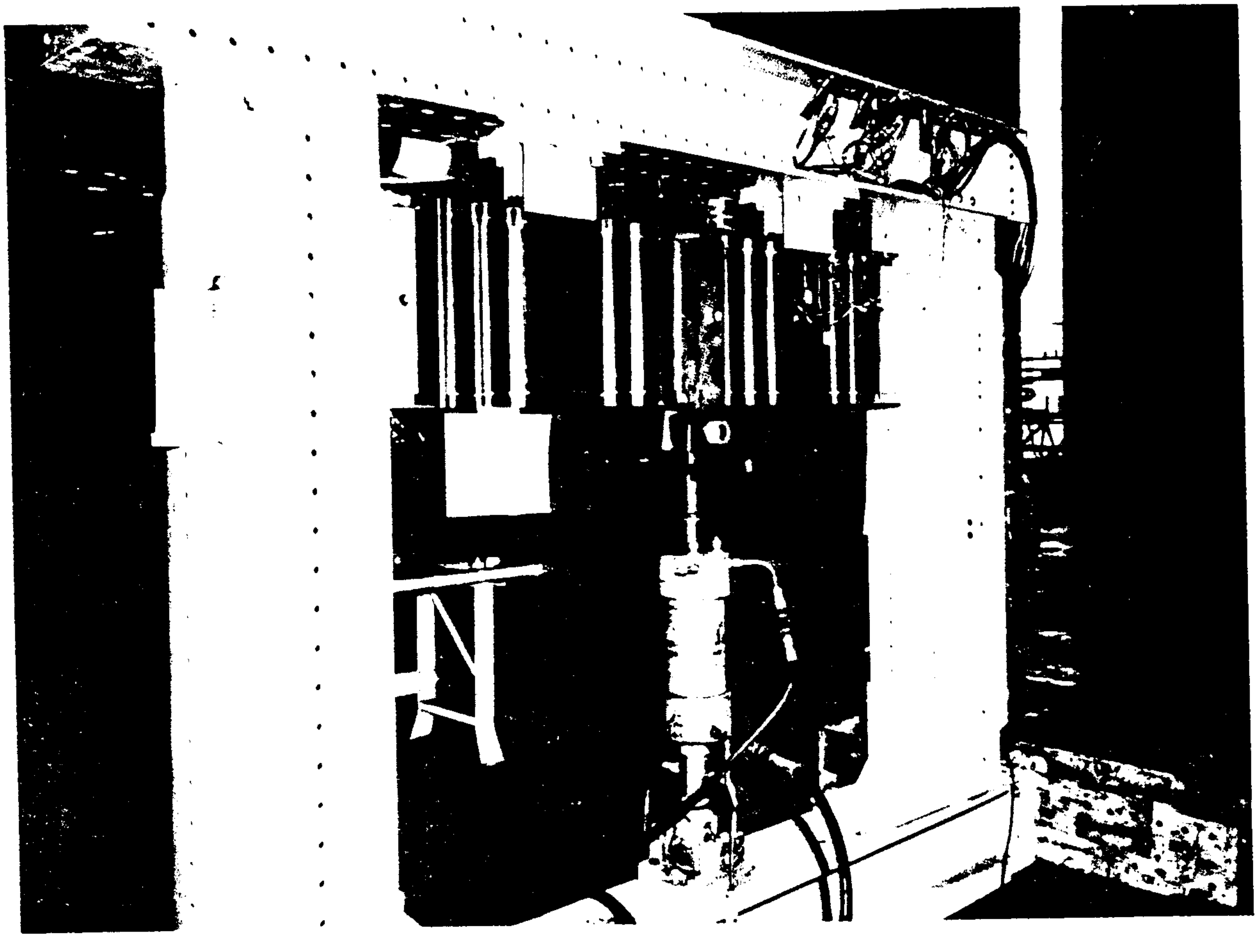


FIGURE 19. SINE-WAVE SHEAR WEB COMPONENT IN TEST FIXTURE

ORIGINAL PAGE IS
OF POOR QUALITY

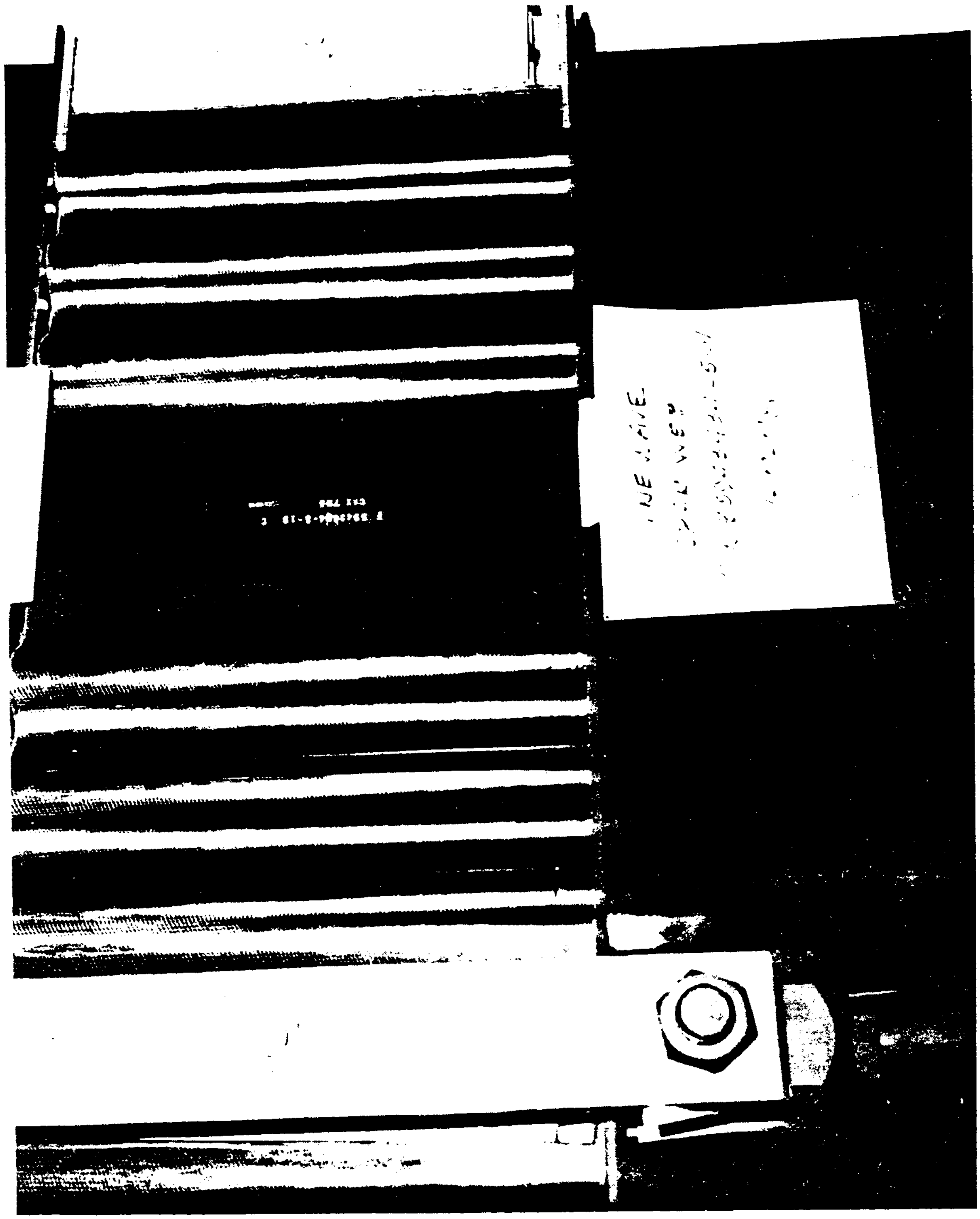


FIGURE 20. FLAT AREA IN Z5943434-501 SINE WAVE SPAR WEB

ORIGINAL PAGE IS
OF POOR QUALITY

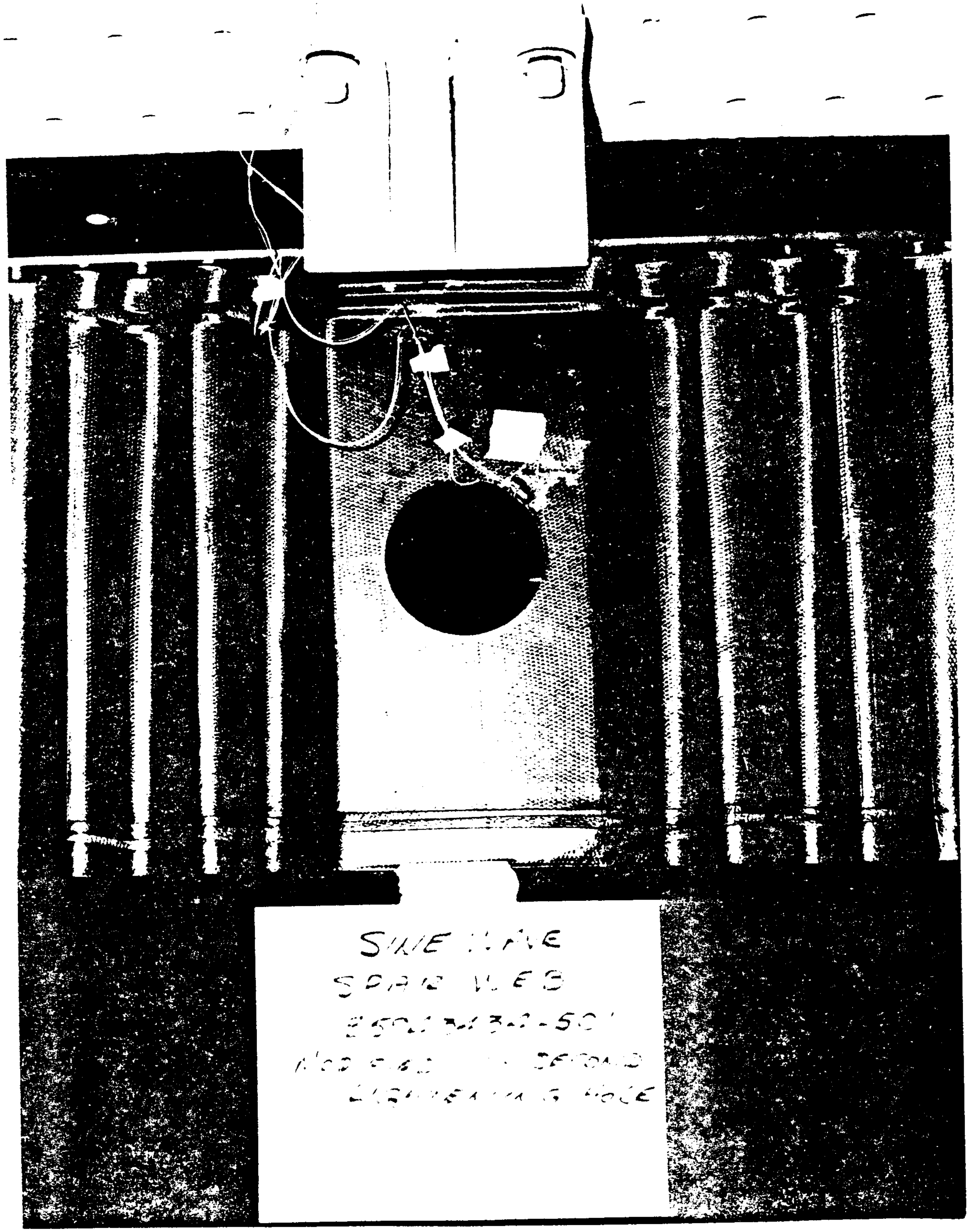


FIGURE 21. UNFLANGED ACCESS OPENING IN SINE-WAVE SHEAR WEB COMPONENT

excessive circumferential tensile strains at the edge of the cutout as shown in Figure 22. A tensile strain of 5925 microinches per inch was recorded at the edge of the unflanged cutout at failure. The test indicated the need for local reinforcing flanges at the shear-web cutouts to meet design shear load requirements.

LIGHTNING TEST PANEL

Current transfer and lightning restrike tests were completed on the Z3943451 lightning evaluation panel. The 5-mil aluminum spray coating was adequate for all lightning current transfer and restrike tests.

The test panel configuration is illustrated in Figure 23. The metal tabs at the left hand edge of the panel represented candidate joint configurations at the metal leading edge structure interface with the graphite stabilizer box-structure. The joint was effected with flush screws at normal installation torque and at two higher torque values. The metal tabs at the right-hand edge of the panel represented candidate joint configurations at the trailing edge structure interface with the graphite stabilizer box-structure in the vicinity of a rudder hinge bracket. The simulation of the metal piano-hinge which will attach the trailing edge structure to the graphite box structure was attached with various rivet combinations. Tabs 1A, 1B, 3A, 3B, 5A and 5B all had metal-to-metal contact between the tab and the metal spray coating. The remaining tabs had a faying surface seal (PRC 1431G) between the tabs and the metal spray coating.

Lightning Current Transfer Tests

During a severe 200 kiloampere (KA) peak-current lightning-strike at the tip of the stabilier, the current transferred in the skins of the composite vertical stabilizer will be approximately 0.5 KA per centimeter of width. The 9.5 centimeter wide joints of the test panel, therefore, must be capable of transferring about 5 KA. The current transfer tests were made with the panel mounted in the test fixture as shown in Figure 24.

ORIGINAL PAGE IS
OF POOR QUALITY

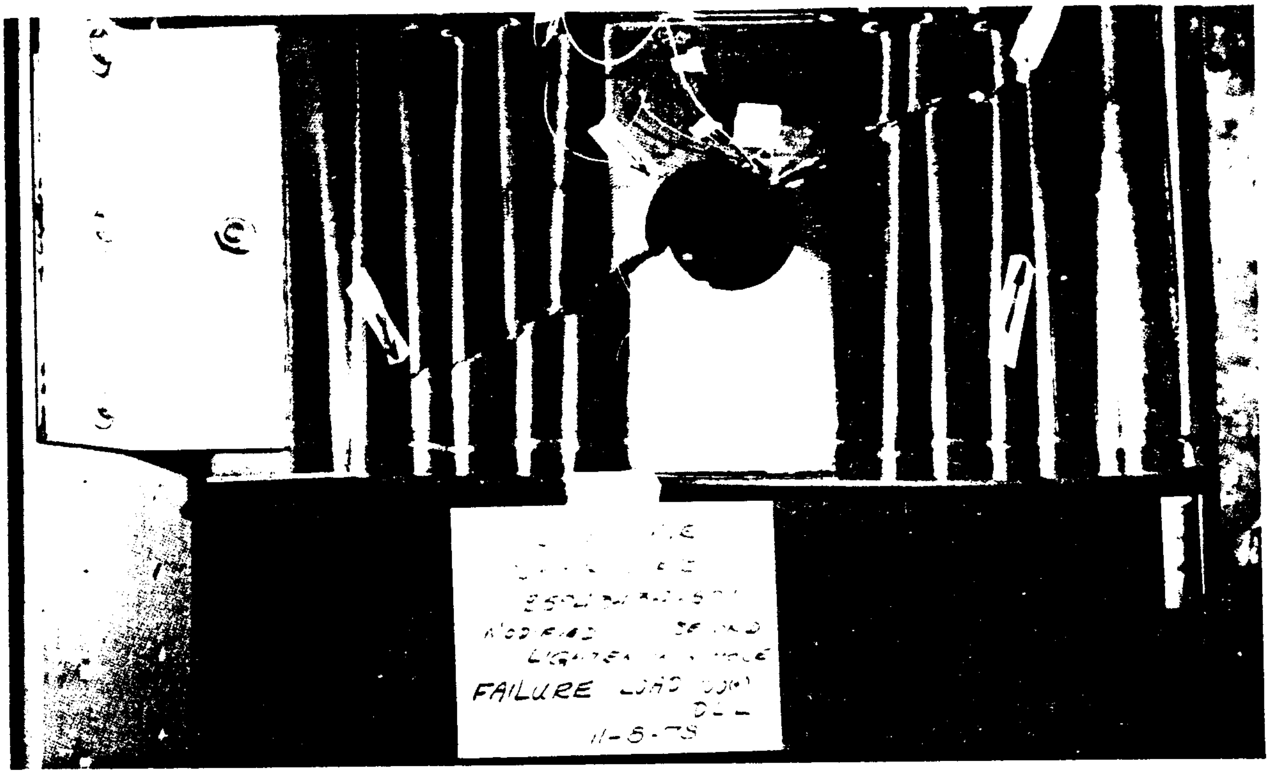


FIGURE 22. FAILURE OF SHEAR WEB AT UNFLANGED ACCESS OPENING

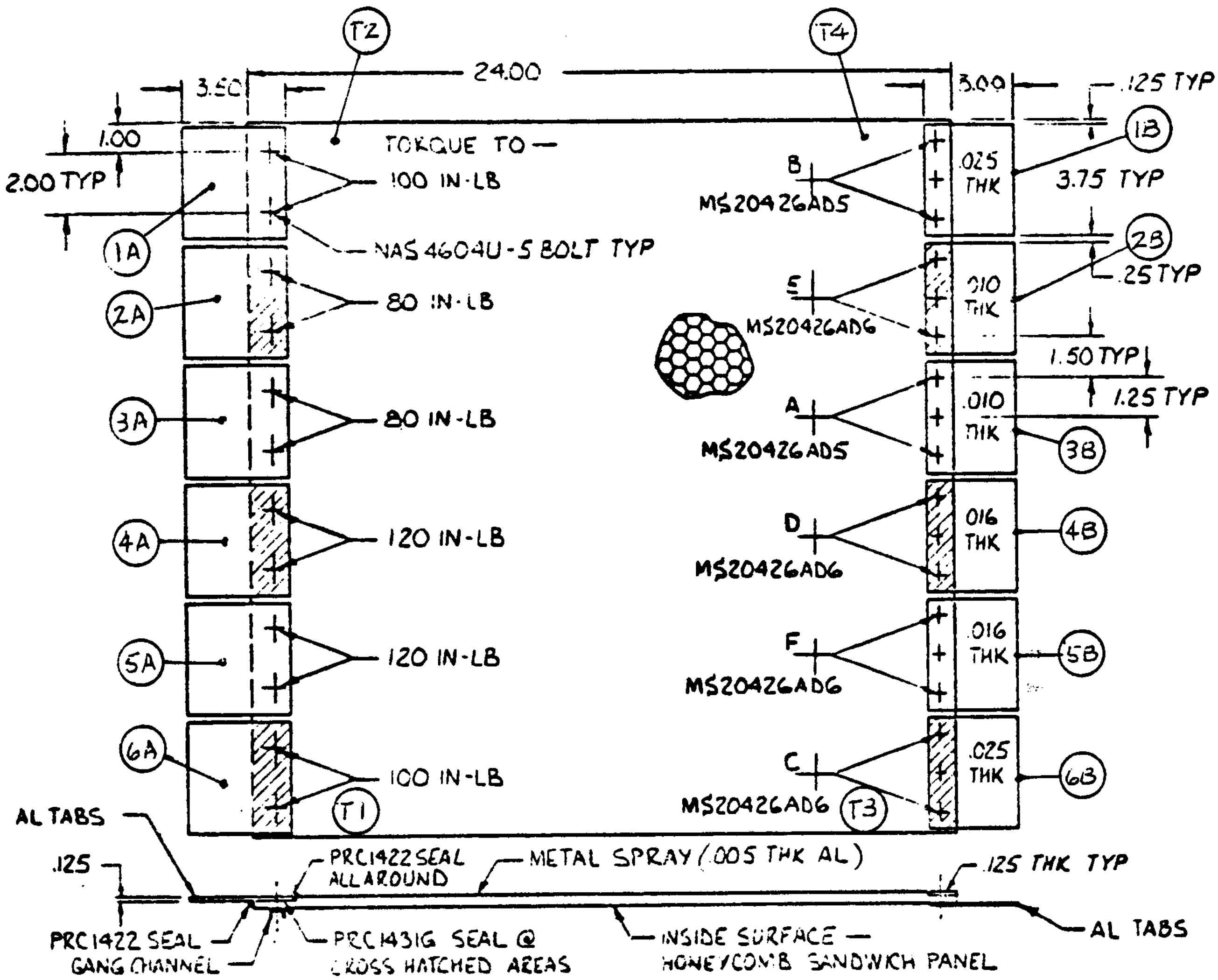


FIGURE 23. SKETCH OF LIGHTNING PANEL SHOWING TEST POINTS

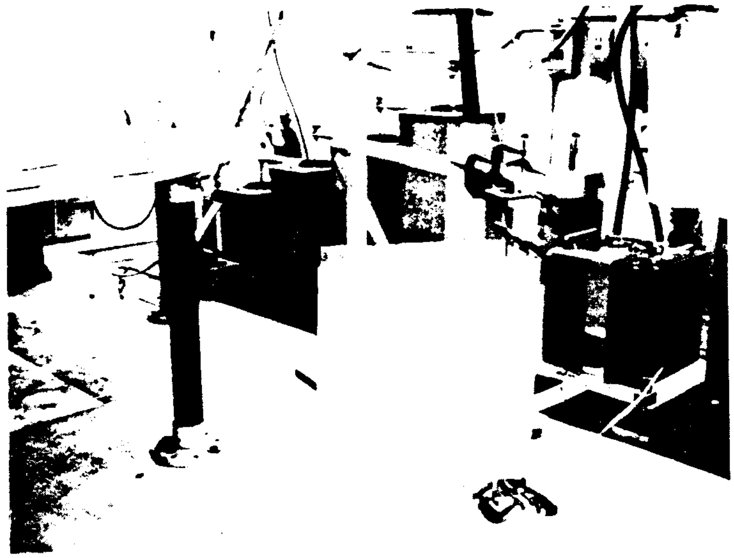


FIGURE 24. TEST SETUP – SIMULATED LIGHTNING CURRENT TRANSFER TEST

The initial test was a discharge of 5.9 KA peak current from tab 1A to 1B. The action integral was .0489 x 10^4 ampere squared seconds. The same test was made from tab 6A to 6B. Additional tests were made between the other tab pairs with peak currents of 11.6 KA and 16.9 KA. Typical current waveforms for the discharges made during the tests are shown in Figure 25. The discharge paths, current levels, and resistance values are tabulated in Table 5.

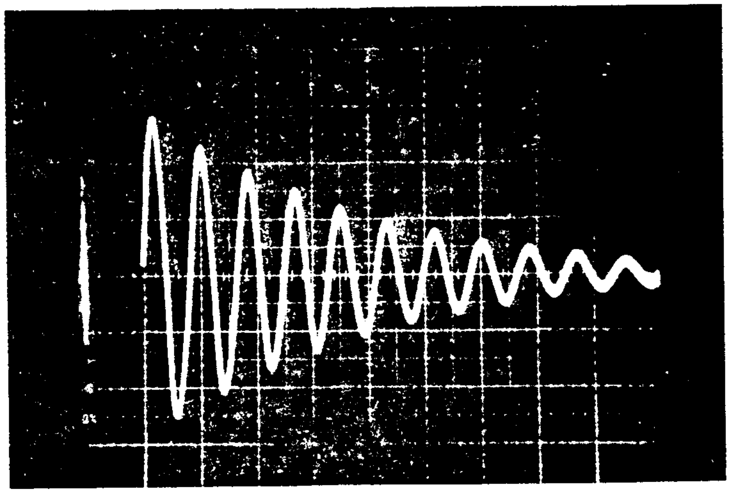
There was no measureable difference in the resistance values obtained before and after test or between the various joints. These tests indicate that all joint configurations tested are acceptable for transferring the necessary lightning current densities. The joints with the faying surface seal are preferred, because of the greater corrosion resistance.

Simulated Lightning Restrike Tests

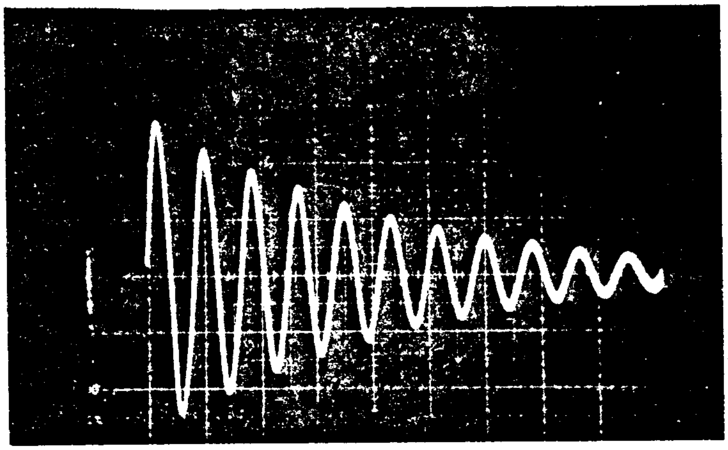
Photographs of the test panel mounted in the test fixture before and after the 116 KA lightning restrike test are shown in Figure 26. The test waveform is shown in Figure 27. The action integral of 0.55 x 10^6 ampere squared seconds was greater than the required test value of 0.25 x 10^6 ampere square seconds and the peak current of 116 KA was greater than the required level of 100 KA. The discharge path was from the center of the panel to tabs 1B, 2B, 3B, 4B, 5B, and 6B which were clamped together. There were no changes in the resistances of the panel caused by the high current discharge (see Table 6). Photographs of the test panel showing the area where the metal spray was vaporized are shown in Figures 28 and 29.

Upon completion of the lightning tests, the lightning panel was examined using x-ray and ultrasonic through transmission NDI techniques. This examination revealed that the high current lightning strike to the panel caused a delamination of approximately 7.5 centimeters (3 inches) diameter between the outer facing and the honeycomb core in the area where the metal spray was vaporized. The damage was repairable and considered to be acceptable for composite vertical stabilizer from a safety standpoint.

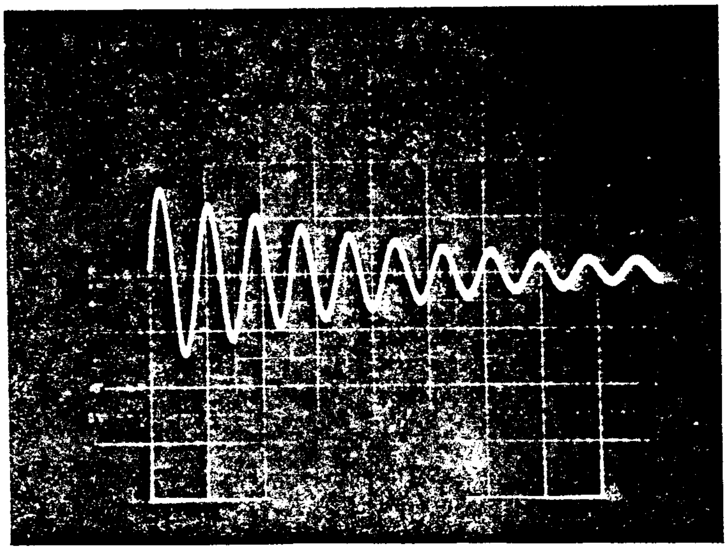
ORIGINAL PAGE IS
OF POOR QUALITY



VERTICAL SCALE: 2.11 KA PER DIVISION
HORIZONTAL SCALE: 10 μSEC PER DIVISION
PEAK CURRENT: 5.9 KA
DISCHARGE PATH: POINT 1A TO POINT 1B



VERTICAL SCALE: 4.22 KA PER DIVISION
HORIZONTAL SCALE: 10 μSEC PER DIVISION
PEAK CURRENT: 11.6 KA
DISCHARGE PATH: POINT 2A TO POINT 2B



VERTICAL SCALE: 10.55 KA PER DIVISION
HORIZONTAL SCALE: 10 μSEC PER DIVISION
PEAK CURRENT: 16.9 KA
DISCHARGE PATH: POINT 1A TO POINT 1B

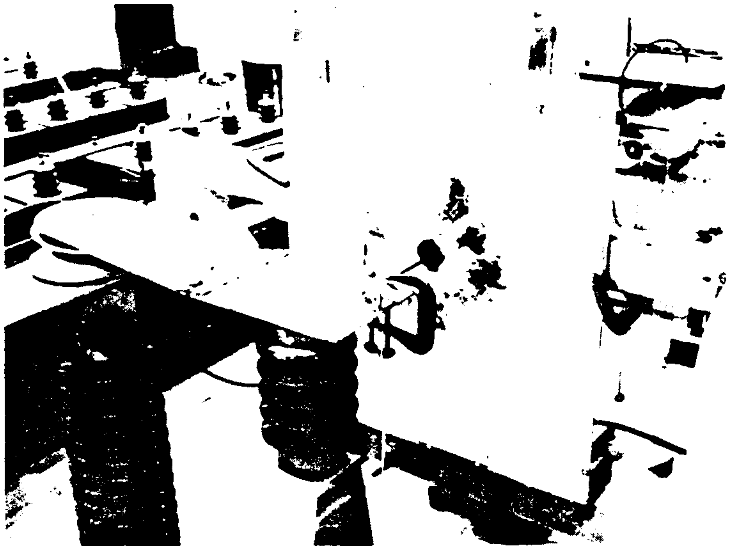
FIGURE 25. TYPICAL TEST WAVEFORMS – CURRENT TRANSFER TESTS

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 5
PANEL RESISTANCE MEASUREMENTS
CURRENT TRANSFER TESTS

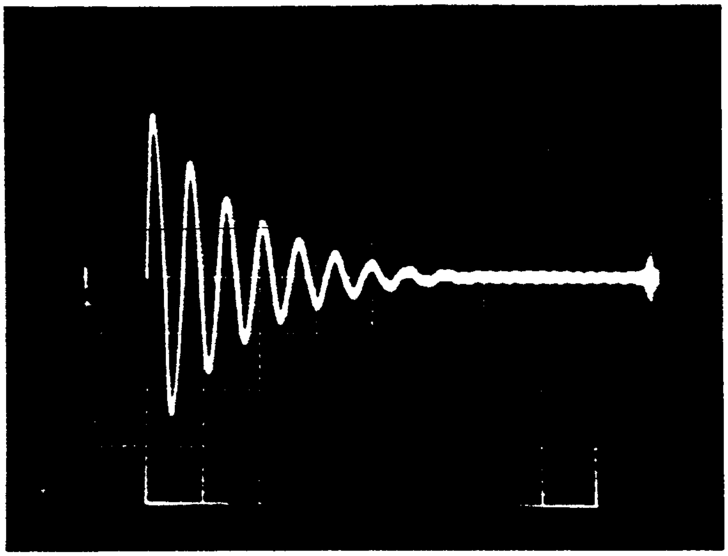
DISCHARGE CURRENT (KILOAMPERES)	DISCHARGE PATH	RESISTANCE CHECK POINTS	RESISTANCE (MILLIOHMS)	
			BEFORE TEST	AFTER TEST
5.9	1A-1B	1A-1B	10.0	6.0
		2A-2B	6.0	5.0
		3A-3B	4.5	5.0
		T1-T2	6.5	7.0
		T3-T4	5.0	9.0
		T2-T4	6.0	7.0
		1A-T2	3.0	2.0
		1B-T4	5.0	2.0
	6A-6B	4A-4B	9.0	4.5
		5A-5B	13.0	4.0
		6A-6B	27.0	5.0
		T1-T2	7.0	6.5
		T3-T4	9.5	5.0
		T1-T3	8.0	7.0
		6A-T1	8.0	1.0
		6B-T3	20.0	3.0
11.6	2A-2B	1A-1B	6.0	6.0
		2A-2B	5.0	4.5
		3A-3B	5.0	4.5
		T1-T2	7.0	6.5
		T3-T4	9.0	7.5
		2A-T2	3.0	3.0
		2B-T4	4.0	3.5
	3A-3B	2A-2B	4.5	4.5
		3A-3B	4.5	4.0
		4A-4B	4.5	4.5
		T1-T2	6.5	6.5
		T3-T4	7.5	8.0
		3A-T2	4.0	4.0
		3B-T4	4.5	4.5
16.9	1A-1B	1A-1B	6.0	5.5
		2A-2B	5.0	5.0
		3A-3B	4.5	4.5
		T1-T2	7.0	6.5
		T2-T4	7.0	7.0
	6A-6B	4A-4B	4.5	4.0
		5A-5B	4.0	4.0
		6A-6B	5.0	5.0
		T1-T2	8.5	6.5
		T1-T3	7.0	6.0
	2A-2B	1A-1B	6.0	6.0
		2A-2B	4.5	4.5
		3A-3B	4.5	4.5
		T1-T2	6.5	7.0
	3A-3B	2A-2B	4.5	4.5
		3A-3B	4.0	4.0
		4A-4B	4.5	4.0
		T1-T2	6.5	2.0
	4A-4B	3A-3B	4.0	4.0
		4A-4B	4.5	4.0
		5A-5B	4.5	4.5
		T1-T2	6.5	6.5
	5A-5B	4A-4B	4.0	4.0
		5A-5B	4.5	4.0
		6A-6B	5.5	5.5
		T1-T2	6.5	4.0

BEFORE TEST



AFTER TEST

FIGURE 26. TEST SETUP – SIMULATED LIGHTNING RESTRIKE TEST TO COMPOSITE PANEL (116-KA PEAK)



VERTICAL SCALE: 40 KA PER DIVISION
HORIZONTAL SCALE: 100 μSEC PER DIVISION
PEAK CURRENT: 116 KA

FIGURE 27. TEST WAVEFORM – SIMULATED LIGHTNING RESTRIKE TEST TO CENTER OF PANEL

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 6

PANEL RESISTANCE MEASUREMENTS
LIGHTNING RESTRIKE TEST

DISCHARGE CURRENT (KILOAMPERES)	DISCHARGE PATH	RESISTANCE CHECK POINTS	RESISTANCE (MILLIOHMS)	
			BEFORE TEST	AFTER TEST
116.0	CENTER OF PANEL TO TABS 1B, 2B, 3B, 4B, 5B, 6B	1A-1B	6.0	6.0
		2A-2B	5.0	5.0
		3A-3B	4.5	5.0
		T1-T2	7.0	7.0
		T3-T4	9.0	7.5
		T2-T4	7.0	4.5
		1B-T4	2.5	3.0
		4A-4B	4.5	3.0
		5A-5B	4.0	5.5
		6A-6B	5.0	5.5
		T1-T3	7.0	7.0
		6B-T3	3.0	3.0

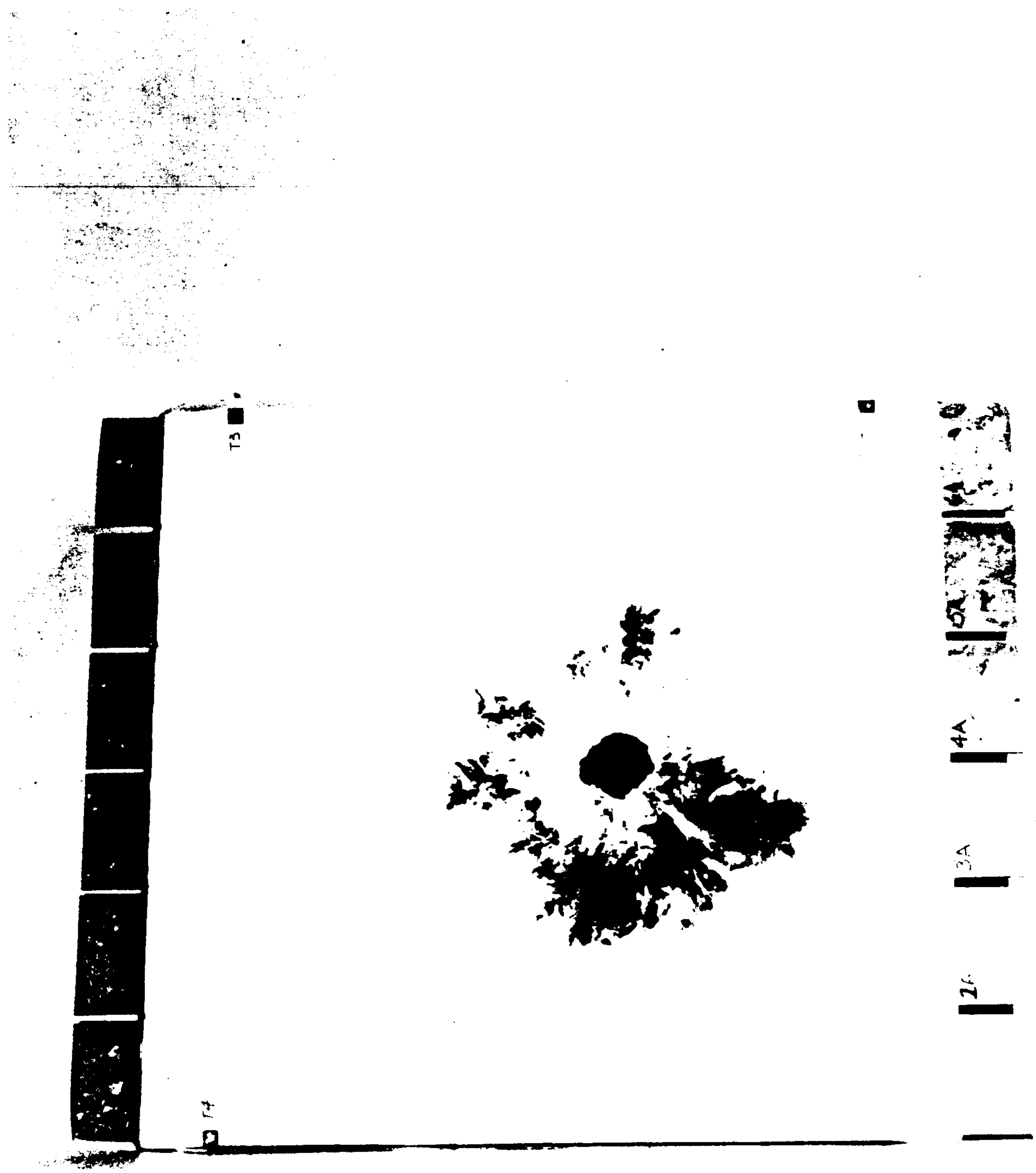


FIGURE 28. COMPOSITE PANEL AFTER 116-KA SIMULATED LIGHTNING RESTRIKE TEST

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 29. COMPOSITE PANEL AFTER 116-KA SIMULATED LIGHTNING RESTRIKE TEST (CLOSE-UP VIEW)

The metal tabs were all removed from the lightning panel for visual examination. There was no burning or other evidence of lightning damage at any of the joints. One joint that had only an edge seal was filled with fluid. The fluid entered the joint through a break in the seal when the panel was submerged for ultrasonic test. This incident emphasized the importance of using a faying surface seal to eliminate moisture intrusion and the resulting corrosion.

SECTION 4
JOINT DEVELOPMENT COMPONENTS

The joint development component testing for the program will be completed on successful testing of the Z5943453 actuator (-1) and tie-rod (-501) rudder fitting components. These tests will simulate critical load conditions in the actuator ribs and tie-rod ribs discussed previously in Section 2, Detail Design. Previously completed tests in this component group included the leading edge splice tests, leading edge attachment fatigue tests, spar cap to cover panel attachment tests, and major attach fitting tests (see References 7 through 9).

Detail part fabrication was completed for both the Z5943453-1 and -501 specimen configurations during the reporting period and final assembly was completed for the -1 (actuator) component. The completed -1 component is shown in Figures 30 and 31. The -501 component during setup for final assembly is shown in Figure 32. Test fixture installation and testing for both components will be completed in January 1979. Fabrication of the full-size rib tooling for the CVS will not be started until these tests are successfully completed.

PRECEDING PAGE BLANK NOT FILMED

ORIGINAL PAGE IS
OF POOR QUALITY

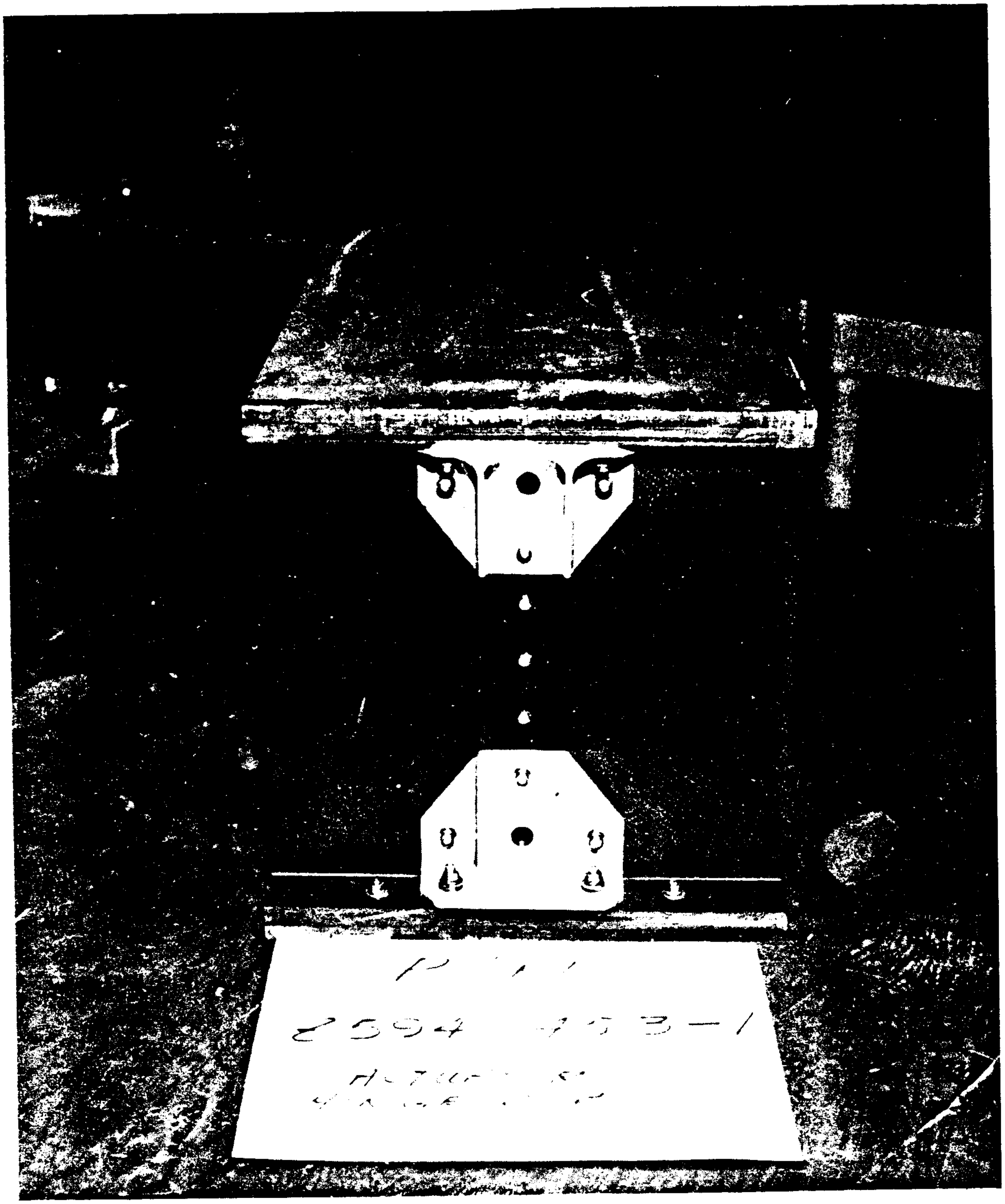


FIGURE 30. Z5943453-1 ACTUATOR HINGE RIB COMPONENT – VIEW LOOKING FORWARD AT SIMULATED REAR SPAR

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 31. Z5943453-1 ACTUATOR HINGE RIB COMPONENT – VIEW SHOWING INTERNAL FITTING AND SIMULATED SINE-WAVE RIB WEB

ORIGINAL PAGE IS
OF POOR QUALITY

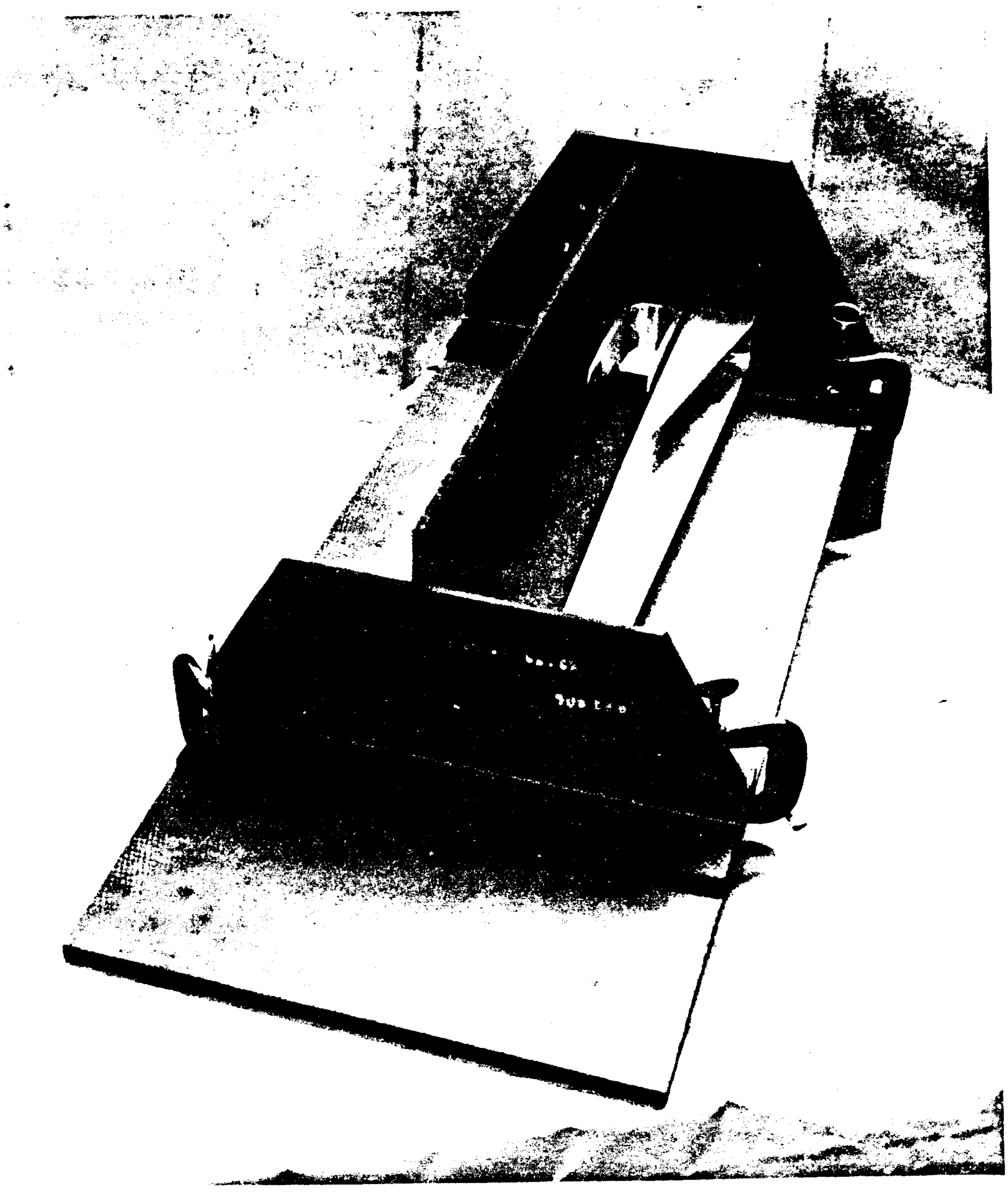


FIGURE 32. Z5943453-501 TIE-ROD RUDDER FITTING COMPONENT DURING SETUP FOR FINAL ASSEMBLY

SECTION 5
MECHANICAL PROPERTY TESTING

Mechanical property testing for the program was completed during the reporting period with the completion of laminate fatigue testing and fracture mechanics data testing on a variety of damaged and debonded specimens. Previously completed laminate property tests for static tension and compression allowables, fatigue data, and bolt bearing and shear-out data were reported in References 5 and 8.

Test conditions and results for the completed fatigue tests and the fracture mechanics tests are described in this section.

LAMINATE PROPERTY TESTS

Fatigue testing was completed on the Z3943432-505 quasi-isotropic laminate sandwich beam specimens. The results of these tests are plotted in Figures 33 through 36. The test data are tabulated in Tables B-1 and B-2 in Appendix B.

A plot of the fatigue data at a stress ratio of R = -1.0 is shown in Figure 33. Tests were conducted at temperatures of 219°K (-65°F), ambient, and 350°K (170°F). All specimens included a central hole of 0.635 cm (0.250 in) diameter providing a width-to-hole-diameter ratio of 6. The average fatigue strength exhibited by the specimens tested at ambient and 350°K was approximately 185 megapascals (26800 psi) at the one-life equivalent of 130,000 load cycles. The specimens tested at 219°K exhibited a somewhat higher average fatigue strength of 225 megapascals (32700 psi) or about a 22 percent increase in fatigue strength.

A plot of the fatigue data at a stress ratio of R = 0.05 is shown in Figure 34. Tests were conducted at temperatures of 219°K, ambient and 350°K as before. These specimens also included a central hole of 0.635 cm. The data at this

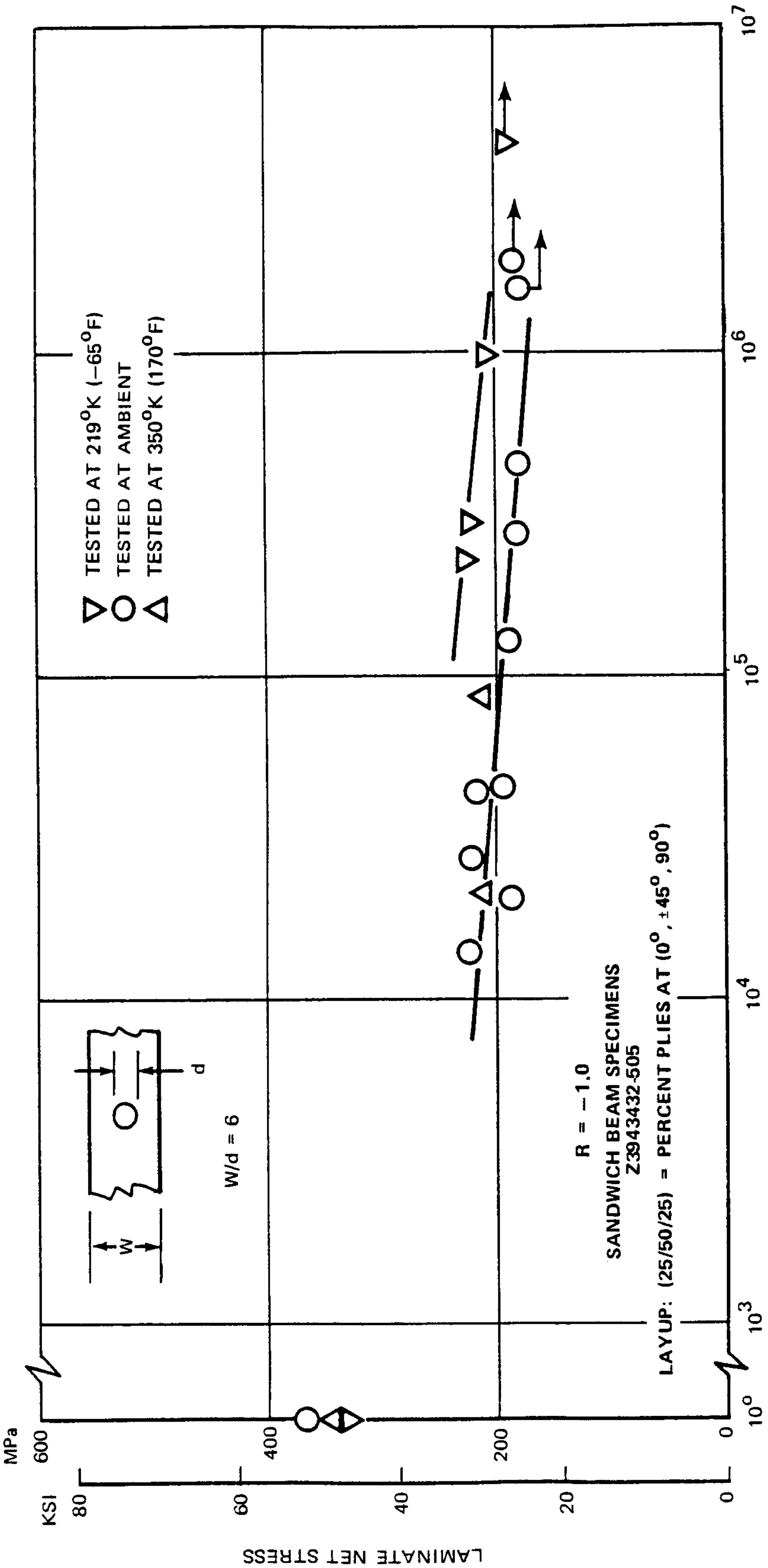


FIGURE 33. FATIGUE CHARACTERISTICS OF T300/5208 GRAPHITE/EPOXY LAMINATES

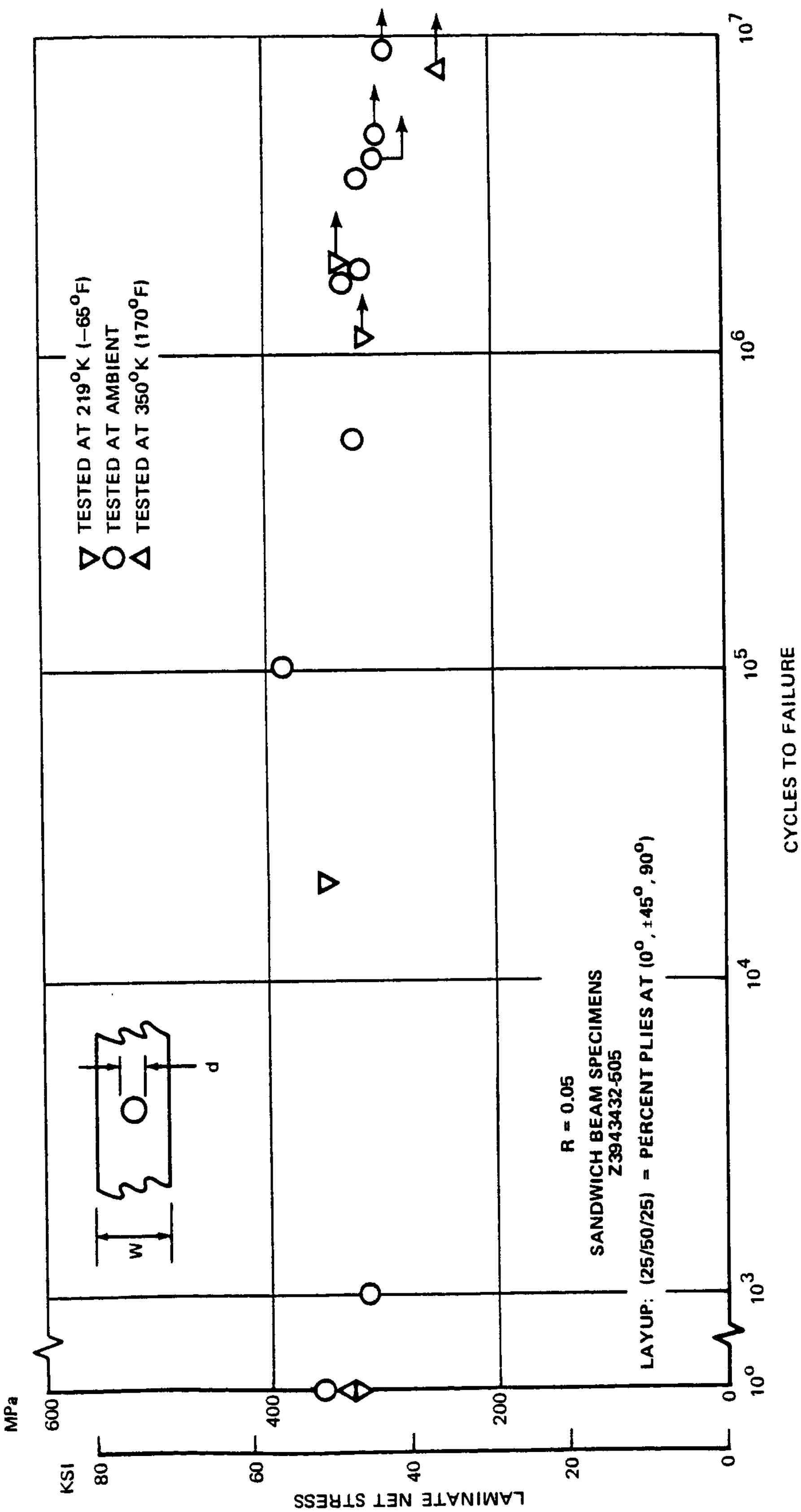
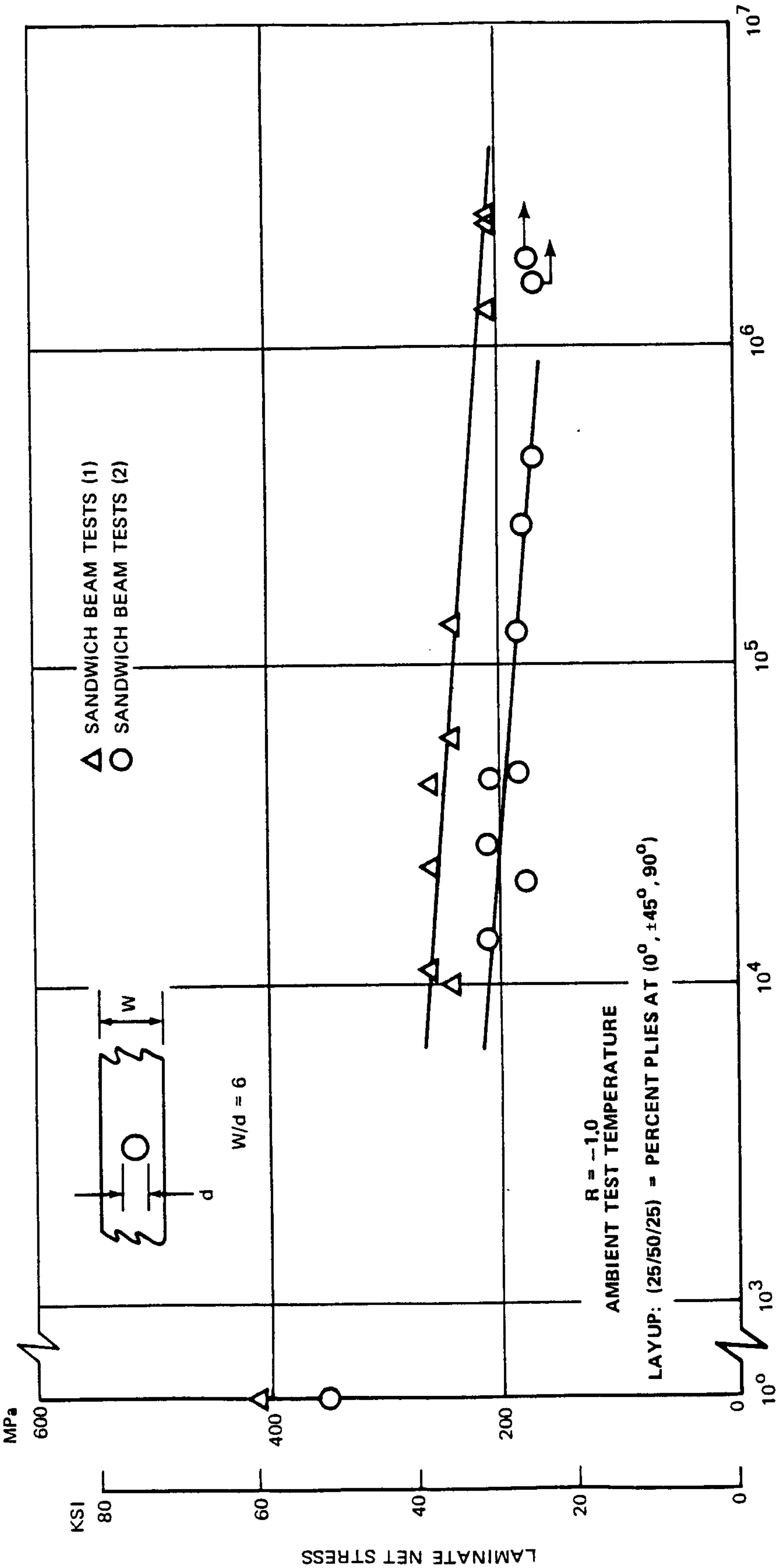


FIGURE 34. FATIGUE CHARACTERISTICS OF T300/5208 GRAPHITE/EPOXY LAMINATES



(1) UNIDIRECTIONAL TAPE, DATA FROM REFERENCE 10.
(2) BI-WOVEN BROADGOODS, DATA FROM CVS PROGRAM (TABLE B-1, APPENDIX B)

FIGURE 35. FATIGUE CHARACTERISTICS OF T300/5208 GRAPHITE/EPOXY LAMINATES

ORIGINAL PAGE IS
OF POOR QUALITY

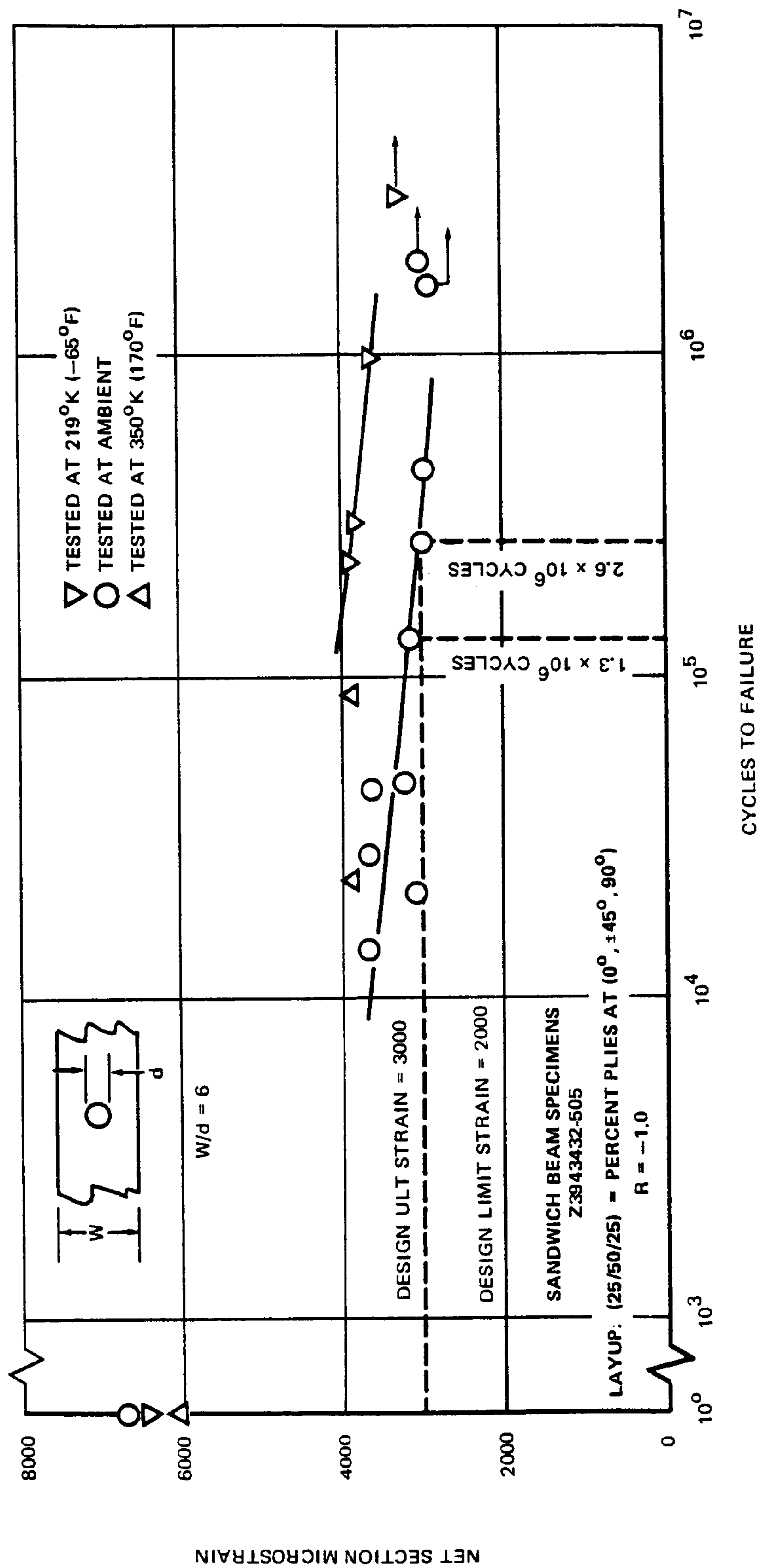


FIGURE 36. FATIGUE CHARACTERISTICS OF T300/520B GRAPHITE/EPOXY LAMINATES

stress ratio do not show the drop in fatigue strength with increasing load cycles that was evident at R = -1.0. The data all fall within the scatter band of the static tensile strength data obtained on similar sandwich beam specimens tested in the same environments (Reference 5). It is apparent that cyclic loading at a stress ratio of R = 0.05 has a negligible effect on laminate strength.

The results of the ambient fatigue tests and the results of tests on similar sandwich beams from the DC-10 composite rudder program (Reference 10) are compared in Figure 35. The test results from the rudder program are for T300/5208 laminates made from unidirectional tape as opposed to the bi-woven broadgoods used in the composite stabilizer sandwich beams. The data show a difference in fatigue strength between the two types of prepreg of approximately 39 percent at 130,000 cycles in favor of the unidirectional tape. Unidirectional tape material has now been specified for the CVS spar cap laminates.

The same data in terms of strain levels for each beam specimen at failure are shown in Figure 36. No failures occurred below the design limit micro-strain of 2000 even for those cases where the load cycles exceeded the one-life equivalent of 130,000 cycles. Strain levels were computed using the modulus values from the static tensile strength data (Reference 5).

It was concluded that the selected quasi-istropic laminate of T300/5208 unidirectional tape will provide more than adequate fatigue life for the expected in-service loads and environments of the CVS.

FRACTURE MECHANICS TESTS

Fatigue testing was completed on the Z3943442-1 debond tension specimens and on the Z3943442-505 damaged tension specimens. The test data are tabulated in Tables B-3 and B-4 in Appendix B.

Photographs showing a typical test set-up and a close-up of the anti-buckling plates used to prevent lateral instability at the laminate under compression load are shown in Figures 37 and 38.

A plot of the fatigue data for the Z3943442-1 debond specimens is shown in Figure 39. All testing was conducted at a stress ratio of R = -1.0 and at temperatures of 219°K, ambient, and 350°K. All specimens included a laminate debond area of approximately 1.27 cm (0.50 in.) diameter located in the center of the test region. All specimens were subjected to 130,000 load cycles (equivalent to one life-time of structural loading) at the design limit microstrain of 2000 prior to undergoing the additional fatigue loading shown. No failures occurred during the first life cycle tests and no changes to the debond area were noted.

The second life cycle tests were run at higher load levels to establish the fatigue characteristics of the laminate in the presence of debonds. None of the debond specimens failed through the delaminated area but through the minimum section adjacent to the tangent point of the 4.0 inch shoulder radius. The X-ray, Figure 40, clearly indicates a significant stress concentration in this area. An opaque liquid was applied to the specimen edges to accent the damage. Figure 41 shows that no significant, consistent difference exists between the results for the moisture conditioned specimens and those tested "dry".

A plot of the fatigue data for the Z3943442-505 damaged specimens is shown in Figure 42. All testing was conducted at a stress ratio of R = -1.0 and at temperatures of 219°K, ambient, and 350°K as before. All specimens included a damaged area in the center of the test region to provide a w/d ratio (specimen width to damage size) of 6.0. This ratio was selected to provide a similar stress concentration effect to that in the sandwich beam fatigue test specimens. The tests were conducted at strain levels ranging from 2000 microstrain (design limit strain) down to 1500 microstrain (84 occurrances in one lifetime). None of the specimens failed at this strain level even when tested for 260,000 cycles (two lifetimes).

ORIGINAL PAGE IS
OF POOR QUALITY

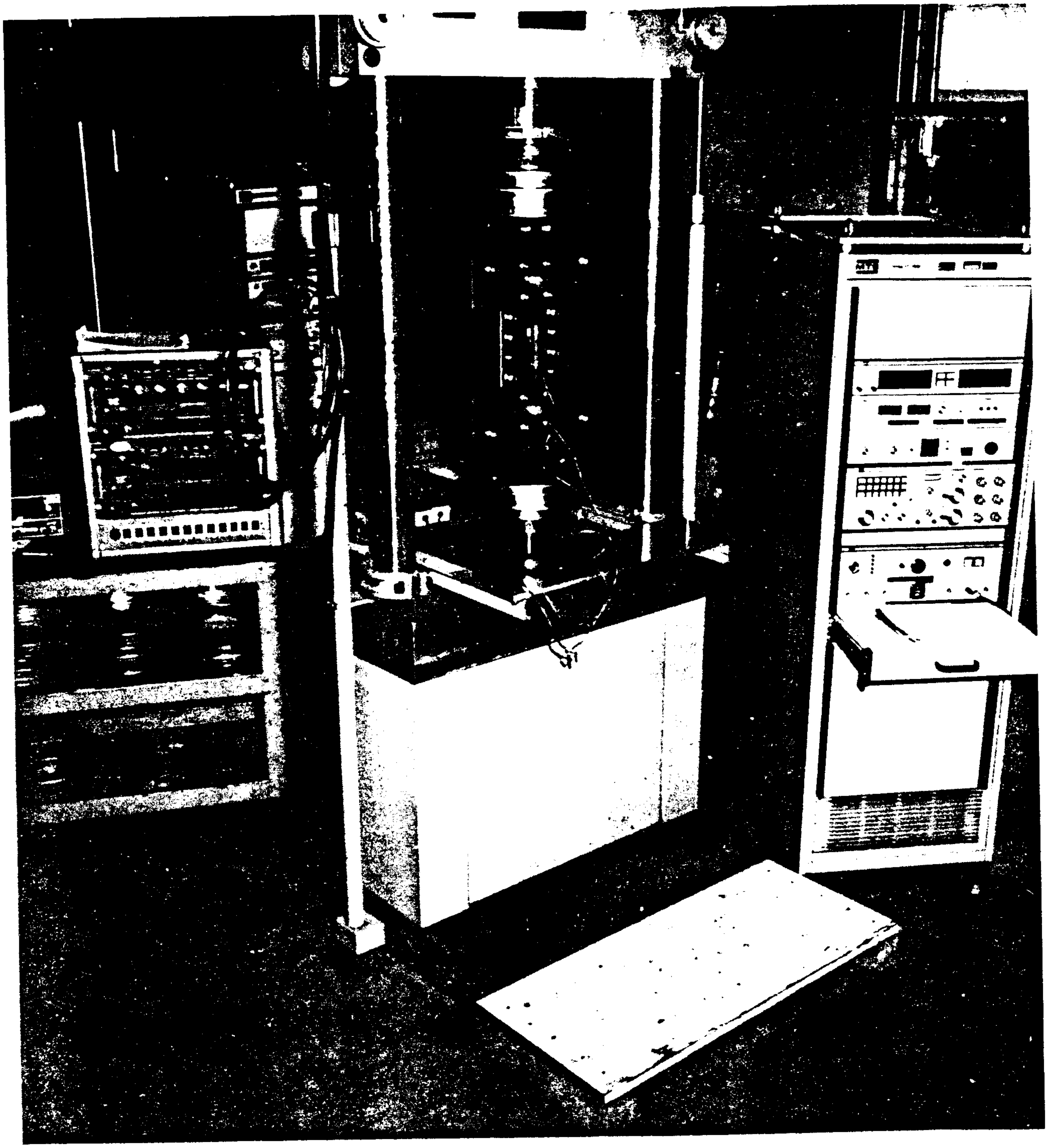


FIGURE 37. TEST SETUP FOR DAMAGE AND DEBOND TEST

ORIGINAL PAGE IS
OF POOR QUALITY

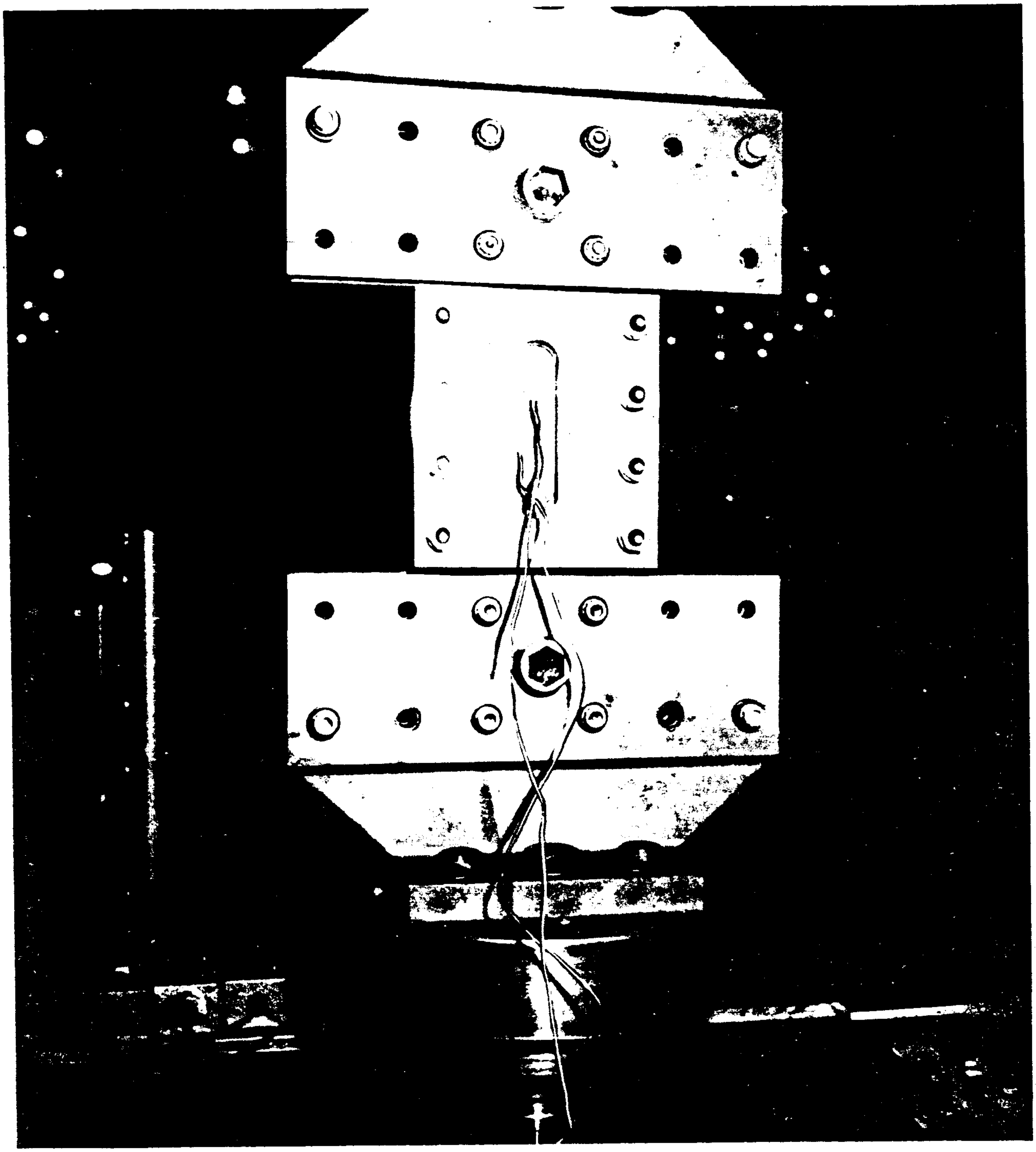
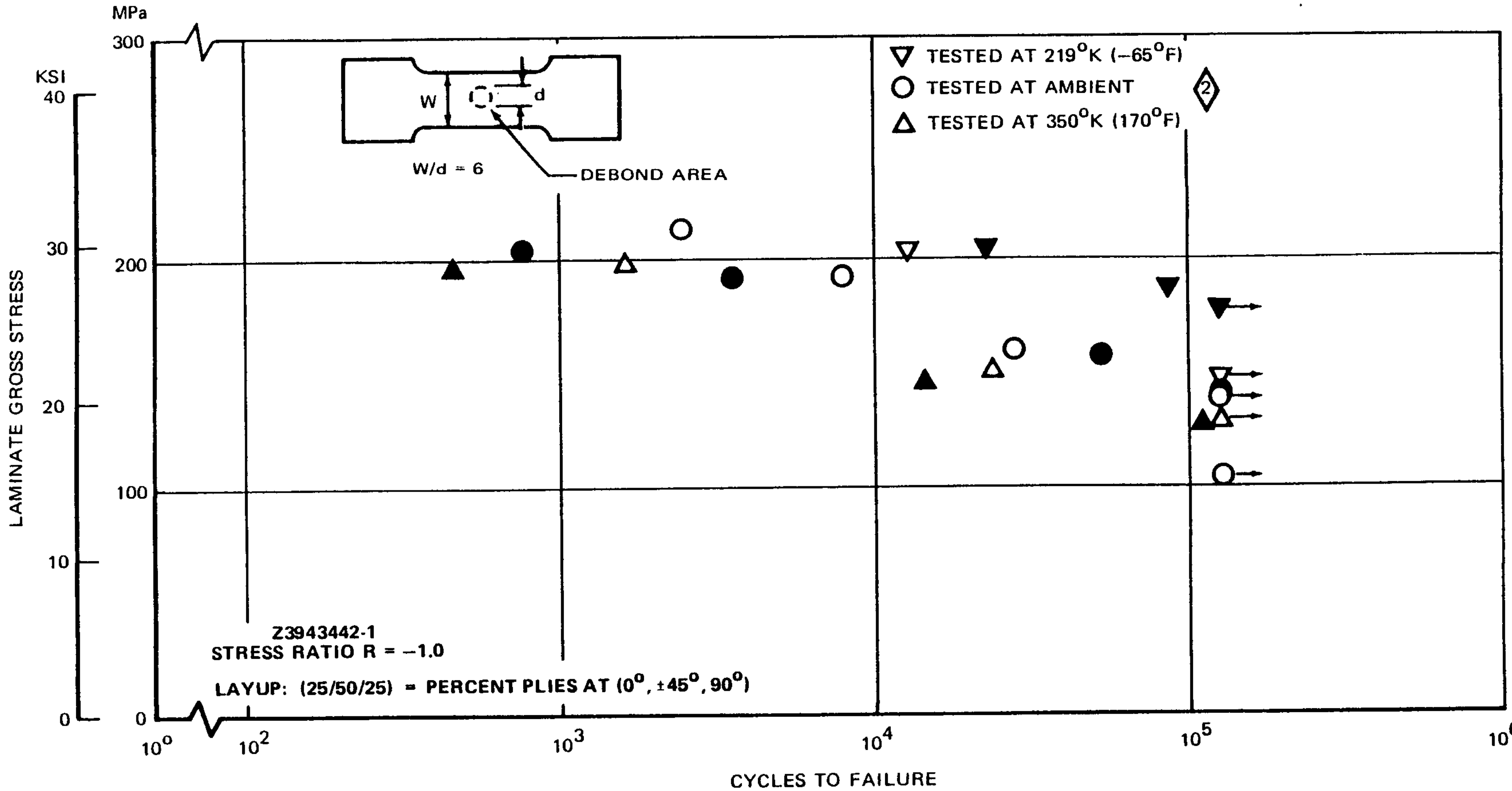


FIGURE 38. CLOSE-UP VIEW OF PLATES USED TO PREVENT BUCKLING OF DAMAGE AND DEBOND SPECIMENS

ORIGINAL PAGE IS
OF POOR QUALITY



1. ALL SPECIMENS WERE SUBJECTED TO 130,000 LOAD CYCLES (ONE SERVICE LIFE) AT APPROXIMATELY 2000 MICROSTRAIN (DESIGN LIMIT STRAIN) WITHOUT FAILURE PRIOR TO UNDERGOING THE ABOVE LOADING. NO FAILURES OCCURED IN THE DEBOND AREA.

2. SHADED SYMBOLS INDICATE THOSE SPECIMENS THAT WERE PRETEST MOISTURE CONDITIONED. REMAINDER WERE TESTED DRY.

FIGURE 39. FATIGUE TEST RESULTS FOR LAMINATE TENSION SPECIMENS WITH DEBONDS

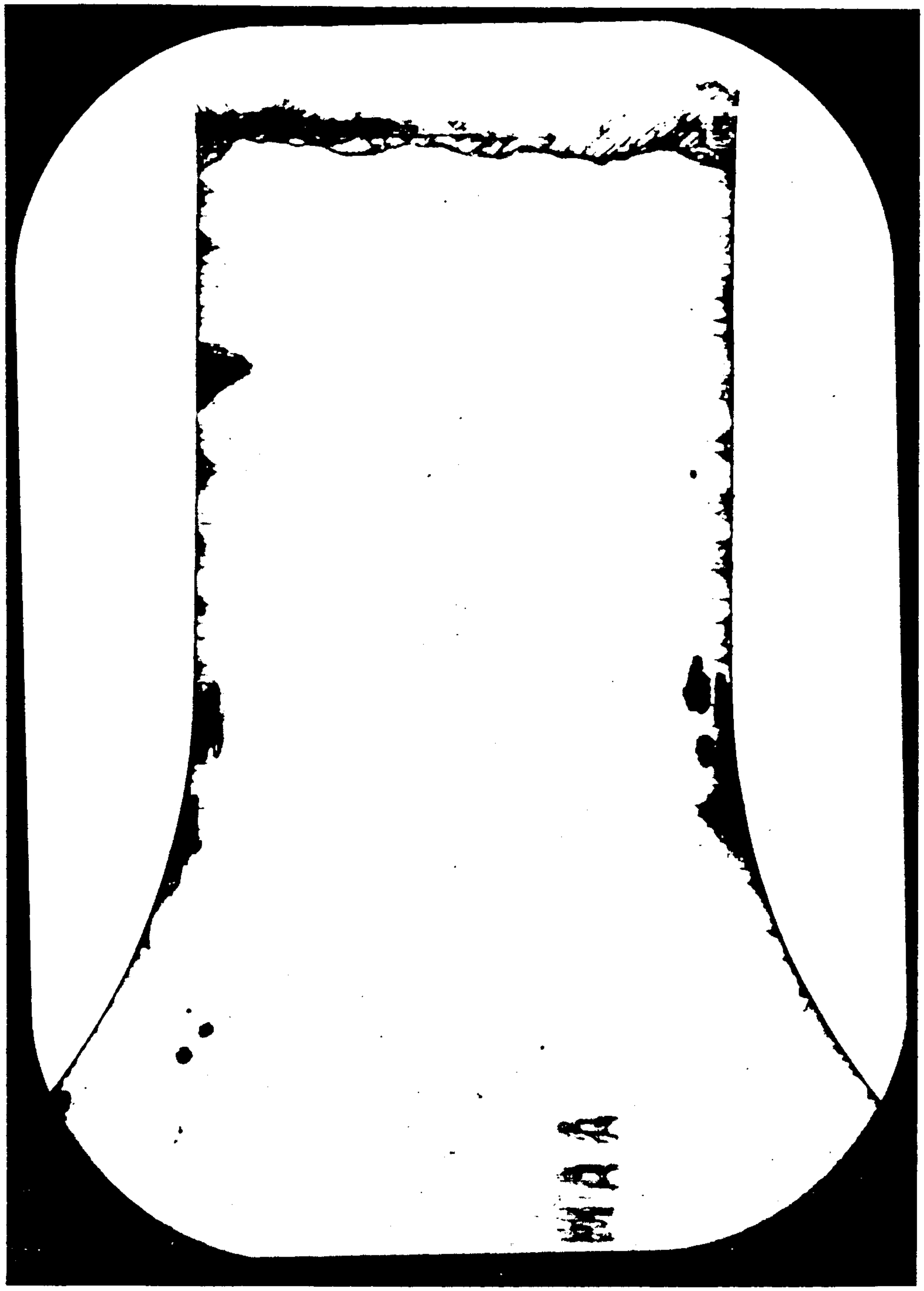


FIGURE 40. X-RAY OF DEBOND SPECIMEN SHOWING FATIGUE DAMAGE

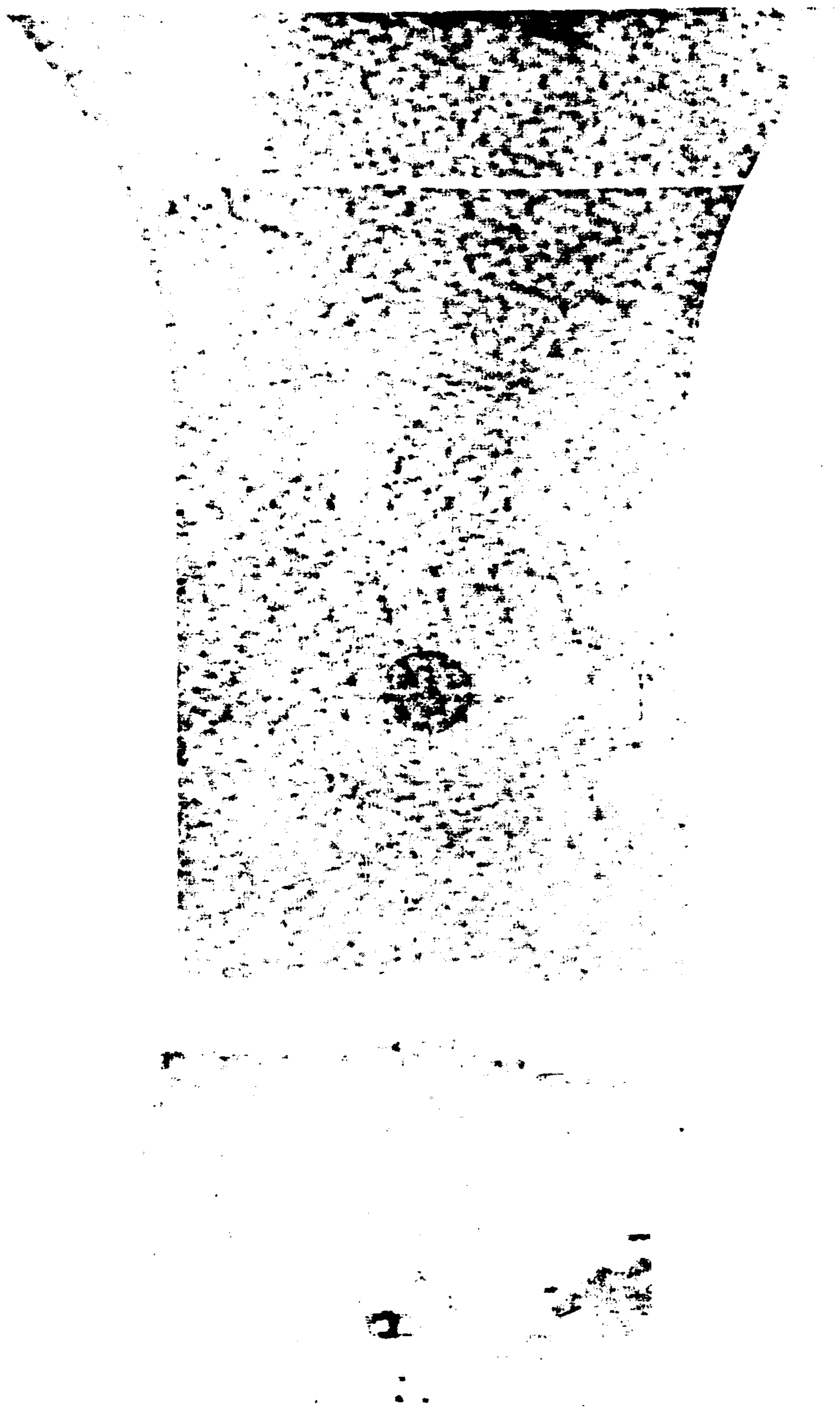
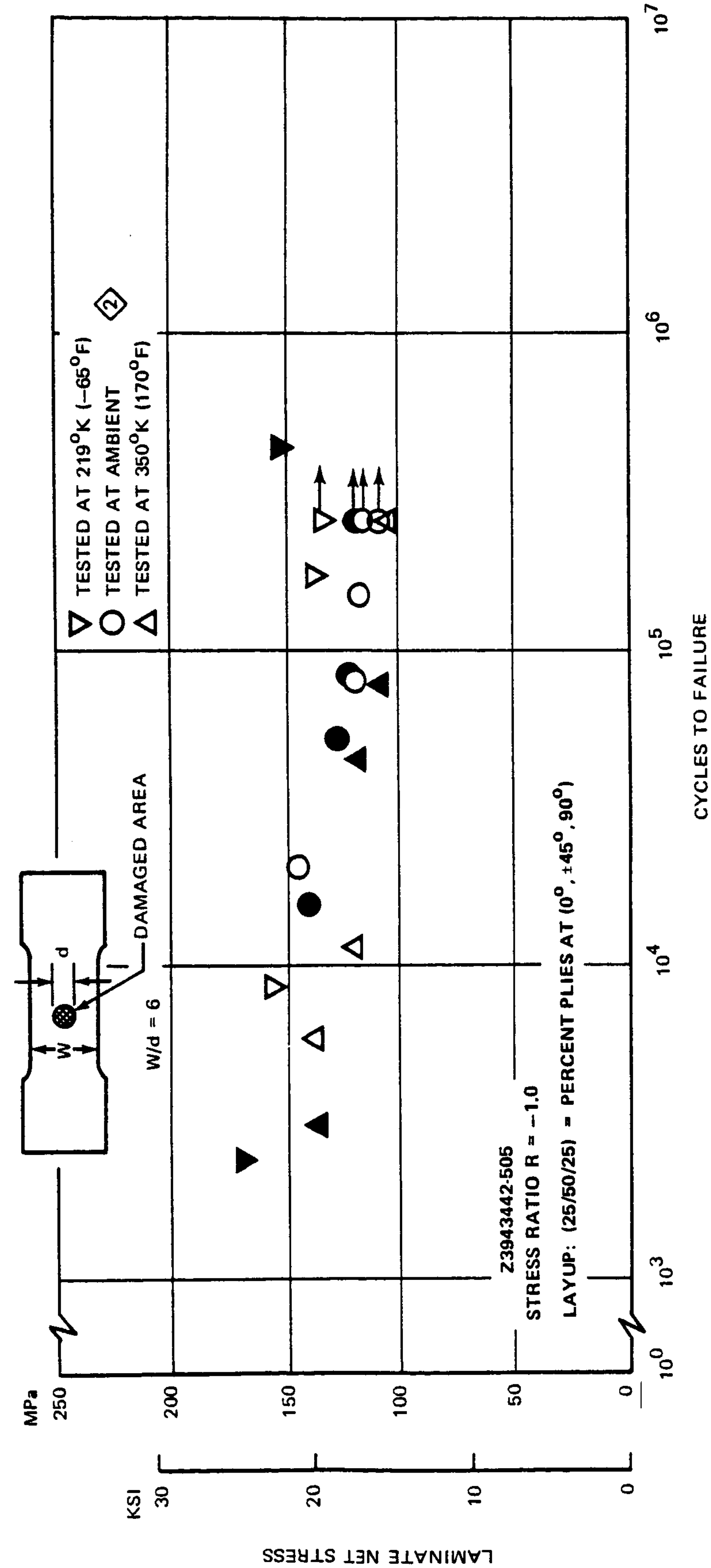


FIGURE 41. X-RAY OF DEBOND SPECIMEN AFTER FATIGUE TEST SHOWING STATIC FAILURE



1. ALL FAILURES OCCURRED THROUGH THE DAMAGED AREA.
2. SHADED SYMBOLS INDICATE THOSE SPECIMENS THAT WERE PRETEST MOISTURE CONDITIONED. REMAINDER WERE TESTED DRY.

FIGURE 42. FATIGUE TEST RESULTS FOR DAMAGED LAMINATE TENSION SPECIMENS 1

Trial impact energy tests were conducted on a piece of 0.052 inch thick quasi-isotropic laminate to determine what energy levels would be required to produce the desired damage level (Figure 43). These tests were conducted using a standard Gardner impact tester with a 0.50 inch diameter anvil. The desired level of damage was a 0.50 inch diameter area on the impact side with complete penetration through the laminate. The energy levels were varied from 10 inch-pounds to 70 inch-pounds. An energy level of 40-inch-pounds produced the desired damage and this level was used in damaging the Z3943442-505 test specimens.

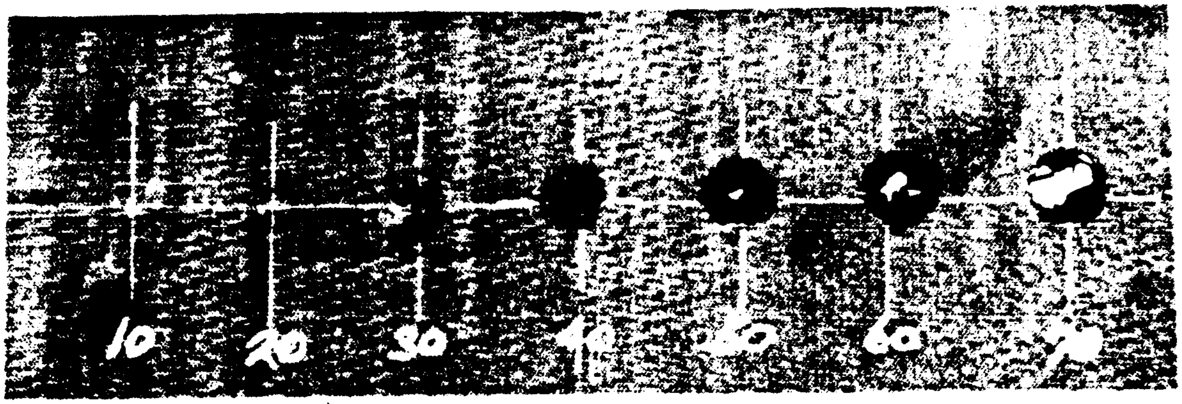
Fatigue damage sustained by the damage specimens progressed fairly rapidly under cyclic load with failures occurring through the minimum net section of the damage area. Damage propagation initially appeared as surface pitting accompanied by a brownish discoloration of the epoxy with subsequent localized buckling of the graphite woven fabric. Figures 44 and 45 show typical fatigue effects. Figures 46, 47, and 48 show typical failures of the damage and debond specimens together with C-scan records after test.

The results of the damaged specimen fatigue tests and the sandwich beam fatigue tests are compared in Figure 49. An apparent 36.6 percent reduction in strength is indicated at 130,000 cycles from 185 megapascals (26800 psi) for the sandwich beams (drilled holes) to 117 megapascals (16990 psi) for the impact damaged specimens. The theoretical stress concentration factor from Reference 11 for the sandwich beams is calculated as follows:

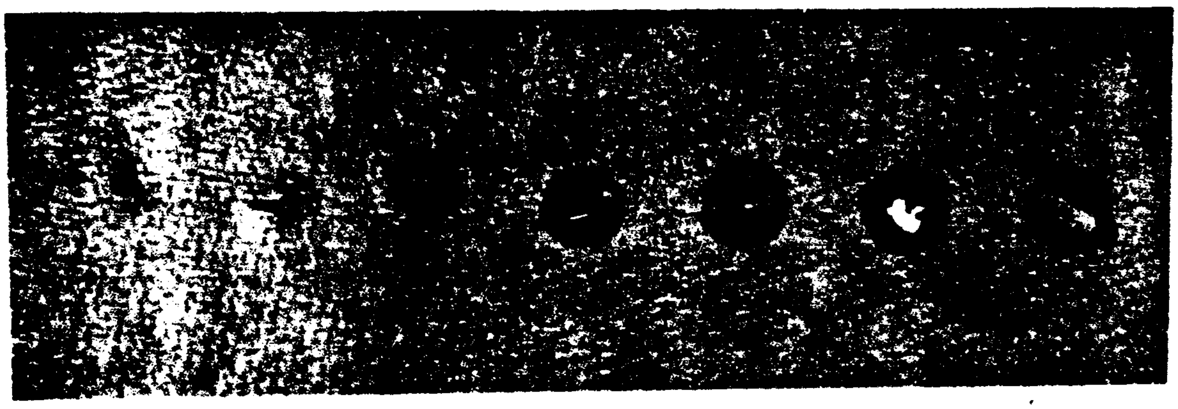
$$k_{t_e} = 2 + (1 - d/w)^3 = 2 + (1 - 0.25/1.50)^3 = 2.58$$

The composite stress concentration factor from Reference 11 is:

$$k_{t_c} = 0.73 + 0.27\, k_{t_e} = 0.73 + 0.27 \times 2.58 = 1.43$$



A. IMPACT SIDE



B. REVERSE SIDE

FIGURE 43. TRIAL IMPACT ENERGY TESTS

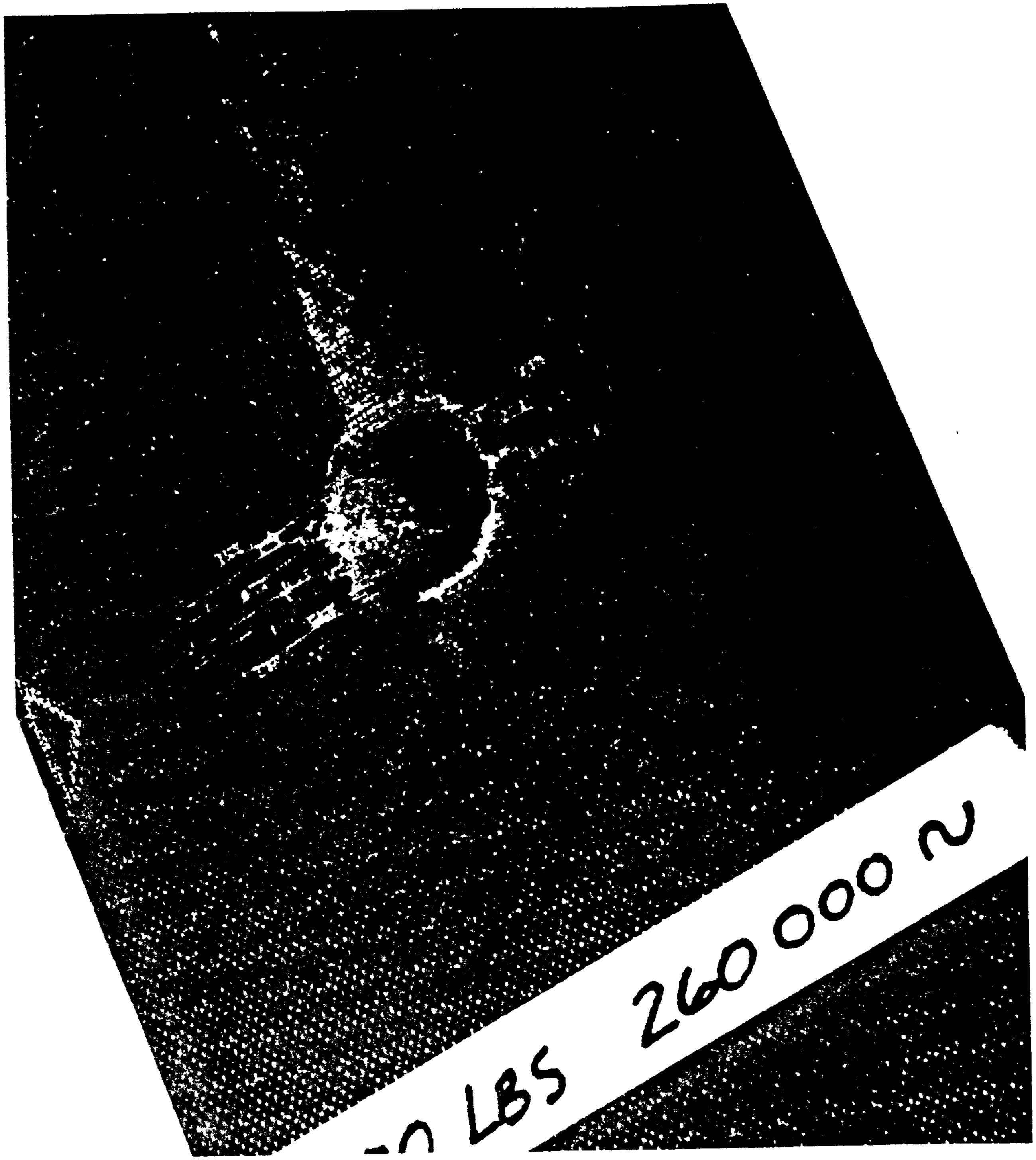


FIGURE 44. CLOSE-UP VIEW SHOWING FATIGUE DAMAGE IN IMPACT-DAMAGED SPECIMEN

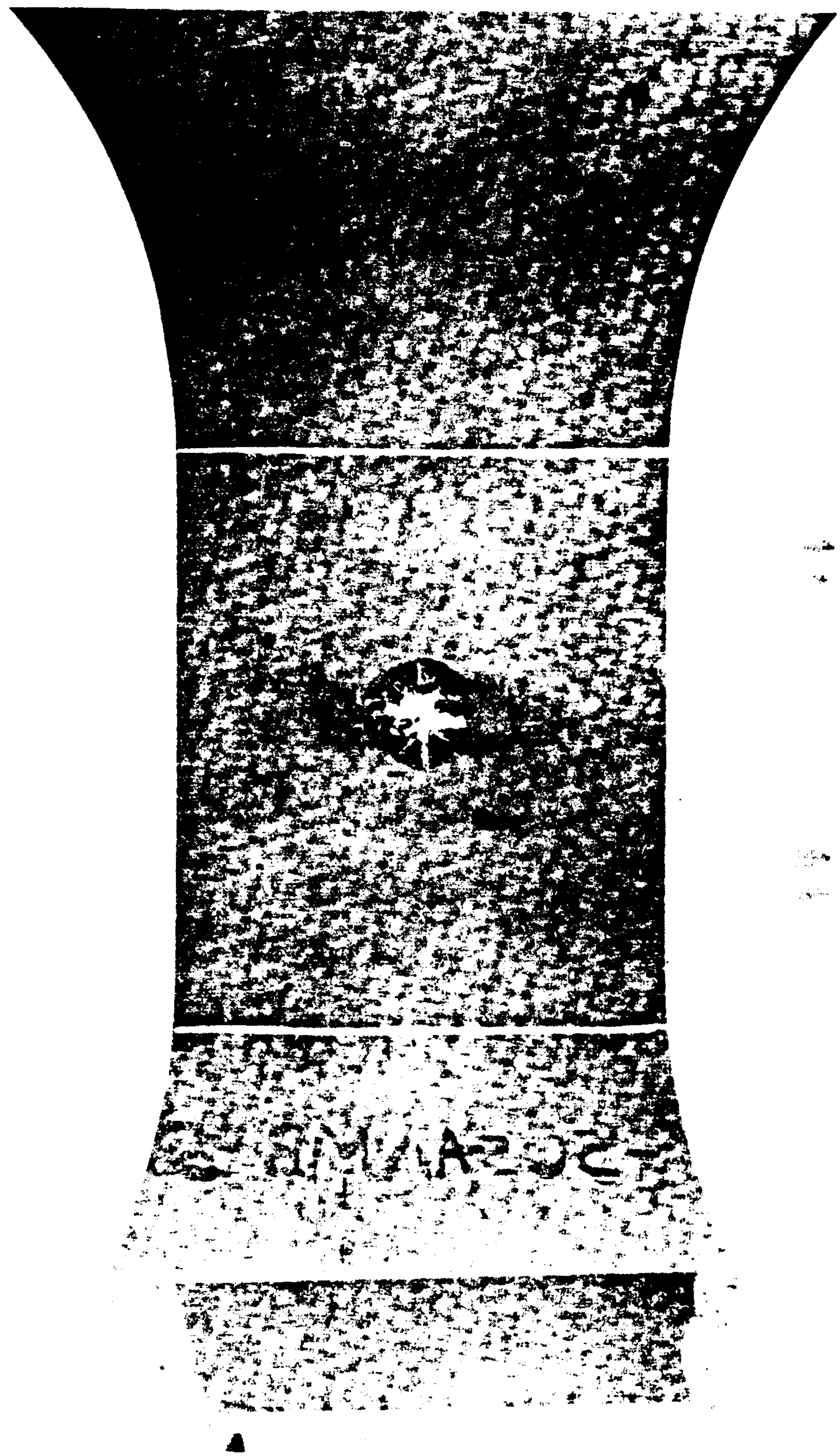


FIGURE 45. X-RAY OF IMPACT-DAMAGED SPECIMEN SHOWING FATIGUE DAMAGE

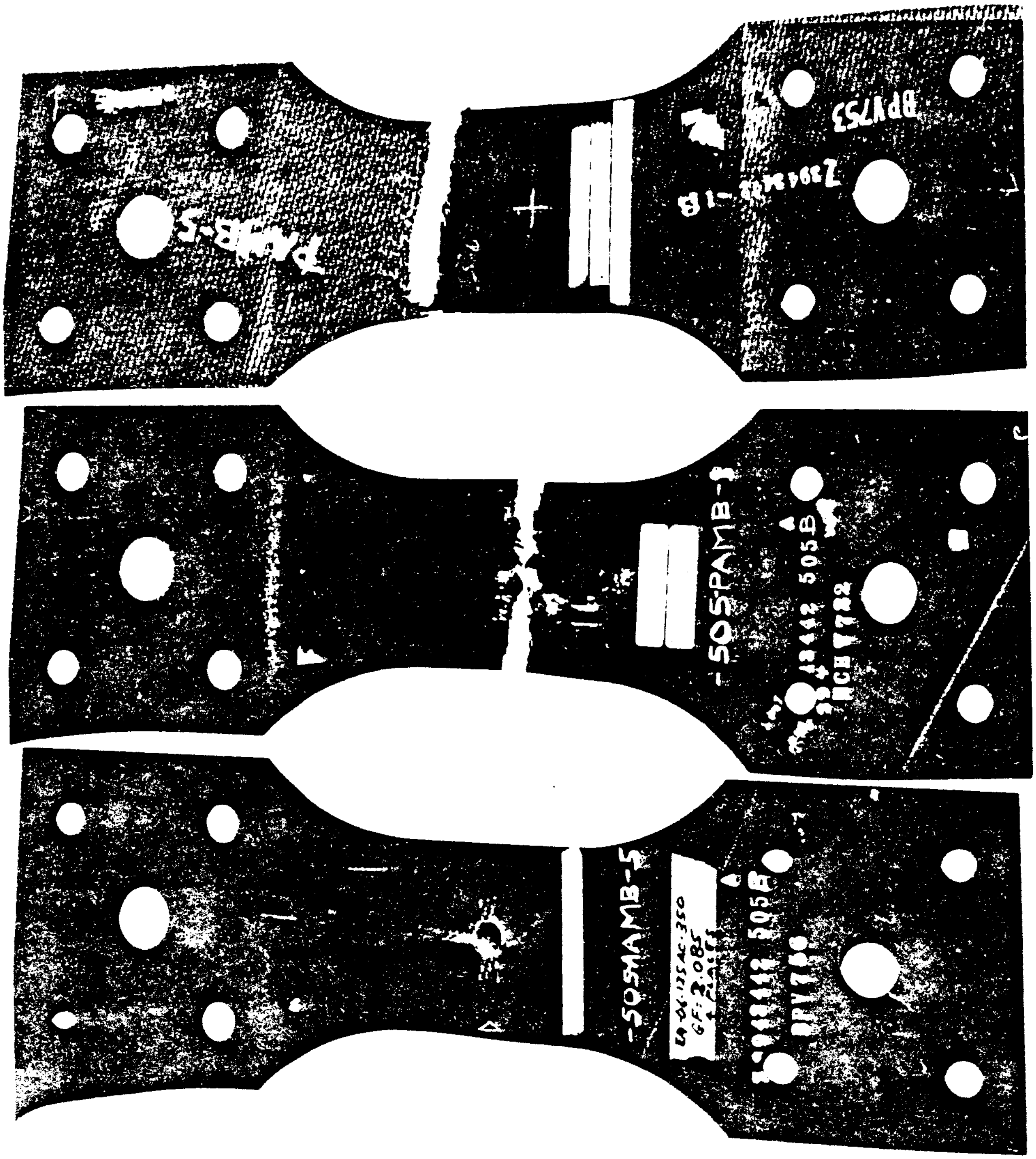
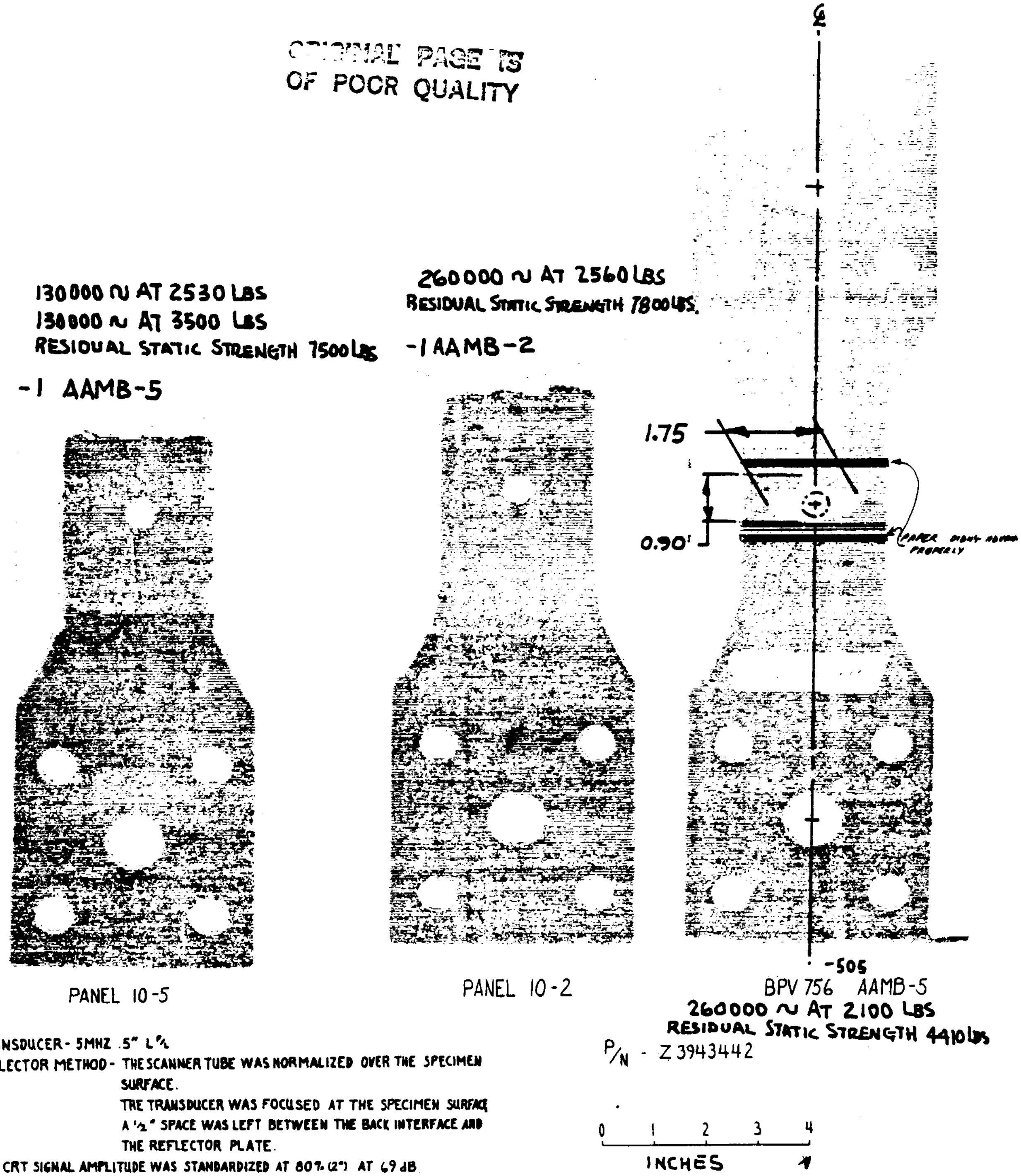
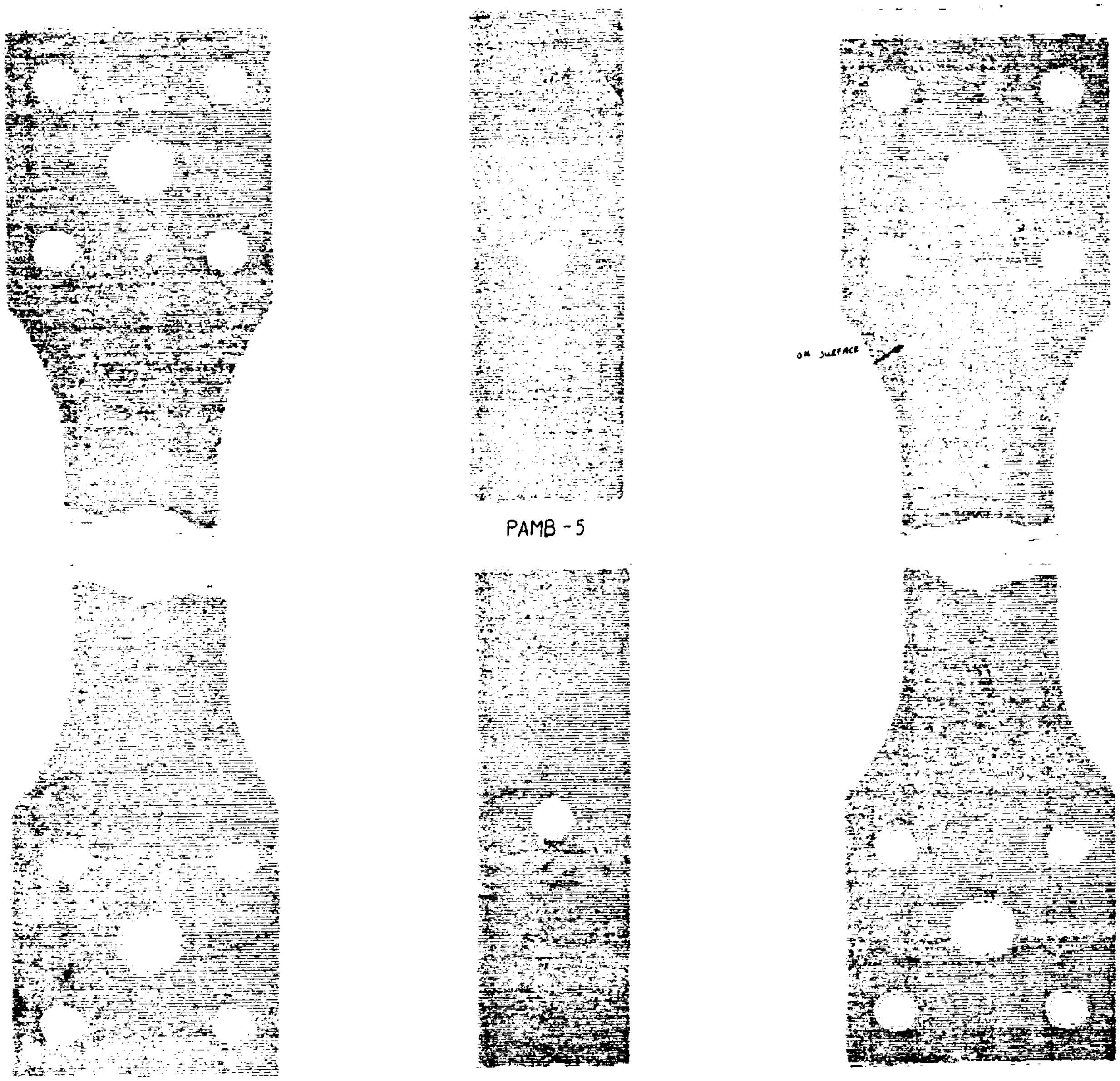


FIGURE 46. TYPICAL FAILURE MODES OF DAMAGE AND DEBOND SPECIMENS



NOTE:
TRANSDUCER - 5MHZ .5" L/4
REFLECTOR METHOD - THE SCANNER TUBE WAS NORMALIZED OVER THE SPECIMEN SURFACE.
THE TRANSDUCER WAS FOCUSED AT THE SPECIMEN SURFACE.
A 1/2" SPACE WAS LEFT BETWEEN THE BACK INTERFACE AND THE REFLECTOR PLATE.
THE CRT SIGNAL AMPLITUDE WAS STANDARDIZED AT 80% (2") AT 69 dB
REFERENCE CONTROL - CCW.
THE GATE THRESHOLD WAS SET AT 50% (1").

FIGURE 47. TYPICAL C-SCANS SHOWING FATIGUE DAMAGE SUSTAINED BY DAMAGE AND DEBOND SPECIMENS



·505 PAMB - 4
15600 ~ AT 2640 LBS

PAMB-4
PRECONDITIONING COUPONS

-505 PAMB-5
52400 ~ AT 2400 LBS

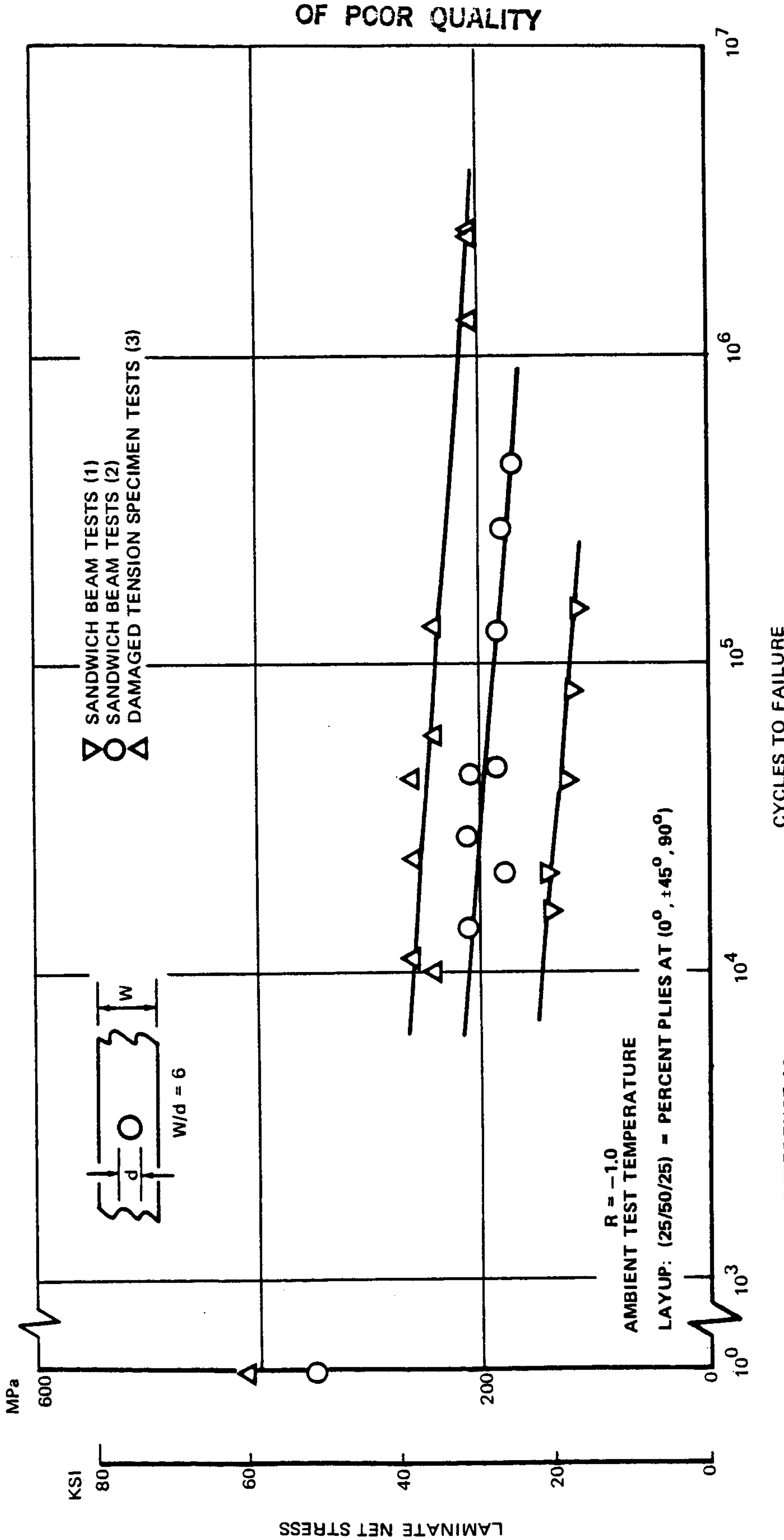
NOTE:

TRANSDUCER - 5MHZ .5" L/I
REFLECTOR METHOD - THE SCANNER TUBE WAS NORMALIZED OVER THE SPECIMEN SURFACE.
THE TRANSDUCER WAS FOCUSED AT THE SPECIMEN SURFACE
A 1/2" SPACE WAS LEFT BETWEEN THE BACK INTERFACE AND THE REFLECTOR PLATE.
THE CRT SIGNAL AMPLITUDE WAS STANDARDIZED AT 80% (2") AT 69 dB
REFERENCE CONTROL - CCW
THE GATE THRESHOLD WAS SET AT 50% (1").

P/N - Z3943442 S/N - HCH-7722
505 B

0 1 2 3 4

FIGURE 48. C-SCANS OF DAMAGE SPECIMENS AND MOISTURE CONTROL COUPONS



(1) DATA FROM REFERENCE 10
(2) DATA FROM TABLE B-1, APPENDIX B
(3) DATA FROM TABLE B-4, APPENDIX B

FIGURE 49. FATIGUE CHARACTERISTICS OF T300/5208 GRAPHITE/EPOXY LAMINATES

The average measured stress concentration factor for the damaged specimens from Table B-4, Appendix B, is 1.75. From these factors, the strength reduction from the drilled hole to the damage-induced hole is 18.3 percent (1 - 1.43/1.75). The damage is apparently more severe than is indicated by the strain gage readings. This is probably due to local invisible damage to the epoxy around the edge of the damaged area.

Testing of the three Z3943443 axial load cover panels with a transverse center slit was completed. The data obtained from the tests are tabulated in Table 7. One of the specimens mounted in the MTS test machine is shown in Figure 50. The photograph also shows the environmental chamber used for testing at 350°K (170°F) or 219°K (-65°F). Figure 51 is a photograph of the ambient specimen after test indicating crack growth as a function of the number of cycles. Final rupture occurred at 10,000 cycles. A similar failure occurred in the specimen tested at 350°K at 4670 cycles. The specimen tested at 219°K did not fail after two lifetimes of load cycling. The first life cycle test was run at a load level of 10231 Newtons (2300 pounds). This load level was doubled for the second life cycle test in an attempt to induce crack propagation. No failures occurred so the specimen was tested statically to determine residual strength. Failure occurred at 194.04 MPa (28143 psi) across the net section. It is evident from these tests that crack propagation will not be a problem at low temperature (219°K) but will be a significant consideration at room and elevated temperatures. These tests indicate the need for further test and evaluation in this area.

Testing was completed on the three Z5943428-501 damaged shear panels. The data obtained from the tests are tabulated in Table 8.

The specimens were load cycled to the equivalent of two lifetimes (260,000 cycles) and then tested to failure to determine residual strength. The testing was stopped after each 130,000 load cycles and the specimens visually and sonically inspected to determine damage growth. Neither specimen exhibited

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE 7

FATIGUE TEST RESULTS ON SANDWICH SKIN TENSION PANELS WITH TRANSVERSE CENTER SLIT
Z3943443-1

STRESS RATIO R = –1.0

slitted specimens

SPEC NO.	TEST TEMP		MOISTURE LEVEL	SKIN LAMINATES				TEST LOAD LEVEL		CALCULATED STRESSES				CYCLES TO FAILURE	REMARKS
				WIDTH		THICKNESS[1]				GROSS SECTION		NET SECTION[2]			
	°K	°F	PERCENT	CM	IN.	CM	IN.	NEWTONS	POUNDS	MPa	PSI	MPa	PSI		
P065-1	219	–65		25.418	10.007	0.1092	0.0430	10,231 20,462	2300 4600	36.85 73.71	5,345 10,690	40.94 81.89	5,938 11,877	130,000 130,000	NO FAILURE NO FAILURE (3)
PAMB-1	AMB	AMB		25.438	10.015	0.1054	0.0415	7,767	1746 (4)	28.96	4,201 (4)	32.18	4,667	10,000	FAILED THROUGH SLIT
P170-1	350	170		25.420	10.008	0.1016	0.0400	6,731	1513 (4)	26.06	3,780 (4)	28.96	4,200	4,670	FAILED THROUGH SLIT

(1) THICKNESS IS NET LAMINATE THICKNESS FOR BOTH FACES BASED ON MEASURED PANEL THICKNESS LESS 0.762 CM (0.300 IN.) FOR CORE.

(2) NET SECTION STRESS BASED ON MEASURED PANEL WIDTH LESS 2.54 CM (1.00 IN.) FOR SLIT.

(3) STATIC RESIDUAL STRENGTH OF SPECIMEN WAS 48,486 NEWTONS (10,900 LB) OR 194.04 MPa (28,143 PSI) BASED ON NET SECTION. FAILURE OCCURRED THROUGH CENTER SLIT.

(4) TEST LOAD LEVELS FOR THE AMBIENT AND 350°K (170°F) CASES WERE NOT OBTAINED BECAUSE OF EQUIPMENT CALIBRATION ERROR. LOAD LEVELS AND STRESSES SHOWN ARE BASED ON MEASURED STRAINS.

ORIGINAL PAGE IS
OF POOR QUALITY

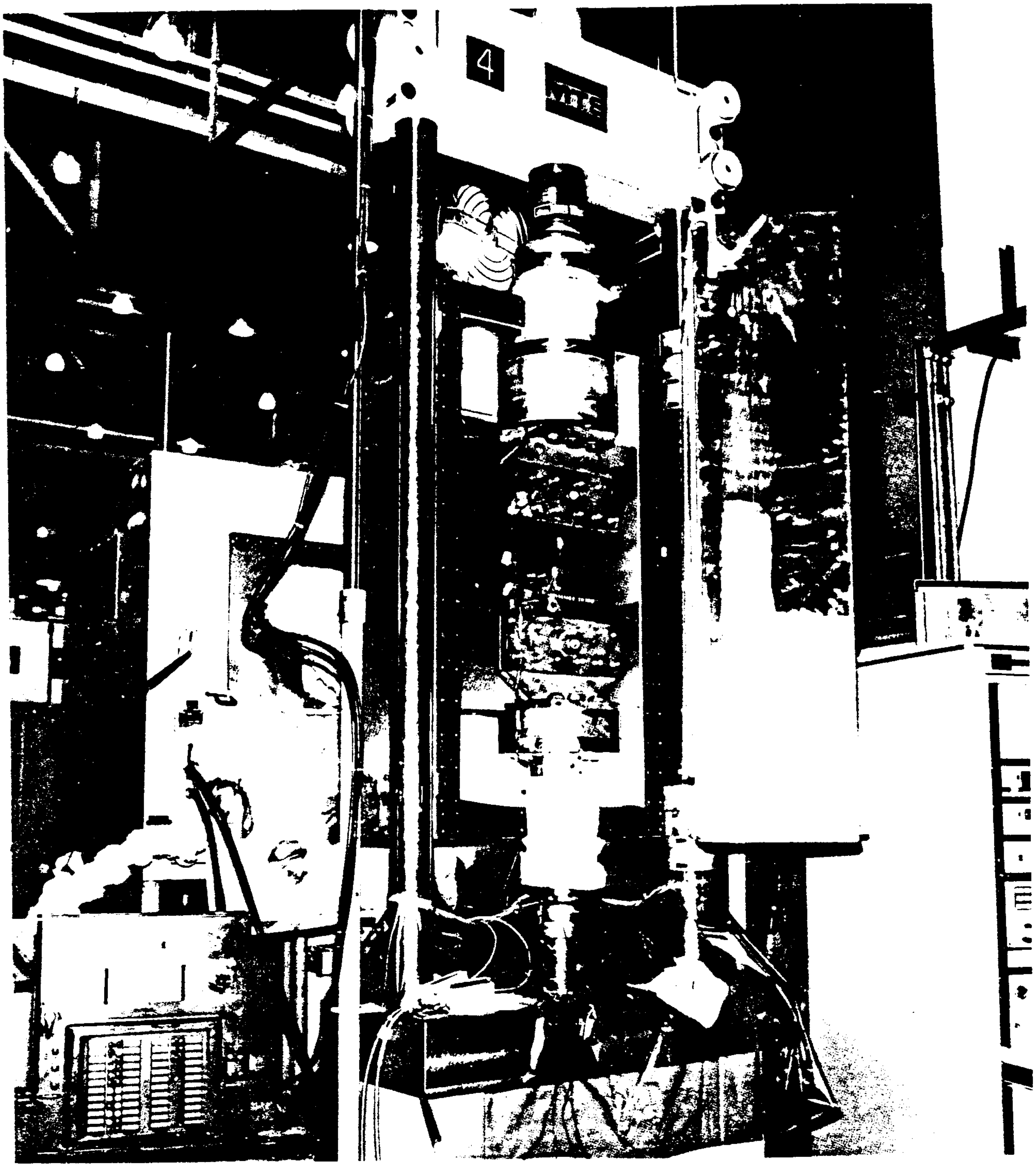


FIGURE 50. Z3943443 CENTER SLIT PANEL SPECIMEN IN TEST MACHINE

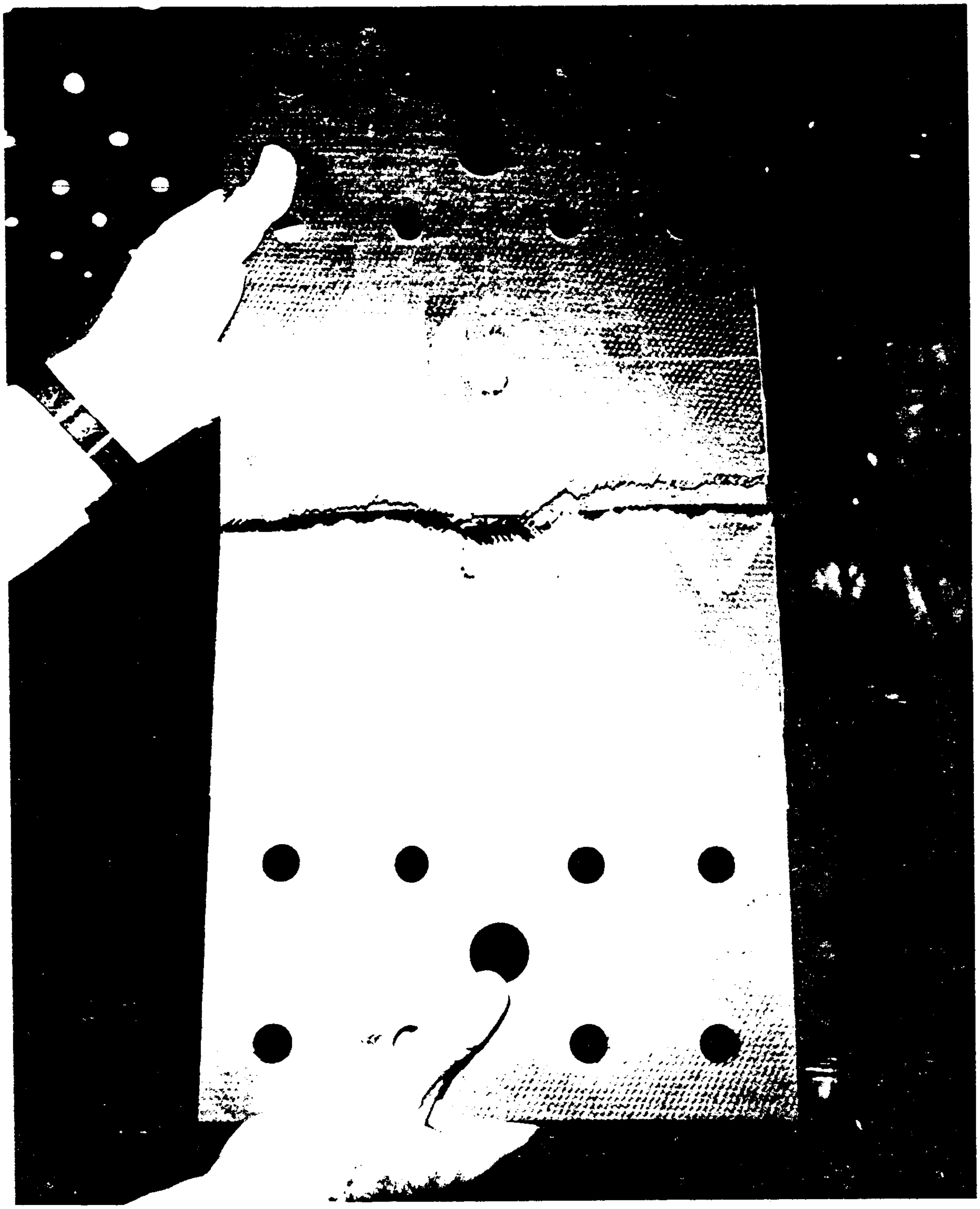
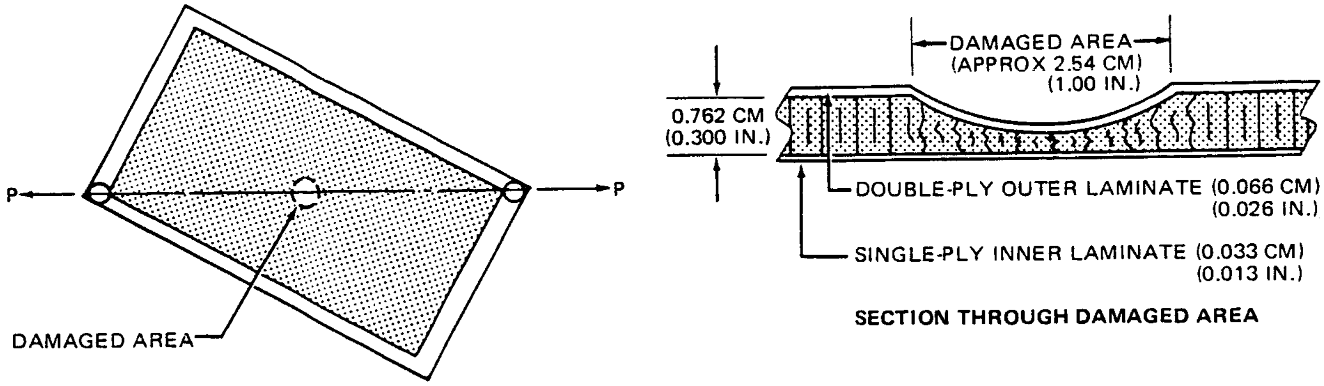


FIGURE 51. FAILURE OF Z3943443 CENTER SLIT PANEL SPECIMEN

TABLE 8
DAMAGED SHEAR PANEL TEST RESULTS
Z5943428-501



SECTION THROUGH DAMAGED AREA

PANEL NUMBER	PERCENT MOISTURE CONTENT	TEST TEMPERATURE		RESIDUAL STRENGTH AT FAILURE P(1)		SHEAR FLOW AT FAILURE N_{XY}		SHEAR STRESS IN LAMINATE AT FAILURE τ_{XY}		PERCENT OF DESIGN ULTIMATE LOAD(2)
		°K	°F	NEWTONS	POUNDS	N/M	LB/IN.	MPa	PSI	
1	1.31	219	−65	131,303	29,518	200,870	1147	202.77	29,410	151
2	1.66	AMBIENT	AMBIENT	105,103	23,628	160,766	918	162.29	23,538	121
3	0.99	350	170	125,066	28,116	191,239	1092	199.05	28,000	144

(1) RESIDUAL STRENGTH AFTER THE EQUIVALENT OF TWO LIFETIMES OF CYCLIC LOADING AT A LOAD RATIO OF R = −1.0.
(2) DESIGN ULTIMATE SHEAR FLOW = 132,746 N/M (758 LB/IN.)

any change or growth in size of the damaged area. The residual strengths were approximately 42 percent below the undamaged (and uncycled) panel at ambient temperature and 22 percent below the undamaged panel at 350°K. A typical failure mode for these panels is shown in Figure 52. All failures occurred through the damaged area.

FIGURE 52. FAILURE OF Z5943428-501 DAMAGED SHEAR PANEL

C-2

SECTION 6
DESIGN VERIFICATION TEST COMPONENTS

Tooling and detail part fabrication were continued on all elements of this component group. Final assembly operations were started as detail part availability permitted. The verification tests components are:

- Z5943445 Concept Verification Panels
- Z5943446 Concept Verification Spars
- Z5943452 Attach Fitting Splice Specimens

The fabrication status of these components is discussed in this section.

CONCEPT VERIFICATION PANELS

Fabrication and assembly were continued on the Z5943445 combined load test panel (-1) and the acoustic test panels (-501). Current fabrication emphasis is on parts for the -1 configuration, illustrated in Figure 53, because this activity is on the critical schedule path of the program. The -1 panel will be tested in combined compression, in-plane shear, and lateral pressure to verify the CVS skin panel design concept. Fabrication of the CVS skin panel tooling will not begin until this test is successfully completed.

Tool fabrication for the combined load test panel was completed on 6 November 1978. Some joggled regions were omitted on the sine-wave rib laminating mold and the initially cured rib-elements were rejected as a result. The mold was modified per engineering drawing requirements and replacement parts were fabricated.

Assembly of the Z5943445-1 combined loads panel is in progress as shown in Figure 54. The cured skin panel, protected by peel plies on the outer surfaces, has been fit to the metal parts which will connect it to the test fixture. The sine-wave rib and spar-web elements have been trimmed to size and fit together. Subsequent operations will cocure and bond the rib and spar-web junctions using graphite-epoxy attach angles, and mechanically fasten the skin panel to the sine-wave substructure elements. Finally, the graphite-epoxy panel will be mechanically attached to the test frame.

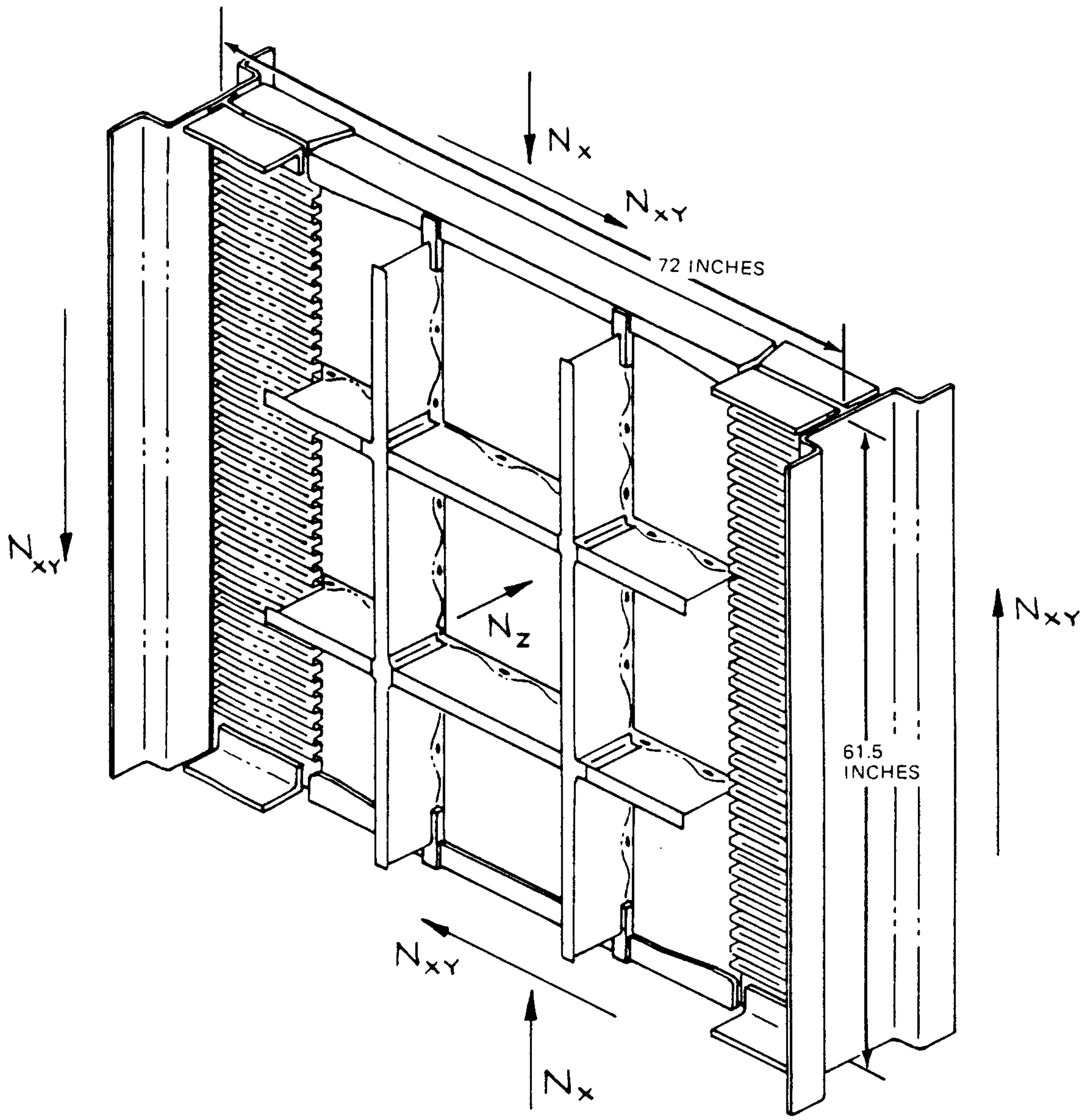


FIGURE 53. Z5943445 COVER PANEL COMBINED LOAD TEST SPECIMEN

FIGURE 54. FINAL ASSEMBLY OF Z5943445 COMBINED LOAD TEST SPECIMEN

Following completion of final assembly and instrumentation, the component will undergo a four-day moisture exposure period to achieve a minimum moisture content of one percent in the honeycomb sandwich skin facings. The component will then be tested under combined compression,in-plane shear, and lateral pressure. Test completion is presently projected at 23 February 1979.

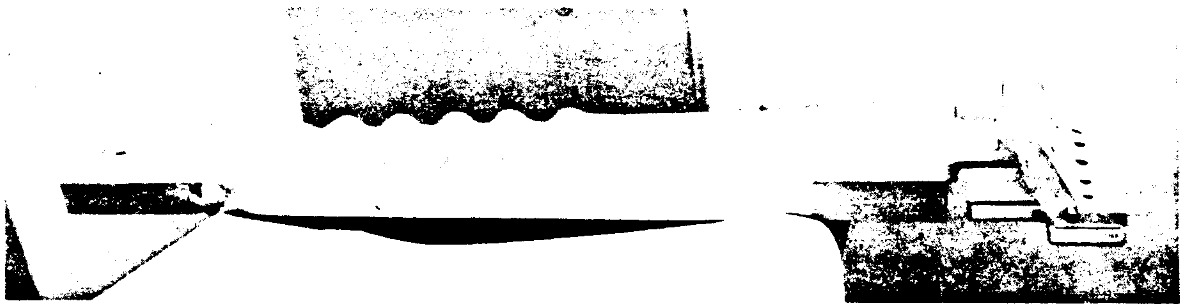
CONCEPT VERIFICATION SPARS

Tool fabrication for the Z5943446-1 concept verification spar component was essentially completed during the reporting period. The machined aluminum alloy lower half of the laminating mold together with the mold end piece is shown in Figure 55a. The upper half of the laminating mold is shown in Figure 55b. The upper mold half consists of a rigid aluminum alloy component (which in conjunction with the lower half will maintain the spar cap contours and bevels) and a cast rubber facing. Side pressure plates will also be provided to transmit autoclave pressure to the spar cap flanges during the cure cycle. This tooling concept is further illustrated in Section 7, Tool Design. Fabrication of the spar tooling for the CVS will not be started until the Z5943446 spar component is successfully tested.

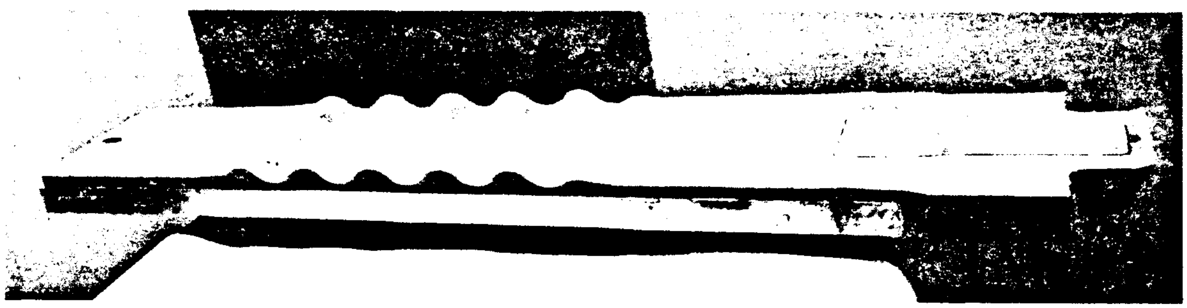
ATTACH FITTING SPLICE SPECIMENS

Fabrication of the Z5943452-1, -501, and -503 splice specimens, three each, was completed during the reporting period and the specimens were placed in a moisture chamber to start a 30-day exposure period. The completed -1 and -501 specimens are shown in Figure 56. The specimens represent the bonded/bolted splice joint at the root-end of a CVS spar between the laminates and the titanium alloy fitting as shown in Figure 4.

The thicker -1 specimens, Figure 57, represent the joint interface between the thick laminated spar-web and the titanium alloy fitting. The thinner -501 specimen, Figure 58, represents a double-lap scarf-joint at the skin flange of the spar in the same region. The -503 specimen represents a single-lap scarf-joint at the skin flange of the spar. This single-lap scarf-joint configuration is being used in the CVS spar drawings to simplify the spar layup and processing.



(a) LOWER MOLD HALF AND END-PIECE



(b) UPPER MOLD HALF

FIGURE 55. Z5943446 SPAR COMPONENT LAMINATING MOLD

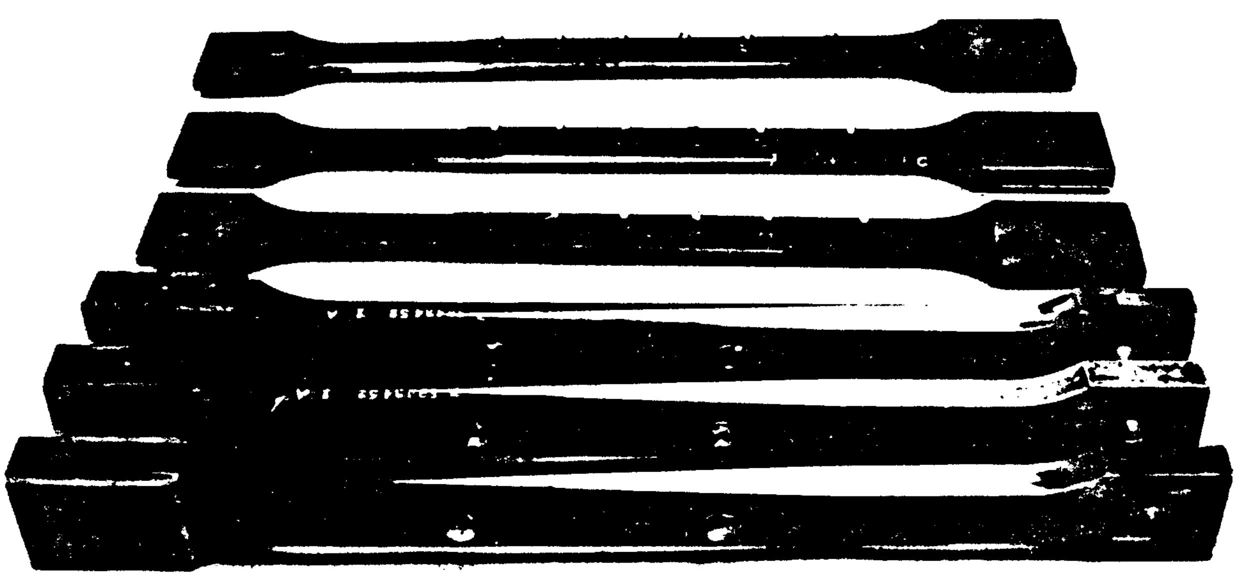


FIGURE 56. Z5943452-1 AND -501 SPECIMEN

ORIGINAL PAGE IS
OF POOR QUALITY

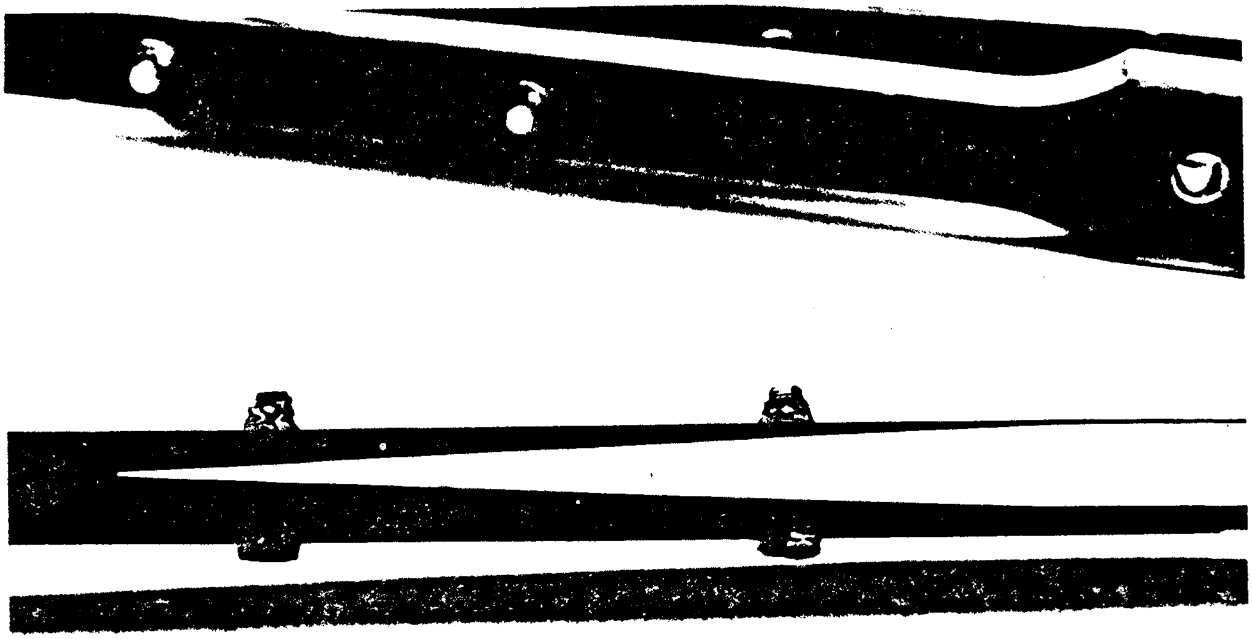


FIGURE 57. Z5943452-1 SPAR WEB SPLICE

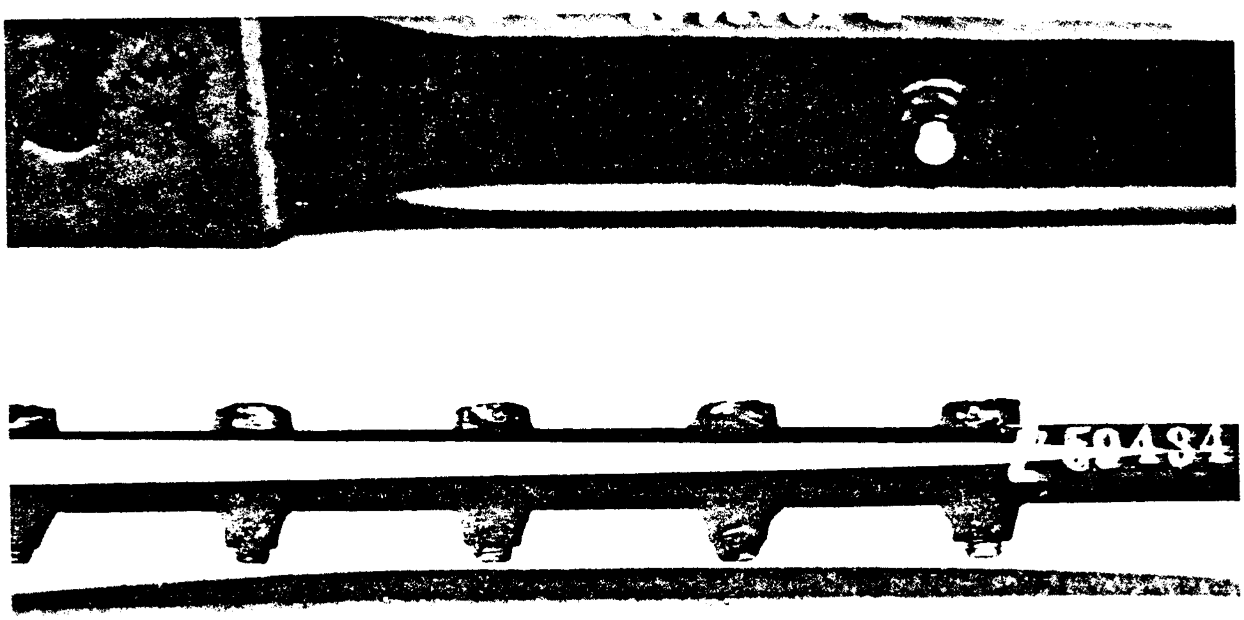


FIGURE 58. Z5943452-501 SPAR SKIN-FLANGE SPLICE

Resin and void content samples indicated good laminate quality in all specimens as shown in the following table.

Specimen Number	Nominal Thickness-Layers (inches)	Sample Number	Resin Content Weight %	Void Content Volume %
Z5943452-1	60 (0.780)	1 2 Average	25.49 26.77 26.13	1.70 1.30 1.50
Z5943452-501	28 (0.364)	1 2 Average	28.02 28.41 28.21	0.90 0.90 0.90
Z5943452-503	34 (0.422)	1 2 Average	26.34 27.13 26.74	0.90 0.57 0.74
DPS Requirement	all		27 ± 5	2.00 max

Computer runs have been made using an infinite series solution to Fick's Second Law of Diffusion to show moisture distribution in different laminate thicknesses for various exposure times. Average moisture content vs. thickness is plotted in Figure 59 for various times of exposure to 170°F and 100 percent relative humidity. The plot indicates that an average moisture content over one percent will be achieved in laminates up to a thickness of about 0.35 inches during the 30-day exposure period. Additional studies indicate that discernible moisture will not penetrate to the center of the thicker section (-1) in the lifetime of the DC-10 aircraft.

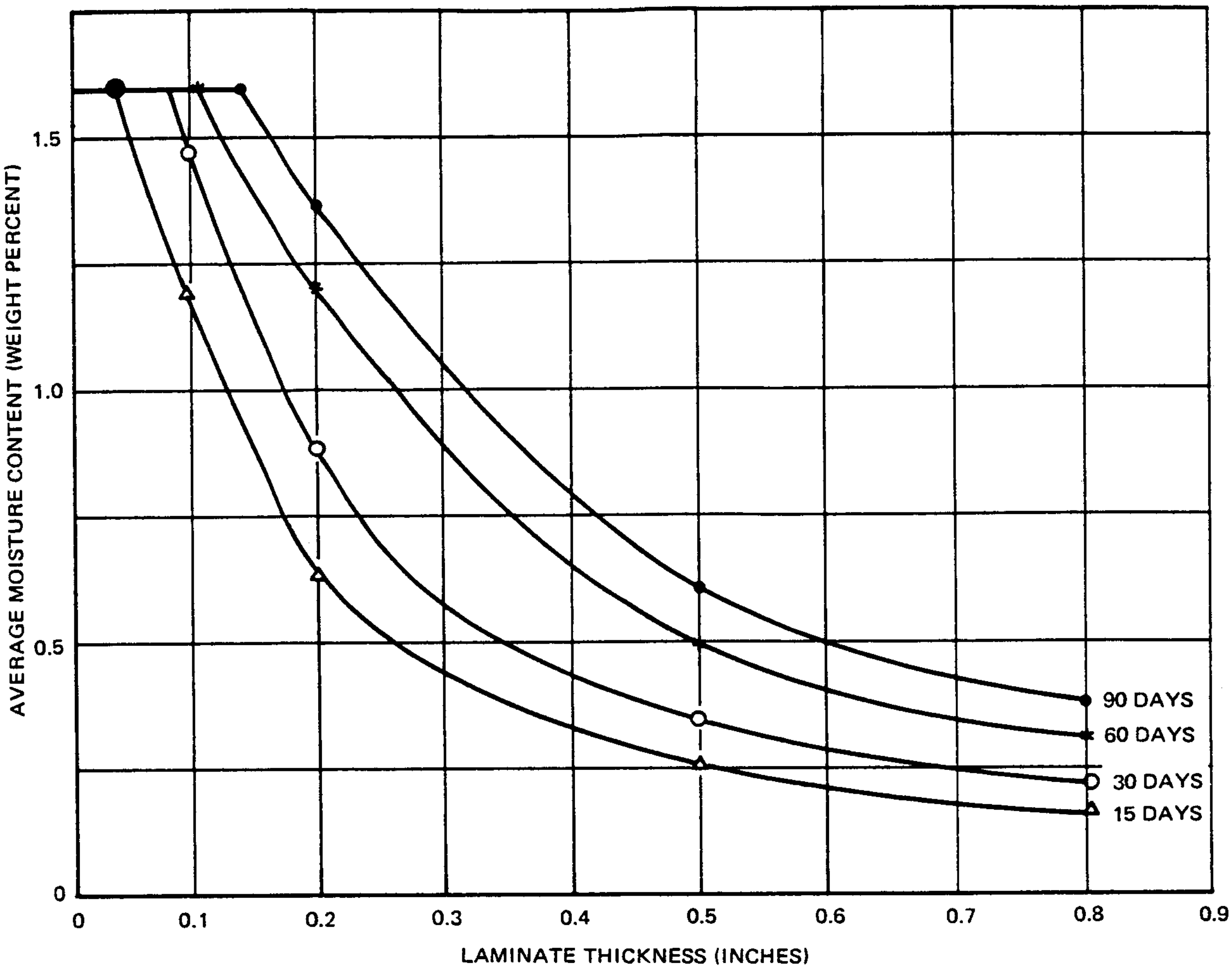


FIGURE 59. AVERAGE MOISTURE CONTENT VERSUS LAMINATE THICKNESS FOR VARIOUS TIMES OF EXPOSURE TO 170°F AND 100 PERCENT RELATIVE HUMIDITY

SECTION 7
TOOL DESIGN

Tool design activities are proceeding on the released engineering drawings. With the exception of the station 295 rib tools, fabrication of hard tooling will not be started until appropriate joint development or concept verification tests are completed. The station 295 rib tools will be fabricated directly on completion of the tool design. One set of station 295 rib parts for the box-beam verification component will be fabricated to prove the rib tooling design concept.

SKIN FABRICATION TOOLING

The skin panel tool design is in progress based on the requirements of drawing number AMC7840. The tool concept is illustrated in Figure 60. The outer surface of the skin panel will be the tooled surface to facilitate net molding of the recesses for access doors, antenna bays, and leading and trailing edge attachments. The basic mold surface will be a 1/4 inch thick steel plate rolled to contour. The plate will be stud-welded at the back surface and bolted to an egg-crate supporting structure. The supporting structure will be designed to facilitate air circulation and rapid heat-up in the autoclave. Honeycomb locators which index to the mold surface will be used to facilitate placement of the core segments during the skin panel buildup. A caul plate will be used during the cure cycle to maintain a smooth inner surface on the cured part.

SPAR FABRICATION TOOLING

The design of spar tools is in progress based on the requirements of drawing numbers AMC7845, AMC7847, AMC7848, AMC7849, and AMC7893. The spar tool concept is illustrated in Figure 61. A machined aluminum alloy tool for the upper surface will be used. The titanium fittings of the spar assembly will be held in position by locating bolts through the end piece of the tool. The lower half of the laminating mold will consist of a cast rubber mold

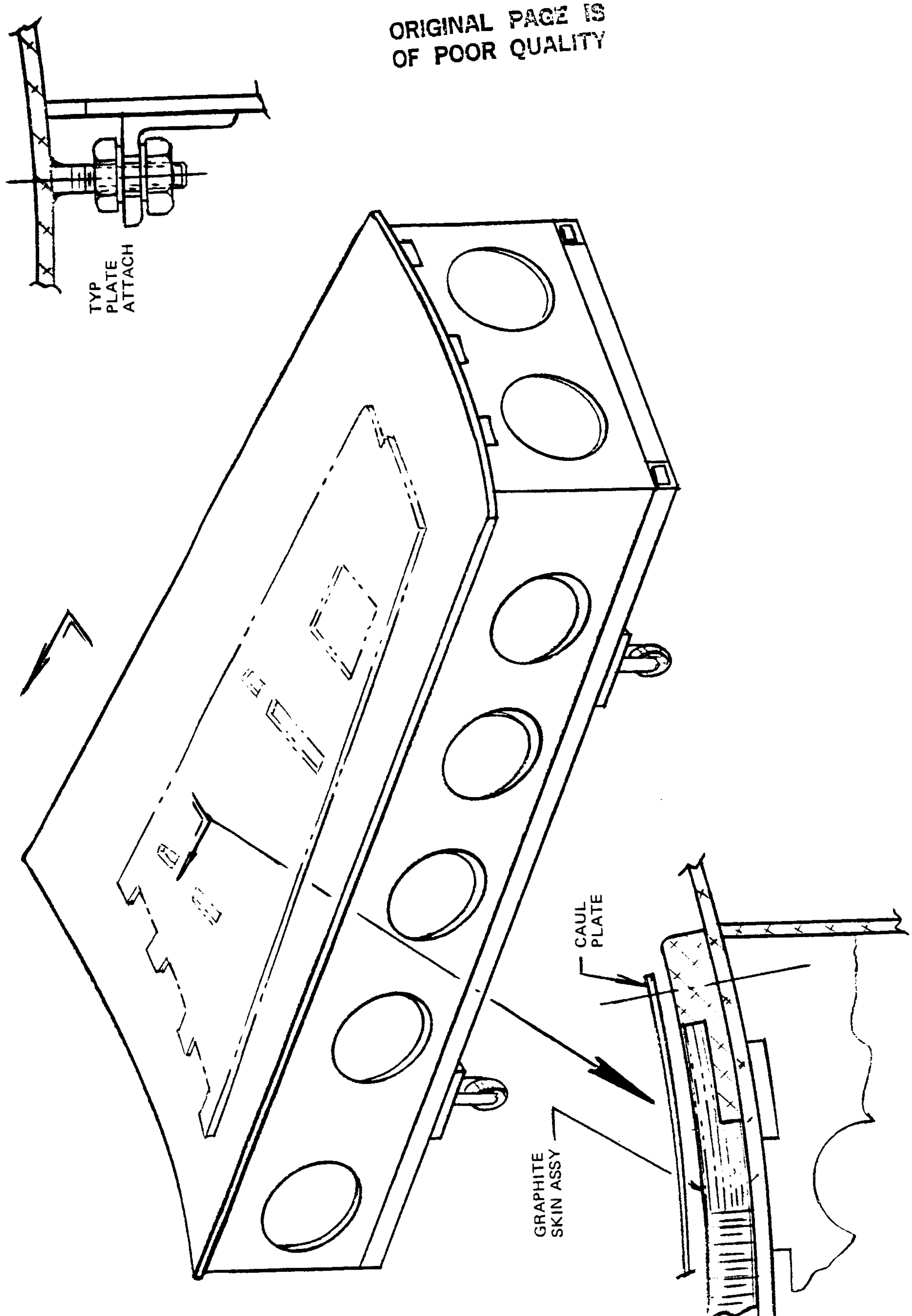


FIGURE 60. TOOLING CONCEPT FOR COMPOSITE VERTICAL STABILIZER SKIN PANELS

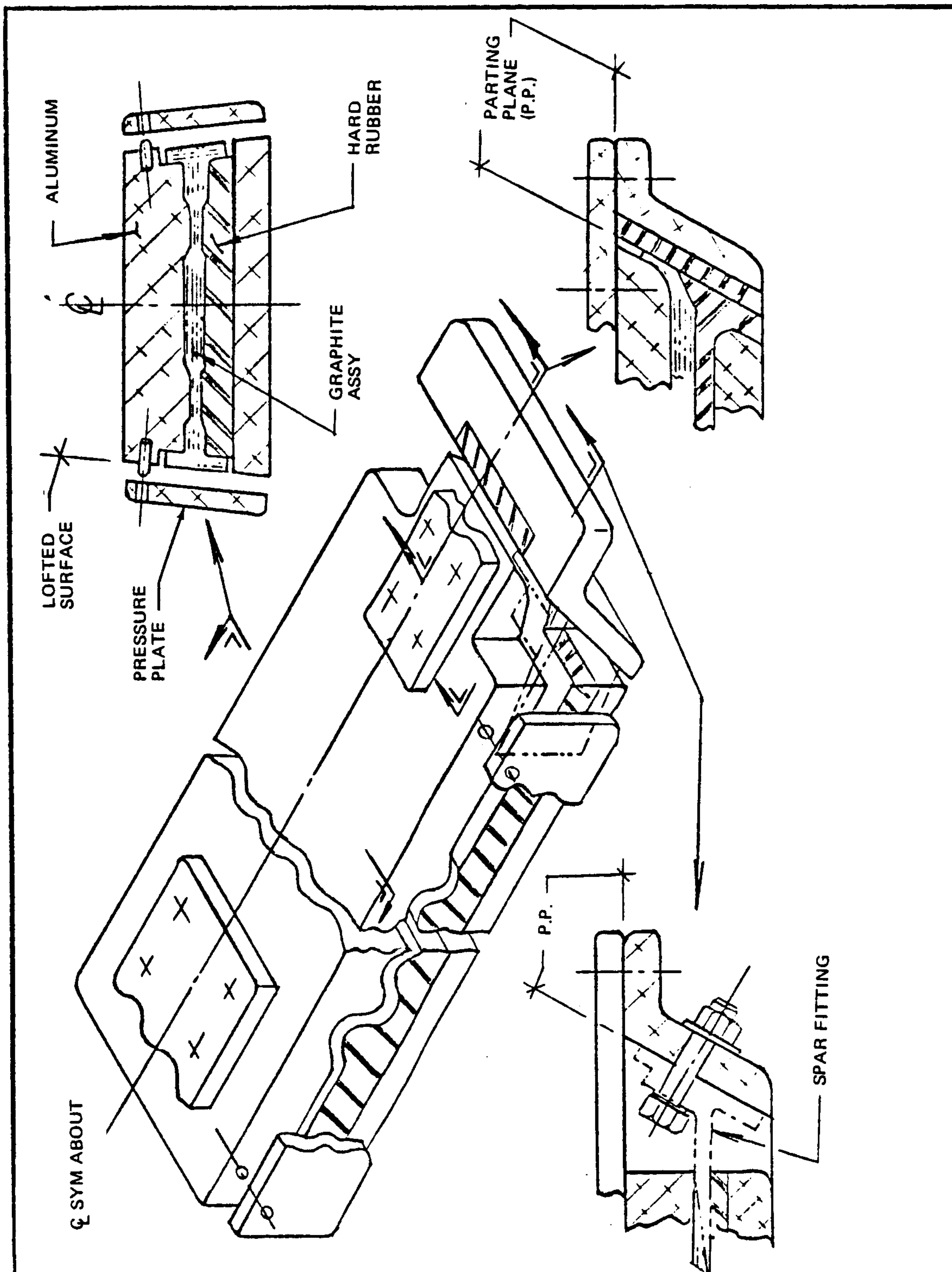


FIGURE 61. TOOLING CONCEPT FOR COMPOSITE VERTICAL STABILIZER SPARS

backed up by a rigid aluminum alloy plate. The rubber mold will be Teflon coated to preclude laminate sticking after a cure cycle. The side pressure plates will maintain the lofted bevels and contours of the spar cap flanges which interface with the skin panels.

RIB FABRICATION TOOLING

The design of the base rib tool is in progress based on the requirements of drawing number AMC7853. The tooling concept is illustrated in Figure 62. An aluminum female mold will be used to control the outer loft surface of the part. A fiberglass caul plate will be used to control the internal surfaces to insure a good fit with the spar ends. A split base rib was designed to provide a tolerance take-up feature at a centerline overlap splice joint.

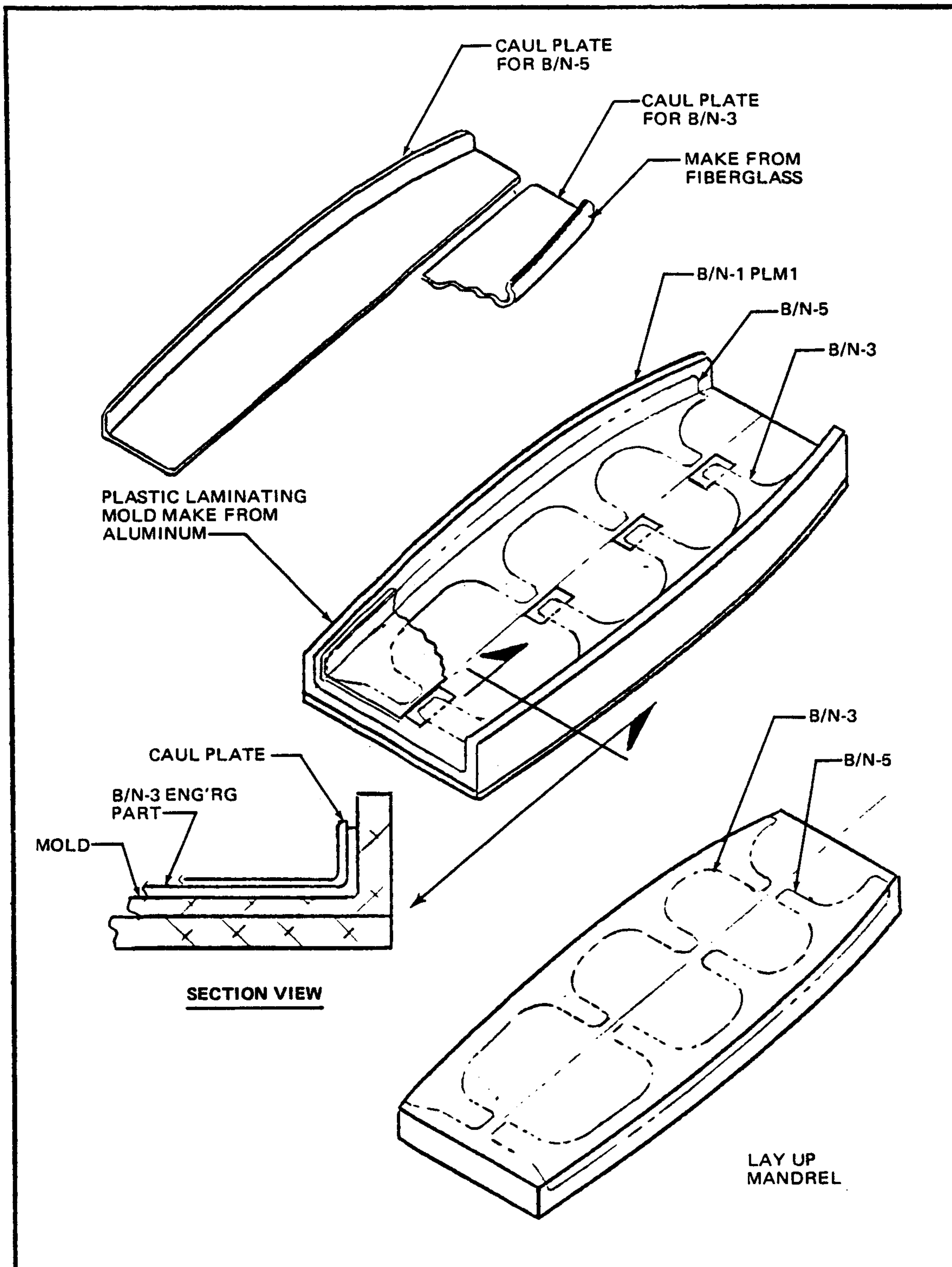


FIGURE 62. TOOLING CONCEPT FOR COMPOSITE VERTICAL STABILIZER BASE RIB

SECTION 8
COST ANALYSIS

An economic analysis was completed using the technical and manufacturing information developed for the current structural configuration (e.g., mechanically attached skin panels, sine-wave stiffened shear panels). The assumptions and analysis guidelines reported previously (Reference 9) were applied in this current analysis. Experience and information obtained in the composite upper-aft rudder program (Reference 6) were also applied.

The economic analysis results are expressed in terms of the number of composite stabilizers to be manufactured in a production mode to achieve cost parity with the current unit costs of the metal stabilizer. This cost cross-over point was estimated at 100 composite stabilizer units at the start of the program. The current analysis indicates that the cost cross-over point will be achieved after approximately 32 units are produced (see Figure 63).

New labor estimates were made to reflect the current design concept. The estimates associated with the economic analysis were selectively extracted from the overall program labor estimates. Development costs were excluded. The manufacturing data shown in Table 9 represents estimates of the eight stabilizers incorporating the present design concept. These estimates will be updated as actual cost data are accrued. In Table 9, the manufacturing labor hours and the planning hours were derived from the current estimates. The recurring tooling was allocated arbitrarily to the eight units as sustaining tooling. Sustaining Engineering and Inspection/NDT were assumed to be the same as shown in the prior analysis, Reference 9. Manufacturing T_1 labor hours (recurring labor hours for the first production unit) derived from the base estimate are shown in Table 10 together with production progress (learning) curve assumptions used in the cost cross-over analysis.

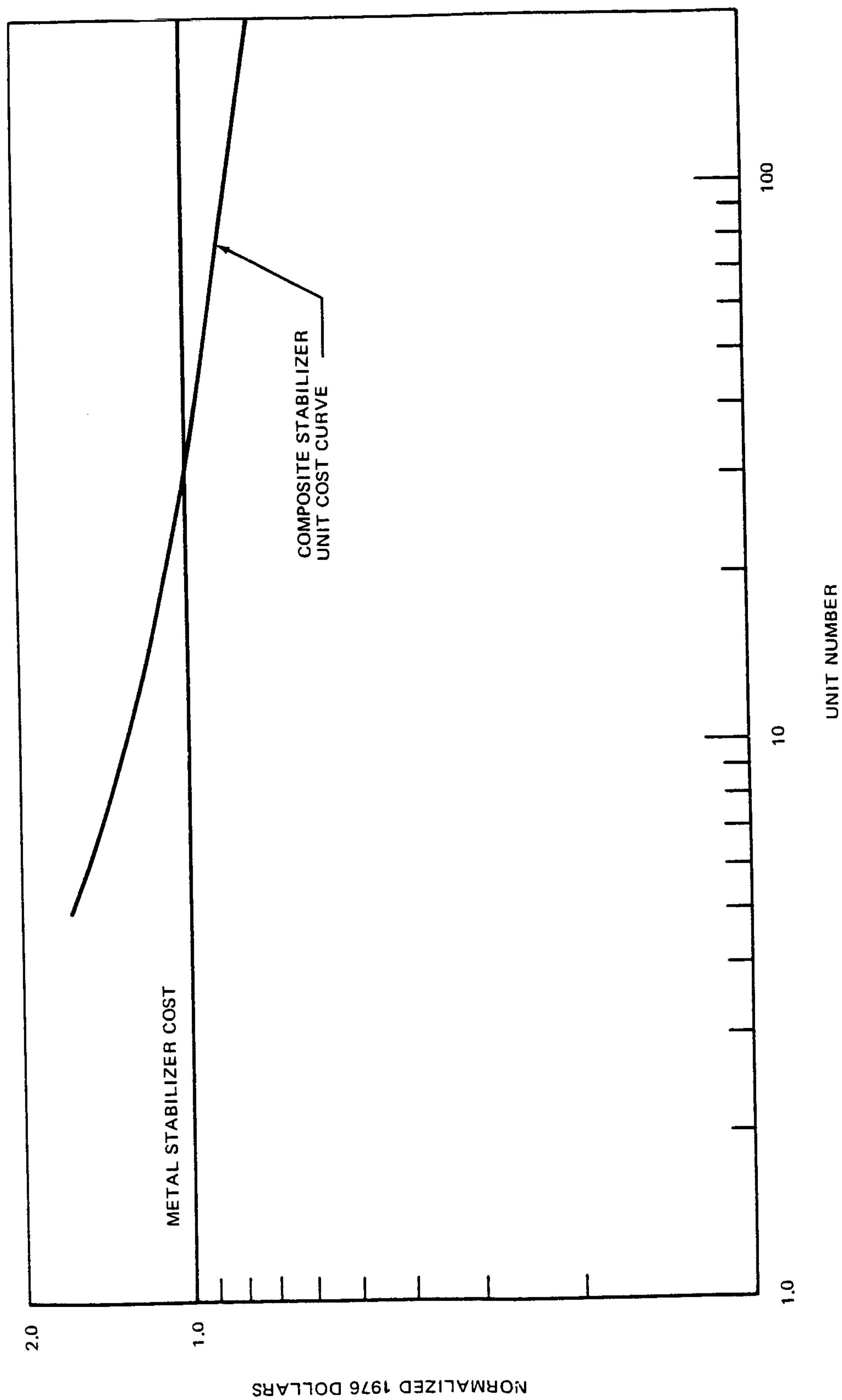


FIGURE 63. PROJECTED COST CROSS-OVER POINT FOR DC-10 COMPOSITE VERTICAL STABILIZERS

TABLE 9

RECURRING LABOR HOURS FOR DC-10 COMPOSITE VERTICAL STABILIZERS

MANUFACTURING FUNCTION	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	TOTAL
COMPOSITE STRUCTURE	11,153	9,050	10,073	9,348	8,968	8,692	8,475	8,296	74,055
LE/TIP/RUDDER	(102)	(99)	133	133	133	132	132	132	795
METAL DETAILS	(387)	(383)	512	512	511	511	511	511	3,068
STRUCTURE ASSEMBLY	286	286	286	286	286	286	286	285	2,287
BOX ASSEMBLY	2,377	2,377	2,377	2,377	2,377	2,377	2,377	2,377	19,016
FINAL ASSEMBLY	1,164	1,164	1,164	1,164	1,164	1,164	1,164	1,164	9,312
PLANNING	542	462	499	473	459	449	440	432	3,756
INSPECTION/NDT	1,770	1,600	1,410	1,300	1,250	1,220	1,190	1,170	10,910
TOOLING	700	700	700	700	700	699	699	699	5,597
ENGINEERING	260	250	240	230	220	190	150	140	1,680
TOTAL	18,252	15,889	17,394	16,523	16,068	15,720	15,424	15,206	130,476

TABLE 10
PROJECTED T1 LABOR HOURS FOR
DC-10 COMPOSITE VERTICAL STABILIZER

MANUFACTURING FUNCTION	T1 AVERAGE DERIVED FROM UNITS 1 THROUGH 8	ESTIMATING CURVE AND FACTORS
COMPOSITE STRUCTURE	9257	80/84%*
LE/TIP/RUDDER	133	90%
METAL DETAILS	511	90%
STRUCTURE ASSEMBLY	286	80%
BOX ASSEMBLY	2377	80%
FINAL ASSEMBLY	1164	80%
PLANNING	FACTORED	6.7%
INSPECTION/NDT	FACTORED	13.6%
TOOLING	8	K
ENGINEERING	126	91%

*ASSUMES AN 80 PERCENT LEARNING FROM T1 TO T100 AND AN 84 PERCENT FROM T101 TO T200

SECTION 9
QUALITY ASSURANCE

Non-destructive inspections (NDI) were performed on the Z5943434-501 sine-wave shear web component and the Z5943445-21 combined load test panel using ultrasonic, radiographic, and Fokker Bondtester NDI methods for the various types of construction (e.g., flat laminates, sine-wave laminates, and honeycomb sandwich regions).

The Z5943434-501 sine-wave shear web component was evaluated using an ultrasonic C-scan reflector technique to test the flat areas of the web, an ultrasonic C-scan pulse-echo technique to evaluate the solid laminate caps, and a pulse-echo digital thickness gage to contact scan the convoluted web areas. These ultrasonic tests indicated the test component to be of acceptable quality.

The Z5943445-21 combined load test panel was evaluated using X-radiography to view core quality and ultrasonic C-scan to detect discontinuities in the solid laminate and the skin-to-core bond lines. The solid laminate areas that could not be reached by the thru-transmission fixture were evaluated using an ultrasonic pulse-echo thickness gage. Skin-to-core bond areas were evaluated using the Fokker Bondtester. The core closures and skin-to-core bonds were judged to be of acceptable quality by the X-ray and Fokker Bondtester inspections.

Interpretation of the ultrasonic inspections was difficult because of the presence of peel plies on both surfaces of the panel and the lack of applicable inspection standards. The peel plies will not be removed until hole preparation is complete during final assembly of the panel and test fixturing. The panel was therefore examined ultrasonically for consistent homogeniety in both the solid laminate and honeycomb core regions. The inspection indicated several areas of porosity on the solid laminate. These regions were sufficiently porous to attenuate digital thickness gage readouts.

Resin and void samples will be obtained from these regions after the panel tests are completed to help define QC acceptance levels in the CVS parts. These test results are also being considered during planning of the necessary CVS inspection standards.

Incoming quality assurance tests were conducted on 23.7 kilograms (52.2 pounds) of bi-woven material. The material met all specification requirements as shown in Table 11.

TABLE 11
PREPREG QUALITY CONTROL RECEIVING INSPECTION RESULTS

MATERIAL 5208 T300 BIWOVEN VENDOR NARMCO LOT NUMBER 199 DATE OF MFG. 10-20-78 PG. 1 OF 1

DATE REC'D 10-30-78 QUANTITY REC'D 52.2 CCN ____ / DATE REC'D ____ QUANTITY REC'D ____ CCN ____ DMS 2163

TEST / UNIT IDENTITY	PREPREG PROPERTIES: RESIN CONTENT WT %	VOLATILE CONTENT WT. %	GEL TIME MINUTES	FIBER AREAL WT. GMS/M^2		LAMINATE PROPERTIES: TENSILE STRENGTH 10^3 PSI	TENSILE MODULUS 10^6 PSI	COMPRESSION STRENGTH 10^3 PSI	COMPRESSION MODULUS 10^6 PSI	FLEXURAL STRENGTH 10^3 PSI	FLEXURAL MODULUS 10^6 PSI	SHEAR STRENGTH 10^3 PSI	RESIN CONTENT WT. %	VOID CONTENT VOL. %	THICKNESS PER PLY MILS	FIBER VOLUME	COMMENTS
DMS REQUIREMENTS	39-45	2.0 MAX	17-28	345-385						125.0	10.0	9.0	N/A	2 MAX	N/A	N/A	
AVERAGE RESULTS																	
UNIT 8 -1	41.0			367.8						175.9	12.8	12.6			13.0		
-2			20.6										28.1	0.8		64.6	
-3		1.0		366.5						175.5	13.3	13.1			13.1		
-4	40.9									177.0	12.8	13.6			13.1		
-5																	
AVG.	41.0			367.2						176.1	13.0	13.1			13.1		
UNIT -1																	
-2																	
-3																	
-4																	
-5																	
AVG.																	
UNIT -1																	
-2																	
-3																	
-4																	
-5																	
AVG.																	
UNIT -1																	
-2																	
-3																	
-4																	
-5																	
AVG.																	
UNIT -1																	
-2																	
-3																	
-4																	
-5																	
AVG.																	

REMARKS:

MEETS SPEC. ☐ DOES NOT MEET SPEC. ☐
MEETS P.O. ☐ DOES NOT MEET P.O. ☐
Q.C. REPRESENTATIVE ____
DATE: ____

SECTION 10
REFERENCES

1. Grubb, D. W., "DC-10 Composite Vertical Stabilizer Design Criteria and External Loads," McDonnell Douglas Corporation Report Number MDC J7718, September 1977.

2. Abelkis, P. R., "DC-10 Aft Section Fatigue Test, Volume I, Spectrum Derivation," McDonnell Douglas Corporation Report Number DAC 67725, 23 July 1970.

3. Hunter, P. A., "An Analysis of VGH Data From One Type of Four-Engine Turbojet Transport Airplane During Commercial Operations," NASA TN D-4330, February 1968.

4. Hunter, P. A. and M. W. Fetner, "Maneuver Accelerations Experienced During Routine Operations of a Commercial Turbojet Transport Airplane," NASA TN D-1801, May 1968.

5. "Advanced Composite Vertical Stabilizer for DC-10 Transport Aircraft," Contract NAS1-14869, Sixth Quarterly Technical Progress Report, McDonnell Douglas Corporation, Report Number ACEE-03-PR-8549, 20 October 1978.

6. "Advanced Composite Vertical Stabilizer for DC-10 Transport Aircraft," Contract NAS1-14869, Second Quarterly Technical Progress Report, McDonnell Douglas Corporation, Report Number ACEE-03-PR-7240, 15 October 1977.

7. "Advanced Composite Vertical Stabilizer for DC-10 Transport Aircraft," Contract NAS1-14869, Third Quarterly Technical Progress Report, McDonnell Douglas Corporation, Report Number ACEE-03-PR-8332, 20 January 1978.

8. "Advanced Composite Vertical Stabilizer for DC-10 Transport Aircraft," Contract NAS1-14869, Fifth Quarterly Technical Progress Report, McDonnell Douglas Corporation, Report Number ACEE-03-PR-8484, 26 July 1978.

9. "Advanced Composite Vertical Stabilizer for DC-10 Transport Aircraft," Contract NAS1-14869, Fourth Quarterly Technical Progress Report, McDonnell Douglas Corporation, Report Number ACEE-03-PR-8394, 24 April 1978.

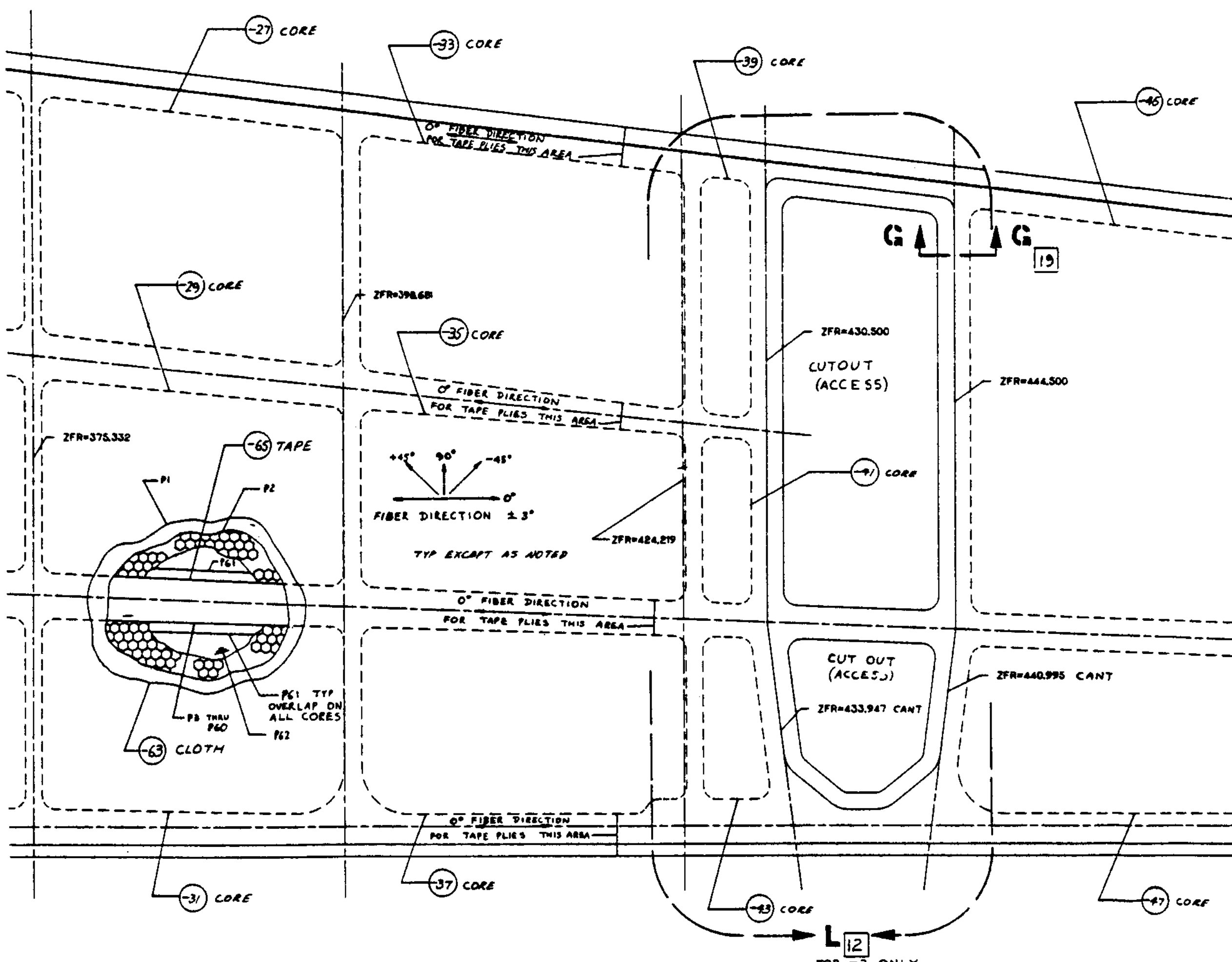
10. Lehman, G. M., et al, "Advanced Composite Rudders for DC-10 Aircraft - Design, Manufacturing, and Ground Tests," NASA CR-145068, April 1976.

11. Hart-Smith, L. J., "Bolted Joints in Graphite-Epoxy Composites," Report NASA CR-144899, Contract NAS1-13172, January 1977.

APPENDIX A

ENGINEERING DRAWINGS

ORIGINAL PAGE IS
OF POOR QUALITY



VIEW LKG INBD LEFT SIDE

SCALE: 1/4

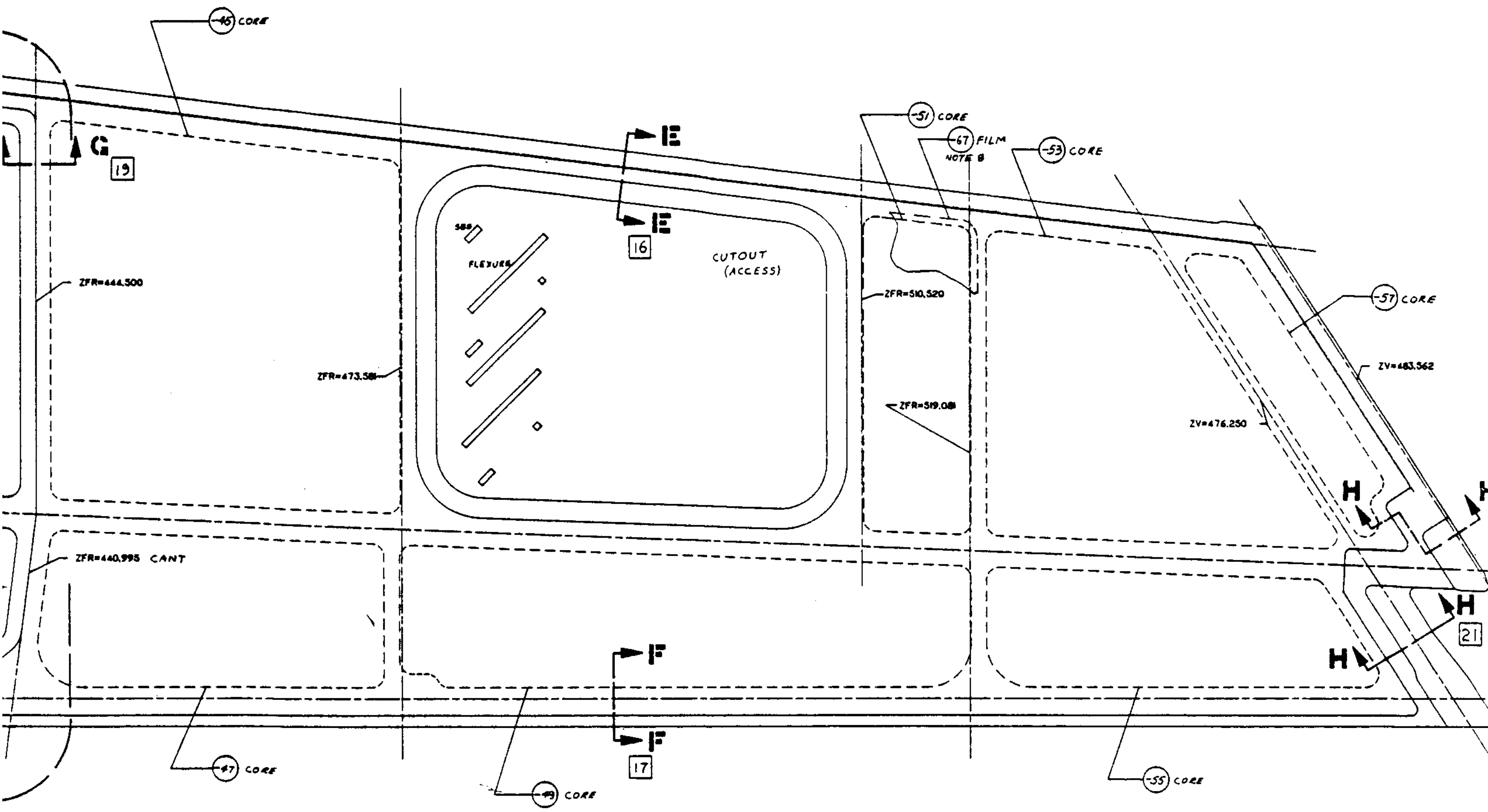
FOLDOUT FRAME

AMC7840

Douglas
Contrac

5	4	3

2 FOLDOUT FRAME

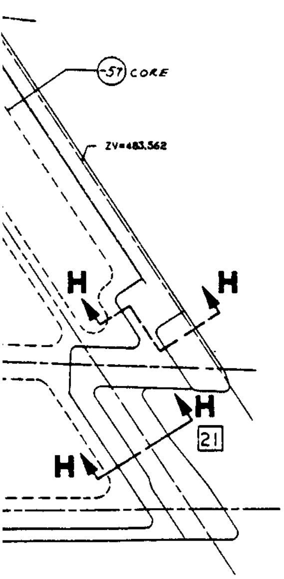


PRECEDI

BLUE PRINT: PRINT ONLY SHEETS LISTED BELOW

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED

1. IDENTIFY PER DPS 3.02
2. FABRICATE PER DPS 1.622
3. NUMERIC DEFINITION OR ACCURATE REPRODUCTION OF PARTS WILL BE FURNISHED BY CI TOOLING DIVISION
4. INSPECT PER D.P.S. 4.738 TYPE 2 CLASS (TBD)
5. HONEYCOMB RIBBON DIRECTION OPTIONAL
6. BOND HONEYCOMB CORE TO GRAPHITE/EPOXY PER DPS. 1.966
7. FOR BI-WEAVE CLOTH WARP AND FILL ARE INTERCHANGEABLE
8. APPLY (1) LAYER (.001) OF TEDLAR FILM IN AREA OF HONEYCOMB CORES WITH .25 OVERLAP TO INNER SURFACE OF PANEL
9. ALLOW VOIDS TO FILL WITH EXCESS RESIN
10. WHEN NECESSARY TO JOIN ADJACENT WIDTHS OF CLOTH THE EDGES SHALL OVERLAP .50 ± .25 STAGGER OVERLAPS
11. TEST SHORT BEAM SHEAR SPECIMEN PER D.M.S 2163
12. TEST RESIN AND VOID CONTENT PER D.M.S 2163
13. LOCATE LAP SHEAR SPECIMENS TEST UNDER SAME BAG AS THE PARTS. TEST PER D.M.S. 2177
14. LINES ON SHEET 1 ARE TAKEN AT INTERSECTION SHOWN ⊕ ON DIAGRAMMATIC VIEW
15. FILL PERIPHERY OF HONEYCOMB CORE FOR A DISTANCE OF .25 +.25/-.0 PER D.P.S. 1.901 TYPE III
16. FILL GAPS BETWEEN HONEYCOMB CORE AND GRAPHITE/EPOXY WITH 350° F CURE FOAMING ADHESIVE PER D.P.S. 1.99. GAP SHALL NOT EXCEED .06
17. TEST FLEXURAL SPECIMEN PER D.M.S. 2163
18. NUMERIC DEFINITION OF THE PARTS ON THIS DRAWING IS AVAILABLE FROM THE COMPUTER AIDED DESIGN DRAFTING SYSTEM. ACCESS TO THE NUMERIC DATA (CADD MODEL) IS GAINED BY ENTERING THE CADD SYSTEM WITH THE APPROPRIATE RELEASED IDENTIFIER.
19. THE PRECISION OF THE NUMERIC DATA DOES NOT IMPLY A TOLERANCE.
20. ALL CADD DATA IS THEORETICAL AND WITHOUT TOLERANCE. LOFT LINE SURFACE MAY VARY BY ±.015 FROM THEORETICAL BUT MUST FAIR.
21. TRIM OF PARTS MAY VARY BY ±.03 FROM THEORETICAL. THICKNESS OF PARTS MAY VARY BY ±.010 FROM THREE PLACE DIMENSIONS



PRECEDING PAGE BLANK NOT FILMED

AMC7840

SEE SEPARATE PARTS LIST

-1 SHOWN
-2 OPP EXCEPT AS SHOWN

CONTRACT NO. NAS1-14869

DOUGLAS AIRCRAFT COMPANY
LONG BEACH, CALIFORNIA

PANEL ASSY- COMPOSITE
VERTICAL STABILIZER SKIN
CADD MASTERED DRAWING

CHECK C.C.SPEN
PREP BY M. ASHIBA

NEXT ASSY AMC 6301 DC-10

SIZE J CODE IDENT NO 88277 AMC7840

SCALE 1/4 & NOTED SHEET 1 OF 2

ORIG SECTION MC01

FIGURE A1. DRAWING AMC7840 – SKIN PANEL ASSEMBLY (SHEET 1 OF 4)

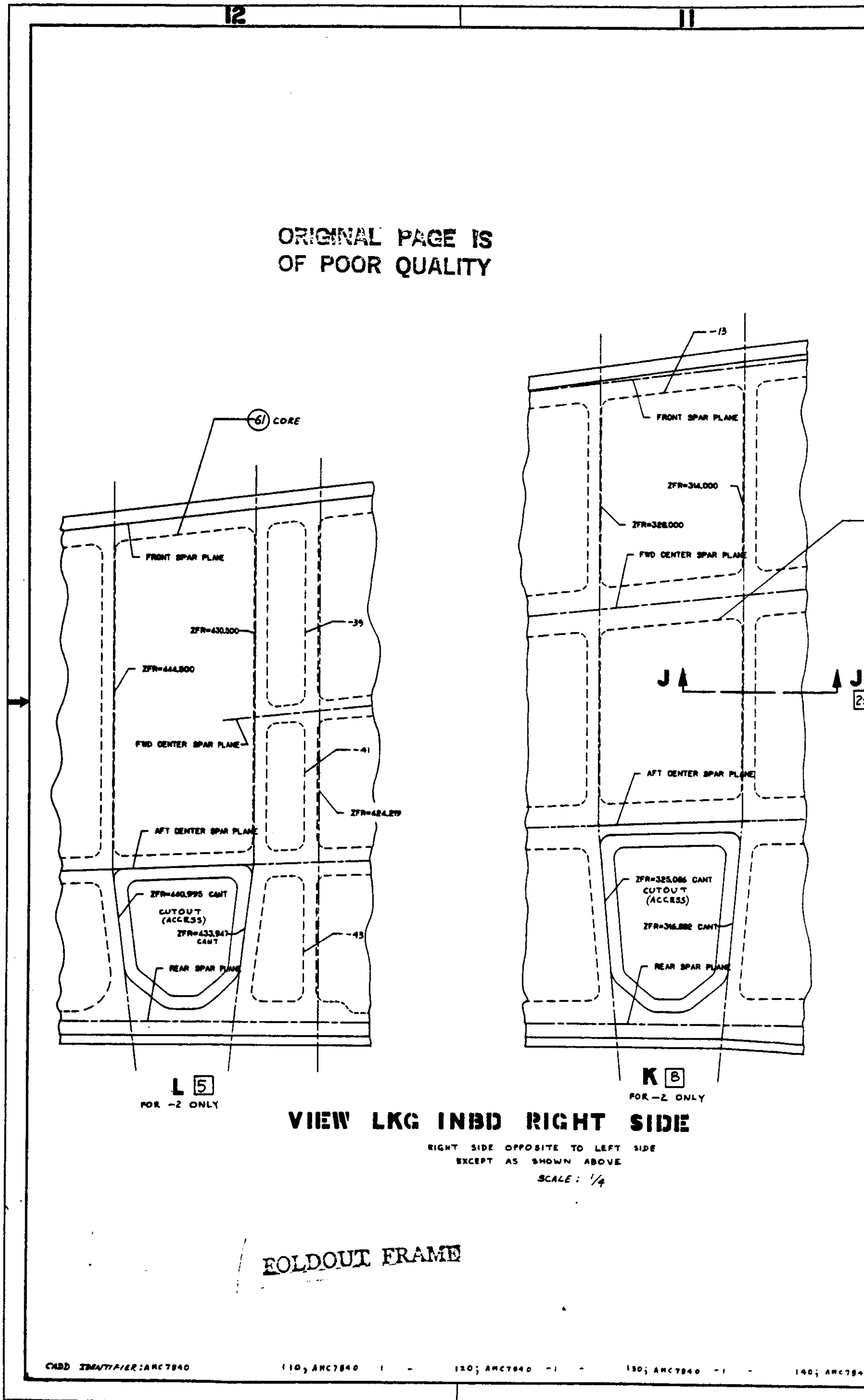
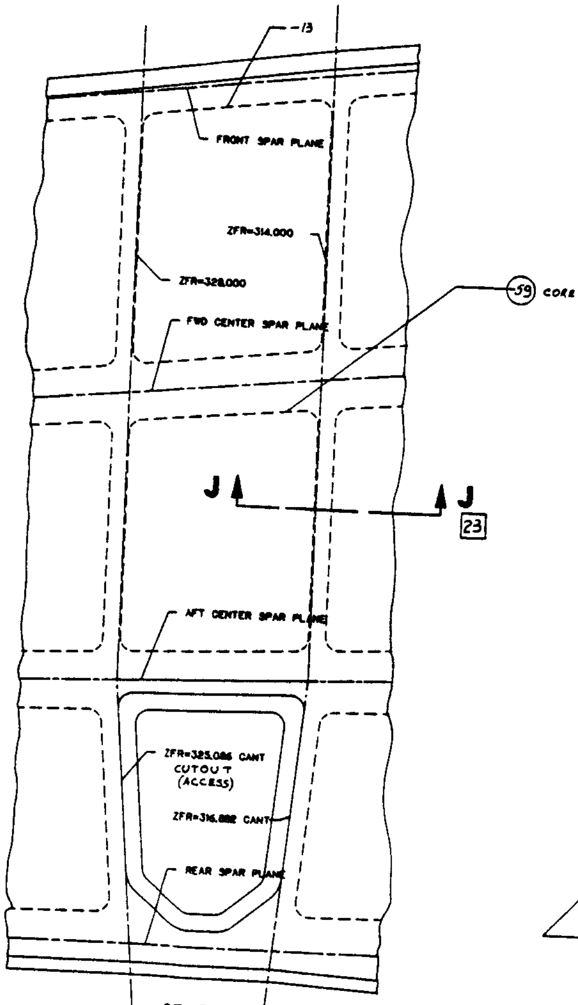


FIGURE A1. DRAWING AMC7840 – SKIN PANEL ASSEMBLY (SHEET 2 OF 4)

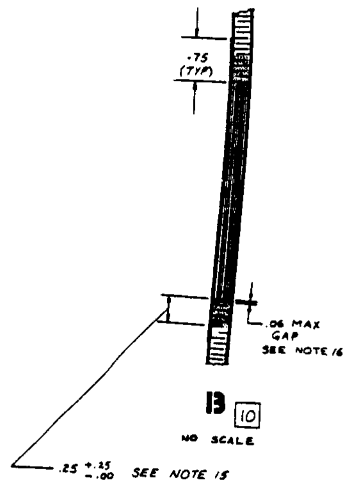
ORIGINAL PAGE IS
OF POOR QUALITY



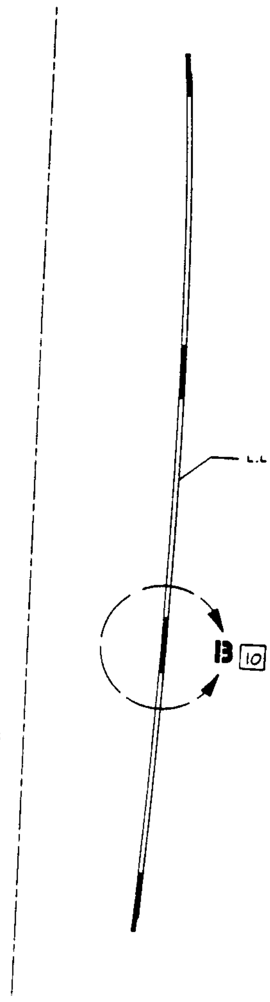
K 8
FOR -2 ONLY

INBD RIGHT SIDE

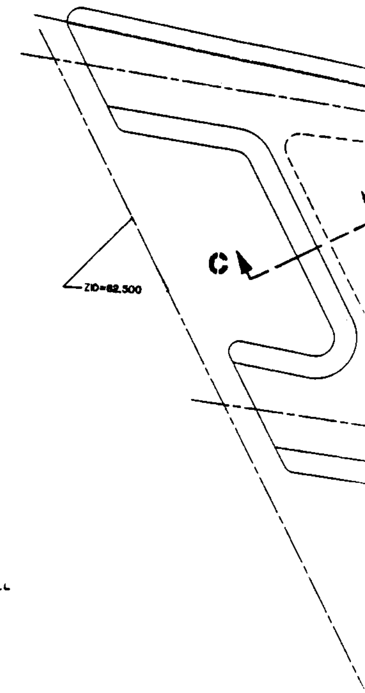
RIGHT SIDE OPPOSITE TO LEFT SIDE
EXCEPT AS SHOWN ABOVE
SCALE: 1/4



B 10
NO SCALE



A - A 7

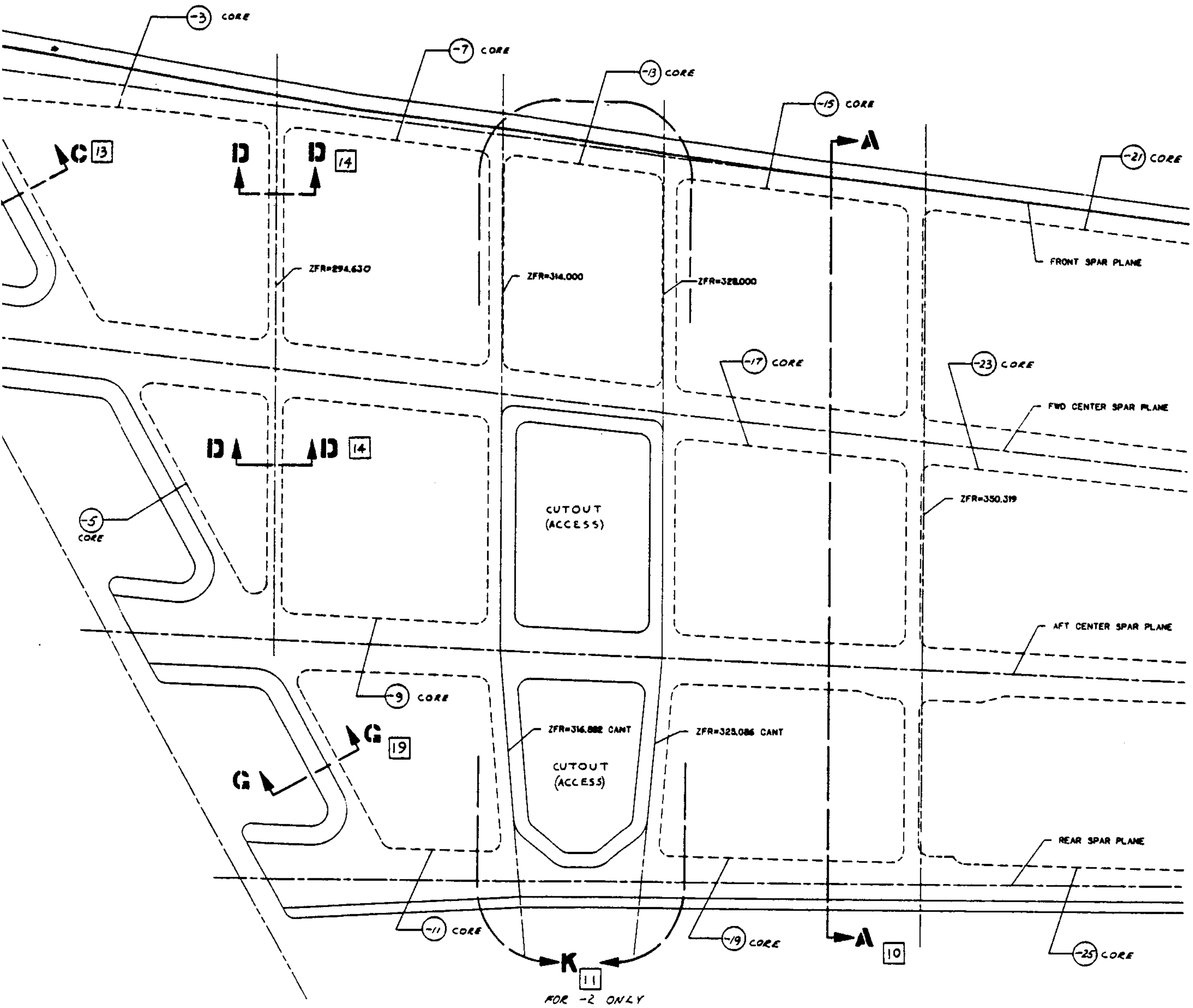


120; ANC7840 -1 - 130; ANC7840 -1 - 140; ANC7840 -1 - 150

ASSEMBLY (SHEET 2 OF 4)

. PAGE IS
R QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

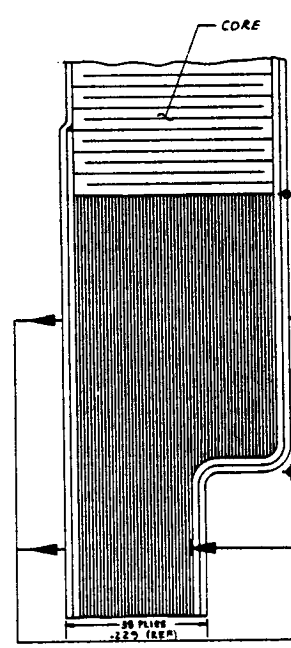


AMC7840	LTR –	SHEET 1

ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME

TABLE C				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	PLY PATT SHT NO.
P1	SEE	TABLE	"A"	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P23				
P24				
P25				
P26				
P27				
P28				
P29				
P30				
P31				
P32				
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P54				
P55				
P56				
P57				
P58				
P59				
P60				
P61				
P62	SEE	TABLE	"A"	



F - F

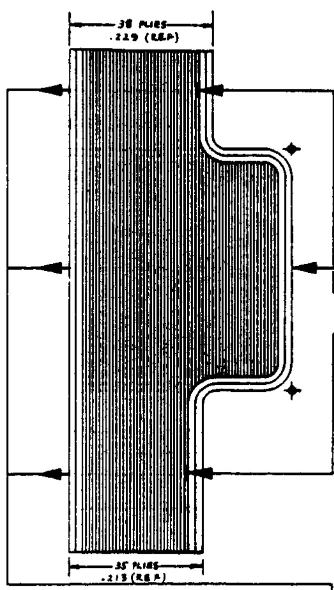
DIAGRAMMATIC ONLY 4

TYPICAL

17 | 16 | 15

TABLE C

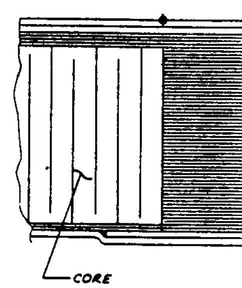
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (DEG)	PLY PATT SHT NO.
P1	SEE	TABLE	"A"	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P23				
P24				
P25				
P26				
P27				
P28				
P29				
P30				
P31				
P32				
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P54				
P55				
P56				
P57				
P58				
P59				
P60				
P61				
P62	SEE	TABLE	"A"	



E - E
DIAGRAMMATIC ONLY 4

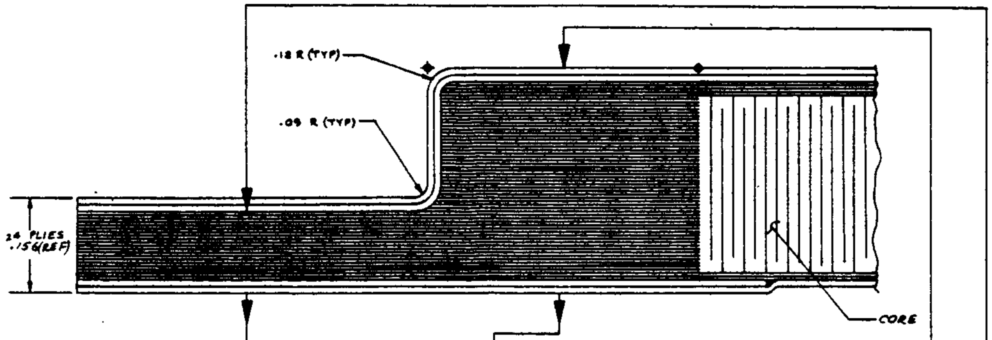
TABLE B

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (DEG)	PLY PATT SHT NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P23				
P24				
P25				
P26				
P27				
P28				
P29				
P30				
P31				
P32				
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P54				
P55				
P56				
P57				
P58				
P59				
P60				
P61				
P62	SEE	TABLE	A	



14 13

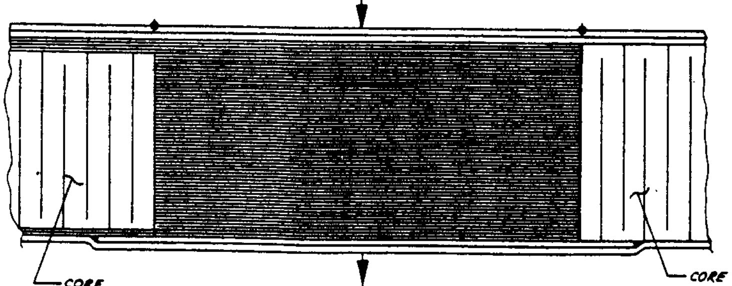
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	—	SEE SHEET 1		



C - C 9
DIAGRAMMATIC ONLY
ROTATED 90° CW
2 PLCS

TABLE A

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	[illegible]
P1	1	-63	±45	
P2	1	-63	±45	
P3	1	-65	0	
P4	1		90	
P5	1		0	
P6	1		90	
P7	1		+45	
P8	1		0	
P9	1		-45	
P10	1		90	
P11	1		+45	
P12	1		0	
P13	1		-45	
P14	1		90	
P15	1		+45	
P16	1		0	
P17	1		-45	
P18	1		90	
P19	1		+45	
P20	1		0	
P21	1		-45	
P22	1		90	
P23	1		+45	
P24	1		0	
P25	1		-45	
P26	1		90	
P27	1		+45	
P28	1		0	
P29	1		-45	
P30	1		90	
P31	1		0	
P32	1		0	
P33	1		90	
P34	1		-45	
P35	1		0	
P36	1		+45	
P37	1		90	
P38	1		-45	
P39	1		0	
P40	1		+45	
P41	1		90	
P42	1		-45	
P43	1		0	
P44	1		+45	
P45	1		90	
P46	1		-45	
P47	1		0	
P48	1		+45	
P49	1		90	
P50	1		-45	
P51	1		0	
P52	1		+45	
P53	1		90	
P54	1		-45	
P55	1		0	
P56	1		+45	
P57	1		90	
P58	1		0	
P59	1		90	
P60	1	-65	0	
P61	1	-63	±45	
P62	1	-68	±45	



D - D 8
DIAGRAMMATIC ONLY

ORIGINAL PAGE IS
OF POOR QUALITY

2

AMC7840

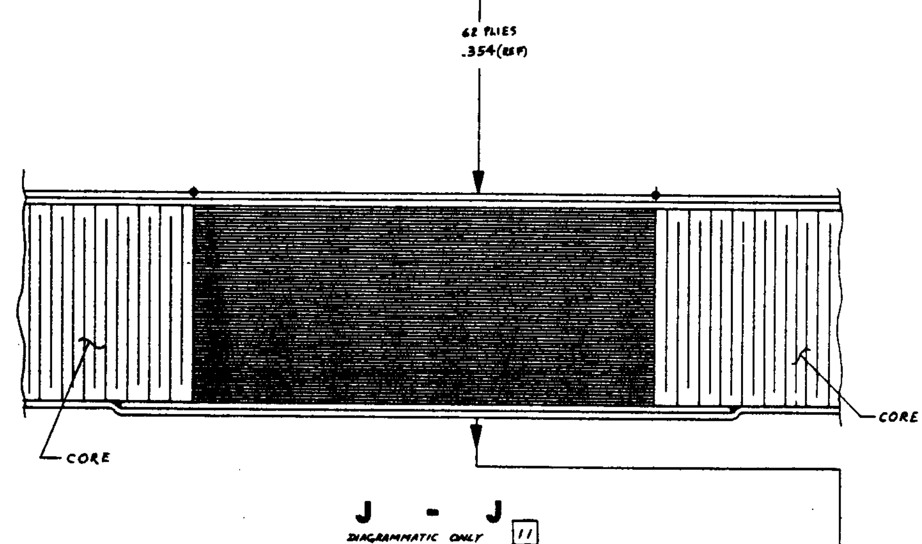
DOUGLAS	SIZE J	CODE IDENT NO. 88277	AMC7840
			SHEET 2

FIGURE A1. DRAWING AMC7840 – SKIN PANEL ASSEMBLY (SHEET 3 OF 4)

24 23

ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME



TABLE

PLY LAYUP S		
PLY NO.	NO. REQD	MAKE FROM
P101	1	-63
P102	1	-63
P103	1	-65
P104	1	
P105	1	
P106	1	
P107	1	
P108	1	
P109	1	
P110	1	
P111	1	
P112	1	
P113	1	
P114	1	
P115	1	
P116	1	
P117	1	
P118	1	
P119	1	
P120	1	
P121	1	
P122	1	
P123	1	
P124	1	
P125	1	
P126	1	
P127	1	
P128	1	
P129	1	
P130	1	
P131	1	
P132	1	
P133	1	
P134	1	
P135	1	
P136	1	
P137	1	
P138	1	
P139	1	
P140	1	
P141	1	
P142	1	
P143	1	
P144	1	
P145	1	
P146	1	
P147	1	
P148	1	
P149	1	
P150	1	
P151	1	
P152	1	
P153	1	
P154	1	
P155	1	
P156	1	
P157	1	
P158	1	
P159	1	
P160	1	-65
P161	1	-63
P162	1	-63

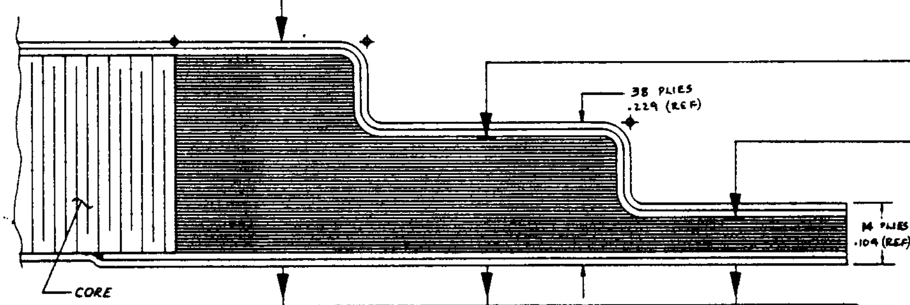
FIGURE A1. DRAWING AMC7840 – SKIN PANEL ASSEMBLY (SHEET 4 OF 4)

22 21 20

TABLE F

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (DEG)	PLY PATT SHT NO.
P101	1	-63	±45	
P102	1	-63	±45	
P103	1	-65	0	
P104	1		90	
P105	1		0	
P106	1		90	
P107	1		+45	
P108	1		0	
P109	1		-45	
P110	1		90	
P111	1		+45	
P112	1		0	
P113	1		-45	
P114	1		90	
P115	1		+45	
P116	1		0	
P117	1		-45	
P118	1		90	
P119	1		+45	
P120	1		0	
P121	1		-45	
P122	1		90	
P123	1		+45	
P124	1		0	
P125	1		-45	
P126	1		90	
P127	1		+45	
P128	1		0	
P129	1		-45	
P130	1		90	
P131	1		0	
P132	1		0	
P133	1		90	
P134	1		-45	
P135	1		0	
P136	1		+45	
P137	1		90	
P138	1		-45	
P139	1		0	
P140	1		+45	
P141	1		90	
P142	1		-45	
P143	1		0	
P144	1		+45	
P145	1		90	
P146	1		-45	
P147	1		0	
P148	1		+45	
P149	1		90	
P150	1		-45	
P151	1		0	
P152	1		+45	
P153	1		90	
P154	1		-45	
P155	1		0	
P156	1		+45	
P157	1		90	
P158	1		0	
P159	1		90	
P160	1	-65	0	
P161	1	-63	±45	
P162	1	-63	±45	

CORE



H - H 3
DIAGRAMMATIC ONLY
ROTATED 90 CW
2 PLCS

TABL

PLY LAYUP		
PLY NO.	NO. REQD	MA FR
P1	SEE	TA
P2		
P3		
P4		
P5		
P6		
P7		
P8		
P9		
P10		
P11		
P12		
P13		
P14		
P15		
P16		
P17		
P18		
P19		
P20		
P21		
P22		
P23		
P24		
P25		
P26		
P27		
P28		
P29		
P30		
P31		
P32		
P33		
P34		
P35		
P36		
P37		
P38		
P39		
P40		
P41		
P42		
P43		
P44		
P45		
P46		
P47		
P48		
P49		
P50		
P51		
P52		
P53		
P54		
P55		
P56		
P57		
P58		
P59		
P60		
P61		
P62	SEE	TA

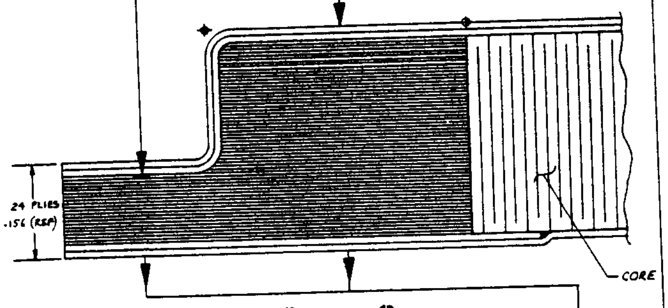
2 FOLDOUT FRAME

AMC7840 - 2

TABLE E

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR(REF)	PLY PATT SHT NO.
P1	SEE	TABLE	"A"	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P23				
P24				
P25				
P26				
P27				
P28				
P29				
P30				
P31				
P32				
P32				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P54				
P55				
P56				
P57				
P58				
P59				
P60				
P61				
P62	SEE	TABLE	"A"	

14 PLIES
.104 (REF)



G - G 5 8

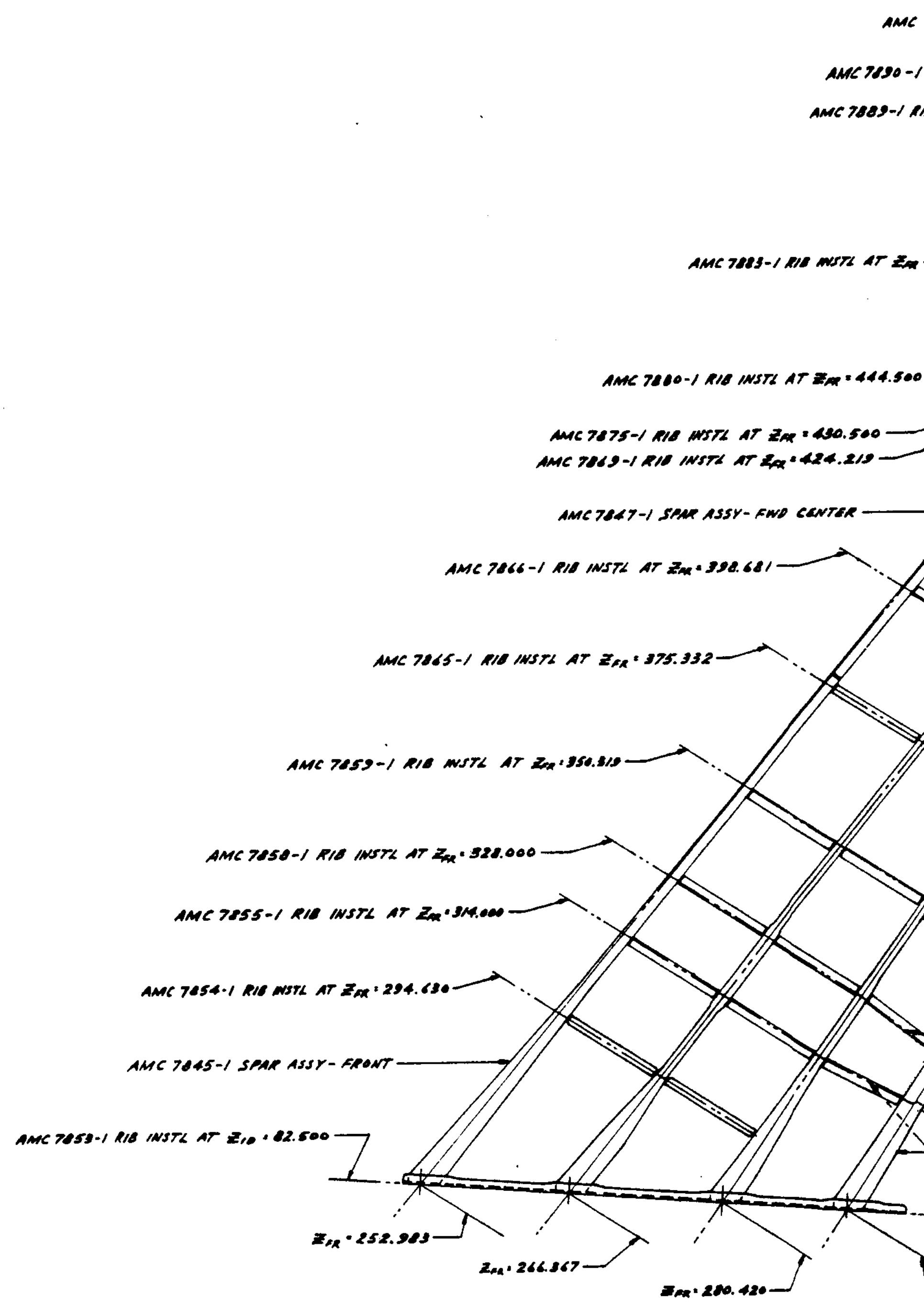
DIAGRAMMATIC ONLY

TYP AT CUTOUT (ACCESS) AREAS
EXCEPT AS SHOWN

TABLE D

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR(REF)	PLY PATT SHT NO.
P1	SEE	TABLE	"A"	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P23				
P24				
P25				
P26				
P27				
P28				
P29				
P30				
P31				
P32				
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P54				
P55				
P56				
P57				
P58				
P59				
P60				
P61				
P62	SEE	TABLE	"A"	

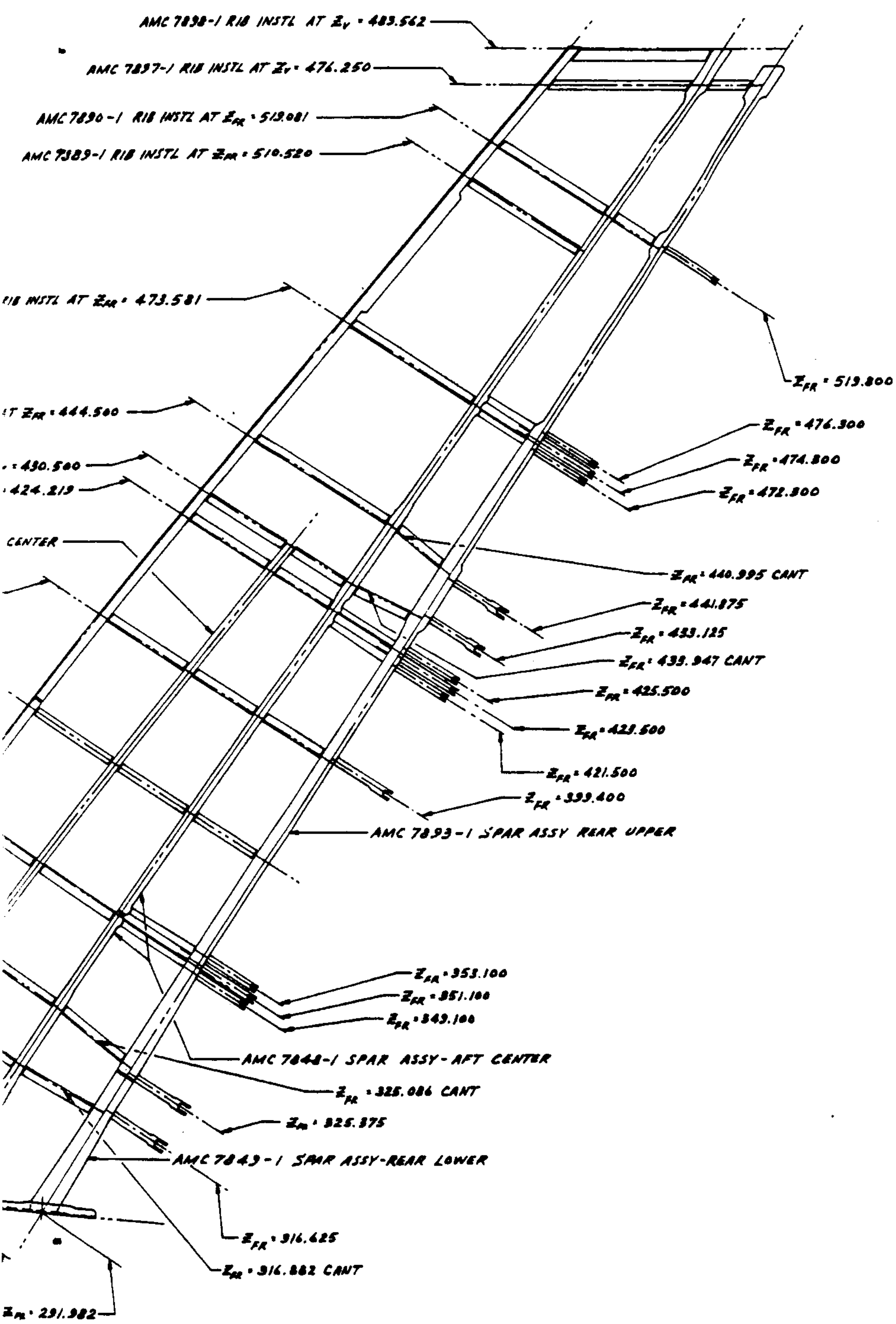
6 5



FOLDOUT FRAME

AMC7844 | - | 1

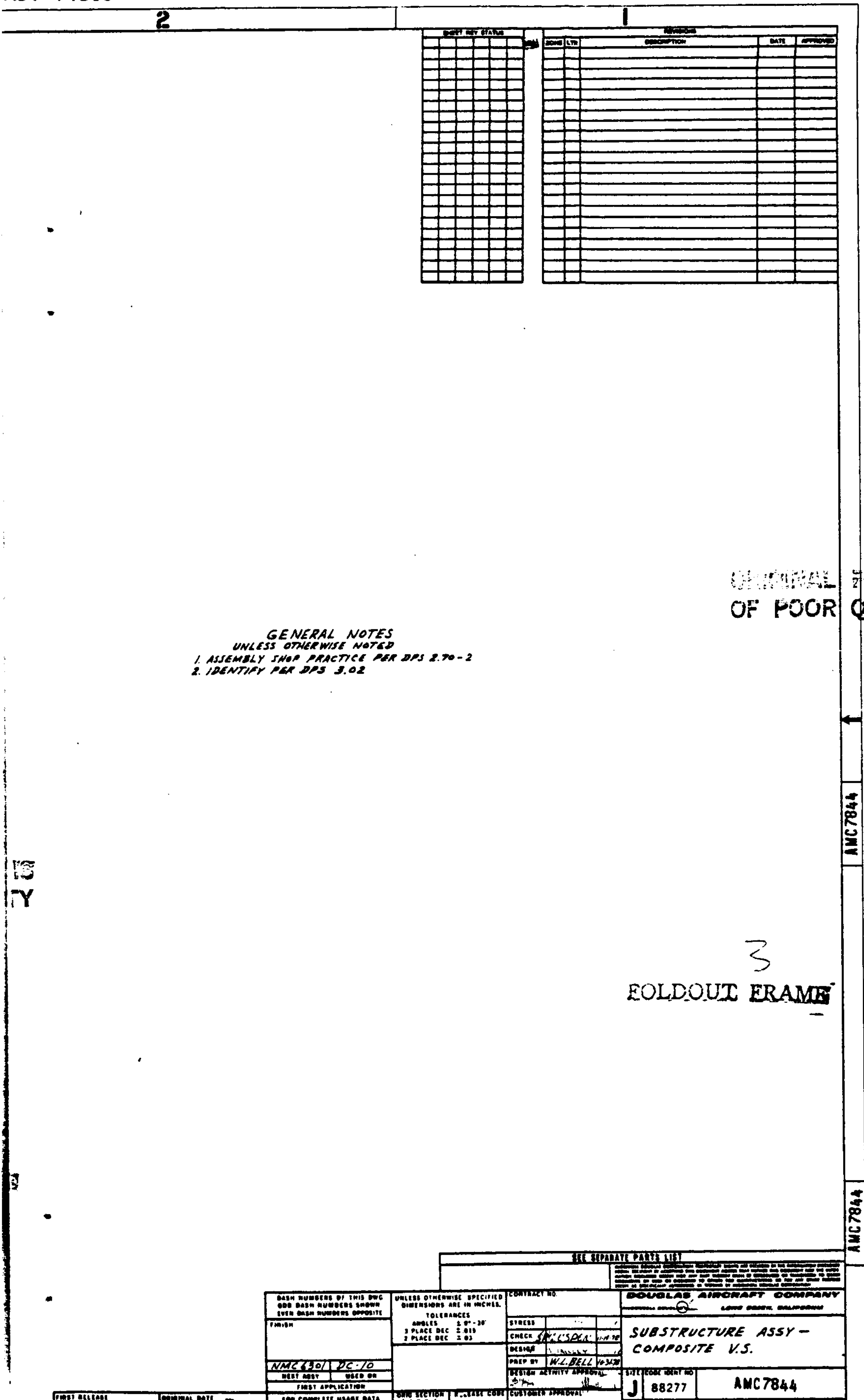
4 3 2



ORIGINAL PAGE IS
OF POOR QUALITY

2 FOLDOUT FRAME

FIRST RELEASE OF PRINTS
ORIGINAL DATE OF DRAWING



ORIGINAL PAGE IS
OF POOR QUALITY

3

FOLDOUT FRAME

FIGURE A2. DRAWING AMC7844 – SUBSTRUCTURE ASSEMBLY

ORIGINAL P
OF POOR Q

FOLDOUT FRA

FOLDOUT FRAME

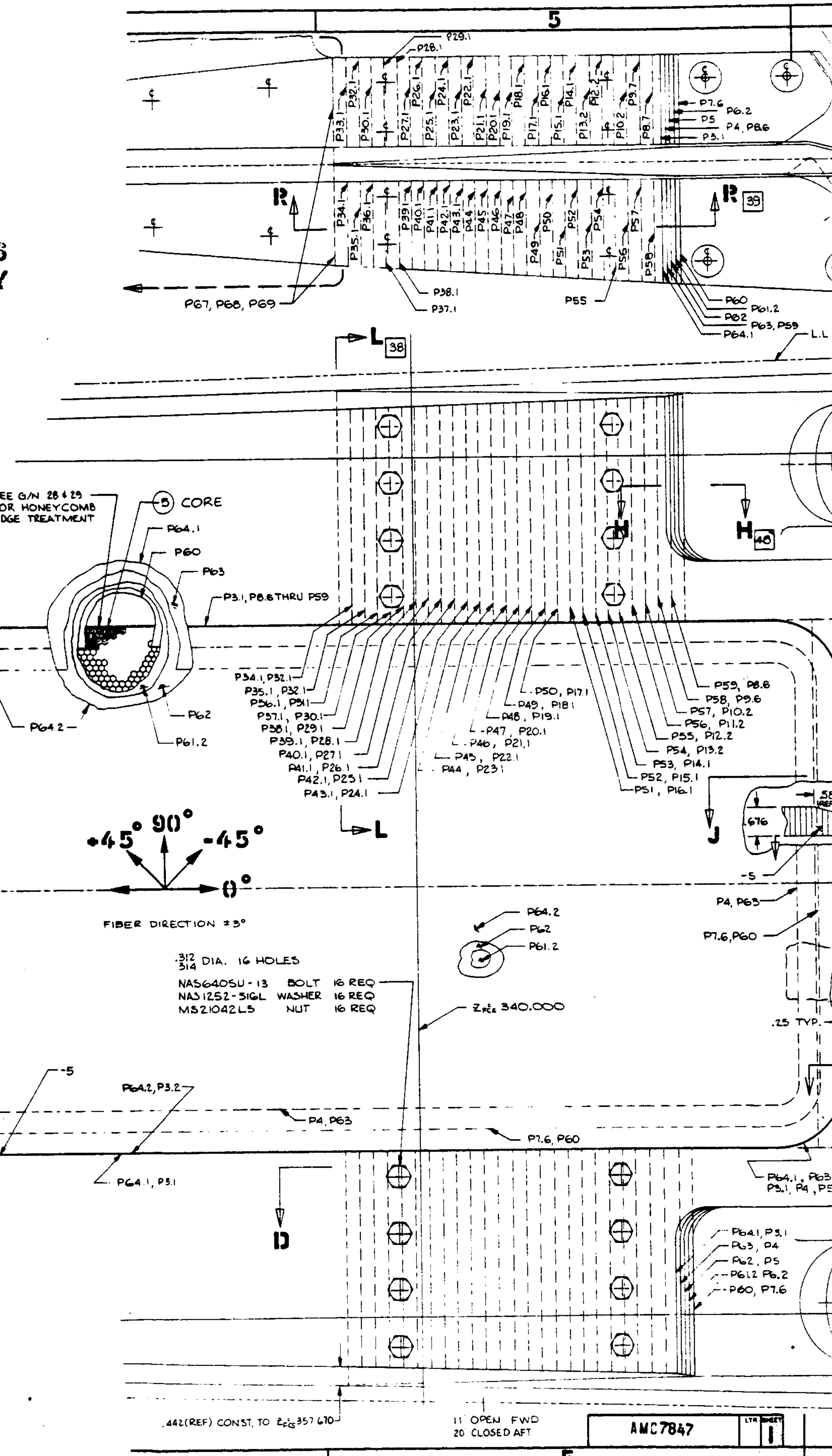
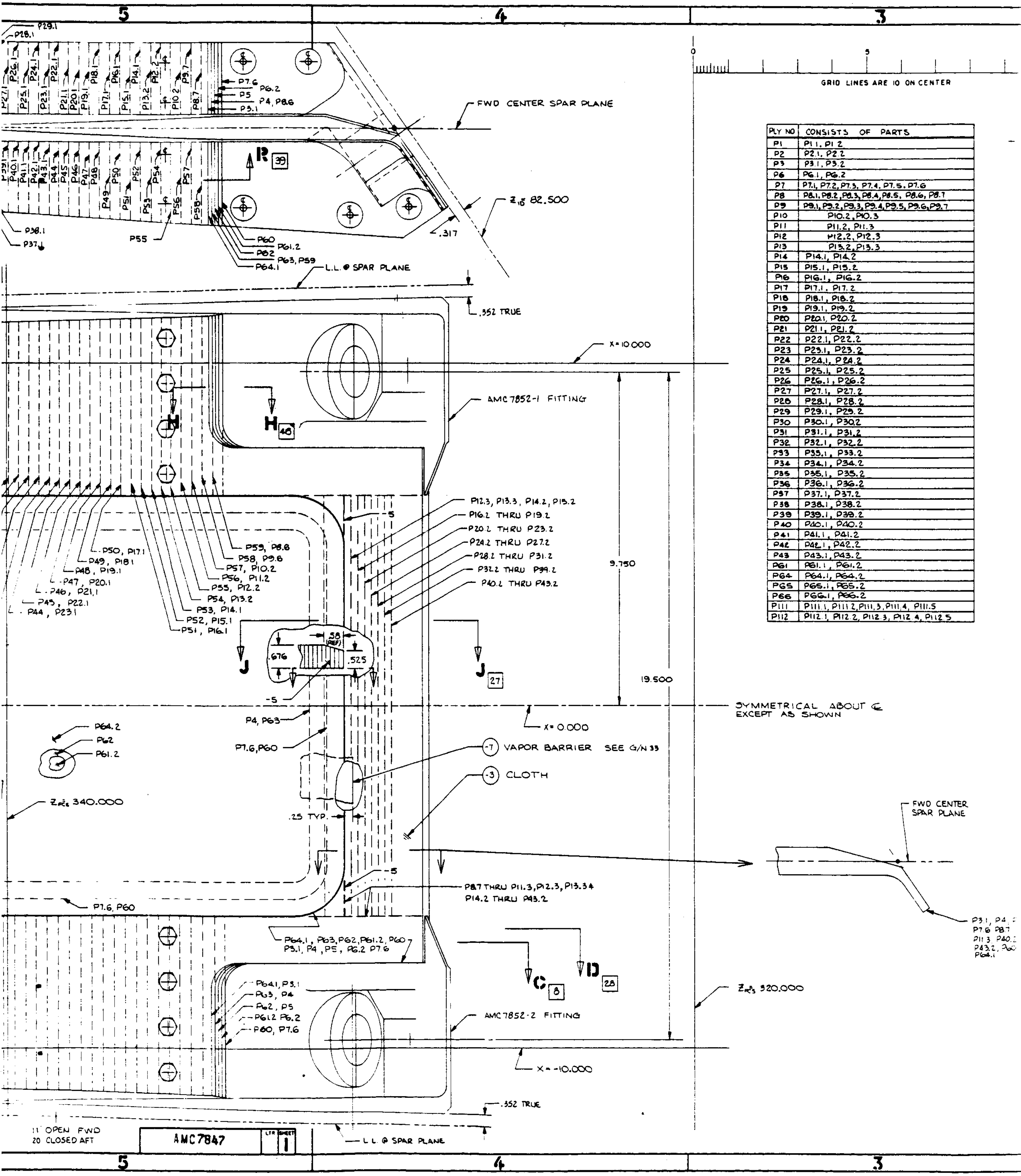


FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 1 OF 10)

ACEE-03-PR-9642



PLY NO	CONSISTS OF PARTS
P1	P1.1, P1.2
P2	P2.1, P2.2
P3	P3.1, P3.2
P6	P6.1, P6.2
P7	P7.1, P7.2, P7.3, P7.4, P7.5, P7.6
P8	P8.1, P8.2, P8.3, P8.4, P8.5, P8.6, P8.7
P9	P9.1, P9.2, P9.3, P9.4, P9.5, P9.6, P9.7
P10	P10.2, P10.3
P11	P11.2, P11.3
P12	P12.2, P12.3
P13	P13.2, P13.3
P14	P14.1, P14.2
P15	P15.1, P15.2
P16	P16.1, P16.2
P17	P17.1, P17.2
P18	P18.1, P18.2
P19	P19.1, P19.2
P20	P20.1, P20.2
P21	P21.1, P21.2
P22	P22.1, P22.2
P23	P23.1, P23.2
P24	P24.1, P24.2
P25	P25.1, P25.2
P26	P26.1, P26.2
P27	P27.1, P27.2
P28	P28.1, P28.2
P29	P29.1, P29.2
P30	P30.1, P30.2
P31	P31.1, P31.2
P32	P32.1, P32.2
P33	P33.1, P33.2
P34	P34.1, P34.2
P35	P35.1, P35.2
P36	P36.1, P36.2
P37	P37.1, P37.2
P38	P38.1, P38.2
P39	P39.1, P39.2
P40	P40.1, P40.2
P41	P41.1, P41.2
P42	P42.1, P42.2
P43	P43.1, P43.2
P61	P61.1, P61.2
P64	P64.1, P64.2
P65	P65.1, P65.2
P66	P66.1, P66.2
P111	P111.1, P111.2, P111.3, P111.4, P111.5
P112	P112.1, P112.2, P112.3, P112.4, P112.5

1 OF 10) LAST SECTION

ORIGINAL PAGE IS
OF POOR QUALITY

2 FOLDOUT FRAME

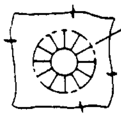
BLUEPRINT PRINT ONLY SHEETS NOTED BELOW

SHEET REV STATUS				
5	4	3	2	1
A	A	A	A	A

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	SEE E.O.		

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED (APPLY AS NECESSARY)

1. FOR FAB WITH A DIMENSIONALLY ACCURATE REPRO, TWO PLACE DEC TOLERANCES APPLY WHERE DIM ARE NOT GIVEN.
2. LOFT DESIGNATION IS FOR ENGRG REF ONLY.
3. FAB STANDARDS & TOOLING HOLES PER DPS 4.710.
4. TOOLING & PIN HOLE DIA INDICATED ON BODY OF DWG ARE MAX, SMALLER HOLES ARE PERMISSIBLE.
5. EDGE DISTANCE FOR ATTACHMENTS MAY VARY FROM THAT SHOWN ON DWG BY .03 ON DETAILS, 2D MIN ACCEPTABLE ON ASSY.
6. ASSEMBLY SHOP PRACTICE PER DPS 2.70-2.
7. HEAT TREAT 2024-0 TO 2024-T42, 2014-0 & T3 TO 2014-T6 & 7075-0 TO 7075-T62 PER DPS 7.00.
8. INSTALL RIVETS & FLUSH SCREWS PER S5076280.
9. INSTALL HI-LOK PINS PER S7933654 & LOCKBOLTS PER S7933655. STANDARD INTERFERENCE FITS APPLY UNLESS OTHERWISE INDICATED BY SYMBOL DESIGNATION.
10. FORM ALUMINUM ALLOY PER DPS 3.69.
11. JOGGLES PER S1292008.
12. ATTACH NUTPLATES WITH MS20426AD3 RIVETS.
13. IDENTIFY PER DPS 3.02.
14. STATION NO. APPLY TO BASIC __DC-10__ ONLY. FOR OTHER SERIES SEE DWG ______ FOR STATION RELATIONSHIP.
15. POINTS LOCATED BY MASTER DIAGRAM ______.
16. LOCATION FOR ATTACHMENT INSTALLED ON SUBQ ASSY.
17. LOCATION FOR ATTACHMENT IS ON THE DWG INVOLVED.
18. LOCATION DUPLICATED FROM A PRECEDING VIEW.
19. ATTACHMENT CALLED OUT ON OTHER DWGS.
20. FABRICATE PER DPS 1.622
21. INSPECT PER DPS 4.758 TYPE 2, CLASS (TBD)
22. RIBBON DIRECTION OPTIONAL FOE - 5
23. FOR BI-WEAVE CLOTH WARP & FILL ARE INTERCHANGEABLE.
24. FILL VOIDS PER DPS 1.622
25. BOND HONEYCOMB CORE TO GRAPHITE/EPOXY PER DPS 1.966
26. BOND AMC 7852-14-2 FITTINGS TO GRAPHITE/EPOXY PER DPS 1.966.
27. SEAL GRAPHITE/EPOXY ASSEMBLY PER DPS 2.512
28. FILL PERIPHERY OF HONEYCOMB CORE FOR A DISTANCE OF .25 ±.12 PER DPS 1.901 TYPE III
29. FILL GAPS BETWEEN HONEYCOMB CORE & GRAPHITE/EPOXY WITH 350° F CURE FORMING ADHESIVE PER DPS 1.99 GAP SHALL NOT EXCEED .06.
30. INSTALL FASTENERS WITH WET SEALANT PER DPS 2.512
31. FULL SIZE REPRODUCTIONS OF UNDIMENSIONED DRAWING SHEETS WILL BE FURNISHED ON REQUEST.
32. WHEN NECESSARY TO JOIN ADJACENT WIDTHS OF CLOTH, THE EDGES SHALL OVERLAP .50 ±.25. STAGGER OVERLAPS TO PREVENT EXCESSIVE BUILDUP OF CROSS SECTION.
33. APPLY 1 LAYER (.001) TEDLAR FILM IN AREA OF HONEYCOMB CORE ON TOOL SIDE OF ASSEMBLY. FILM TO OVERLAP CORE BY .25
34. TEST SHORT BEAM SHEAR, RESIN & VOID CONTENT, AND FLEXURAL TEST SPECIMENS PER DMS 2163
35. FOR LIGHTENING HOLE FLANGES IT IS PERMISSIBLE TO CUT EACH PLY AT 30° INTERVALS FROM ITS OWN FIBER DIRECTION TO FACILITATE FOLDING THE FLANGE. SEE DIAGRAM.
36. FILLET RADII .09.
37.
38. SPACING BETWEEN CENTERLINES OF HOLES IS THEORETICAL. HOLES MUST BE ON THEORETICAL CENTER WITHIN .015 RADIUS
39. PLACE A 3 IN. BY 6 IN. LAYUP UNDER THE SAME BAG AS THE PART AND CURE WITH THE PART. THE NUMBER OF PLIES AND LAYUP DETAILS SHALL BE PER DMS 2163. TEST PER DMS 2163. ROOM TEMPERATURE FLEXURAL STRENGTH, FLEXURAL MODULUS, AND SHORT BEAM SHEAR SHALL MEET THE REQUIREMENTS OF TABLE 2, DMS 2163
40. TEST SPECIMENS ARE IDENTIFIED AS FOLLOWS:
    FLEXURAL [FLEX]
    SHORT BEAM SHEAR [SBS]
    RESIN AND VOID CONTENT [R&V]
41.



ORIGINAL PAGE IS
OF POOR QUALITY

3 FOLDOUT FRAME

ENTER
P8.7
P9.7
11.5
P112.5
10 CENTER
AR PLANE
P3.1, P4, P5, P6.2
P7.6, P8.7, P9.7, P10.3,
P11.3, P40.2, P41.2, P42.2,
P43.2, P60, P61.2, P62, P63
P64.1

TEMPERATURE 70 HUMIDITY 58
GRIDS ARE -.003 IN 90 INCHES
RECORDED BY [signature] DATE 9-7-78

SEE SEPARATE PARTS LIST

AMC 7844 | DC-10
NEXT ASSY | USED ON
FIRST APPLICATION

CONTRACT NO. NAS 1-14869

DOUGLAS AIRCRAFT COMPANY
LONG BEACH, CALIFORNIA

SPAR ASSY, COMPOSITE V.S.
FWD CENTER

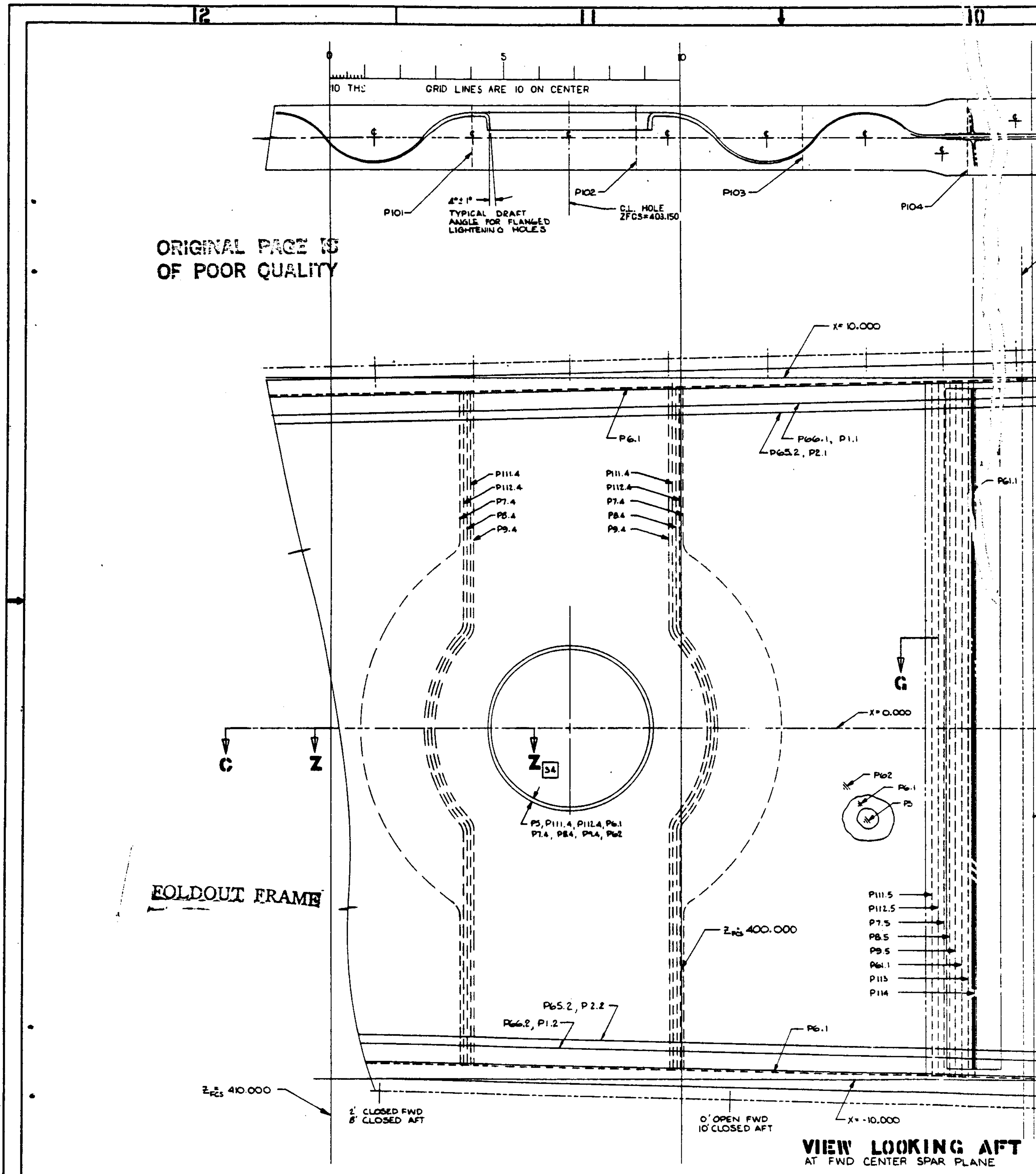
UNDIMENSIONED DRAWING

SIZE J | CODE IDENT NO 88277 | AMC7847

SCALE 1/1 & NOTED | SHEET 1 OF 5

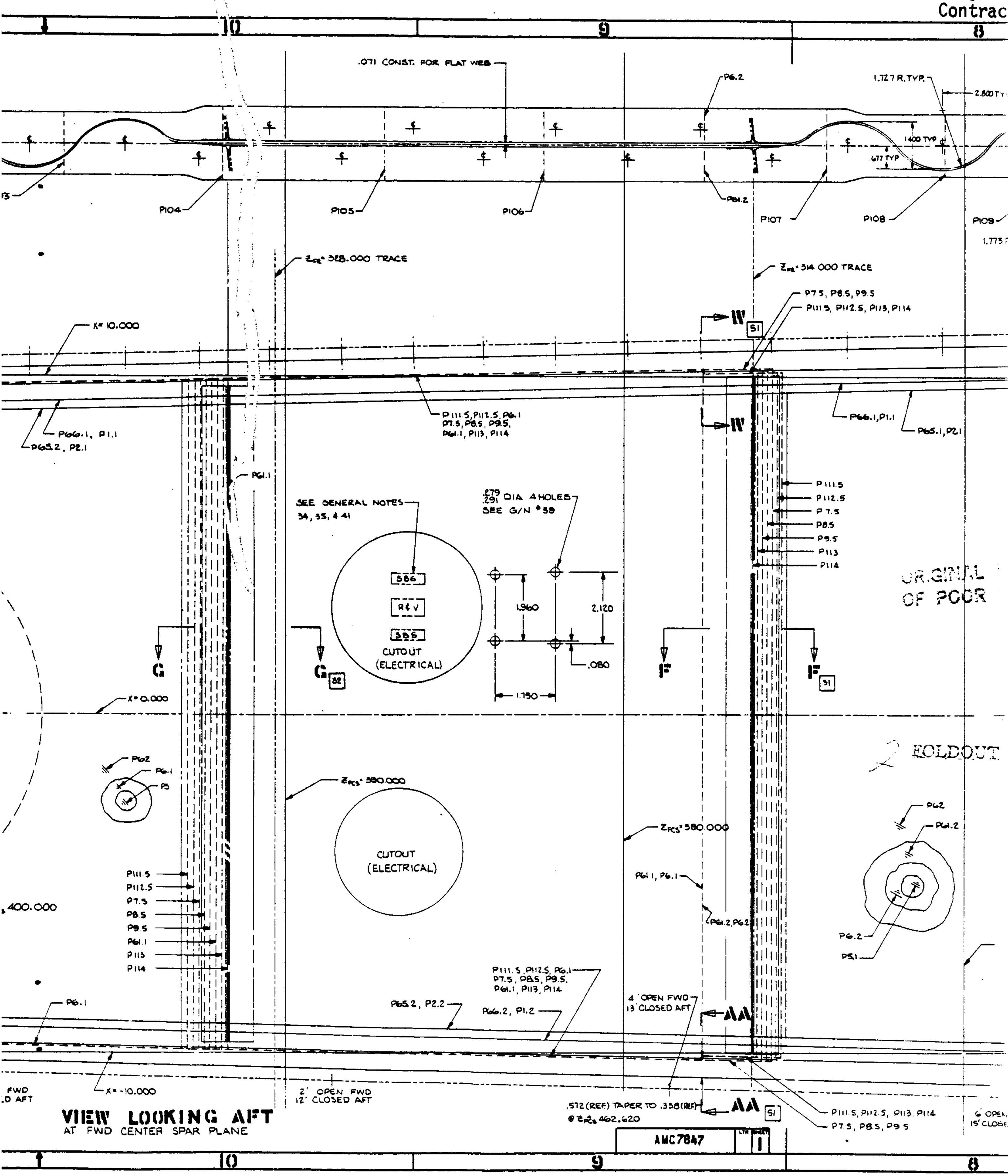
ORIG SECTION MC01

AMC7847



VIEW LOOKING AFT
AT FWD CENTER SPAR PLANE

Douglas
Contrac



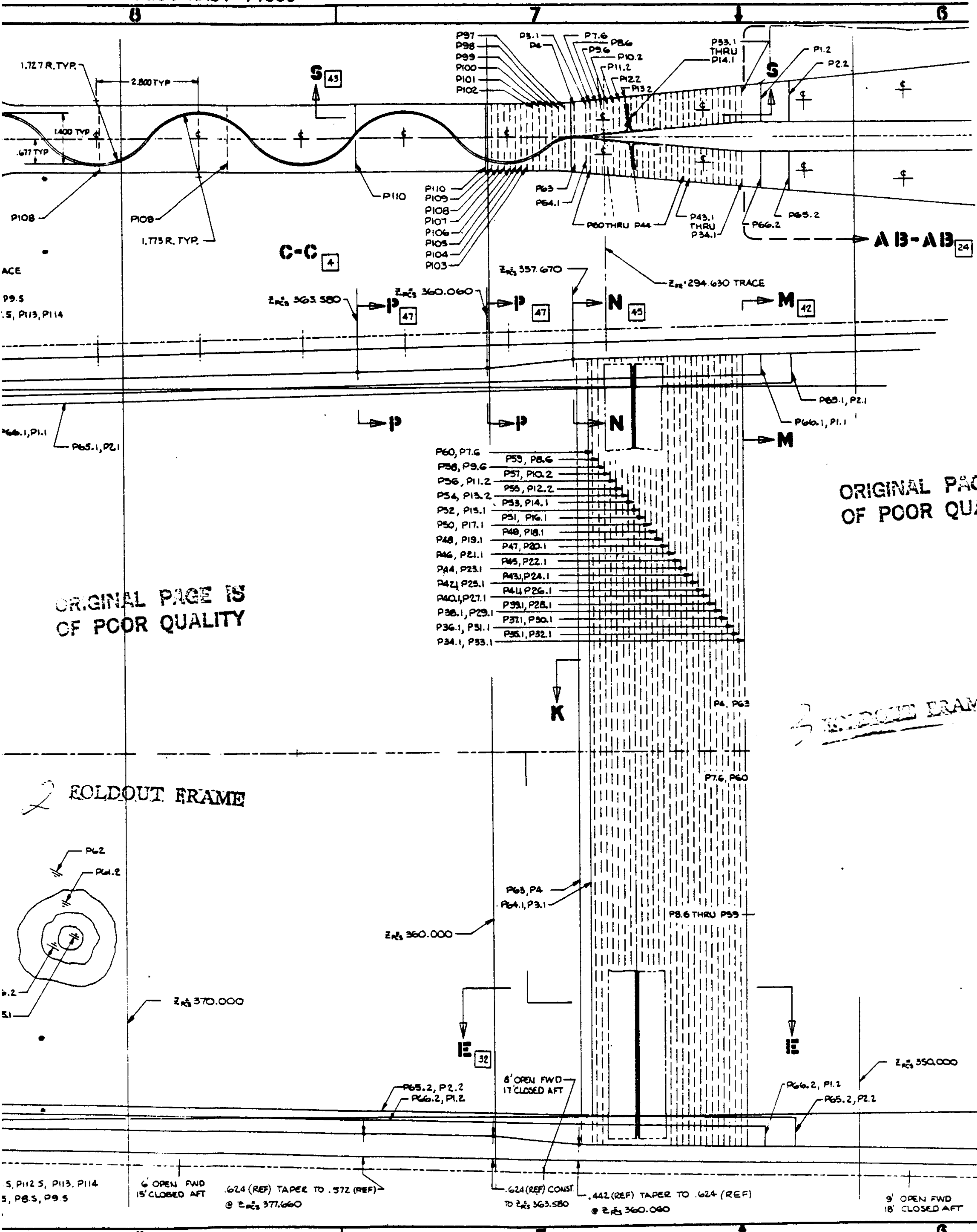
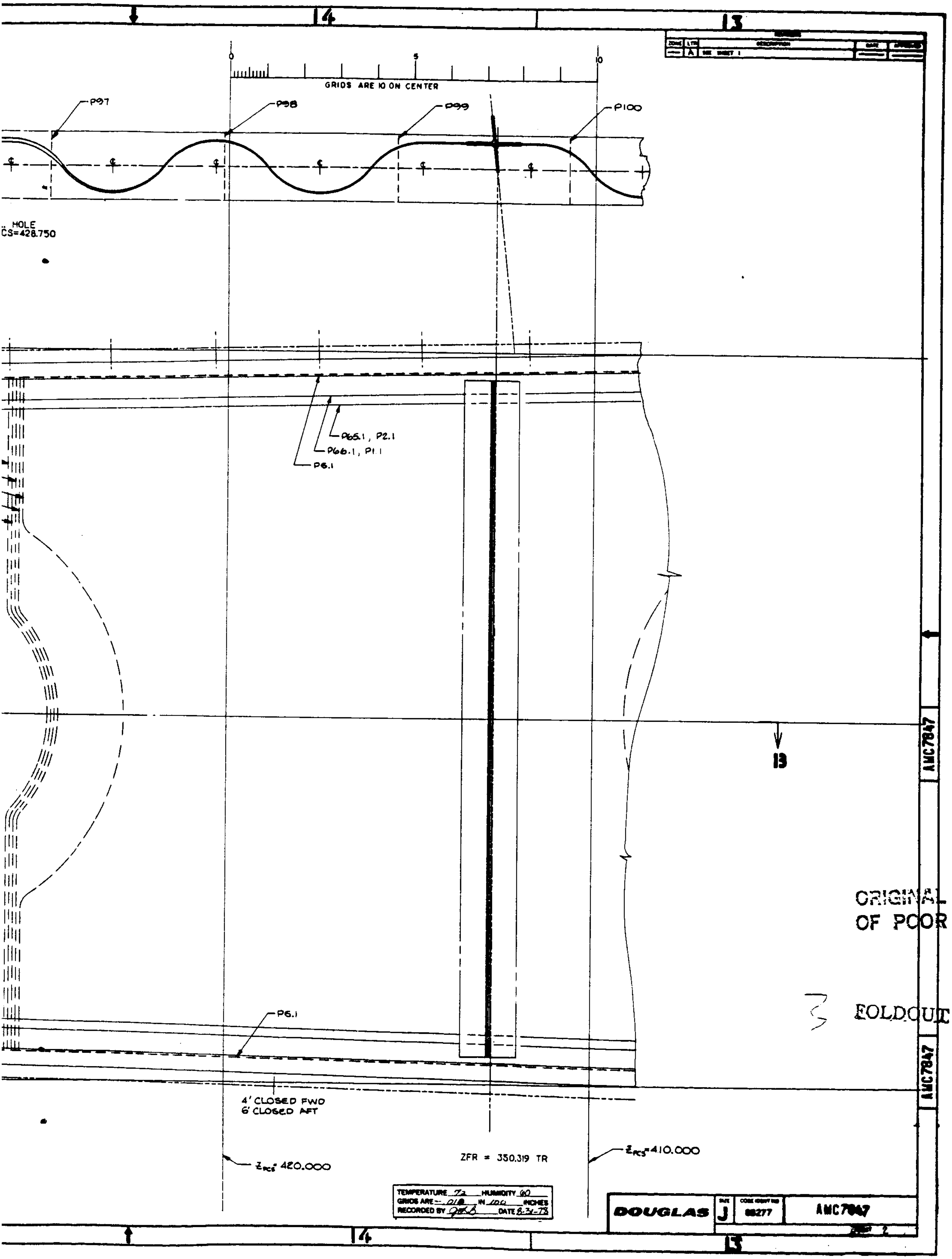


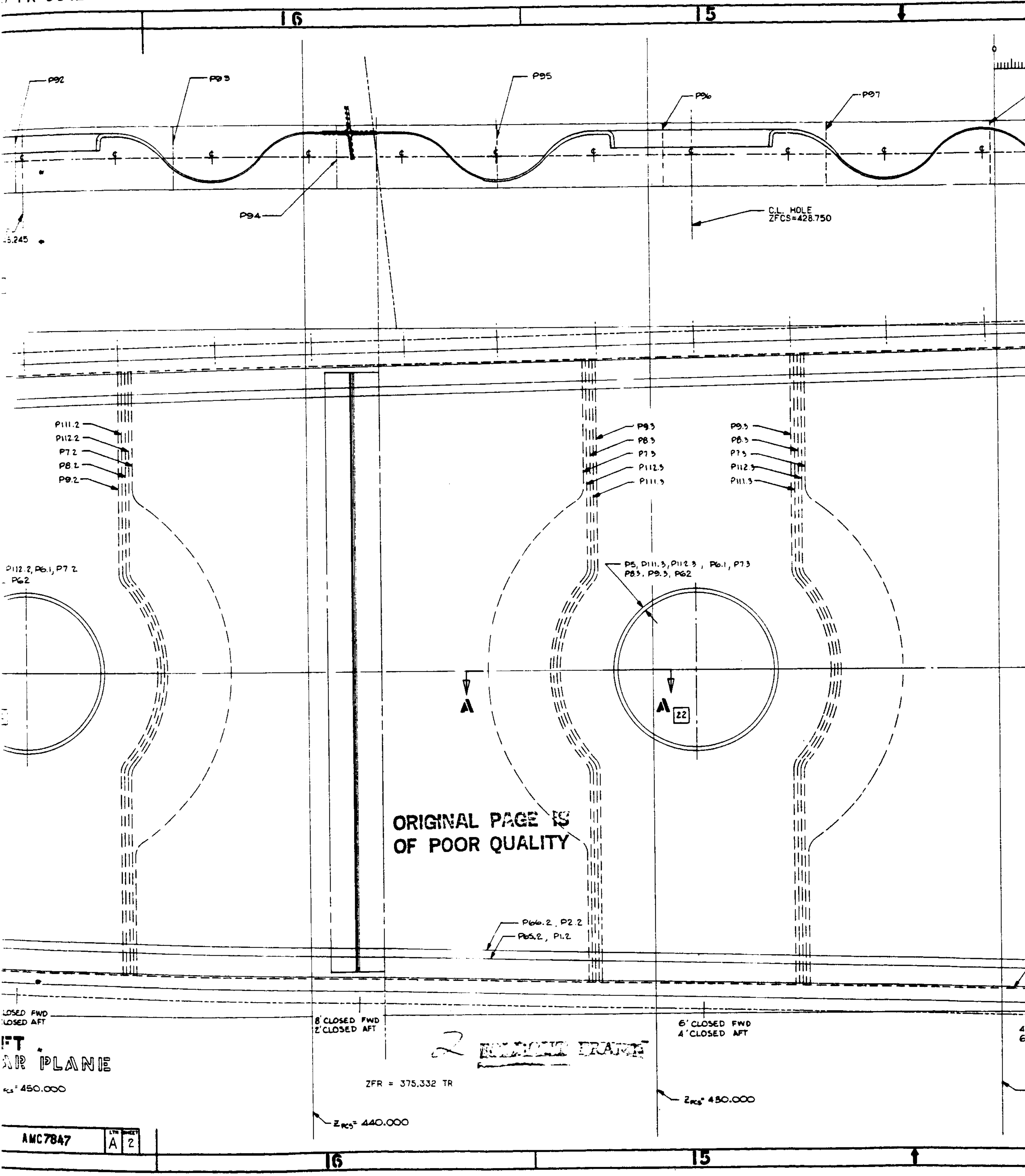
FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 2 OF 10)



ORIGINAL PAGE IS
OF POOR QUALITY

3

FOLDOUT FRAME



ORIGINAL PAGE IS
OF POOR QUALITY

ENTER SPAR ASSEMBLY (SHEET 3 OF 10)

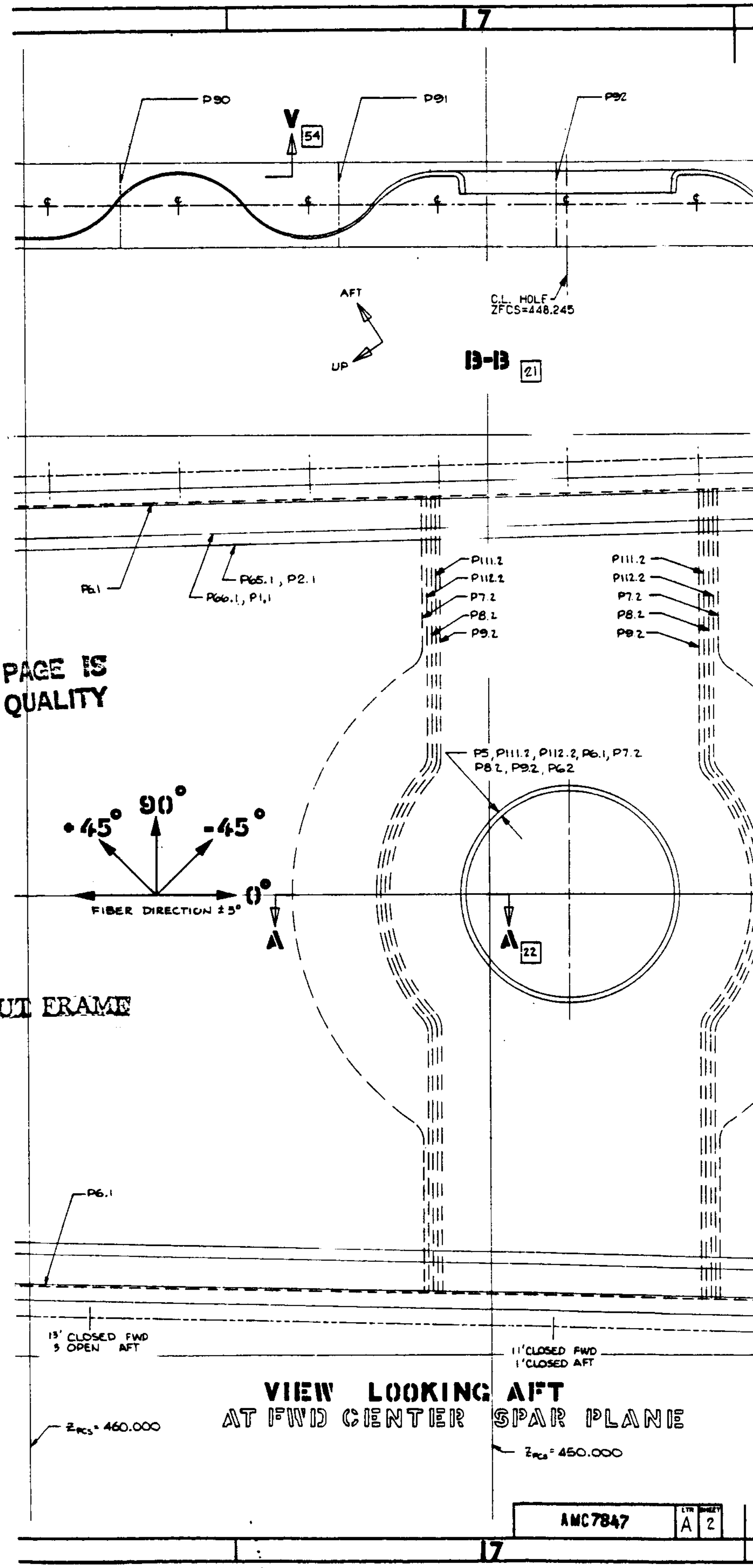


FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMB

24 | 23 | 22

0 5 10

GRIDS ARE 10 ON CENTER

ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME

Z_{RCS} = 473.700

TABLE A				
PLY LAYUP SEQUENCE				
PLY NO.	No. REQ.	MAKE FROM	FIBER DIR	PLY PATT SH. NO.
P5	SEE	TABLE	H	ZONE 40
P6.1	SEE	TABLE	W	ZONE 54
P.7.1	1	-3	0/90	
P8.1	1	-3	±45	
P9.1	1	-3	0/90	
P62	SEE	TABLE	G	ZONE 37
P111.1	1	-3	0/90	
P111.2	1	-3	±45	

8 PLIES
.104 (REF)

Z_{RCS} = 448.245

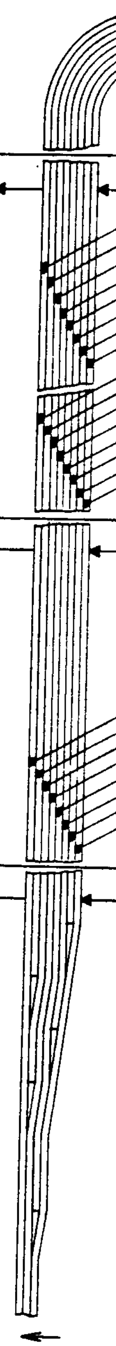
TABLE B				
PLY LAYUP SEQUENCE				
PLY NO.	NO REQ	MAKE FROM	FIBER DIR	PLY PATT. SH. NO.
P5	SEE	TABLE	H	ZONE 40
P6.1	SEE	TABLE	W	ZONE 54
P7.2	1	-3	0/90	
P8.2	1	-3	±45	
P9.2	1	-3	0/90	
P62	SEE	TABLE	G	ZONE 57
P111.2	1	-3	0/90	
P112.2	1	-3	±45	

8 PLIES
.104 (REF)

Z_{RCS} = 428.150

TABLE C				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ	MAKE FROM	FIBER DIR	PLY PATT SH. NO.
P5	SEE	TABLE	H	ZONE 40
P6.1	SEE	TABLE	W	ZONE 54
P7.3	1	-3	0/90	
P8.3	1	-3	±45	
P9.3	1	-3	0/90	
P62	SEE	TABLE	G	ZONE 37
P111.3	1	-3	0/90	
P112.3	1	-3	±45	

8 PLIES
.104 (REF)



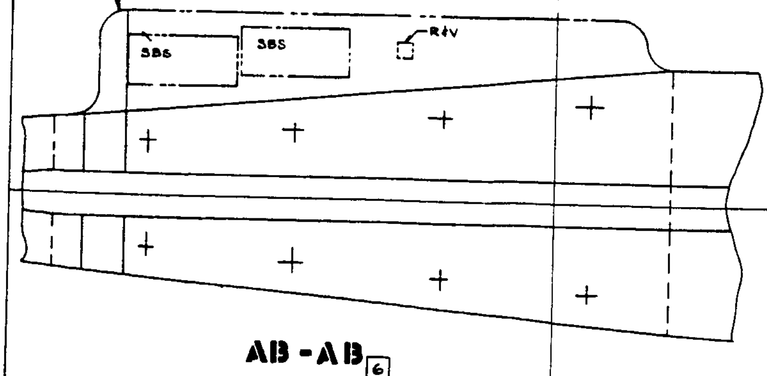
AFT

A-A

ROTATED 90° CC
OMITTED FOR C

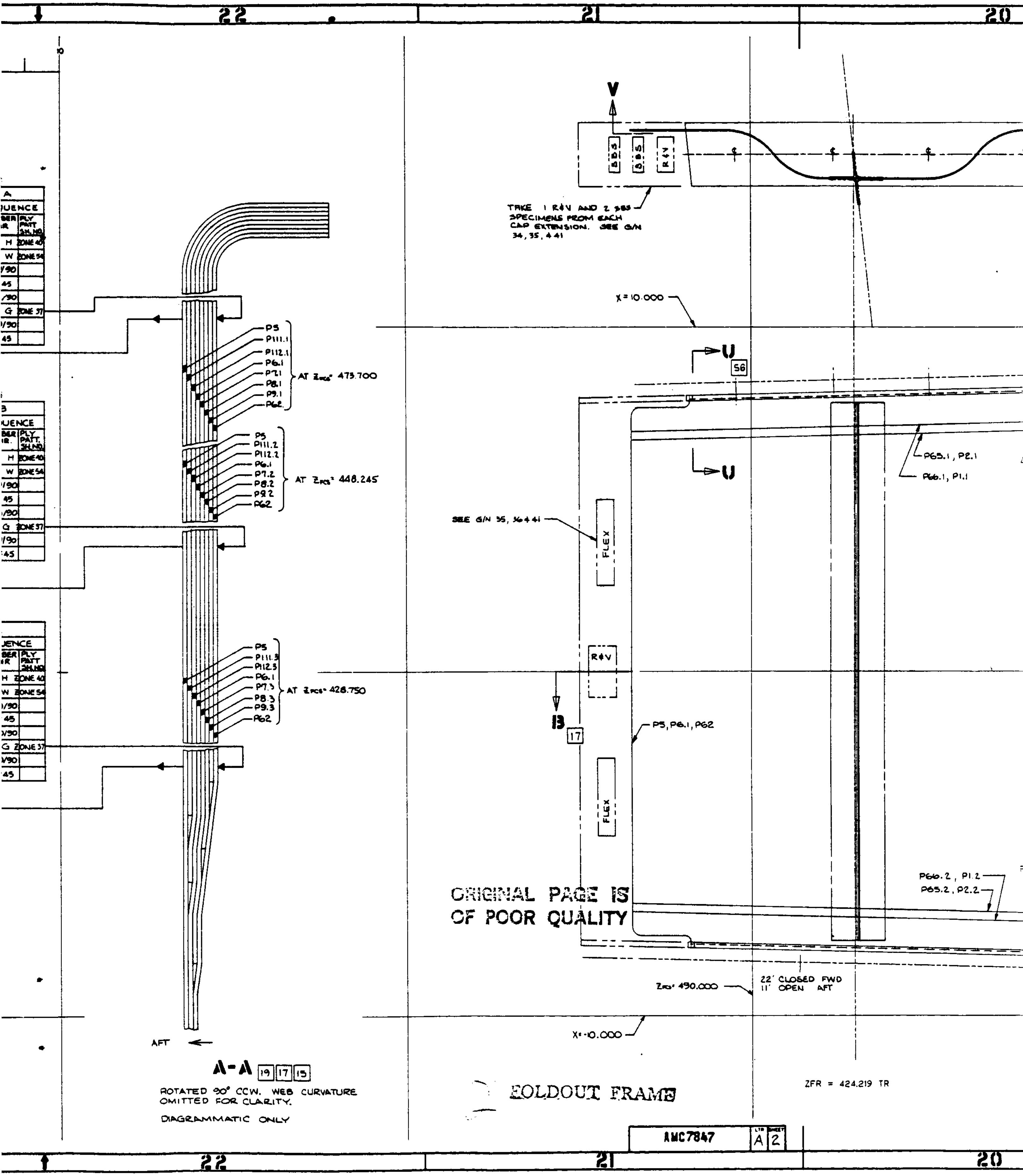
DIAGRAMMATIC

AN EXTENSION OF THE CAP MATERIAL IS REQUIRED ON BOTH THE LEFT SIDE AND RIGHT SIDE CAPS IN THE AREA OF THE .441 FLANGE THICKNESS ON EITHER THE FORWARD OR AFT FLANGE. THE SHAPE AND SIZE OF THE EXTENSION MUST BE SUFFICIENT TO ALLOW TEST SPECIMENS OF THE SIZE AND ORIENTATION SHOWN TO BE OBTAINED



AB - AB 6

24 | 23 | 22



ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME

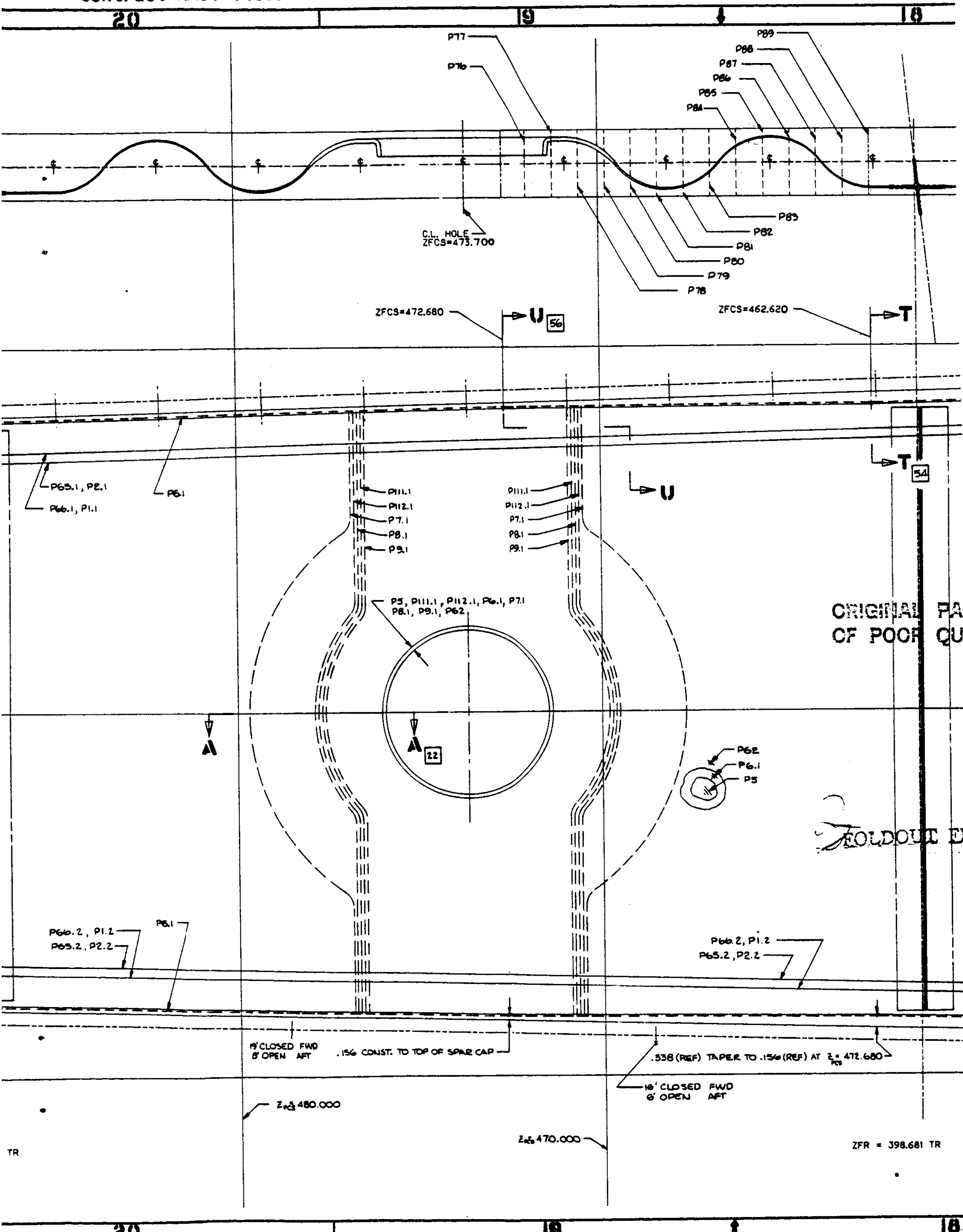


FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 4 OF 10)

Douglas Aircraft Compnay
Contract NAS1-14869

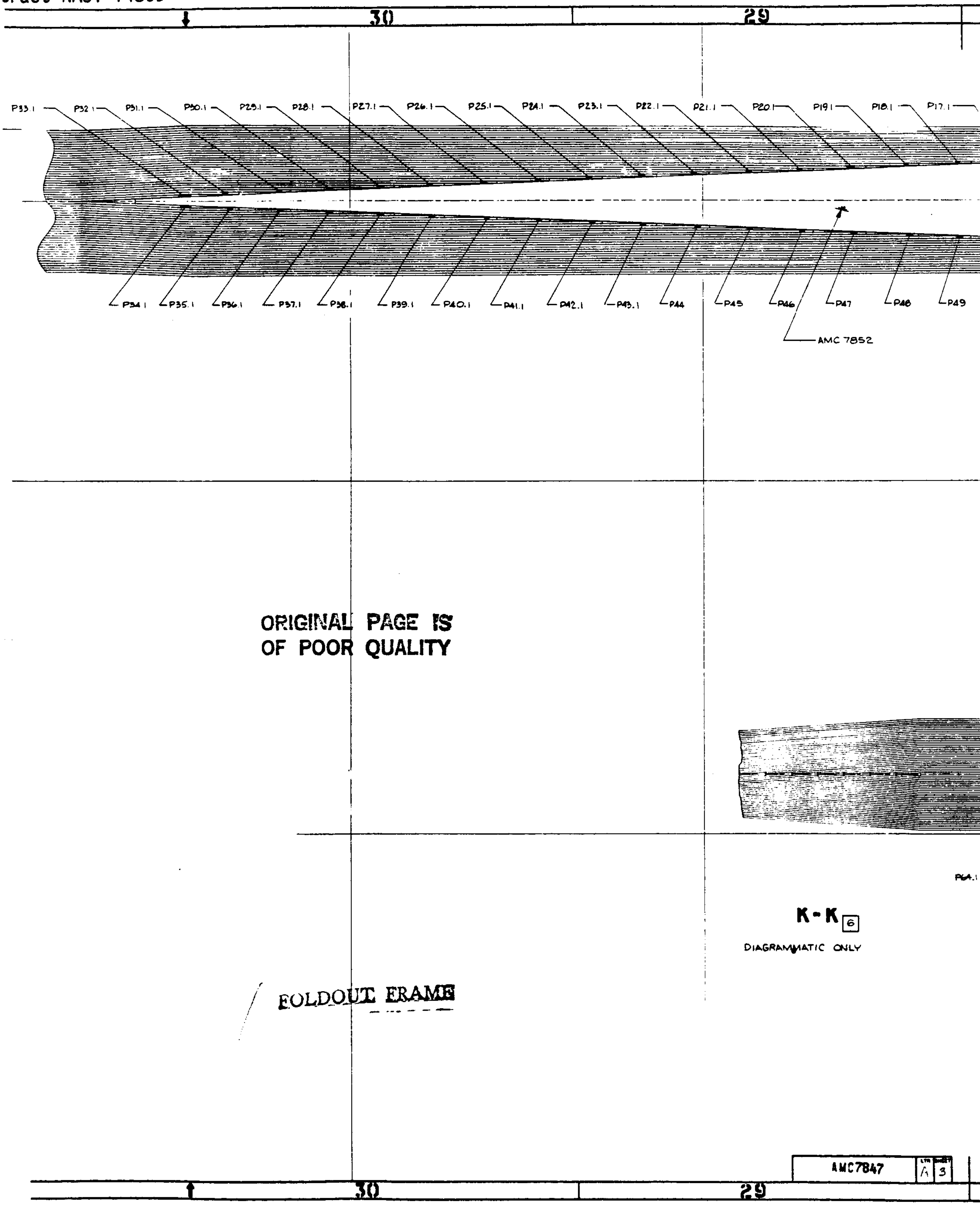
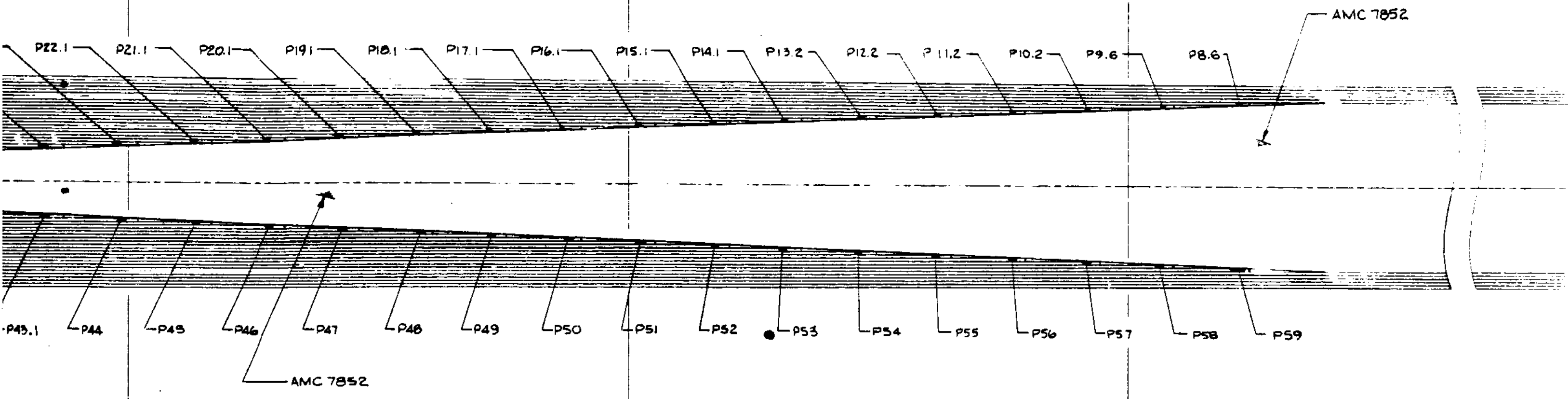


FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 5 OF 10)

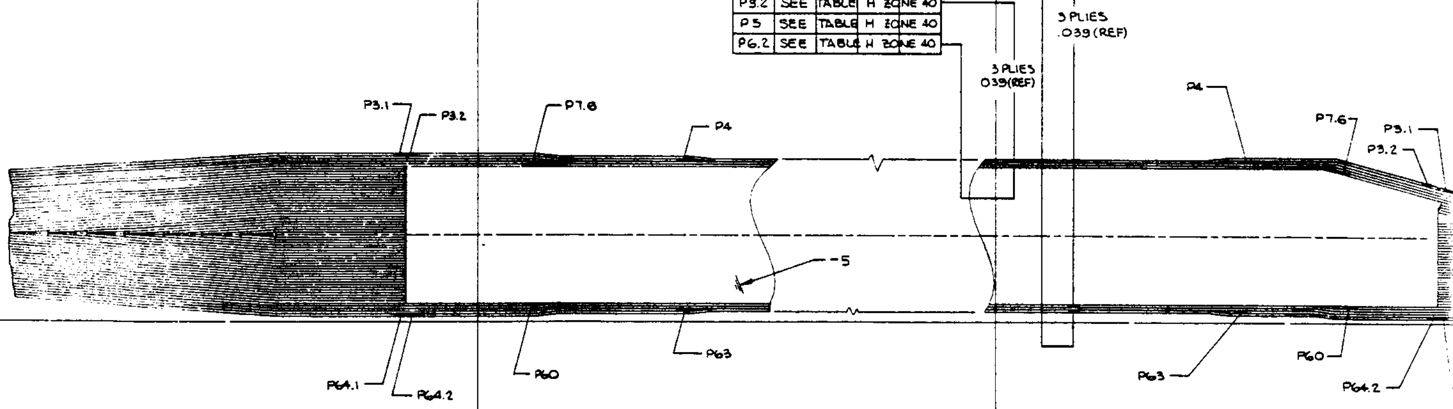
29 28 27



D-D [4]

DIAGRAMMATIC ONLY

TABLE F				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ	MAKE FROM	FIBER DIR.	
P61.2	SEE	TABLE	G	ZONE 37
P62	SEE	TABLE	G	ZONE 37
P64.2	SEE	TABLE	G	ZONE 31
P3.2	SEE	TABLE	H	ZONE 40
P5	SEE	TABLE	H	ZONE 40
P6.2	SEE	TABLE	H	ZONE 40



K-K [6]

DIAGRAMMATIC ONLY

ORIGINAL PAGE IS OF POOR QUALITY

J-J [4]

DIAGRAMMATIC ONLY

FOLDOUT FRAME

AMC7847 A 3

29 28 27

ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	A	SEE SHEET 1	—	—

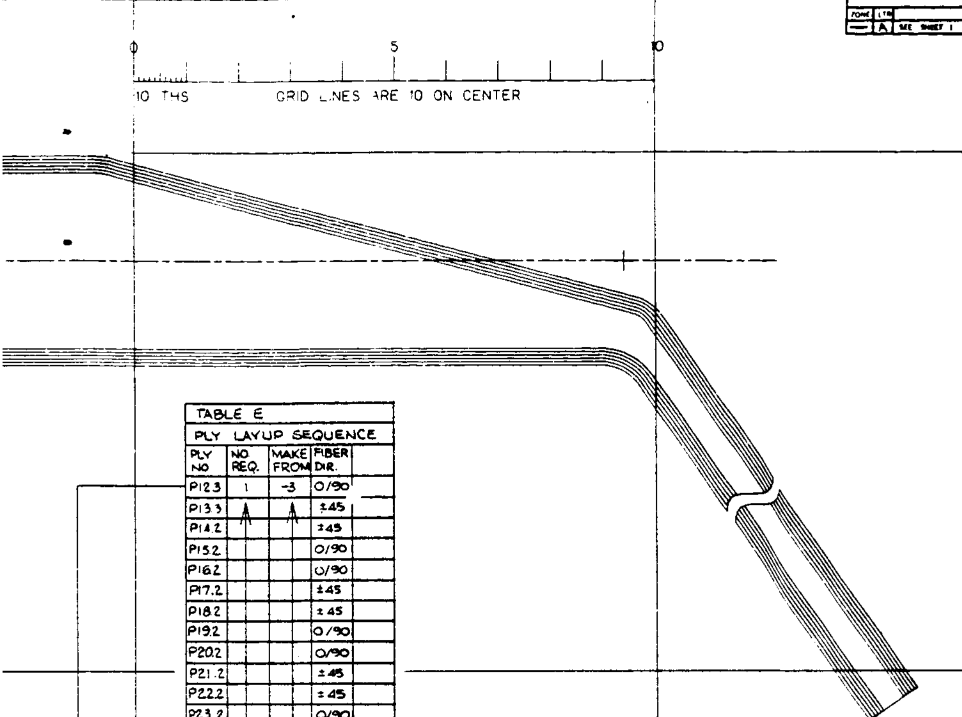
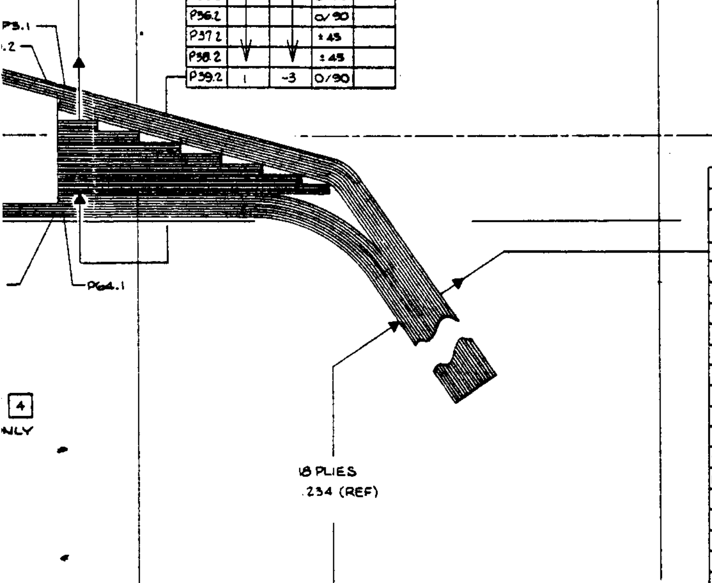


TABLE E				
PLY LAYUP SEQUENCE				
PLY NO	NO REQ.	MAKE FROM	FIBER DIR.	
P12.3	1	-3	0/90	
P13.3	↑	↑	±45	
P14.2			±45	
P15.2			0/90	
P16.2			0/90	
P17.2			±45	
P18.2			±45	
P19.2			0/90	
P20.2			0/90	
P21.2			±45	
P22.2			±45	
P23.2			0/90	
P24.2			0/90	
P25.2			±45	
P26.2			±45	
P27.2			0/90	
P28.2			0/90	
P29.2			±45	
P30.2			±45	
P31.2			0/90	
P32.2			0/90	
P33.2			±45	
P34.2			±45	
P35.2			0/90	
P36.2			0/90	
P37.2			±45	
P38.2	↓	↓	±45	
P39.2	1	-3	0/90	



ORIGINAL PAGE IS
OF POOR QUALITY

TABLE D				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ	MAKE FROM	FIBER DIR	PLY PATT SH NO
P5.1	SEE	TABLE	H	ZONE 40
P4	SEE	TABLE	H	ZONE 40
P5	SEE	TABLE	H	ZONE 40
P6.2	SEE	TABLE	H	ZONE 40
P7.6	SEE	TABLE	H	ZONE 40
P8.7	1	-5	0/90	
P9.7	↑	↑	±45	
P10.3			±45	
P11.3			0/90	
P40.2			0/90	
P41.2			±45°	
P42.2	↓	↓	±45°	
P43.2	1	-5	0/90	
P60	SEE	TABLE	G	ZONE 37
P61.2	SEE	TABLE	G	ZONE 37
P62	SEE	TABLE	G	ZONE 37
P63	SEE	TABLE	G	ZONE 37
P64.1	SEE	TABLE	G	ZONE 37

TEMPERATURE [illegible] HUMIDITY 42%
GRIDS ARE ±.001 IN 100 INCHES
RECORDED BY D.J.V. DATE 8-31-78

DOUGLAS | J | 88277 | AMC7847
SHEET 5

AMC7847

AMC7847

26 25

FOLDOUT FRAME

36 35

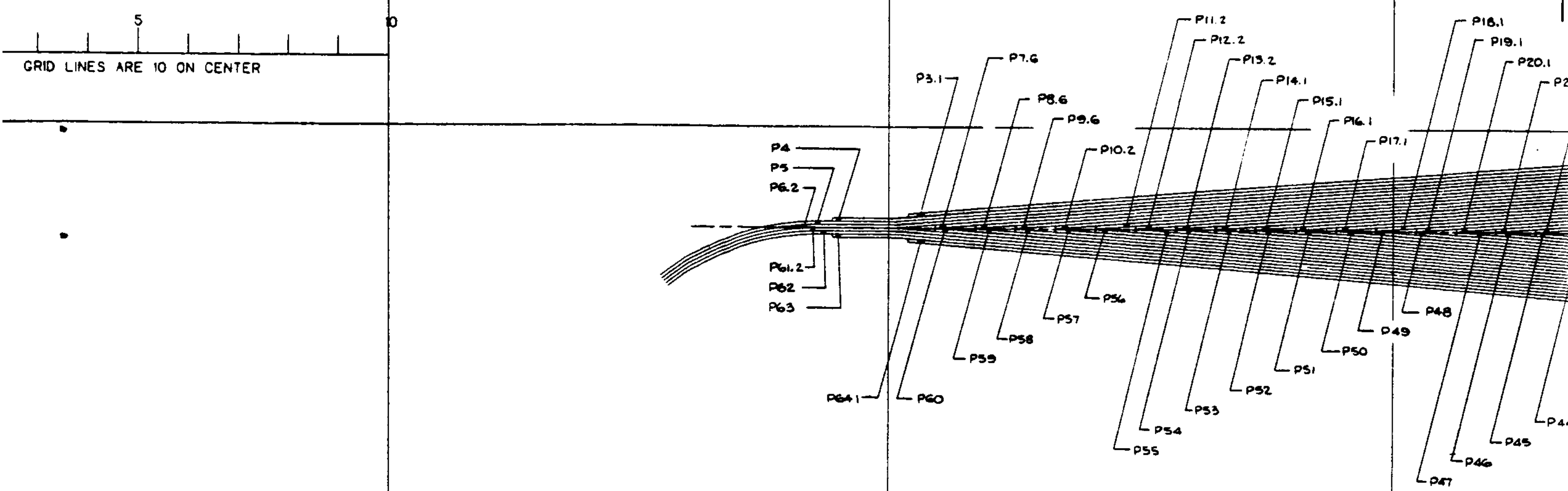
0 5 10

10 THS GRID LINES ARE 10 ON CENTER

36 35

Doug
Cont

35 34 33



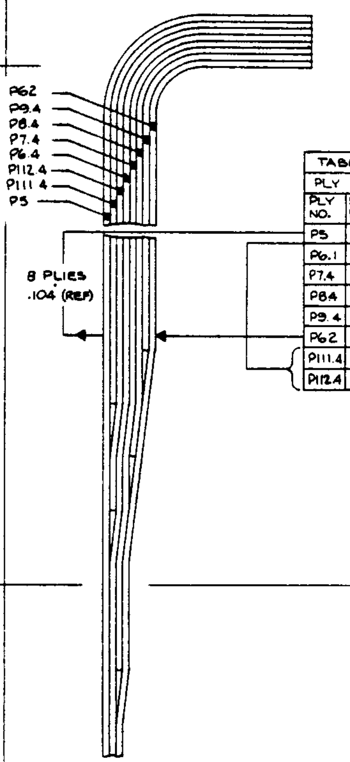
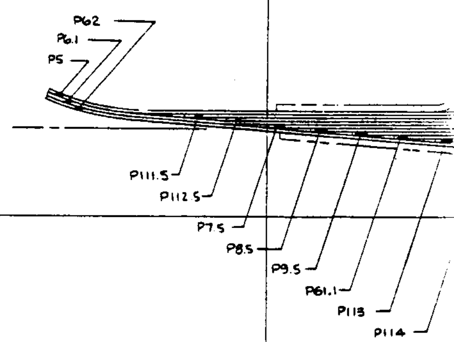


TABLE NO. P				
PLY LAYUP SEQUENCE				
PLY NO.	NO REQ.	MAKE FROM	FIBER DIR.	
P5	SEE	TABLE	H	ZONE 40
P6.1	SEE	TABLE	W	ZONE 54
P7.4	1	-3	0/90	
P8.4	1	-3	±45	
P9.4	1	-3	0/90	
P62	SEE	TABLE	G	ZONE 37
P111.4	1	-3	0/90	
P112.4	1	-3	±45	

ORIGIN
OF PO



Z-Z 11

ROTATED 90° COUNTERCLOCKWISE
WEB CURVATURE OMITTED FOR CLARITY
DIAGRAMMATIC ONLY

G-G

DIAGRAMMATIC

2 FOLDOUT FRAME

FRAME

AMC7847 A 3

35 34 33

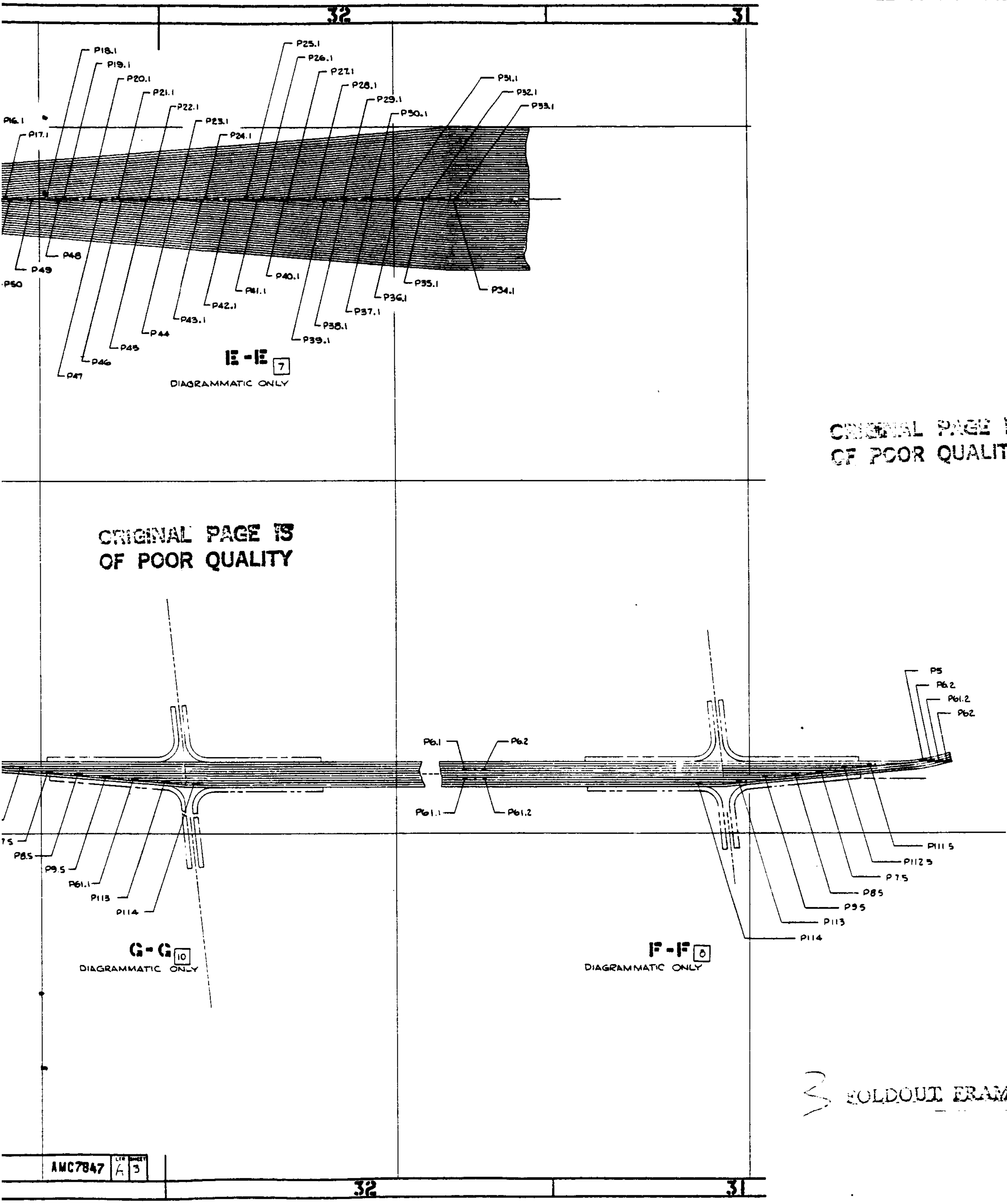


FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 6 OF 10)

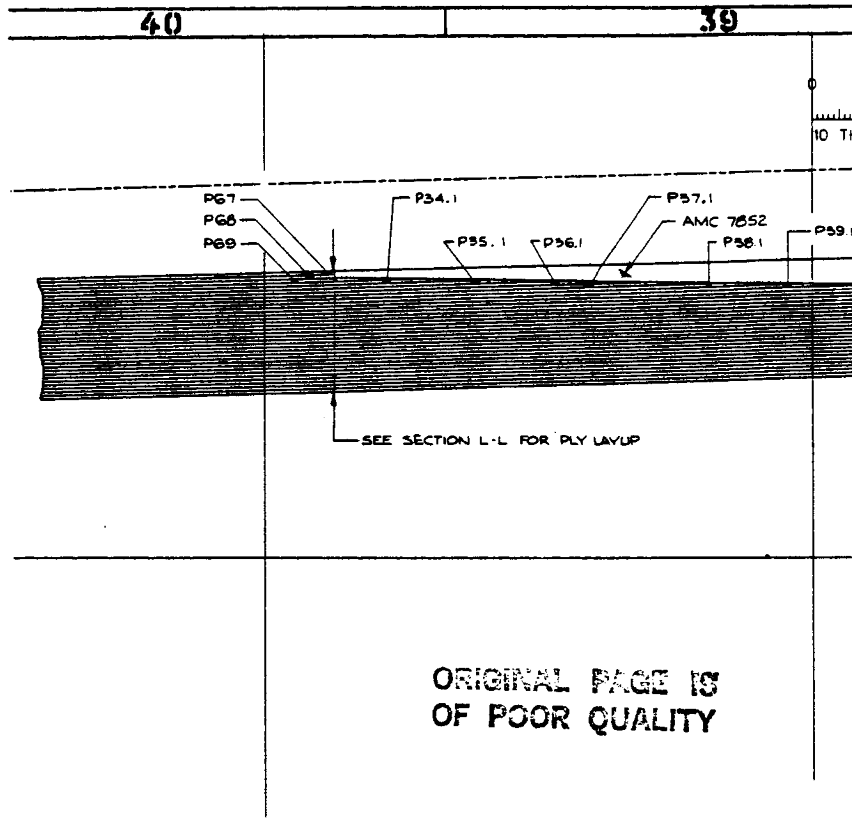


TABLE NO. H				
PLY LAYUP SEQUENCE				
PLY NO	NO REQ	MAKE FROM	FIBER DIR	
P33.1	1	-3	±45	
P32.1			0/90	
P31.1			±45	
P30.1			±45	
P29.1			0/90	
P28.1			0/90	
P27.1			±45	
P26.1			±45	
P25.1			0/90	
P24.1			0/90	
P23.1			±45	
P22.1			±45	
P21.1			0/90	
P20.1			0/90	
P19.1			±45	
P18.1			±45	
P17.1			0/90	
P16.1			0/90	
P15.1			±45	
P14.1			±45	
P13.2			0/90	
P12.2			0/90	
P11.2			±45	
P10.2			±45	
P9.6			0/90	
P8.6			0/90	
P7.6			±45	
P6.2			0/90	
P5			±45	
P4			±45	
P3.1			0/90	
P3.2	1	-3	±45	

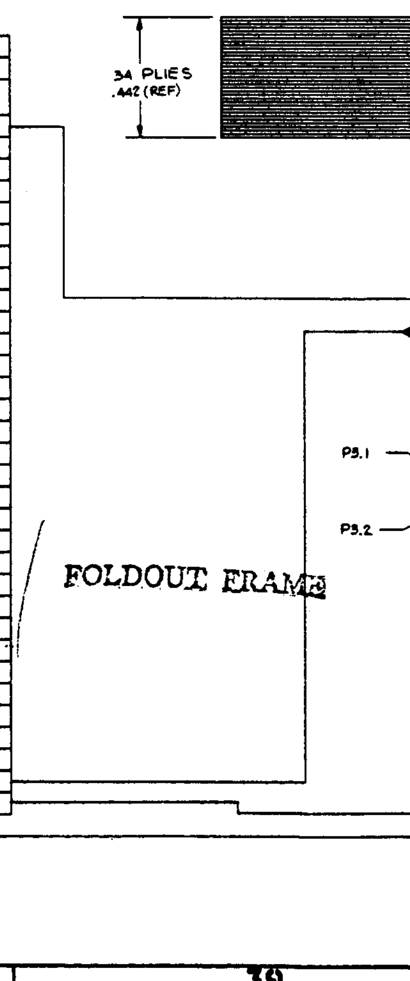
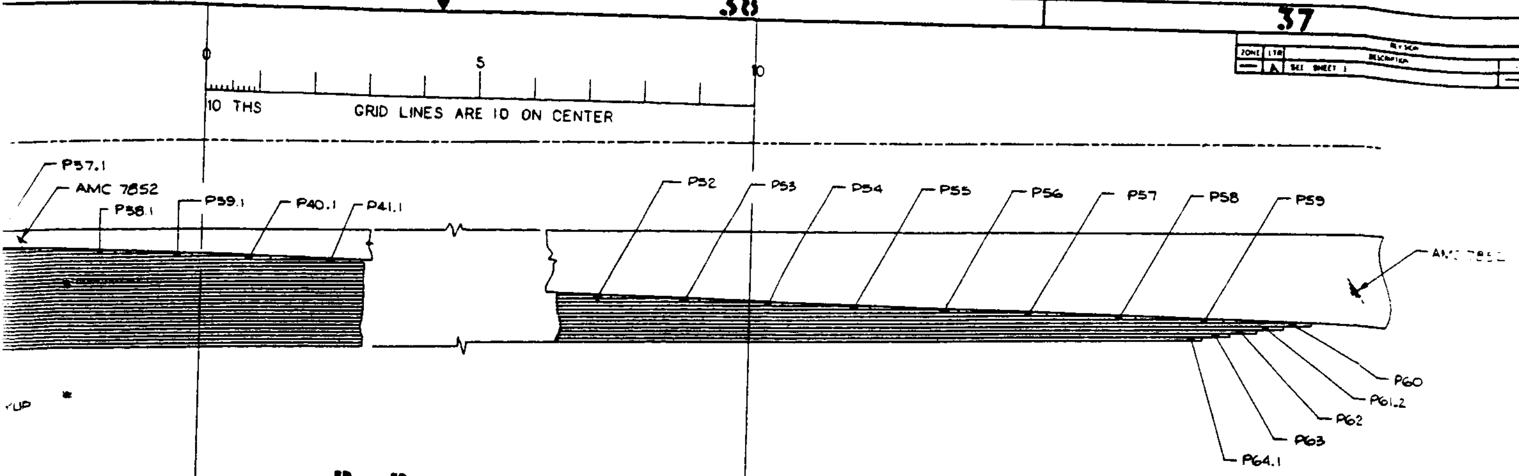


FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMB

39 38 37



R - R [5]
DIAGRAMMATIC ONLY

FOLDOUT FRAME

ORIGINAL PAGE IS OF POOR QUALITY

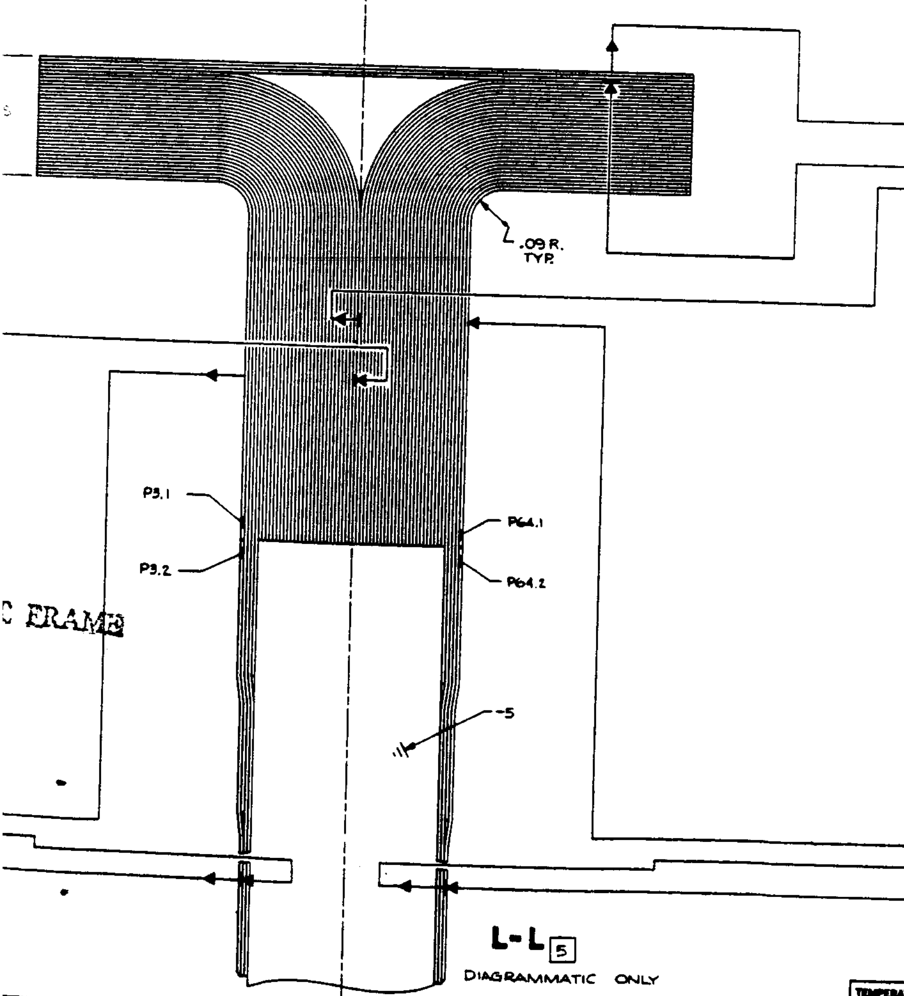


TABLE NO. G			
PLY LAYUP SEQUENCE			
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.
P67	2	-3	0/90
P68	2		±45
P69	2		±45
P34.1	1		0/90
P35.1			0/90
P36.1			±45
P37.1			±45
P38.1			0/90
P39.1			0/90
P40.1			±45
P41.1			±45
P42.1			0/90
P43.1			0/90
P44			±45
P45			±45
P46			0/90
P47			0/90
P48			±45
P49			±45
P50			0/90
P51			0/90
P52			±45
P53			±45
P54			0/90
P55			0/90
P56			±45
P57			±45
P58			0/90
P59			0/80
P60			±45
P61.2			0/90
P62			±45
P63			±45
P64.1			0/90
P64.2	1	-3	±45

L-L [5]
DIAGRAMMATIC ONLY

FOLDOUT FRAME

TEMPERATURE 68° HUMIDITY 69 %
GRIDS ARE .008 IN .020 INCHES
RECORDED BY DATE 11-2-78

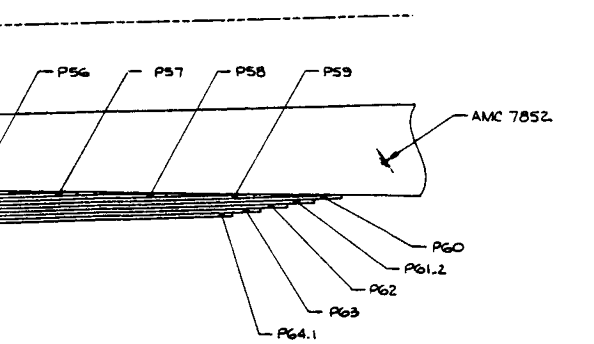
DOUGLAS | J | 88277 | AMC7847
SHEET 4

AMC7847

39 38 37

ER SPAR ASSEMBLY (SHEET 7 OF 10)

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
—	A	SEE SHEET 1	—	—



FOLDOUT FRAME

TABLE NO. G				
PLY LAYUP SEQUENCE				
Y	NO. REQ.	MAKE FROM	FIBER DIR.	
7	2	-3	0/90	
8	2		±45	
9	2		±45	
4.1	1		0/90	
5.1			0/90	
.1			±45	
7.1			±45	
3.1			0/90	
9.1			0/90	
0.1			±45	
1.1			±45	
2.1			0/90	
3.1			0/90	
4			±45	
5			±45	
6			0/90	
7			0/90	
8			±45	
9			±45	
0			0/90	
1			0/90	
2			±45	
3			±45	
4			0/90	
5			0/90	
6			±45	
7			±45	
8			0/90	
9			0/80	
0			±45	
1.2			0/90	
2			±45	
3			±45	
4.1			0/90	
4.2	1	-3	±45	

ORIGINAL PAGE IS
OF POOR QUALITY

AMC7847

AMC7847

68° HUMIDITY 69 %
.008 IN /100 INCHES
DATE 12-2-78

DOUGLAS | SIZE J | CODE IDENT NO 88277 | AMC7847 | SHEET 4

37

FOLDOUT FRAME

ORIGINAL PAGE IS
OF POOR QUALITY

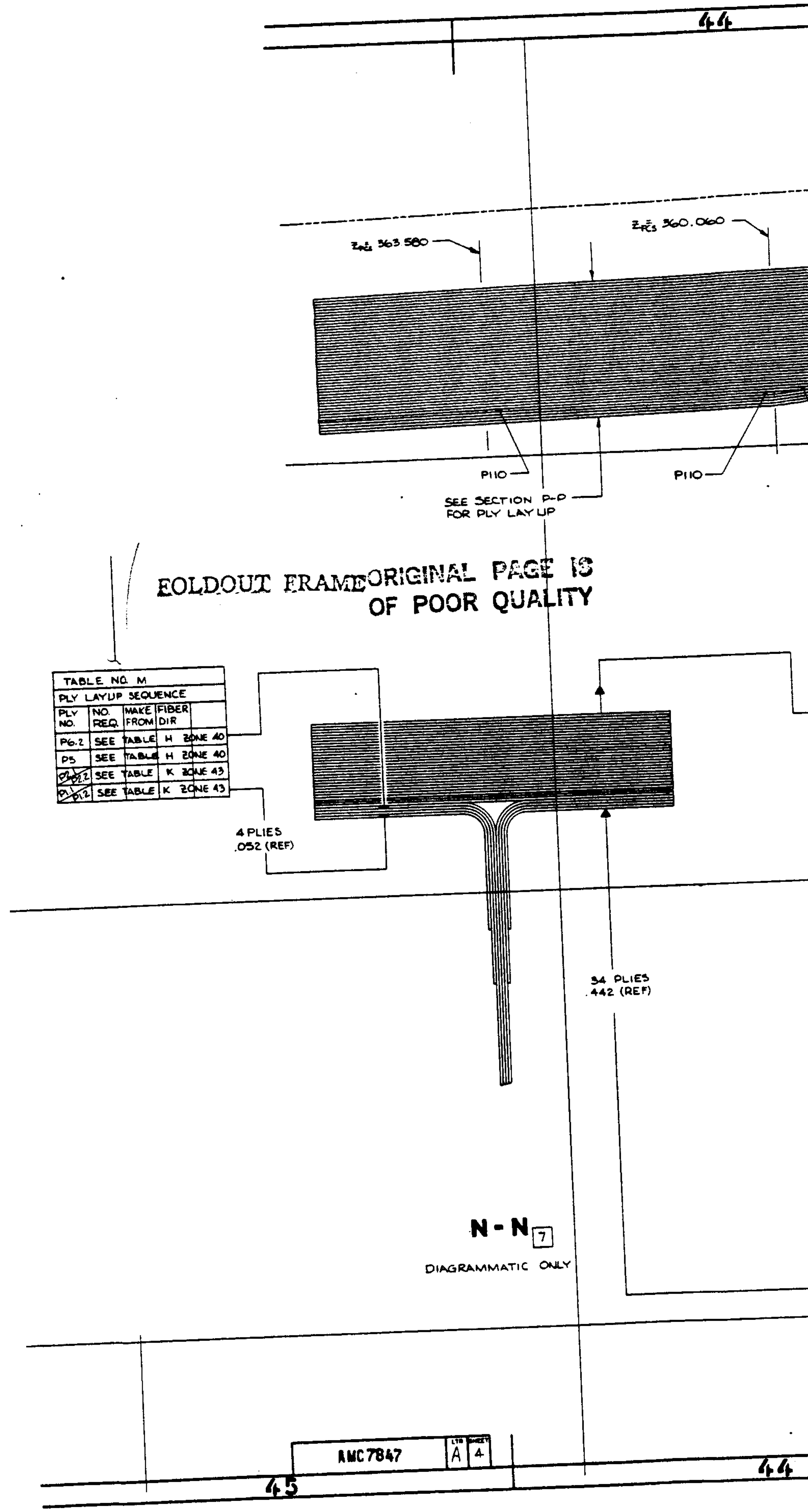
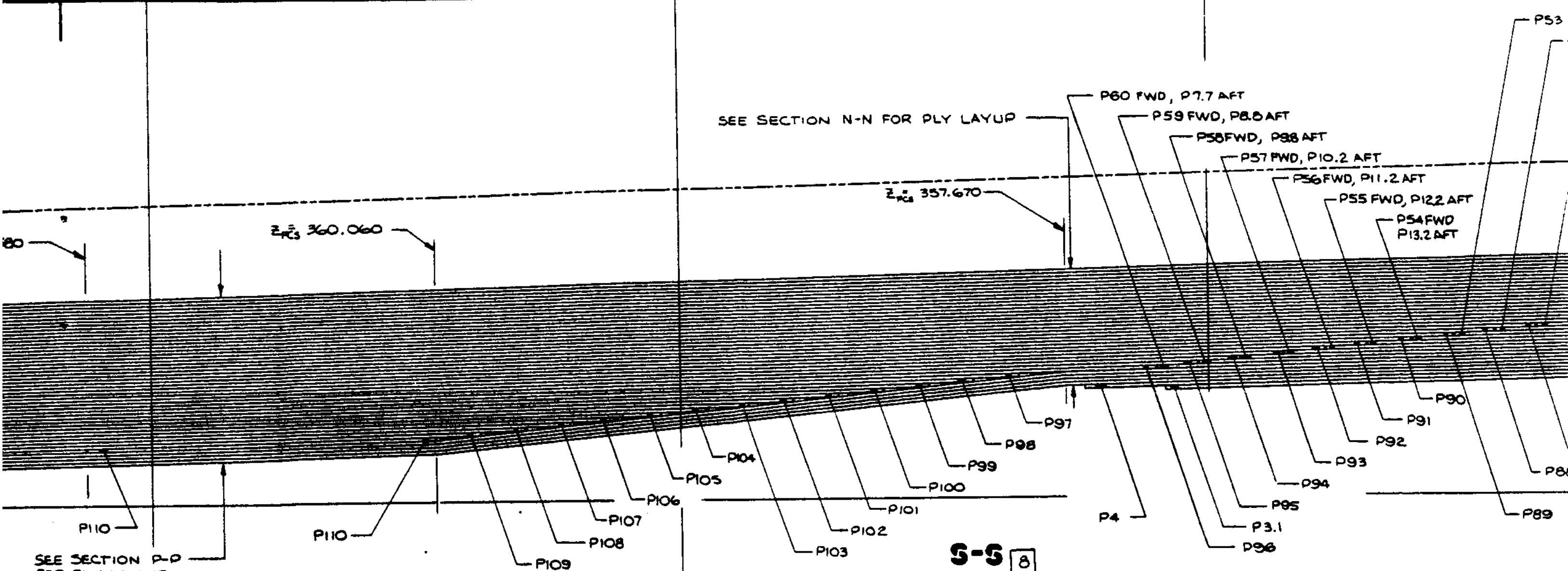


TABLE NO. M				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR	
P6.2	SEE	TABLE	H	ZONE 40
P5	SEE	TABLE	H	ZONE 40
~~P2~~ P22	SEE	TABLE	K	ZONE 43
~~P1~~ P12	SEE	TABLE	K	ZONE 43

44 | 43 | 42

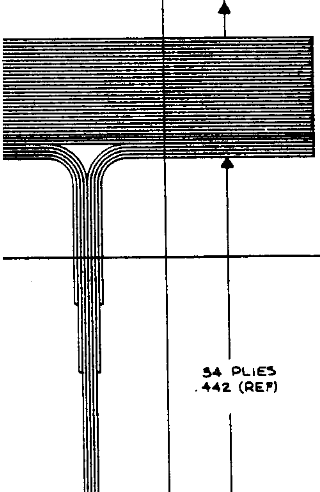


S-S 8

DIAGRAMMATIC ONLY

INAL PAGE IS
POOR QUALITY

ORIGIN
OF PO



N-N 7

AGRAMMATIC ONLY

TABLE NO. L

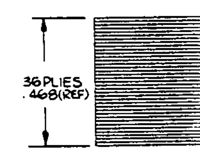
PLY LAYUP SEQUENCE

PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.	
P67	SEE	TABLE	G ZONE 37	
P68	SEE	TABLE	G ZONE 37	
P69	SEE	TABLE	G ZONE 37	
P70	2	-3	0/90	
P71	↑	↑	0/90	
P72			±45	
P73			±45	
P74			0/90	
P75			0/90	
P76			±45	
P77			±45	
P78			0/90	
P79			0/90	
P80			±45	
P81			±45	
P82			0/90	
P83			0/90	
P84			±45	
P85			±45	
P86			0/90	
P87			0/90	
P88			±45	
P89			±45	
P90			0/90	
P91			0/90	
P92			±45	
P93			±45	
P94	↓	↓	0/90	
P95			0/90	
P96	2	-3	±45	
P61.2	SEE	TABLE	G ZONE 37	
P62	SEE	TABLE	G ZONE 37	
[illegible]	SEE	TABLE	J ZONE 40	
[illegible]	SEE	TABLE	J ZONE 40	

TABLE NO K

PLY LAYUP SEQUENCE

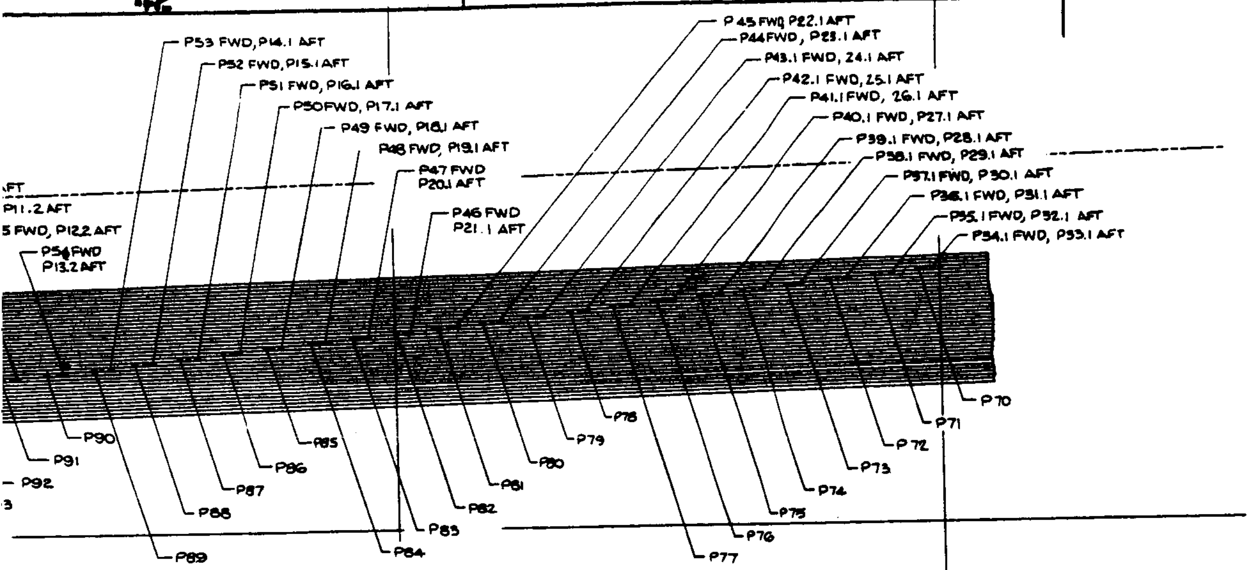
PLY NO	NO REQ	MAKE FROM	FIBER DIR	
P33.1	SEE	TABLE	H ZONE 40	
P32.1		↑		
P31.1				
P30.1				
P29.1				
P28.1				
P27.1				
P26.1				
P25.1				
P24.1				
P23.1				
P22.1				
P21.1				
P20.1				
P19.1				
P18.1				
P17.1				
P16.1				
P15.1				
P14.1				
P13.2				
P12.2		↓		
P11.2				
P10.2	SEE	TABLE	H ZONE 40	
P9.7	SEE	TABLE	D ZONE 25	
P8.7	SEE	TABLE	D ZONE 25	
P7.6	SEE	TABLE	H ZONE 40	
P6.2		↕		
P5				
P4				
P3.1	SEE	TABLE	H ZONE 40	
~~P2~~ P2.2	1	-3	±45	
~~P1.1~~ P1.2	1	-3	0/90	



FOLDOUT F

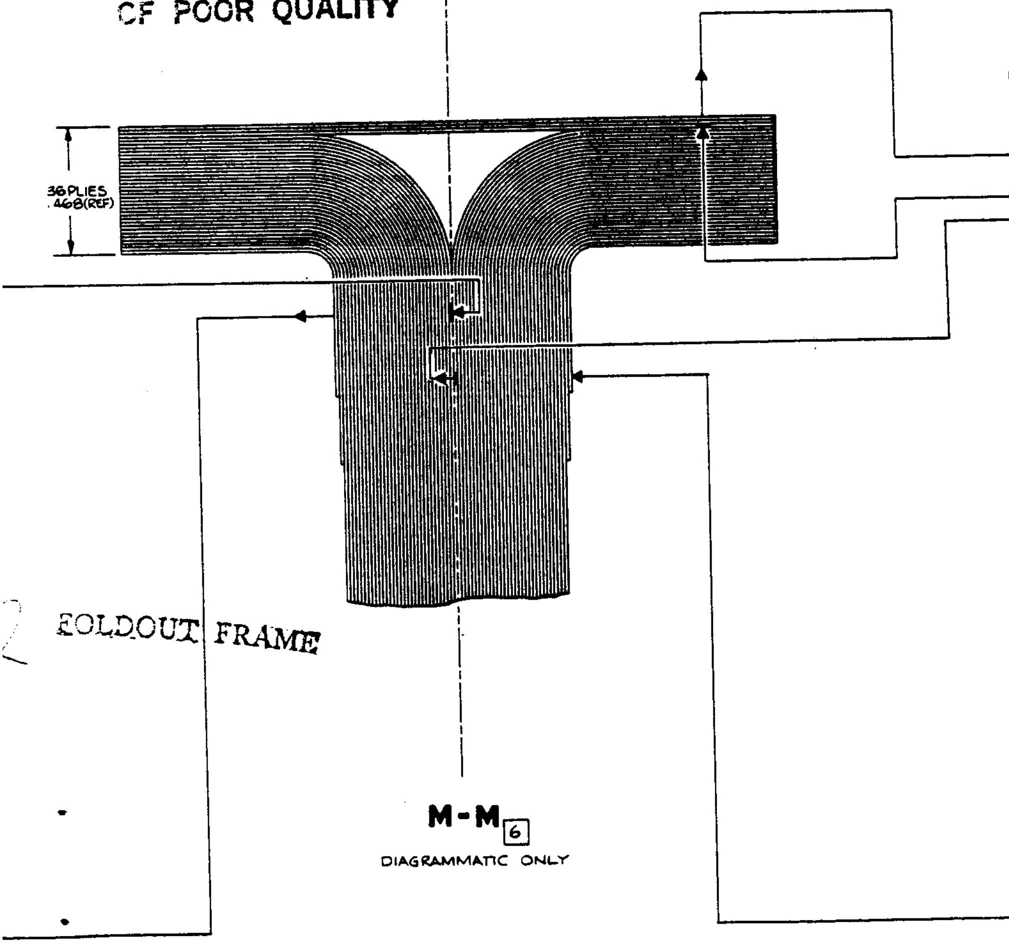
A 4

44 | 43 | 42



ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY



M-M $\boxed{6}$

DIAGRAMMATIC ONLY

TABLE NO. J				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.	
P67	SEE	TABLE	G	ZONE 37
P68				
P69				
P34.1				
P35.1				
P36.1				
P37.1				
P38.1				
P39.1				
P40.1				
P41.1				
P42.1				
P43.1				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P54				
P55				
P56				
P57				
P58				
P59				
P60				
P61.2				
P62				
P63				
P64.1	SEE	TABLE	G	ZONE 37
[illegible]	1	-3	±45	
[illegible]	1	-3	0/90	

FOLDOUT FRAME 3

FOLDOUT FRAME 2

AMC7847	A	4

42 41 40

FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 8 OF 10)

50 | 49

FOLDOUT FRAME

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE NO. T				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.	
P67	SEE	TABLE	G	ZONE 37
P68	SEE	TABLE	G	ZONE 37
P69	SEE	TABLE	G	ZONE 37
P70	SEE	TABLE	L	ZONE 44
P71				
P72				
P73				
P74				
P75				
P76				
P77				
P78				
P79				
P80				
P81				
P82				
P83				
P84				
P85				
P86				
P87				
P88				
P89				
P90				
P91				
P92				
P93				
P94				
P95				
P96	SEE	TABLE	L	ZONE 44
P97	SEE	TABLE	N	ZONE 46
P98				
P99				
P100				
P101				
P102				
P103				
P104				
P105				
P106	SEE	TABLE	N	ZONE 46

TEMPERATURE HUMIDITY
GRIDS ARE IN INCHES
RECORDED BY DATE

DOUGLAS | J | 88277 | AMC7847

50 | 49

FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 9 OF

49

FOLDOUT FRAME

ORIGINAL PAGE IS OF POOR QUALITY

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	SEE SHEET 1		

DOUGLAS | J | 88277 | AMC7847 | SHEET 5

AMC7847

49

WARD CENTER SPAR ASSEMBLY (SHEET 9 OF 10)

48 47

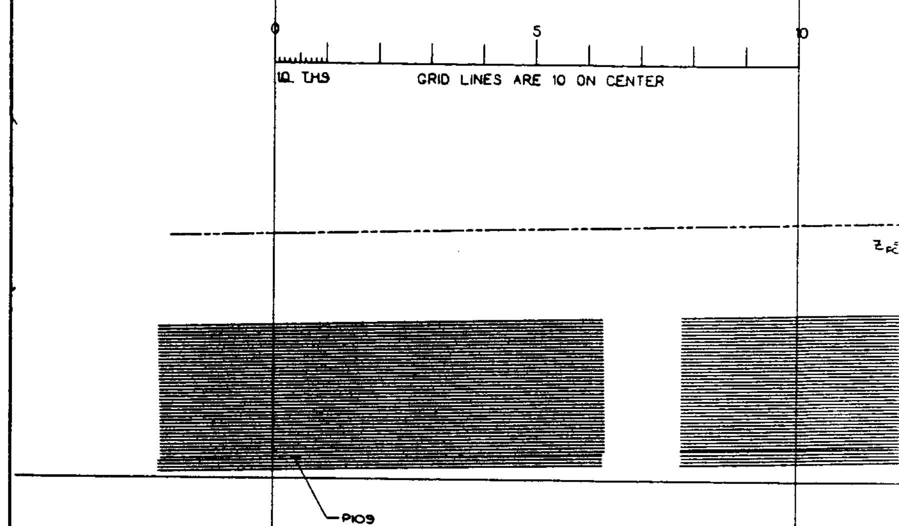
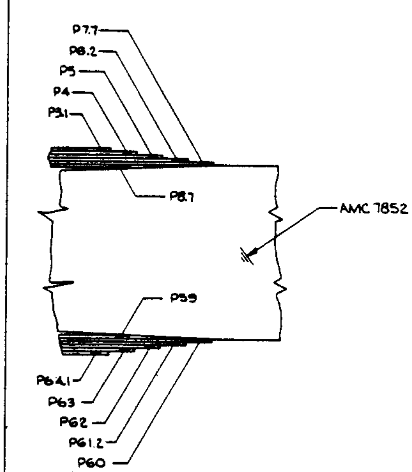


TABLE NO. 5				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR	
P6.2	SEE	TABLE	H	ZONE 40
P5	SEE	TABLE	H	ZONE 40
~~P1.2~~	SEE	TABLE	K	ZONE 43
P1.2	SEE	TABLE	K	ZONE 43

4 PLIES .052 (REF)

FOLDOUT FRAME

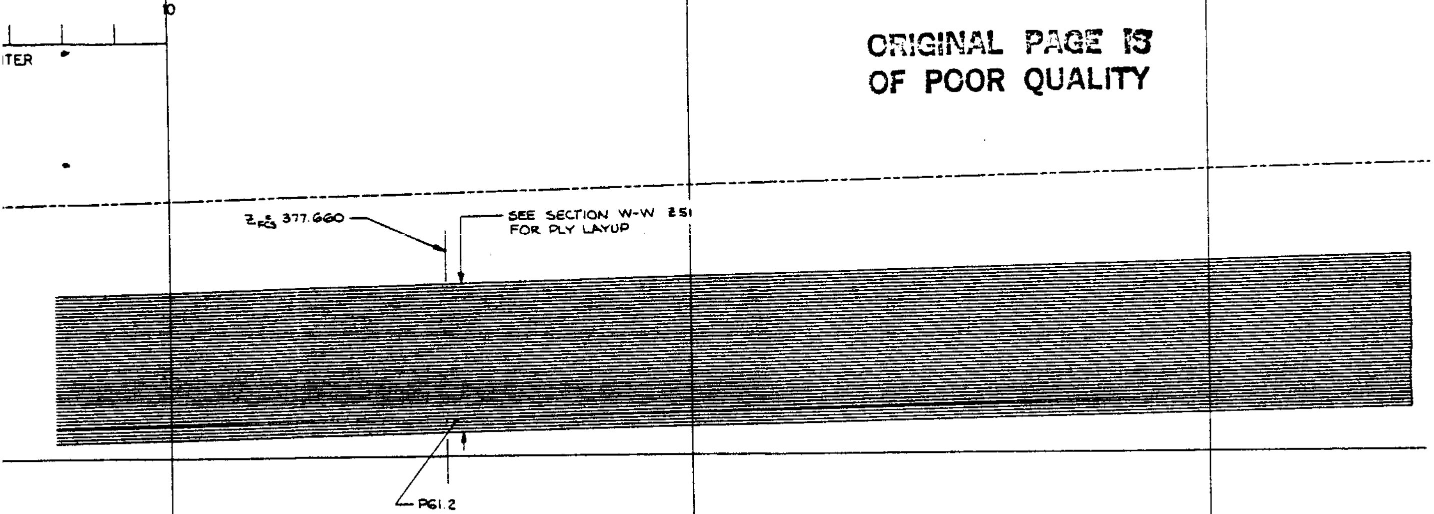


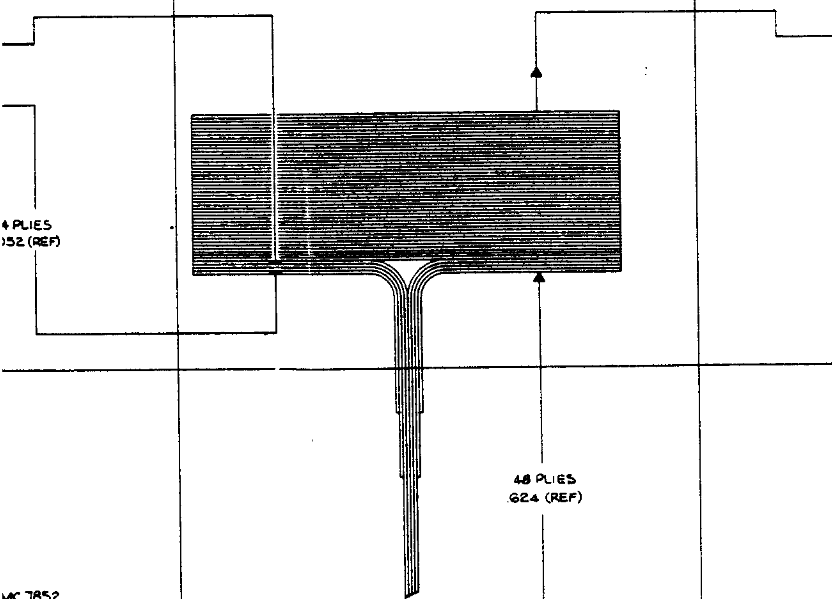
H - H $\boxed{5}$

DIAGRAMMATIC ONLY

48 47

47 46 45





P-P [7]
DIAGRAMMATIC ONLY

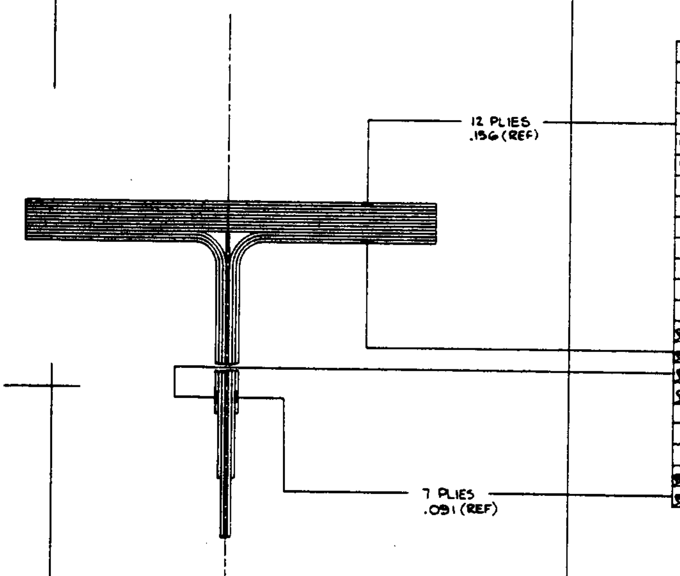
TABLE NO. N				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR	
P67	SEE	TABLE	G	ZONE 37
P68	SEE	TABLE	G	ZONE 37
P69	SEE	TABLE	G	ZONE 37
P70	SEE	TABLE	L	ZONE 44
P71				
P72				
P73				
P74				
P75				
P76				
P77				
P78				
P79				
P80				
P81				
P82				
P83				
P84				
P85				
P86				
P87				
P88				
P89				
P90				
P91				
P92				
P93				
P94				
P95				
P96	SEE	TABLE	L	ZONE 44
P97	2	-3	±45	
P98			0/90	
P99			0/90	
P100			±45	
P101			±45	
P102			0/90	
P103			0/90	
P104			±45	
P105			±45	
P106			0/90	
P107			0/90	
P108			±45	
P109			±45	
P110	2	-3	0/90	
P61.2	SEE	TABLE	G	
P62	SEE	TABLE	G	
[illegible]	SEE	TABLE	J	ZONE 40
[illegible]	SEE	TABLE	J	ZONE 40

3

47 46

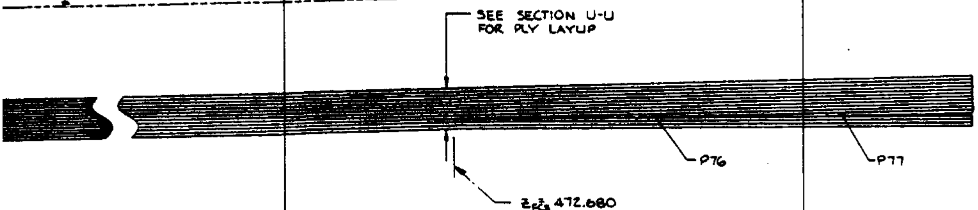
FOLDOUT FRAME

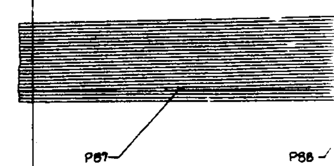
ORIGINAL PAGE IS
OF POOR QUALITY



U-U 19 21

TABLE NO. Y				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.	
P67	SEE	TABLE	G	ZONE 57
P68	SEE	TABLE	G	ZONE 57
P69	SEE	TABLE	G	ZONE 57
P70	SEE	TABLE	L	ZONE 44
P71				
P72				
P73				
P74				
P75	SEE	TABLE	L	ZONE 44
P62	SEE	TABLE	G	ZONE 57
[illegible]	SEE	TABLE	J	ZONE 40
[illegible]	SEE	TABLE	J	ZONE 40
[illegible]	SEE	TABLE	K	ZONE 43
[illegible]	SEE	TABLE	K	ZONE 43
P5	SEE	TABLE	H	ZONE 40
P6.1	SEE	TABLE	W	ZONE 54
P62	SEE	TABLE	G	ZONE 57
[illegible]	SEE	TABLE	J	ZONE 40
[illegible]	SEE	TABLE	J	ZONE 40





V - V 17

DIAGRAMMATIC ONLY

ORIGINAL PAGE IS
OF POOR QUALITY

2 FOLDOUT FRAME

(PLY LAYUP SEQ)UENCE	
FIBER DIR.	
G	ZONE 37
G	ZONE 37
G	ZONE 37
L	ZONE 44
L	ZONE 44
G	ZONE 37
J	ZONE 40
J	ZONE 40
K	ZONE 43
K	ZONE 43
H	ZONE 40
W	ZONE 54
G	ZONE 37
J	ZONE 40
J	ZONE 40

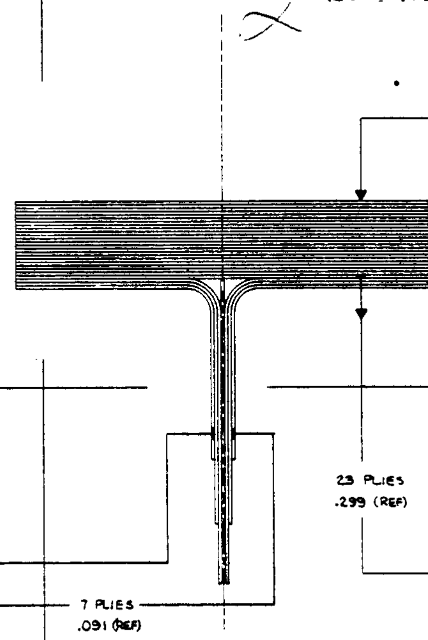


TABLE NO. W				
PLY LAYUP SEQUENCE				
PLY NO	NO REQ	MAKE FROM	FIBER DIR	
~~P11 P12~~	SEE	TABLE	K	ZONE 43
~~P21 P22~~	SEE	TABLE	K	ZONE 43
P5	SEE	TABLE	H	ZONE 40
P6.1	1	-3	0/90	
P62	SEE	TABLE	G	ZONE 37
[illegible]	SEE	TABLE	J	ZONE 40
[illegible]	SEE	TABLE	J	ZONE 40

T - T 18

DIAGRAMMATIC ONLY

TABLE NO. V				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.	
P67	SEE	TABLE	G	ZONE
P68	SEE	TABLE	G	ZONE
P69	SEE	TABLE	G	ZONE
P70	SEE	TABLE	L	ZONE
P71				
P72				
P73				
P74				
P75				
P76				
P77				
P78				
P79				
P80				
P81				
P82				
P83				
P84				
P85				
P86				
P87				
P88				
P89	SEE	TABLE	L	ZONE

AMC 7847

53 52 51

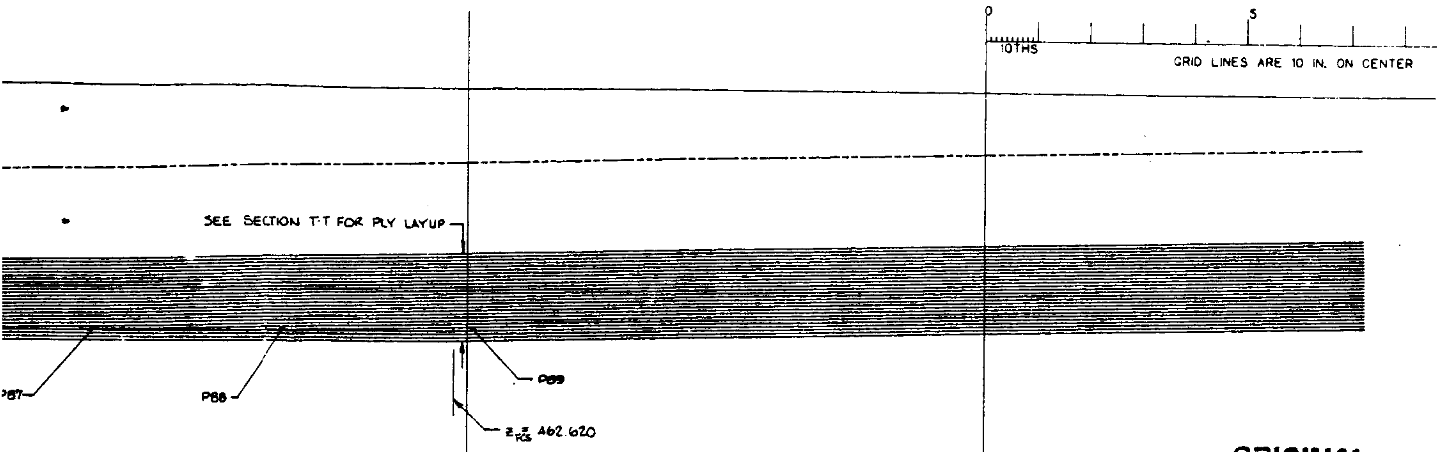


TABLE NO. V				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ.	MAKE FROM	FIBER DIR.	
P67	SEE	TABLE	G	ZONE 37
P68	SEE	TABLE	G	ZONE 37
P69	SEE	TABLE	G	ZONE 37
P70	SEE	TABLE	L	ZONE 44
P71		↑		
P72				
P73				
P74				
P75				
P76				
P77				
P78				
P79				
P80				
P81				
P82				
P83				
P84				
P85				
P86				
P87				
P88		↓		
P89	SEE	TABLE	L	ZONE 44

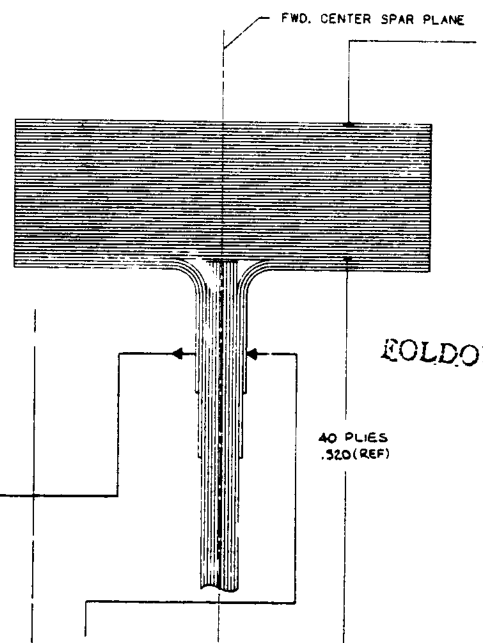


TABLE NO. U				
PLY LAYUP SEQUENCE				
PLY NO	NO. REQ	MAKE FROM	FIBER DIR	
~~P1.1/P1.2~~	SEE	TABLE	K	ZONE 43
~~P2.1/P2.2~~	SEE	TABLE	K	ZONE 43
P5	SEE	TABLE	H	ZONE 40
P111.5	1	-3	0/90	
P112.5	1	-3	±45°	
P6.1	SEE	TABLE	W	ZONE 54
P7.5	1	-3	±45	
P8.5	↑	↑	0/90	
P9.5			±45	
P61.1	↓	↓	0/90	
P113	1	-3	±45	
P114	1	-3	0/90	
P62	SEE	TABLE	G	ZONE 37
~~P65.1/P65.2~~	SEE	TABLE	J	ZONE 40
~~P66.1/P66.2~~	SEE	TABLE	J	ZONE 40

W - W $\boxed{9}$

DIAGRAMMATIC ONLY

AA - AA $\boxed{9}$

ROTATED 180°

FOLDOUT FRAME

AMC7847 | LTR | SHEET 5

53 52 51

FIGURE A3. DRAWING AMC7847 – FORWARD CENTER SPAR ASSEMBLY (SHEET 10 OF 10)

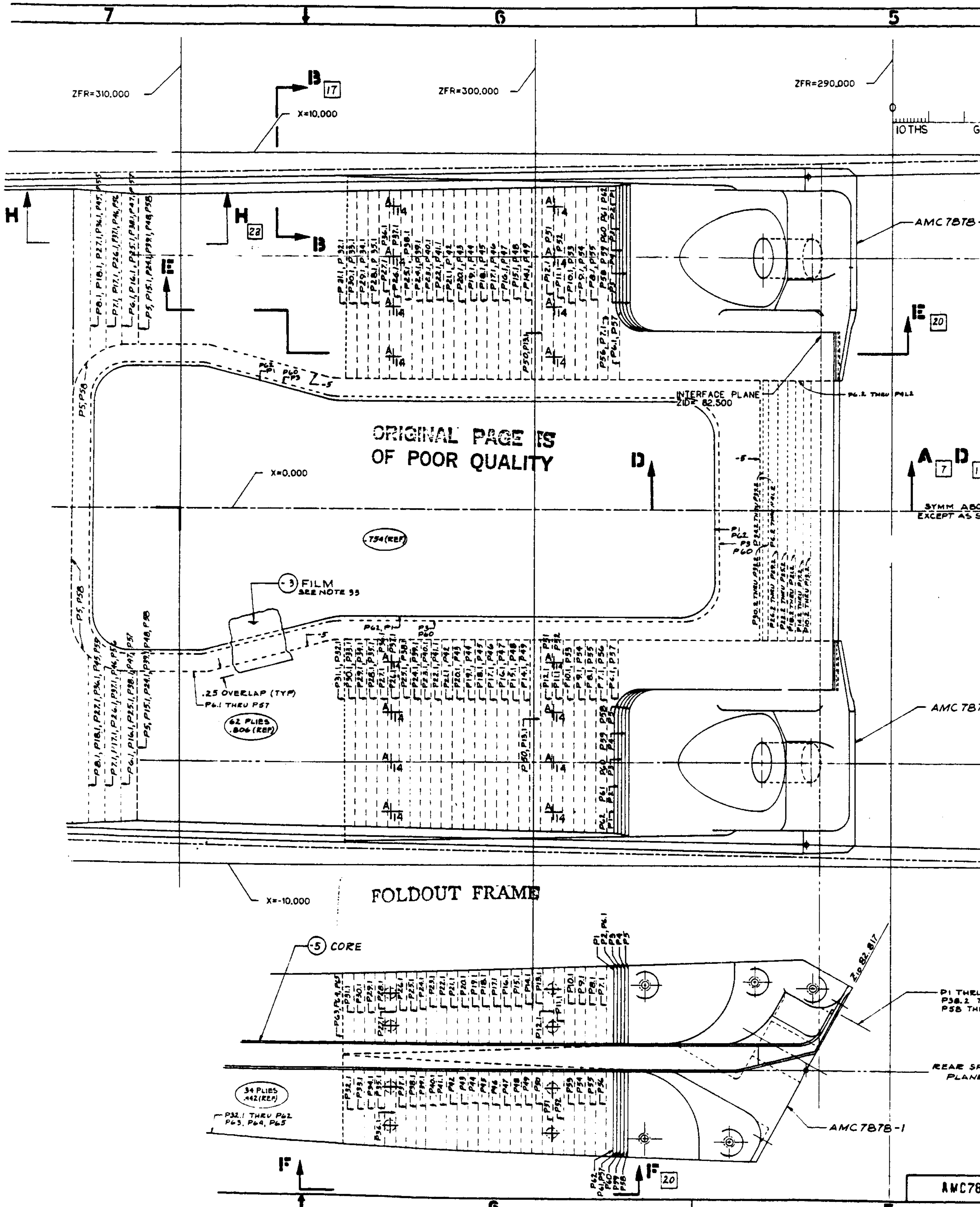
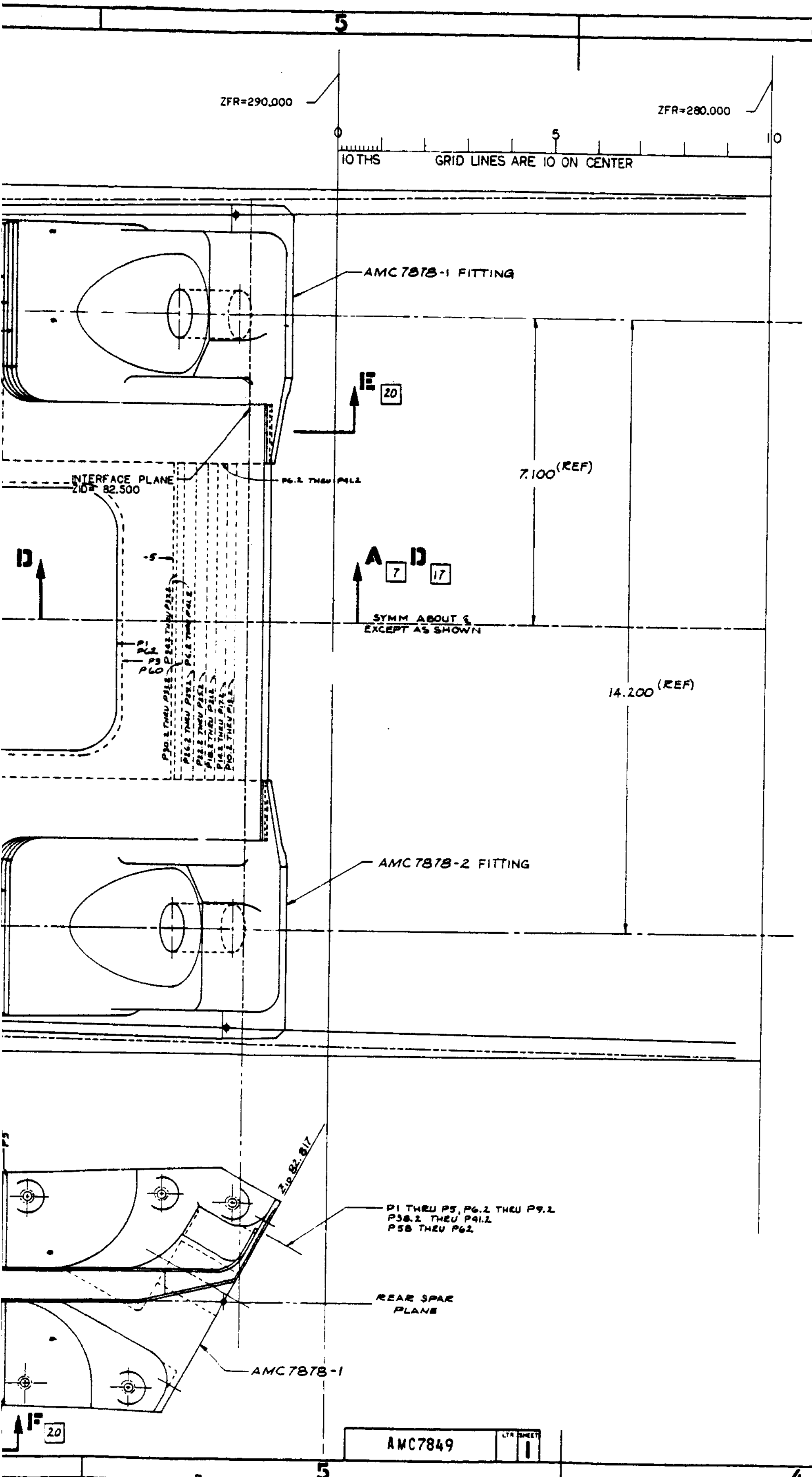


FIGURE A4. DRAWING AMC7849 – LOWER REAR SPAR ASSEMBLY (SHEET 1 OF 4)

ACEE-03-PR-9642

ORIGINAL
OF POOR



PLY No	CONSISTS OF PARTS	
P6	P6.1	P6.2
P7	P7.1	P7.2
P8	P8.1	P8.2
P9	P9.1	P9.2
P10	P10.1	P10.2
P11	P11.1	P11.2
P12	P12.1	P12.2
P13	P13.1	P13.2
P14	P14.1	P14.2
P15	P15.1	P15.2
P16	P16.1	P16.2
P17	P17.1	P17.2
P18	P18.1	P18.2
P19	P19.1	P19.2
P20	P20.1	P20.2
P21	P21.1	P21.2
P22	P22.1	P22.2
P23	P23.1	P23.2
P24	P24.1	P24.2
P25	P25.1	P25.2
P26	P26.1	P26.2
P27	P27.1	P27.2
P28	P28.1	P28.2
P29	P29.1	P29.2
P30	P30.1	P30.2
P31	P31.1	P31.2
P32	P32.1	P32.2
P33	P33.1	P33.2
P34	P34.1	P34.2
P35	P35.1	P25.2
P36	P36.1	P36.2
P37	P37.1	P37.2
P38	P38.1	P38.2
P39	P39.1	P39.2
P40	P40.1	P40.2
P41	P41.1	P41.2

FOLDOUT FRAME

(SHEET 1 OF 4)

3 | 2 | 1

BLUE PRINT: PRINT ONLY SHEETS LISTED BELOW

SHEET REV STATUS

				2	1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED (APPLY AS NECESSARY)

1. FOR FAB WITH A DIMENSIONALLY ACCURATE REPRO, TWO PLACE DEC TOLERANCES APPLY WHERE DIM ARE NOT GIVEN.
2. LOFT DESIGNATION IS FOR ENGRG REF ONLY.
3. FAB STANDARDS & TOOLING HOLES PER DPS 4.710.
4. TOOLING & PIN HOLE DIA INDICATED ON BODY OF DWG ARE MAX, SMALLER HOLES ARE PERMISSIBLE.
5. EDGE DISTANCE FOR ATTACHMENTS MAY VARY FROM THAT SHOWN ON DWG BY .03 ON DETAILS, 2D MIN ACCEPTABLE ON ASSY.
6. ASSEMBLY SHOP PRACTICE PER DPS 2.70-2.
7. HEAT TREAT 2024-0 TO 2024-T42, 2014-0 & T3 TO 2014-T6 & 7075-0 TO 7075-T62 PER DPS 7.00.
8. INSTALL RIVETS & FLUSH SCREWS PER S5076260.
9. INSTALL HI-LOK PINS PER S7933654 & LOCKBOLTS PER S7933665. STANDARD INTERFERENCE FITS APPLY UNLESS OTHERWISE INDICATED BY SYMBOL DESIGNATION.
10. FORM ALUMINUM ALLOY PER DPS 3.69.
11. JOGGLES PER S1292000.
12. ATTACH NUTPLATES WITH MS20426AD3 RIVETS.
13. IDENTIFY PER DPS 3.92.
14. STATION NO. APPLY TO BASIC ______ ONLY. FOR OTHER SERIES SEE DWG ______ FOR STATION RELATIONSHIP.
15. POINTS LOCATED BY MASTER DIAGRAM ______.
16. LOCATION FOR ATTACHMENT INSTALLED ON SUBQ ASSY.
17. LOCATION FOR ATTACHMENT IS ON THE DWG INVOLVED.
18. LOCATION DUPLICATED FROM A PRECEDING VIEW.
19. ATTACHMENT CALLED OUT ON OTHER DWGS.
20. FABRICATE PER D.P.S 1.622
21. UNDIMENSIONED DRAWING SHEETS WILL BE FURNISHED AS FULL SCALE REPRODUCTIONS ON REQUEST.
22. INSPECT PER D.P.S 4.738 TYPE 2 CLASS (T.B.D)
23. RIBBON DIRECTION OPTIONAL
24. FOR BI-WEAVE CLOTH WARP AND FILL ARE INTERCHANGEABLE
25. ALLOW VOIDS TO FILL WITH EXCESS RESIN
26. BOND HONEYCOMB CORE TO GRAPHITE/EPOXY PER D.P.S.1.966 WITH FM 300K ADHESIVE
27. BOND AMC 7878-1 & -2 FITTING TO GRAPHITE/EPOXY PER D.P.S. 1.966
28. WHEN NECESSARY TO JOIN ADJACENT WIDTHS OF CLOTH, THE EDGES SHALL OVERLAP .50±.25. STAGGER OVERLAPS
29. FILL PERIPHERY OF HONEYCOMB CORE FOR A DISTANCE OF $.25^{+.25}_{-0}$ PER D.P.S 1.901 TYPE III
30. SEAL GRAPHITE-EPOXY ASSY PER DPS. 2.512.
31. CENTERS OF FASTENERS TO BE LOCATED WITHIN .030 RADIUS OF POSITION SHOWN
32. FASTENERS ARE CODED AS SHOWN;

    A .3120 / XX .3140 DIA HOLE
    NAS 6405U14 BOLT
    NAS 1252-516H WASHER (2 REQ'D)
    MS 21042L5 NUT
    INDICATES BOLT GRIP IN SIXTEENTHS (TYP)

33. APPLY 1 LAYER (.001) OF TEDLAR FILM (-3) TO -1 ASSY IN AREA OF HONEYCOMB CORE (-5) WITH .25 OVERLAP, ON TOOL SIDE OF -1 ASSY
34. TEST SHORT BEAM SHEAR SPECIMENS PER DMS 2163
35. TEST RESIN AND VOID CONTENT PER DMS 2163
36. LOCATE LAP SHEAR SPECIMENS TEST UNDER SAME BAG AS THE PARTS. TEST PER DMS 2177
37. FILL GAPS BETWEEN HONEYCOMB CORE AND GRAPHITE-EPOXY WITH 350° CURE FOAMING ADHESIVE PER D.P.S. 1.99. GAP SHALL NOT EXCEED .06.

LL OK 10/1/78

TEMPERATURE HUMIDITY
GRIDS ARE .001 IN 30 INCHES
RECORDED BY DATE

FIRST RELEASE OF PRINTS OCT 2 1 1978 | ORIGINAL DATE OF DRAWING

SEE SEPARATE PARTS LIST

DASH NUMBERS OF THIS DWG: ODD DASH NUMBERS SHOWN, EVEN DASH NUMBERS OPPOSITE

FINISH

25943454	CRAD
AMC7844	DC-10
NEXT ASSY	USED ON

FIRST APPLICATION

FOR COMPLETE USAGE DATA SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ± 0° 30'
3 PLACE DEC ± .015
2 PLACE DEC ± .03

DWG SECTION MC 01 | RELEASE CODE

CONTRACT NO. NAS 1-14869

STRESS		
CHECK	G ESPEN	
DESIGN	A HAWLEY	
PREP BY	A. CRONK	10-1-78

DESIGN ACTIVITY APPROVAL

CUSTOMER

DOUGLAS AIRCRAFT COMPANY
LONG BEACH, CALIFORNIA

SPAR ASSY - COMPOSITE V.S. REAR LOWER

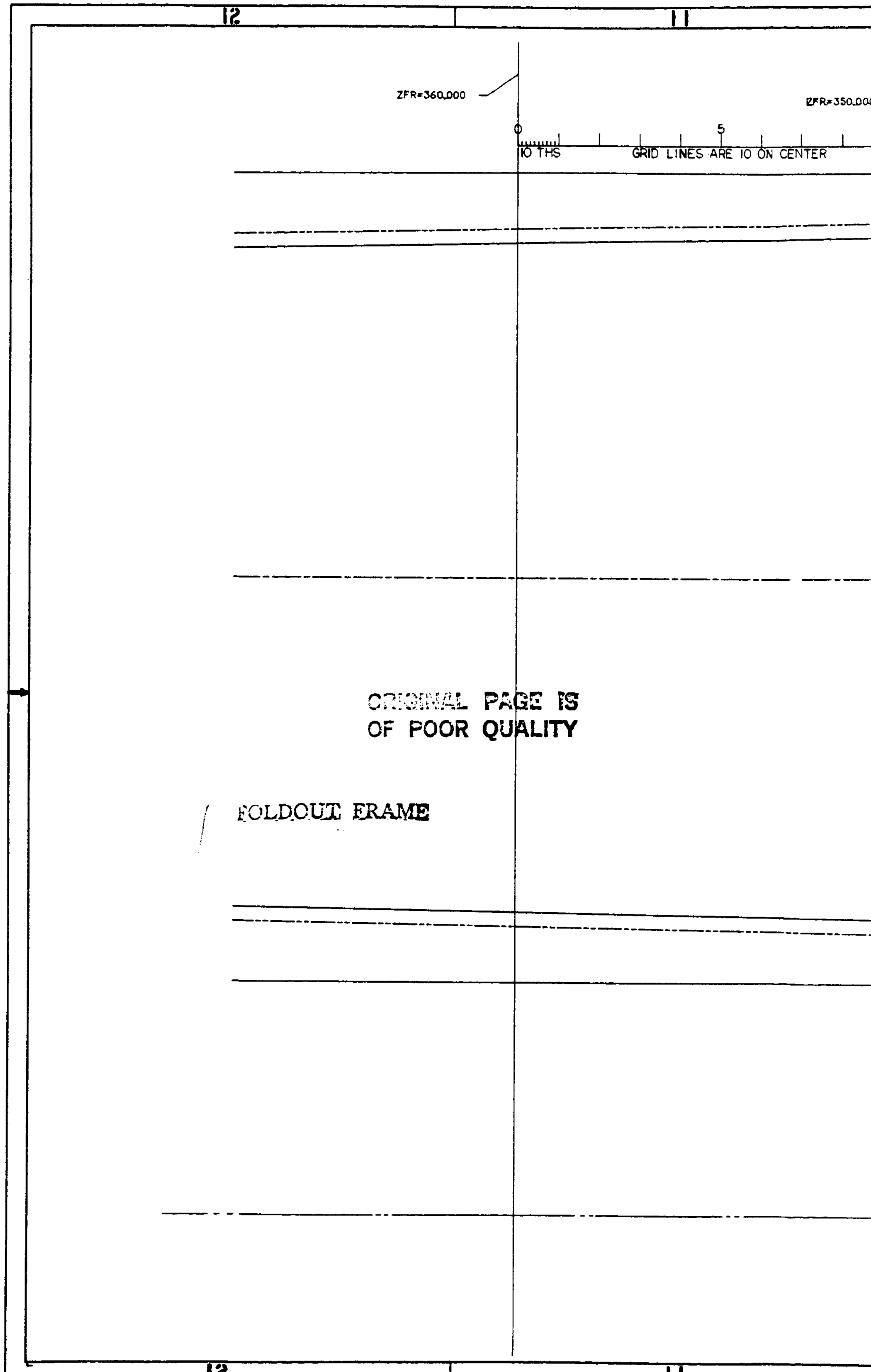
UNDIMENSIONED DRAWING

SIZE J | CODE IDENT NO 88277 | AMC7849

SCALE 1/1 (NOTED) | SHEET 1 OF 2

3 | 2 | 1

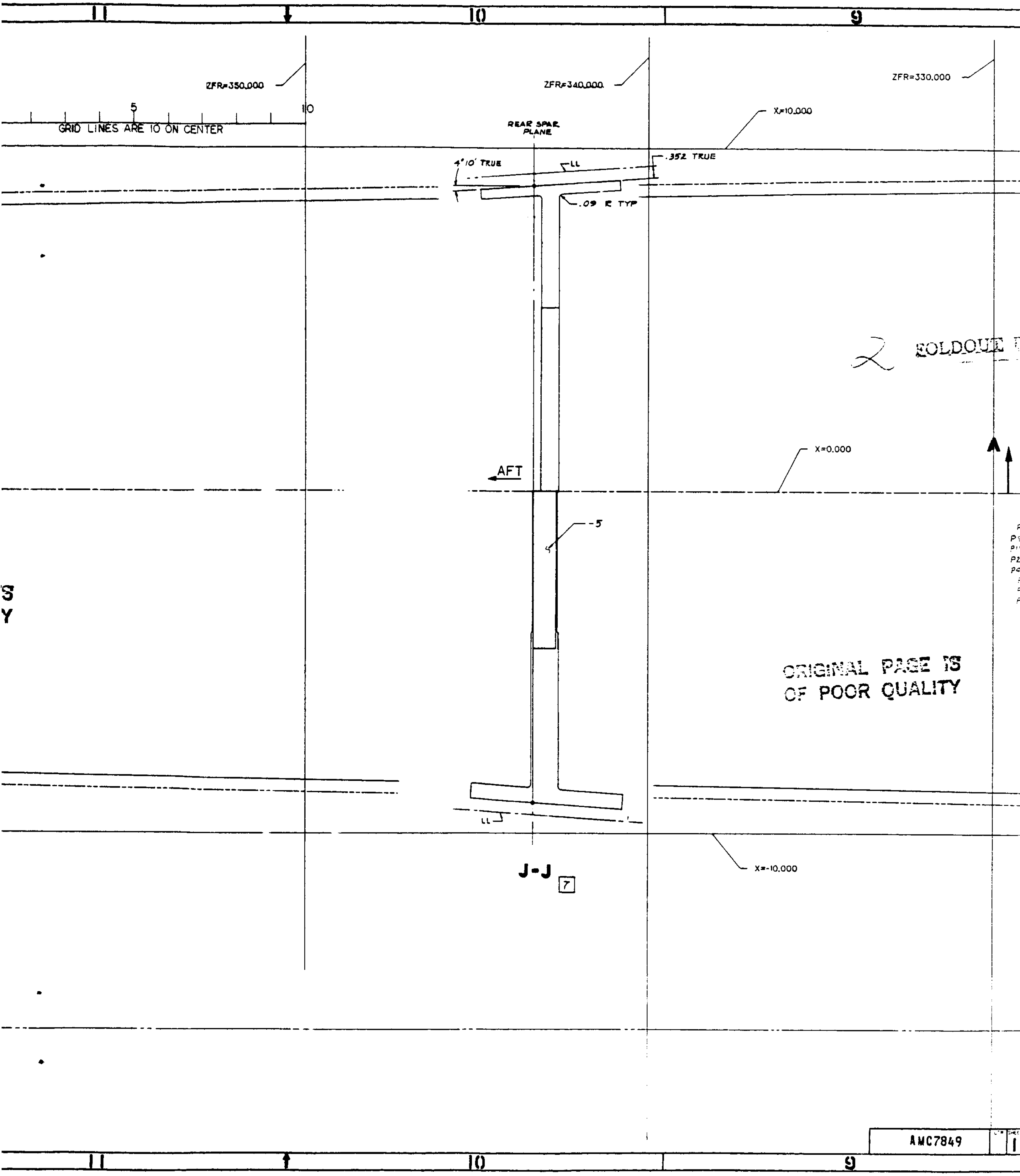
SIMILAR TO AMC 7122



ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME

Dougla
Contra



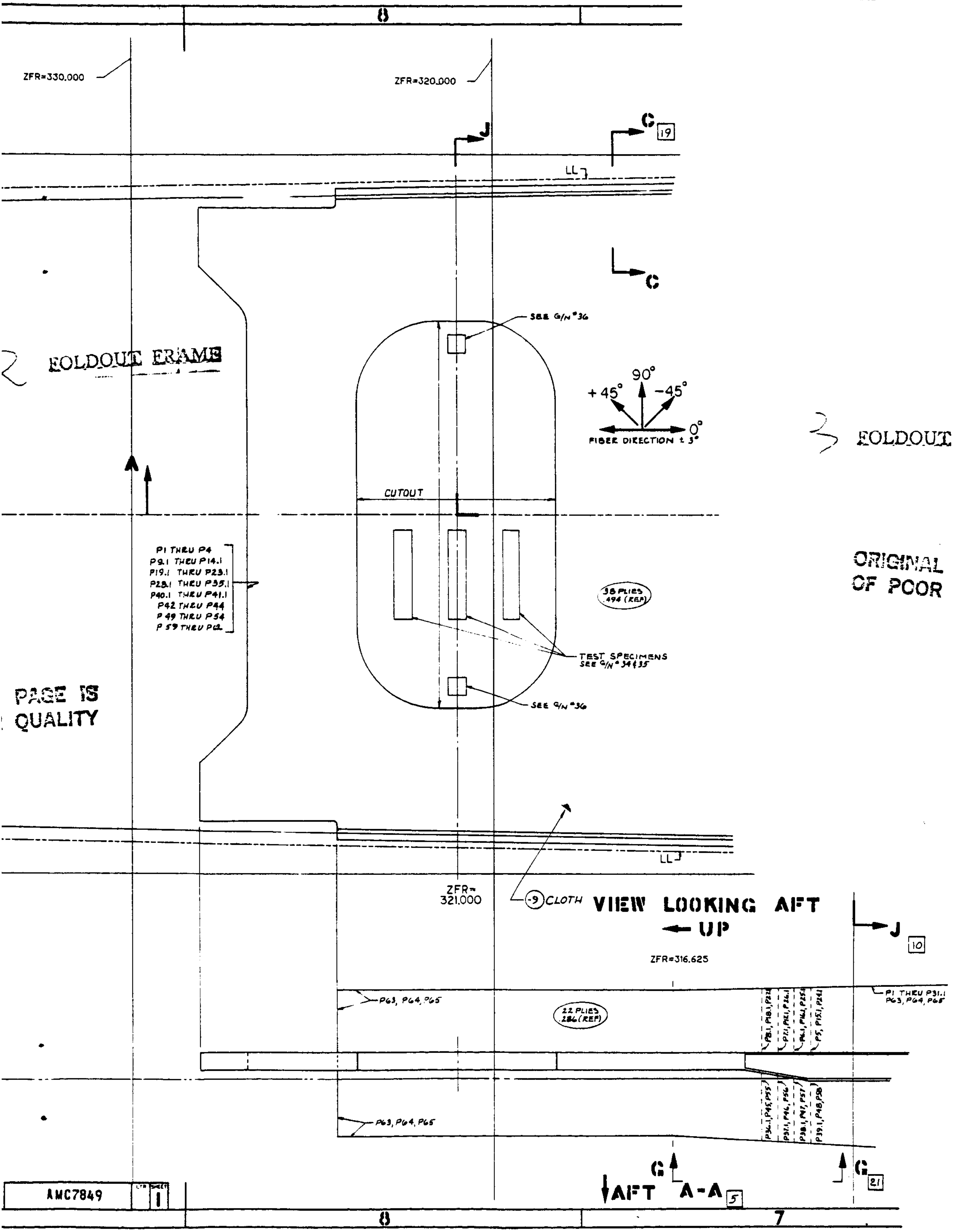


FIGURE A4. DRAWING AMC7849 — LOWER REAR SPAR ASSEMBLY (SHEET 2 OF 4)

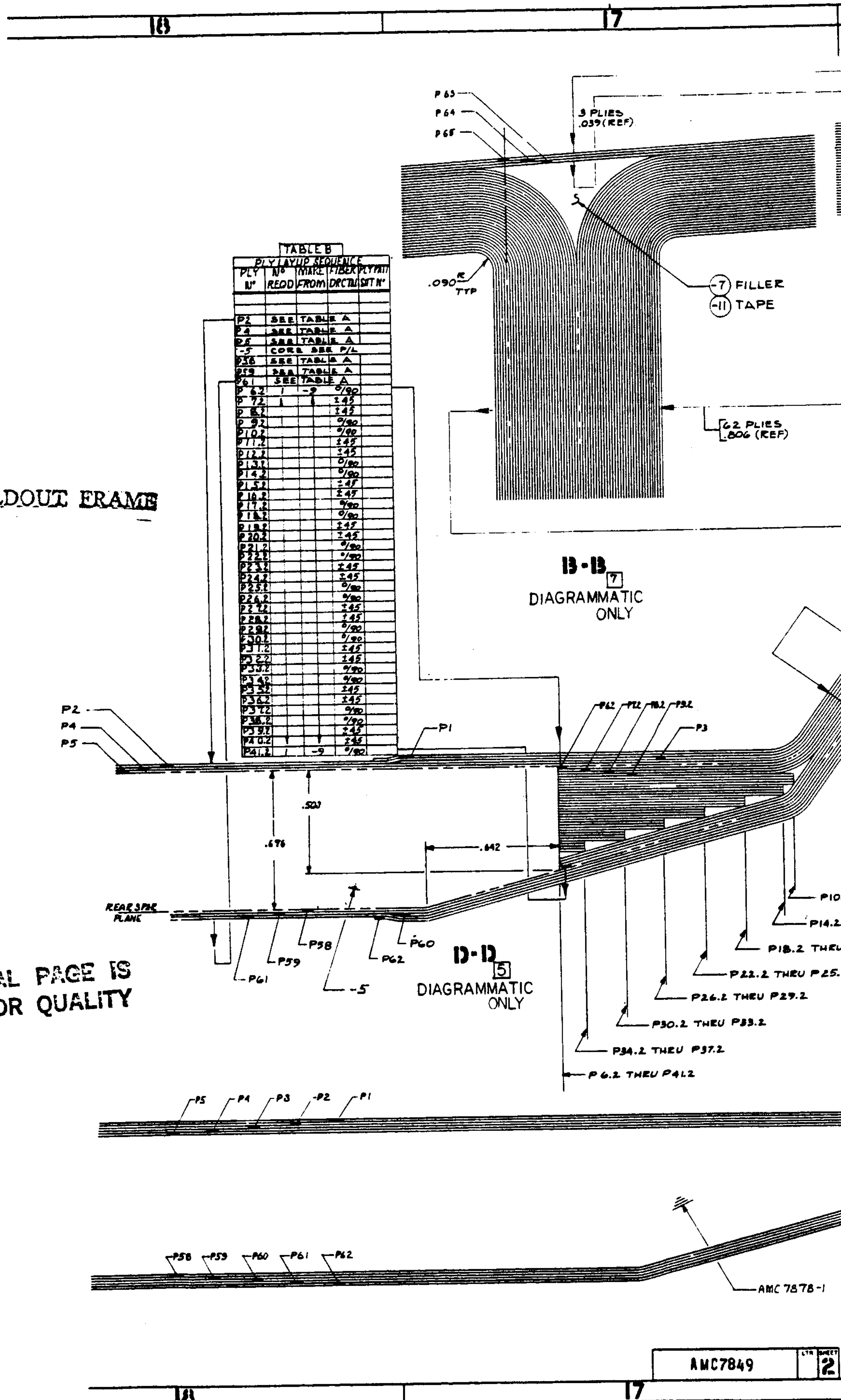


TABLE B

PLY LAYUP SEQUENCE				
PLY Nº	Nº REQD	MAKE FROM	FIBER DRCTN	PLY PATT SHT Nº
P2	SEE TABLE A			
P4	SEE TABLE A			
P5	SEE TABLE A			
-5	CORE SEE P/L			
P58	SEE TABLE A			
P59	SEE TABLE A			
P61	SEE TABLE A			
P 6.2	1	-9	0/90	
P 7.2			±45	
P 8.2			±45	
P 9.2			0/90	
P10.2			0/90	
P11.2			±45	
P12.2			±45	
P13.2			0/90	
P14.2			0/90	
P15.2			±45	
P16.2			±45	
P17.2			0/90	
P18.2			0/90	
P19.2			±45	
P20.2			±45	
P21.2			0/90	
P22.2			0/90	
P23.2			±45	
P24.2			±45	
P25.2			0/90	
P26.2			0/90	
P27.2			±45	
P28.2			±45	
P29.2			0/90	
P30.2			0/90	
P31.2			±45	
P32.2			±45	
P33.2			0/90	
P34.2			0/90	
P35.2			±45	
P36.2			±45	
P37.2			0/90	
P38.2			0/90	
P39.2			±45	
P40.2			±45	
P41.2	1	-9	0/90	

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE A4. DRAWING AMC7849 – LOWER REAR SPAR ASSEMBLY (SHEET 3 OF 4

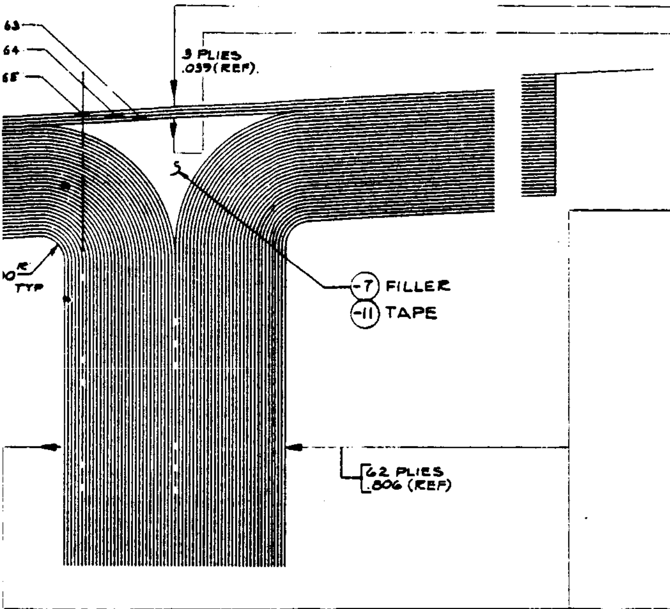
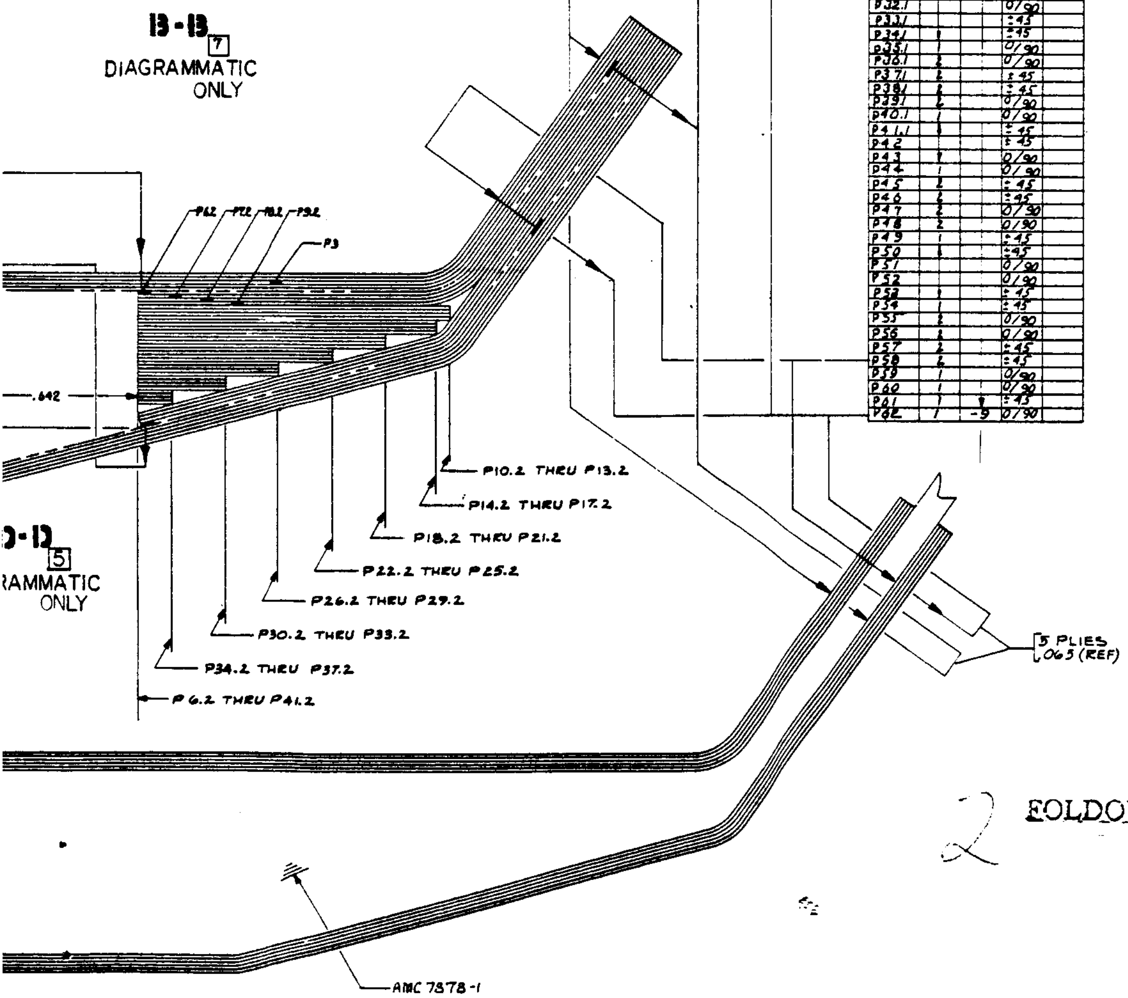


TABLE A

PLY LAYUP SEQUENCE				
PLY No	No REQD	MAKE FROM	FIBER DIREC'N	PLY PATT SHT No
P65	2	-9	0/90	
P64	2		±45	
P63	2		0/90	
P1	1		0/90	
P2			±45	
P3			0/90	
P4			0/90	
P5	1		±45	
P6.1	2		±45	
P7.1	2		0/90	
P8.1	2		0/90	
P9.1	1		±45	
P10.1			±45	
P11.1			0/90	
P12.1			0/90	
P13.1			±45	
P14.1	1		±45	
P15.1	2		0/90	
P16.1	2		0/90	
P17.1	2		±45	
P18.1	2		±45	
P19.1	1		0/90	
P20.1			0/90	
P21.1			±45	
P22.1			±45	
P23.1	1		0/90	
P24.1	2		0/90	
P25.1	2		±45	
P26.1	2		±45	
P27.1	2		0/90	
P28.1	1		0/90	
P29.1			±45	
P30.1			±45	
P31.1			0/90	
P32.1			0/90	
P33.1			±45	
P34.1			±45	
P35.1	1		0/90	
P36.1	2		0/90	
P37.1	2		±45	
P38.1	2		±45	
P39.1	2		0/90	
P40.1	1		0/90	
P41.1			±45	
P42			±45	
P43			0/90	
P44	1		0/90	
P45	2		±45	
P46	2		±45	
P47	2		0/90	
P48	2		0/90	
P49	1		±45	
P50			±45	
P51			0/90	
P52			0/90	
P53			±45	
P54	1		±45	
P55	2		0/90	
P56	2		0/90	
P57	2		±45	
P58	2		±45	
P59	1		0/90	
P60	1		0/90	
P61	1		±45	
P62	1	-9	0/90	



FOLDOUT FRAME

AMC7849 | LTR | SHEET 2

R REAR SPAR ASSEMBLY (SHEET 3 OF 4)

14 13

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
—		SEE SHEET 1	—	—

ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME

AMC7849

AMC7849

DIAGRAMMATIC VIEWS ONLY
GRIDS AND GRID CHECK NOT REQ'D.

DESIGN APPRVL. A. Y. Hanley

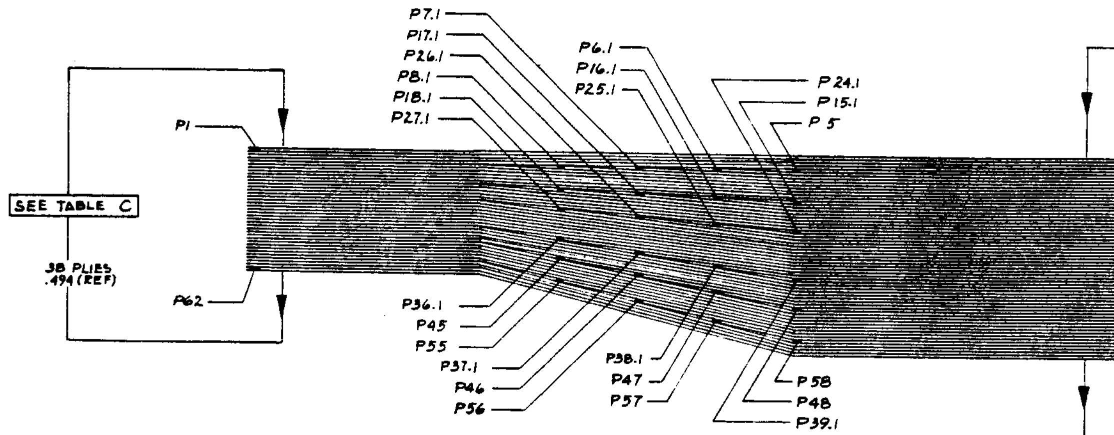
TEMPERATURE 72°F HUMIDITY 51%
GRIDS ARE ______ IN ______ INCHES
RECORDED BY E. R. Kerr DATE 9/26/76

DOUGLAS	SIZE J	CODE IDENT NO 88277	AMC7849
			SHEET 2

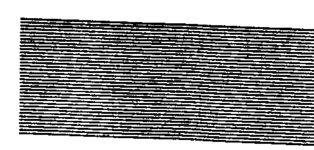
14 13

AMC7849

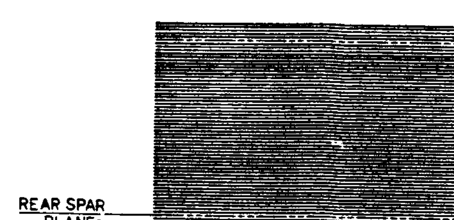
24 23



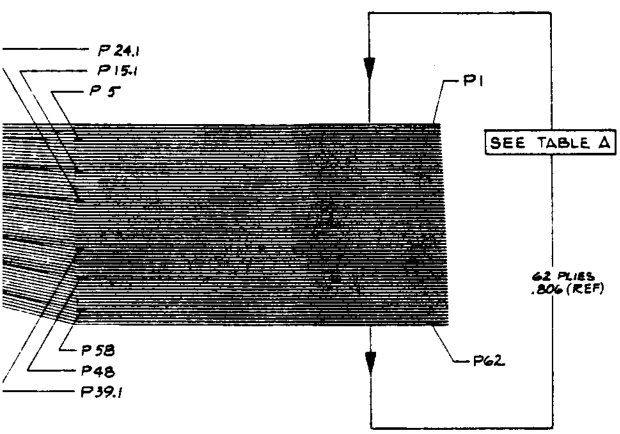
H-H $\boxed{7}$
DIAGRAMMATIC
ONLY

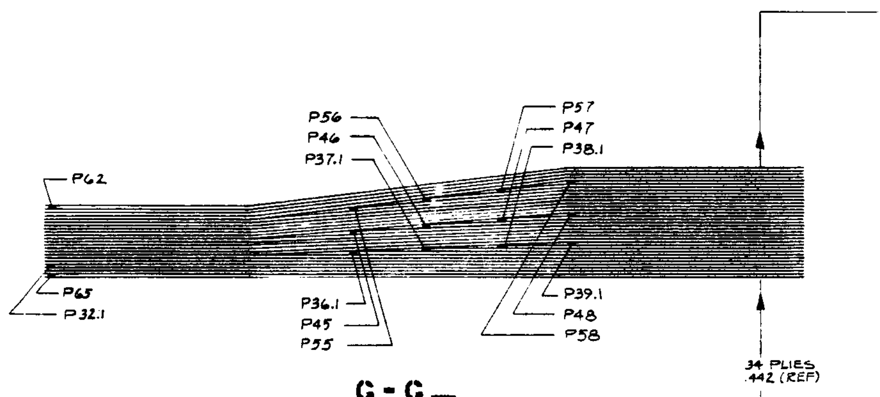


FOLDOUT FRAME



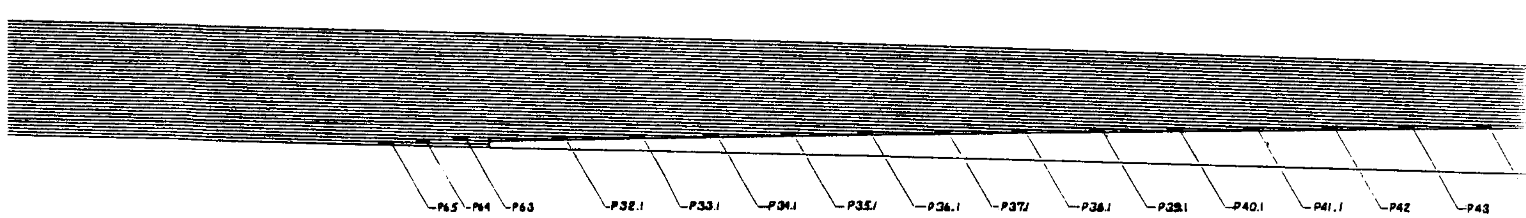
24 23



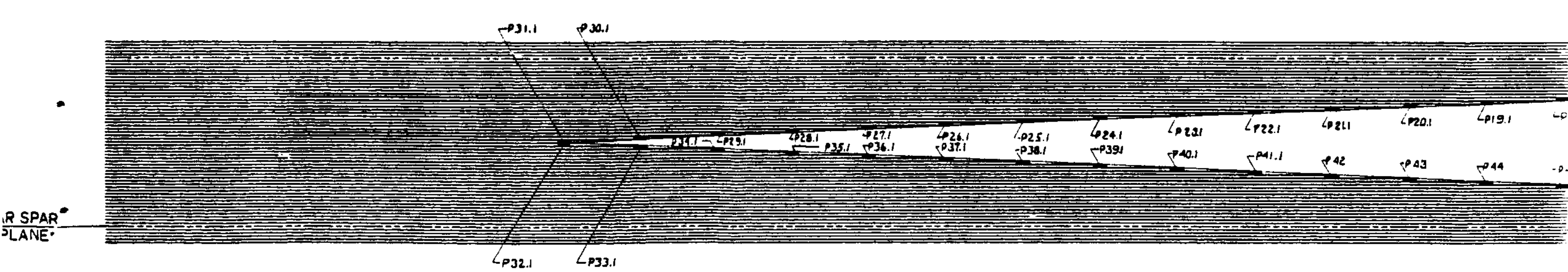


G - G [7]
DIAGRAMMATIC ONLY

FOLDOUT FRAME 2



DIAG



AMC7849 | SHEET 2

20 19

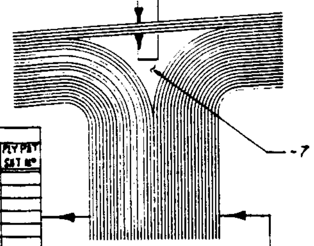


TABLE C

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DRCTN	PLY PAT SHT N°
P 65	SEE	TABLE	A	
P 64				
P 63				
P 62				
P 61				
P 60				
P 59				
P 54				
P 53				
P 52				
P 51				
P 50				
P 49				
P 44				
P 43				
P 42				
P 41.1				
P 40.1				
P 35.1				
P 34.1				
P 33.1				
P 32.1				
P 31.1				
P 30.1				
P 29.1				
P 28.1				
P 23.1				
P 22.1				
P 21.1				
P 20.1				
P 19.1				
P 14.1				
P 13.1				
P 12.1				
P 11.1				
P 10.1				
P 9.1				
P 4				
P 3				
P 2				
P 1	SEE	TABLE	A	

C-C
7
DIAGRAMMATIC
ONLY

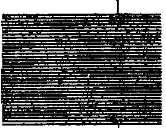


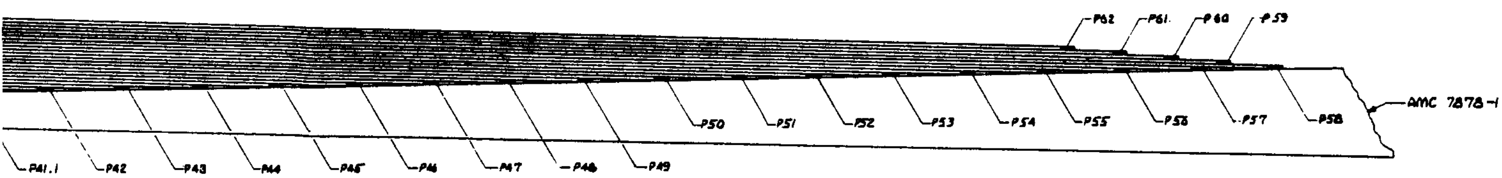
TABLE D

PLY LAYUP SEQUENCE				
PLY N°	N° REQD	MAKE FROM	FIBER DRCTN	PLY PAT SHT N°
P62	SEE	TABLE	A	
P61				
P60				
P59				
P58				
P57				
P56				
P55				
P54				
P53				
P52				
P51				
P50				
P49				
P48				
P47				
P46				
P45				
P44				
P43				
P42				
P41.1				
P40.1				
P39.1				
P38.1				
P37.1				
P36.1				
P35.1				
P34.1				
P33.1				
P32.1				
P63				
P64				
P65	SEE	TABLE	A	

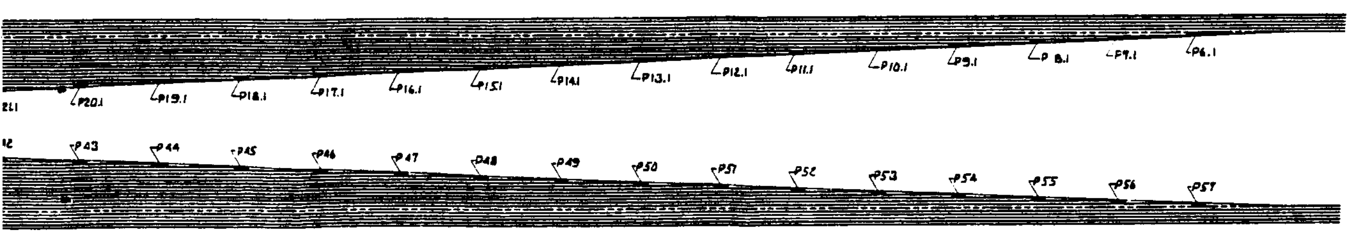
ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

FOLDOUT FRAME



F-F
6
DIAGRAMMATIC
ONLY



E-E
5
DIAGRAMMATIC
ONLY

SHEET 2

20 19

FIGURE A4. DRAWING AMC7849 – LOWER REAR SPAR ASSEMBLY (SHEET 4 OF 4)

2

BLUEPRINT:
PRINT ONLY SHEETS LISTED BELOW

SHEET REV STATUS			
	3	2	1
	-	-	-

ZONE	LTR	DESCRIPTION	DATE	APPROVED
		REVISIONS		

GEN. NOTES CONT'D.

18. FOR BI-WEAVE CLOTH WARP & FILL ARE INTERCHANGEABLE.
19. ALLOW VOIDS TO FILL WITH EXCESS RESIN.

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED (APPLY AS NECESSARY)

1. FOR FAB WITH A DIMENSIONALLY ACCURATE REPRO, TWO PLACE DEC TOLERANCES APPLY WHERE DIM ARE NOT GIVEN.
2. LOFT DESIGNATION IS FOR ENGRG REF ONLY.
3. FAB STANDARDS & TOOLING HOLES PER DPS 4.710.
4. TOOLING & PIN HOLE DIA INDICATED ON BODY OF DWG ARE MAX, SMALLER HOLES ARE PERMISSIBLE.
5. EDGE DISTANCE FOR ATTACHMENTS MAY VARY FROM THAT SHOWN ON DWG BY .03 ON DETAILS, 2D MIN ACCEPTABLE ON ASSY.
6. ASSEMBLY SHOP PRACTICE PER DPS 2.70-2.
7. HEAT TREAT 2024-0 TO 2024-T42, 2014-0 & T3 TO 2014-T6 & 7075-0 TO 7075-T62 PER DPS 7.00.
8. INSTALL RIVETS & FLUSH SCREWS PER S5076260.
9. INSTALL HI-LOK PINS PER S7933654 & LOCKBOLTS PER S7933655. STANDARD INTERFERENCE FITS APPLY UNLESS OTHERWISE INDICATED BY SYMBOL DESIGNATION.
10. FORM ALUMINUM ALLOY PER DPS 3.69.
11. JOGGLES PER S1293000.
12. ATTACH NUTPLATES WITH MS20426AD3 RIVETS.
13. IDENTIFY PER DPS 3.02.
14. STATION NO. APPLY TO BASIC __________ ONLY. FOR OTHER SERIES SEE DWG __________ FOR STATION RELATIONSHIP.
15. POINTS LOCATED BY MASTER DIAGRAM __________.
16. LOCATION FOR ATTACHMENT INSTALLED ON SUBQ ASSY.
17. LOCATION FOR ATTACHMENT IS ON THE DWG INVOLVED.
18. LOCATION DUPLICATED FROM A PRECEDING VIEW.
19. ATTACHMENT CALLED OUT ON OTHER DWGS.
20. LAY UP AND CURE LAMINATES PER DPS 1.622.
21. WHERE NECESSARY TO JOIN ADJACENT WIDTHS OF CLOTH, THE EDGES SHALL OVERLAP .50 MIN. STAGGER OVERLAPS. OVERLAPS SHALL NOT BE IN AREAS OF P29, P30, P31, P60, P61 & P62. OVERLAPS SHALL BE IN +45° DIRECTION ONLY.
22. FASTENERS ARE CODED AS FOLLOWS:

XBB 6/5 INDICATES: HLT335-6-5 PIN
NAS1252-10H WASHER
MS21042L3 NUT

XBB 8/5 INDICATES: HLT335-8-5 PIN
NAS1252-416H WASHER
MS21042L4 NUT

XBB 8/8 INDICATES: HLT335-8-8 PIN
NAS1252-416H WASHER
MS21042L4 NUT

XBB 8/9 INDICATES: HLT335-8-9 PIN
NAS1252-416H WASHER
MS21042L4 NUT

XBB 8/12 INDICATES: HLT335-8-12 PIN
NAS1252-416H WASHER
MS21042L4 NUT

XBB 8/13 INDICATES: HLT335-8-13 PIN
NAS1252-416H WASHER
MS21042L4 NUT

XBB 8/14 INDICATES: HLT335-8-14 PIN
NAS1252-416H WASHER
MS21042L4 NUT

XBB 10/5 INDICATES: HLT335-10-5 PIN
NAS1252-516H WASHER
MS21042L5 NUT

XBB 10/8 INDICATES: HLT335-10-8 PIN
NAS1252-516H WASHER
MS21042L5 NUT

XBB 10/9 INDICATES: HLT335-10-9 PIN
NAS1252-516H WASHER
MS21042L5 NUT

23. HOLE PATTERN DIMENSIONS ARE BASIC. PATTERN MUST BE DUPLICATED FROM MASTER TO INSURE INTERCHANGEABILITY.
24. TEST FLEXURAL STRENGTH, FLEXURAL MODULUS, SHORT BEAM SHEAR STRENGTH, RESIN CONTENT AND VOID CONTENT PER DMS 2163.
25. WET SEAL ALL FASTENERS IN CONTACT WITH GRAPHITE PER DPS 2.512.
26.

ENGINEERING REQUIREMENT
INSPECT PER DPS 4.738
TYPE 2 CLASS T.B.D.

27. UNDIMENSIONED DRAWING SHEETS WILL BE FURNISHED AS FULL SCALE REPRODUCTIONS ON REQUEST.

:OUT FRAME

:RIGINAL PAGE IS
:F POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

3

FOLDOUT FRAME

...CONSISTS OF PARTS
...3.1, P23.2, P23.3, P23.4
...4.1, P24.2, P24.3, P24.4
...5.1, P25.2, P25.3, P25.4
...9.1, P29.2, P29.3, P29.4
...0.1, P30.2, P30.3, P30.4
...1.1, P31.2, P31.3, P31.4
...4.1, P54.2, P54.3, P54.4
...5.1, P55.2, P55.3, P55.4
...6.1, P56.2, P56.3, P56.4
...0.1, P60.2, P60.3, P60.4
...1.1, P61.2, P61.3, P61.4
...2.1, P62.2, P62.3, P62.4

SEE SEPARATE PARTS LIST

TEMPERATURE ___ HUMIDITY ___
GRIDS ARE ___ IN ___ INCHES
RECORDED BY ___ DATE ___

FIRST RELEASE OF PRINTS NOV ... 978 | ORIGINAL DATE OF DRAWING ... 1978

DASH NUMBERS OF THIS DWG
ODD DASH NUMBERS SHOWN
EVEN DASH NUMBERS OPPOSITE

FINISH

AMC7844 | DC-10
NEXT ASSY | USED ON
FIRST APPLICATION
FOR COMPLETE USAGE DATA SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES
ANGLES ± 0°-30'
3 PLACE DEC ± .015
2 PLACE DEC ± .03

ORIG SECTION MC01 | RELEASE CODE | CUSTOMER

CONTRACT NO. NAS1-14869
STRESS ... SUTTON
CHECK G. ESPEN 10-26-78
DESIGN ... HAWLEY
PREP BY R.W. SMITH
DESIGN ACTIVITY APPROVAL

DOUGLAS AIRCRAFT COMPANY
LONG BEACH, CALIFORNIA

RIB INSTL - COMPOSITE
VERT. STAB. BASE

UNDIMENSIONED DRAWING

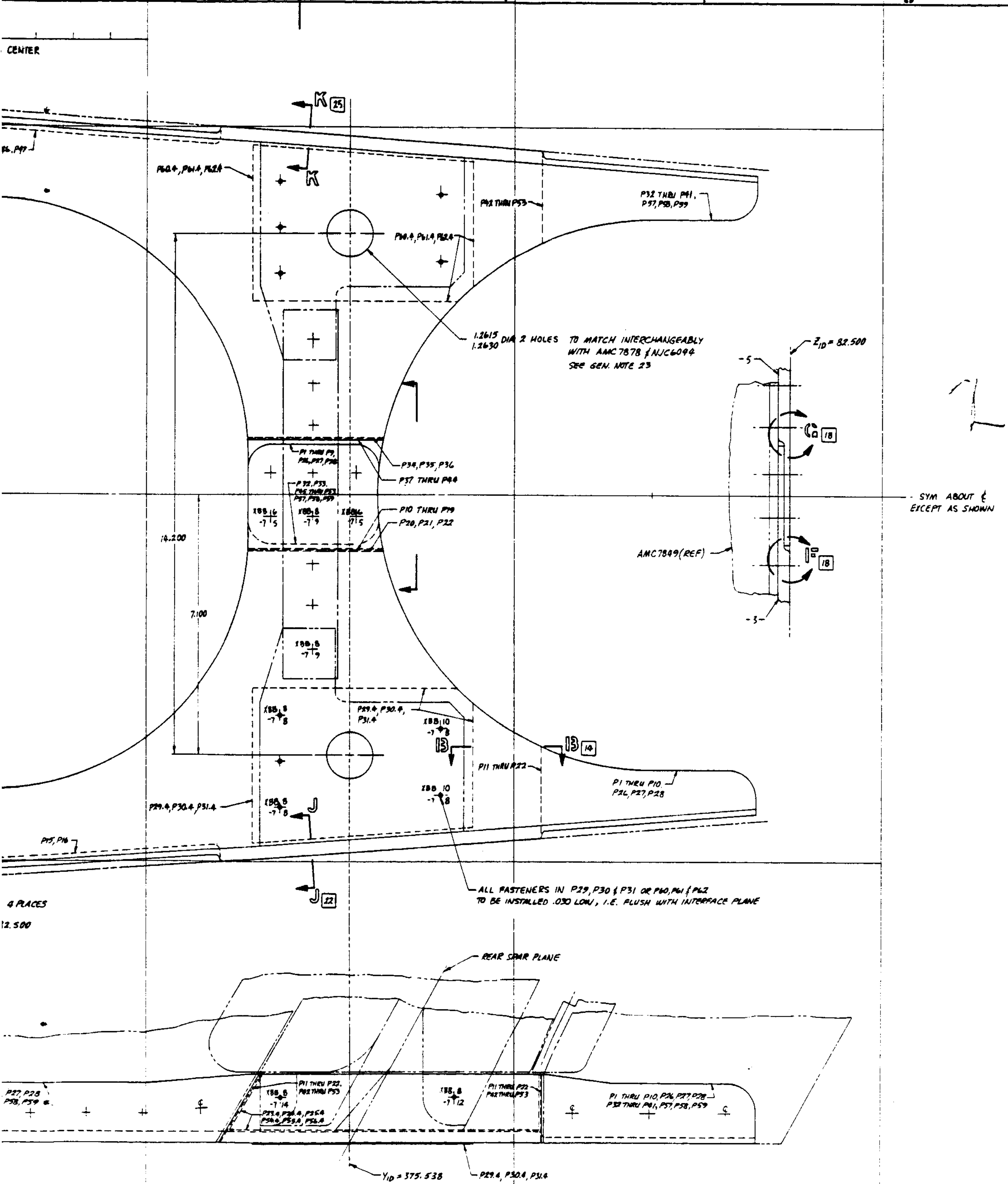
SIZE J | CODE IDENT NO 88277 | AMC7853
SCALE 1/1 & NOTED | SHEET 1 OF 3

AMC7853

AMC7853

2

ACEE-03-PR-9642



PLY NO.	CONSISTS OF PARTS
P23	P23.1, P23.2, P23.3, P23.4
P24	P24.1, P24.2, P24.3, P24.4
P25	P25.1, P25.2, P25.3, P25.4
P29	P29.1, P29.2, P29.3, P29.4
P30	P30.1, P30.2, P30.3, P30.4
P31	P31.1, P31.2, P31.3, P31.4
P54	P54.1, P54.2, P54.3, P54.4
P55	P55.1, P55.2, P55.3, P55.4
P56	P56.1, P56.2, P56.3, P56.4
P60	P60.1, P60.2, P60.3, P60.4
P61	P61.1, P61.2, P61.3, P61.4
P62	P62.1, P62.2, P62.3, P62.4

AMC7853 | SHEET 1

53 – BASE RIB ASSEMBLY (SHEET 1 OF 6)

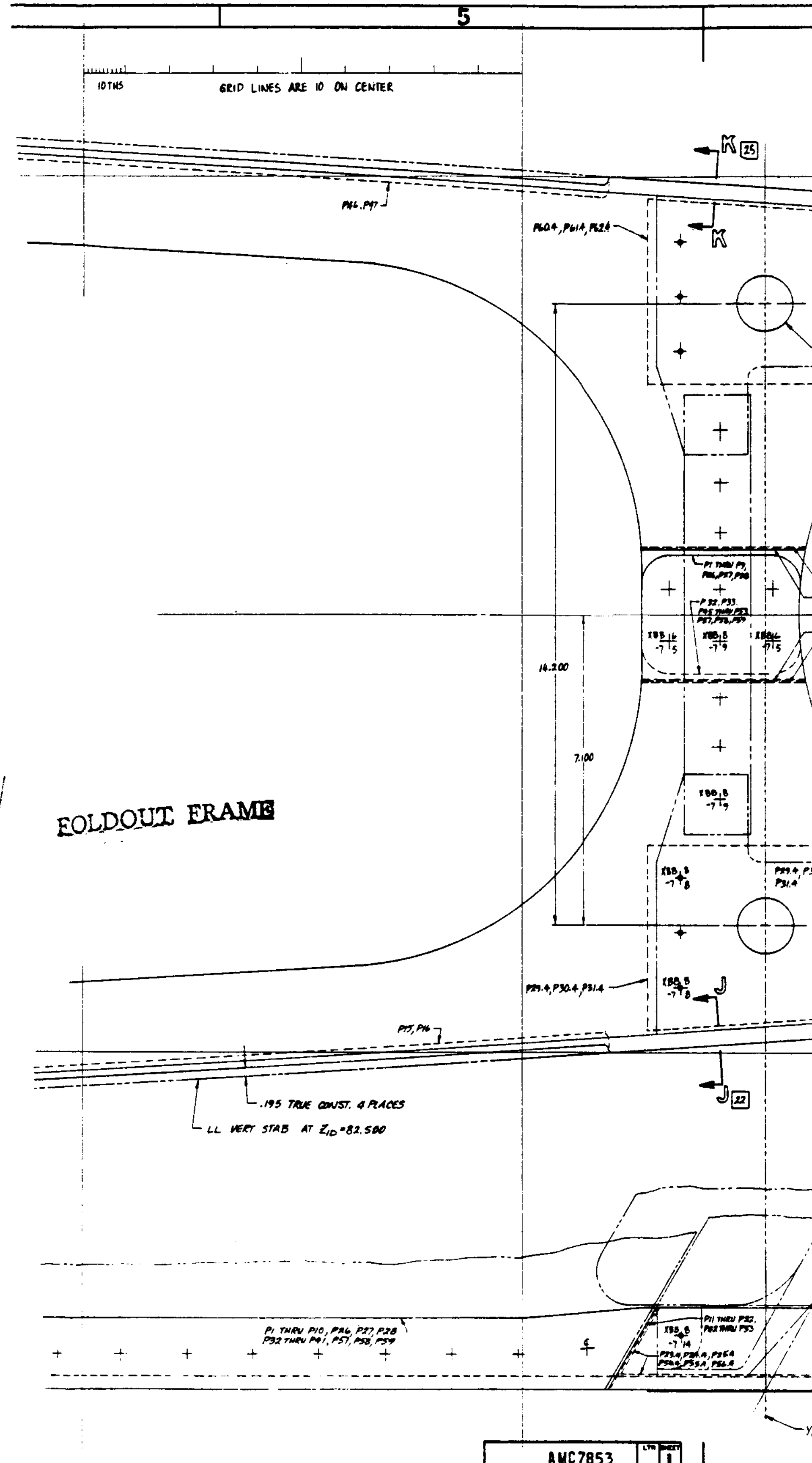


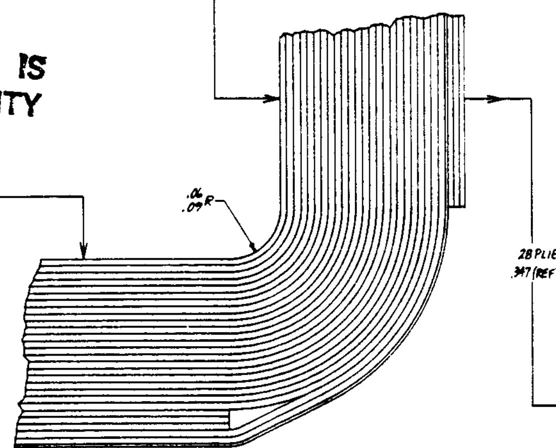
FIGURE A5. DRAWING AMC7853 – BASE RIB ASSEMBLY (SHEET 1 OF 6)

TABLE B

PLY LAY UP SEQUE			
PLY NO.	NO. REQD	MAKE FROM	FIB DI (RE
P1	SEE	TABLE	A
P2			
P3			
P4			
P5			
P6			
P7			
P8			
P9			
P10			
P11			
P12			
P13			
P14			
P15			
P16			
P17			
P18			
P19			
P20			
P21			
P22			
P26			
P27			
P28	SEE	TABLE	A
P29.3	1	-11	OP
P30.3	1	-11	OP
P31.3	1	-11	OP

TABLE A

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	1	-7	0/90	
P2			±45	
P3			±45	
P4			0/90	
P5			0/90	
P6			±45	
P7			±45	
P8			0/90	
P9			0/90	
P10			±45	
P11			±45	
P12			0/90	
P13			0/90	
P14			±45	
P15			±45	
P16			0/90	
P17			0/90	
P18			±45	
P19			±45	
P20			0/90	
P21			0/90	
P22			±45	
P23.3			±45	
P24.3			0/90	
P25.3			±45	
P26			±45	
P27		-7	0/90	
P28	1	-9	OPT	



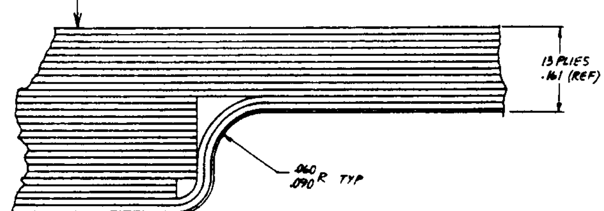
C 6

DIAGRAMMATIC ONLY

FOLDOUT FRAME

TABLE E

PLY LAY UP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	ZONE 16
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22	SEE	TABLE	A	ZONE 16
P23.2	1	-7	±45	
P24.2	1	-7	0/90	
P25.2	1	-7	±45	
P26	SEE	TABLE	A	ZONE 16
P27				
P28	SEE	TABLE	A	ZONE 16



E 9

DIAGRAMMATIC ONLY

AMC7853 | LTR - | SHEET 2

FIGURE A5. DRAWING AMC7853 – BASE RIB ASSEMBLY (SHEET 3 OF 6)

15 14

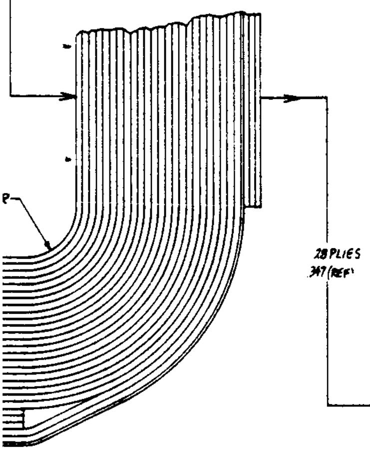
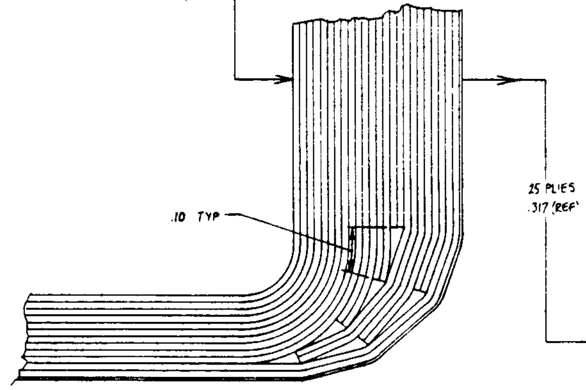


TABLE B				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	ZONE 16
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	ZONE 16
P29.3	1	-11	OPT.	
P30.3	1	-11	OPT.	
P31.3	1	-11	OPT.	



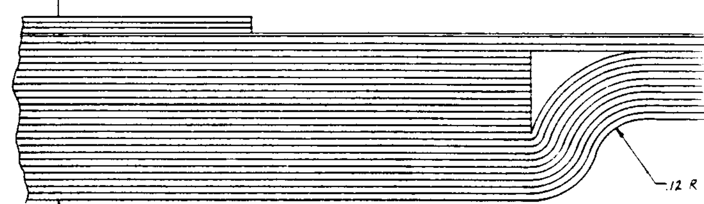
TABL[E]		
PLY LAYUP		
PLY NO.	NO. REQD.	MA[KE] FR[OM]
P1	SEE	TAB[LE]
P2		
P3		
P4		
P5		
P6		
P7		
P8		
P9		
P10		
P11		
P12		
P13		
P14		
P15		
P16		
P17		
P18		
P19		
P20		
P21		
P22		
P26		
P27		
P28	SEE	TAB[LE]

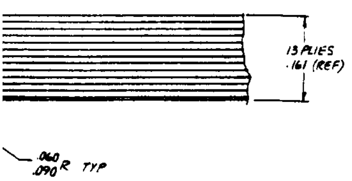
C [6]
[DIAGRAM]MATIC ONLY

D [8]
3 PLACES
DIAGRAMMATIC ONLY

ORIGINAL
OF POOR

[F]OLDOUT FRAME





B-B [4]
DIAGRAMMATIC ONLY

[9]
[DIAGRAMMA]TIC ONLY

TABLE C				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQ'D	MAKE FROM	FIBER DIR. (REF)	PLY PATT SH. NO.
P1	SEE	TABLE	A	ZONE 16
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	ZONE 16
P29.4	1	-11	OPT.	
P30.4	1	-11	OPT.	
P31.4	1	-11	OPT.	

DOUGLAS

[S]HEET 3 OF 6)

13

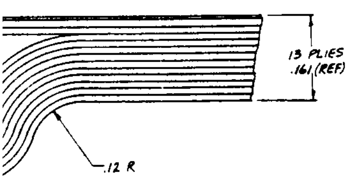
ZONE	LTR	DESCRIPTION	DATE	APPROVED
REVISIONS				
—	·	SEE SHEET 1	—	—

TABLE D

PLY LAYUP SEQUENCE

PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	ZONE 16
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	ZONE 16

RIGINAL PAGE IS
F POOR QUALITY

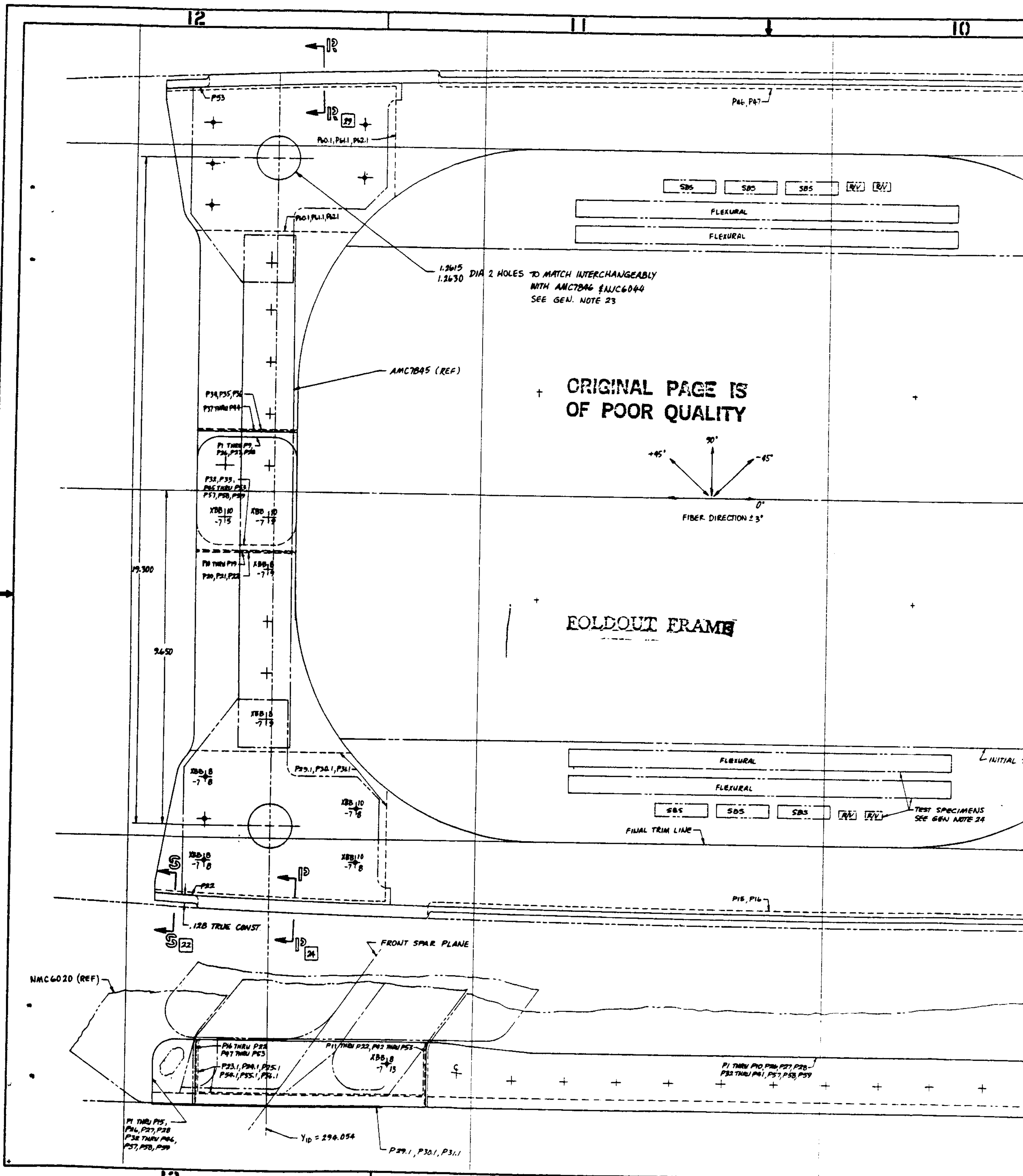


AMC7853

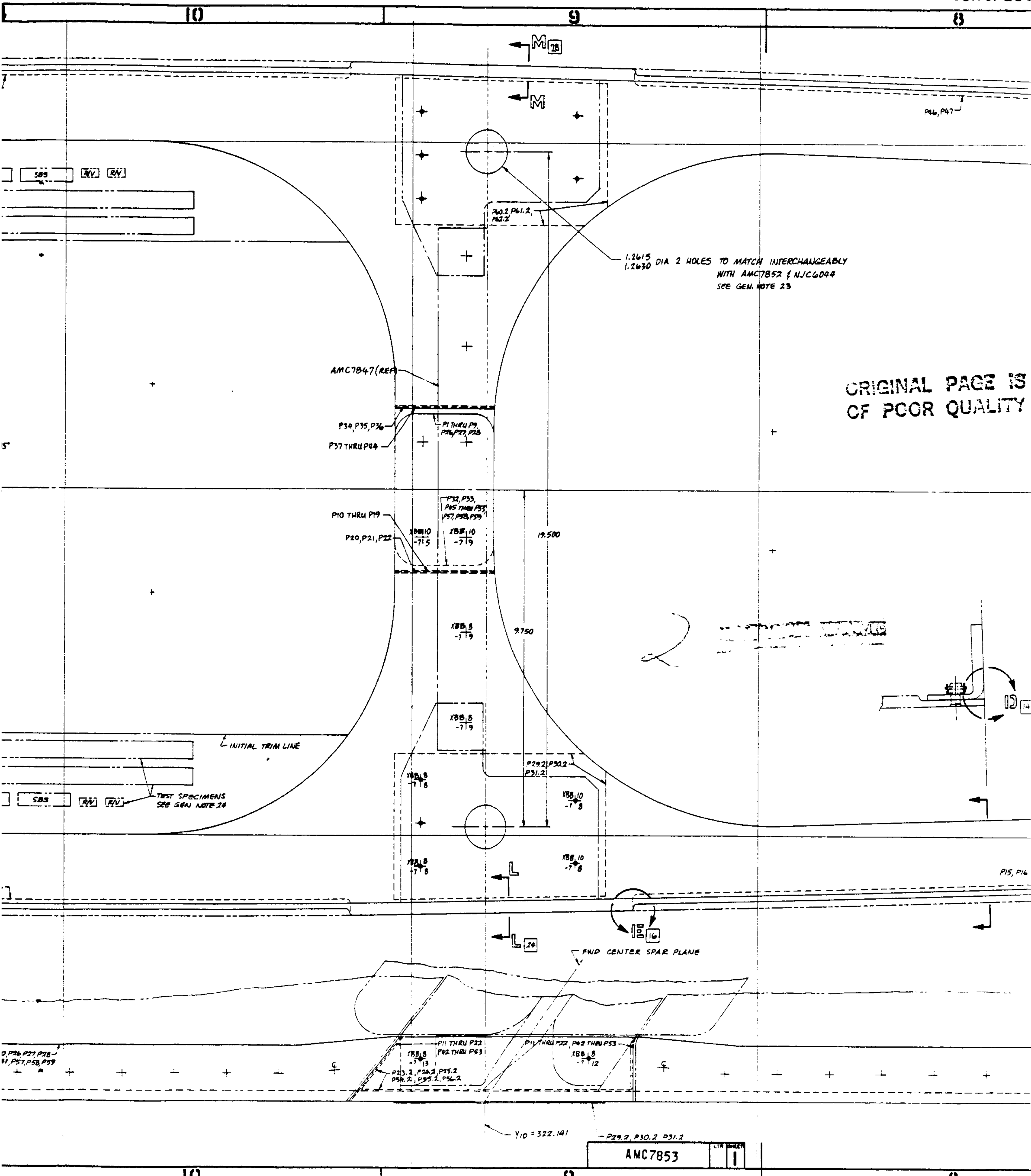
AMC7853

DIAGRAMMATIC VIEWS ONLY
GRIDS & GRID CHECK NOT REQD
R.W. SMITH

	SIZE	CODE IDENT NO	
DOUGLAS	J	88277	AMC7853
			SHEET 2


ORIGINAL PAGE IS
OF POOR QUALITY
FOLDOUT FRAME
1.2615
1.2630 DIA 2 HOLES TO MATCH INTERCHANGEABLY
WITH AMC7846 & NJC6044
SEE GEN. NOTE 23
AMC7845 (REF)
FLEXURAL
SBS
FIBER DIRECTION ± 3°
TEST SPECIMENS
SEE GEN NOTE 24
FINAL TRIM LINE
.128 TRUE CONST.
FRONT SPAR PLANE
NMC6020 (REF)
12
11
10

Douglas
Contract



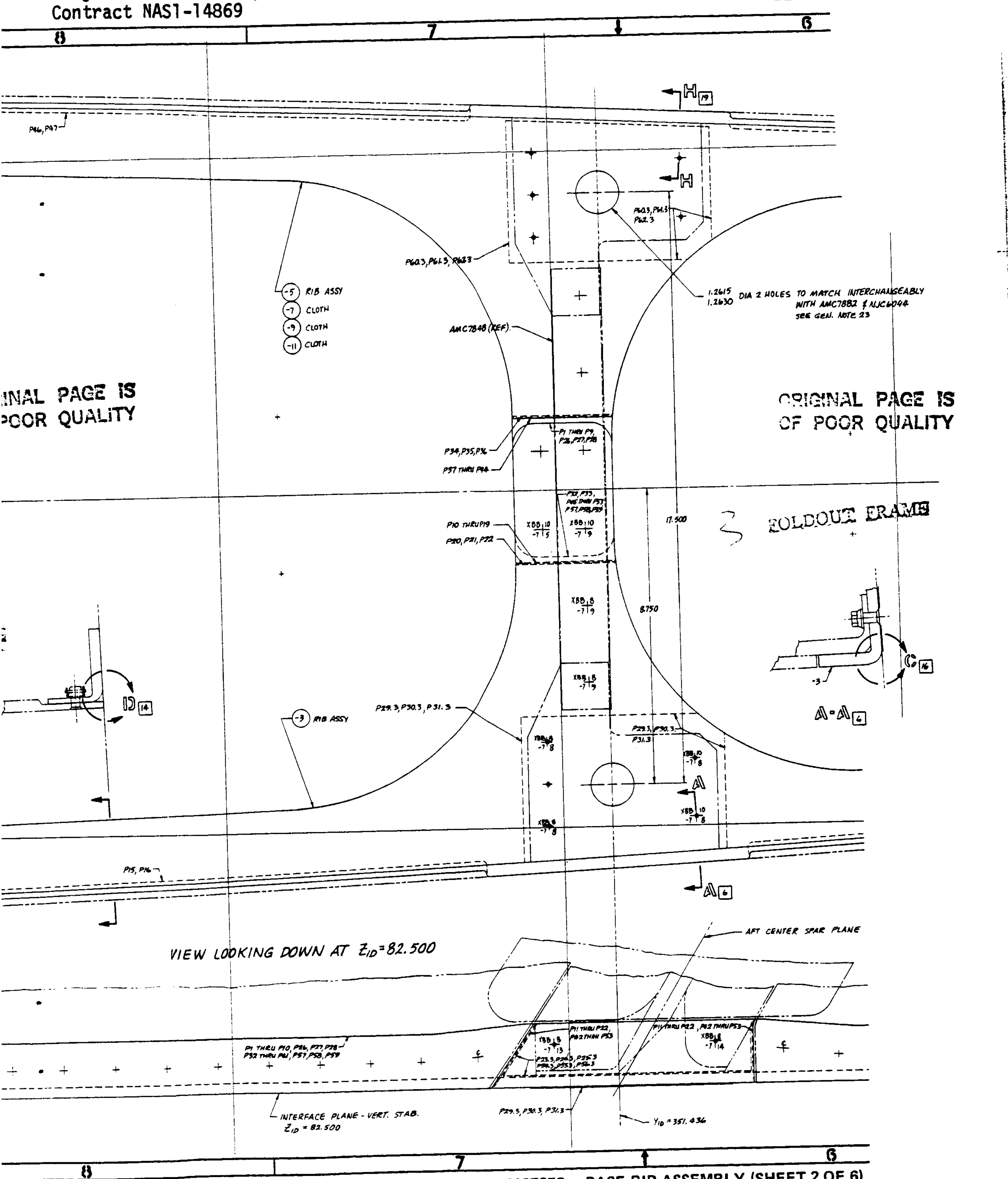


FIGURE A5. DRAWING AMC7853 – BASE RIB ASSEMBLY (SHEET 2 OF 6)

20

19

28 PLIES
.356 (REF)

ORIGINAL PAGE IS
OF POOR QUALITY

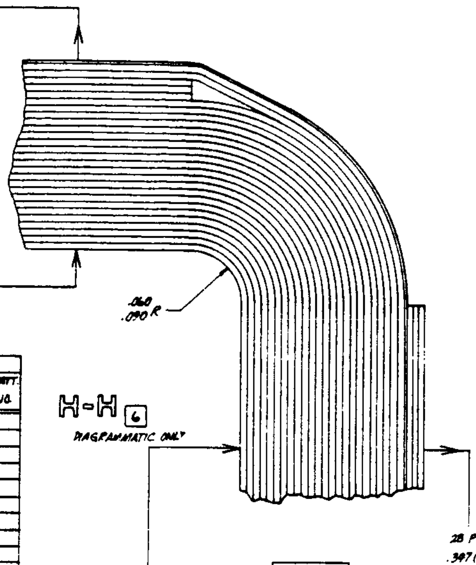
TABLE J

PLY LAYUP SEQUENCE

PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR (REF)	PLY SH.
P32	1	-7	0/90	
P33			±45	
P34			±45	
P35			0/90	
P36			0/90	
P37			±45	
P38			±45	
P39			0/90	
P40			0/90	
P41			±45	
P42			±45	
P43			0/90	
P44			0/90	
P45			±45	
P46			±45	
P47			0/90	
P48			0/90	
P49			±45	
P50			±45	
P51			0/90	
P52			0/90	
P53			±45	
P54.3			±45	
P55.3			0/90	
P56.3			±45	
P57			±45	
P58		-7	0/90	
P59	1	-9	OPT	

FOLDOUT FRAME

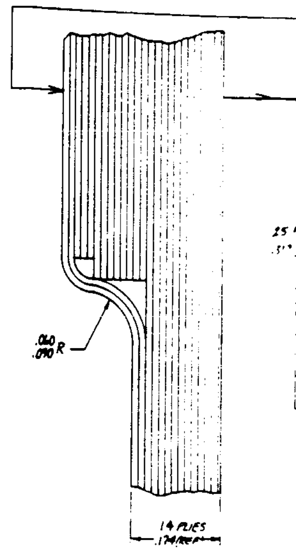
19 18 17



H-H 6
DIAGRAMMATIC ONLY

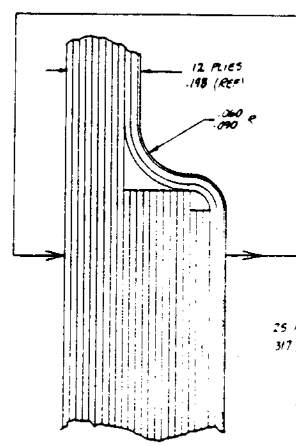
TABLE J			
LAYUP SEQUENCE			
NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
	-7	0/90	
		±45	
		±45	
		0/90	
		0/90	
		±45	
		±45	
		0/90	
		0/90	
		±45	
		±45	
		0/90	
		0/90	
		±45	
		±45	
		0/90	
		0/90	
		±45	
		±45	
		0/90	
		0/90	
		±45	
		±45	
		0/90	
		±45	
		±45	
	-7	0/90	
	-9	OPT	

TABLE H				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P32	SEE	TABLE	J	
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P57				
P58				
P59	SEE	TABLE	J	
P60.3	1	-11	OPT	
P61.3	1	-11	OPT	
P62.3	1	-11	OPT	



G 3
4 PLACES
DIAGRAMMATIC ONLY

TABLE G				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P32	SEE	TABLE	J	
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P57				
P58				
P59	SEE	TABLE	J	



F 3
4 PLACES
DIAGRAMMATIC ONLY

TABLE F				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. REF.	PLY PATT. SH. NO.
P1	SEE	TABLE	A	ZONE 6
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	ZONE 6

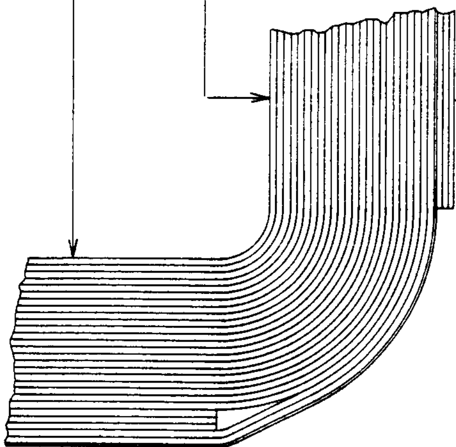
FIGURE A5. DRAWING AMC7853 – BASE RIB ASSEMBLY (SHEET 4 OF 6)

24 23

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE Q

PLY LAY UP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22	SEE	TABLE	A	
P23.1	1	-7	±45	
P24.1	1	-7	0/90	
P25.1	1	-7	±45	
P26	SEE	TABLE	A	
P27				
P28	SEE	TABLE	A	



P-P [12]

DIAGRAMMATIC ONLY

TABLE N

PLY LAY UP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	
P29.1	1	-11	OPT.	
P30.1	1	-11	OPT.	
P31.1	1	-11	OPT.	

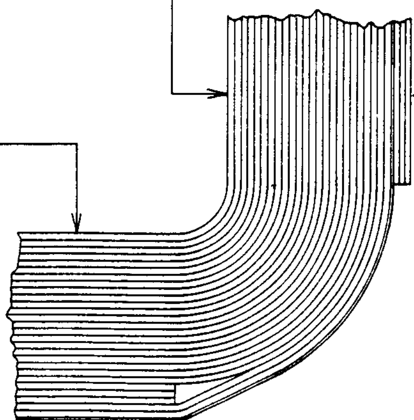
FOLDOUT FRAME

TABLE O

PLY LAY UP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	
P29.2	1	-11	OPT.	
P30.2	1	-11	OPT.	
P31.2	1	-11	OPT.	

TABLE P

PLY LAY UP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22	SEE	TABLE	A	
P23.2	1	-7	±45	
P24.2	1	-7	0/90	
P25.2	1	-7	±45	
P26	SEE	TABLE	A	
P27				
P28	SEE	TABLE	A	



L-L [9]

DIAGRAMMATIC ONLY

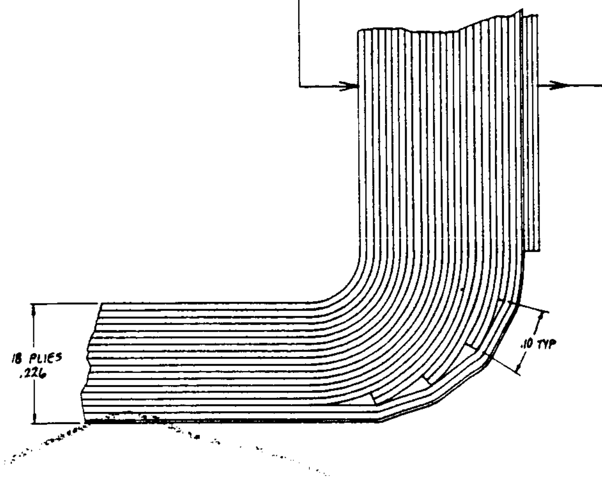
AMC7853 LTR - SHEET 3

FIGURE A5. DRAWING AMC7853 – BASE RIB ASSEMBLY (SHEET 5 OF 6)

22 21

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	—	SEE SHEET 1		

TABLE L				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	
P29.1	1	-11	OPT	
P30.1	1	-11	OPT	
P31.1	1	-11	OPT	



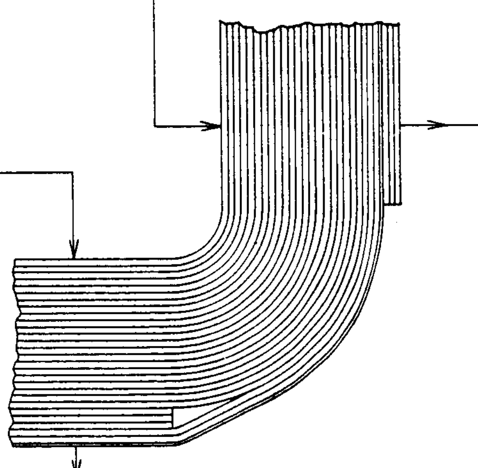
S-S [12]

DIAGRAMMATIC ONLY

2 FOLDOUT FRAME

TABLE K				
PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	SEE	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22				
P26				
P27				
P28	SEE	TABLE	A	
P29.4	1	-11	OPT	
P30.4	1	-11	OPT	
P31.4	1	-11	OPT	

TABLE M				
PLY LAY UP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P1	See	TABLE	A	
P2				
P3				
P4				
P5				
P6				
P7				
P8				
P9				
P10				
P11				
P12				
P13				
P14				
P15				
P16				
P17				
P18				
P19				
P20				
P21				
P22	SEE	TABLE	A	
P23.4	1	-7	±45	
P24.4	1	-7	0/90	
P25.4	1	-7	±45	
P26	SEE	TABLE	A	
P27				
P28	SEE	TABLE	A	



J-J [4]

DIAGRAMMATIC ONLY

ORIGINAL PAGE IS OF POOR QUALITY

DIAGRAMMATIC VIEWS ONLY
GRIDS & GRID CHECK NOT REQD
R.W. SMITH

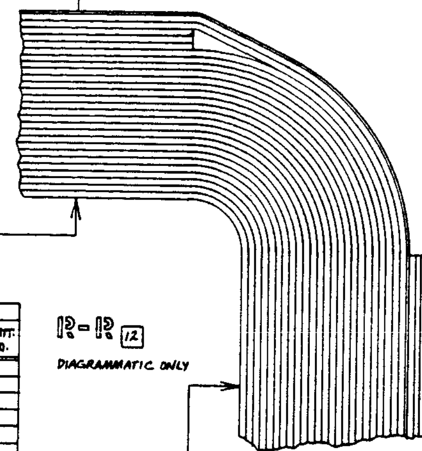
DOUGLAS	SIZE J	CODE IDENT NO 88277	AMC7853
			SHEET 3

AMC7853

AMC7853

28

27



R-R [12]

DIAGRAMMATIC ONLY

TABLE W

PLY LAY UP SEQUENCE

PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P32	SEE	TABLE	J	
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53	SEE	TABLE	J	
P54.1	1	-7	±45	
P55.1	1	-7	0/90	
P56.1	1	-7	±45	
P57	SEE	TABLE	J	
P58				
P59	SEE	TABLE	J	

TABLE V

PLY LAY UP SE

PLY NO.	NO. REQD.	MAKE FROM
P62.1	1	-11
P61.1	1	-11
P60.1	1	-11
P59	SEE	TABLE
P58		
P57		
P53		
P52		
P51		
P50		
P49		
P48		
P47		
P46		
P45		
P44		
P43		
P42		
P41		
P40		
P39		
P38		
P37		
P36		
P35		
P34		
P33		
P32	SEE	TABLE

FOLDOUT FRAME

ORIGINAL PAGE IS OF POOR QUALITY

TABLE U

PLY LAY UP SEQUENCE

PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P59	SEE	TABLE	J	
P58				
P57	SEE	TABLE	J	
P56.2	1	-7	±45	
P55.2	1	-7	0/90	
P54.2	1	-7	±45	
P53	SEE	TABLE	J	
P52				
P51				
P50				
P49				
P48				
P47				
P46				
P45				
P44				
P43				
P42				
P41				
P40				
P39				
P38				
P37				
P36				
P35				
P34				
P33				
P32	SEE	TABLE	J	

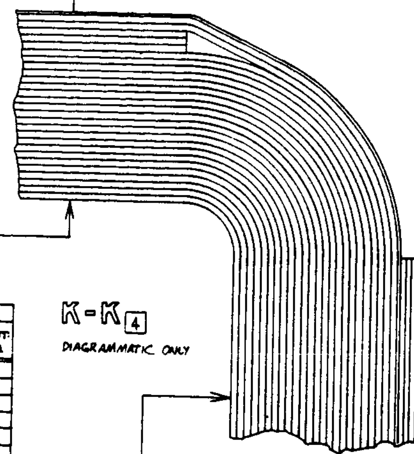
27 26 25

TABLE V

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P62.1	1	-11	OPT	
P61.1	1	-11	OPT	
P60.1	1	-11	OPT	
P59	SEE	TABLE	J	
P58				
P57				
P53				
P52				
P51				
P50				
P49				
P48				
P47				
P46				
P45				
P44				
P43				
P42				
P41				
P40				
P39				
P38				
P37				
P36				
P35				
P34				
P33				
P32	SEE	TABLE	J	

TABLE S

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P32	SEE	TABLE	J	
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53	SEE	TABLE	J	
P54.4	1	-7	±45	
P55.4	1	-7	0/90	
P56.4	1	-7	±45	
P57	SEE	TABLE	J	
P58				
P59	SEE	TABLE	J	



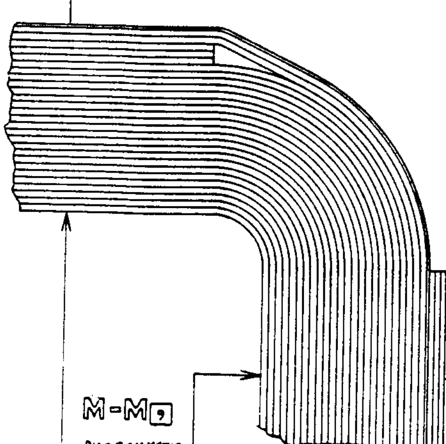
K-K [4]
DIAGRAMMATIC ONLY

TABLE R

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P32	SEE	TABLE	J	
P33				
P34				
P35				
P36				
P37				
P38				
P39				
P40				
P41				
P42				
P43				
P44				
P45				
P46				
P47				
P48				
P49				
P50				
P51				
P52				
P53				
P57				
P58				
P59	SEE	TABLE	J	
P60.4	1	-11	OPT	
P61.4	1	-11	OPT	
P62.4	1	-11	OPT	

2 FOLDOUT FRAME

...SEQUENCE	
FIBER DIR. (REF)	PLY PATT. SH. NO.
J	
J	
±45	
0/90	
±45	
J	
J	



M-M [9]
DIAGRAMMATIC ONLY

TABLE T

PLY LAYUP SEQUENCE				
PLY NO.	NO. REQD.	MAKE FROM	FIBER DIR. (REF)	PLY PATT. SH. NO.
P62.2	1	-11	OPT	
P61.2	1	-11	OPT	
P60.2	1	-11	OPT	
P59	SEE	TABLE	J	
P58				
P57				
P53				
P52				
P51				
P50				
P49				
P48				
P47				
P46				
P45				
P44				
P43				
P42				
P41				
P40				
P39				
P38				
P37				
P36				
P35				
P34				
P33				
P32	SEE	TABLE	J	

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE A5. DRAWING AMC7853 – BASE RIB ASSEMBLY (SHEET 6 OF 6)

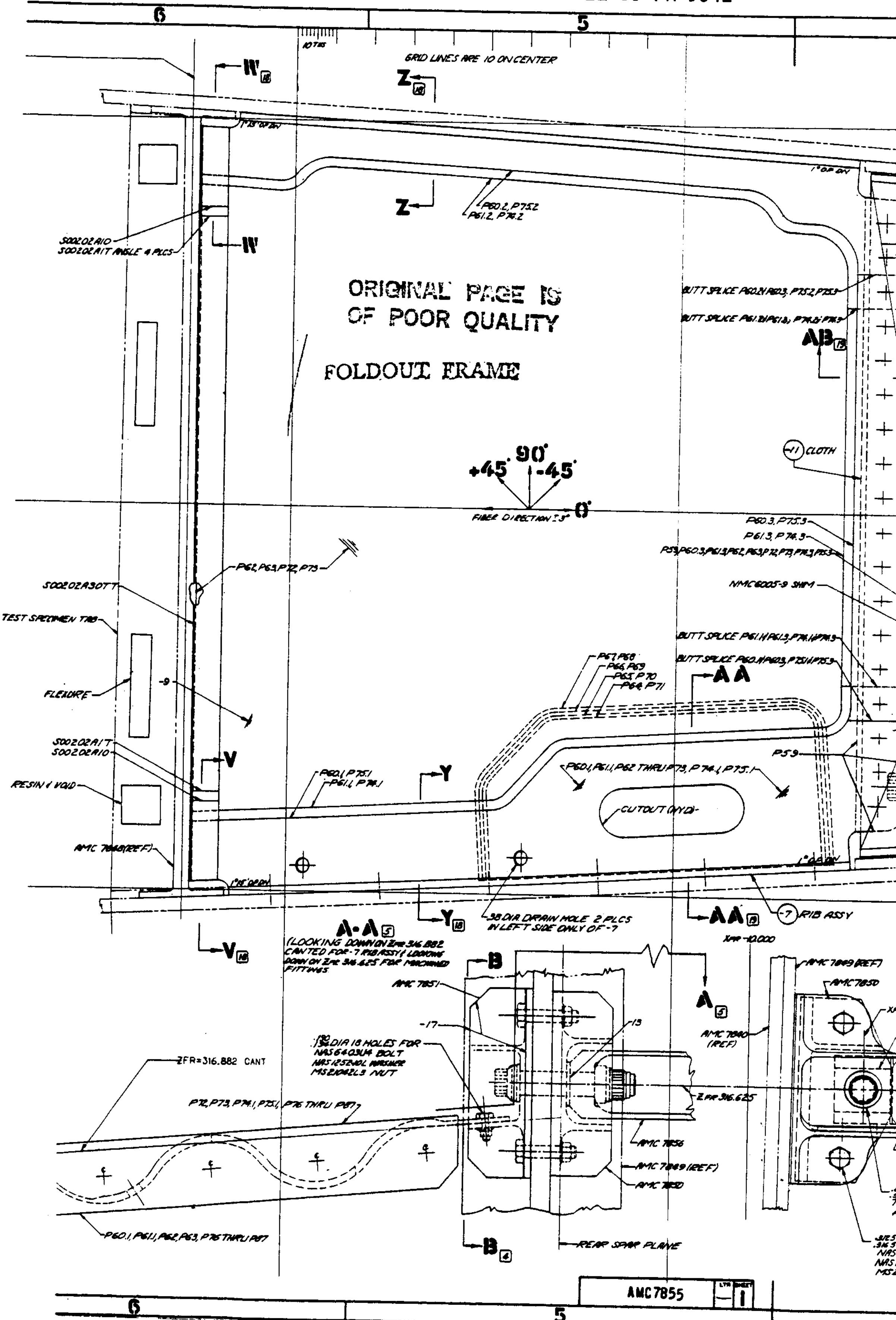
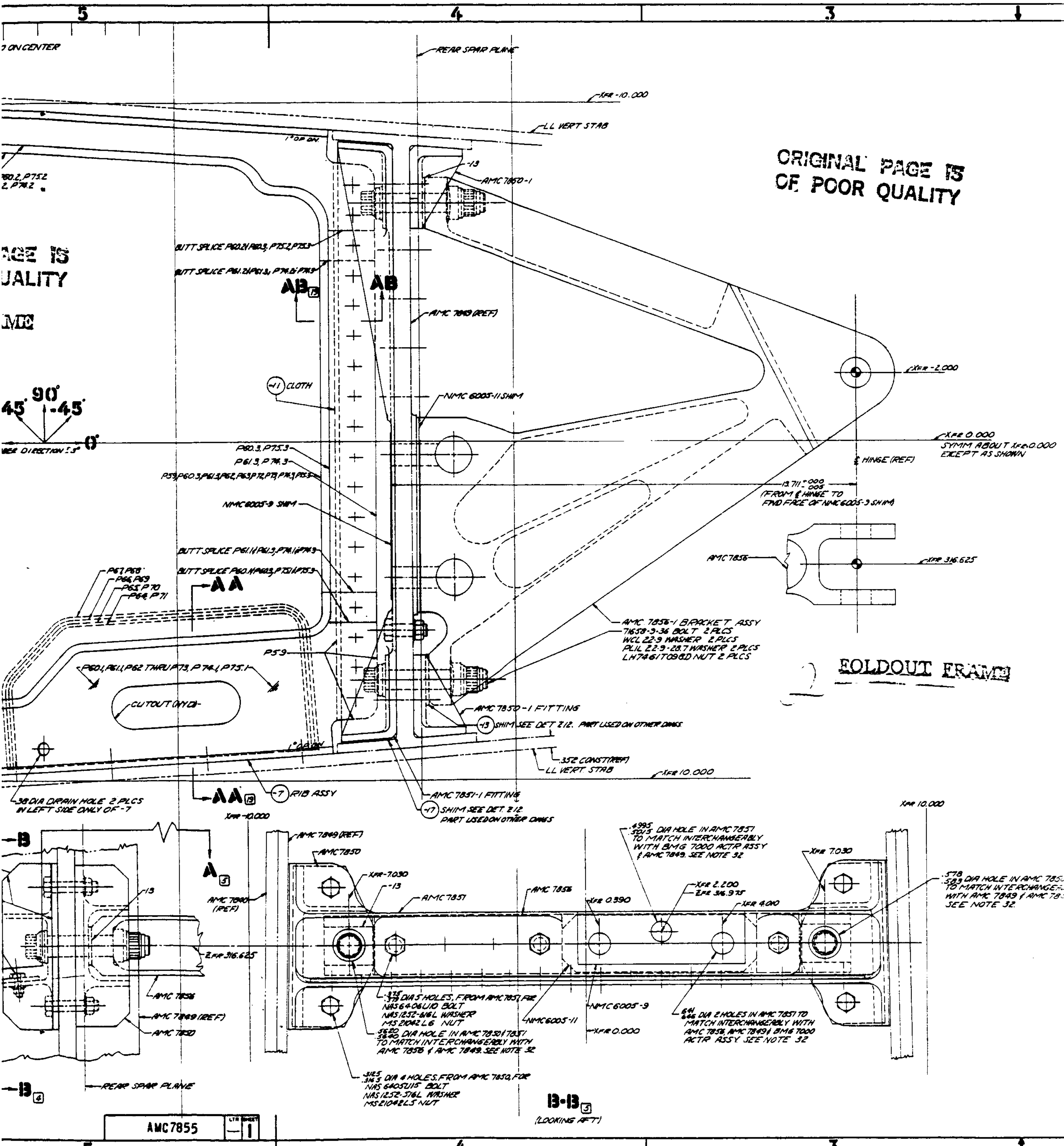


FIGURE A6. DRAWING AMC7855 – Z_{FR} 314.000 RIB INSTALLATION (SHEET 1 OF 4)



ORIGINAL PAGE IS OF POOR QUALITY

FOLDOUT FRAME

AMC7855

5 4 3

RIB INSTALLATION (SHEET 1 OF 4)

MATERIALS AND PRODUCIBILITY ENGINEERING APPROVAL

BLUEPRINT! PRINT ONLY SHEETS LISTED BELOW

SHEET REV STATUS

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

2

S
Y

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED (APPLY AS NECESSARY)

1. FOR FAB WITH A DIMENSIONALLY ACCURATE REPRO, TWO PLACE DEC TOLERANCES APPLY WHERE DIM ARE NOT GIVEN.
2. LOFT DESIGNATION IS FOR ENGRG REF ONLY.
3. FAB STANDARDS & TOOLING HOLES PER DPS 4.710.
4. TOOLING & PIN HOLE DIA INDICATED ON BODY OF DWG ARE MAX, SMALLER HOLES ARE PERMISSIBLE.
5. EDGE DISTANCE FOR ATTACHMENTS MAY VARY FROM THAT SHOWN ON DWG BY .03 ON DETAILS, 2D MIN ACCEPTABLE ON ASSY.
6. ASSEMBLY SHOP PRACTICE PER DPS 2.70-2.
7. HEAT TREAT 2024-0 TO 2024-T42, 2014-0 & T3 TO 2014-T6 & 7075-0 TO 7075-T62 PER DPS 7.00.
8. INSTALL RIVETS & FLUSH SCREWS PER S5076240.
9. INSTALL HI-LOK PINS PER S7933654 & LOCKBOLTS PER S7933655. STANDARD INTERFERENCE FITS APPLY UNLESS OTHERWISE INDICATED BY SYMBOL DESIGNATION.
10. FORM ALUMINUM ALLOY PER DPS 3.69.
11. JOGGLES PER S1292000.
12. ATTACH NUTPLATES WITH MS20426AD3 RIVETS.
13. IDENTIFY PER DPS 3.02.
14. STATION NO. APPLY TO BASIC ________ ONLY. FOR OTHER SERIES SEE DWG ________ FOR STATION RELATIONSHIP.
15. POINTS LOCATED BY MASTER DIAGRAM AMZ 7000
16. LOCATION FOR ATTACHMENT INSTALLED ON SUBQ ASSY.
17. LOCATION FOR ATTACHMENT IS ON THE DWG INVOLVED.
18. LOCATION DUPLICATED FROM A PRECEDING VIEW.
19. ATTACHMENT CALLED OUT ON OTHER DWGS.
20. UNDIMENSIONED DRAWING SHEETS WILL BE FURNISHED AS FULL SCALE REPRODUCTIONS ON REQUEST.
21. INSPECT PER DPS 4.738 TYPE 2, CLASS (TBD)
22. FILL VOIDS PER DPS 1.622.
23. FABRICATE PER DPS 1.622
24. FOR BI-WEAVE CLOTH WARP AND FILL ARE INTERCHANGEABLE
25. ASSEMBLE S00202 & S00203 ANGLES TO -3, -5, & -7 RIB ASSYS & TO AMC 7845, 7847 & 7848 SPAR ASSYS BY COCURE & ADHESIVE BOND USING FM300K ADHESIVES PER DPS 1.966.
26. TEST SHORT BEAM SHEAR & FLEXURE SPECIMENS PER DMS 2163.
27. TEST RESIN & VOID CONTENT PER DMS 2163.
28. BOND -17 & NMC 6005-9 SHIMS TO AMC 7851 & BOND -13 SHIM TO AMC 7850, PER DPS 1.07-2 TYPE II.
29. MACHINE -13 & NMC 6005-9 & -11 SHIMS AS REQD TO ACHIEVE FIT & MAINTAIN HINGE POINT DIM. MAX THICKNESS -13 NOT TO EXCEED .145.
30. MACHINED SURFACES, HOLES AND SPOTFACES PER ANSI B46.1.
31. INSTALL FUL INDICATING WASHERS PER DPS 1.336.
32. HOLE PATTERN DIMENSIONS ARE BASIC. PATTERN MUST BE DUPLICATED FROM MASTER TO INSURE INTERCHANGEABILITY.
33. INSTALL FASTENERS WITH WET SEALANT PER DPS 2.512.
34. BOND NMC 6005-11 SHIM TO AMC 7849 GRAPHITE/EPOXY PER DPS 1.07-2 TYPE II.
35. LOCATE LAP SHEAR SHEAR TEST SPECIMEN UNDER SAME BAG AS THE PARTS. TEST PER DPS 1.966.
36. MACHINE -17 SHIMS AS REQUIRED TO ACHIEVE FIT. MAX. ALLOWABLE GAP .010.
37. CURE THREE (3) (ONE FOR EACH OF -3, -5 & -7) 3x6 LAYUPS UNDER THE SAME BAG AND AT THE SAME TIME AS -3, -5 & -7. (NOTE: IF THE MATERIAL FOR -3, -5 AND -7 IS ALL FROM THE SAME LOT AND -3, -5 & -7 ARE CURED ON THE SAME CURE CYCLE THEN ONLY ONE (1) 3x6 LAYUP IS REQUIRED. DIFFERENT LOTS OF MATERIAL AND/OR DIFFERENT CURE CYCLES REQUIRE DIFFERENT 3X6 LAYUPS.) THE NUMBER OF PLIES AND LAYUP DETAILS SHALL BE PER DMS 2163. TEST AT ROOM TEMPERATURE PER DMS 2163. FLEXURAL STRENGTH, FLEXURAL MODULUS AND SHORT BEAM SHEAR STRENGTH SHALL MEET THE REQMTS OF TABLE 2 DMS 2163.

ORIGINAL PAGE IS OF POOR QUALITY

00

Xre 0.000
SYMM ABOUT Xre 0.000
EXCEPT AS SHOWN

316.625

FRAME

FOLDOUT FRAME

PLY NO.	CONSISTS OF PARTS
P1	P1.1, P1.2
P2	P2.1, P2.2
P13	P13.1, P13.2
P14	P14.1, P14.2
P30	P30.1, P30.2
P31	P31.1, P31.2
P38	P38.1, P38.2
P39	P39.1, P39.2
P60	P60.1, P60.2, P60.3
P61	P61.1, P61.2, P61.3
P74	P74.1, P74.2, P74.3
P75	P75.1, P75.2, P75.3

00

.578/.583 DIA HOLE IN AMC 7850 & 7851 TO MATCH INTERCHANGEABLY WITH AMC 7849 & AMC 7856. SEE NOTE 32.

LL OKAY [signature] 11/27/78

AMC7855

AMC7855

SEE SEPARATE PARTS LIST

TEMPERATURE 70° HUMIDITY 60%
GRIDS ARE ~~.000~~ IN 90 INCHES
RECORDED BY [signature] DATE 10-4-78

DASH NUMBERS OF THIS DWG ODD DASH NUMBERS SHOWN EVEN DASH NUMBERS OPPOSITE	
FINISH	
Z5943454	CRAD
AMC 7844	DC10
NEXT ASSY	USED ON
FIRST APPLICATION	
FOR COMPLETE USAGE DATA SEE ENGINEERING RECORDS	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES
ANGLES ± 0° - 30'
3 PLACE DEC ± .010
2 PLACE DEC ± .03

CONTRACT NO. NAS1-14869

STRESS	J.O. SUTTON	12-17-78
CHECK	K. ESPEN	12-13-78
DESIGN	J. HAWLEY	2-4-79
PREP BY	J. STEELE	11/27/78

DESIGN ACTIVITY APPROVAL

DWG SECTION MC01 | RELEASE CODE | CUSTOMER

DOUGLAS AIRCRAFT COMPANY
LONG BEACH, CALIFORNIA

RIB INSTL-COMPOSITE VERT STAB. ZFR 314.000 AND ZFR 316.882 CANTED

UNDIMENSIONED DRAWING

SIZE J | CODE IDENT NO 88277 | AMC7855

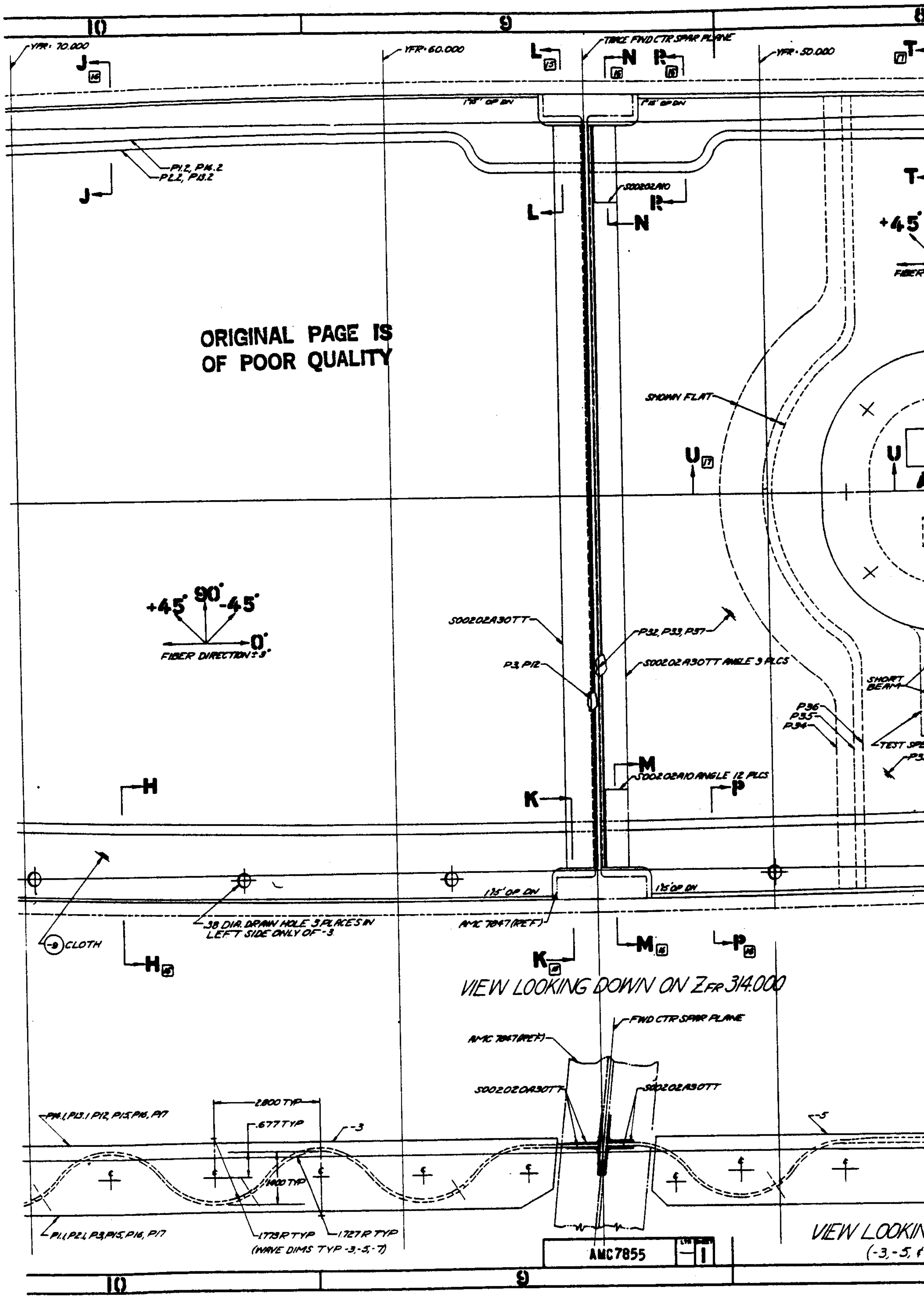
SCALE 1/1 & NOTED | SHEET 1 OF 2

FIRST RELEASE OF PRINTS | ORIGINAL DATE OF DRAWING

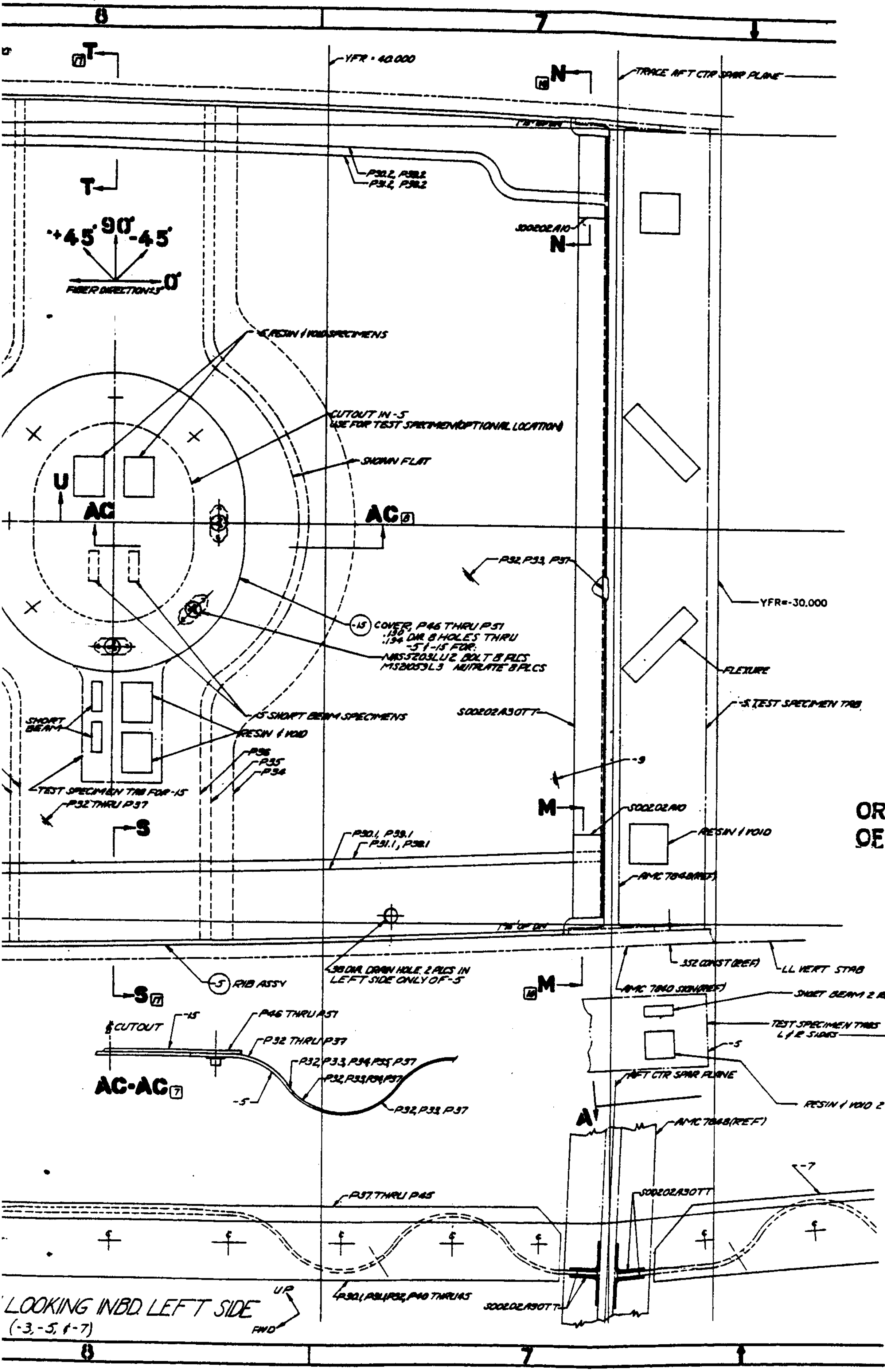
2

SIMILAR TO AMC 7180

AMC7855



FOLDOUT FRAME



FOLDOUT FRAME

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE A6. DRAWING AMC7855 – Z_{FR} 314.000 RIB INSTALLATION (SHEET 2 OF 4)

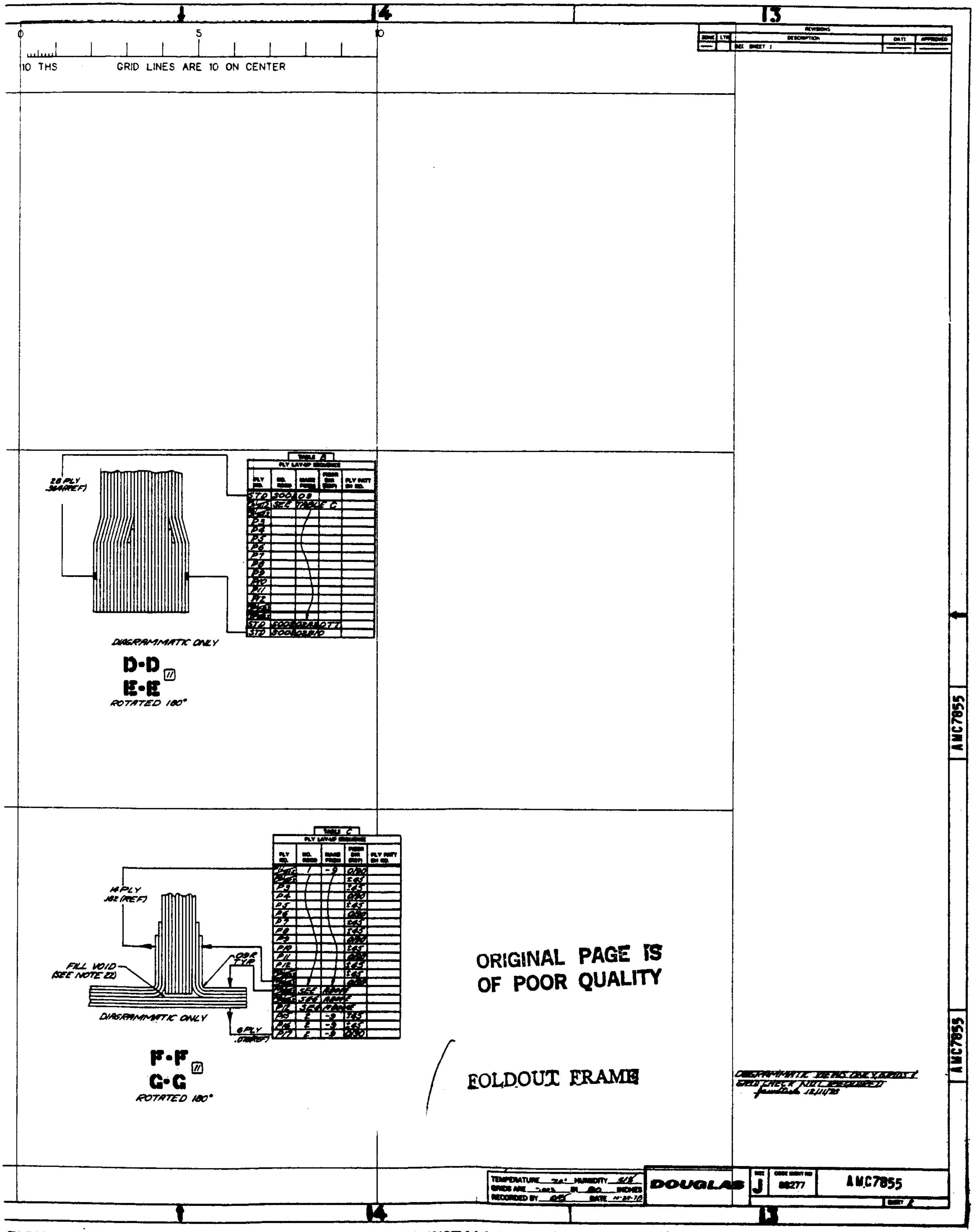
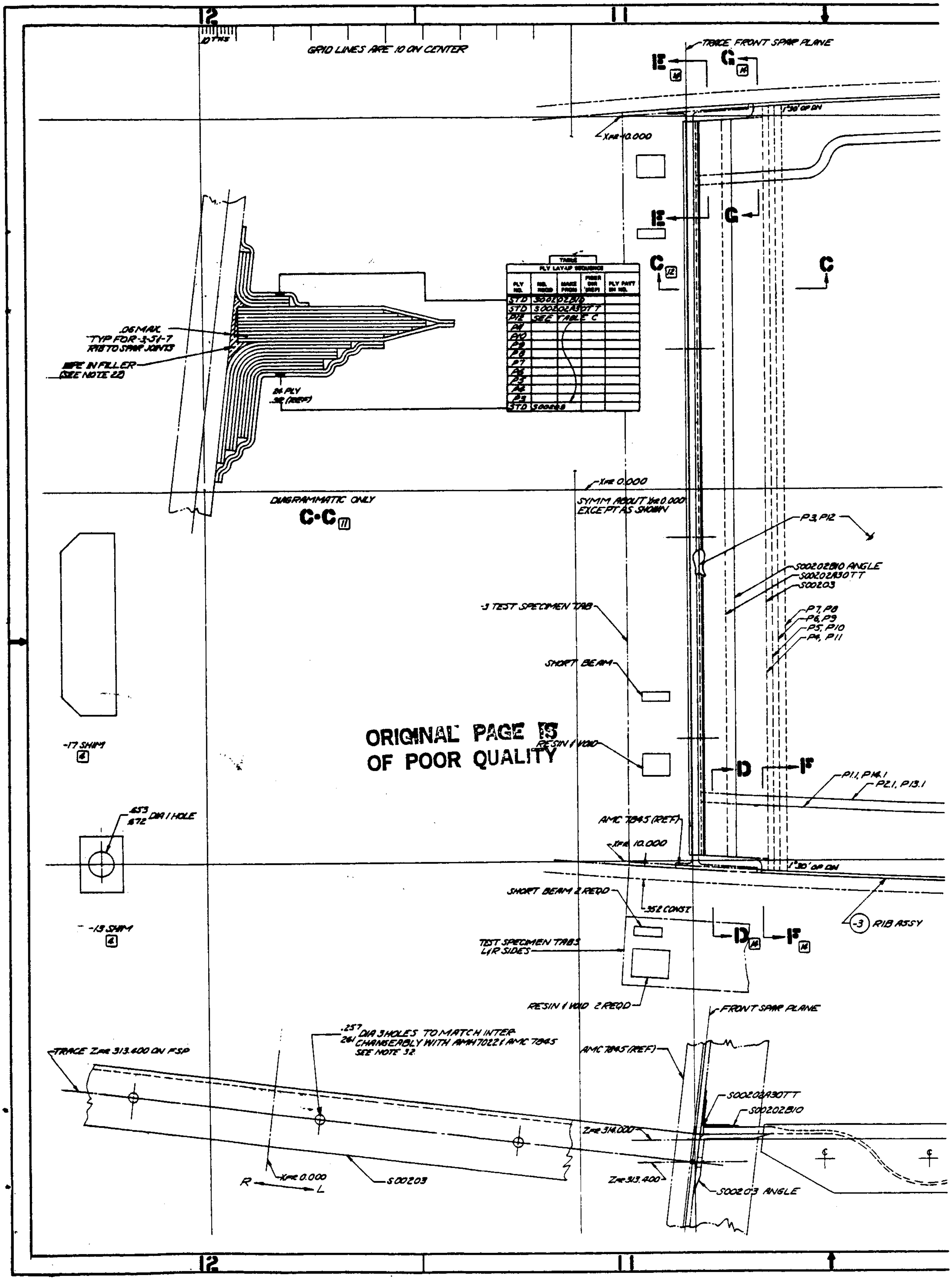
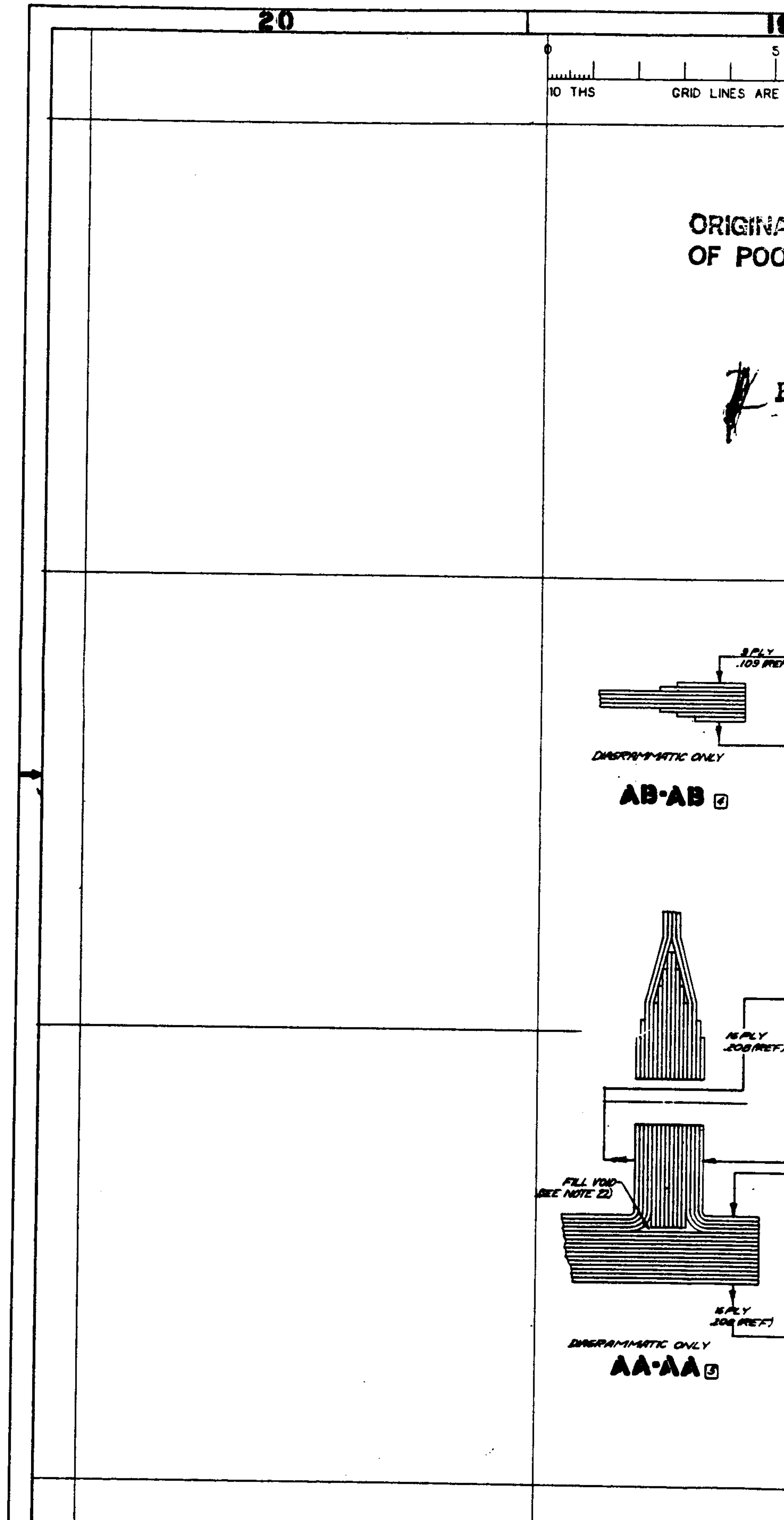


FIGURE A6. DRAWING AMC7855 – Z_{FR} 314.000 RIB INSTALLATION (SHEET 3 OF 4)



ORIGINAL PAGE IS OF POOR QUALITY

FOLDOUT FRAME



20
10 THS
GRID LINES ARE
ORIGINA
OF POO
3 PLY
.109 (REF
DIAGRAMMATIC ONLY
AB-AB
16 PLY
.208 (REF)
FILL VOID
(SEE NOTE 22)
16 PLY
.208 (REF)
DIAGRAMMATIC ONLY
AA-AA
20
19

19 | 18 | 17

10 THS GRID LINES ARE 10 ON CENTER

ORIGINAL PAGE IS
OF POOR QUALITY

1 FOLDOUT FRAME

2 F

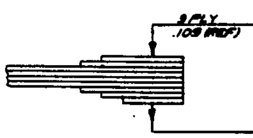


TABLE M				
PLY LAY-UP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	PLY PATT DH NO.
[illegible]	1	-9	0/90	
[illegible]	1	-9	±45	
P73	SEE TABLE L			
P72				
P63				
P62				
[illegible]	1	-9	±45	
[illegible]	1	-9	0/90	
P59	1	-21	[illegible]	

DIAGRAMMATIC ONLY

AB-AB 4

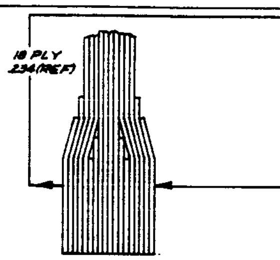


TABLE J				
PLY LAY-UP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	PLY PATT DH NO.
STD	S0026D2A[illegible]			
STD	S0026D2A[illegible]			
STD	S0026D2A[illegible]			
[illegible]	1	-9	0/90	
[illegible]	1	-9	±45	
P62	SEE TABLE L			
P63				
P72				
P73				
[illegible]	1	-9	±45	
[illegible]	1	-9	0/90	
STD	S0026D2A[illegible]			
STD	S0026D2A[illegible]			
STD	S0026D2A[illegible]			

DIAGRAMMATIC ONLY

V-V 6
W-W
ROTATED 180°

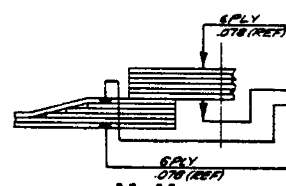


TABLE I				
PLY LAY-UP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	
P51	1	-9	±45	
P50			0/90	
P49			±45	
P48			±45	
P47			0/90	
P46			±45	
P37	SEE TABLE H			
P36				
P35				
P34				
P33				
P32				

U-U 6
DIAGRAMMATIC ONLY

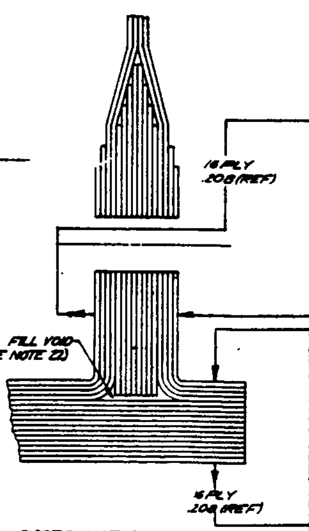


TABLE L				
PLY LAY-UP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	PLY PATT DH NO.
P60/	SEE TABLE J			
P61/	SEE TABLE J			
P62	1	-9	±45	
P63			0/90	
P64			0/90	
P65			±45	
P66			±45	
P67			0/90	
P68			0/90	
P69			±45	
P70			±45	
P71			0/90	
P72			0/90	
P73			±45	
[illegible]	SEE TABLE J			
[illegible]				
[illegible]				
[illegible]				
P73	SEE ABOVE			
P72	SEE ABOVE			
P76	2	-9	0/90	
P77			±45	
P78			±45	
P79			0/90	
P80			0/90	
P81			±45	
P82			±45	
P83			0/90	
P84			0/90	
P85			±45	
P86			±45	
P87			0/90	

DIAGRAMMATIC ONLY
AA-AA 5

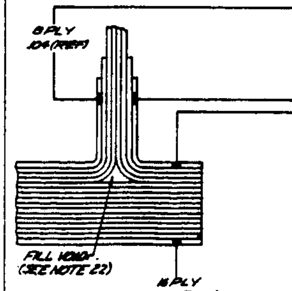


TABLE K				
PLY LAY-UP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	PLY PATT DH NO.
[illegible]	SEE TABLE J			
[illegible]	SEE TABLE J			
P62	SEE TABLE L			
P63				
P72				
P73				
[illegible]	SEE TABLE J			
[illegible]				
[illegible]				
[illegible]				
P73	SEE TABLE L			
P72				
P76				
P77				
P78				
P79				
P80				
P81				
P82				
P83				
P84				
P85				
P86				
P87				

Y-Y 5
Z-Z
ROTATED 180°
DIAGRAMMATIC ONLY

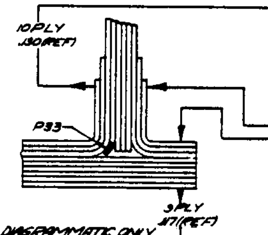


TABLE H				
PLY LAY-UP SEQUENCE				
PLY NO.	NO. REQD	MAKE FROM	FIBER DIR (REF)	PLY PATT DH NO.
[illegible]	1	-9	0/90	
[illegible]			±45	
P32			±45	
P33			0/90	
P34			±45	
P35			±45	
P36			0/90	
P37			±45	
[illegible]			±45	
[illegible]			0/90	
[illegible]	SEE ABOVE			
[illegible]	SEE ABOVE			
P39	2	-9	±45	
P40			0/90	
P41			±45	
P42			0/90	
P43			±45	
P44			±45	
P45			0/90	

DIAGRAMMATIC ONLY
S-S 6
T-T
ROTATED 180°

AMC

19 | 18 | 17

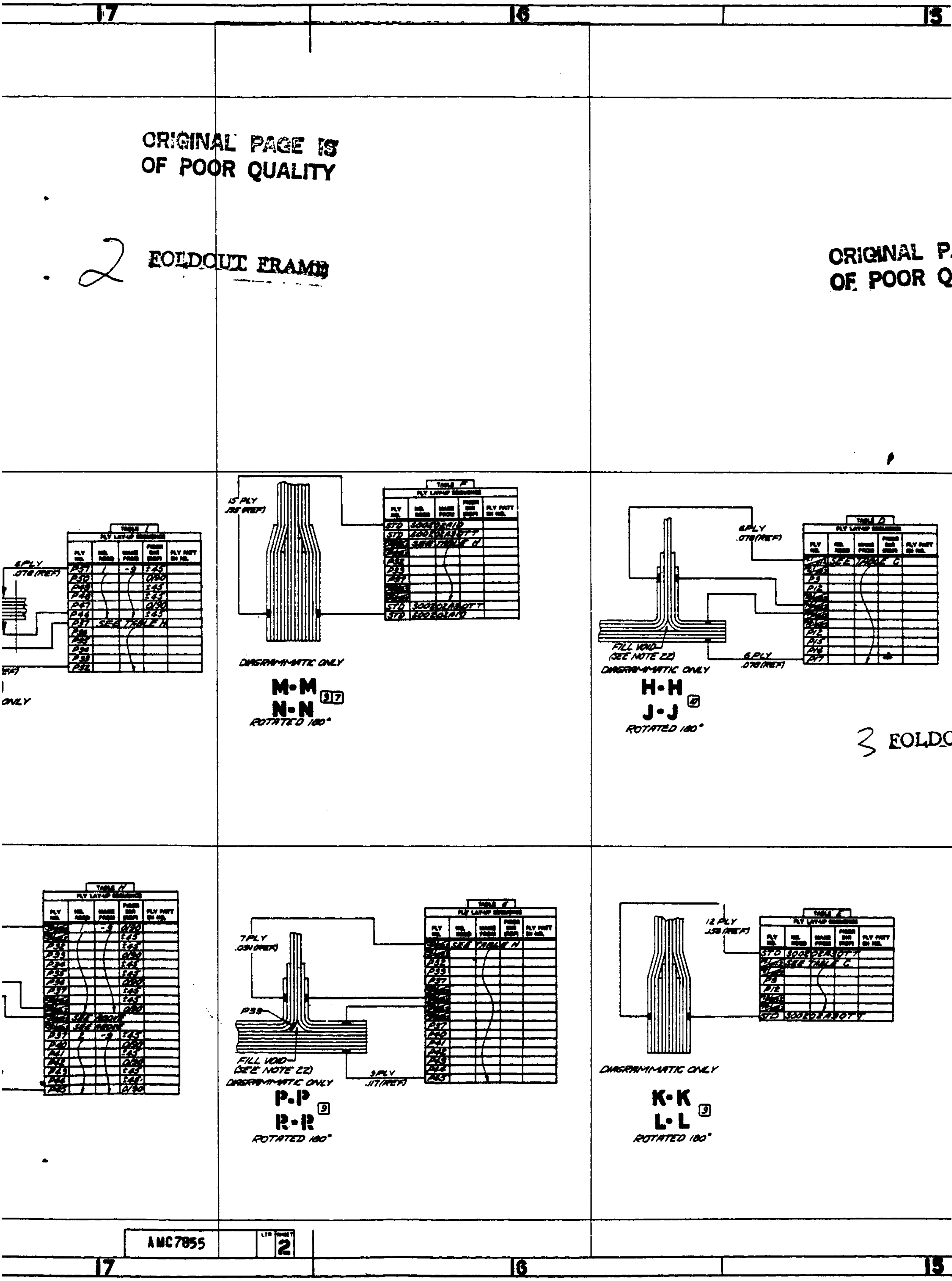


FIGURE A6. DRAWING AMC7855 – Z_{FR} 314.000 RIB INSTALLATION (SHEET 4 OF 4)

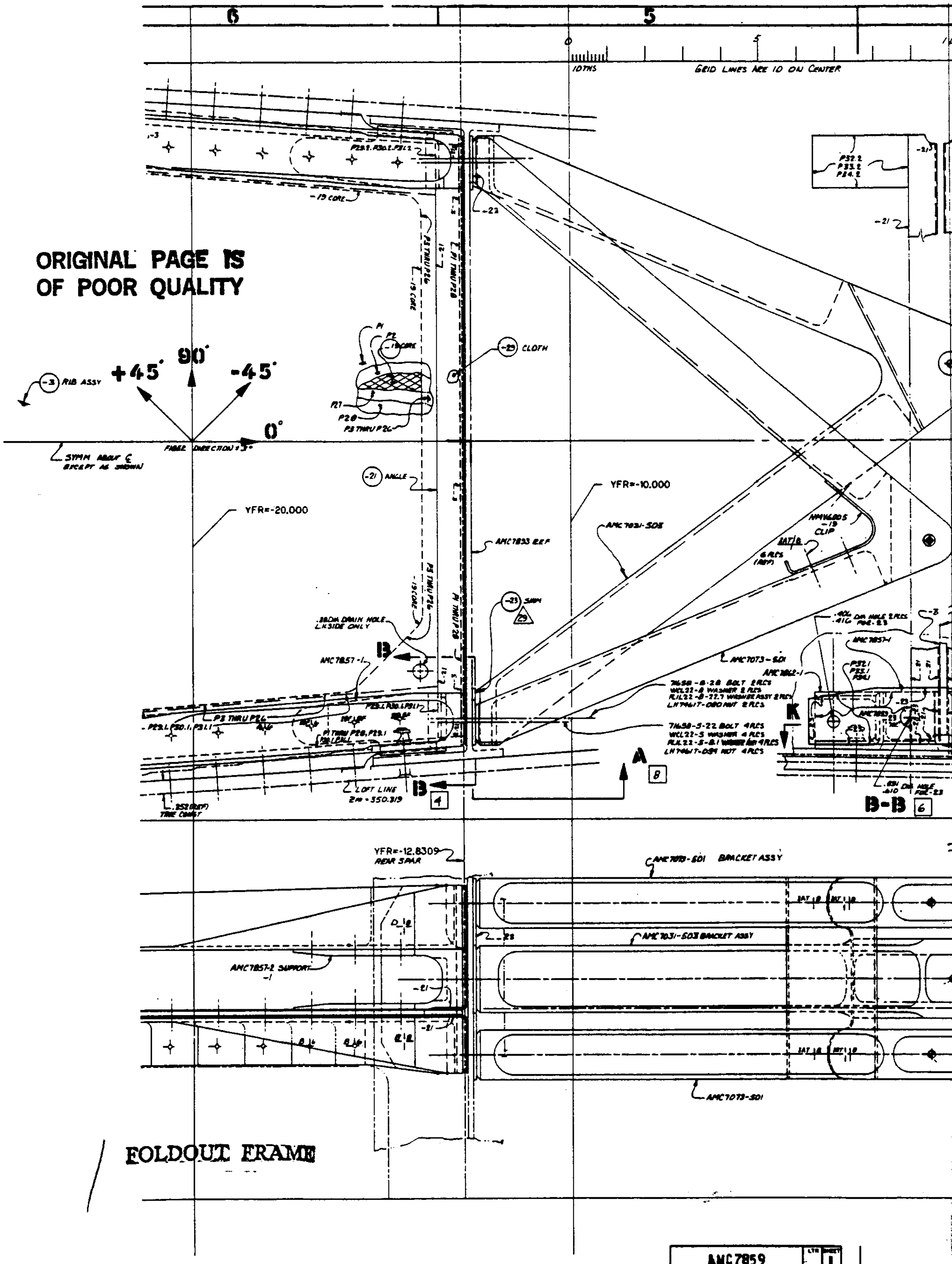
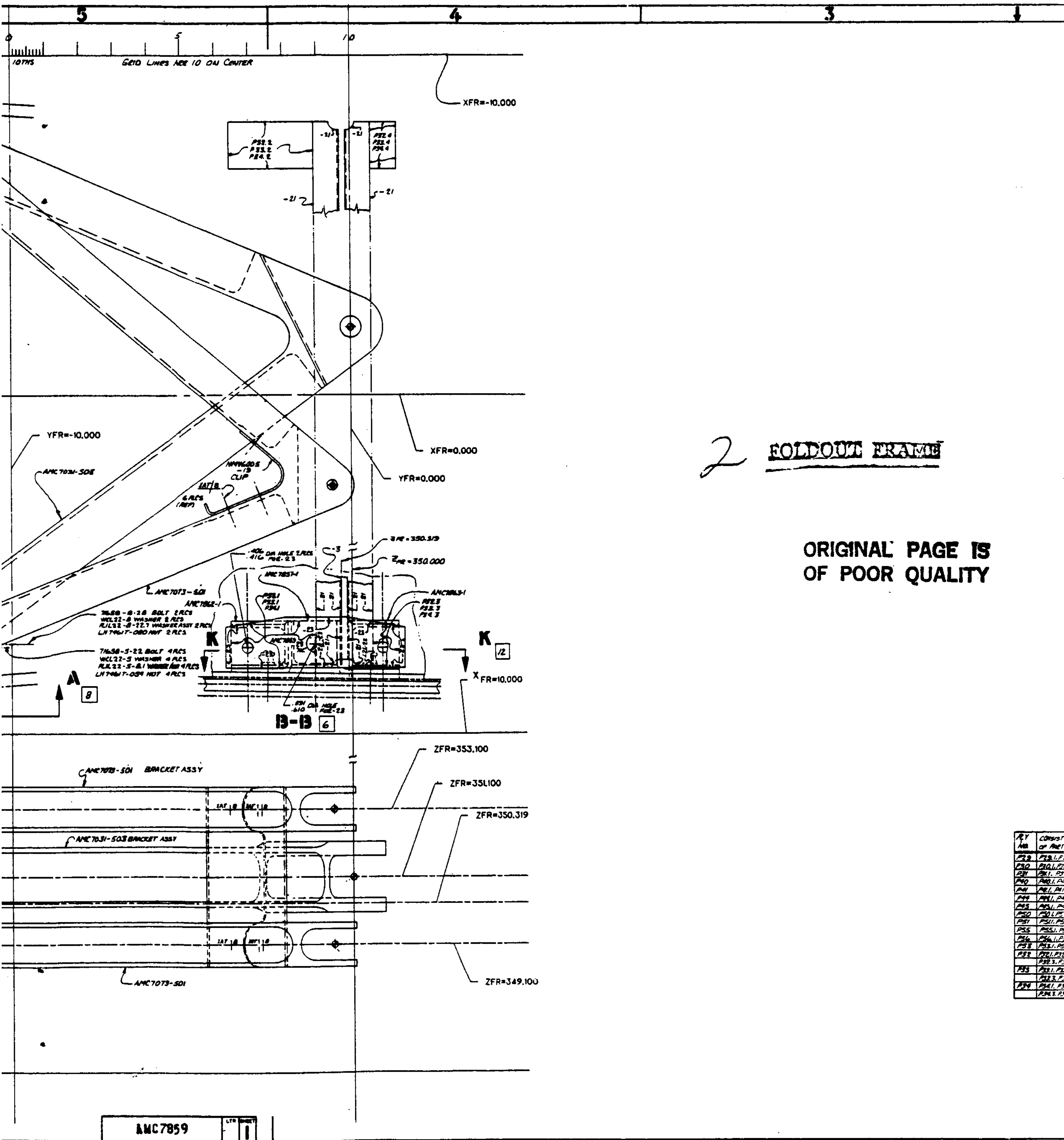


FIGURE A7. DRAWING AMC7859 – Z_{FR} 350.319 RIB INSTALLATION (SHEET 1 OF 2)

ACEE-03-PR-9642



2 FOLDOUT FRAME

ORIGINAL PAGE IS OF POOR QUALITY

RIB INSTALLATION (SHEET 1 OF 2)

2

BLUEPRINT: PRINT ONLY SHEETS LISTED BELOW

SHEET REV STATUS					

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

ORIGINAL PAGE IS
OF POOR QUALITY

35. LOCATE 3 FLATWISE TENSION SPECIMENS UNDER SAME BAG AS PART AND TEST PER D.P.S. 1.98
36. LOCATE LAP SHEAR SPECIMENS UNDER SAME BAG AS PART AND TEST PER D.P.S. 1.966
37. FILL PERIPHERY OF HONEYCOMB CORE FOR DISTANCE NOTED PER D.P.S. 1.901 TYPE III
38. FILL GAPS BETWEEN HONEYCOMB CORE AND GRAPHITE/EPOXY WITH 350°F CURE FOAMING ADHESIVE PER D.P.S. 1.99 GAP SHALL NOT EXCEED .06
39. RIBBON DIRECTION OPTIONAL

GENERAL NOTES
UNLESS OTHERWISE SPECIFIED (APPLY AS NECESSARY)

1. FOR FAB WITH A DIMENSIONALLY ACCURATE REPRO, TWO PLACE DEC TOLERANCES APPLY WHERE DIM ARE NOT GIVEN.
2. LOFT DESIGNATION IS FOR ENGRG REF ONLY.
3. FAB STANDARDS & TOOLING HOLES PER DPS 4.710.
4. TOOLING & PIN HOLE DIA INDICATED ON BODY OF DWG ARE MAX, SMALLER HOLES ARE PERMISSIBLE.
5. EDGE DISTANCE FOR ATTACHMENTS MAY VARY FROM THAT SHOWN ON DWG BY .03 ON DETAILS, 2D MIN ACCEPTABLE ON ASSY.
6. ASSEMBLY SHOP PRACTICE PER DPS 2.70-2.
7. HEAT TREAT 2024-0 TO 2024-T42, 2014-0 & T3 TO 2014-T6 & 7075-0 TO 7075-T62 PER DPS 7.00.
8. INSTALL RIVETS & FLUSH SCREWS PER S0SF6260.
9. INSTALL HI-LOK PINS PER S7923654 & LOCKBOLTS PER S7923660. STANDARD INTERFERENCE FITS APPLY UNLESS OTHERWISE INDICATED BY SYMBOL DESIGNATION.
10. FORM ALUMINUM ALLOY PER DPS 3.69.
11. JOGGLES PER S1292000.
12. ATTACH NUTPLATES WITH MS20426AD3 RIVETS.
13. IDENTIFY PER DPS 3.02.
14. STATION NO. APPLY TO BASIC ______ ONLY. FOR OTHER SERIES SEE DWG ______ FOR STATION RELATIONSHIP.
15. POINTS LOCATED BY MASTER DIAGRAM AMZ 7000
16. LOCATION FOR ATTACHMENT INSTALLED ON SUBQ ASSY.
17. LOCATION FOR ATTACHMENT IS ON THE DWG INVOLVED.
18. LOCATION DUPLICATED FROM A PRECEDING VIEW.
19. ATTACHMENT CALLED OUT ON OTHER DWGS.
20. MACHINED SURFACES 125/, HOLES AND SPOTFACES 125/, PER ANSI B46.1
21. UNDIMENSIONED DRAWING SHEETS WILL BE FURNISHED AS FULL SCALE REPRODUCTIONS ON REQUEST
22. INSPECT PER D.P.S. 4.738 TYPE 2. CLASS (TBD)
23. FILL VOIDS PER D.P.S. 1.622
24. FABRICATE PER D.P.S 1.622
25. FOR BI-WEAVE CLOTH WARP AND FILL ARE INTERCHANGEABLE
26. TEST SHORT BEAM SHEAR SPECIMENS PER DMS 2163
27. TEST RESIN AND VOID CONTENT PER DMS 2163
28. ASSEMBLE -9,-11,-13,-15,-17 & -21 ANGLES TO -3,-5, & -7 CIG ASSYS AND TO AMC 7846, 7847, 7848, & 7853 SPAR ASSYS BY COCURE AND ADHESIVE BOND USING FM 300K ADHESIVE PER D.P.S 1.966
29. MACHINE SHIMS AS REQUIRED TO MAINTAIN HARD POINT. MAXIMUM SHIM THICKNESS NOT TO EXCEED .15
30. INSTALL FLT INDICATING WASHERS PER D.P.S 1.396
31. INSTALL FASTENERS WITH WET SEALANT PER D.P.S 2.512
32. BOND HONEYCOMB CORE TO GRAPHITE/EPOXY PER D.P.S 1.966
33. APPLY 1 LAYER (.001) OF TEDLAR FILM (-31) TO -3 ASSY IN AREA OF HONEYCOMB CORE WITH .25 OVERLAP ON TOOL SIDE OF -3 ASSY.
34. ATTACHMENTS CODED THUS:

XAT / 8	2008V-( )	LOCKBOLT
	NAS1080-8	COLLAR
A / 6	HLT336-6-( )	HI-LOK
	S4933652-3	NUT ASSY
10P / 6	HLT336-6-( )	HI-LOK
	NAS1048L3	NUT
	NAS1252-10L	WASHER
10P / 8	HLT336-8-( )	HI-LOK
	NAS1048L4	NUT
	NAS1252-4LL	WASHER
B / 6	HLT335-6-( )	HI-LOK
	S4933653-3	NUT ASSY
B / 8	HLT335-8-( )	HI-LOK
	S4933652-4	NUT ASSY
C / 8	106560-8-10 BOLT	
	S4933653-4	NUT ASSY .2495/.2515 DIA. HOLE
D / 8	106560-8-11 BOLT, S4933653-4 NUT ASSY	.2495/.2515 DIA. HOLE

GIN'S CONTINUED ZONE 2

3 FOLDOUT FRAME

PLY NO.	CONSISTS OF PLIES
P29	P29.1, P29.2
P30	P30.1, P30.2
P31	P31.1, P31.2
P40	P40.1, P40.2
P41	P41.1, P41.2
P44	P44.1, P44.2
P45	P45.1, P45.2
P50	P50.1, P50.2
P51	P51.1, P51.2
P55	P55.1, P55.2
P56	P56.1, P56.2
P58	P58.1, P58.2
P32	P32.1, P32.2
	P32.3, P32.4
P33	P33.1, P33.2
	P33.3, P33.4
P34	P34.1, P34.2
	P34.3, P34.4

LOFT LINES GENERATED BY CADD ROUTINE J.G. 10/26/78

TEMPERATURE 70°F HUMIDITY 51%
GRIDS ARE .001 IN 80 INCHES
RECORDED BY [illegible] DATE 10-26-78

SEE SEPARATE PARTS LIST

DASH NUMBERS OF THIS DWG ODD DASH NUMBERS SHOWN EVEN DASH NUMBERS OPPOSITE	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ANGLES ± 0°-30' 3 PLACE DEC ± .005 2 PLACE DEC ± .03	CONTRACT NO. NASA 14869	DOUGLAS AIRCRAFT COMPANY LONG BEACH, CALIFORNIA
FINISH		STRESS / CHECK ... KESPEN 11-9-78 / DESIGN ... / PREP BY ...	RIB INSTL. - COMPOSITE VERT STAB ZRE = 350.319
85943454 / CRAD			UNDIMENSIONED DRAWING
AMC7899 / DC10		DESIGN ACTIVITY APPROVAL	SIZE J / CODE IDENT NO 88277 / AMC7859
NEXT ASSY / USED ON			
FIRST APPLICATION			
FOR COMPLETE USAGE DATA SEE ENGINEERING RECORDS	DWG SECTION MC01 / RELEASE CODE	CUSTOMER	SCALE AS NOTED / SHEET 1 OF 6

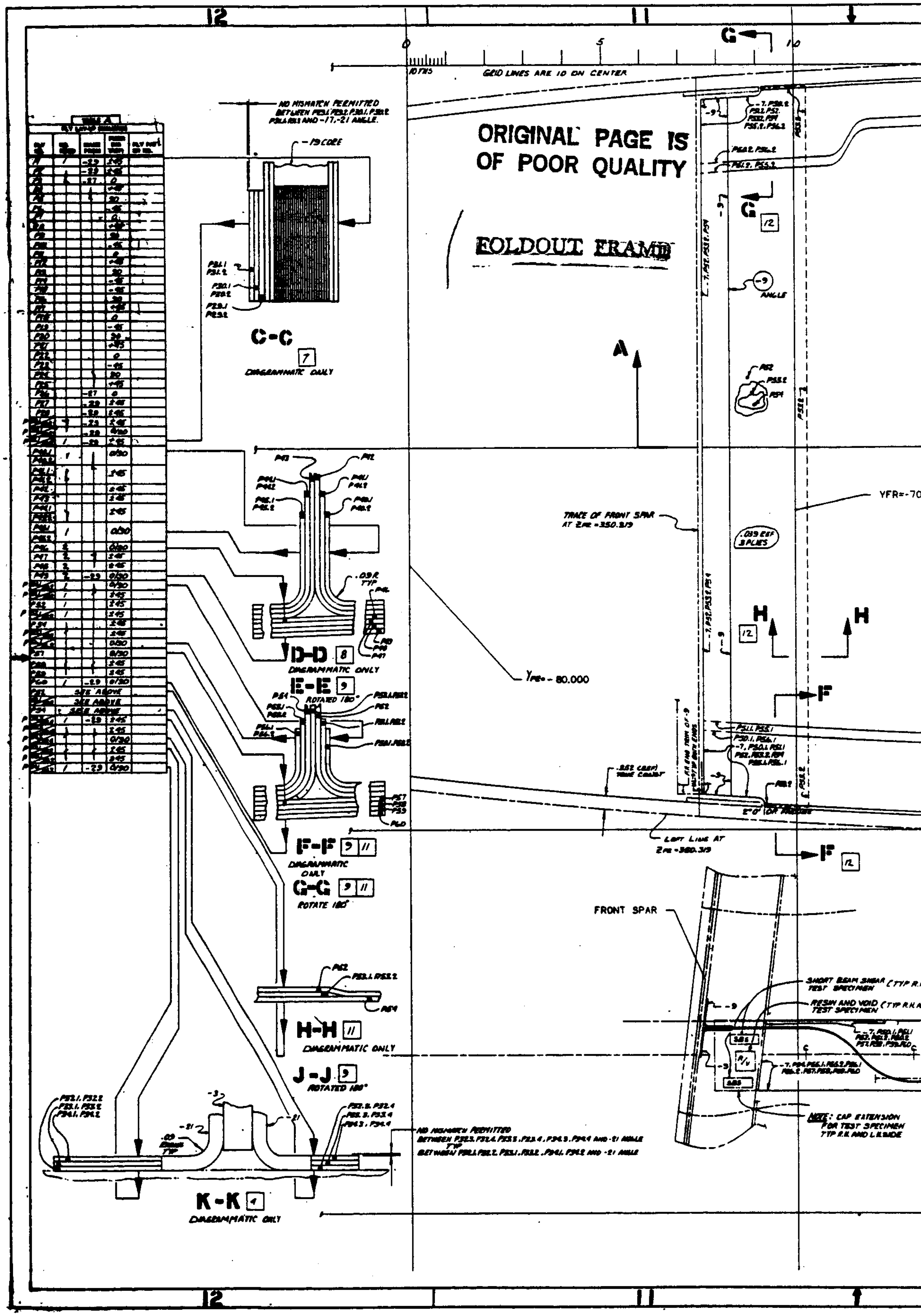
PART RELEASE OF PRINTS NOV 17 1978
ORIGINAL DATE OF DRAWING

AMC7859

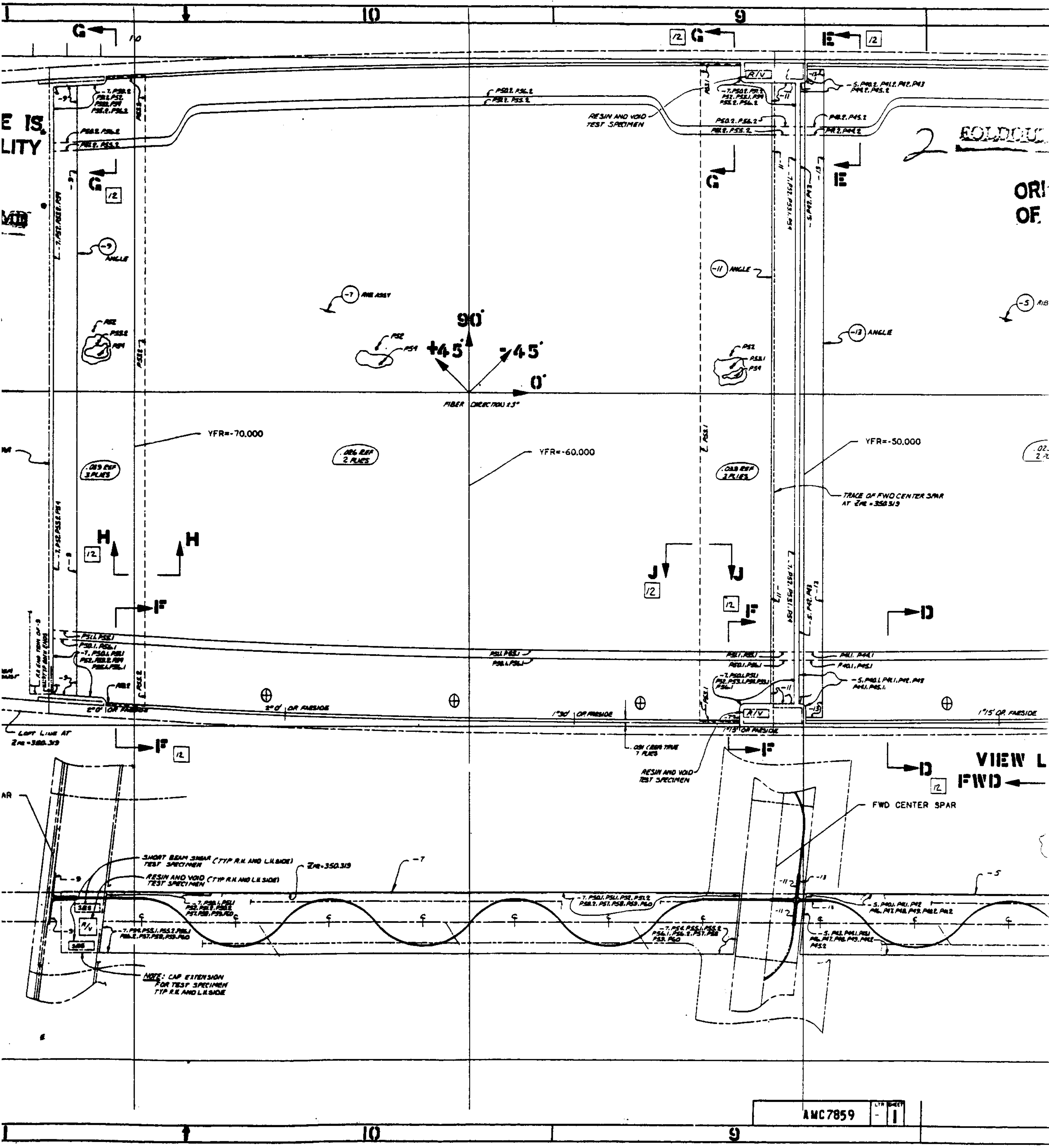
AMC7859

2

SIMILAR TO AMC7773


ORIGINAL PAGE IS
OF POOR QUALITY
FOLDOUT FRAME
GRID LINES ARE 10 ON CENTER
NO MISMATCH PERMITTED
-19 CORE
C-C
DIAGRAMMATIC ONLY
D-D
DIAGRAMMATIC ONLY
E-E
ROTATED 180°
F-F
DIAGRAMMATIC ONLY
G-G
ROTATE 180°
H-H
DIAGRAMMATIC ONLY
J-J
ROTATED 180°
K-K
DIAGRAMMATIC ONLY
ANGLE
TRACE OF FRONT SPAR
AT ZFR = 350.319
YFR = -80.000
YFR=-70
LOFT LINE AT
ZFR = 380.319
FRONT SPAR
SHORT BEAM SHEAR TEST SPECIMEN
RESIN AND VOID TEST SPECIMEN
NOTE: CAP EXTENSION FOR TEST SPECIMEN TYP R.H. AND L.H. SIDE

Doug
Contr



10
9
FOLDOUT
ORI
OF
90°
+45°
-45°
0°
FIBER DIRECTION ±5°
-7 RIB ASSY
-9 ANGLE
-11 ANGLE
-13 ANGLE
-5 RIB
RESIN AND VOID TEST SPECIMEN
YFR=-70.000
YFR=-60.000
YFR=-50.000
TRACE OF FWD CENTER SPAR AT ZFR=-350.319
.028 REF 2 PLIES
.033 REF 3 PLIES
.033 REF 3 PLIES
LOFT LINE AT ZFR=-380.319
.031 (REF) TRUE 7 PLIES
VIEW L
FWD
FWD CENTER SPAR
SHORT BEAM SHEAR TEST SPECIMEN (TYP R.H. AND L.H. SIDE)
RESIN AND VOID TEST SPECIMEN (TYP R.H. AND L.H. SIDE)
ZFR-350.319
NOTE: CAP EXTENSION FOR TEST SPECIMEN TYP R.H. AND L.H. SIDE
2°0' OP FARSIDE
1°30' OP FARSIDE
1°15' OP FARSIDE
AMC7859

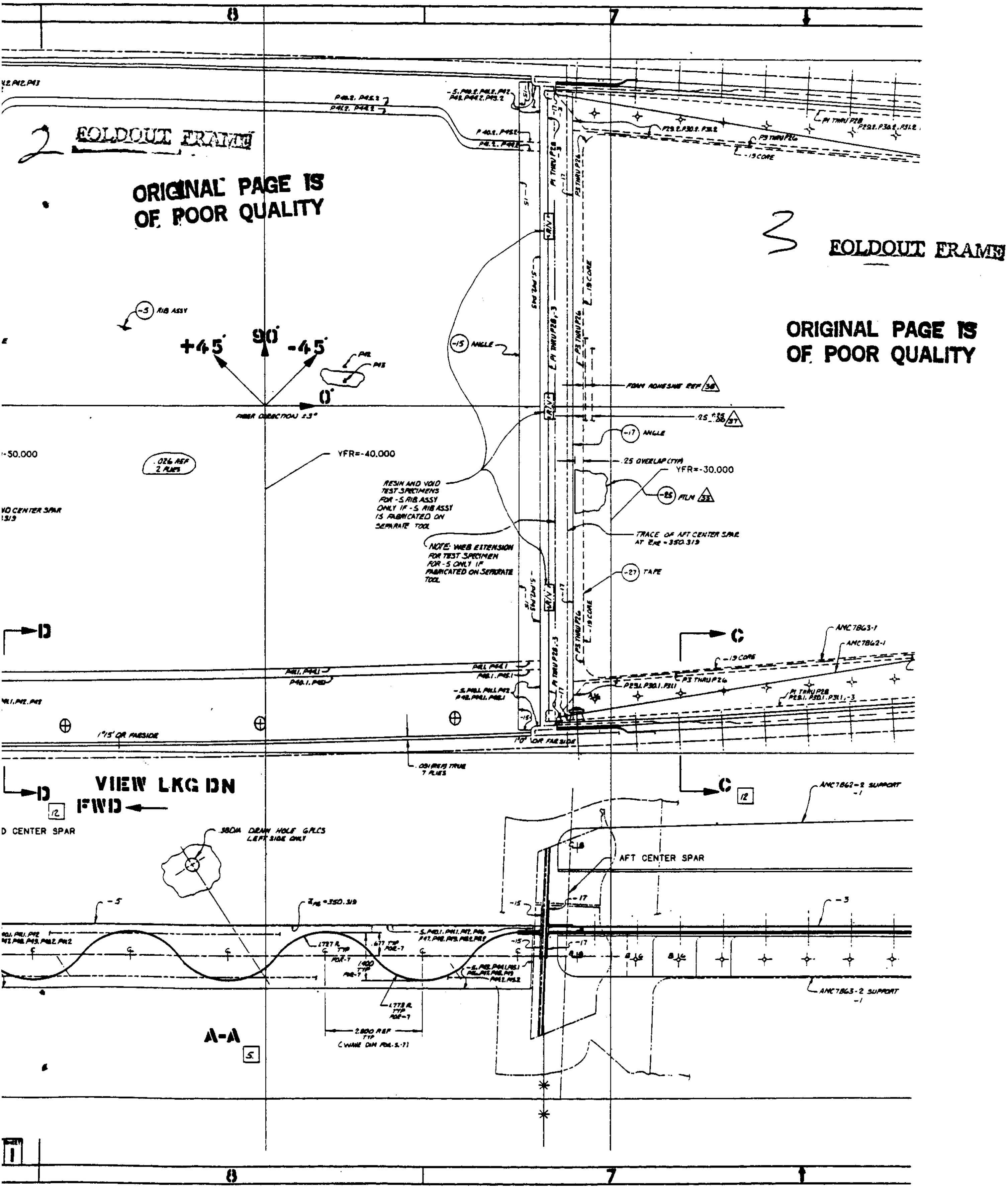


FIGURE A7. DRAWING AMC7859 – Z_{FR} 350.319 RIB INSTALLATION (SHEET 2 OF 2)

APPENDIX B

MECHANICAL PROPERTIES TEST DATA

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE B-1
SANDWICH BEAM FATIGUE TEST RESULTS

Z3943432-505

LAYUP: (25/50/25) = PERCENT PLIES AT (0°, $\pm 45^\circ$, 90°)

STRESS RATIO R = −1.0

SPECIMEN NUMBER	TEST TEMP $^\circ$K ($^\circ$F)	MOISTURE CONTENT (PERCENT)	MAX LOAD NEWTONS (POUNDS)	LAMINATE WIDTH cm (IN.)	LAMINATE THICKNESS cm (IN.)	SANDWICH DEPTH cm (IN.)	MAX NET STRESS MPa (PSI)	CYCLES TO FAILURE x 10^6	COMMENTS
BET 394	AMBIENT	1.12	3203 (720)	3.815 (1.502)	0.1501 (0.0591)	4.394 (1.730)	268.69 (389.70)	–	2
BET 395	AMBIENT	1.21	2135 (480)	3.815 (1.502)	0.1491 (0.0587)	4.389 (1.728)	180.54 (26.186)	0.021	1
BET 396	AMBIENT	0.75	2135 (480)	3.818 (1.503)	0.1435 (0.0565)	4.387 (1.727)	187.41 (27.182)	0.045	1
BET 397	AMBIENT	0.76	2135 (480)	3.820 (1.504)	0.1455 (0.0573)	4.404 (1.734)	183.90 (26.672)	0.127	1
BET 398	AMBIENT	0.75	2447 (550)	3.823 (1.505)	0.1453 (0.0572)	4.381 (1.725)	212.09 (30,761)	0.044	1
BET 399	AMBIENT	1.24	2446 (550)	3.820 (1.504)	0.1430 (0.0563)	4.392 (1.729)	215.06 (311.91)	0.014	1
BET 400	AMBIENT	0.99	2446 (550)	3.820 (1.504)	0.1440 (0.0567)	4.387 (1.727)	213.83 (31.013)	0.027	1
BET 401	AMBIENT	0.71	2002 (450)	3.820 (1.504)	0.1458 (0.0574)	4.384 (1.726)	172.96 (25.086)	0.433	1
BET 402	AMBIENT	0.70	2002 (450)	3.817 (1.503)	0.1427 (0.0562)	4.392 (1.729)	176.40 (25.585)	0.267	1
BET 403	AMBIENT	0.65	1913 (430)	3.807 (1.499)	0.1415 (0.0557)	4.382 (1.725)	171.02 (24.804)	>1.580	2
BET 404	AMBIENT	0.64	1933 (430)	3.787 (1.491)	0.1377 (0.0542)	4.389 (1.728)	176.47 (25.595)	>1.853	2
BET 391	219 (−65)	1.24	2002 (450)	3.810 (1.500)	0.1384 (0.0545)	4.389 (1.728)	182.36 (26.449)	3.000	NO FAILURE
BET 392	219 (−65)	1.12	2135 (480)	3.815 (1.502)	0.1405 (0.0553)	4.386 (1.727)	191.56 (27.783)	3.000	1 3
			2447 (550)				219.50 (31.836)	0.224	
BET 393	219 (−65)	0.91	2447 (550)	3.813 (1.501)	0.1433 (0.0564)	4.392 (1.729)	215.20 (31.212)	0.291	1
BET 405	219 (−65)	0.65	2269 (510)	3.815 (1.502)	0.1415 (0.0557)	4.394 (1.730)	201.72 (29.258)	0.968	1
BET 427	350 (170)	–	1975 (444)	3.805 (1.498)	0.1425 (0.0561)	4.394 (1.730)	174.95 (25.374)	–	2
BET 407	350 (170)	0.58	2358 (530)	3.797 (1.495)	0.1457 (0.0574)	4.379 (1.724)	205.44 (29.796)	0.023	1
BET 408	350 (170)	0.54	2358 (530)	3.797 (1.495)	0.1455 (0.0573)	4.386 (1.727)	205.41 (29.791)	0.085	1

1 LAMINATE FAILURE THROUGH CENTER OF 0.630 cm (0.248 IN.) DIAMETER HOLE

2 DELAMINATION OF LAMINATE ADJACENT TO LOADING CLAMP

3 TEST EQUIPMENT MALFUNCTION ALLOWED 480 LB LOAD LEVEL TO DROP OFF TO UNKNOWN MAGNITUDE. RESET LOAD LEVEL TO 550 LB AND CYCLED UNTIL FAILURE.

PRECEDING PAGE BLANK NOT FILMED

TABLE B-1
SANDWICH BEAM FATIGUE TEST RESULTS (CONTINUED)

Z3943432-505

LAYUP: (25/50/25) = PERCENT PLIES AT (0°, ±45°, 90°)

STRESS RATIO R = 0.05

SPECIMEN NUMBER	TEST TEMP °K (°F)	MOISTURE CONTENT (PERCENT)	MAX LOAD NEWTONS (POUNDS)	LAMINATE WIDTH cm (IN.)	LAMINATE THICKNESS cm (IN.)	SANDWICH DEPTH cm (IN.)	MAX NET STRESS MPa (PSI)	CYCLES TO FAILURE x 10^6	COMMENTS
BET 412	AMBIENT	1.45	3692 (830)	3.820 (1.504)	0.1372 (0.0540)	4.384 (1.726)	338.75 (49.132)	0.101	(1)
BET 413	AMBIENT	1.45	3692 (830)	3.817 (1.503)	0.1448 (0.0570)	4.392 (1.729)	320.88 (46.540)	–	(1) (4)
BET 414	AMBIENT	1.47	3692 (830)	3.815 (1.502)	0.1473 (0.0580)	4.394 (1.730)	315.50 (45.760)	0.001	(1)
BET 415	AMBIENT	1.41	3470 (780)	3.817 (1.503)	0.1478 (0.0582)	4.412 (1.737)	293.99 (42.640)	9.000	NO FAILURE
BET 416	AMBIENT	1.46	3514 (790)	3.822 (1.505)	0.1463 (0.0576)	4.392 (1.729)	301.81 (43.744)	4.000	NO FAILURE
BET 417	AMBIENT	1.37	3670 (825)	3.830 (1.508)	0.1534 (0.0604)	4.394 (1.730)	299.93 (43.500)	5.000	NO FAILURE
BET 418	AMBIENT	1.50	3692 (830)	3.823 (1.505)	0.1468 (0.0578)	4.392 (1.729)	316.01 (45.833)	1.833	(1)
BET 419	AMBIENT	1.64	3959 (890)	3.822 (1.505)	0.1499 (0.0590)	4.399 (1.732)	331.47 (48.076)	1.629	(1)
BET 420	AMBIENT	1.41	3959 (890)	3.828 (1.507)	0.1425 (0.0561)	4.387 (1.727)	348.82 (50.592)	–	(4) (6)
BET 421	AMBIENT	1.40	3914 (880)	3.840 (1.512)	0.1514 (0.0596)	4.384 (1.726)	323.91 (46.979)	0.526	(1)
BET 422	AMBIENT	1.29	3870 (870)	3.830 (1.508)	0.1527 (0.0601)	4.394 (1.730)	317.83 (46.098)	3.514	(1)
BET 423	219 (–65)	1.32	4137 (930)	3.828 (1.507)	0.1476 (0.0581)	4.407 (1.735)	350.43 (50.826)	0.021	(1)
BET 409	219 (–65)	1.02	3603 (810)	3.813 (1.501)	0.1450 (0.0571)	4.387 (1.727)	313.50 (45.468)	1.107	NO FAILURE
BET 410	219 (–65)	0.85	3692 (830)	3.813 (1.501)	0.1438 (0.0566)	4.394 (1.730)	323.42 (46.910)	1.750	NO FAILURE
BET 411	219 (–65)	1.37	3825 (860)	3.815 (1.502)	0.1430 (0.0563)	4.394 (1.730)	336.60 (48.820)	1.900	NO FAILURE
BET 424	350 (170)	–	2785 (626)	3.833 (1.509)	0.1440 (0.0567)	4.379 (1.724)	242.86 (35.224)	–	(5)
BET 425	350 (170)	–	2785 (626)	3.804 (1.498)	0.1519 (0.0598)	4.389 (1.728)	231.95 (33.641)	–	(5)
BET 426	350 (170)	0.80	2785 (626)	3.815 (1.502)	0.1438 (0.0566)	4.392 (1.729)	243.89 (35.373)	8.000	NO FAILURE

(1) LAMINATE FAILURE THROUGH CENTER OF 0.630 cm (0.248 IN.) DIAMETER HOLE

(4) IMMEDIATE FAILURE AFTER START OF TEST. UNABLE TO OBTAIN NUMBER OF CYCLES SINCE COUNTER IS CALIBRATED IN 1000 CYCLES.

(5) JIG FAILURE

(6) LAMINATE TENSILE FAILURE ADJACENT TO LOAD PAD

TABLE B-2
FATIGUE TEST RESULTS FOR DEBONDED LAMINATE TENSION SPECIMENS
Z3943442-1
STRESS RATIO R = −1.0

LAYUP: (25/50/25) = PERCENT PLIES AT (0°, $\pm 45^{\circ}$, 90°)

SPECIMEN	TEST TEMP		MOISTURE LEVEL	LAMINATE				LOAD LEVEL		GROSS SECTION STRESS		CYCLES TO FAILURE	RESIDUAL STATIC STRENGTH (2)	
				WIDTH		THICKNESS								
	$^{\circ}$K	$^{\circ}$F	%	CM	IN.	CM	IN.	NEWTONS	POUNDS	MPa	PSI	(1)	MPa	PSI
A065-1	219	−65	AMB	7.628	3.003	0.1435	0.0565	11,254	2530	102.81	14,911	130,000	–	–
								22,508	5060	205.62	29,823	12,750	–	–
A065-2	219	−65	AMB	7.630	3.004	0.1448	0.0570	11,254	2530	101.87	14,776	130,000	–	–
								20,462	4600	185.23	26,865	22,090	–	–
A065-3	219	65	AMB	7.630	3.004	0.1448	0.0570	11,254	2530	101.87	14,775	130,000	–	–
								16,369	3680	148.18	21,492	130,000	270.99	39,304
P065-1	219	−65	1.55	7.638	3.007	0.1428	0.0562	11,254	2530	103.22	14,971	130,000	–	–
								22,508	5060	206.44	29,942	23,280	–	–
P065 2	219	65	1.58	7.630	3.004	0.1435	0.0565	11,254	2530	102.78	14,906	130,000	–	–
								20,462	4600	186.87	27,103	87,500	–	–
P065-3	219	−65	1.45	7.628	3.003	0.1461	0.0575	11,254	2530	101.02	14,652	130,000	–	–
								16,369	4450	146.94	25,771	130,000	250.76	36,369
A170-1	350	170	AMB	7.628	3.003	0.1410	0.0555	11,254	2530	104.66	15,180	130,000	–	–
								21,351	4800	198.57	28,800	1,650	–	–
A170-2	350	170	AMB	7.625	3.002	0.1397	0.0550	11,254	2530	105.65	15,323	130,000	–	–
								16,014	3600	150.33	21,803	23,900	–	–
A170-3	350	170	AMB	7.625	3.002	0.1435	0.0565	11,254	2530	102.84	14,916	130,000	–	–
								13,789	3100	126.01	18,276	130,000	275.61	39,973
P170-1	350	170	1.18	7.633	3.005	0.1435	0.0565	11,254	2530	102.74	14,901	130,000	–	–
								21,351	4800	194.92	28,271	460	–	–
P170-2	350	170	1.31	7.625	3.002	0.1448	0.0570	11,254	2530	101.94	14,785	130,000	–	–
								16,014	3600	145.06	21,039	14,170	–	–
P170-3	350	170	0.96	7.625	3.002	0.1435	0.0565	11,254	2430	102.84	14,916	130,000	–	–
								13,789	3100	126.01	18,276	109,620	–	–

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE B-2 (Cont'd)
FATIGUE TEST RESULTS FOR DEBONDED LAMINATE TENSION SPECIMENS
Z3943442-1
STRESS RATIO R = −1.0 LAYUP: (25/50/25) = PERCENT PLIES AT (0°, ±45°, 90°)

SPECIMEN	TEST TEMP		MOISTURE LEVEL	LAMINATE				LOAD LEVEL		GROSS SECTION STRESS		CYCLES TO FAILURE	RESIDUAL STATIC STRENGTH ②	
				WIDTH		THICKNESS								
	°K	°F	%	CM	IN.	CM	IN.	NEWTONS	POUNDS	MPa	PSI	①	MPa	PSI
AAMB 1	AMB	AMB	AMB	7.628	3.003	0.1397	0.0550	11,387	2560	106.87	15,500	130,000	–	–
								22,775	5120	213.73	31,000	2,600	–	–
AAMB 2	AMB	AMB	AMB	7.628	3.003	0.1442	0.0560	11,387	2560	104.96	15,222	130,000	–	–
								11,387	2560	104.96	15,222	130,000	319.79	46,382
AAMB-3	AMB	AMB	AMB	7.625	3.004	0.1447	0.0570	11,121	2500	100.67	14,600	130,000	–	–
								17,793	4000	161.07	23,361	28,800	–	–
AAMB 4	AMB	AMB	AMB	7.620	3.000	0.1461	0.0575	11,387	2560	102.32	14,840	130,000	–	–
								21,351	4800	191.85	27,826	8,600	–	–
AAMB 5	AMB	AMB	AMB	7.630	3.004	0.1473	0.0580	11,254	2530	100.12	14,521	130,000	–	–
								15,569	3500	138.50	20,088	130,000	296.79	43,046
AAMB-6	AMB	AMB	AMB	7.630	3.004	0.1486	0.0585	11,254	2530	99.26	14,397	130,000	–	–
								15,569	3500	137.32	19,916	130,000	275.42	39,947
PAMB 1	AMB	AMB	1.27	7.628	3.003	0.1397	0.0550	11,030	2480	103.53	15,015	130,000	–	–
								11,030	2480	103.53	15,015	130,000	357.75	51,888
PAMB-2	AMB	AMB	1.19	7.630	3.004	0.1422	0.0560	11,121	2500	102.46	14,861	130,000	–	–
								22,241	5000	204.93	29,722	800	–	–
PAMB-3	AMB	AMB	1.18	7.625	3.002	0.1461	0.0575	11,121	2500	99.86	14,483	130,000	–	–
								21,352	4800	191.73	27,808	3,700	–	–
PAMB-4	AMB	AMB	1.18	7.630	3.004	0.1448	0.0570	11,121	2500	100.67	14,600	130,000	–	–
								15,568	3500	140.93	20,440	130,000	263.34	38,195
PAMB-5	AMB	AMB	1 20	7.630	3.004	0.1473	0.0580	11,121	2500	98.93	14,349	130,000		
								15,568	3500	138.50	20,088	130,000	254.45	36,905
PAMB 6	AMB	AMB	1.18	7.625	3.002	0.1473	0.0580	11,121	2500	99.00	14,358	130,000	–	–
								17,793	4000	158.39	22,973	55,600	–	–

① ALL SPECIMENS SUBJECTED TO 130,000 LOAD CYCLES (ONE LIFE) AT APPROXIMATELY 2000 MICROSTRAIN (DESIGN LIMIT STRAIN) WITHOUT FAILURE PRIOR TO UNDERGOING SECOND FATIGUE LOAD TEST. ALL FATIGUE FAILURES OCCURRED AWAY FROM THE DEBOND AREA NEAR THE NECK — DOWN.

② ALL RESIDUAL STATIC FAILURES OCCURRED AWAY FROM THE DEBOND AREA NEAR THE NECK — DOWN.

TABLE B-3
FATIGUE TEST RESULTS FOR DAMAGED LAMINATE TENSION SPECIMENS
Z3943442-505
STRESS RATIO R = −1.0

LAYUP: (25/50/25) = PERCENT PLIES AT (0^{o}, $\pm45^{o}$, 90^{o})

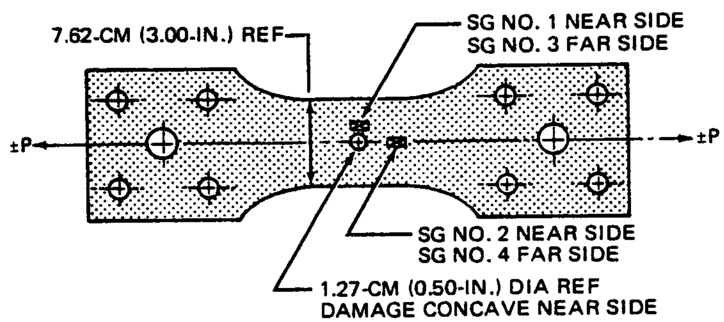
SPECIMEN	TEST TEMP		MOISTURE LEVEL	LAMINATE				LOAD LEVEL		NET SECTION STRESS (1)		CYCLES TO FAILURE	NET SECTION RESIDUAL STATIC STRENGTH (2)	
				WIDTH		THICKNESS								
	°K	°F	%	CM	IN.	CM	IN.	NEWTONS	POUNDS	MPa	PSI	(2)	MPa	PSI
A065-1	219	−65	AMB	7.087	2.790	0.145	0.057	11,565	2600	137.34	19,919	172,380	–	–
A065-2	219	−65	AMB	7.087	2.790	0.144	0.057	11,121	2500	133.22	19,322	260,000	185.98	26,974
A065-3	219	−65	AMB	7.084	2.789	0.142	0.056	12,900	2900	155.99	22,624	8,630	–	–
P065-1	219	−65	1.11	7.079	2.787	0.149	0.059	11,565	2600	133.99	19,433	260,000	190.67	27,655
P065-2	219	−65	1.34	7.084	2.789	0.146	0.058	12,900	2900	151.91	22,033	438,220	–	–
P065-3	219	−65	1.26	7.082	2.788	0.145	0.057	14,234	3200	169.17	24,536	6,890	–	–
AAMB-1	AMB	AMB	AMB	7.074	2.785	0.141	0.056	11,810	2655	144.33	20,934	20,600	–	–
AAMB-2	AMB	AMB	AMB	7.082	2.788	0.144	0.057	9,786	2200	117.34	17,018	149,400	–	–
AAMB-3	AMB	AMB	AMB	7.079	2.787	0.145	0.057	8,896	2000	105.79	15,343	260,000	(3)	(3)
AAMB-4	AMB	AMB	AMB	7.082	2.788	0.147	0.058	10,231	2300	119.49	17,331	80,500	–	–
AAMB-5	AMB	AMB	AMB	7.074	2.785	0.142	0.056	9,341	2100	113.15	16,411	260,000	237.62	34,464
AAMB 6	AMB	AMB	AMB	7.082	2.788	0.143	0.056	8,896	2000	106.86	15,499	260,000	176.32	25,573
PAMB-1	AMB	AMB	1.03	7.074	2.785	0.142	0.056	9,341	2100	113.15	16,411	260,000	206.90	30,009
PAMB 2	AMB	AMB	1.05	7.079	2.787	0.144	0.057	10,231	2300	122.72	17,799	83,800	–	–
PAMB-3	AMB	AMB	1.07	7.082	2.788	0.145	0.057	10,231	2300	121.60	17,636	260,000	181.86	26,377
PAMB-4	AMB	AMB	1.12	7.074	2.785	0.145	0.057	11,743	2640	139.75	20,269	15,600	–	–
PAMB-5	AMB	AMB	1.15	7.081	2.788	0.144	0.057	10,675	2400	128.01	18,566	52,400	–	–
PAMB 6	AMB	AMB	1.13	7.079	2.787	0.145	0.057	9,341	2100	111.07	16,109	260,000	174.54	25,315
A170-1	350	170	AMB	7.076	2.786	0.145	0.057	11,565	2600	137.58	19,954	5,850	–	–
A170-2	350	170	AMB	7.079	2.787	0.147	0.058	10,231	2300	120.06	17,413	11,310	–	–
A170 3	350	170	AMB	7.079	2.787	0.147	0.058	8,896	2000	103.95	15,077	260,000	203.24	29,477
P170-1	350	170	0.99	7.079	2.787	0.147	0.058	11,565	2600	135.14	19,600	3,120	–	–
P170-2	350	170	0.91	7.079	2.787	0.150	0.059	10,231	2300	117.52	17,045	44,760	–	–
P170-3	350	170	0.92	7.076	2.786	0.144	0.057	8,896	2000	106.77	15,485	77,070	–	–

(1) BASED ON A DAMAGED AREA HAVING A DIAMETER OF APPROXIMATELY 1.27 CM (0.500 INCH)
(2) ALL SPECIMENS FAILED THROUGH DAMAGED AREA
(3) RESIDUAL STRENGTH NOT OBTAINED BECAUSE OF TEST EQUIPMENT MALFUNCTION

TABLE B-4

STRAIN GAGE MEASUREMENTS FOR Z3943442 DAMAGE AND DEBOND SPECIMENS

LAYUP: (25/50/25) = PERCENT PLIES AT (0°, $\pm 45^{\circ}$, 90°)



SPECIMEN IDENTIFICATION	APPLIED GROSS AREA STRESS σ_G MPa	σ_G PSI	MEASURED STRAIN μ CM/CM, IN./IN. SG NO. 1	SG NO. 2	SG NO. 3	SG NO. 4	GROSS AREA STRESS CONCENTRATION FACTOR K_{t_g} (1)
DEBOND							
-1 AAMB-1	106.87	15,500	2050	2168	1957	2131	–
-1 AAMB-3	100.67 –100.67	14,600 –14,600	1989 –1645	2091 –2504	2014 –2410	2075 –1790	– –
-1 PAMB-1	103.53 –103.53	15,015 –15,015	2010 –2191	2079 –2130	2020 –1951	2161 –2252	– –
-1 PAMB-2	102.46 –102.46	14,861 –14,861	1950 –1550	2032 –2545	2092 –2550	2130 –1790	– –
DAMAGE							
-505 AAMB-1	118.42	17,176	2085	3617	1925	3259	1.71
-505 AAMB-2	96.29	13,966	1660	3030	1650	2712	1.73
-505 PAMB-1	116.71 –116.71	16,927 –16,927	1975 –1130	3427 –4744	2022 –2976	3614 –2535	1.76 1.77
-505 PAMB-2	100.71 –100.71	14,606 –14,606	1818 –2034	3011 –2520	1774 –1635	3236 –4001	1.74 1.78

(1) GROSS AREA STRESS CONCENTRATION FACTOR K_{t_g}, SHOWN ABOVE, IS THE SUM OF THE MICROSTRAINS FOR SG NO. 2 AND 4 DIVIDED BY THE SUM OF THE MICROSTRAINS FOR SG NO. 1 AND 3.