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AFFDL-TR-76-63

LOW-COST AIRCRAFT STRUCTURAL REPAIR AND MAINTENANCE STUDY

ROCKWELL INTERNATIONAL
LOS ANGELES AIRCRAFT DIVISION
LOS ANGELES, CALIFORNIA

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MARCH 1977

FINAL REPORT FOR PERIOD AUGUST 1974 - MAY 1976
TECHNICAL REPORT AFFDL-TR-76-63

AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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This technical report has been reviewed and is approved for publication.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: AFFDL-TR-76-63	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Low-Cost Aircraft Structural Repair and Maintenance Study	5. TYPE OF REPORT & PERIOD COVERED: Final Report. 15 Aug 1974 - 31 May 1976
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): W. D. Dotseth, R. W. Nickel, W. E. Routh	8. CONTRACT OR GRANT NUMBER(s): F33615-74-C-3101
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Rockwell International, Los Angeles Aircraft Division, Los Angeles, California 90009	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Project 1368, WU 13670219
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio 45433	12. REPORT DATE: March 1977
	13. NUMBER OF PAGES: 128
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution limited to U. S. Government agencies only, test and evaluation; statement applied March 1977. Other requests for this document must be referred to Air Force Flight Dynamics Laboratory (FBS), Wright-Patterson Air Force Base, Ohio 45433.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(16) 1368

(17) 02

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aircraft structure repair and maintenance, life cycle cost impact, aircraft structure defects, low-cost repair concepts, structure maintenance design criteria and guidance, AFM66-1 maintenance reporting system, air logistics centers repair facilities

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents the research and analysis conducted to (1) identify high-cost structural repair and maintenance items in existing U.S. military aircraft, (2) conduct a design study on means to reduce life cycle costs for a number of selected structural problems on fighter, bomber, and cargo/tanker class aircraft, and (3) to develop a design handbook to provide guidance and information on methods to reduce aircraft structure cost of ownership. This

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408 245

20. ABSTRACT (Continued)

program was limited to existing military aircraft metallic-type structures since separate programs for adhesively bonded and advanced composite structure design and repair are being developed by the Structures Division (FBS) of the Air Force Flight Dynamics Laboratory. The design handbook has been published as document No. AFFDL-TR-76-72, "Aircraft Structural Design Handbook for Lower Cost Maintenance and Repair."

FOREWORD

This technical report was prepared by the Los Angeles Aircraft Division (LAAD) of Rockwell International, Los Angeles, California, for the Advanced Structures Development Branch, Structural Mechanics Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio under Contract F33615-74-C-3101. This research was conducted under Project 1368 "Advanced Structures for Military Aerospace Vehicles", Task 136802 "Advanced Airframes for Military Flight Vehicles". Mr. Clark Bech (AFFDL/FBS) was project Engineer.

The technical effort described in this report was performed between 15 August 1974 and 31 May 1976.

SUMMARY

This report documents the research and analysis conducted to (1) identify high-cost structural repair and maintenance items in existing U.S. military aircraft, (2) conduct a design study on means to reduce life cycle costs for a number of selected structural problems on fighter, bomber, and cargo tanker class aircraft, and (3) to develop a design handbook to provide guidance and information on methods to reduce aircraft structure cost of ownership. This program was limited to existing military aircraft metallic-type structures since separate programs for adhesively bonded and advanced composite structure design and repair are being developed by the Structures Division (FBS) of the Air Force Flight Dynamics Laboratory. The design handbook has been published as document No. AFFDL-TR-76-72, "Aircraft Structural Design Handbook for Lower Cost Maintenance and Repair."

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I

INTRODUCTION

Substantial costs have been and are being expended by the Air Force each year for the maintenance and repair efforts of the structures on existing inservice aircraft. They constitute a large percentage of the cost of ownership to the military on these systems and have been identified as an area of potential improvement by the Structures Division of the Air Force Flight Dynamics Laboratory.

Many of the cost-associated maintenance and repair problems have been the result of changes in the basic operational missions for which the aircraft was originally designed, significant extension of the service life of the majority of operational aircraft, and the lack of requirements and guidance for aircraft structure maintenance and repair considerations in the original aircraft system specifications. The acquisition costs of aircraft systems in the past have enjoyed the place of prominent consideration for design considerations, with the operational costs being relegated to a secondary role. Recently, the Air Force has become highly concerned with the life cycle costs of all of its existing and future systems. One of the primary objectives of this concern has been the reduction of operational and support costs related to aircraft maintenance and repair.

Past investigations have indicated a significant frequency of structural defects detected in all types of military aircraft. Extensive structural integrity programs have also been conducted on a number of Air Force aircraft and have provided a wealth of information on operational structural load spectrum, defect detection, and repair concepts. The science of fracture mechanics has been established during the past decade and provides a quantitative means of evaluating the choice of materials and new structural design concepts. The experience and lessons learned from past problems and subsequent solutions thereby provide valuable data for the future.

Recognizing these factors, the Air Force Flight Dynamics Laboratory has sponsored a number of programs dedicated to research and development of design information and guidance that will permit substantial life cycle cost savings to be gained by lower maintenance and repair expenditures on the structural portions of their aircraft.

This report documents the results of a study conducted to identify and develop cost-effective design solutions for selected Air Force aircraft structural maintenance and repair problems and to develop a design handbook. The program was arranged in five phases as follows:

- Phase I - Data Search and Acquisition
- Phase II - Data Analysis and Selection
- Phase III - Selected Items Analysis and Design Study
- Phase IV - Life Cycle Analysis of Selected Design Studies
- Phase V - Preparation of Design Handbook for Lower Cost Maintenance and Repair of Aircraft Structure

The means by which each of the program phases were conducted and the results obtained are described in subsequent sections of this report. Also included is a summary of the findings and recommendations for future Air Force actions and programs.

SECTION II

PROGRAM ORGANIZATION

The program was organized and conducted as shown by the task/event flow diagram in Figure 1. It provides an overall view of each of the tasks performed in the program. Phase I consisted of a data research and acquisition effort where information on current military aircraft structure maintenance and repair problems were obtained through visitations to Government and industry activities, use of Air Force and Navy maintenance reporting systems, and literature searches. The information obtained was then organized, and specific elements were selected for analysis. The information was also placed in a data bank for future use in the program. A briefing and an interim report were then prepared by the contractor and reviewed by AFFDL/FBS. Concurrently with this activity, a detailed program plan was prepared for the conduct of the subsequent program phases.

In phase II, analysis of the acquired data was conducted and a number of critical aircraft structure repair and maintenance items were selected for design study. The selections were representative of problems in fighter, bomber, and cargo tanker-type aircraft. The candidate critical items were documented in a report and reviewed with AFFDL for discussion and approval. The results of the selection were then documented in an interim report for phase II.

Phase III effort consisted of a study to develop candidate innovative design improvements or repairs for the selected critical items that would eliminate or significantly reduce future expenditures of maintenance actions. As each candidate improvement was developed, phase IV life cycle cost analyses were conducted to evaluate the benefits that could be realized. The criterion for acceptance was a break-even point in 3 years after implementation and a significant life cycle cost savings after 10 years. The results of phase III and IV efforts were documented in a report and a briefing presented to AFFDL for review and approval. The candidate structural design improvements and potential savings were presented to the specific aircraft system managers at their respective Air Logistic Centers by AFFDL/FBS. Several of the design concepts are currently being considered for additional study, evaluation, and implementation by these activities.

In phase V, a design handbook, entitled "Aircraft Structural Design Handbook for Lower Cost Maintenance and Repair," was developed. It contains information and guidance on methods to achieve lower maintenance costs on existing and future aircraft systems.

Detailed summaries of each of the program phases are contained in Section III of this report.

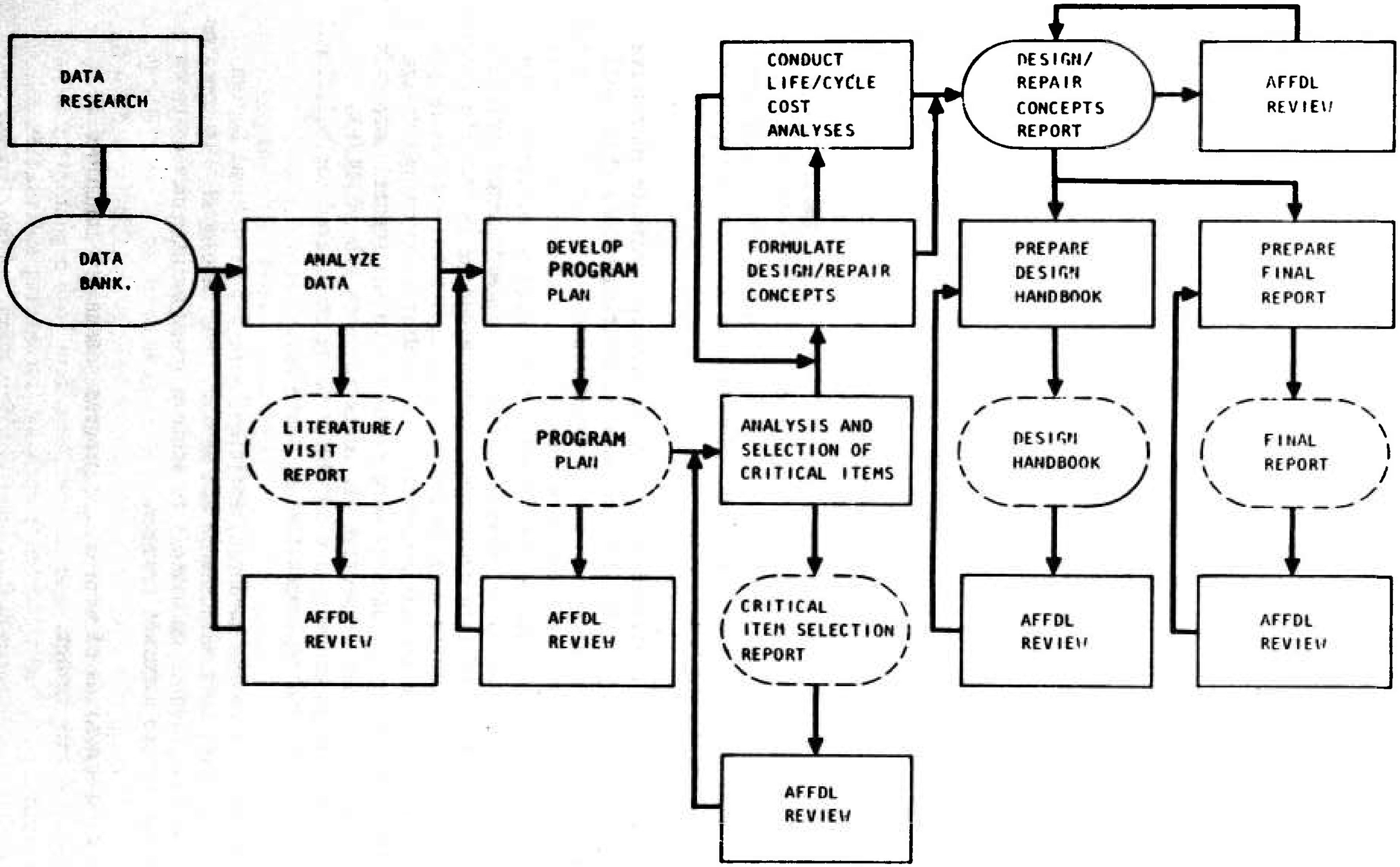

Figure 1. Program task/event flow diagram.

SECTION III

PROGRAM SUMMARY

PHASE I - DATA RESEARCH AND ACQUISITION

The objectives of the data research and acquisition were to (1) conduct visitations to selected military and industry aircraft repair facilities to identify and document structural maintenance and repair problems on existing operational aircraft, (2) obtain and analyze AFM66-1 maintenance and IROS data, and (3) conduct a literature search for relevant information and data.

In this program, aircraft structure was defined as those elements normally associated with the airframe and the interfaces with other major subsystems where structural loads are accepted. This included the landing gear, flight controls, propulsion system, and crew stations.

Visitations were made to the military and industry activities shown in Table 1. They included Air Force Air Logistic Centers (ALC's), Navy Aircraft Rework Facilities (NARF's), commercial airlines, and aircraft manufacturers. The specific aircraft for which each activity has responsibility is also noted in the table. Specific information was sought in these visits. Figures 2 and 3 show the type of information sought at each repair activity and for specific aircraft problems and formed the basis for the general discussions. Considerable data and information were obtained during these visits on the most critical and chronic repair and maintenance problems being experienced. The results of the visitations were compiled and summarized into a report for use in the subsequent program phases.

Other sources of information on the Air Force aircraft were the structural repair manuals, inspection manuals, corrosion control manuals, and the illustrated parts breakdown manuals. These were identified and acquired during phase I activities for future use in the program.

A literature search was conducted through the Defense Documentation Center (DDC) to identify published documents on aircraft structure defects, repair and inspection techniques, and innovative repair concepts. A bibliography was obtained, and selected documents were acquired and placed in the program data bank. A systematic data filing and retrieval method was used for the program data bank. As each document was received, it was reviewed and the information relevant to the program was identified. This information was entered on a special form, as shown in Figure 4. Subject descriptors assigned to each document identified the type of information which it contained. Figure 5 is the listing of subject categories that were established for the program. This information on the bibliography form was then keypunched on IBM cards. These, in turn, were used as the input data to a computerized data sorting system, which identified each document containing information on specific subjects to ensure that no useful information was overlooked.

TABLE 1. LISTING OF AIRCRAFT REPAIR FACILITIES VISITATIONS

Organization	Location	Aircraft
U.S. Air Force		
Sacramento Air Logistics Center	McClellan AFB, Calif.	A-1, FB-111, C-121, F-84, F-86, F-100, F-104, F-105, F-111, T-28, T-33, T-39, C-12A, E3A
Ogden Air Logistics Center	Hill AFB, Utah	A-26, B-26, F-4, F-89, F-101
Oklahoma Air Logistics Center	Tinker AFB, Okla.	A-7, B-1, B-52, C-97, C/KC-135, VC-137, E-4
San Antonio Air Logistics Center	Kelly AFB, Tex.	C-5, C-6, C-131, F-5, F-51, F-102, F-106, O-2, T-29, T/A-37, T-38, T-41, T-43, OV-10, C-9
Warner-Robins Air Logistics Center	Robins AFB, Ga.	B-57, B-66, C-7A, C-46, C-47, C-54, C-117, C-118, C-119, C-123, C-124, C-130, C-133, C-140, C-141, F-15, O-1, U-1A, U-3, U-4, U-6, U-10, U-17
Davis-Monthan MASDC	Davis-Monthan AFB, Ariz.	Storage and disposition of all types military aircraft
U.S. Navy Air Rework Facilities		
NARF	North Island, Calif.	F-4, F-14
NARF	Norfolk, Va.	A-6, F-8, C-118, P-2, F-14

TABLE 1. LISTING OF AIRCRAFT REPAIR FACILITIES VISITATIONS (CONCL)

Organization	Location	Aircraft
NARF	Cherry Point, N.C.	OV-10, F-4, C-130, C-131, AV-8
Aircraft Manufacturing Co.		
Northrop Corp Aircraft Division	Hawthorne, Calif.	T-38, F-5
McDonnell Douglas	Long Beach, Calif	A-4, DC-9, DC-10
McDonnell Douglas	St. Louis, Mo.	F-4, F-15
General Dynamics	Fort Worth, Tex.	F-16, F-111, FB-111
Ling Temco Vought	Dallas, Tex.	F-8, A-7
Boeing Aircraft Corp	Wichita, Kans.	B-52, 707, 727, 737, 747
Commercial Airlines		
Continental Airlines	Los Angeles, Calif.	720, 727, DC-9, DC-10
Eastern Airlines	Miami, Fla.	727, DC-9, L1011
United Airlines	San Francisco, Calif.	727, 737, 747, DC-8, DC-10
TWA	Kansas City, Mo.	707, 727, 747, DC-9, L1011
Western Airlines	Los Angeles, Calif.	720, 727, 737, DC-10

GENERAL MAINTENANCE FACILITY INFORMATION

DATE ____________________

ORGANIZATION ______________________________ LOCATION ____________________

1. AIRCRAFT TYPE/MODELS SERVICED. TOTAL INVENTORY AND OVERHAUL RATE
2. STRUCTURE INSPECTION TECHNIQUES/EQUIPMENT
3. STRUCTURAL MAINTENANCE/REPAIR EQUIPMENT
4. STRUCTURE MAINTENANCE/REPAIR RECORDS/STATISTICS
5. MOST FREQUENT STRUCTURAL MAINTENANCE/REPAIR ITEM
6. MOST COSTLY STRUCTURAL MAINTENANCE/REPAIR ITEM
7. REPAIR TECHNIQUES UTILIZED
   - a. Permanent
   - b. Temporary
8. COST ACCOUNTING DATA
   - a. Labor
   - b. Material
9. ENGINEERING SUPPORT
   - a. In-house
   - b. Contractor
10. STRUCTURE REPAIR MANUALS/INSTRUCTIONS
11. STRUCTURAL STRESS ANALYSIS REPORTS
12. STRUCTURAL INTEGRITY PROGRAMS
13. OPERATING CONDITION OF AIRCRAFT (i.e., FLIGHT HOURS, PROFILES, ENVIRONMENT, ETC)
14. REPORTING SYSTEMS FOR MAINTENANCE/REPAIR WORK
15. PERSONNEL SKILL LEVELS AND LENGTH OF SERVICE
16. RECOMMENDATIONS FOR IMPROVED STRUCTURAL DESIGN
17. RECOMMENDED STRUCTURAL MODIFICATION TO IMPROVE SERVICE LIFE/MAINTENANCE
18. COMMENTS/OBSERVATIONS

Figure 2. General maintenance facility information.

SPECIFIC STRUCTURAL REPAIR INFORMATION

DATE ______________

ORGANIZATION ______________________ LOCATION ______________

AIRCRAFT TYPE ____________ MODEL ________ SERIAL/BLOCK NO. ________

AIRCRAFT OR PART HOURS ________________

1. PART NO ________________ PART NAME ________________
2. PARTS CATALOG NO. ____________ REPAIR MANUAL NO. ____________
3. PARTS CATALOG FIGURE/PAGE NO. __________ REPAIR MANUAL PAGE NO. ________
4. PART LOCATION IN AIRCRAFT ________________
5. WHEN DISCOVERED ________________
6. HOW DISCOVERED ________________
7. TYPE OF FAILURE ________________
8. REPAIR OR REPLACEMENT ________________
9. REPAIR INFORMATION SOURCE ________________
10. TYPE OF REPAIR INFORMATION ________________
11. TYPE AND FORM OF MATERIAL IN DAMAGED PART ________________
12. TYPE OF REPAIR MATERIAL ________________
13. TYPE OF REPAIR FASTENERS ________________
14. STRESS REPORTS ________________
15. FABRICATION METHODS ________________
16. MATERIAL PROCESSING ________________
17. REPAIR/REPLACEMENT MAN-HOURS __________ LABOR RATE __________
18. MATERIALS/PARTS/KIT COST ________________
19. SPECIAL TOOLS REQUIRED ________________
20. COST OF SPECIAL TOOLS ________________
21. TOTAL DOWNTIME OF AIRCRAFT FOR REPAIR ________________
22. COMMENTS ON DESIGN OF REPAIR (COMPLEXITY, MATERIALS, FASTENERS, FABRICATION DIFFICULTIES)

Figure 3. Specific structural repair information.

23. ACCESS OPENINGS. SUFFICIENT ________________ INSUFFICIENT ____________________
IF INSUFFICIENT, GIVE SIZE AND LOCATION OF ADDITIONAL ACCESS OPENING(S) RECOMMENDED

24. SUGGESTION TO IMPROVE DESIGN OF REPAIR TO LOWER MAN-HOUR AND/OR MATERIAL COSTS

25. OTHER COMMENTS

Figure 3. Specific structural repair information (concl).

Job No.
Page of

BIBLIOGRAPHY DATA SHEET

		Card Columns
CARD NO.	A (All Cards)	A1
1. Index No.	CB10021	2-10
2. Govt Sponsor ID	AFFDL	A11-20
3. Sponsor Report No.	AFFDL-TR-70-149	A21-45
4. Source/Contractor ID	UTC	A46-55
5. Source Report No.	NØNE	A56-80
CARD NO.	2	B1
6. Date / 7. Security Classification / 8. Format	MAR71 / U / H	B11-19
9. Title	INVESTIGATIØN AND ANALYSIS DEV	B20-49
(Title Cont)	ELØPMENT ØF EARLY LIFE AIRCRAFT	B50-80
CARD NO.	3	C1
Title (Cont)	STRUCTURAL FAILURES	C11-30
Title (Cont)		C31-50
10. Subject Code	05 16 22 28 25	C51-80
CARD NO.	4	D1
USEFULNESS COMMENTS	SURVEY AND ANALYSIS ØF HIGHLY STRES	D11-45
	SED AIRCRAFT STRUCTURAL ELEMENTS TH	D46-80
CARD NO.	5	E1
	AT HAVE SIGNIFICANT SERVICE FAILURE	E11-45
	S LARGE PØPULATIØN FAILURE TABULAT	E46-80
CARD NO.	6	F1
	IØN PRESENTED FRACTURE MECHANICS A	F11-45
	NALYSIS METHØD SHØWN	F46-80

FORM 1000-J NEW 3-73

Figure 4. Bibliography data sheet.

AIRCRAFT TYPE

01 FIGHTER
02 BOMBER
03 CARGO/TANKER
04 COMMERCIAL
05 ALL TYPES

STRUCTURAL ELEMENTS

11 AIRFRAME
12 CREW ACCOMMODATIONS
13 PROPULSION INSTALLATION
14 FLIGHT CONTROLS
15 ENGINE MOUNTING
16 ALL STRUCTURAL ELEMENTS

DAMAGE/MAINTENANCE FACTORS

21 CORROSION DAMAGE
22 CRACKING
23 FASTENERS
24 COSTS
25 MATERIAL PROPERTIES
26 ACOUSTIC DAMAGE
27 MAINTENANCE PROCEDURES
28 FAILURE ANALYSIS/DATA

INSPECTION TECHNIQUES

31 VISUAL
32 PENETRANT
33 MAGNETIC
34 EDDY CURRENT
35 ULTRASONIC
36 RADIOGRAPHIC
37 HOLOGRAPHY

OPERATIONAL FACTORS

41 ENVIRONMENT
42 LOGISTICS
43 MAINTENANCE FACILITIES

DESIGN FACTORS

51 MATERIAL SELECTION
52 PROTECTIVE FINISHES
53 FASTENER SELECTION
54 FRACTURE MECHANICS
55 COMPOSITES/PLASTICS
56 CORROSION CONTROL
57 REPAIR TECHNIQUES

AIRCRAFT MANUALS

61 MAINTENANCE
62 REPAIR
63 CORROSION CONTROL
64 PARTS CATALOG
65 NDI

TRADE-OFF/LIFE CYCLE LOST FACTORS

71 IROS DATA
72 OPERATIONAL COST
73 LCC METHODS
74 COST PLANNING FACTORS

Figure 5. Subject categories.

The maintenance actions on Air Force aircraft at the organizational (field) level are recorded in the AFM66-1 system. The information is submitted to AFLC and stored on magnetic tape for use in data analysis. In this program, a number of aircraft models were selected for analysis of structural maintenance and repair actions. The criteria for selection of the candidate aircraft were (1) there would be a minimum of two aircraft model types in each bomber, fighter, and cargo/tanker category, (2) the aircraft selected would have experienced significant levels of flying hours in the past, and (3) there are a reasonable number of aircraft in service and would be expected to remain in operational use for another 10 years. The aircraft selected under these ground rules are:

- Fighter/trainers - A-7D, F-4D, F-111A, and T-38A
- Bombers - B-52H, FB-111A
- Cargo/tankers - C-130E, C-141, C-5A, and KC-135

A 12-month period of AFM66-1 maintenance records was selected for each aircraft. The primary criterion was to select a time period where the greatest number of maintenance actions would have occurred. The period between mid-1969 and early 1972 was judged to have the highest flying hours for the majority of the aircraft due to the extensive flying hours related to support of the conflict in Southeast Asia. Three exceptions to this time frame were found to be necessary due to the low number of aircraft in service at that time and to the unavailability of the AFM66-1 data. The magnetic tapes for the following aircraft were obtained from the Air Force Logistic Command (AFLC):

Aircraft	Time Period
A-7D	January through December 1973
T-38	January through December 1973
C-130E	January through December 1973
F-4D	January through December 1971
F-111A	November 1970 through October 1971
B-52H	June 1969 through May 1970
FB-111	November 1970 through October 1971
C-141A	April 1971 through May 1972
C-5A	June 1971 through May 1972
KC-135	January through October 1971

Data on structural maintenance actions were extracted from each magnetic tape. This was accomplished by a computer program that first identified those maintenance actions against the following work unit code (WUC) series:

WUC Series	Subsystem
11000	Airframe
12000	Crew accommodations
13000	Landing gear
14000	Flight controls
23000	Propulsion

Next, structure-related how malfunction codes (HMC's) were selected for on-aircraft defects. Those selected for the program are shown in Table 2.

For the 10 aircraft, over 7-1/2 million AFM66-1 event records were screened. Of these, approximately 866,000 structure-related actions were identified and extracted for analysis. Figure 6 shows the total number of maintenance actions processed on each type of aircraft and the number of structure-related items identified.

The data for each aircraft were then processed with a reliability and maintainability (RAM) computer system that listed and ranked the major WUC contributors of maintenance man-hours (MMH) per flight hour (FH). They were listed for scheduled MMH/FH, unscheduled MMH/FH, and total MMH/FH. An example of the data listing is shown in Figure 7 for the FB-111 aircraft for a 12-month period where 11,362 flights were made in 16,704 operating hours. For example, the No. 1 contributor to scheduled maintenance is the WUC 11ACD, center section skin, with 5.16 percent of all on-aircraft scheduled maintenance. The No. 1 contributor to unscheduled maintenance is WUC 13GAH, main gear tire. (This item was purged from the file during the next phase as the file was reduced to pure structure components.) The main gear tire was also the total major contributor.

A structural maintenance analysis (SMA) computer program was developed to analyze the high contributors to maintenance man-hours. It was programmed to list the WUC of a structural element and identify each HMC recorded against the WUC. It also lists the when discovered code (WDC), the action taken code (ATC), the number of occurrences, and the man-hour time expended. Figure 8 shows an example of the SMA data format for the FB-111A aircraft. A center-section frame (11ACA) was found by the ground crew (WDC "F") to be broken (HMC 070) between flights. Minor repairs (ATC "G") were made on 6 of the items during the reporting period, with an expenditure of 71.0 maintenance man-hours. This would result in an average repair time of 11.8 hours for that specific unit.

TABLE 2. SELECTED HOW MALFUNCTION CODES

Code	Nomenclature
020	Worn, chafed, or frayed
070	Broken
105	Loose or damaged bolts, screws, etc.
106	Missing bolts, screws, etc.
111	Burst or broken
116	Cut
117	Deteriorated
135	Binding, stuck, or jammed
170	Corroded
190	Cracked
425	Nicked
520	Pitted
540	Punctured
585	Sheared
605	Crazed
660	Stripped
731	Battle damage
780	Bent, buckled, collapsed, dented
846	Delaminated
878	Weather damage
910	Chipped
917	Impending failure
935	Scored or scratched
947	Torn

Aircraft type	Total maintenance actions	Structure-related actions
FB-111	93,288	5,416
F-111A	217,835	11,834
KC-135	309,377	30,804
B-52H	425,419	45,809
C-5A	496,120	41,167
C-141	1,872,384	371,311
F-4D	2,011,441	112,564
C-130E	687,572	137,571
A-7D	185,749	24,101
T-38	1,210,680	85,342
	7,509,865	865,919

Figure 6. Total AFM66-1 maintenance and structure-related actions by aircraft type.

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F6111 STRUCTURE RAM NOV70-OCT71 UH1152 JOB NUMBER 1608-44 DEC. 04 1974
OPERATING HOURS 16704. AIRCRAFT TYPE F6111 NO. OF FLIGHTS FLOWN 11362.

MAJOR CONTRIBUTORS TO MANHOURS PER FLIGHT HOUR

* SCHEDULED *			* UNSCHEDULED *			* TOTAL *		
CODE	MANHOURS PER FLIGHT HOUR	PERCENT	CODE	MANHOURS PER FLIGHT HOUR	PERCENT	CODE	MANHOURS PER FLIGHT HOUR	PERCENT
11AGG	0.146124E-01	3.1613	13GAH	0.226007E-01	4.6182	13GAH	0.285141E-01	3.9166
11BAH	0.105667E-01	3.0236	14EAA	0.179957E-01	3.9411	13GBG	0.185584E-01	2.5487
13UAA	0.746922E-02	2.7521	13GEG	0.138089E-01	3.0417	11BAH	0.165165E-01	2.5430
11ADW	[illegible]	2.4605	11EAL	0.122560E-01	2.6765	11BAL	0.182711E-01	2.5092
13GAH	[illegible]	2.3967	14DCW	0.119072E-01	2.6006	11AGD	0.181992E-01	2.4994
11EAL	0.604047E-02	2.2248	14DCM	0.109012E-01	2.3875	14EAA	0.179957E-01	2.4114
14DCX	0.560695E-02	2.1380	13EAD	0.999102E-02	2.1862	13UAA	0.158525E-01	2.1771
13DAD	0.541702E-02	1.9953	14GAB	0.981601E-02	2.1502	13DAD	0.154095E-01	2.1163
14ECK	0.511255E-02	1.8828	11AFB	0.969822E-02	2.1239	14DCX	0.148860E-01	2.0447
13GEG	0.466954E-02	1.7197	14DCX	0.900165E-02	1.9669	14UCH	0.143439E-01	1.9699
11AMB	0.465757E-02	1.7153	14DAE	0.880627E-02	1.9286	14DAE	0.128412E-01	1.7635
11ABJ	0.450572E-02	1.6866	13UAA	0.838527E-02	1.8316	11ADW	0.125539E-01	1.7241
11ADL	0.423850E-02	1.5609	11EAM	0.813577E-02	1.7818	14DCM	0.119373E-01	1.6394
14DAE	0.403496E-02	1.4860	14FAA	0.718391E-02	1.5733	11AFB	0.107759E-01	1.4799
14DCP	0.395712E-02	1.4573	11BAK	0.690839E-02	1.5261	14DCP	0.107280E-01	1.4733
11AMT	0.395115E-02	1.4551	14DCP	0.677083E-02	1.4828	14GAB	0.993774E-02	1.3648
11AUB	0.392720E-02	1.4463	11AFD	0.590204E-02	1.3058	11AMB	0.979406E-02	1.3451
14EAE	0.391195E-02	[illegible]	11ADW	0.587284E-02	1.2862	11BAK	0.801604E-02	1.1009
11AGF	0.366309E-02	1.1354	13JAU	0.586066E-02	1.2849	11ADB	0.759099E-02	1.0425
11ADV	0.303532E-02	1.1176	14DCY	0.544779E-02	1.1931	14FAA	0.718391E-02	0.9866
11AMG	0.302525E-02	1.1134	11AMB	0.513644E-02	1.1249	11ADL	0.692050E-02	0.9504
11AMA	0.287356E-02	1.0583	11ABD	0.503472E-02	1.1026	11ACK	0.667565E-02	0.9167
11ACK	0.277776E-02	1.0230	11ACK	0.493693E-02	1.0816	11AGF	0.613625E-02	0.8427
11AGH	0.255627E-02	0.9414	11ACA	0.472941E-02	1.0358	11ABC	0.607040E-02	0.8337
11AMM	0.247240E-02	0.9106	11ABC	0.465154E-02	1.0187	11AFD	0.605245E-02	0.8312
11AAK	0.246049E-02	0.9061	11EFD	0.443600E-02	0.9715	11ABD	0.587284E-02	0.8065
11EBK	0.245450E-02	0.9039	11AEA	0.432830E-02	0.9479	13JAU	0.586066E-02	0.8057
11AGE	0.244255E-02	0.8995	14CCC	0.419001E-02	0.9176	11ACA	0.580699E-02	0.7975
14DCW	0.237660E-02	0.8753	11AGD	0.418463E-02	0.9164	11ABA	0.580100E-02	0.7967
11AGM	0.220008E-02	[illegible]	11ADE	0.366379E-02	0.8024	14EAE	0.562739E-02	0.7728
11ADC	0.217912E-02	0.8025	13ECG	0.359794E-02	0.7860	11AMG	0.557351E-02	0.7654
13CDA	0.215517E-02	0.7937	13FBA	0.356202E-02	0.7801	14DCY	0.555556E-02	0.7630
14DCA	0.196959E-02	0.7254	11AFA	0.346025E-02	0.7578	11ADV	0.553700E-02	0.7605

Figure 7. Sample RAM tab printout.

WUC	HOW MALFUNCTION CODE	WHEN DISCOVERED CODE	ACTION TAKEN CODE	UNITS	TIME
11ACA	070	F	G	6	71.0
		F	A	1	4.0
		Q	G	4	17.0
	135	M	G	1	1.0

MAN HOURS
NUMBER OF ACTIONS
MINOR REPAIR
BETWEEN FLIGHTS BY GROUND CREW
BROKEN
CENTER SECTION FRAME

- FLIGHT HOURS: 16704
- FLIGHTS: 11362
- PERIOD: NOV 70 - NOV 71

Figure 8. Structural maintenance analysis for major contributors for FB-111A.

In the same manner, structural maintenance analysis were conducted on the data for each selected aircraft.

PHASE II - DATA ANALYSIS AND CRITICAL ITEM SELECTION

The objective of phase II was to conduct a detailed analysis of the data acquired in phase I in order to identify the most costly and frequent structural problems experienced on Air Force aircraft. The results of this analysis were then used to select a minimum of 6 critical items for design study directed to the development of innovative design changes or repairs. The selections were made from the analysis of the AFM66-1 maintenance data and the information obtained from the Air Logistics Centers. The structural maintenance analysis (SMA) identified the top contributors for maintenance of aircraft structures for each of the 10 selected aircraft systems. The top contributors for each aircraft were listed (Figure 9) and analyzed to determine the specific cause for the problem. This was accomplished through use of the illustrated parts breakdown, repair manuals, and direct contact with maintenance personnel at the responsible Air Logistics Center and at selected operational organizations. In many of the cases, it was found that the WUC discriptor was not definitive enough to identify the specific structural element that was the primary problem. Figure 10 shows a listing of some of the top contributors on the FB-111A aircraft where the WDC's were used as an aid in identification of the reason for maintenance actions. Further analysis was then performed to determine the existence of specific problem trends in each aircraft. Figure 11 contains a listing of the descriptor codes used in the analysis. The type of structure involved in the maintenance action was first identified. The structural importance of the item (primary load path, secondary, or other) was then determined. The part form, as indicated by the descriptors in the listing, were next identified. The part material type was also identified to aid in determining any specific trends. A summary sheet was then prepared for each top contributor item, to provide the needed detail information for selection of items for design study. Figure 12 shows an example of one of the summary sheets for an aileron assembly on the F-4D aircraft. It provides the description of the part as to its type of structure, material form and type, its ranking in maintenance man-hours per 1,000 flight hours, ranking in maintenance demand rates (MDR's), and the predominate WDC's and ATC's.

As part of this evaluation, the Air Force increased reliability of operational systems (IROS) data were obtained on magnetic tape. Through the use of a computer search program, the ranking of each identified WUC item in terms of overall maintenance costs were established. This provided an indication of the operational organization costs only, since the costs for repair at the individual Air Logistics Centers are not included in the IROS data.

MAINTENANCE MANHOUR CONTRIBUTOR(S) TO FLIGHT CONTROLS
F-4D

WUC	NOMENCLATURE	HMC	UNITS	TIME	MMH/ 1000 FH
14210	AILERON ASSY	105	2774	6038.0	34.6916
14310	STABILATOR ASSY	105	2458	4759.7	27.3470
1431B	STEEL TRAIL EDGE	190	296	2842.2	16.3300
14210	AILERON ASSY	106	867	1883.6	10.8223
14510	INBD LEAD EDGE	190	284	1865.4	10.7177
14310	STABILATOR ASSY	190	273	1571.2	9.0274
14310	STABILATOR ASSY	106	556	1213.1	6.9669
1431B	STEEL TRAIL EDGE	105	534	1128.1	6.4815
1431C	ALUM TR EDGE	190	113	980.0	5.6306
14510	INBD LEAD EDGE	105	588	884.4	5.0814
14210	AILERON ASSY	020	330	800.8	4.6010
14210	AILERON ASSY	190	154	693.0	3.9817
14310	STABILATOR ASSY	020	85	599.5	3.4445
14510	INBD LEAD EDGE	106	281	504.9	2.9009
1431C	ALUM TR EDGE	846	64	500.5	2.8756
1431B	STEEL TRAIL EDGE	170	13	490.9	2.8205
14210	STEEL TRAIL EDGE	947	240	490.6	2.8188
1431B	STEEL TRAIL EDGE	106	155	369.2	2.1213
14210	AILERON ASSY	780	109	366.7	2.1069
1431C	STABILATOR ASSY	947	26	324.5	1.8644
1431C	ALUM TR EDGE	105	137	313.8	1.8030
14310	STABILATOR ASSY	170	71	243.8	1.4008
1431B	STEEL TRAIL EDGE	117	26	236.5	1.3588
1431C	ALUM TR EDGE	780	39	234.3	1.3462
14310	STABILATOR ASSY	846	31	214.6	1.2330
14210	AILERON ASSY	117	78	194.5	1.1175
14310	ALUM TR EDGE	106	71	171.4	0.9848
1431C	ALUM TR EDGE	117	14	140.0	0.8044
1431B	STEEL TRAIL EDGE	846	21	137.0	0.7871
1431B	ALUM TR EDGE	947	6	136.0	0.7814

Figure 9. Structural maintenance analysis (sample).

WUC	HOW MALFUNCTION CODE	WHEN DISCOVERED CODE	ACTION TAKEN CODE	UNITS	TIME
11ABD	106	H	G	3	1.3
		H	L	2	0.6
		M	G	3	3.5
	135	F	G	18	26.8
		M	G	2	4.5
11ABE	070	F	G	1	0.5
	105	F	G	16	20.5
		M	L	1	0.3
	135	F	G	6	8.4
		M	G	2	3.5
11ABF	105	F	G	1	2.0
	135	M	G	1	2.0
11ABG	105	F	G	8	11.6
		H	G	2	0.6
		H	L	1	0.1
		M	G	4	2.8
	106	F	G	2	3.0
		M	G	1	1.0
	135	F	G	6	10.0
		M	G	10	18.0
11ABJ	105	F	G	4	5.4
		H	G	2	0.5
		H	L	1	0.1
		M	G	3	2.8
	106	F	G	3	3.0
		M	G	2	3.0

Figure 10. Structural maintenance analysis for major contributors for FB-111A (sample).

CODING SYSTEM FOR THE COMPREHENSIVE FAILURE DATA FORM

	DIVISION	DESCRIPTION	CODE
1.	TYPE OF STRUCTURE	AIRFRAME	1
		LANDING GEAR	2
		FLIGHT CONTROLS	3
		OTHER	4
2.	STRUCTURAL IMPORTANCE	PRIMARY STRUCTURE	1
		SECONDARY STRUCTURE	2
		OTHER	3
3.	PART FORM	FORGING	1
		CASTING	2
		SHEET	3
		PLATE (0.25 & THICKER)	4
		ROD	5
		BOLTS & FASTNERS	6
		EXTRUSIONS	7
		HONEYCOMB	8
		ASSEMBLY	9
		OTHER	10
4.	PART MATERIAL	ALUMINUM	1
		STEEL	2
		TITANIUM	3
		FIBERGLASS	4
		MAGNESIUM	5
		COMBINATION	6
		TRANSPARENT	7

Figure 11. Structural information codes.

CODE NOMENCLATURE
020 WORN, CHAFEO, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGEO BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 OETERIORATED
135 BENOING, STUCK, OR JAMMEO
170 CORROOEO
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPEO
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
M - PERIODIC/PHASED INSP.
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP.
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP.

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL F-4D
WUC - 14210
TITLE: AILERON ASSY

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES			IROS COST RANKING	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	S	3	3	020			7			61.3	1					OVERALL STRUCTURE
G	M	9	8	070												AIRFRAME
G	M	1	1	105												LOG GEAR
G	F	2	2	106				1	1						X	FL. CONT.
				111												OTHER
G	F	16	12	116												PRIMARY
G	F	7	6	117				1	1					X		SECONOARY
G	M	11	11	135												OTHER
F	M	13	10	170												FORGING
G	M	4	4	190												CASTING
G	M	15	11	425												SHEET
R	H	12	12	520												PLATE
G	F	8	7	540												ROD
				585												BOLTS & FAST
				605												EXTR:
G	M	15	12	660												H. COMB
				731				1	1				X			ASSY
G	F	6	5	780												OTHER
G	F	10	9	846												ALUM.
				878												STEEL
G	F	14	12	910												TITAN
				917												FIBERGLAS
				935												MAGNESIUM
G	F	5	4	947				1	1			X				COMBINATION
																TRANSPARENT
G	F			SUMMARY												

Figure 12. Evaluation summary sheet (sample).

A total of 241 candidate critical items, discovered during the visitations to the Air Logistics Centers, were also analyzed. Summary sheets were prepared for the most promising of these items to the extent that specific information was available. Copies of all AFM66-1 and ALC items summary sheets are contained in appendix A of this report.

The repair of battle-damaged structure was also investigated through search of AFM66-1 data, HMC how malfunction code 731, and by visitations to Air Force and Navy aircraft repair facilities. It was found that only a small percentage of maintenance actions were attributed to this code. For example, on the F-4D aircraft for the time period of January 1971 to January 1972, of the 112,564 structure maintenance actions, only 266 were reported battle-damaged. This accounts for approximately two-tenths of 1 percent of the total. The highest single repair action was 83.6 man-hours required for a fuselage skin duct (WUC 111BB). A total of 3,094.9 man-hours for battle-damaged repair was reported with an average repair time of 11.6 man-hours per occurrence. On the C-130E aircraft for the time period January 1973 to January 1974, 137-571 structure maintenance actions were identified. Out of these, 23 battle-damaged actions were found. A total of 382.2 man-hours was recorded for repair of these items. An average of 16.6 man-hours for each repair was determined. The highest repair time was 48.4 man-hours for a spar fitting (WUC 1152B). Altogether, there were 14 WUC's identified on this aircraft. The battle-damage reported was less than two-tenths of 1 percent of the total maintenance actions.

From the foregoing data, it might be concluded that the impact of battle-damaged repair upon the total system maintenance costs is miniscule and has no appreciable effect upon life cycle costs. This would be a misleading assumption, since the AFM66-1 data reflect only that battle-damaged repair that was accomplished within the capabilities of the organizational maintenance units. This included only limited damage repair. For any battle damage beyond its capability, the aircraft was set aside for repair by the rapid area maintenance (RAM) teams from the Sacramento Air Logistics Center (ALC). The effort for these repairs was charged to depot maintenance and was not recorded in the AFM66-1 system. Where it was determined that a level of damage repair could not be accomplished by the RAM team in the theater of operation, the aircraft would be disassembled, crated, and sent back to the appropriate ALC. Visitations to each of the ALC's has revealed that no specific accounting was utilized by the ALC's to record the man-hours required for repair of battle-damage alone. Each aircraft was repaired and modified to incorporate necessary Time Compliance Technical Orders (TCTO's) together with the normal inspection and repair as necessary (IRAN) procedures.

Data were obtained from the Sacramento Air Logistics Center on the battle-damaged repair efforts performed by the RAM teams on the aircraft in Southeast Asia. Analysis of this information revealed that the most significant repair factor was the extensive time required to obtain replacement parts or repair materials.

SELECTION OF CRITICAL ITEMS

In the analysis of the 250 AFM66-1 data items and 241 depot items, it was necessary to develop a set of criteria to be used throughout the analysis, evaluation, and final selection process. The following items were established as requirements to be met by each critical repair item ultimately selected for cost reduction study:

1. Item must be used on a USAF aircraft of significant number in current inventory and placed in service after 1950

2. Item must be on an aircraft with probable active military usage over the next 10 years

3. At least one item must be selected from each aircraft category: flighter/trainer, bomber, and cargo/tanker, with a minimum of 6 items total

4. Item must rank among top maintenance cost contributors

5. Item must have a record of repetitive repair/maintenance action, either in the field or at a depot

6. Item must appear to have a significant cost saving potential

With the foregoing criteria in mind, an evaluation of all items obtained from the data analysis produced 85 depot data items and 69 items from the AFM66-1 data, or a total of 154 which were identified as candidate study items requiring further evaluation. Those depot items which could be identified with WUC were added to the top 25 AFM66-1 items for each of the 10 aircraft in the computer data bank.

A second evaluation produced 65 items which met most of the selection criteria. Further elimination of less profitable items for cost reduction left 26 prime candidates.

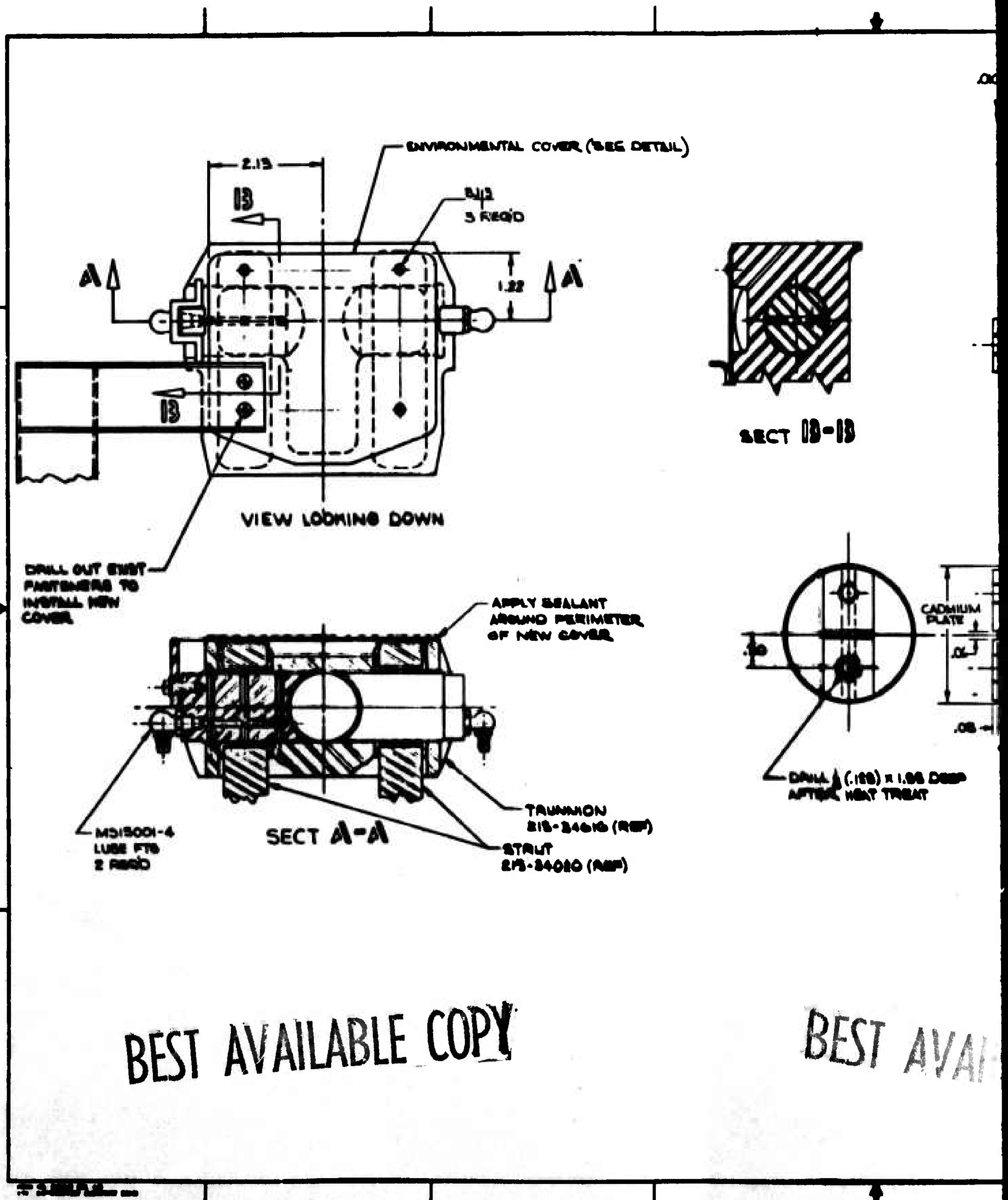
The final iterative selection was made using the evaluation summary sheet and judging the life cycle cost saving potentials. Due to the possibility that some items would prove to have no significant life cycle cost reduction potential after detail drawings and cost data were obtained and reviewed, an allowance was made by selecting an initial group of 14 items in order to assure a suitable number for study.

PHASE III - INNOVATIVE DESIGN STUDY

Upon identification of the 14 selected critical items, drawings on each structural area were ordered from the Air Force Logistics Command (AFLC) Headquarters at Wright-Patterson Air Force Base, Ohio. Costs for the candidate critical items were also obtained through AFLC Headquarters for use in phase IV life cycle cost evaluation. Preliminary design studies were conducted on the candidate items to a degree where 8 could be identified as having the most profitable potential. These are:

- A-7D main landing gear shock and tension strut trunnion and pin assembly
- A/T-37 engine tailpipe clamp
- T-38 removable aft fuselage firewall assembly
- F-4 fuselage fuel tank reinforcement liner skins
- B-52 forward fuselage urinal area
- C-5A wing leading edge slat actuator doors
- C-5A engine cowl door hinge fitting
- C/KC-135 inner to outer wing joint ribs

Each of these items was subjected to a detailed design study to develop either an improved design concept or a cost-effective repair approach. The results of the design study are described in the following paragraphs.


ENVIRONMENTAL COVER (SEE DETAIL)
2.13
B
A
A
1.22
3 REQ'D
VIEW LOOKING DOWN
DRILL OUT EXIST FASTENERS TO INSTALL NEW COVER
APPLY SEALANT AROUND PERIMETER OF NEW COVER
SECT A-A
MS15001-4 LUBE FTG 2 REQ'D
TRUNNION 215-34616 (REF)
STRUT 215-34020 (REF)
SECT B-B
CADMIUM PLATE
DRILL (.128) x 1.88 DEEP AFTER HEAT TREAT

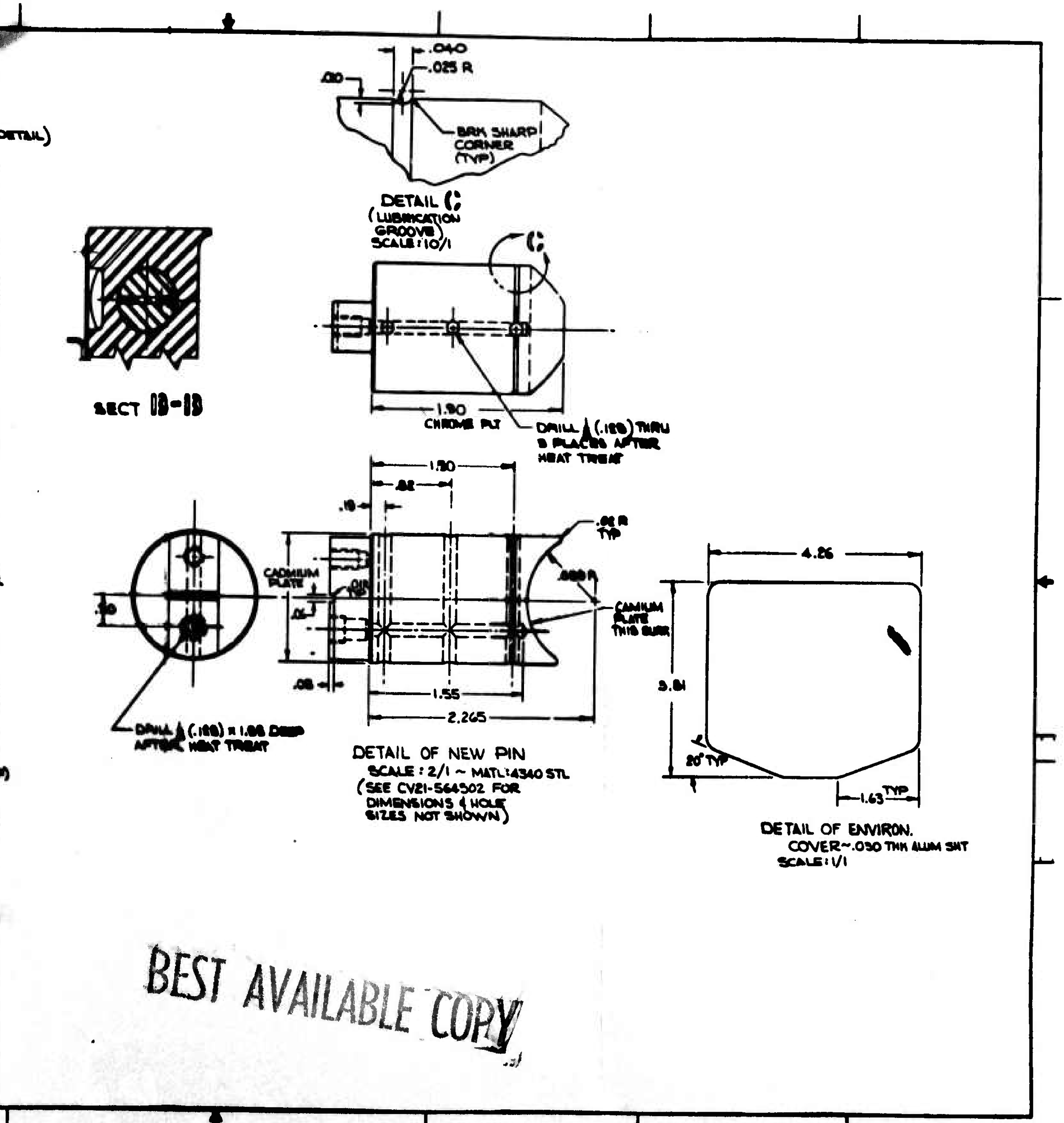


Figure 13. Item No. 1 - A-7D main landing gear shock and tension strut trunnion and pin assembly.

2

ITEM NO. 1 - A-7D MAIN LANDING GEAR SHOCK AND TENSION STRUT TRUNNION AND PIN ASSEMBLY

PROBLEM:

Galling and corrosion of pin on lower trunnion bearing surface.

CAUSE:

Drainage of dirty water from the aft bulkhead of the main wheel well and support fitting can enter trunnion bearing surfaces through openings on the upper surface of the fitting and settle in the small gap between the pin and trunnion on the lower side. Water carried grit, which, during taxiing and takeoff/landing operations on rough runways, erodes the chrome surface of the pin and the unprotected surface of the trunnion material.

LOW-COST DESIGN (See Figure 13):

1. Cover openings on upper trunnion surface with a metal cap which is fastened to trunnion.

2. Provide additional passageways in pin to allow grease from existing lubricating system to be applied to pin/trunnion bearing surfaces to provide a barrier to grit which can possibly enter from underneath trunnion during taxi on wet runways.

3. Provide a dry lube surface on trunnion bearing area, either cadmium plate or dry lube.

4. Bearing stresses may be reduced by adding approximately 20 percent to the bearing width on the aft side of the trunnion fitting and by reshaping the inner end of the pin to add more bearing surface on the upper and lower sides of the trunnion hole.

5. Existing trunnion fittings which have galled or damaged bearing surfaces may be salvaged by reaming out the damaged area and plating or flame spraying to build up the area sufficiently for rehoning the hole to proper diameter. Existing fittings are currently discarded and replaced.

ITEM NO. 4 - F-4 FUSELAGE FUEL TANKS REINFORCEMENT LINER SKINS

PROBLEM:

The present F-4 fuselage fuel tank floors consists of zee frames covered with 0.032- and 0.040-inch-thick aluminum floor skins and closed out on the lower side with an engine compartment insulation shroud. No fore and aft stiffeners (intercostals) are used.

Fatigue cracks have developed in the floor skins of fuselage fuel tanks 3, 4, 5, and 6 on numerous F-4 aircraft. The cracks tend to develop along the heel line of the frames and then propagate to the frame. Attach rivets into the areas between the frames. A limited number of cracks have also been experienced in the 0.016-inch aluminum.

CAUSE:

Fuel loads due to surge, hydrostatic pressures, maneuvers, etc., in conjunction with shear and vibration loads from the engines, cause repeated cycling of the floor skins between frames until the aforementioned cracks occur. The crack pattern is considered to be a classical example of a fluid overpressure condition. The fuel cavity floor and side wall skins are fabricated from 7178-T6 aluminum material that does not have adequate fatigue resistance.

LOW-COST DESIGN:

Two approaches were considered for repair and to prevent future cracks. The first configuration (Figure 14) consists of beaded straps with scalloped edge trims. These straps would be installed over existing station frames and the cracks in question. Existing fasteners would not be disturbed except those used at each end of the new strap. Existing attachment locations may be utilized if strength requirements dictate.

Merit of this repair is its ease of fabrication and installation. Roll-formed straps could be utilized, and a universal size selected for each fuel bay needing repair. The beaded section is used to "bridge" over existing fasteners. All work would be accomplished from the top side of the tank floor, and no floor would need to be removed to install new straps. Due to the design of the straps, existing load paths will not be changed. Installation will be accomplished per T.O. manual methods currently in use regarding bonding, stop drilling of cracks, sealing, finishing, and chafing tape application. Total weight of repair is 2.41 pounds for cell No. 4.

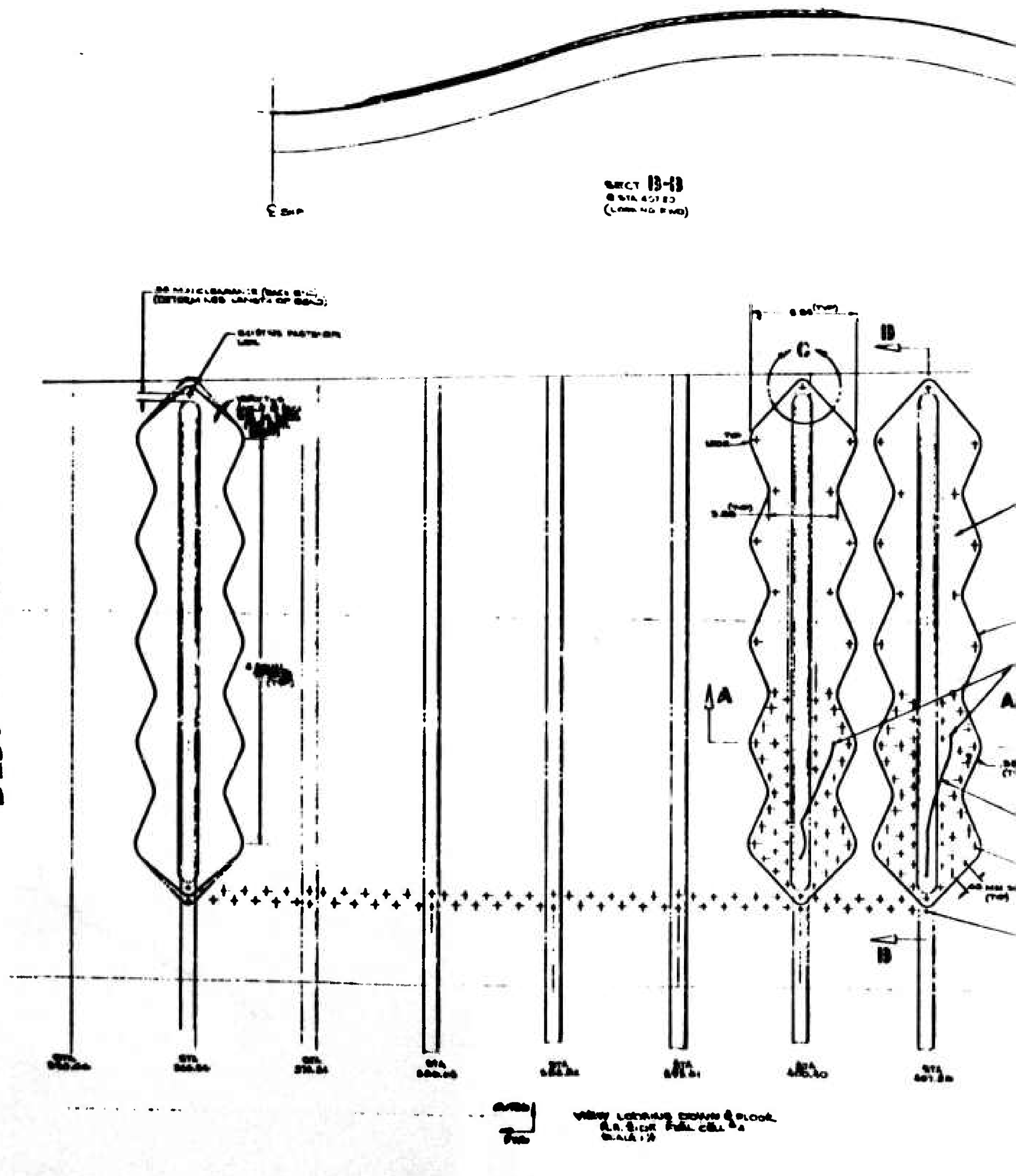


Figure 14. Item

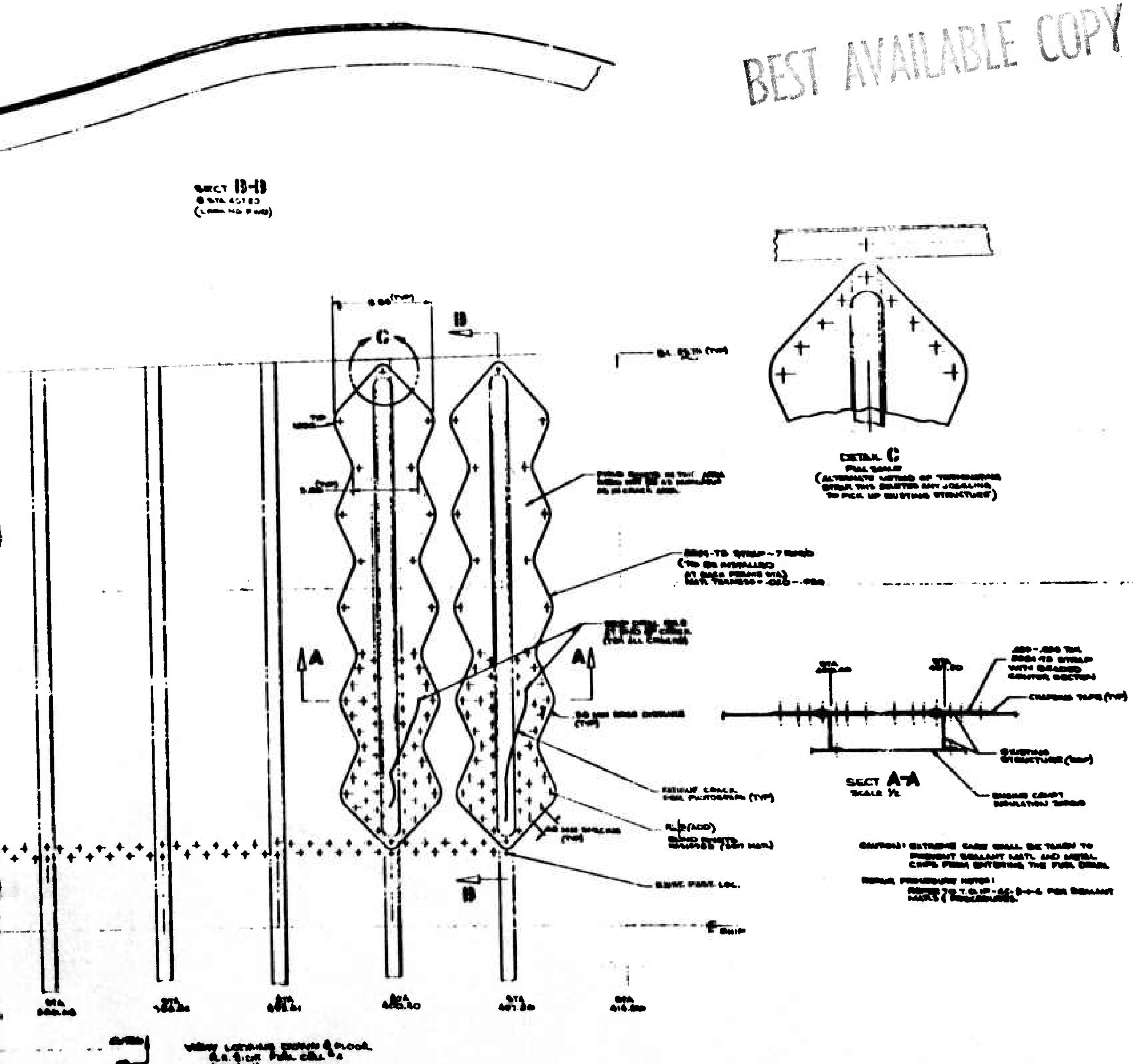
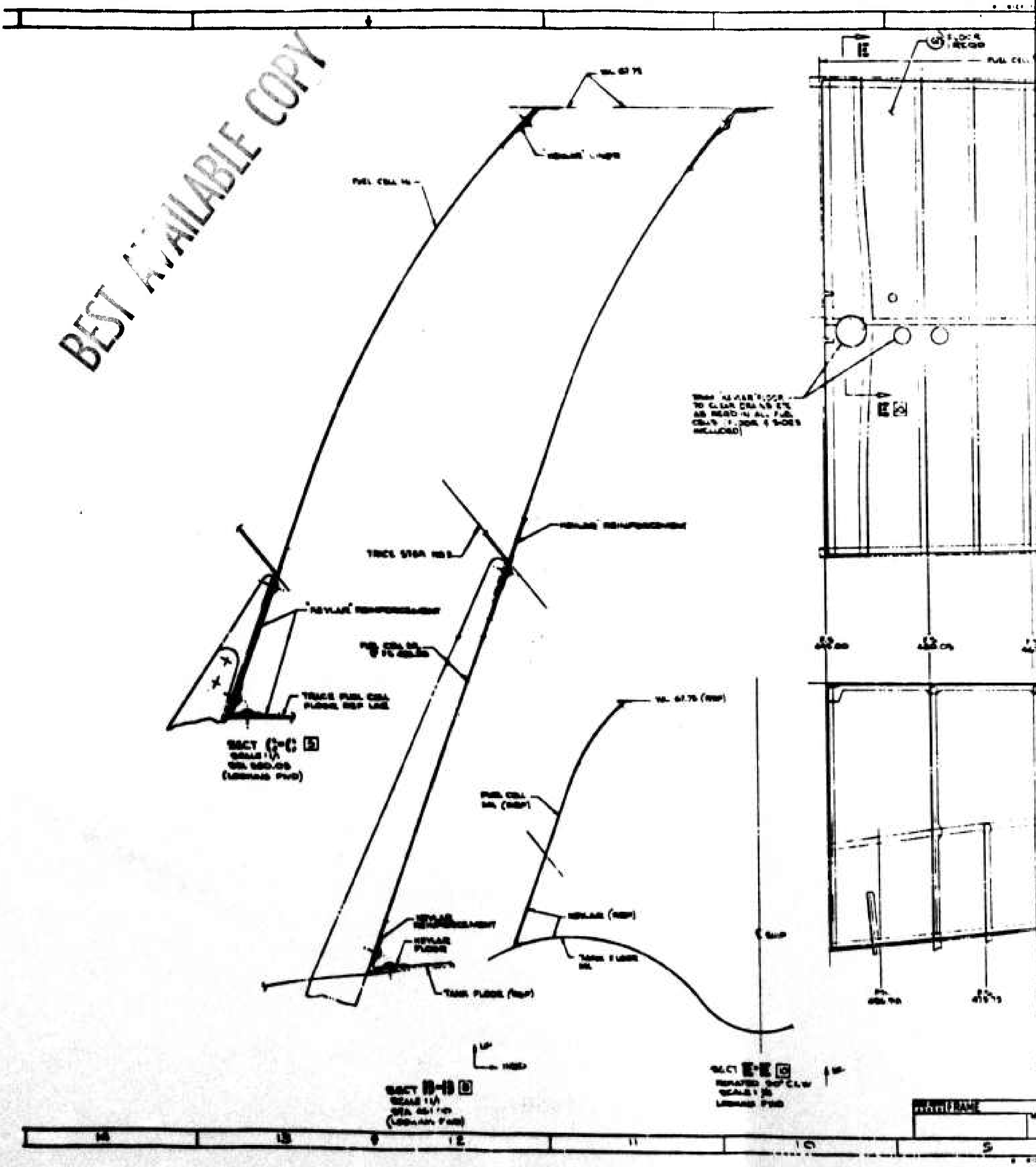


Figure 14. Item No. 4 - F-4 fuselage fuel tank reinforcement liner skins.



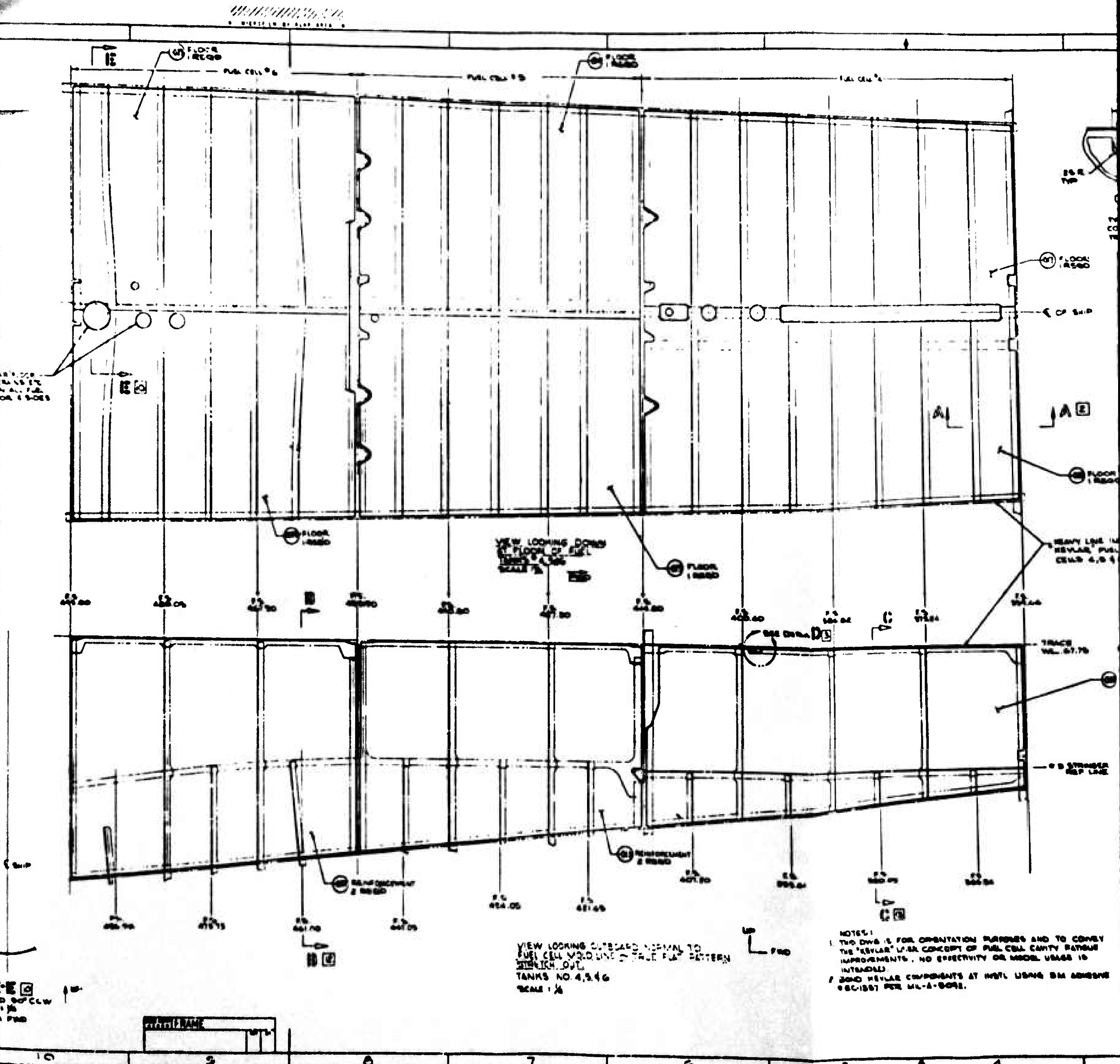


Figure 14. Item No. 4 - F-4 fuselag

2

BEST AVAILABLE COPY

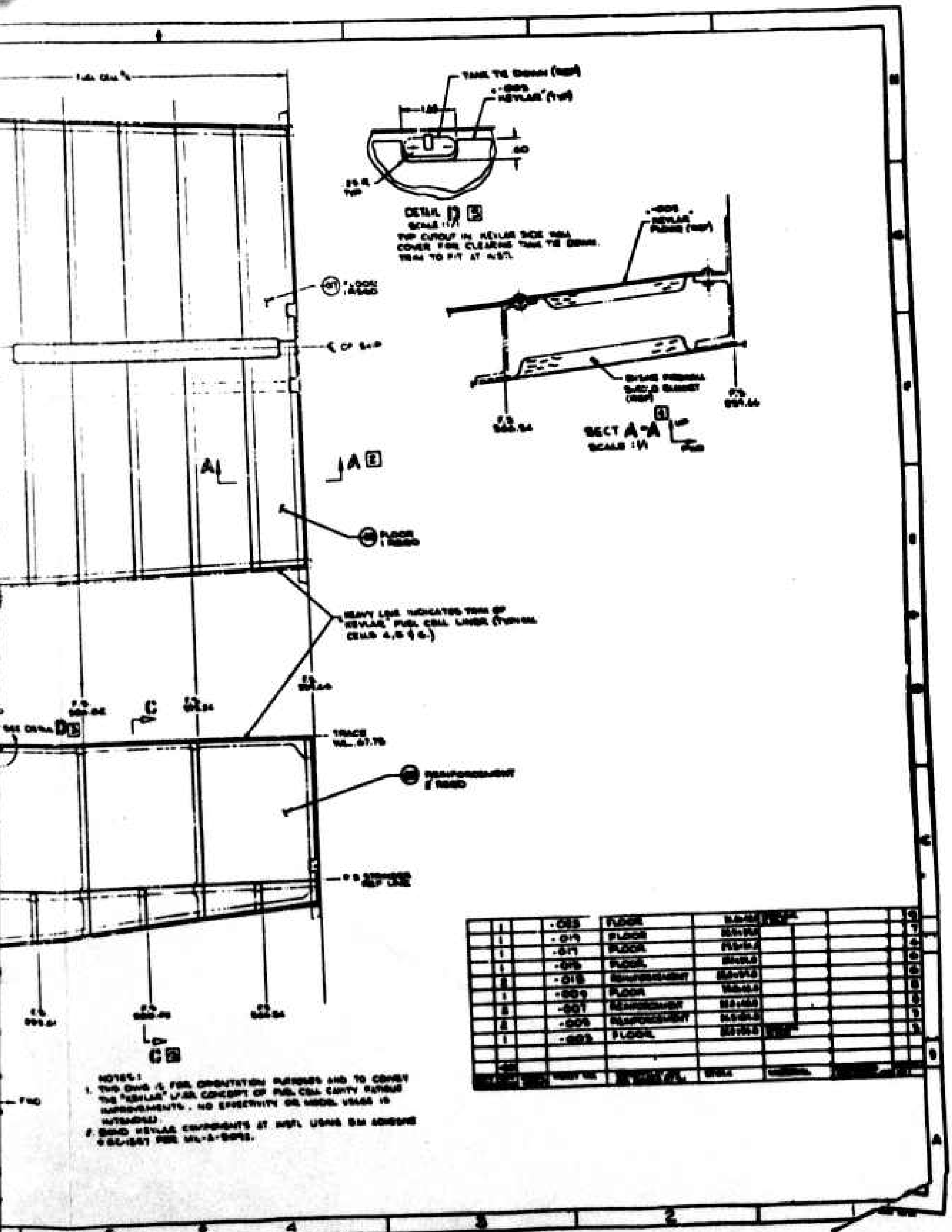
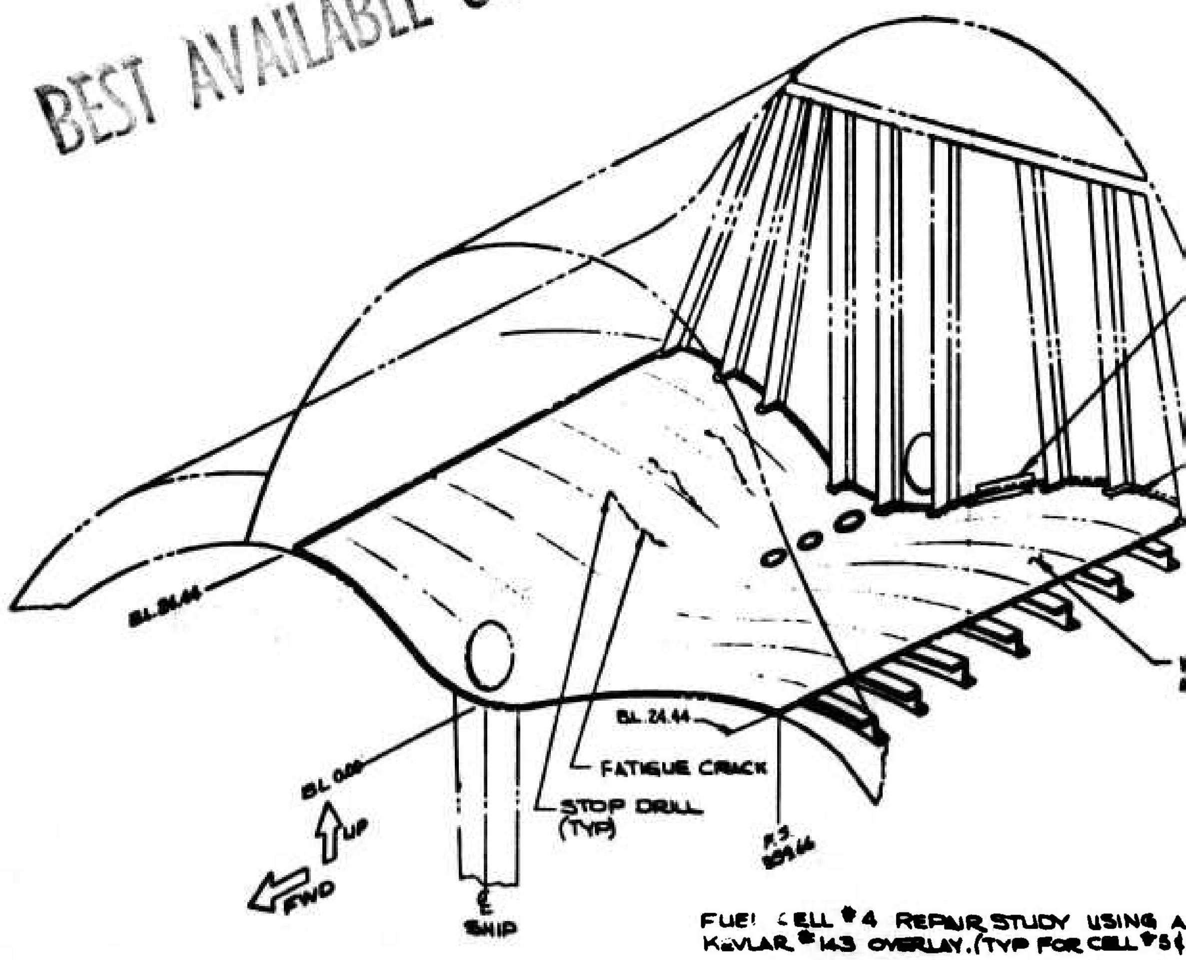


Figure 14. Item No. 4 - F-4 fuselage fuel tank reinforcement liner skins (cont).

3

BEST A



FUEL CELL #4 REPAIR STUDY USING A
KEVLAR #143 OVERLAY. (TYP FOR CELL #5

EXISTING FATIGUE CRACKS ARE TO BE S
DRILLED (SEE ILLUSTRATION) AND STANDAR
PATCHING METHODS USED AS REQD.
KEVLAR #143 MAY THEN BE APPLIED (
VENDOR INSTRUCTIONS) IN A 3 PLY LAMI

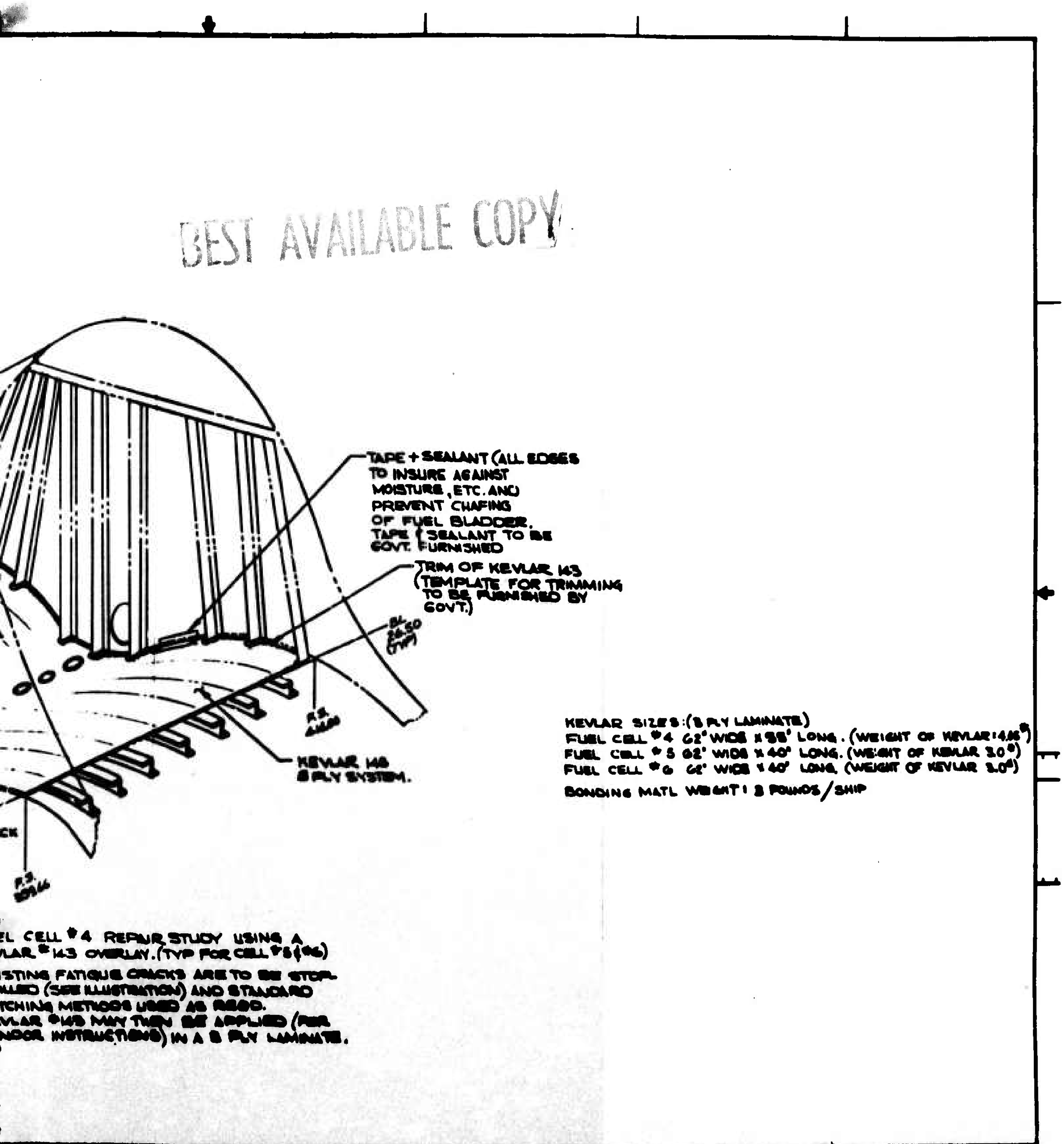


Figure 14. Item No. 4 - F-4 fuselage fuel tank reinforcement liner skins (concl).

Kelvar, a high-strength organic material produced by DuPont was considered as a second method of crack prevention (Figure 14). This approach would involve patching cracks that exist using standard localized patching methods found in existing repair manuals and forming a Kevlar composite liner to act as a tension load-carrying member between frames and act to reduce the fatigue stress loads in the aluminum sheet metal skin.

Method of installing Kevlar:

1. After removal of fuel cell bladder and preliminary cleanup, the existing fatigue cracks would be repaired according to the standard repair manual methods.

2. Using a Kevlar unidirectional weave, multiply system, the desired shape is designed to fit the fuel cell floor, including any cutouts for drains, stiffeners, etc. The Kevlar composite material would be in a semiflexible state (0.030 to 0.040-inch thick).

3. Remove foreign material and give fuel cell floor a solvent wipe cleaning.

4. Brush on adhesive (bonding agent) and lay pretrimmed Kevlar in place. Press sheet in place to desired fit and allow to cure for approximately 10 hours at room temperature. After a leak check, the fuel bladder is reinstalled.

A weight comparison between the metallic and nonmetallic (Kevlar) design concepts was made, as shown in the following table:

Repair Concept	Weight of Repair			Total Repair Weight (lb)
	Tank No. 4	Tank No. 5	Tank No. 6	
Metal doubler	2.41	1.75	1.75	5.91
Kevlar	1.77	1.29	1.29	4.35

ITEM NO. 5 - A/T-37 ENGINE TAILPIPE CLAMP

PROBLEM:

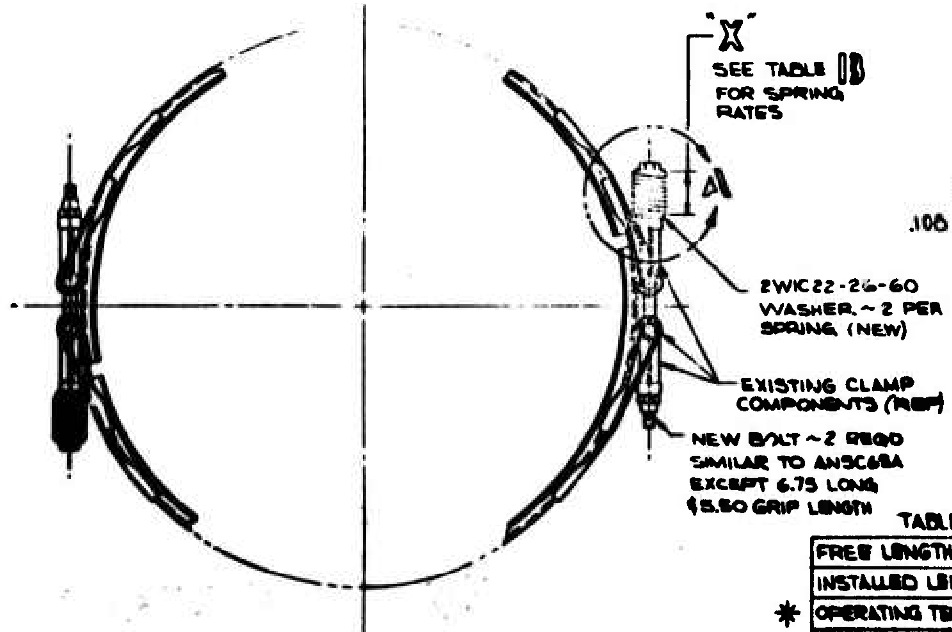
There is a band-type V-section clamp which couples the engine tailpipe to the aft flange of the engine case. It has had a chronic history of breakage. When this occurs, the tailpipe jams the opening in the fairing aft end, causing hot jet impingement on the primary structure. Damage to the structure usually occurs by reduction of allowable strength; however, the extent of damage is difficult to determine. Usually, the structure is replaced when the extent of damage is in question.

CAUSE:

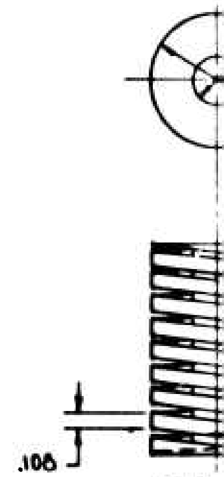
The clamp band is in contact with the engine and tailpipe flanges over a very small percentage of its total area. Upon engine start, the engine and tailpipe flanges heat up rapidly and expand. Due to the limited thermal conductivity and transfer, the clamp band does not heat up as quickly, and a high-tension stress is experienced. Yielding of the band material occurs during these thermal cycles until fatigue failure occurs. Existing maintenance instructions specify a maximum clamp bolt torque of 25 inch-pounds upon installation, with no additional tightening during service. Maintenance personnel find clamps that have been stretched and are loose. They usually retorque the bolts again and set up another overstress condition that accelerates the time of clamp failure.

LOW-COST DESIGN (See Figure 15):

A spring of suitable strength and deflection may be incorporated into the clamping bolt assembly to prevent overstress of the clamp band when differential heating occurs. A rectangular section compression spring has been designed to serve this function. From existing test data, it has been estimated that a temperature differential as high as 500° F between the engine and clamp can be experienced. This requires 0.11-inch spring deflection in addition to the initial installation deflection. Inconel was selected as the spring material to withstand the maximum operating temperatures and stresses without loss of spring characteristics.



COUPLING # NH1000850 (AEROQUIP) WITH ADDITIONAL TEMPERATURE COMPENSATOR SPRING INSTALLED
SCALE : 1/2



DETA
B.5 AC
MATL:
SPRING

TABLE "B"

	"X"
FREE LENGTH	1.375
INSTALLED LENGTH	1.117
* OPERATING TEMP LENGTH	.987
SOLID LENGTH	.972

* BASED ON 500°F TEMP.
BETWEEN CLAMP AND TAI

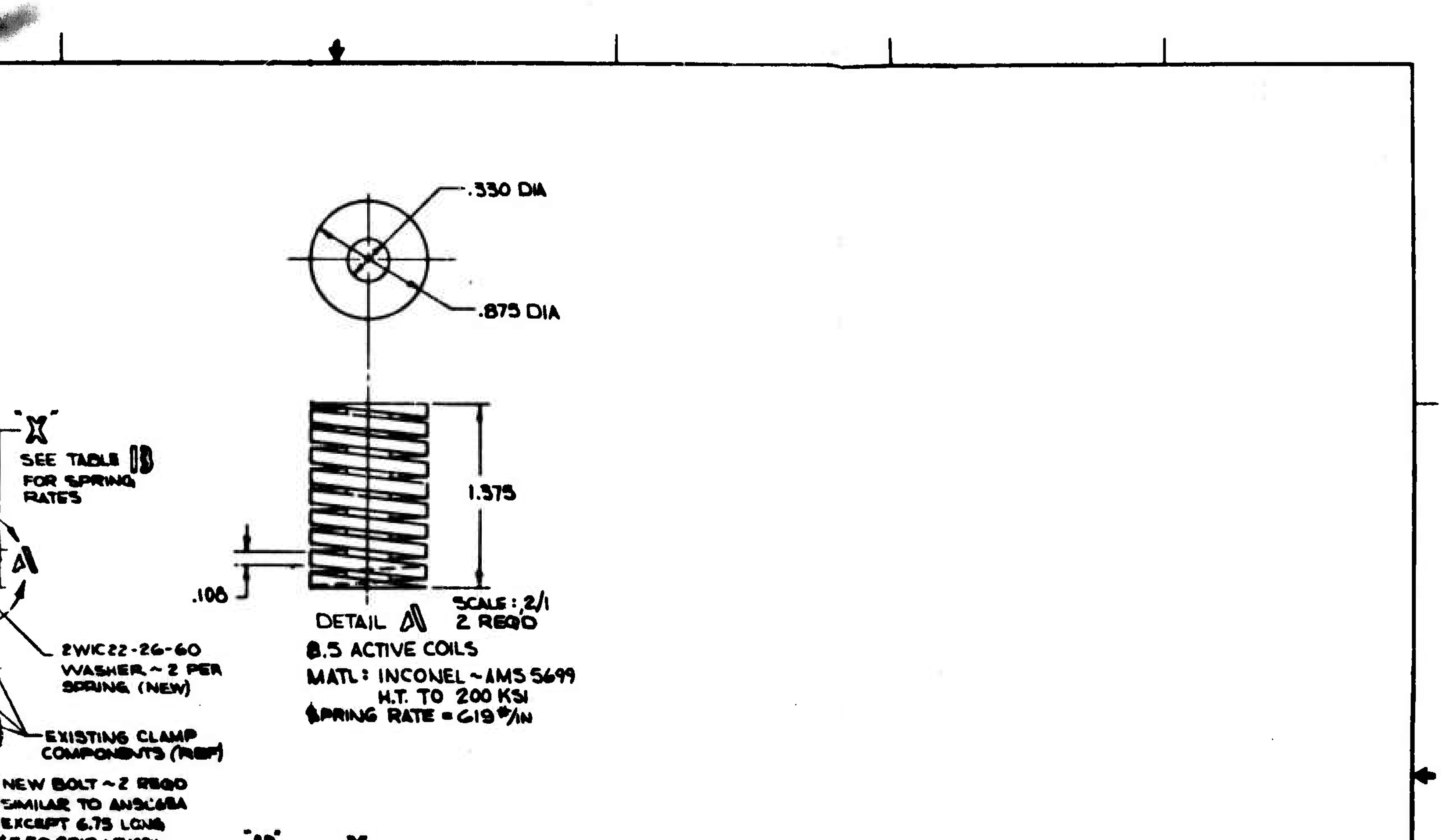


TABLE "B"

	X	BOLT TENSION
FREE LENGTH	1.378	⬥
INSTALLED LENGTH	1.117	160#
* OPERATING TEMP. LENGTH	.987	240#
SOLID LENGTH	.972	249.5#

* BASED ON 500°F TEMP. DIFFERENTIAL BETWEEN CLAMP AND TAILPIPE

Figure 15. Item No. 5 - A/T-37 engine tailpipe clamp.

2

ITEM NO. 5 - T-38 REMOVABLE AFT FUSELAGE FIREWALL ASSEMBLY

PROBLEM:

Damage to the aft fuselage firewall assembly has been occurring during the removal and replacement operation of the aft fuselage section with the center fuselage section. This causes damage to the firewall titanium skin encircling the aft engine area, in the form of dents, gouges, and abrasions. Any gouges or holes require immediate repair, and the lesser types of damage can result in fatigue cracks that require additional repair or replacement of the firewall.

CAUSE:

Damage to the thin titanium firewall sheets is due primarily to contact of engine components due to small engine-to-firewall clearances (reported to be less than one-eighth inch in places). The method of removing and replacing the aft fuselage section, using the component handling trailer No. 3-76500-1, allows significant misalignment between the engine and the aft fuselage section.

The current procedure requires attachment of a clamp mechanism on the main gear struts to prevent their vertical movement. No similar provision is provided for the nose gear. The handling trailer is then positioned beneath the removable aft fuselage section, and the trailer brakes are set. The aft section is then secured to the trailer, and the demating procedure is initiated. As an orientation method for the realignment of the two fuselage sections, a strip of tape is applied across the production break to be used as a visual alignment guide during the remating operation.

The aft fuselage section is manually rolled along the trailer rails (after the disconnect operation is complete) until it is clear of the the engine aft sections. During this operation, the close-tolerance problems are aggravated by improper trailer positioning, wind gusts (causing an abrupt ship-to-trailer misalignment to occur), tire deflection, vertical nose gear strut movement due to a weight transfer caused by the removal of the heavy aft section, and uneven work surfaces between the ship and the trailer (causing centerline-to-centerline discrepancies during the roll-back operation).

During the remating operation, the aforementioned misalignment factors are again experienced, as the trailer operator must visually attempt to realign the tape on the sides of the forward fuselage and the aft section as it is rolled forward.

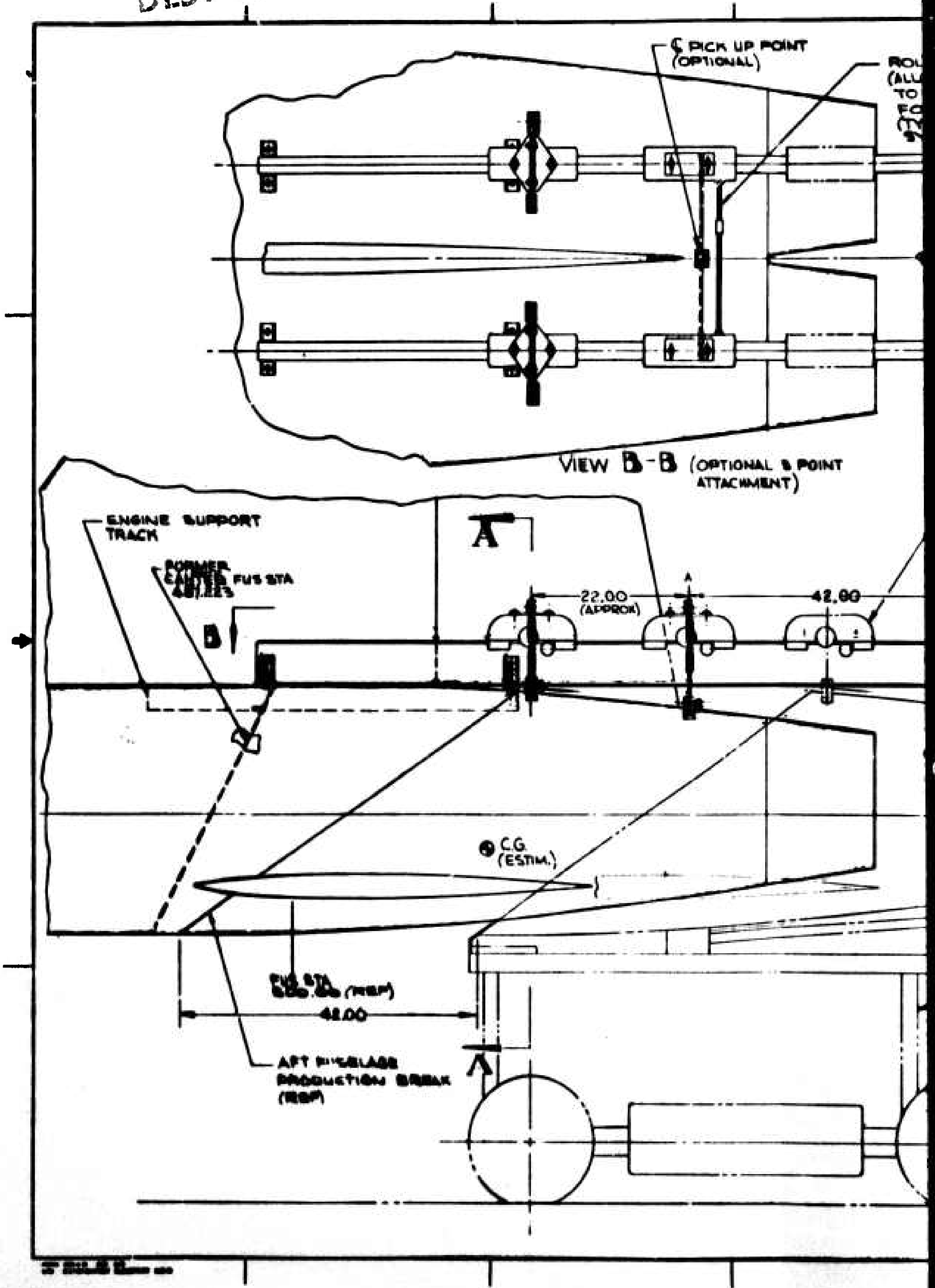
LOW-COST DESIGN (See Figure 16):

The design study indicates that a supplementary handling guide system can be adapted to the center fuselage section. This guide would be composed of two 6-inch-deep I-beams (aluminum) rigidly attached by removable bolts to existing fuselage hard points; i.e., engine tracks which lie directly beneath the I-beams and existing frames using suitable attachment brackets.

The I-beams would extend approximately 6 feet over the component handling trailer. Four roller adapters (stock items manufactured by the Air Logistics Corporation) would be installed on these I-beams and, using an adjustable yoke system, tie into the aft fuselage section at frame hard points. These tie-in points would have quick-release pull-pins to separate the adapter yokes once the mating and demating operation has been accomplished.

This method would ensure that the aft section would remain in a known reference system in relationship to the center fuselage section while the removal and replacement operations take place. This method allows the aft section to be moved aft approximately 3-1/2 feet before attachment to the component handling trailer. This distance would be ample to provide safe margin and negate the change for firewall damage.

Reversal of the foregoing procedure would be utilized for remating the two fuselage sections. The guide system has the additional merit of a built-in capability that may be utilized to make incremental forward movements during the final mating operation.



℄ PICK UP POINT (OPTIONAL)
VIEW B-B (OPTIONAL 3 POINT ATTACHMENT)
ENGINE SUPPORT TRACK
FORMER CANTED FUS STA
A
B
22.00 (APPROX)
42.00
C.G. (ESTIM.)
FUS STA (REF)
42.00
AFT FUSELAGE PRODUCTION BREAK (REF)

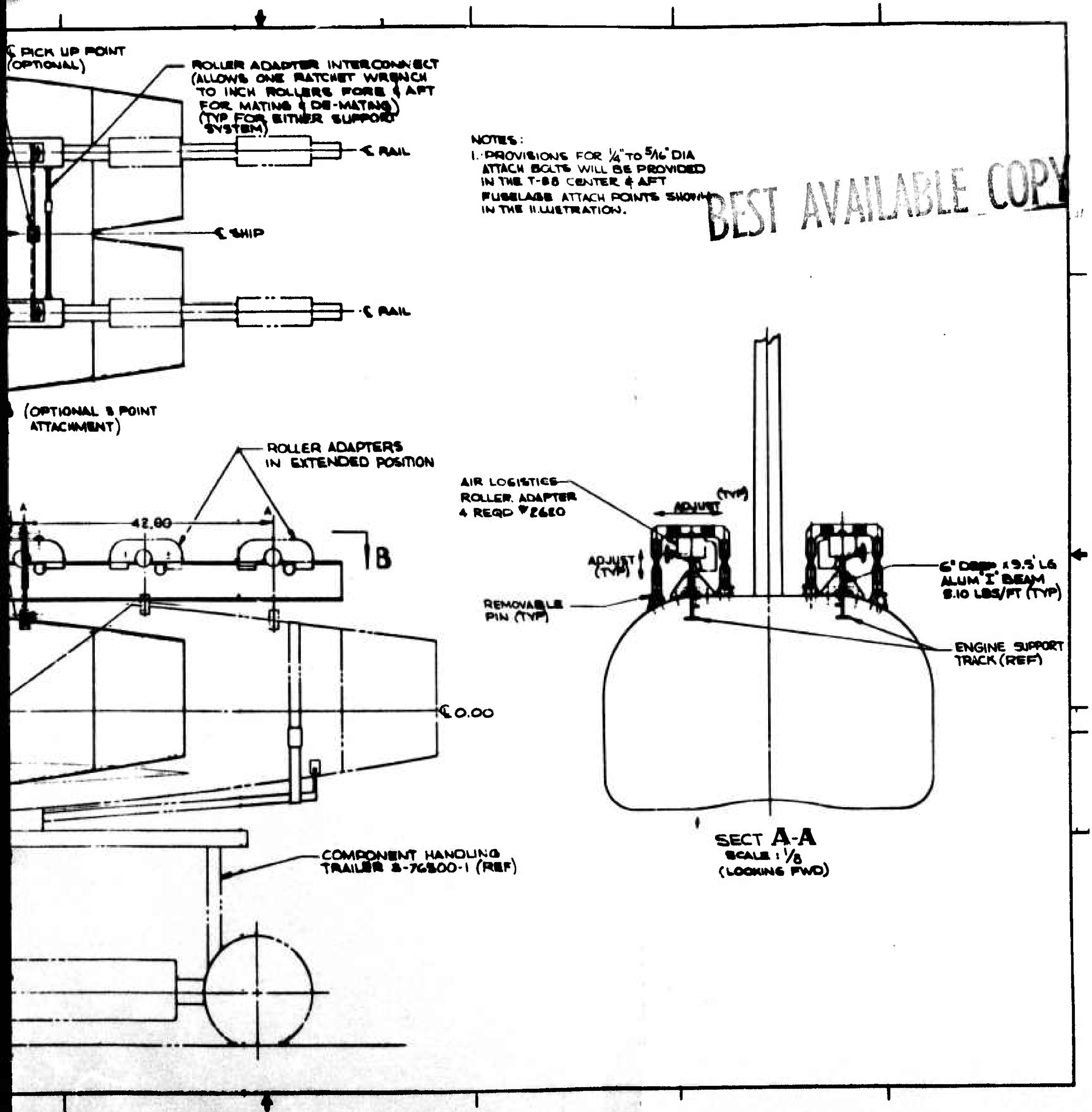


Figure 16. Item No. 6 - T-38 removable aft fuselage firewall assembly.

ITEM NO. 8 - B-52 FORWARD FUSELAGE URINAL AREA

PROBLEM:

Corrosion of structural items (i.e., floor skins, frames, etc) occurs below the urinal and necessitates extensive repairs. The area found to be experiencing the corrosion damage is below the equipment deck, between fuselage stations 267 and 345.5. This area cannot be inspected without removing permanent floor panels or the external fuselage skin. Failure of various elements in the urinal tank assembly itself have also been noted.

CAUSE:

The existing urinal tank is the prime factor in the corrosion problem. Leakage or spillage from the container allows liquid to contact wall panel and floor surfaces, ultimately seeping through floor skins and corroding structural members. In addition to the foregoing problem, servicing of the tank and premature failure of the tank itself have come to light. This is attributed to inadequate design of the urinal tank and is retaining system. Improper servicing methods and carelessness are considered to be the primary cause of spillage.

LOW-COST DESIGN (See Figures 17, 18, and 19)

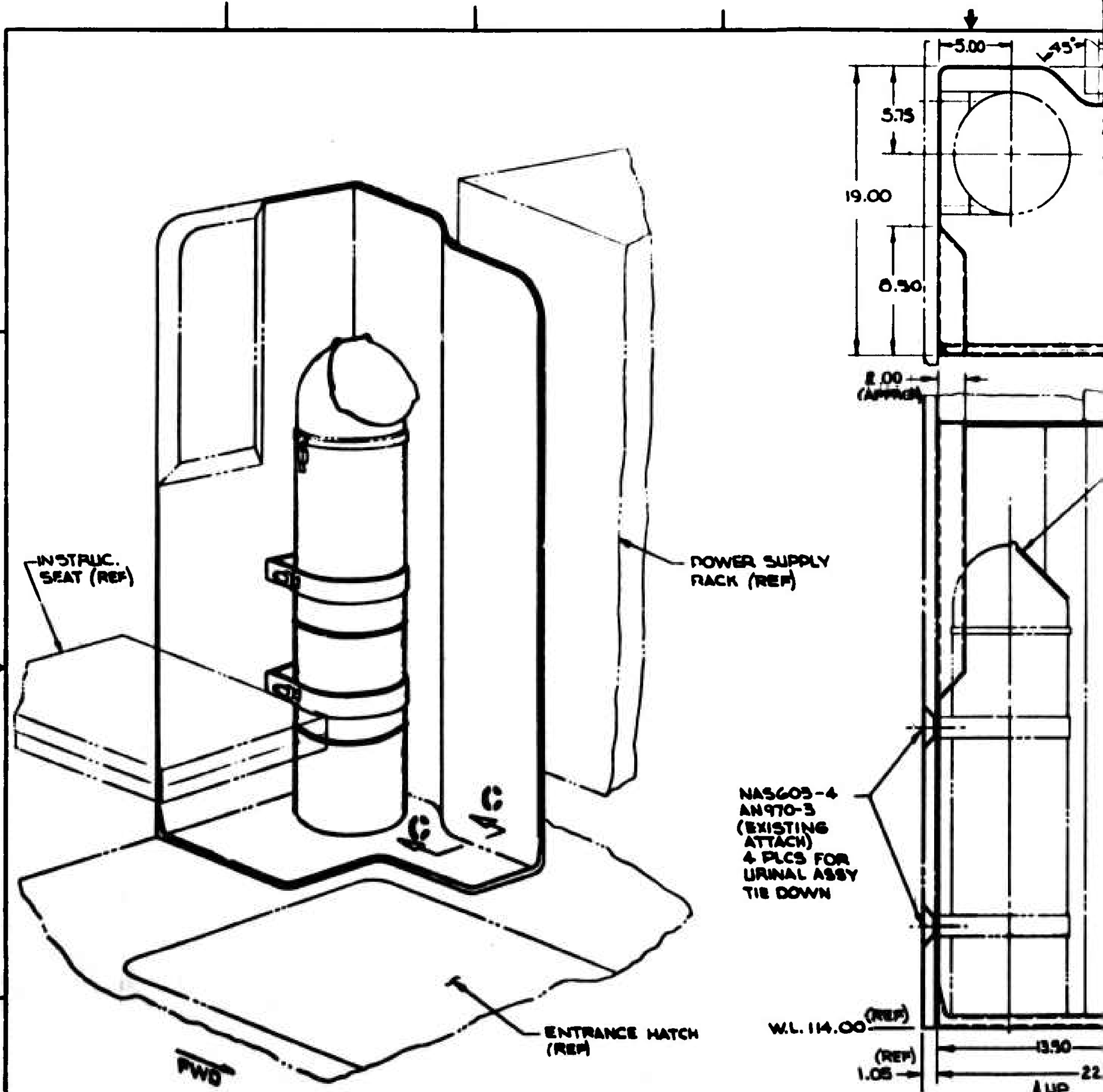
As a prevention against corrosion caused by moisture in the urinal area of the B-52D, the wall and floor area behind and below the urinal tank assembly would be covered with a protective shield and floor pan. The wall shield would be localized (extend several inches either side of the tank), and the floor pan would cover from wall to wall. These items may be fabricated from fiberglass. The wall shield would pick up convenient existing fasteners and extend up and under the existing electronic bay fiberglass cover. The lower edge of the wall shield would joggle over the flange of the floor pan to prevent any joint leakage and to eliminate use of fasteners that would create additional leak paths.

The floor pan would extend from the vertical shield across to the opposite wall, and fore and aft from the vertical face of the forward entry hatch frame, back to the auxiliary crew seat. In the walkway area, a beaded section would extend from the corner of the electrical bay diagonally outboard to the vertical face of the forward raised floor area. The perimeter of the floor pan would incorporate a vertical lip section to retain any moisture and to clear existing attachments in the floor edge members.

As a prevention against corrosion caused by moisture in the urinal area of the B-52G and H models, a one-piece molded fiberglass stall would be required. It would consists of two vertical walls (right and rear) plus a floor panel. The one-piece design would prevent joint leakage. As a further precaution against leakage and corrosion points, the stall would be fastened with Velcro tape to existing structure.

The floor pan would have a beaded section along its free edge high enough to retain excess moisture and would be shaped to allow clearance around the main entry hatch opening.

The urinal tank assembly would be restrained against the rear wall, using the existing brackets. These attachments would be sealed with a leakproof corrosion material.



NOTES:

1. MATERIAL FOR -003 STALL TO BE EPOXY PREIMPREGNATED GLASS FABRIC. 1/32" THK PER STD ... TYPE I (REF VOL. 13 OF MATL STD. DESIGN PRACTICES, SHT 6 OF 21 #363-00016F). -003 TO BE FABRICATED IN ONE LAYUP IF POSSIBLE (FLOOR & TWO SIDES)
2. ATTACH PROTECTIVE SHIELD TO AIRCRAFT STRUCTURE USING VELCRO TAPE. APPLY VELCRO IN SUFFICIENT QUANTITY TO RETAIN SHIELD DURING FLIGHT CONDITIONS.

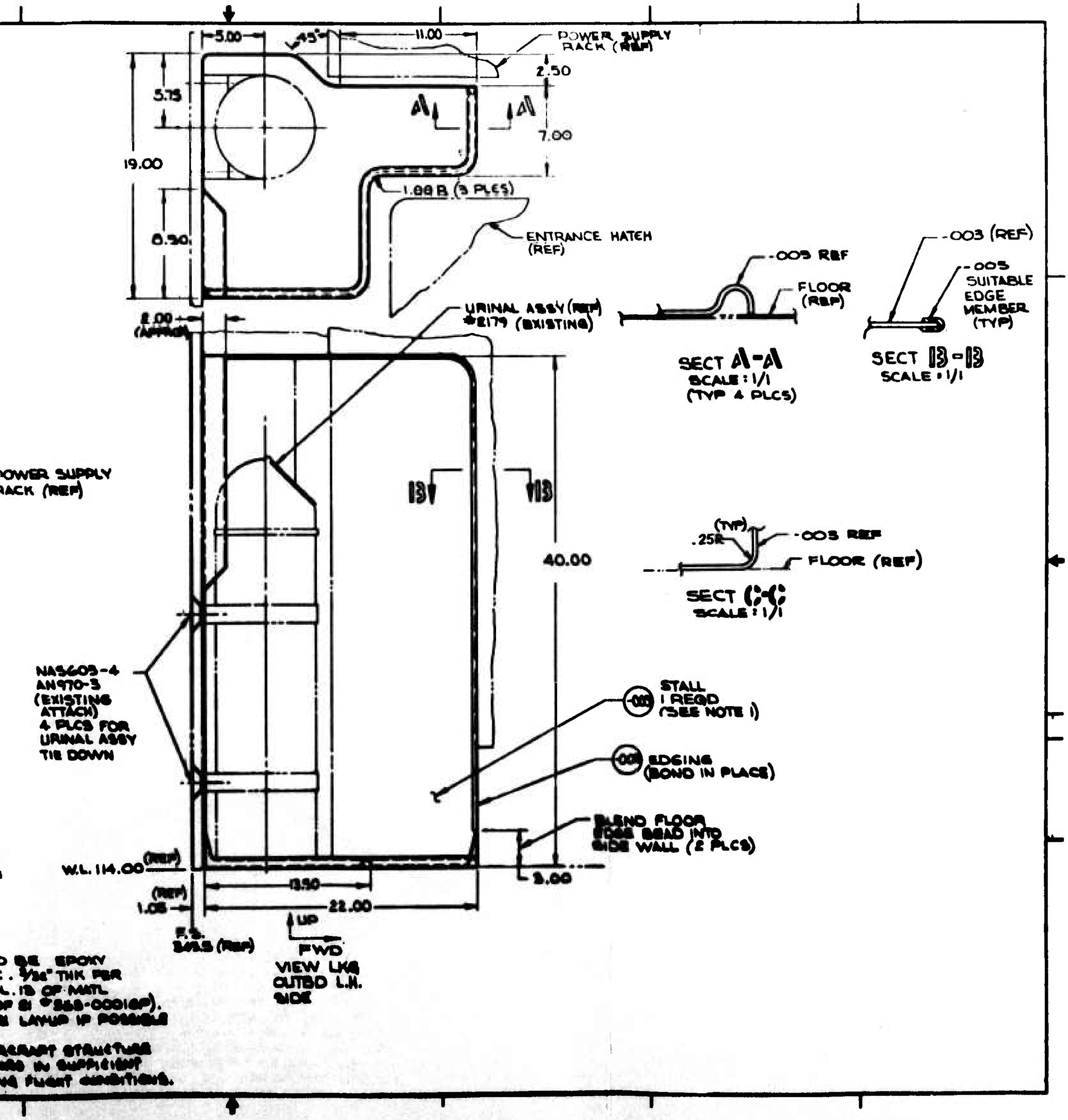
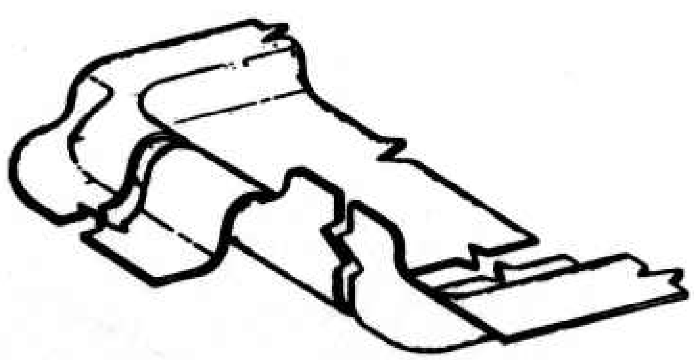
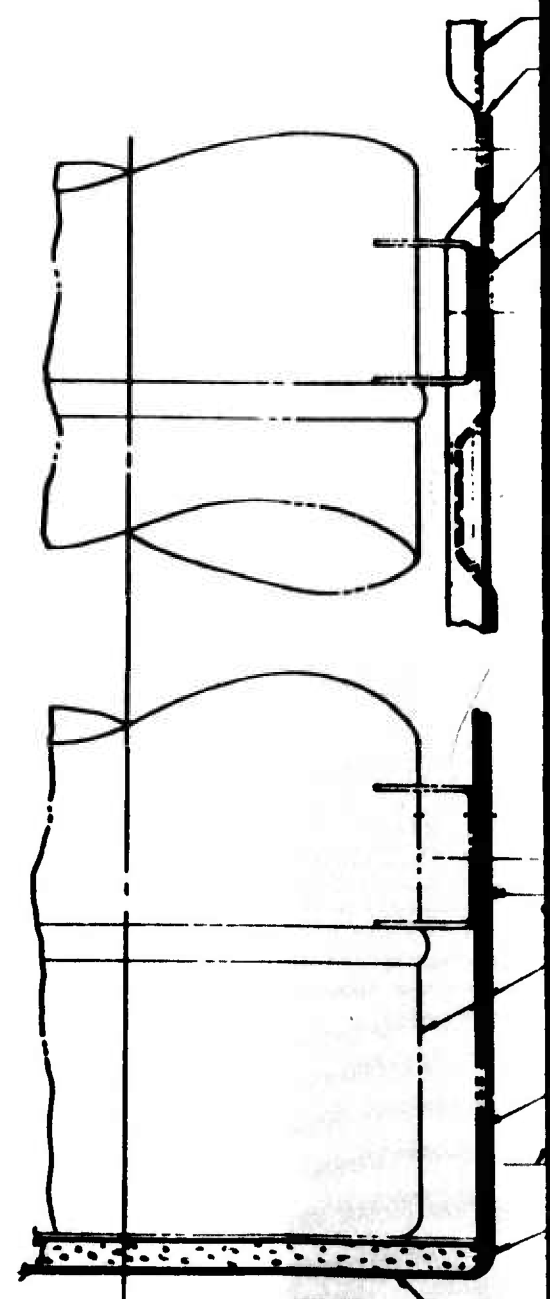


Figure 17. Item No. 8B - B-52G and H forward fuselage urinal area.

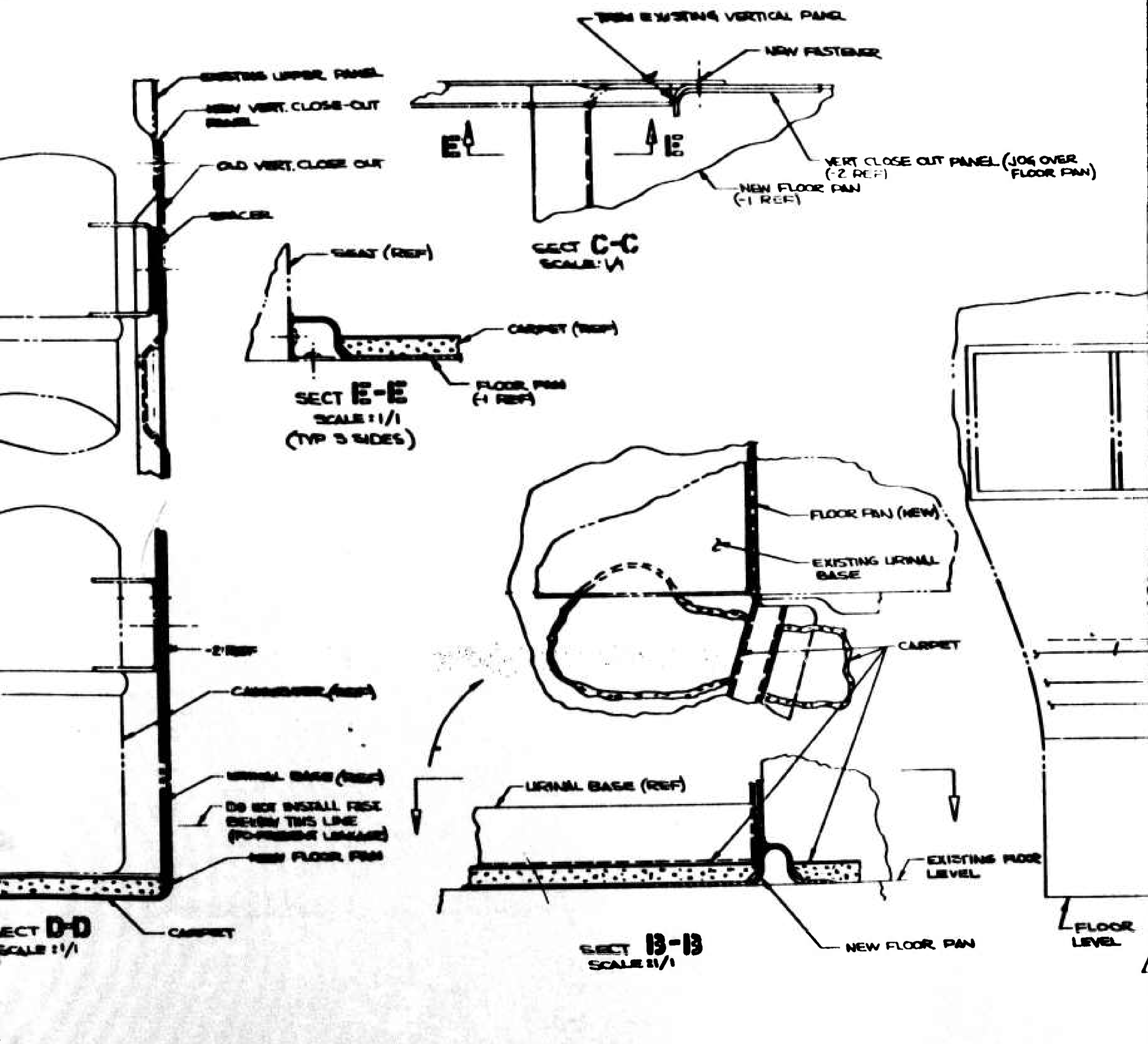
2

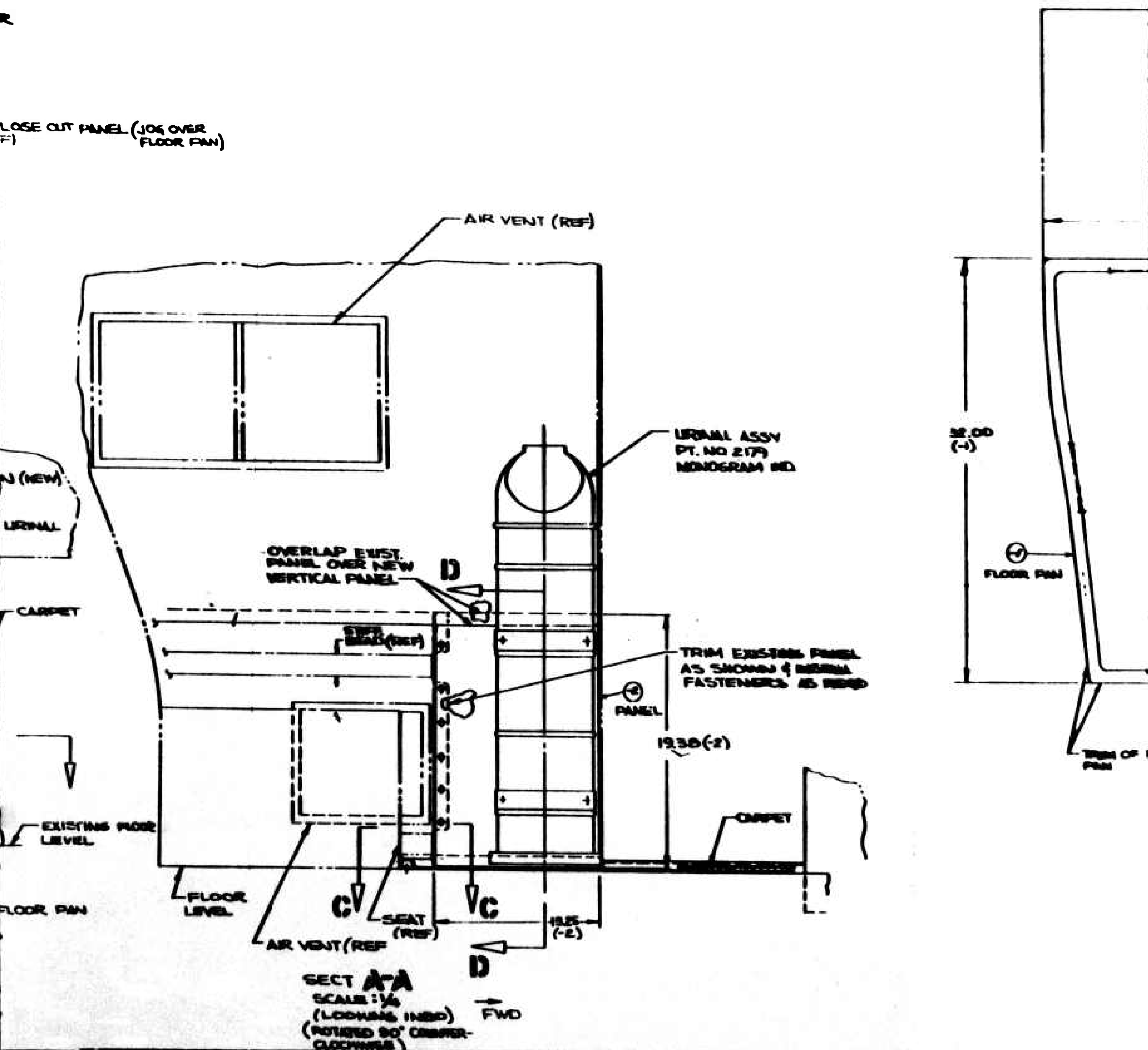


DETAIL F
(FLOOR PAN DETAIL ONLY)
(-1 REF)



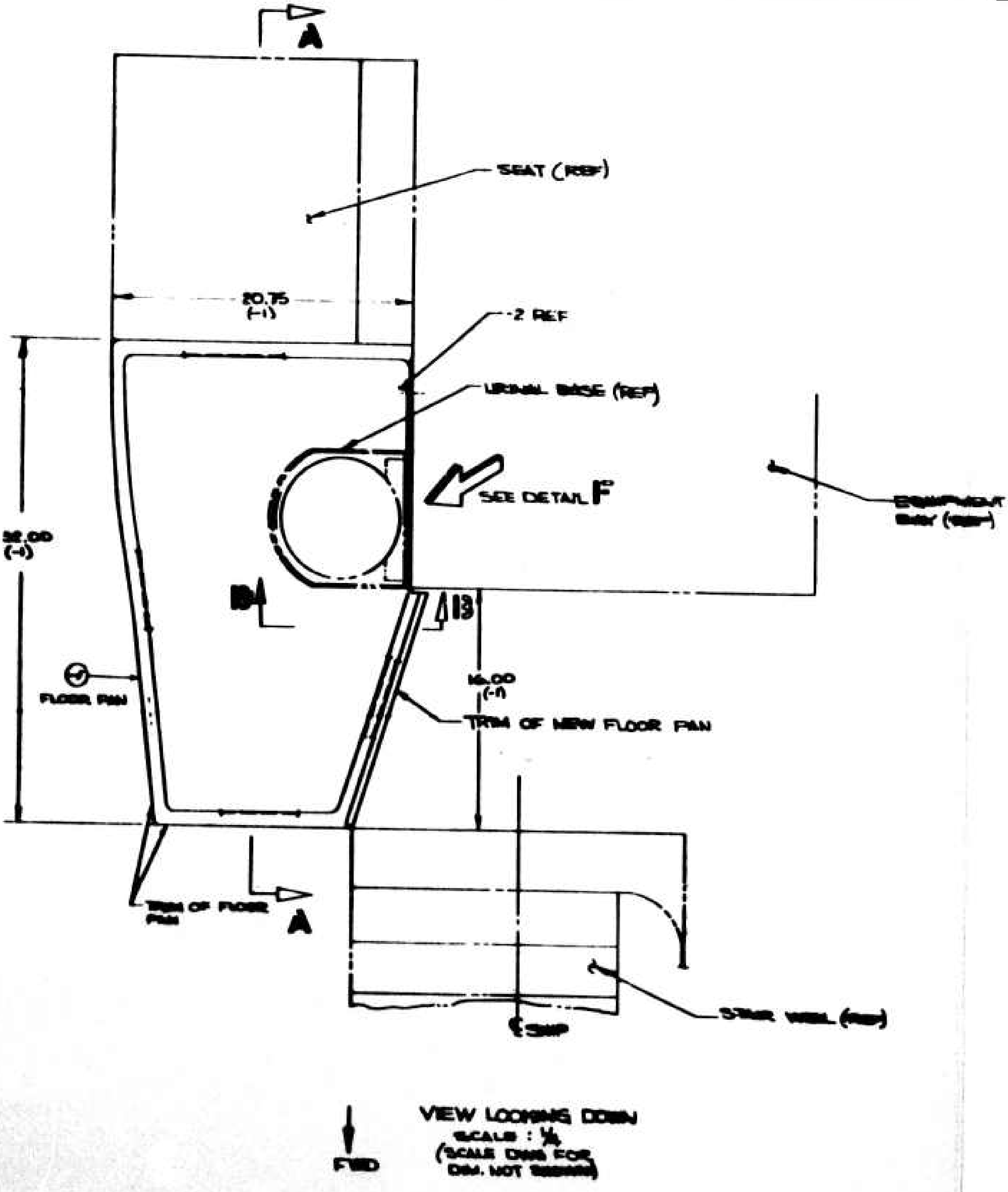
SECT D-D
SCALE 1/1


NEW FASTENER
VERT CLOSE OUT PANEL (JOG OVER FLOOR PAN)
(-2 REF)
NEW FLOOR PAN
(-1 REF)
E
E
SECT C-C
SEAT (REF)
CARPET (REF)
FLOOR PAN
(-1 REF)
SECT E-E
SCALE 1/1
(TYP 3 SIDES)
OLD VERT. CLOSE OUT
SPACER
FLOOR PAN (NEW)
EXISTING URINAL BASE
CARPET
-2 REF
URINAL BASE (REF)
NEW FLOOR PAN
EXISTING FLOOR LEVEL
CARPET
SECT D-D
SCALE 1/1
NEW FLOOR PAN
SECT B-B
SCALE 1/1
FLOOR LEVEL



LOSE OUT PANEL (JOG OVER FLOOR PAN)
AIR VENT (REF)
URINAL ASSY PT. NO 2179
OVERLAP EXIST. PANEL OVER NEW VERTICAL PANEL
D
CARPET
URINAL
TRIM EXISTING PANEL AS SHOWN & INSTALL FASTENERS AS REQD
PANEL
19.30(-2)
EXISTING FLOOR LEVEL
CARPET
FLOOR LEVEL
FLOOR PAN
C
C
SEAT (REF)
AIR VENT (REF
D
SECT A-A
SCALE: 1/4
FWD
32.00 (-1)
FLOOR PAN

3



A
SEAT (REF)
20.75
(-1)
-2 REF
URINAL BASE (REF)
SEE DETAIL F
32.00
(-1)
B
B
16.00
(-1)
FLOOR PAN
TRIM OF NEW FLOOR PAN
TRIM OF FLOOR PAN
A
STAIR WELL (REF)
℄ SHIP
VIEW LOOKING DOWN
SCALE : 1/4
(SCALE DWG FOR DIM. NOT SHOWN)
FWD

Fig

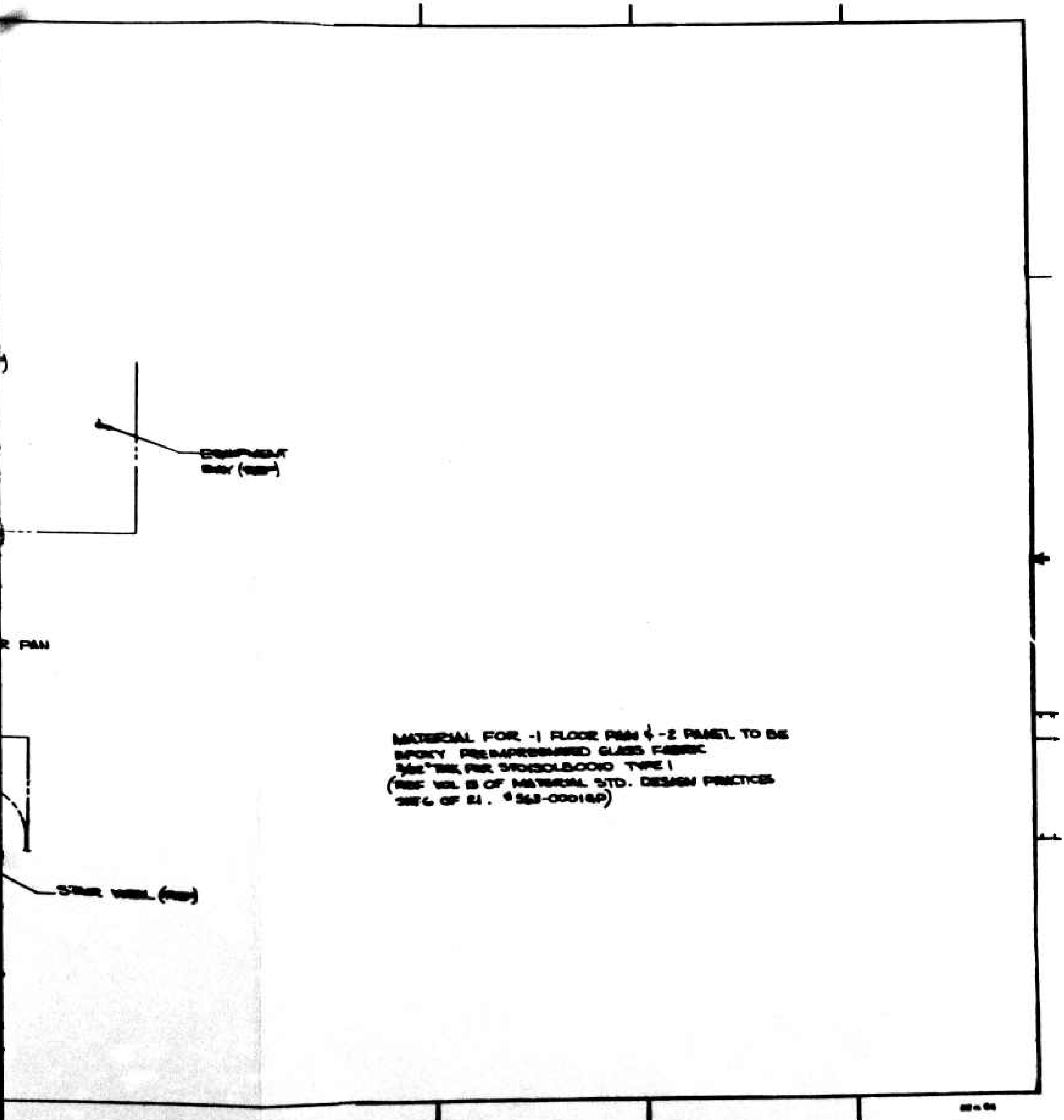
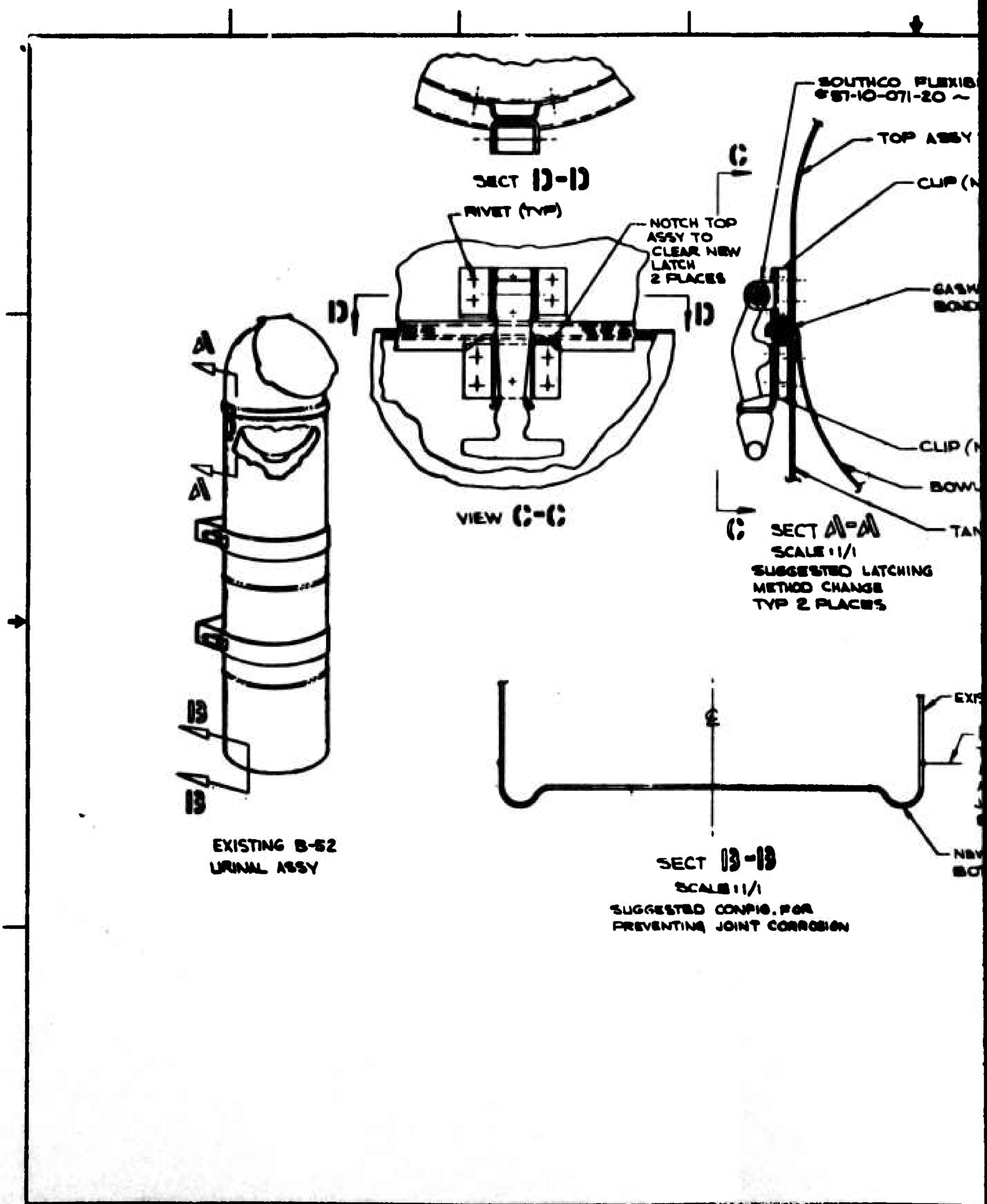


Figure 18. Item No. 8A - B-52D forward fuselage urinal area.



PRECEDING PAGE BLANK-NOT FILMED

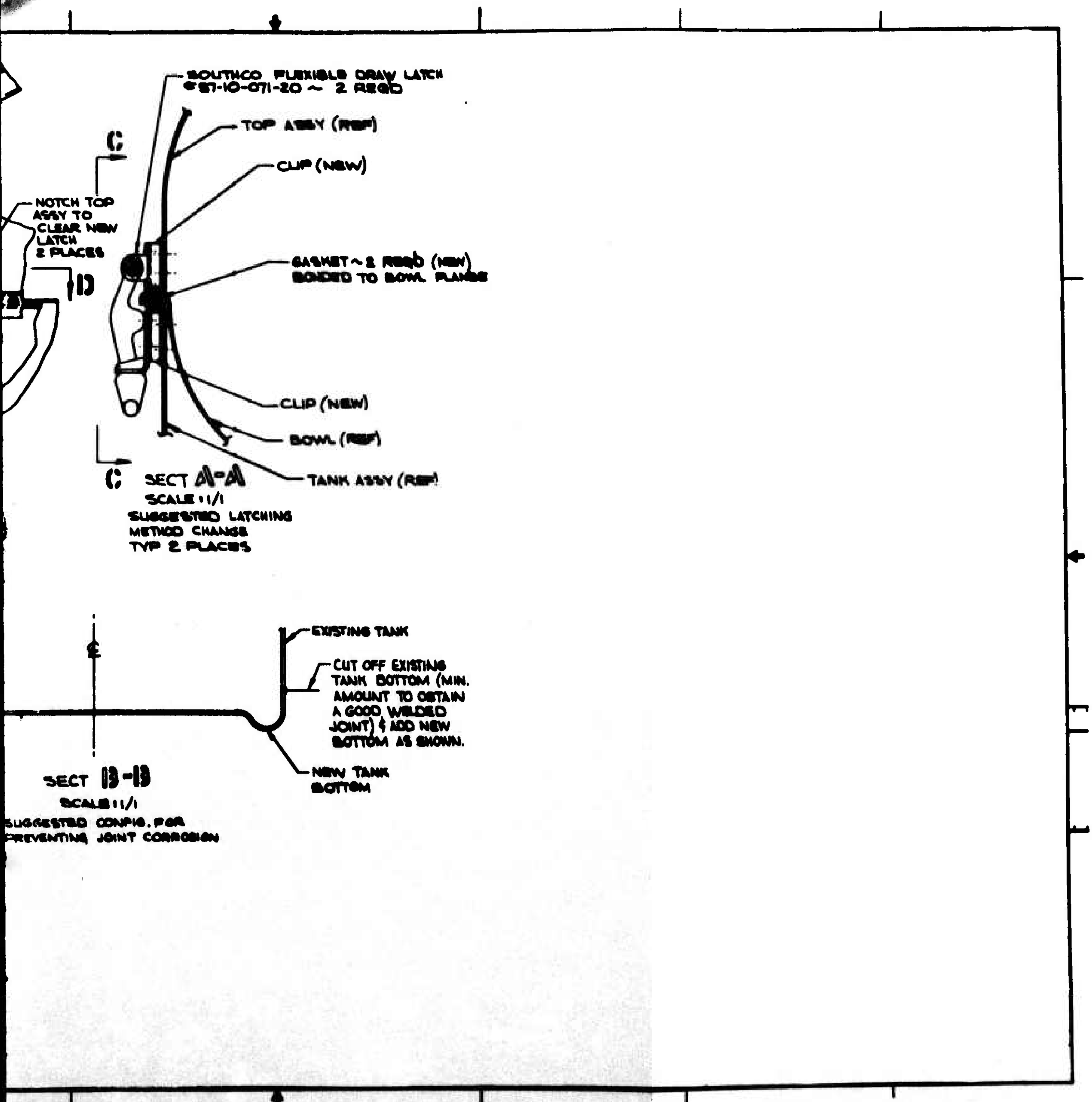
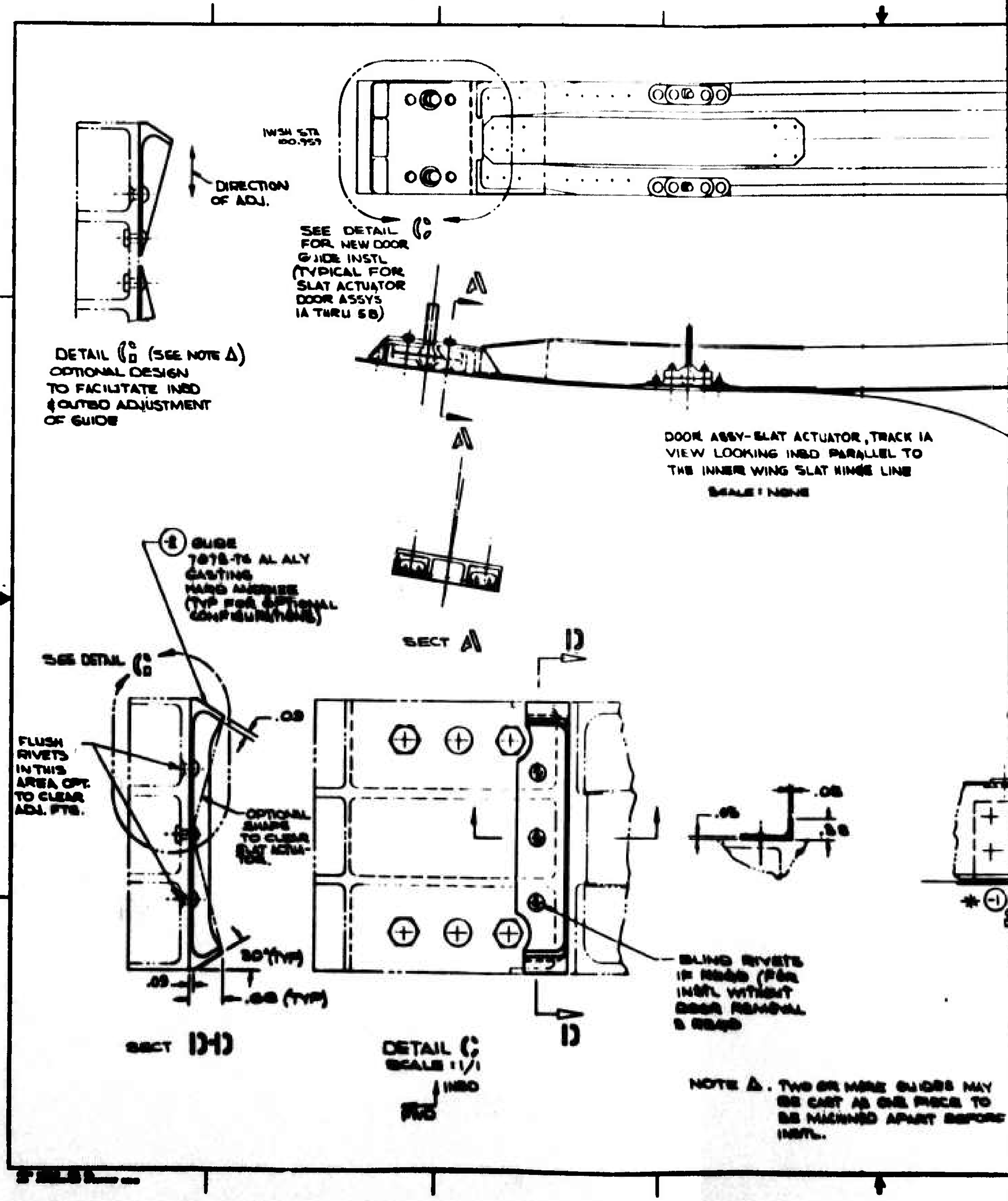


Figure 19. Items No. 8A and 8B - B-52 forward fuselage urinal.


IWSH STA 100.959
DIRECTION OF ADJ.
SEE DETAIL C FOR NEW DOOR GUIDE INSTL (TYPICAL FOR SLAT ACTUATOR DOOR ASSYS IA THRU 5B)
DETAIL C (SEE NOTE A) OPTIONAL DESIGN TO FACILITATE INBD & OUTBD ADJUSTMENT OF GUIDE
DOOR ASSY-SLAT ACTUATOR, TRACK IA
VIEW LOOKING INBD PARALLEL TO THE INNER WING SLAT HINGE LINE
SCALE: NONE
GUIDE
7075-T6 AL ALY CASTING
SECT A
SEE DETAIL C
FLUSH RIVETS IN THIS AREA OPT. TO CLEAR ADJ. FTG.
OPTIONAL SHAPE TO CLEAR SLAT ACTUATOR
30°(TYP)
.09
.06 (TYP)
SECT D-D
DETAIL C
SCALE: 1/1
INBD
FWD
BLIND RIVETS
NOTE A. TWO OR MORE GUIDES MAY BE CAST AS ONE PIECE TO BE MACHINED APART BEFORE INSTL.

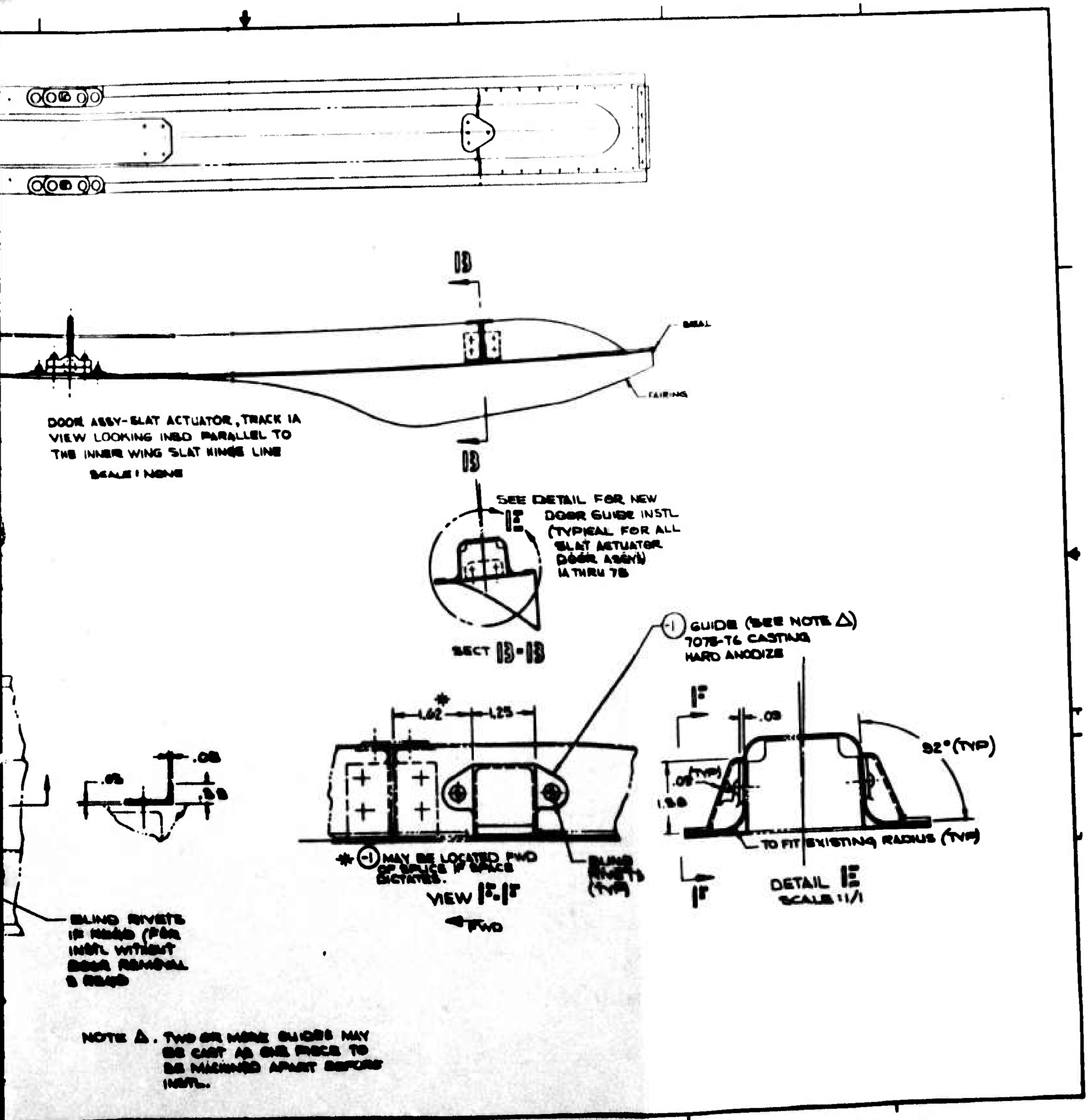


Figure 20. Item No. 9 - C-5A wing leading edge slat actuator doors.

ITEM NO. 9 - C-5A WING LEADING EDGE SLAT ACTUATOR DOORS

PROBLEM:

High maintenance man-hours are being experienced at operational bases on the subject doors to replace failed parts in the mechanism and to keep the doors adjusted for proper alignment with the opening in the wing structure. Failures are occurring in the spherical head adjustment fittings due to tension failure at the base of the head or by pulling the threaded inserts out of the slat track fitting.

CAUSE:

The cause of these failures has been analyzed to be an excessive load induced during slat retraction when the door misaligns with the door jamb on the wing structure before the slat has completed its retraction. Misalignment may occur from the following conditions:

1. Initial maladjustment
2. Airload deflections
3. Excessive play in the mechanism
4. Slippage of the ball joint fittings, relative to the door, due to loose bolts that clamp them to the door through a slotted hole
5. Broken attach links or adjustment fittings
6. Pulled thread inserts in the slat track attach fittings

LOW-COST DESIGN (See Figure 20)

Addition of self-aligning ramp guides to each side of the doors at the forward and aft ends to bring it into alignment with the jamb for proper seating during retraction and prevent a misaligned door from catching on the structure.

An additional recommendation is that a review be made of the kimematics of the subject door actuating mechanism to redesign the adjustment links and fittings to permit use of one standard-size spherical head link that would eliminate the possibility of installation of a link with insufficient length of thread engagement. This would reduce the failure rates for the door assembly.

ITEM NO. 10 - C-5A ENGINE COWL DOOR HINGE FITTING

PROBLEM:

The powerplant cowl door hinge fitting at station 179.000 has experienced numerous structural failures in the small-radius flange area closest to the cowl door. The crack on the cowl hinge fitting under study extends diagonally across the inner fillet radius for approximately 3/16 inch and is readily visible to the naked eye.

CAUSE:

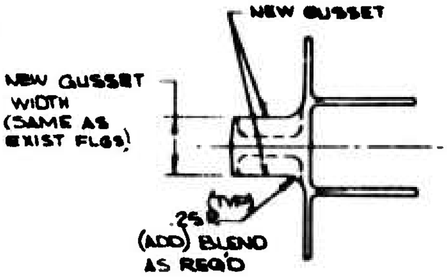
One of the more apparent causes of the cracked fitting is overextension of the cowl door during maintenance operations. This allows the adjacent cowl structure to bottom out against the hinge fitting, thereby inducing bending stresses capable of failing the area in question.

Another factor capable of causing the cracked hinge fitting failure may be excessive loads induced by wind gusts when the door is in its open position. A tension load in the hinge fitting would occur due to the door strut geometry in the open position.

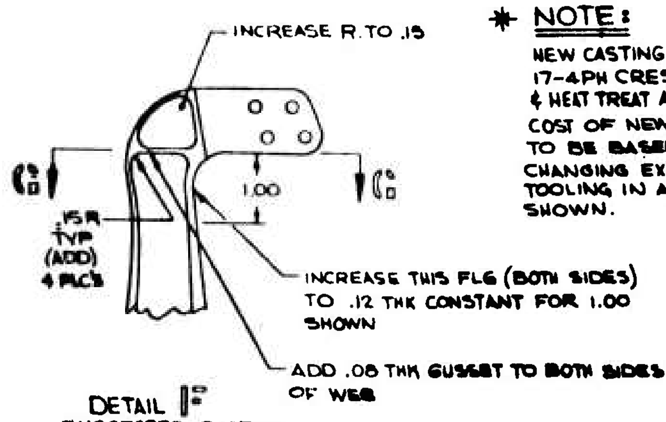
LOW-COST DESIGN (See Figure 21)

Two approaches to the cracked fitting were considered. The first was a new fitting with an adequate beefup of the flange area. The increased thickness of the flanges and the addition of gussets would insure adequate load paths for momentary high stress loads the fitting may experience.

An alternate approach considered was reinforcement of the crack-prone area by welding. The flanges on either side of the critical area could be built up with weld until the cross-sectional area is large enough to withstand higher stress loads. This method may also be used to repair cracked fittings.



SECT C-C



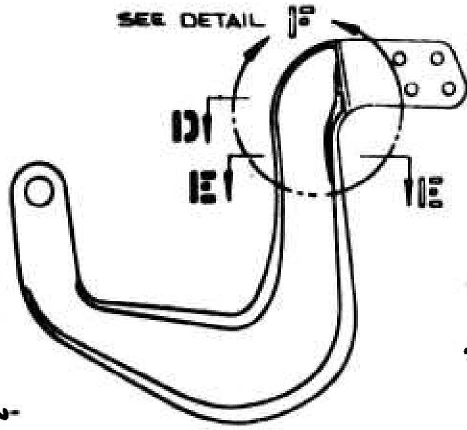
DETAIL F
SUGGESTED CASTING CHANGES TO BEEF-UP WEAK CORNER JOINT

* NOTE:
NEW CASTING TO BE 17-4PH CRES (SAME MATL TYPE & HEAT TREAT AS ORIG. PART). COST OF NEW CASTING TO BE BASED ON CHANGING EXISTING TOOLING IN AREA SHOWN.

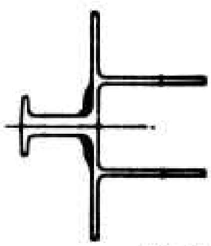
PREPARATION OF HINGE FTG PRIOR TO WELDING & WELDING PROC.

1. CLEAN FTG. USING SOLVENT & EMULSION CLEANING METHODS.
2. ANNEAL FTG AT A TEMP OF 1900 ±25°F FOR MIN OF 45 MIN. USING
   A. ARGON, HELIUM OR DRY HYDROGEN ATMOSPHERE OR VACUUM FURNACE
   B. APPLY SCALE INHIBITING COMP. .0005 THK TO PREVENT OXIDATION DURING ANNEALING.
3. BLEND OUT CRACKS INSURING NO PART OF CRACK REMAINS. USE 60° VEE GROOVE IF POSSIBLE.
4. WELD THE CRACK(S) USING TUNGSTEN-ARC WELDING PROCESS & 17-4PH CRES STEEL WIRE, VACUUM MELTED
5. BUILD UP WELD PER VIEW C, D & E AND GRIND AS REQD FOR INSTL. OF PART.
6. REPEAT STEP #1 (CLEANING)
7. RADIOGRAPHIC INSPECT HINGE
8. REPEAT ANNEAL STEP #2
9. PRECIPITATION HARDEN FTG TO COND H925, SPEC STP54-013 (LOCKHEED)
10. PASSIVATE FTG BY IMMERSION FOR 20 TO 30 MIN IN SOLUTION OF 60 TO 70 OZS. OF FED. SPEC O-N-350 NITRIC ACID IN ONE GAL OF H2O AT A TEMP OF 150°F. & DRY.

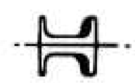
SEE DETAIL F



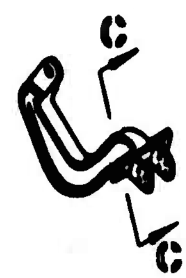
VIEW C
SCALE: 1/1
SUGGESTED METHOD OF SALVAGING EXISTING COWL HINGE BY INCREASING CROSS SECTIONAL AREA USING WELD BUILD-UP. (SEE DARKENED AREA IN ILLUSTRATION)



SECT D-D



SECT E-E



DETAIL B
COWL HINGE

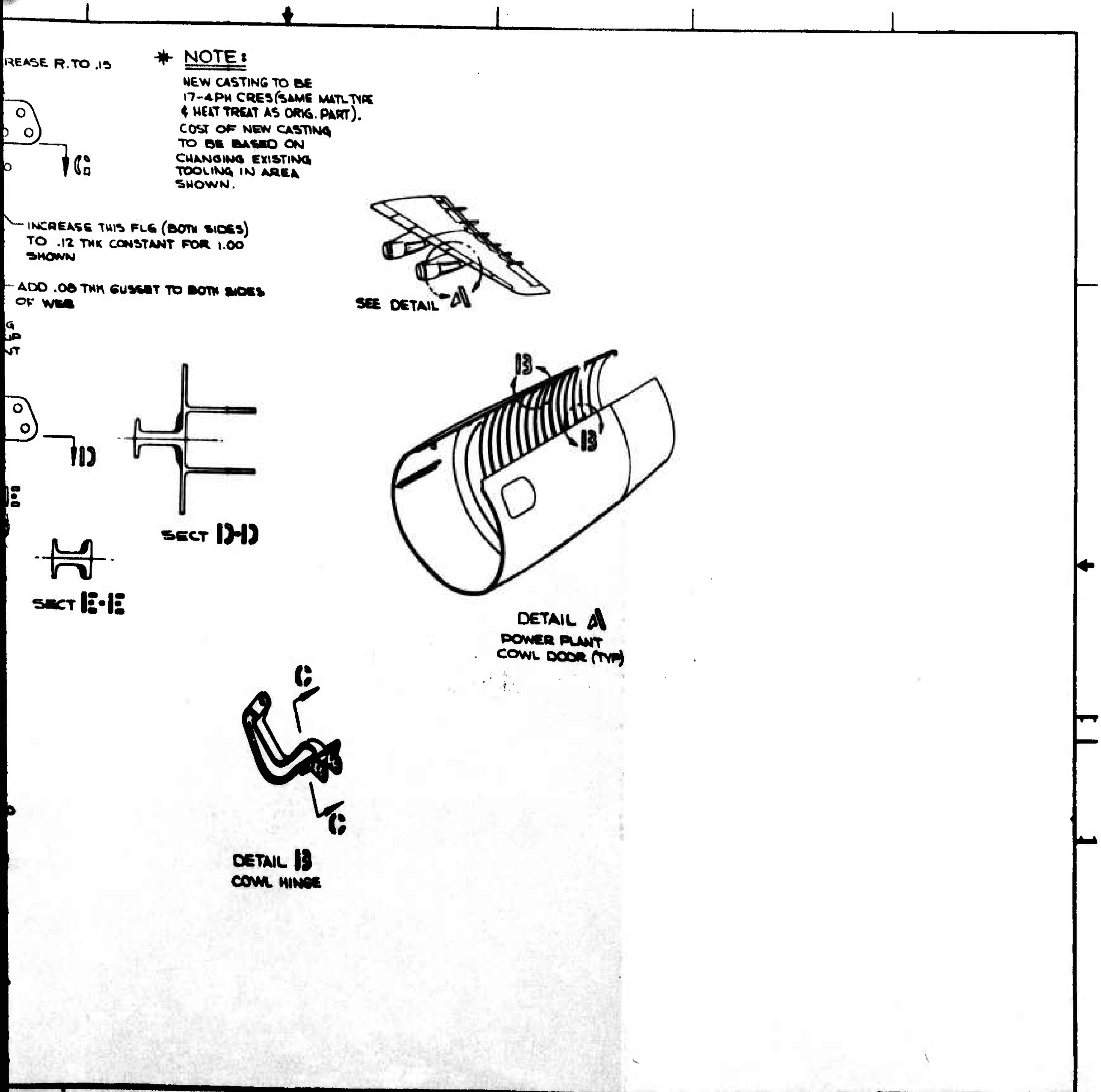


Figure 21. Item No. 10 - C-5A engine cowl door hinge fitting.

ITEM NO. 13 - C/KC-135 INNER TO OUTER WING JOINT RIBS

PROBLEM:

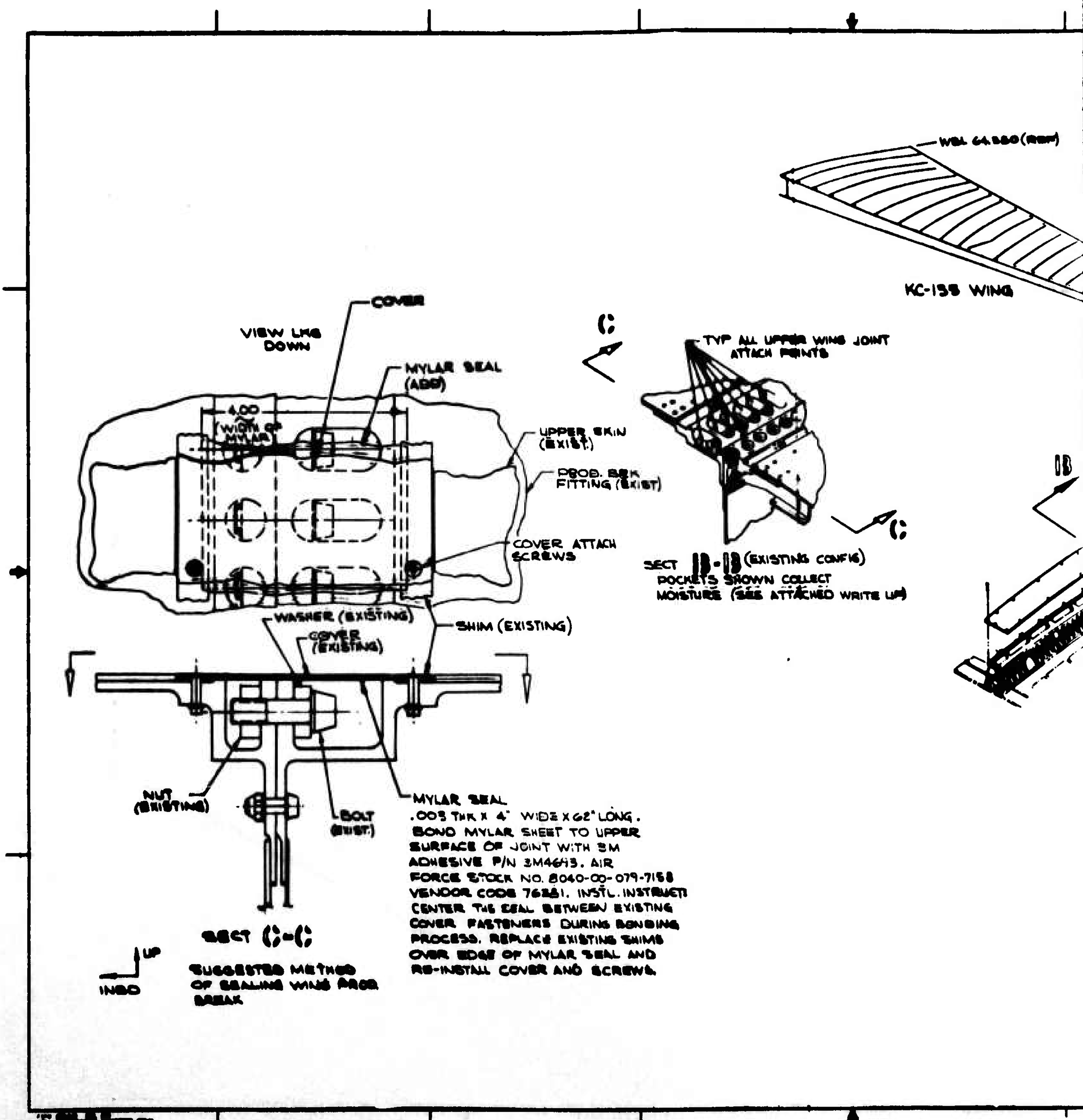
Severe surface corrosion has been encountered in the bathtub pockets in the wing joint rib around attach bolts. The bolts and nuts have also been highly corroded. This condition is prevalent primarily on the upper bolting rib caps.

CAUSE:

Leakage of water and anti-icing fluids around the rib joint cover fairing allows moisture to collect in the pockets of the bolting fittings. No provision has been made for drainage or sealing of the area.

LOW-COST DESIGN (See Figure 22)

The fairing cover has been designed to provide an adequate seal. A Mylar-type gasket would be cemented to the fittings covering the bathtub recesses so that moisture would be prevented from entering the cavities.



KC-135 WING
COVER
VIEW LKG DOWN
MYLAR SEAL (ADD)
4.00 (WIDTH OF MYLAR)
UPPER SKIN (EXIST)
PROD. BRK FITTING (EXIST)
COVER ATTACH SCREWS
WASHER (EXISTING)
COVER (EXISTING)
SHIM (EXISTING)
NUT (EXISTING)
BOLT (EXIST)
MYLAR SEAL
.005 THK X 4" WIDE X 62" LONG. BOND MYLAR SHEET TO UPPER SURFACE OF JOINT WITH 3M ADHESIVE P/N 3M4693. AIR FORCE STOCK NO. 8040-00-079-7158 VENDOR CODE 76381. INSTL. INSTRUCT: CENTER THE SEAL BETWEEN EXISTING COVER FASTENERS DURING BONDING PROCESS. REPLACE EXISTING SHIMS OVER EDGE OF MYLAR SEAL AND RE-INSTALL COVER AND SCREWS.
SECT C-C
SUGGESTED METHOD OF SEALING WING PROD BREAK
UP
INBD
TYP ALL UPPER WING JOINT ATTACH POINTS
SECT B-B (EXISTING CONFIG)
POCKETS SHOWN COLLECT MOISTURE (SEE ATTACHED WRITE UP)

Figure 2

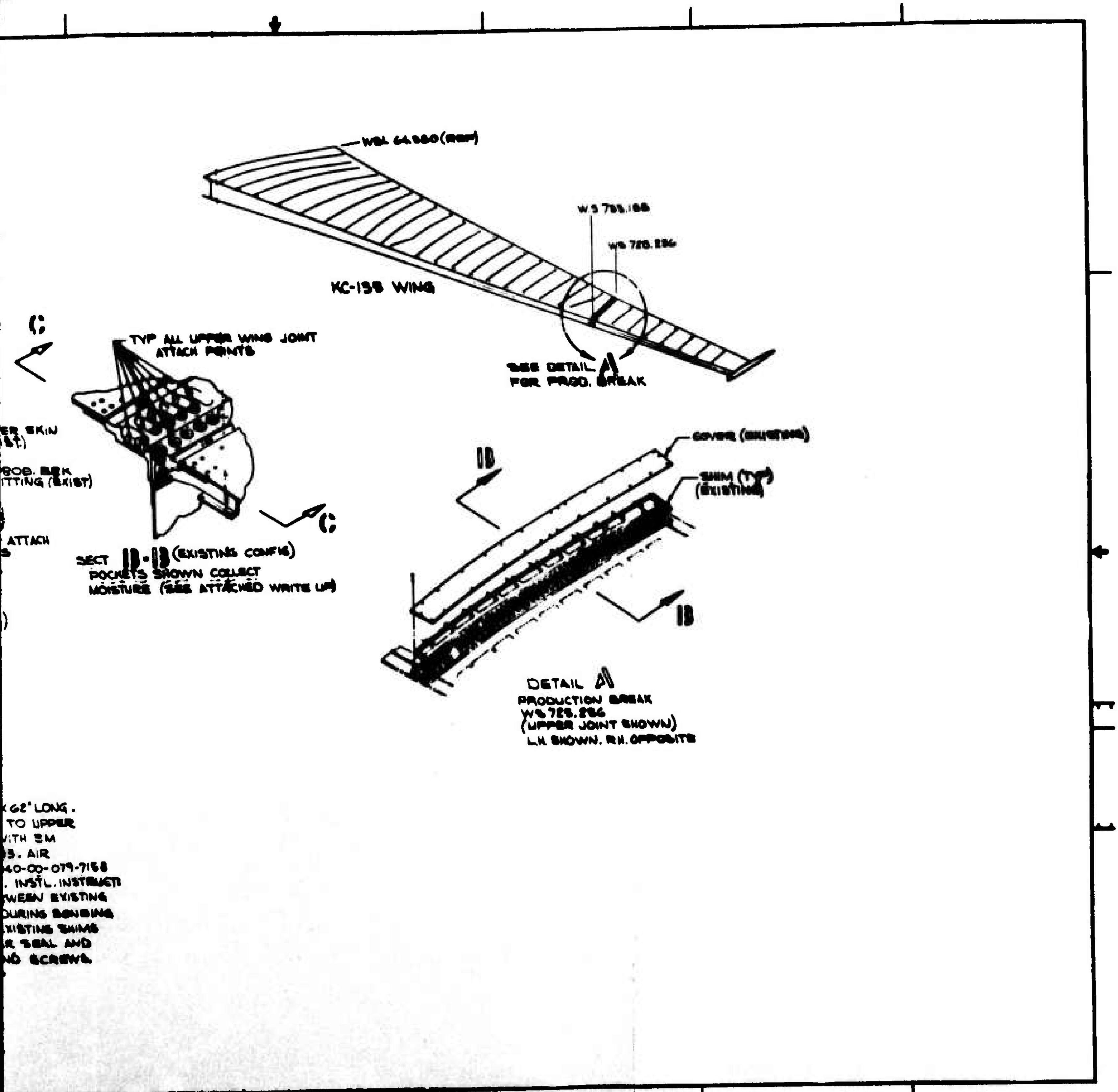


Figure 22. Item No. 13 - C/KC-135 inner to outer wing joint ribs.

ITEM NO. 14 - C-141A ENGINE NACELLE AFT COWL

PROBLEM:

The engine nacelle aft cowl has experienced structural failure of its longitudinal vane assembly and associated inner and outer cap angles. This failure has been in the form of fatigue cracks in the vane assembly and in the corners of the cap angles. Damage in the form of delamination of the honeycomb core has also been found in the area of the outer vane assembly attach members.

Repair of the foregoing damage is tedious and, if extensive enough, requires special tooling to maintain door configuration during repair. Accessibility is the prime problem encountered in repairing the area. Replacement or repair of the vane assembly and caps from either end of the cowl door is limited to the extent a man can reach into the openings. Repair beyond the end areas entails extensive door disassembly at a major repair depot.

The outer honeycomb panel is not removable, and repairs must therefore be made from the inner surface. This is hampered by a lack of easily removable sections of structure to expose the damaged area.

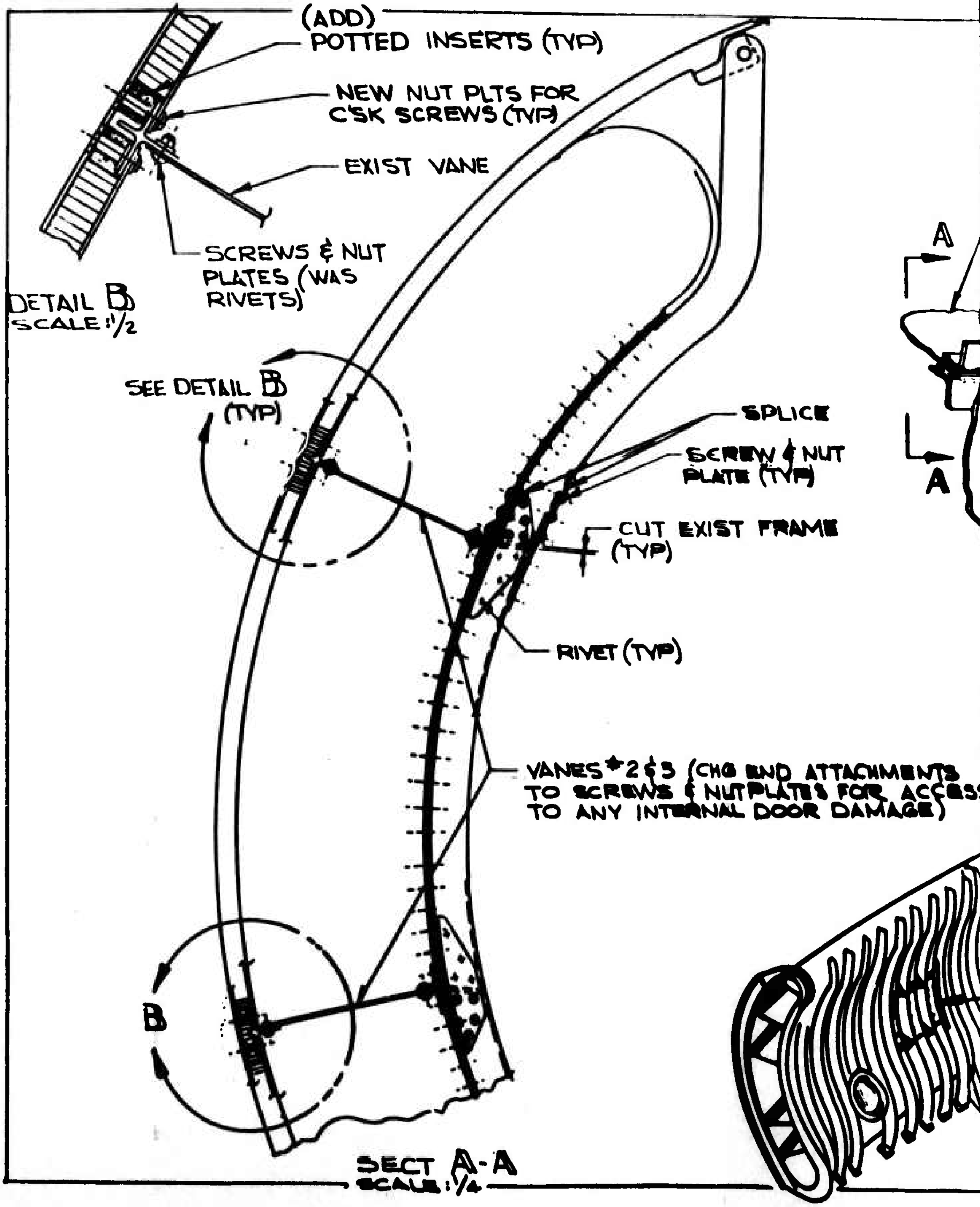
CAUSE:

Repeated cycling of the inner and outer door panels due to airloads and sonic vibration causes working of the vane assemblies and their inboard and outboard attach members, resulting in fatigue cracks.

The constant-tension load in the vanes also causes delamination of the honeycomb panel at the vane outer attach member, which is bonded integrally into the honeycomb panel.

LOW-COST DESIGN (See Figure 23)

Access to areas of the duct, unreachable from either end, is mandatory for repair of the vanes and their attachments. Provisions for two small removable doors in the inboard duct wall structure can be made. These doors would be between the two main vanes and between stations 120.130 and 132.320 for the forward door, and between stations 147.950 and 159.950 for the aft door. The two intermediate frames in each case would require removable splice joints at the upper and lower edges of each door. Sections of each vane in the proximity of each door must also be made movable for access into the upper and lower sections of the duct.


(ADD)
POTTED INSERTS (TYP)
NEW NUT PLTS FOR C'SK SCREWS (TYP)
EXIST VANE
SCREWS & NUT PLATES (WAS RIVETS)
DETAIL B
SCALE: 1/2
SEE DETAIL B (TYP)
SPLICE
SCREW & NUT PLATE (TYP)
CUT EXIST FRAME (TYP)
RIVET (TYP)
VANES #2 & 3 (CHG END ATTACHMENTS TO SCREWS & NUTPLATES FOR ACCESS TO ANY INTERNAL DOOR DAMAGE)
A
A
B
SECT A-A
SCALE: 1/4

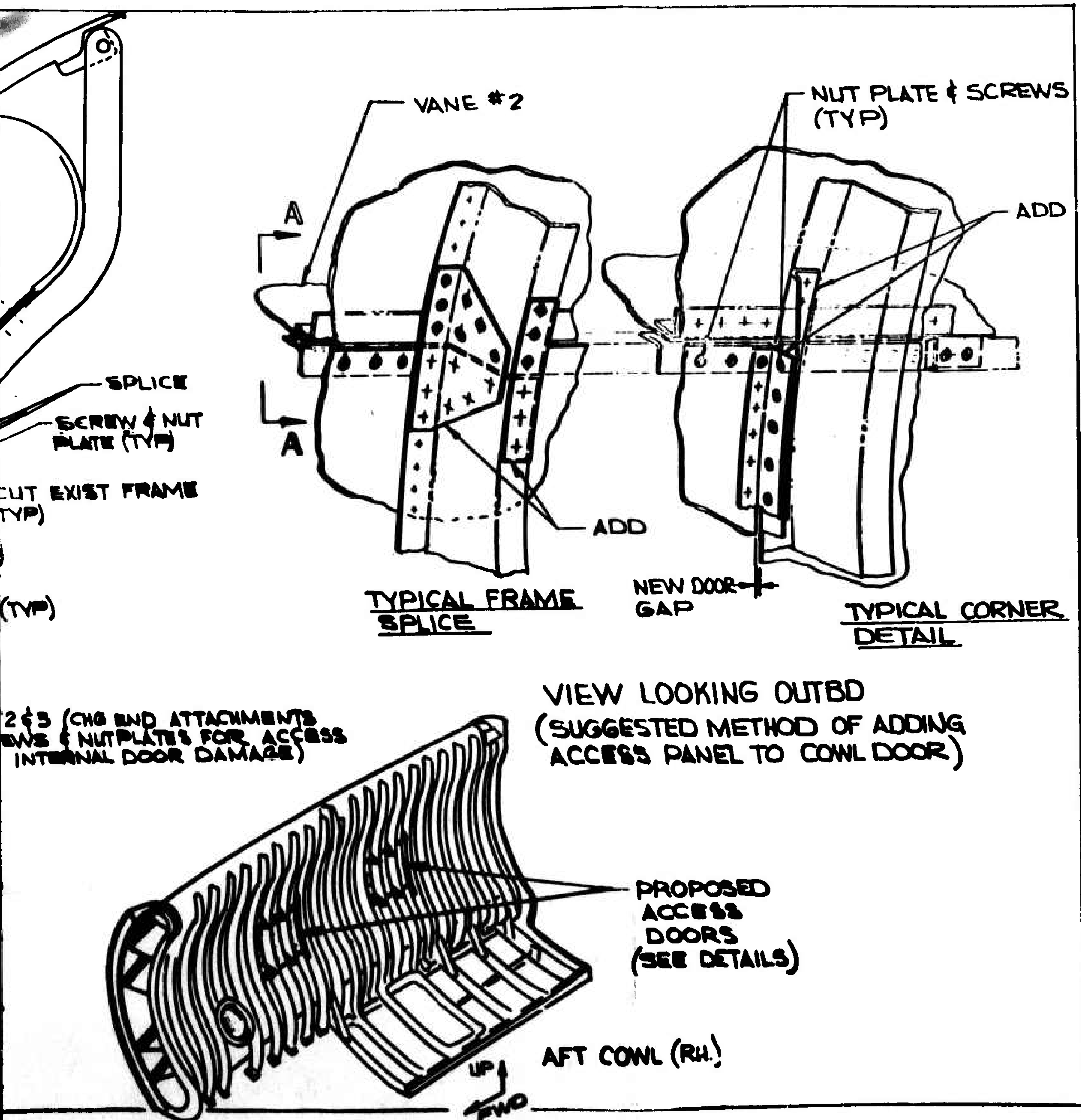


Figure 23. Item No. 14 - C-141 nacelle aft cowl door.

A mechanical attachment of the outboard vane attach member to supplement the integral bonding attachment as shown will also prevent disbonds in the honeycomb.

PHASE IV - LIFE CYCLE COST ANALYSIS

For each selected critical item subjected to design study, the impact of improvements on life cycle costs for the specific aircraft systems were developed. Two specific time periods were used to evaluate the benefits of the redesign or repair concepts. The first was a 3-year period in which the design concept was required to "break even" (or pay for itself). The second was a 10-year operating period in which a reasonable return on the investment of change would be realized. In this program, the life cycle cost methodology was structured to use the basic methods contained in Air Force Regulation AFR 173-10, "Cost Analysis USAF Cost and Planning Factors," dated 6 February 1976.

The cost factors were separated into three basic categories:

- Research and Development Costs

  The costs associated with the research and development of a military aircraft system are those required to design, fabricate, test, and evaluate the air vehicle system. For aircraft structures, this would include the costs for conducting research and evaluation testing of new materials, processes, and design concepts as part of a specific aircraft system program. Also included are the costs for fabrication of prototype aircraft structures and the validation tests conducted to ensure that the design requirements have been achieved.

- Acquisition Costs

  Includes production (flyaway costs and initial spares) and other investment (initial training, AGE and training equipment, AGE and training spares, transportation, facilities, and recurring modifications).

- Operating Costs (Cost of Ownership)

  Includes fuel and lubricants, direct base maintenance personnel (pay and allowances of personnel for inspection, maintenance up through base level, and repair up through base level), replenishment spares, depot maintenance, and base operations support and miscellaneous support (indirect operations costs such as pay and allowances of base operations support personnel, vehicular equipment, material support, rents, utilities, communications, printing and reproduction, medical services, and personnel training costs).

For the program, only the impact of the design innovations were required to determine the benefits of their implementation. Certain ground rules were established to provide a uniform base of cost factors for both depot and operational units, as follows:

- Cost computations and parts bid estimates are based on 1975 dollar values.

- Some parts cost data from ALC show a different cost for left and right opposite parts. An average cost was used in computations.

- Oral estimates from responsible personnel at depots and operational bases for maintenance hours or costs was used where written documentary was unavailable.

- All present, maintenance costs which are not obtainable through contacts with AF facilities along with new parts and installation costs will be estimated by the contractor.

- All future cost estimates were based on current methods and capabilities.

- Quantities of aircraft in the inventory were based on the 1 March 1975 census furnished by AFFDL/FBS.

- Cost savings were based on a retrofit of the fleet within 1 year, on the PDM schedule, or within 3 years, as judged most logical for the particular design.

- If an item were to be implemented during PDM, only the delta costs peculiar to installation of the new design would be included in the cost saving analysis.

- The 10-year life cycle cost period was based on implementation of the new design by 1 October 1976.

- Implementation costs would include the engineering and T.C.T.O. preparation, part fabrication, packaging, installation, and initial kit-proofing where applicable.

- Life cycle cost formula and values provided in AFR 173-10 would be used where applicable.

- All miscellaneous life cycle cost items which are of minor significance and not otherwise identified would be estimated in a lump sum quantity.

- An overall maintenance man-hour rate of $20.00 per hour was used for both depot and operational base modification costs.

- A 10-percent spares allocation would be used for each design concept and assumed to be procured at the same time as the modification parts.

Table 3 contains the summary of the inventory number of each aircraft type and the programmed depot maintenance (PDM) scheduled cycle for each.

For each design concept, two summary charts of costs were developed. The first contains detailed information on the costs for (1) the part or materials and the labor for the existing design and (2) the implementation of the low-cost design concept. The number of parts or quantity of material for a single aircraft is shown. The amortized cost of nonrecurring costs for the low-cost design concept include engineering, maintenance handbook revisions, preparation of the Time Compliance Technical Order (T.C.T.O.), testing and kit proofing, and packaging and shipment of the modification kit.

The second summary chart contains the comparison of life cycle cost impacts between the existing aircraft design and the low-cost design concept. It lists the nonrecurring and recurring cost factors for the existing and low-cost design concepts for 3- and 10-year periods. The nonrecurring costs consist of implementation of the aircraft fleet modification, parts or materials, and labor. The recurring costs include depot and base level maintenance labor, materials, spare parts, spares packaging and shipping, and base operational impacts. The total life cycle cost savings of the low-cost design concept over the existing present design is tabulated for both the 3- and 10-year periods.

The summary for the life cycle cost savings of each design concept study are contained in the tables as listed in the following:

Aircraft Model	Design Concept	Table
A-7D	Main landing gear trunnion pins and fittings	4 and 5
F-4 series	Fuselage fuel tank structure reinforcement	6 and 7
A/T-37 series	Engine tailpipe clamp	8 and 9
B-52D	Forward fuselage urinal area	10 and 11
B-52G/H	Forward fuselage urinal area	12 and 13
C-5A	Wing leading edge slat actuator door	14 and 15
C-5A	Engine cowl door hinge	16 and 17
C/KC-135	Wing rib joint	18 and 19

TABLE 3. AIRCRAFT UNITS AND PDM CYCLES

Aircraft Model	No. Units	PDM Schedule (mo)	Remarks
A-7D	390	42	
F-4C	295	30	3-year total units thru PDM = 1,535
F-4D	504	36	
RF-4C	379	48	
F-4E	603	48	
A-37	140	--	Special 16-month replacement of engine tailpipe clamps
T-37	763	--	
B-52D	127	36	
B-52G	174	48	Aircraft are on a 2-year corrosion control program
B-52H	95	48	
C-5A	77	None	AFM66-1 operational data and SAALC mod frequency
C-135	101	48	3-year total units thru PDM = 569.25
KC-135	658	48	

TABLE 4. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 1 - Main Landing Gear Shock and Tension Strut Trunnion and Pin Assemblies

Aircraft Model A-7D. Effect. on 390 Units. PDM Sched 42 Mo.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Parts or Matl	Qty	Cost	Total
Pin Trunnion, shock Trunnion, tens.	8 2 2	$ 16.00 314.50* 196.00*	$ 89.60[1] 314.50[1] 196.00[1]	Pin Trunnion, shock Trunnion, tens. Cover, trunnion (incl assy to trun)	8 2 2 4	$ 14.00 23.50 23.50 6.57	$112.00[2] 23.50[3] 23.50[3] 26.28[2]
Total			600.10	Total			185.28
Instl (labor at $20/hr)[4]				Instl (labor at $20/hr)[4]			
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: 4,484.00 500.00 800.00 2,277.00 527.00	
				Total nonrec		$8,588.00[5]	
Aircraft total			$600.10	Aircraft total			$185.28[5]

* Average
1. Based on 70% pin and 50% trunnion replacement per Oklahoma City ALC.
2. Based on 100% pin replacement with revised design and installation of all covers.
3. Salvage cost on 50% of trunnions.
4. Removal, installation, and checkout are part of PDM, and are same for both designs.
5. Contractor estimate.

TABLE 5. LIFE CYCLE COST COMPARISON

Item No. 1 - Main Landing Gear Shock and Tension Strut Trunnion and Pin Assemblies

Aircraft Model A-7D. Effect. on 390 Units.

Cost Description	334.28 Units 3-Yr Period		390 Units 10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 8,588		$ 8,588
Fleet Modification				
Parts/Material		61,935		72,259
Labor at $20/hr[2]		0		0
Recurring:				
Depot Maint Labor	0		0	
Base Maint Labor	0		0	
Material	0		0	
Spares	$ 200,605	6,194	668,683	7,226
Spares Pkg & shipping[1]	1,718	195	5,727	228
Base Operations, other[2]				
Total	$ 202,323	$ 76,912	$ 674,410	$ 88,301
Savings:				
Present costs less low-cost		$ 125,411		$ 586,109

1. Does not include unscheduled maintenance, which is assumed equal in both designs.

2. All work assumed accomplished at ALC depot.

TABLE 6. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 4 - Fuselage Fuel Tank Walls and Floor Skins Reinforcement

Aircraft Model F-4. Effect. on 1,781 Units. PDM Sched F-4C - 30 Mo, F-4D - 36 Mo, RF-4C & F-4E - 48 Mo

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Tanks 3, 4, 5 & 6 mod kit	1		$ 2,521.87[1]	Tank 3 reinf Tank 4 reinf Tank 5 reinf Tank 6 reinf Adhesive	1 1 1 1 21 lb	$ 147.84 474.70 371.90 397.90 20.00/lb	$ 147.84 474.70 371.90 397.90 420.00
Total			2,521.87	Total			1,812.34[2]
Instl (labor at $20/hr)	550 hr[4]	$20/hr	11,000.00	Instl (labor at $20/hr)	84 hr[3]	$20/hr	1,680.00
Implementation (nonrecurring):				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/Kit Proofing		Total: 70,856 1,400 800 130,733 2,450	
				Total nonrec		206,239[3]	
Aircraft total			$13,521,87	Aircraft total			$3,492.34

1. Ref Telecon D.O. Jones, MMEMS, OOALC, Hill AFB, Utah, dated 2 July 1975.
2. Ref quotes Russell Ind, Long Island, N.Y. per telecon, dated 17 June 1975.
3. Contractor estimate.
4. Ref Telecon Robt. Jenson, Tech. Services, OOALC, Hill AFB, Utah, dated 24 July 1975.

TABLE 7. LIFE CYCLE COST COMPARISON

Item No. 4 - Fuselage Fuel Tank Walls and Floor Skins Reinforcement

Aircraft Model F-4. Effect. on 1,781 Units.

Cost Description	1,535 Units 3 Yr Period		1,781 Units 10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 206,239		$ 206,239
Fleet Modification				
Parts/Material	$ 3,871,070	2,781,942	$ 4,491,450	3,227,777
Labor at $20/hr	16,885,000	2,578,800	19,591,000	2,992,080
Recurring:				
Depot Maint Labor				
Base Maint Labor				
Material				
Spares				
Spares Pkg & shipping				
Base Operations, other				
Total	$20,756,070	$ 5,566,981	$24,082,450	$ 6,426,096
Savings:				
Present costs less low-cost		$15,189,089		$17,656,354

TABLE 8. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 5 - Engine Tailpipe Clamp

Aircraft Model A/T-37. Effect. on 903 Units. PDM Sched Spec. Repl. at 16 Mo.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Clamp assy	2	$25.20[2]	$ 50.40	Spring Bolt & nut Washer	4 4 8	$ 0.75 4.84 0.14	$ 3.00 19.36 1.12
Total			50.40	Total			23.48
Instl (labor at $20/hr)	2 hr[3]	$20/hr	40.00	Instl (labor at $20/hr	2 hr[1]	$20/hr	40.00
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: $ 3,488 300 1,000 13,527 550	
				Total Nonrec		$18,865[1]	
Aircraft total			90.40	Aircraft total			$ 63.48

1. Contractor estimate.
2. Ref WPAFB ADOPL Product No. D046.E61A, dated 12 May 1975.
3. Ref T.C.T.O. 1T-37 B-506.

TABLE 9. LIFE CYCLE COST COMPARISON

Item No. 5 - Engine Tailpipe Clamp

Aircraft Model A/T-37. Effect. on 903 Units.

Cost Description	3 Yr Period		10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring[1]:				
Implementation		$ 18,865		$ 18,865
Fleet Modification				
Parts/Material		21,202		21,202
Labor at $20/hr		36,120		36,120
Recurring:				
Depot Maint Labor				
Base Maint Labor	$ 81,270		270,900	3,612[2]
Material				
Spares	102,400	2,120	341,334	2,120
Spares Pkg & shipping		1,353		1,353
Base Operations, other[3]				
Total	$ 220,891	$ 96,203	$ 736,306	$ 101,469
Savings:				
Present costs less low-cost		$ 124,688		$ 634,837

1. Assumes low-cost design installed within 3 years.
2. Spares installation.
3. Included in basic $20.00-per-hour labor rate.

TABLE 10. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 8A - Forward Fuselage Urinal Area, Section 41

Aircraft Model B-52D. Effect. on 127 Units. PDM Sched 36 Mo.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Misc corrosion control parts & material			$ 150.00[1]	Pan Panel	1 1	$ 65.00 65.00	$ 65.00 65.00
Total			150.00	Total			130.00[3]
Instl (labor at $20/hr)	546 hr[2]	$20/hr	10,920.00	Instl (labor at $20/hr)	4 hr[3]	$20/hr	80.00
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: 14,797 500 1,200 6,590 520	
				Total nonrec		$ 23,607[3]	
Aircraft total			$11,070.00	Aircraft total			$ 210.00

1. Cost estimate by contractor based on observation at Oklahoma City ALC.
2. Ref estimate by Oklahoma City ALC for corrosion program on PDM for FY 1976.
3. Contractor estimate.

TABLE 11. LIFE CYCLE COST COMPARISON

Item No. 8A - Forward Fuselage Urinal Area, Section 41

Aircraft Model B-52D. Effect. on 127 Units.

Cost Description	3 Yr Period		10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 23,607		$ 23,607
Fleet Modification				
Parts/Material		16,510		16,510
Labor at $20/hr		10,160		10,160
Recurring:				
Depot Maint Labor	$ 1,386,840	0	$ 4,622,800	808,990[1]
Base Maint Labor	0		0	0
Material	19,050	0	63,500	11,375[1]
Spares	0	0	0	0
Spares Pkg & shipping	0	0	0	0
Base Operations, other				
Total	$ 1,405,890	$ 50,277	$ 4,686,300	$ 870,642
Savings:				
Present costs less low-cost		$ 1,355,613		$ 3,815,658

1. Based on low-cost design, reducing corrosion control effort and material requirement by 75%.

TABLE 12. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 8B - Forward Fuselage Urinal Area, Section 41

Aircraft Model B-52 G & H. Effect. on 272 Units. PDM Sched 48 Mo.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Misc corrosion control parts & material			$ 150.00[1]	Shield	1	$ 195.00	$ 195.00
Total			150.00	Total			195.00
Instl (labor at $20/hr)	546 hr[2]	$20/hr	10,920.00	Instl (labor at $20/hr)	5 hr[3]	$20/hr	100.00
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: 22,195 500 1,200 21,166 520	
				Total nonrec		$45,581[3]	
Aircraft total			$11,070.00	Aircraft total			$ 295.00

1. Cost estimate by contractor based on observation at Oklahoma City ALC.
2. Ref estimate by Oklahoma City ALC for corrosion on 2-year fly-in program.
3. Contractor estimate.

TABLE 15. LIFE CYCLE COST COMPARISON

Item No. 8B - Forward Fuselage Urinal Area, Section 41

Aircraft Model B-52 G & H. Effect. on 272 Units.

Cost Description	408 Units 3 Yr Period		10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 45,581		$ 45,581
Fleet Modification				
Parts/Material		53,040		53,040
Labor at $20/hr		27,200		27,200
Recurring:				
Depot Maint Labor	$ 4,455,360	371,280	$14,851,200	2,970,240[1]
Base Maint Labor				
Material	61,200	5,100	204,000	40,800[1]
Spares	0	0	0	0
Spares Pkg & shipping	0	0	0	0
Base Operations, other				
Total	$ 4,516,560	$ 502,201	$15,055,200	$ 3,136,861
Savings: Present costs less low-cost		$ 4,014,359		$11,918,339

1. Based on low-cost design, reducing corrosion control effort and material requirement by 75%.

TABLE 14. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 9 - Wing Leading Edge Slat Actuator Door

Aircraft Model C-5A. Effect. on 77 Units. PDM Sched None.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Fwd ball fitting Attachment fitting	56 56	\$13.00[1] 36.75[1]	\$ 37.70[2] 106.57[2]	-1 Guide, aft -2 Guide, fwd	56 20	\$ 4.88 13.67	\$ 273.28 273.40
Total			144.28	Total			546.68
Instl (labor at \$20/hr)	17.6 hr[3]	\$20/hr	352.00	Instl (labor at \$20/hr)	31 hr[1]	\$20/hr	620.00
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: 8,968.00 2,000.00 1,400.00 2,961.00 1,135.00	
				Total nonrec		\$16,464.00	
Aircraft total			\$496.28	Aircraft total			\$1,166.68

1. Contractor estimate
2. Based on 4.83 maintenance actions per aircraft per year and replacement of 2.90 parts per year.
3. Man-hours obtained from AFM 66-1.

TABLE 15. LIFE CYCLE COST COMPARISON

Item No. 9 - Wing Leading Edge Slat Actuator Door

Aircraft Model C-5A. Effect. on 77 Units.

Cost Description	3 Yr Period		10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 16,464		$ 16,464
Fleet Modification				
Parts/Material		42,094		42,094
Labor at $20/hr		47,740		47,740
Recurring:				
Depot Maint Labor	0	0	0	0
Base Maint Labor	$ 81,312	0	271,040	4,680
Material	0	0	0	0
Spares	33,[illegible]	4,209	111,096	4,209
Spares Pkg & shipping	569	57	1,897	57
Base Operations other[1]				
Total	$ 115,210	$ 110,564	$ 140,133	$ 110,564
Savings:				
Present costs less low-cost		$ 4,646		$ 29,569

1. Costs included in basic $20.00-per-hour labor rate.

TABLE 16. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 10 - Engine Cowl Door Hinge

Aircraft Model C-5A. Effect. on 77 Units. PDM Sched None.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Hinge	8	$69.12 (avg)	$ 552.96	Hinge	8	$ 31.00	$ 248.00
Total			552.96	Total			248.00
Instl (labor at $20/hr)	16 hr[1]	$20/hr	320.00	Instl (labor at $20/hr)	16 hr[2]	$20/hr	320.00
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: 2,241.00 300.00 800.00 412.00 1,135.00	
				Total nonrec		$4,888.00[2]	
Aircraft total			$ 872.96	Aircraft total			$ 568.00

1. Man-hours provided verbally by engine cowl shop personnel at SAALC.
2. Contractor estimate.

TABLE 17. LIFE CYCLE COST COMPARISON

Item No. 10 - Engine Cowl Door Hinge

Aircraft Model C-5A. Effect. on 77 Units

Cost Description	3 Yr Period		10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 4,888		$ 4,888
Fleet Modification				
Parts/Material		19,096		19,096
Labor at $20/hr		24,640		24,640
Recurring:				
Depot Maint Labor	$ 24,640	0	82,133	2,480
Base Maint Labor	0	0	0	0
Material	0	0	0	0
Spares	42,578	1,922	141,946	1,922
Spares Pkg & shipping	385	39	1,283	39
Base Operations, other[1]				
Total	$ 67,603	$ 50,585	$ 225,362	$ 53,065
Savings:				
Present costs less low-cost		$ 17,018		$ 172,297

1. All work accomplished at ALC depot.

TABLE 18. COST BREAKDOWN - PRESENT AND LOW-COST DESIGNS

Item No. 13 - Inner-to-Outer-Wing Joint Rib

Aircraft Model C/KC-135. Effect. on 759 Units. PDM Sched 48 Mo.

Present Design				Low-Cost Design			
Part or Matl	Qty	Cost	Total	Part or Matl	Qty	Cost	Total
Rib, inner Rib, outer	2 2	$4,233.00 3,827.00	$8,466.00[1] 7,654.00[1]	Mylar cover Adhesive	2 1 pint	$ 0.20 1.60	$ 0.40 1.60
Total			16,120.00[1]	Total			2.00
Instl (labor at $20/hr)	2,400 hr[1,3] 36 hr[2]		48,000.00 720.00	Instl (labor at $20/hr)	3 hr[4]	$20/hr	60.00
				Implementation (nonrecurring): Engineering Hndbk Rev T.C.T.O. Prep Pkg & Shipping Test/kit Proofing		Total: 2,241.00 400.00 1,000.00 7,348.00 520.00	
				Total nonrec		$11,509.00[4]	
Aircraft total			$64,120.00[1] 720.00[2]	Aircraft total			$ 62.00

1. Only for aircraft that require rib replacement. Estimated at three aircraft per year by OCALC.
2. For corrosion control on aircraft that do not require rib replacement. Estimate by contractor.
3. Man-hours provided by OCALC.
4. Contractor estimate.

TABLE 19. LIFE CYCLE COST COMPARISON

Item No. 13 - Inner-to-Outer-Wing Joint Rib

Aircraft Model C/KC-135. Effect. on 759 Units.

Cost Description	569.25 Units 3 Yr Period		10 Yr Period	
	Present	Low-Cost	Present	Low-Cost
Nonrecurring:				
Implementation		$ 11,509		$ 11,509
Fleet Modification				
Parts/Material[3]		1,518		1,518
Labor at $20/hr[3]		45,540		45,540
Recurring:				
Depot Maint Labor	$ 835,380[2]		$ 2,784,600[2]	$ 136,620[4]
Base Maint Labor				
Material				
Spares	145,080[1]	152	483,600[1]	152
Spares Pkg & shipping	4,980[1]		16,600[1]	
Base Operations other[5]				
Total	$ 985,440	$ 58,719	$ 3,284,800	$ 195,339
Savings:				
Present costs less low-cost		$ 926,721		$ 3,089,461

1. Based on three aircraft per year requiring rib replacement per OCALC.
2. Includes rib replacement at three aircraft per year and corrosion control on remainder.
3. Based on all 759 aircraft having change accomplished in 1 year.
4. Assumes a residual of 10% of original corrosion costs incurred.
5. Costs included in basic $20.00-per-hour labor costs.

TABLE 20. ESTIMATED COST SAVINGS SUMMARY

Item No.	Title	3 Yr Saving	10 Yr Saving
1	A-7D MLG Strut Trunnion and Pin Assy - 390 Units	$ 125,411	$ 586,109
4	F-4 Fuselage Fuel Tank Skins Reinforcement - 1781 Units	15,189,089	17,656,354
5	A/T-37 Engine Tailpipe Clamp - 903 Units	124,688	634,837
8A	B-52D Forward Fus Urinal Area Section 41 - 127 Units	1,355,613	3,815,658
8B	B-52 G, H Forward Fus Urinal Area Section 41 - 272 Units	4,014,359	11,918,339
9	C5A Wing LE Slat Actuator Doors - 77 Units	4,646	29,569
10	C-5A Engine Cowl Door Hinge - 77 Units	17,018	172,297
13	C/KC - 135 Inner to Outer Wing Joint Rib - 759 Units	926,721	3,089,461
	Totals	$21,757,545	$37,902,624

The total summary of estimated cost savings for the critical items studied is contained in Table 20, which indicates that substantial reductions in military aircraft maintenance costs can be achieved for relatively modest expenditures of material and labor at both the operational base and ALC depot level activities.

PHASE V - PREPARE DESIGN HANDBOOK

The objective of phase V was to develop a design guide handbook to serve a growing need in the military in order to obtain lower aircraft structural maintenance costs to a more reasonable level commensurate with acceptable life cycle costs. It was designed as an informative guide which will aid the aircraft designer in forseeing maintenance problems and making proper trade-off evaluations to optimize the structural design for total life cycle costs.

The handbook points up several examples of high-maintenance-cost items on existing inservice aircraft and suggests changes to substantially reduce the life cycle cost. In addition, many other costly maintenance items discovered during visits to military and industry maintenance and repair facilities are cited which could have been avoided or substantially reduced by more cost-effective considerations for serviceability during design.

In this respect, the handbook includes not only information on past problem areas in the form of "lessons learned," but recommended considerations during initial design of every aspect of structural development. Since corrosion-damage repair was found to be one of the most costly maintenance items, a part of the handbook provides design information usable in its prevention. Also, since the handbook is directed primarily toward the development of military aircraft, a section is devoted to battle damage and design considerations to increase survivability and permit repairs to minimize downtime on the aircraft.

The design handbook is divided in eight sections as follows:

Section 1 - Introduction
Section 2 - Use of Handbook
Section 3 - Background
Section 4 - Lessons Learned
Section 5 - General Design Considerations
Section 6 - Detail Design Considerations
Section 7 - Repair or Modification Design
Section 8 - References

The following paragraphs contain a brief description of the type of information contained in each section.

Section 1 introduces the designer to the handbook with a brief review of the reasons for the development of the handbook, how the information was collected, and the importance of considering maintenance and repair costs during initial design of an aircraft.

Section 2 recommends to the designer the use of the handbook and provides a brief insight of the information contained in each section.

Section 3 acquaints the designer on how the information for the handbook was obtained, the types of aircraft that were considered for inclusion in the handbook, and some of the major factors to be considered during the design of an aircraft to reduce maintenance costs.

Section 4 points out that many design deficiencies that are appearing on current aircraft structures have occurred on previous generations of aircraft. In this section, a number of repetitive problems are identified so that designers of future aircraft structures may take advantage of the lessons learned. The design deficiency problems encountered at the repair facilities have been grouped in five main categories: lubrication deficiencies, corrosion-protection deficiencies, material selection deficiencies, detail design deficiencies, and fatigue design deficiencies. In each category there are examples of the deficiency with a photograph or a sketch, a statement of the problem, and the cause.

Section 5 contains general design consideration information on design techniques for low-cost structural maintenance features that may be incorporated into new aircraft systems. These design techniques are material selection, structural assembly arrangements, aircraft subsystem interfaces, removable and hinged doors, radomes and engine cowls, crew/passenger/cargo provisions, sealing and organic bonding, corrosion prevention, fasteners, and special design considerations.

Section 6 is one of the most important sections for the designer of new aircraft. It contains detail information on construction concepts, material selection, corrosion control, maintenance, life cycle cost impact considerations, trade factors, and a design checklist. There is a table for structural fasteners that provides the part name, type, material and strength, weight, cost, cost installed, maximum misalignment, maximum temperature, and remarks. A materials recommendation for primary structure table provides information on the type of materials, environment, candidate materials, typical application, advantages, and limitations. A cost breakdown table shows an example of the maintenance and parts cost of a present design on one aircraft and the potential savings on that one aircraft in 1 year thru an innovative repair design. A life cycle cost comparison table shows the potential savings of this repair design for the entire fleet of this aircraft over 3- and 10-year periods.

Section 7 contains information on repair or modifications, designs and their drawings and kits. The section also contains battle-damaged repairs with a number of examples of typical battle-damaged repair concepts. Also included are repair concepts with design drawings for some of the design deficiencies listed in Section 4.

Section 8 is a listing of data sources used for the development of the design handbook.

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

In the performance of this program, specific conclusions were developed from the analysis of the information and data obtained and from the personal contacts with military and industry personnel engaged in aircraft structural repair and maintenance. They address a number of areas covered in the investigation and are presented as a part of an effort to provide the reader with an appreciation of the benefits of the study results, and to identify specific areas of aircraft structure maintenance reporting systems that could be modified to provide more useful information to the aircraft system managers, Air Logistics Centers, Air Force Logistics Command Headquarters, Air Force Flight Dynamics Laboratory, Air Force Materials Laboratory, the using commands, and the aircraft manufacturers.

1. The results of the design innovation studies and the life cycle cost analyses have conclusively shown that considerable savings in the cost-of-ownership related to maintenance and repair of aircraft structures can be realized. In many instances, such benefits can be gained for relatively small initial expenditures that would provide the Air Force with a significant return on its investment. The vast amounts of expenditures currently needed to support existing aircraft operations is considered to be a fertile area for numerous improvements and savings that can be achieved on all categories of military aircraft.

2. The capability to obtain sufficient valid data on the cost of military aircraft structure maintenance and repair, for analysis and identification of specific problem areas, is severely hampered by the existing cost accounting systems in the Air Logistics Centers and the limitations in the AFM66-1 reporting system. Neither of these systems were originally developed to provide such detail data, and unless some requirement is endorsed to modify the existing methods, the only way that specific information can be obtained is through onsite visitations and discussions with the maintenance personnel directly associated with a given aircraft system.

3. The existing coverage and description of aircraft structures in the AFM66-1 system is not detailed enough to permit identification of specific problems. This is due to the lack of any criteria for the assignment of work unit codes (WUC) for structural elements at time

of design and manufacture. The "how malfunction codes" (HMC) and "action taken codes" (ATC) are not sufficiently defined and/or described to ensure that the data reported can be analyzed to produce adequate identification of problem causes, occurrences, and corrective actions required. For example, how malfunction code 070 designates "broken," and HMC 111 designates "burst" or "broken." The existing instructions in the WUC manuals used by maintenance personnel do not provide adequate explanation on their applications. Similarly, ATC "F" designates "repair," and ATC "G" designates "repair or replace." ATC "P" designates "remove," and ATC "R" designates "remove and replace." These codes were initially developed for use on line replaceable units (LRU's) where subsystem technicians have been fully trained in the utilization of the HMC and ATC items that apply to replaceable equipment. Unfortunately, no clear-cut ground rules are available for structure repair and replacement.

RECOMMENDATIONS

From the results of the study, and the conclusions drawn, certain recommendations have been developed. They are presented for two basic areas. The first of these are those recommendations for cost savings on existing aircraft systems. The second set of recommendations are for improvements in the reporting of aircraft structure maintenance and repair efforts on existing and future aircraft that will permit adequate analysis of aircraft structure conditions and problems so that profitable improvements may be initiated in a systematic and timely fashion.

1. Based upon the results of the design and life cycle cost research and analysis conducted on the selected critical items in this program, it is recommended that their implementation be considered by the specific aircraft system managers. Information and briefings to these activities have been provided by AFFDL/FBS for their information and review.

2. A number of other candidate structure improvement potentials have been identified in this program. It is recommended that consideration be given to additional design improvement studies to provide the Air Force with additional opportunities for life cycle cost savings on existing aircraft systems.

3. The AFM66-1 maintenance reporting system has not been effectively applied to aircraft structure use. Significant system management insights and cost savings could be realized if adequate information

could be provided to these offices. It is recommended that a study be conducted to analyze the improvements that can be developed in the use of the AFM66-1 system for existing and future aircraft structure maintenance and repair monitoring. Elements that should be included in this study are:

- Criteria established for assignment of work unit code (WUC) identification of structure elements in future aircraft.

- Criteria and guidance for use and/or improvement of how malfunction codes and action taken codes.

- Criteria for establishment of WUC to aircraft part number cross indexes to facilitate and improve AFM66-1 reporting accuracy. Such indexes are currently employed by the U.S. Navy in their 3M maintenance reporting system.

- Conduct an analysis for the use of AFM66-1 reporting system in certain repair categories by the Air Logistics Centers so that significant repair information would be available for analysis and review by the aircraft system managers. This approach is being used by the U.S. Navy with the 3M system.

APPENDIX

CANDIDATE CRITICAL ITEMS

SUMMARY SHEETS

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL A-7D
WUC - 11AEE
TITLE: PANEL GUN
STAB. ACCESS

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	F	1	1	020		8			3.8	4					OVERALL STRUCTURE
G	F	5	5	070			1	23						X	AIRFRAME
G	M	2	2	105											LDG GEAR
G	M	3	3	106											FL. CONT.
				111											OTHER
				116											PRIMARY
				117			1	7					X		SECONDARY
				135											OTHER
				170											FORGING
				190											CASTING
				425			1	10				X			SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
G	M	4	4	660											H. COMB
				731											ASSY
				780											OTHER
				846			1	18			X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
G	M			SUMMARY											

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

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N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
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ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL A-7D
WUC - 13 ABC
TITLE: TRUNNION MLG
SHOCK STRUT

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
R	F	1	1	020		22			0.3	26					OVERALL STRUCTURE
G	M	3	3	070											AIRFRAME
G	M	2	2	105			1	1						X	LDG GEAR
G	M	3	3	106											FL. CONT.
				111											OTHER
				116			84	61					X		PRIMARY
				117											SECONDARY
				135											OTHER
				170											FORGING
R	F	1	2	190											CASTING
				425											SHEET
				520			4	3				X			PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780											OTHER
				846											ALUM.
				878			12	10			X				STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
G	M			SUMMARY											

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
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C - IN-FLIGHT - ABORT
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G - GROUND ALERT - NOT DEGRADED
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J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL A-7D
WUC - 14EAJ
TITLE: HORIZONTAL STAB. PIVOT BEARING

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
R	S	3	3	020		26			32.4	25					OVERALL STRUCTURE
				070											AIRFRAME
				105											LDG GEAR
				106			3	2						X	FL. CONT.
				111											OTHER
				116			76	53					X		PRIMARY
R	S	1	1	117											SECONDARY
				135											OTHER
				170											FORGING
R	S	2	2	190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR.
				660											H. COMB
				731			1	1				X			ASSY
				780											OTHER
				846											ALUM.
				878			10	8			X				STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
R	S			SUMMARY											

AIRCRAFT MODEL B-52-H

WUC - 11EMA

TITLE: BOMB BAY DOOR ASSY.

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	S	6	6	020					70.4	2					OVERALL STRUCTURE
G	H	2	4	070			2	17						X	AIRFRAME
G	H	3	2	105											LDG GEAR
F	S	4	3	106											FL. CONT.
				111											OTHER
				116											PRIMARY
R	F	8	7	117			1	7					X		SECONDARY
				135											OTHER
N	Q	5	3	170											FORGING
G	S	1	1	190											CASTING
				425			1	13				X			SHEET
				520											PLATE
F	M	9	7	540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
R	H	7	5	780											OTHER
				846											ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935			1	3			X				MAGNESIUM
				947											COMBINATION
															TRANSPARENT
G	S/M			SUMMARY											

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES

A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES

F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

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N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL B-52-H
WUC - 11 EMB
TITLE: PANEL INSI
SKIN BOMB DOOR

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
F	M	4	5	020		16			47.8	8					OVERALL STRUCTURE
G	H	7	8	070			11	1						X	AIRFRAME
G	M	1	1	105											LDG GEAR
G	M	3	3	106											FL. CONT.
				111											OTHER
				116											PRIMARY
				117			2	1					X		SECONDARY
				135											OTHER
N	M	5	4	170											FORGING
G	M	2	2	190											CASTING
				425			5	6				X			SHEET
				520											PLATE
F	M	9	8	540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
G	H	6	6	780											OTHER
				846											ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935			3	1			X				MAGNESIUM
G	F	8	7	947											COMBINATION
															TRANSPARENT
G	M			SUMMARY											

AIRCRAFT MODEL B-52

WUC -

TITLE: URINAL AREA

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES	IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	STRUCTURE
				020										OVERALL STRUCTURE
				070									X	AIRFRAME
				105										LOG GEAR
				106										FL. CONT.
				111										OTHER
				116								X		PRIMARY
				117										SECONDARY
				135										OTHER
				170										FORGING
				190										CASTING
				425										SHEET
				520										PLATE
				540										ROD
				585										BOLTS & FAST
				605										EXTR:
				660										H. COMB
				731							X			ASSY
				780										OTHER
				846						X				ALUM.
				878										STEEL
				910										TITAN
				917										FIBERGLAS
				935										MAGNESIUM
				947										COMBINATION
														TRANSPARENT
				SUMMARY										

(NOT IN AFM66-1 DATA)

AIRCRAFT MODEL C-5A

WUC - 11 DAD

TITLE: PAD RAMP SUPPORT, FWD RAMP

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WD DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES	IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
X	M	6	5	020	5			13.0	7					OVERALL STRUCTURE
R	F	2	2	070		5	8						X	AIRFRAME
G	K	3	3	105										LDG GEAR
G	F	1	1	106										FL. CONT.
				111										OTHER
				116										PRIMARY
				117										SECONDARY
Y	F	4	5	135		1	1					X		OTHER
Z	M	4	4	170										FORGING
				190										CASTING
				425										SHEET
				520										PLATE
				540										ROD
				585										BOLTS & FAST
				605										EXTR:
G	H	5	5	660										H. COMB
				731		2	1				X			ASSY
				780										OTHER
				846										ALUM.
				878										STEEL
				910										TITAN
				917										FIBERGLAS
				935										MAGNESIUM
				947		1	1			X				COMBINATION
														TRANSPARENT
G	F/M			SUMMARY										

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES

- A - BEFORE FLIGHT - ABORT
- B - BEFORE FLIGHT - NO ABORT
- C - IN-FLIGHT - ABORT
- D - IN-FLIGHT - NO ABORT
- E - AFTER FLIGHT - AIR CREW
- F - BETWEEN FLIGHTS - GROUND
- G - GROUND ALERT - NOT DEGRADED
- H - BASIC POST FLIGHT
- J - PREFLIGHT INSP
- K - POST FLIGHT INSP
- M - PERIODIC/PHASED INSP
- N - GROUND ALERT - DEGRADED
- P - FUNCTIONAL CHECKFLIGHT
- Q - SPECIAL INSP
- R - QUALITY CONTROL CHECK
- S - DEPOT LEVEL MAINTENANCE
- U - NON-DESTRUCT INSP

ACTION TAKEN CODES

- F - REPAIR
- G - REPAIR OR REPLACE
- L - ADJUST
- P - REMOVE
- Q - INSTALL
- R - REMOVE AND REPLACE
- X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL C-5A

WUC - 14LLB

TITLE: DOOR ASSY LE ACTUATOR SLAT WING

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020		24			27.0	1					OVERALL STRUCTURE
R	M	3	4	070			1	1						X	AIRFRAME
G	M	2	2	105											LDG GEAR
G	M	1	1	106											FL. CONT.
				111											OTHER
				116											PRIMARY
G	M	6	5	117			1	1					X		SECONDARY
				135											OTHER
				170											FORGING
Y	F	5	6	190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731			1	1				X			ASSY
				780											OTHER
G	M	7	7	846			1	1			X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
G	M	4	3	947											COMBINATION
															TRANSPARENT
G	M			SUMMARY											

AIRCRAFT MODEL C-5A

WUC - 23EBB,C,D,&E

TITLE: ENGINE COWL

DOOR HINGE

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020											OVERALL STRUCTURE
				070										X	AIRFRAME
				105											LDG GEAR
				106											FL. CONT.
				111											OTHER
				116											PRIMARY
				117									X		SECONDARY
				135											OTHER
				170								X			FORGING
				190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780											OTHER
				846											ALUM.
				878							X				STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
				SUMMARY											

(NOT RANKED WITH AFM66-1 DATA)

AIRCRAFT MODEL C-130

WUC - 11271

TITLE: FRAME MLG DOOR

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	M	5	6	020		2			250	5					OVERALL STRUCTURE
G	M	7	5	070			14	1						X	AIRFRAME
G	M	1	1	105											LDG GEAR
G	M	3	3	106											FL. CONT.
				111											OTHER
G	M	13	9	116											PRIMARY
G	M	8	8	117			3	1					X		SECONDARY
G	H	16	14	135											OTHER
N	S	9	10	170											FORGING
G	M	2	2	190											CASTING
G	S	17	13	425			1	1				X			SHEET
				520											PLATE
G	H	10	11	540											ROD
				585											BOLTS & FAST
				605											EXTR:
G	F	14	14	660											H. COMB
				731											ASSY
G	M	4	4	780											OTHER
G	M	11	12	846			4	2			X				ALUM.
				878											STEEL
G	F/M	15	13	910											TITAN
				917											FIBERGLAS
G	S	12	13	935											MAGNESIUM
G	M	6	7	947											COMBINATION
															TRANSPARENT
G	M			SUMMARY											

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL C-141A

WUC - 12 CAZ

TITLE: CARGO TIE-DOWN FTG (25,000 LB)

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES
- A - BEFORE FLIGHT - ABORT
- B - BEFORE FLIGHT - NO ABORT
- C - IN-FLIGHT - ABORT
- D - IN-FLIGHT - NO ABORT
- E - AFTER FLIGHT - AIR CREW
- F - BETWEEN FLIGHTS - GROUND
- G - GROUND ALERT - NOT DEGRADED
- H - BASIC POST FLIGHT
- J - PREFLIGHT INSP
- K - POST FLIGHT INSP
- M - PERIODIC/PHASED INSP
- N - GROUND ALERT - DEGRADED
- P - FUNCTIONAL CHECKFLIGHT
- Q - SPECIAL INSP
- R - QUALITY CONTROL CHECK
- S - DEPOT LEVEL MAINTENANCE
- U - NON-DESTRUCT INSP

ACTION TAKEN CODES
- F - REPAIR
- G - REPAIR OR REPLACE
- L - ADJUST
- P - REMOVE
- Q - INSTALL
- R - REMOVE AND REPLACE
- X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IRDS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM.	STRUCT. IMPORTANCE	TYPE STRUCTURE	
R	M	8	7	020		11			0.8	20					OVERALL STRUCTURE
G	F	5	4	070			89	63						X	AIRFRAME
G	F	2	2	105											LDG GEAR
G	M	6	6	106											FL. CONT.
				111											OTHER
				116			38	26					X		PRIMARY
				117											SECONDARY
G	F	4	3	135											OTHER
G	S	1	5	170			9	1				X			FORGING
Y	U	3	1	190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780											OTHER
				846			81	56			X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
F	M	7	8	947											COMBINATION
															TRANSPARENT
G	M/F			SUMMARY											

AIRCRAFT MODEL C-141A

WUC - 23PQZ

TITLE: AFT COWL DOOR, LEFT

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	MDW MAL. CODES		IRDS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	M	3	3	020		19			173	2					OVERALL STRUCTURE
G	K	7	7	070			5	1						X	AIRFRAME
G	M	1	1	105											LOG GEAR
G	K	4	5	106											FL. CONT.
R	C	10	10	111											OTHER
R	M	13	14	116											PRIMARY
G	M	9	9	117			2	1					X		SECONDARY
G	K	17	13	135											OTHER
G	M	14	12	170											FORGING
G	M	2	2	190											CASTING
G	M	16	14	425											SHEET
				520											PLATE
G	C	8	8	540											ROD
				585											BOLTS & FAST
				605											EXTR:
R	M	12	9	660											H. COMB
				731			2	1				X			ASSY
G	K	6	4	780											OTHER
G	F	11	9	846											ALUM.
				878											STEEL
G	K	15	11	910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
R	D	5	6	947			2	1			X				COMBINATION
															TRANSPARENT
G	M			SUMMARY											

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL KC-135
WUC - 1114H
TITLE: COPILOT NO. 1
WINDOW

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020		6			2.4	6					OVERALL STRUCTURE
R	F.	4	6	070			7	36						X	AIRFRAME
G	F	6	3	105											LOG GEAR
				106											FL. CONT.
				111											OTHER
				116											PRIMARY
G	M	5	2	117			5	36					X		SECONDARY
				135											OTHER
2	4	7	6	170											FORGING
R	B	1	1	190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780			2	7				X			OTHER
R	F	2	4	846											ALUM.
				878											STEEL
R	D	3	5	910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
							2	3			X				TRANSPARENT
R	F			SUMMARY											

AIRCRAFT MODEL KC-135

WUC - 1114N

TITLE: PILOT NO. 1 WINDOW

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020		7			3.1	4					OVERALL STRUCTURE
R	D	6	4	070			6	43						X	AIRFRAME
G R	B D R	7	3	105											LDG GEAR
Q	M	9	4	106											FL. CONT.
				111											OTHER
				116											PRIMARY
R	F	3	2	117			4	31					X		SECONDARY
				135											OTHER
R	F	8	5	170											FORGING
R	F	1	1	190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
R	D	4	4	605											EXTR:
				660											H. COMB
				731											ASSY
				780			1	5				X			OTHER
R	B	2	3	846											ALUM.
				878											STEEL
R	F	4	4	910											TITAN
				917											FIBERGLAS
R	B	5	5	935											MAGNESIUM
				947											COMBINATION
							1	1			X				TRANSPARENT
R	F			SUMMARY											

CODE NOMENCLATURE

020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES

A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES

F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL KC-135

WUC - 14 ADA

TITLE: TAB ASSY

INBD AILERON

CODE NOMENCLATURE
- 020 WORN, CHAFED, OR FRAYED
- 070 BROKEN
- 105 LOOSE OR DAMAGED BOLTS
- 106 MISSING BOLTS, SCREWS,
- 111 BURST OR BROKEN
- 116 CUT
- 117 DETERIORATED
- 135 BENDING, STUCK, OR JAMMED
- 170 CORRODED
- 190 CRACKED
- 425 NICKED
- 520 PITTED
- 540 PUNCTURED
- 585 SHEARED
- 605 CRAZED
- 660 STRIPPED
- 731 BATTLE DAMAGE
- 780 BENT, BUCKLED, COLLAPSED
- 846 DELAMINATED
- 878 WEATHER DAMAGE
- 910 CHIPPED
- 917 IMPENDING FAILURE
- 935 SCORED OR SCRATCHED
- 947 TORN

WHEN DISCOVERED CODES
- A - BEFORE FLIGHT - ABORT
- B - BEFORE FLIGHT - NO ABORT
- C - IN-FLIGHT - ABORT
- D - IN-FLIGHT - NO ABORT
- E - AFTER FLIGHT - AIR CREW
- F - BETWEEN FLIGHTS - GROUND
- G - GROUND ALERT - NOT DEGRADED
- H - BASIC POST FLIGHT
- J - PREFLIGHT INSP
- K - POST FLIGHT INSP
- M - PERIODIC/PHASED INSP
- N - GROUND ALERT - DEGRADED
- P - FUNCTIONAL CHECKFLIGHT
- Q - SPECIAL INSP
- R - QUALITY CONTROL CHECK
- S - DEPOT LEVEL MAINTENANCE
- U - NON-DESTRUCT INSP

ACTION TAKEN CODES
- F - REPAIR
- G - REPAIR OR REPLACE
- L - ADJUST
- P - REMOVE
- Q - INSTALL
- R - REMOVE AND REPLACE
- X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHES. WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES	IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
R	H	1	2	020	15			4.0	2					OVERALL STRUCTURE
R	M	5	6	070		8	7						X	AIRFRAME
L	H	2	1	105										LOG GEAR
G	M	11	9	106										FL. CONT.
				111										OTHER
				116										PRIMARY
R	F	8	7	117		6	7					X		SECONDARY
P	C	9	9	135										OTHER
R	F	6	5	170										FORGING
R	F	4	4	190										CASTING
				425										SHEET
				520										PLATE
				540										ROD
P	F	10	10	585										BOLTS & FAST
				605										EXTR:
				660		3	6				X			H. COMB
				731										ASSY
R	B	7	8	780										OTHER
R	F	3	3	846		5	5			X				ALUM.
				878										STEEL
				910										TITAN
				917										FIBERGLAS
				935										MAGNESIUM
				947										COMBINATION
														TRANSPARENT
				SUMMARY										
R	F													

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	AIRCRAFT MODEL KC-135 WUC - 118AP TITLE: STRUT SUPPORT FITTING ENGINE
				020		10			0.03	26					OVERALL STRUCTURE
R	M	2	2	070			138	148						X	AIRFRAME
				105											LDG GEAR
				106											FL. CONT.
				111											OTHER
				116			19	19					X		PRIMARY
				117											SECONDARY
				135											OTHER
Z	Q	4	2	170											FORGING
X	F	1	1	190											CASTING
				425											SHEET
				520											PLATE
				540			2	2				X			ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780											OTHER
				846											ALUM.
				878			5	6			X				STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
F	F	3	2	947											COMBINATION
															TRANSPARENT
ALL	F			SUMMARY											

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL KC-135
WUC -
TITLE: OUTER WING
ATTACH RIBS

(NOT IN AFM66-1 DATA)

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020											OVERALL STRUCTURE
				070										X	AIRFRAME
				105											LDG GEAR
				106											FL. CONT.
				111											OTHER
				116									X		PRIMARY
				117											SECONDARY
				135											OTHER
				170								X			FORGING
				190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780											OTHER
				846							X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
				SUMMARY											

AIRCRAFT MODEL F-4 WUC - 1123E TITLE: WINGTIP FOLD RIB (OUTER)	OVERALL STRUCTURE	AIRFRAME	LOG GEAR	FL. CONT.	OTHER	PRIMARY	SECONDARY	OTHER	FORGING	CASTING	SHEET	PLATE	ROD	BOLTS & FAST	EXTR:	H. COMB	ASSY	OTHER	ALUM.	STEEL	TITAN	FIBERGLAS	MAGNESIUM	COMBINATION	TRANSPARENT		
TYPE STRUCTURE		X																									
STRUCT. IMPORTANCE						X																					
PART FORM									X																		
PART MATERIAL																			X								
WUC-MMH/FH RANK	26																										
VALUE MMH/1000FH	1.9																										
MDR RANKING		60				13			2										42								
MMH RANKING		75				16			3										61								
IROS COST RANKINGS	18																										
HOW MAL. CODES	020	070	105	106	111	116	117	135	170	190	425	520	540	585	605	660	731	780	846	878	910	917	935	947			SUMMARY
HMC-MDR RANK	6	9	1	2		10	7	10	3	4						8		5	8					9			
HMC-MMH RANK	6	10	1	4		12	10	11	3	2						8		5	7					9			
HIGHEST WH DISC. CODE	S	M	F	M		M	M	F	S	M						H		M	S					M			M
HIGHEST ACT. TAKEN CODE	G	G	G	G		R	G	G	F	F						G		G	G					G			G

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
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M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL F-4D
WUC - 1323F
TITLE: INBOARD DOOR MLG

HIGHEST ACT. TAKEN CODE	HIGHEST WD DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES	IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
F	S	2	3	020	20	13		16.9	16					OVERALL STRUCTURE
F	S	5	6	070										AIRFRAME
G	M	1	1	105		1	1						X	LOG GEAR
G	F	4	4	106										FL. CONT.
				111										OTHER
				116										PRIMARY
G	S	6	7	117										SECONDARY
E	S	11	11	135		2	1					X		OTHER
F	S	13	11	170										FORGING
F	S	3	2	190										CASTING
G	F	14	10	425										SHEET
				520										PLATE
G	F	8	9	540										ROD
				585										BOLTS & FAST
				605										EXTR:
				660										H. COMB
				731		15	9				X			ASSY
F	S	7	5	780										OTHER
G	F	9	8	846		11	8			X				ALUM.
				878										STEEL
G	M	10	8	910										TITAN
				917										FIBERGLAS
F	S	15	12	935										MAGNESIUM
G	M	12	9	947										COMBINATION
														TRANSPARENT
F/G	S			SUMMARY										

AIRCRAFT MODEL F-4D WUC - 1431B TITLE: STABILATOR STEEL TRAILING EDGE	OVERALL STRUCTURE	AIRFRAME	LOG GEAR	FL. CONT.	OTHER	PRIMARY	SECONDARY	OTHER	FORGING	CASTING	SHEET	PLATE	ROD	BOLTS & FAST	EXTR:	H. COMB	ASSY	OTHER	ALUM.	STEEL	TITAN	FIBERGLAS	MAGNESIUM	COMBINATION	TRANSPARENT
TYPE STRUCTURE				X																					
STRUCT. IMPORTANCE							X																		
PART FORM																X									
PART MATERIAL																				X					
WUC-MMH/FH RANK	3																								
VALUE MMH/1000FH	31.2																								
MDR RANKING				6			21									1				3					
MMH RANKING				3			3									1				1					
IROS COST RANKINGS	23																								

HOW MAL. CODES	020	070	105	106	111	116	117	135	170	190	425	520	540	585	605	660	731	780	846	878	910	917	935	947	SUMMARY
HMC-MDR RANK	10	9	1	3			4	11	7	2			10		11			5	6					8	
HMC-MMH RANK	11	10	2	4			5	12	3	1			9		13			8	6					7	
HIGHEST WM DISC. CODE	M	M	M	F			S	M	S	F			M		M			S	S					S	M
HIGHEST ACT. TAKEN CODE	G	G	G	G			F	L	F	G			G		G			F	F					F	G

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL F-4J

WUC -

TITLE: FLOOR SKIN FUEL TANKS 4, 5 & 6

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES
- A - BEFORE FLIGHT - ABORT
- B - BEFORE FLIGHT - NO ABORT
- C - IN-FLIGHT - ABORT
- D - IN-FLIGHT - NO ABORT
- E - AFTER FLIGHT - AIR CREW
- F - BETWEEN FLIGHTS - GROUND
- G - GROUND ALERT - NOT DEGRADED
- H - BASIC POST FLIGHT
- J - PREFLIGHT INSP
- K - POST FLIGHT INSP
- M - PERIODIC/PHASED INSP
- N - GROUND ALERT - DEGRADED
- P - FUNCTIONAL CHECKFLIGHT
- Q - SPECIAL INSP
- R - QUALITY CONTROL CHECK
- S - DEPOT LEVEL MAINTENANCE
- U - NON-DESTRUCT INSP

ACTION TAKEN CODES
- F - REPAIR
- G - REPAIR OR REPLACE
- L - ADJUST
- P - REMOVE
- Q - INSTALL
- R - REMOVE AND REPLACE
- X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES	IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK
				020					
				070					
				105					
				106					
				111					
				116					
				117					
				135					
				170					
				190					
				425					
				520					
				540					
				585					
				605					
				660					
				731					
				780					
				846					
				878					
				910					
				917					
				935					
				947					
				SUMMARY					

(NOT IN AFM66-1 DATA)

	TYPE STRUCTURE	STRUCT. IMPORTANCE	PART FORM	PART MATERIAL
OVERALL STRUCTURE				
AIRFRAME	X			
LDG GEAR				
FL. CONT.				
OTHER				
PRIMARY		X		
SECONDARY				
OTHER				
FORGING				
CASTING				
SHEET			X	
PLATE				
ROD				
BOLTS & FAST				
EXTR:				
H. COMB				
ASSY				
OTHER				
ALUM.				X
STEEL				
TITAN				
FIBERGLAS				
MAGNESIUM				
COMBINATION				
TRANSPARENT				

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES

- A - BEFORE FLIGHT - ABORT
- B - BEFORE FLIGHT - NO ABORT
- C - IN-FLIGHT - ABORT
- D - IN-FLIGHT - NO ABORT
- E - AFTER FLIGHT - AIR CREW
- F - BETWEEN FLIGHTS - GROUND
- G - GROUND ALERT - NOT DEGRADED
- H - BASIC POST FLIGHT
- J - PREFLIGHT INSP
- K - POST FLIGHT INSP
- M - PERIODIC/PHASED INSP
- N - GROUND ALERT - DEGRADED
- P - FUNCTIONAL CHECKFLIGHT
- Q - SPECIAL INSP
- R - QUALITY CONTROL CHECK
- S - DEPOT LEVEL MAINTENANCE
- U - NON-DESTRUCT INSP

ACTION TAKEN CODES

- F - REPAIR
- G - REPAIR OR REPLACE
- L - ADJUST
- P - REMOVE
- Q - INSTALL
- R - REMOVE AND REPLACE
- X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL F-4
WUC -
TITLE: NOSE LG
DRAG BRACE FTTG

(NOT IN AFM66-1 DATA)

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020											OVERALL STRUCTURE
				070										X	AIRFRAME
				105											LDG GEAR
				106											FL. CONT.
				111											OTHER
				116									X		PRIMARY
				117											SECONDARY
				135											OTHER
				170								X			FORGING
				190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731											ASSY
				780											OTHER
				846							X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
				SUMMARY											

AIRCRAFT MODEL FB-111A
WUC - 11 AAK
TITLE: COVER ACCESS FUS. NOSE SECTION

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WD DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	F	5	4	020		1			23.2	6					OVERALL STRUCTURE
G	F	6	4	070			6	3						X	AIRFRAME
G	F	1	1	105											LDG GEAR
G	F	2	2	106											FL. CONT.
				111											OTHER
				116											PRIMARY
				117			4	3					X		SECONDARY
				135											OTHER
				170											FORGING
G	L	4	4	190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660			2	2				X			H. COMB
				731											ASSY
G	S	3	3	780											OTHER
G	H	7	4	846			1	1			X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
G	H	8	5	947											COMBINATION
															TRANSPARENT
G	F			SUMMARY											

AIRCRAFT MODEL FB111A
WUC - 11AGD
TITLE: COVER
STAB. ACCESS

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020		11			12.3	3					OVERALL STRUCTURE
G	M	5	5	070			4	2						X	AIRFRAME
G	M	1	1	105											LOG GEAR
G	M	2	3	106											FL. CONT.
				111											OTHER
				116			3	1					X		PRIMARY
				117											SECONDARY
G	M	3	2	135											OTHER
				170											FORGING
				190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
G	M	4	4	660											H. COMB
				731			2	1				X			ASSY
G	R	6	6	780											OTHER
				846			4	2			X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
G	M			SUMMARY											

AIRCRAFT MODEL FB-111
WUC - 11BBC
TITLE: PYLON PIVOT BEARING HOUSING

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WM DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020		25			3.3	26					OVERALL STRUCTURE
G	F	3	3	070											AIRFRAME
G	F	1	1	105											LDG GEAR
G	F	2	2	106											FL. CONT.
				111			1	1						X	OTHER
				116											PRIMARY
				117											SECONDARY
				135			1	1					X		OTHER
				170											FORGING
				190											CASTING
				425											SHEET
				520											PLATE
				540											ROD
				585											BOLTS & FAST
				605											EXTR:
				660											H. COMB
				731			1	1				X			ASSY
				780											OTHER
				846			19	15			X				ALUM.
				878											STEEL
				910											TITAN
				917											FIBERGLAS
				935											MAGNESIUM
				947											COMBINATION
															TRANSPARENT
G	F			SUMMARY											

AIRCRAFT MODEL T-37

WUC -

TITLE: ENGINE TAILPIPE CLAMP

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	HMC-MMH RANK	HMC-MDR RANK	HOW MAL. CODES	IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
				020										OVERALL STRUCTURE
				070										AIRFRAME
				105			(NOT IN AFM 66-1 DATA)							LOG GEAR
				106										FL. CONT.
				111									X	OTHER
				116										PRIMARY
				117										SECONDARY
				135								X		OTHER
				170										FORGING
				190										CASTING
				425							X			SHEET
				520										PLATE
				540										ROD
				585										BOLTS & FAST
				605										EXTR:
				660										H. COMB
				731										ASSY
				780										OTHER
				846										ALUM.
				878						X				STEEL
				910										TITAN
				917										FIBERGLAS
				935										MAGNESIUM
				947										COMBINATION
														TRANSPARENT
				SUMMARY										

CODE NOMENCLATURE
020 WORN, CHAFED, OR FRAYED
070 BROKEN
105 LOOSE OR DAMAGED BOLTS
106 MISSING BOLTS, SCREWS,
111 BURST OR BROKEN
116 CUT
117 DETERIORATED
135 BENDING, STUCK, OR JAMMED
170 CORRODED
190 CRACKED
425 NICKED
520 PITTED
540 PUNCTURED
585 SHEARED
605 CRAZED
660 STRIPPED
731 BATTLE DAMAGE
780 BENT, BUCKLED, COLLAPSED
846 DELAMINATED
878 WEATHER DAMAGE
910 CHIPPED
917 IMPENDING FAILURE
935 SCORED OR SCRATCHED
947 TORN

WHEN DISCOVERED CODES
A - BEFORE FLIGHT - ABORT
B - BEFORE FLIGHT - NO ABORT
C - IN-FLIGHT - ABORT
D - IN-FLIGHT - NO ABORT
E - AFTER FLIGHT - AIR CREW
F - BETWEEN FLIGHTS - GROUND
G - GROUND ALERT - NOT DEGRADED
H - BASIC POST FLIGHT
J - PREFLIGHT INSP
K - POST FLIGHT INSP
M - PERIODIC/PHASED INSP
N - GROUND ALERT - DEGRADED
P - FUNCTIONAL CHECKFLIGHT
Q - SPECIAL INSP
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
U - NON-DESTRUCT INSP

ACTION TAKEN CODES
F - REPAIR
G - REPAIR OR REPLACE
L - ADJUST
P - REMOVE
Q - INSTALL
R - REMOVE AND REPLACE
X - TEST, INSPECT-SERVICE

AIRCRAFT MODEL T-38
WUC - 11563
TITLE: FIREWALL, AFT FUS

CODE	NOMENCLATURE
020	WORN, CHAFED, OR FRAYED
070	BROKEN
105	LOOSE OR DAMAGED BOLTS
106	MISSING BOLTS, SCREWS,
111	BURST OR BROKEN
116	CUT
117	DETERIORATED
135	BENDING, STUCK, OR JAMMED
170	CORRODED
190	CRACKED
425	NICKED
520	PITTED
540	PUNCTURED
585	SHEARED
605	CRAZED
660	STRIPPED
731	BATTLE DAMAGE
780	BENT, BUCKLED, COLLAPSED
846	DELAMINATED
878	WEATHER DAMAGE
910	CHIPPED
917	IMPENDING FAILURE
935	SCORED OR SCRATCHED
947	TORN

WHEN DISCOVERED CODES
- A - BEFORE FLIGHT - ABORT
- B - BEFORE FLIGHT - NO ABORT
- C - IN-FLIGHT - ABORT
- D - IN-FLIGHT - NO ABORT
- E - AFTER FLIGHT - AIR CREW
- F - BETWEEN FLIGHTS - GROUND
- G - GROUND ALERT - NOT DEGRADED
- H - BASIC POST FLIGHT
- J - PREFLIGHT INSP
- K - POST FLIGHT INSP
- M - PERIODIC/PHASED INSP
- N - GROUND ALERT - DEGRADED
- P - FUNCTIONAL CHECKFLIGHT
- Q - SPECIAL INSP
- R - QUALITY CONTROL CHECK
- S - DEPOT LEVEL MAINTENANCE
- U - NON-DESTRUCT INSP

ACTION TAKEN CODES
- F - REPAIR
- G - REPAIR OR REPLACE
- L - ADJUST
- P - REMOVE
- Q - INSTALL
- R - REMOVE AND REPLACE
- X - TEST, INSPECT-SERVICE

HIGHEST ACT. TAKEN CODE	HIGHEST WH DISC. CODE	MMC-MMH RANK	MMC-MDR RANK	HOW MAL. CODES		IROS COST RANKINGS	MMH RANKING	MDR RANKING	VALUE MMH/1000FH	WUC-MMH/FH RANK	PART MATERIAL	PART FORM	STRUCT. IMPORTANCE	TYPE STRUCTURE	
G	M	6	4	020		17			13.9	2					OVERALL STRUCTURE
G	M	5	5	070			2	1						X	AIRFRAME 1
G	M	2	2	105											LDG GEAR 2
G	M	3	3	106											FL. CONT. 3
P	F	12	12	111											OTHER 4
				116											PRIMARY 1
G	M	11	11	117			1	1					X		SECONDARY 2
G	M	8	9	135											OTHER 3
				170											FORGING 1
G	M	1	1	190											CASTING 2
				425			1	1				X			SHEET 3
				520											PLATE 4
G	F	10	10	540											ROD 5
				585											BOLTS & FAST 6
				605											EXTR: 7
G	M	9	7	660											H. COMB 8
				731											ASSY 9
G	M	7	8	780											OTHER 10
G	M	14	13	846											ALUM. 1
G	M	13	13	878											STEEL 2
				910			1	1			X				TITAN 3
				917											FIBERGLAS 4
				935											MAGNESIUM 5
G	M	4	6	947											COMBINATION 6
															TRANSPARENT 7
G	M			SUMMARY											

☆ U. S. GOVERNMENT PRINTING OFFICE: 1977 — 757-001/351

UNCLASSIFIED

AD B018696

AUTHORITY: AFWAL

ltr, 13 OCT 81

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