AD-A286 965

WL-TR-97-3093

CORROSION AND FATIGUE STUDY OF JSTARS AIRCRAFT

Volume I

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APRIL 1997

FINAL REPORT - 3 JUL 96 - 3 APR 97

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
April 1997

3. REPORT TYPE AND DATES COVERED
Final, 03 July 96 - 03 April 97

4. TITLE AND SUBTITLE
Corrosion and Fatigue Study of JSTARS Aircraft
Volume I

5. FUNDING NUMBERS
CF 33615-95-D-3215
PE 62201
PR 2401
TA 55
WU 00

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Northrop Grumman Corporation
Military Aircraft System Division
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8. PERFORMING ORGANIZATION REPORT NUMBER
NOR 97-809

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Flight Dynamics Directorate
Wright Laboratory
Air Force Materiel Command
Wright Patterson AFB, OH 45433-7542
POC: CAPT. DANIEL J. GRONER, WL/FIBA (937) 255-5664

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
WL-TR-97-3093

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for Public Release;
Distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
Findings and supporting information from a survey performed in two E8-C Joint STARS aircraft are presented. An access database was formed recording corrosion and fatigue damage from a survey of the teardown documentation of the third and fourth production Joint STARS aircraft. Analysis and commentary on the database are presented. Emphasis was placed on corrosion and fatigue damage of primary structural elements.

14. SUBJECT TERMS
Corrosion, fatigue, JSTARS, E8C, 707, Database

15. NUMBER OF PAGES
158

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

FOREWORD

This report is for work performed under Contract F33615-95-D-3215. The work was administered under the technical direction of Capt. Daniel Groner (WL/FIBA), Wright Laboratory, Wright-Patterson AFB, Ohio 45433-7542.

The contractor was Northrop Grumman Corporation, Military Aircraft System Division, El Segundo, California, 90248. The program manager --- Mr. A. K. Pun. The Northrop Grumman Joint STARS aircraft production personne. . -e Lake Charles, La. and Melbourne, Fla. facilities also provided technical guidance and access to the JSTARS program records.

TABLE OF CONTENTS PAGE

VOLUME 1

VOLUME 2

TABLE OF FIGURES

TABLE OF TABLES

SECTION 1

INTRODUCTION

1.1 ABSTRACT

The operational readiness of an airborne weapon system is largely dependent on the condition of the aircraft structure. The inspection interval of an aircraft is based on the existence of a flaw in the most critical point subjected to a stress history representative of the typical usage of the aircraft. The effects of corrosion and widespread fatigue damage (WFD) are not taken into account in this damage tolerance approach. The first step towards accounting for corrosion and WFD on structural integrity is to survey aging aircraft fleets. Collected data can serve to help develop methods to characterize the interaction of corrosion and fatigue.

Aging aircraft, such as the Boeing 707-300 series, employed in the United States Air Force fleet often require extensive remanufacture to certify the aircraft for operational readiness. The remanufacture includes the identification and repair of areas of structures damaged by corrosion, fatigue, or a combination thereof. With a given aircraft type, the structural elements and areas of the aircraft most susceptible to corrosion and fatigue damage will usually be similar from aircraft to aircraft. The identification of these vulnerable structural elements, type of damage, and damage levels serve as a valuable tool in potentially streamlining the remanufacture process as well as providing data to a broader study of corrosion and fatigue interaction and the resultant effects on the load carrying capabilities of aircraft structures.

1.2 BACKGROUND

The Northrop Grumman Joint Surveillance Target Attack Radar System (Joint STARS), is a powerful airborne surveillance and target acquisition system that provides real-time, accurate information for peacekeeping or decision-making on the battlefield. A cooperative U. S. Air Force and Army program, Joint STARS is managed by the Air Force Materiel Command's Electronic Systems Center, located at Hanscom Air Force Base, Mass. From a standoff position, Joint STARS detects, locates, classifies, tracks, and targets potentially hostile ground movement in all weather. During operations, it is in constant communication through secure data links with Air Force command posts, Army mobile ground stations or centers of military analysis far from the point of conflict. Joint STARS can determine direction, speed and patterns of activity of ground vehicles and helicopters, thereby showing intent as well as content. It can track the evolution of conditions across borders, within a country in turmoil, or around disputed national boundaries. This information resource allows the U.S. and its allies to effectively manage a crisis before a conflict begins, rapidly apply military assets to counter a provocation or conduct a full war fighting scenario if required.

The airborne Joint STARS system includes radar, data processors, operator consoles, secure voice and data links, and other subsystems. Data from the radar sensor, which has a 24-foot-long antenna housed on the underside of the aircraft, is processed on board and displayed to airborne operators as moving or fixed target reports, target tracks, and synthetic aperture radar (SAR) images. This radar data report is distributed simultaneously for display and processing at Army ground stations.

The heart of the E-8C airborne platform is the radar system. Its unique design enables the Joint STARS radar to pick out moving or fixed targets from other types of objects on the ground. The antenna, which looks from either side of the aircraft, is mechanically swiveled and pointed to scan in elevation. The system, using Northrop Grumman-developed algorithms or processing techniques, electronically scans the antenna in azimuth to determine the location and heading of moving targets. These techniques are implemented through four high-speed data processors, each capable of performing more than 600 million operations per second. This processed information is further distributed to tactical operators throughout the aircraft by high-speed computer circuitry.

The Joint STARS production airframe is a Boeing 707-300 series aircraft. The 707 aircraft are remanufactured at Northrop Grumman's Louisiana Operations in Lake Charles, La. The electronics are installed and tested in the modified aircraft at the company's Integrations and Test Facility in Melbourne, Fla.

1.3 PROGRAM GOALS AND METHODOLOGY

The objective of this study is to determine which durability and damage tolerance (DADT) critical components on the Joint STARS aircraft are subjected to corrosion damage. A parallel objective is to identify other components subjected to corrosion that may reduce the residual strength below the limit load.

Inspection reports for the Joint STARS P-3 and P-4 aircraft were assembled, and data pertinent to corrosion and fatigue on principle structural elements was input into an ACCESS Database. This database was then organized to provide consistent nomenclature and the capability of effectively performing searches and queries to extract

Boeing Structural Repair Manual (SRM) for the 707 Intercontinental, gaps in the data related to material, part form, location, and loading direction were filled in when possible. A diskette with the ACCESS Database containing the information is provided with this report.

Included in the database are fields identifying, when possible, the following:

- Component Identification
- Location on the aircraft
- Material
- Manufacturing process
- Principle loading direction
- Corrosion protective scheme
- Inspection technique
- Presence of WFD

Data that was not available for inclusion into the JSTARS survey includes:

- "Kt *" design limit stress used in analysis
- Initial flaw size, location, and orientation
- Critical crack length
- Smallest detectable flaw
- Expected life
- Cause of corrosion and corrosion environment
- Description of WFD - crack coalescence, density, etc.

1.4 REPORT OVERVIEW

This report provides a summary of the Corrosion and Fatigue Study of the Joint STARS aircraft surveyed. These aircraft, designated P-3 and P-4, provide representative data regarding the state of corrosion and fatigue damage present in the airframes assigned to the Joint STARS program.

The following is provided as a brief overview of the report highlighting the contents and the information contained therein.

Section 1 INTRODUCTION provides an introduction to the Joint STARS program in general and specifically to this Corrosion and Fatigue Study. This section includes an abstract addressing the need for the study of corrosion and fatigue on aging aircraft, an introduction to the Joint STARS's role and capabilities, and a summary of the corrosion and fatigue study goals and methodology employed. General background information pertaining to the Joint STARS program and the Corrosion and Fatigue Study of JSTARS Aircraft is also provided.

Section 2 AIRCRAFT HISTORY provides a history of the aircraft assigned to the Joint STARS program. The information consists of previous owner, flight hours, flight cycles, and date of manufacture. Also included is more detailed information specific to the P-3 and P-4 aircraft. The information on the life and history of the airframes provides a basis for assessing the corrosion and fatigue damage.

Section 3 BOEING 707 STRUCTURAL DESCRIPTION describes the aircraft structures relevant to this report. Included in this section is a brief history of the Boeing 707 aircraft, a listing of abbreviations used in specifying aircraft locations, dimensional information, and listings and diagrams of sub-assemblies, aircraft zones, and principle structural elements. This section compiles figures and diagrams detailing the structures and locations of the Joint STARS aircraft relevant to the corrosion and fatigue study.

Section 4 CORROSION AND FATIGUE DAMAGE ANALYSIS is the main body of the report. The corrosion and fatigue damage sites on the P-3 and P-4 aircraft, catalogued in the included database, are all summarized in this section. The damage sites are segregated based on aircraft zone, location and type of structure effected as well as type of material involved. The levels and types of damage based on this segregation are summarized, highlighting highly damaged aircraft structures.

Section 5 P-3 AND P-4 SURVEY DATABASE DESCRIPTION is an introduction and overview of the database for the Joint STARS corrosion and fatigue study survey. This section includes a list of fields found in the database along with definitions and a sample of the data input form.

Section 6 TASK DESCRIPTIONS AND SERVICE BULLETINS is a listing of the task descriptions (TDs) and service bulletins (SBs) for the Boeing 707.

Section 7 NON SURVEY DAMAGE REPORTS is a summary of aircraft specific findings generated as part of the Joint STARS production process.

Section 8 STRUCTURAL LOADS AND PART FORM is an overview of the loading condition on and part form of major structural components on the aircraft.

Section 9 DURABILITY AND DAMAGE TOLERANCE ASSESSMENT ANALYSIS summarizes the DADT analysis on the Joint STARS aircraft. The existing analysis is a compilation of Boeing and USAF studies. Northrop Grumman is in the process of developing DADT analysis for the modifications and 60 non-standard repairs as well as extending the existing finite element model (FEM) to incorporate a greater portion of the aircraft.

Section 10 FLAW SIZE INFORMATION is a summary of the critical flaw sizes by inspection used in the aircraft structural integrity program for the JSTARS aircraft and their effect on critical flaw size analysis.

Section 11 CONCLUSIONS summarizes the findings of the survey.

Section 12 RECOMMENDATIONS makes recommendations for additional studies to expand on the findings of this study.

Section 13 REFERENCES contains a list of reference citations which were utilized in the report.

Appendix A Contains a listing of the How Malfunction Codes and their definitions.

SECTION 2

AIRCRAFT HISTORY

2.1 INTRODUCTION

The current JSTARS program will deliver 20 production aircraft to the U.S. Air Force. The third and fourth production aircraft (P-3 and P-4) were selected for this study. Each of the aircraft assigned to the Joint STARS program was used as a cargo aircraft, and many hauled livestock during their lives. Being a cargo version is a prerequisite for selection as a JSTARS aircraft. Table 2.1 shows a summary of the history for the first 14 JSTARS aircraft. Of note in the following chart is a comparison of flight hours vs. aircraft cycles. The P-3 aircraft, with 19,250 flights accumulated 47,566 flight hours (2.5 hr./flight) while the P-4 aircraft, with 18,808 flights accumulated 65,300 flight hours (3.5 hr./flight). The Northrop Grumman Joint STARS web site was a valuable source for the data presented in this chapter.

Aircraft	Model / Series	Type Engines	Tail Number	Serial Number	A/F No.	Date of Mfg.	Last Owner	Total Airframe Hrs.	A/C Cycles
P-1	707-338C	JT3D-3B Pos #1 644861 / Pos #3 644419 Pos #2 646660 / Pos #4 645382	N4131G	19622	92-3289	Dec 1967	Flonda Wes	57,631 7	19,708
P-2	707-338C	JT3D-3B Pos #1 644681 / Pos #3 646480 Pos #2 644328 / Pos #4 668410	N4115J	19295	92-3290	Aug 1967	Trans Arabian	62,761	20,448
P-3	707-338C	JT3D-3B Pos #1 668778 / Pos #3 646804 Pos #2 668357 / Pos #4 667950	N707HW	19294	93-0597	1967	Anglo Airline	47,466	19,250
P-4	707-338C	JT3D-3B Pos #1 644823 / Pos #3 645809 Pos #2 642682 / Pos #4 668571	N6546L	19296	93-1097	1967	Omega Air	65,300	18,808
P-5	707-338C	JT3D-3B Pos #1 642281 / Pos #3 643809 Pos #2 645336 / Pos #4 667860	N861BX	19293	94-0284	1967	Buffalo Airways	59,473	25,411
P-6	707-373c	JT3D-3B Pos #1 645160 / Pos #3 667929 Pos #2 668212 / Pos #4 645415	N760FW	19442	94-0285	1967	Contram Int.	59,890	17,746
P-7	707-3D3C	JT3D-3B Pos #1 644867 / Pos #3 644771 Pos #2 642394 / Pos #4 644015	JY-ADP	20495		1971	Royal Jordanian	45,498 6	20,208
P-8	707-321C	JT3D-3B Pos #1 668438 / Pos #3 645553 Pos #2 668389 / Pos #4 668458	N770FW	20016		1968	Flonda West	52,582	21,600
S-1		Inducted as P-8							
S-2		Inducted as P-7							
S-3	EC-18B	JT3D-3B Pos #1 668450 / Pos #3 667758 Pos #2 642384 / Pos #4 668575	N8401	19581	81-0896	Oct 1967	Edwards AFB	42,25C 9	21,234
S-4	EC-18D	JT3D-3B Pos #1 668271 / Pos #3 668639 Pos #2 668334 / Pos #4 668541	N7566A	19381	81-0895	Aug 1967	Edwards AFB	33,915 7	16,580
S-5	C-18B	JT3D-3B Pos #1 646015 / Pos #3 645381 Pos #2 668265 / Pos #4 668673	N7565A	19380	81-0898	Oct 1966	WPAFB	43,089 9	19,380
S-6	707-CC137	JT3D-7 Pos #1 670711 / Pos #3 668717 Pos #2 668718 / Pos #4 668698	N705	20319		Oct 1971	Canadian AF	38,051 2	

Table 2.1 - History of aircraft assigned to the Joint STARS program.

2.2 P-3 AIRCRAFT HISTORY

The P-3 aircraft, a Boeing 707-338C, was originally a passenger liner for Quantas in 1967, and continued in service until 1976 when it was sold to Air Niugini. Air Niugini continued to fly the aircraft as a passenger carrier until it was sold to ITEL in 1979. In 1980, ITEL converted the aircraft to a cargo version and completed corrosion repairs. In 1981, International Aircraft Leases (IAL), based in Miami, Florida, purchased and flew the aircraft until it was grounded in 1985. The aircraft was deregistered from the U.S. and sold to Shanghai Airlines in 1985 with 43,171 flight hours and 18,106 flights. Anglo Airlines was the final commercial owner before the US Air Force furnished it to the Joint STARS program in 1993 with a total 47,677 flight hours and 19,250 flights. The P-3 aircraft is considered to be in the worst structural condition of all aircraft inducted to date.

The P-3 has been known as the VH-EBU, P2-ANH, N707MB, 9QCDA, N707HW, B2426, G-EOCO and AF67-30053.

2.3 P-4 AIRCRAFT HISTORY

The P-4 aircraft, also a Boeing 707-338C, rolled off the assembly line on 10 November 1967. It had 9929 flights with 27,442 flight hours when it was accepted by BCAL. The aircraft was transferred to Anglo Cargo on 5 August 1989 with 14,565 flights and 47,336 flight hours. Monarch Aircraft Inc. took over maintenance at 52,354 flight hours. Aerotech Stowstead took over maintenance at 16,913 flights and 58,495 flight hours. The aircraft was acquired by the Joint STARS program on 4 February 1994 with 18,812 flights and 65,311 flight hours. The aircraft was flown primarily between the United Kingdom, Middle East and Africa. The P-4 has been known as the VH-EBW, G-BDEA, EL-AKH, and AF93-1097.

SECTION 3

707-300 SERIES STRUCTURAL DESCRIPTION

3.1 INTRODUCTION

The following section is an overview of the structural description of the Boeing 707-300. The focus of the study was to be limited to principle and secondary structural elements. However, it became apparent very early in the program that the principle structural elements (PSE) list, defined in section 3.7, consists of virtually the entire airframe.

Both the database and the report make references to aircraft zone, wing station, body station, buttock line, water line, skin panel and wing plank numbers, which are detailed in the following sections. The diagrams, which are obtained from the Boeing Structural Repair Manual (SRM), detail the locations of the aircraft that are extensively referenced in the database and the report.

The following information is contained in the subsequent portions of this section:

3.2 707 HISTORY - A brief history and background of the Boeing 707.

3.3 ABBREVIATIONS - A listing of the abbreviations used in regards to identifying aircraft location.

3.4 OVERALL DIMENSIONS - A summary of the aircraft dimensions.

3.5 MAJOR SUB-ASSEMBLIES - A listing of the major sub-assemblies of the aircraft including aircraft zones and locations. This section also includes a breakout diagram showing the sub-assemblies.

3.6 PRIMARY AND SECONDARY STRUCTURES - Diagram of primary and secondary structural elements.

3.7 LIST OF PRINCIPLE STRUCTURAL ELEMENTS - A listing of the principle structural elements (PSE) of the Boeing 707 as specified in the Boeing 707 Intercontinental SRM.

3.8 ZONES AND SUBZONES - A listing and diagram of the various aircraft zones including locations of the zones and structural elements in the zone.

3.9 FUSELAGE SKIN DIAGRAMS - Diagrams detailing the skin panel identification referenced in the database and in the report.

3.10 WING DIAGRAMS - Diagrams detailing the wing structures identification referenced in the database and in the report.

3.11 HORIZONTAL AND VERTICAL STABILIZER DIAGRAMS - Diagrams detailing the stabilizer structures identification referenced in the database and in the report.

3.2 707 HISTORY

The Boeing 707 prototype, called the 367-80, made its maiden flight on July 15, 1954 from Renton Field, Washington. The initial aircraft off the production line were KC-135A tanker/transports, which went into service in 1957. Shortly thereafter, commercial versions went into production. The passenger carrying 707-320B and passenger/cargo 707-320C models were still in production in 1977.

The original 707 line was expanded to include variations of length, wingspan, range, and cargo versus passenger versions. Included in these are the -320 and the -420 series, which are the Intercontinental 707s. The only difference between the -320 and -420 is the engines, the former using Pratt & Whitney JT4s and the latter Rolls-Royce "Conways." The -300 series aircraft are the type that were acquired by the Joint STARS program.

3.3 ABBREVIATIONS

The following abbreviations are used in specifying the locations of corrosion and fatigue damage on the P-3 and P-4 aircraft. These abbreviations are illustrated in Figure 3.1.

BS	Body Station. Distance measured parallel to body centerline to a plane perpendicular to body centerline from a point 130 inches forward of the nose.
BL	Body Buttock Line. Distance in a horizontal plane measured from body vertical centerline.
WL	Water Line. Distance Measured perpendicular from a horizontal plane located 126 inches below bottom of body.
FSS	Front Spar Station.

RSS	Rear Spar Station.
WS	Wing Station. A plane perpendicular to wing chord plane measured from intersection of leading edge and WBL 0.
WBL	Wing Buttock Line. A plane normal to wing chord plane and parallel to body centerline. It is measured from intersection of wing chord plane and BL 76.45.
NAC WL	Nacelle Water Line. A plane parallel to wing chord plane measured from nacelle centerline which is NAC WL 100.
TYP	Typical.
MAX	Maximum.
MIN	Minimum.
HT	Heat Treat.
TE	Trailing Edge.
LE	Leading Edge.

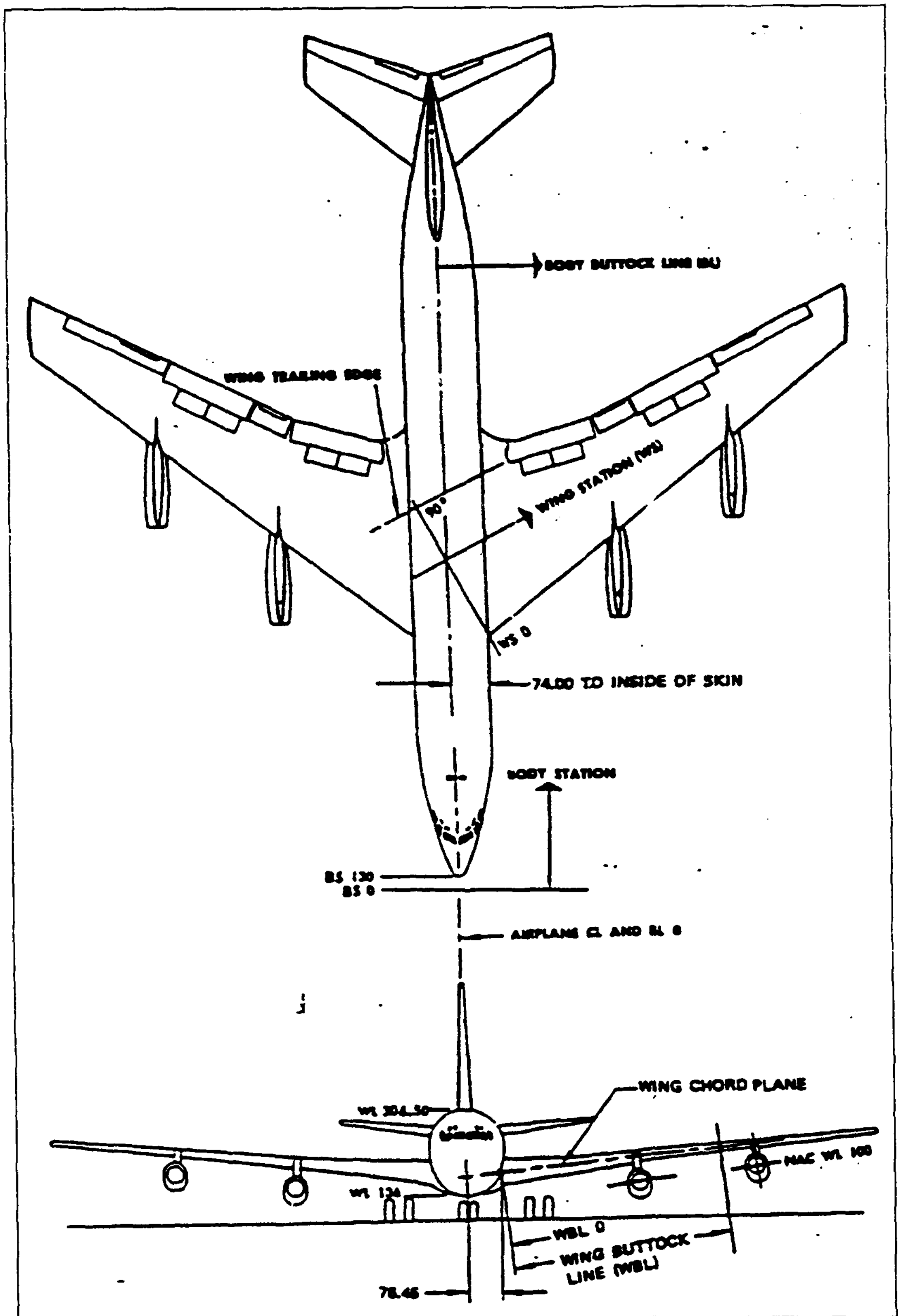


Figure 3.1 - Aircraft Structural Description Abbreviations (Boeing 707 Intercontinental Structural Repair Manual)

3.4 OVERALL DIMENSIONS

Figures 3.2 and 3.3 illustrate the overall dimensions of the Boeing 707 Intercontinental

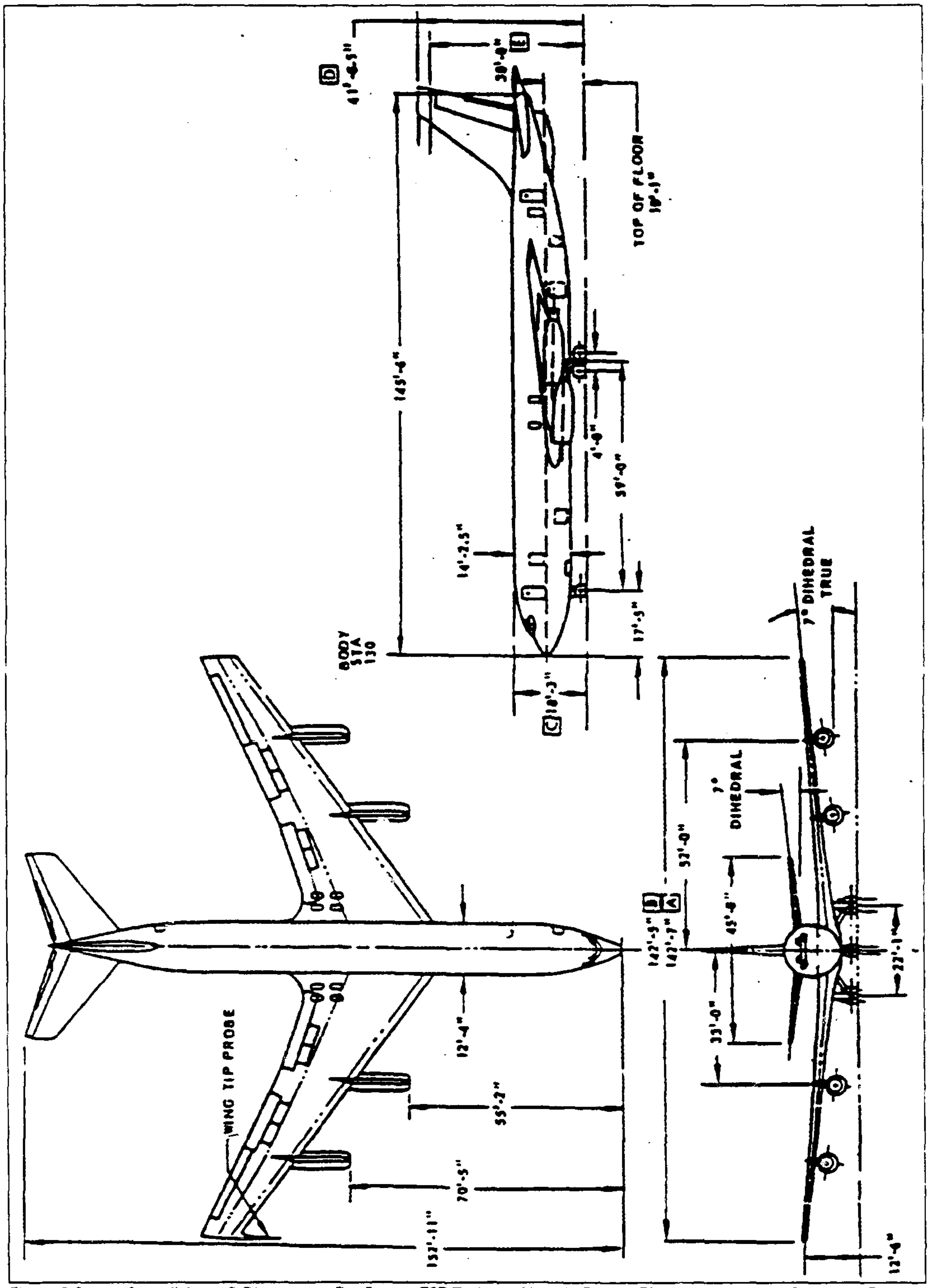


Figure 3.2 - Overall Aircraft Dimensions For Boeing 707 Turbojet Aircraft (Boeing 707 Intercontinental Structural Repair Manual)

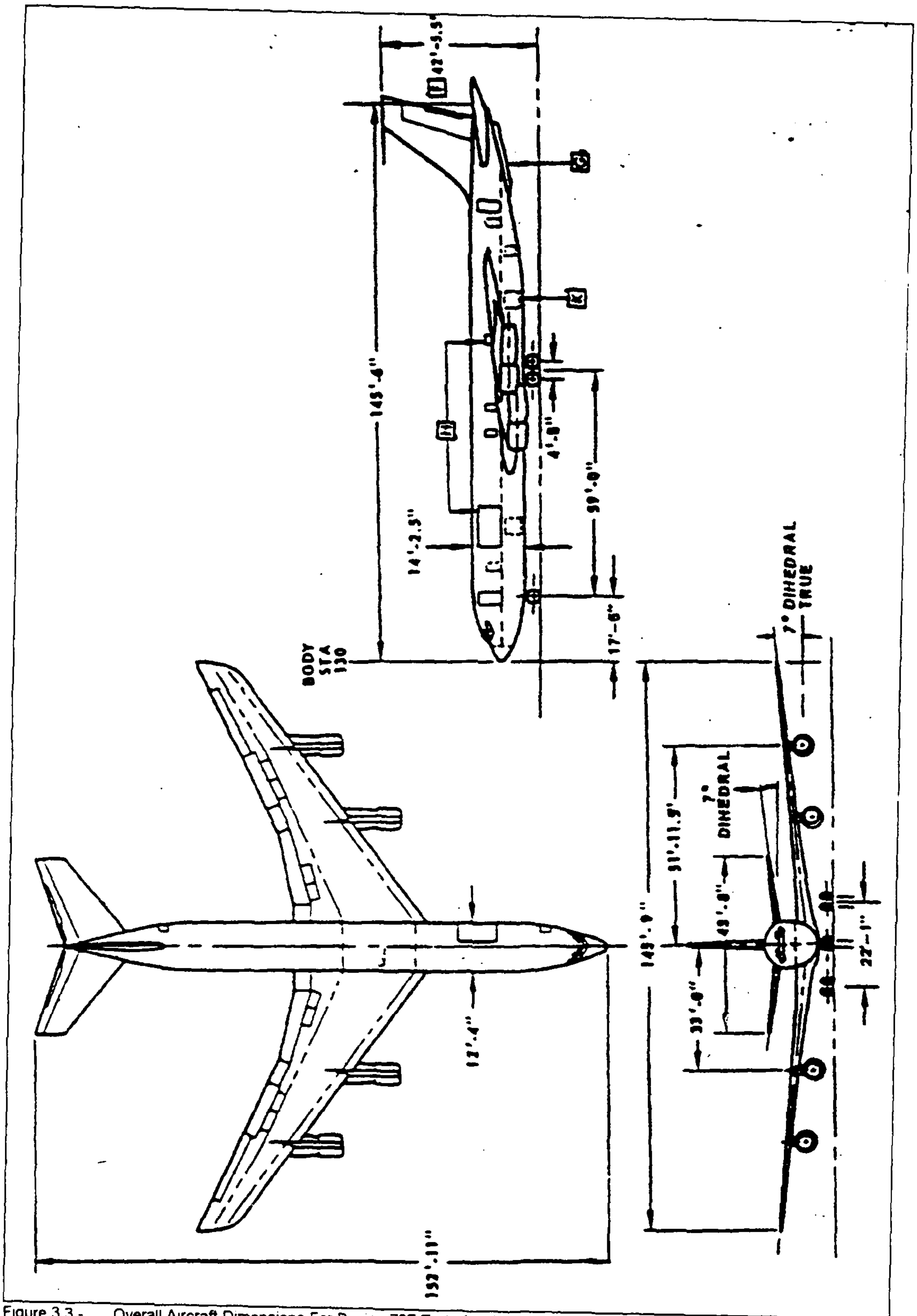


Figure 3.3 - Overall Aircraft Dimensions For Boeing 707 Turbofan Aircraft (Boeing 707 Intercontinental Structural Repair Manual)

3.5 MAJOR SUB-ASSEMBLIES

Table 3.1 is a list of major sub-assemblies of the 707-300. These sub-assemblies are depicted in Figure 3.4.

Sect. No.	Title	Sect. No.	Title
11	Wing Center Section	48	Body Instl Section 48
12	Inboard Wing Assembly	49	Ventral Fin Instl
13	Outboard Wing Assembly	61	Main Landing Gear Instl
14	Inboard Wing Leading Edge Instl	62	Nose Landing Gear Instl
15	Outboard Wing Leading Edge Instl	72	Inboard Strut Instl
16	Inboard Wing Trailing Edge Instl	74	Outboard Strut Instl
17	Outboard Wing Trailing Edge Instl	76	Power Plant Instl
19	Wing Tip Instl	81	Stabilizer Center Section Instl
30	Wing Spoiler Instl	82	Stabilizer Structure Instl
31	Inboard Flap Instl	83	Stabilizer Leading Edge Instl
32	Outboard Flap Instl	84	Elevator and Balance Instl
33	Inboard Aileron Instl	85	Fin Instl Dorsal
34	Outboard Aileron Instl	86	Fin Interspar and Trailing Edge Assembly
41	Body Instl Section 41	87	Fin Leading Edge Instl
43	Body Instl Section 43	88	Rudder and Balance Assembly
46	Body Instl Section 46	89	Fin Tip Instl

Table 3.1 - Major Sub-Assemblies

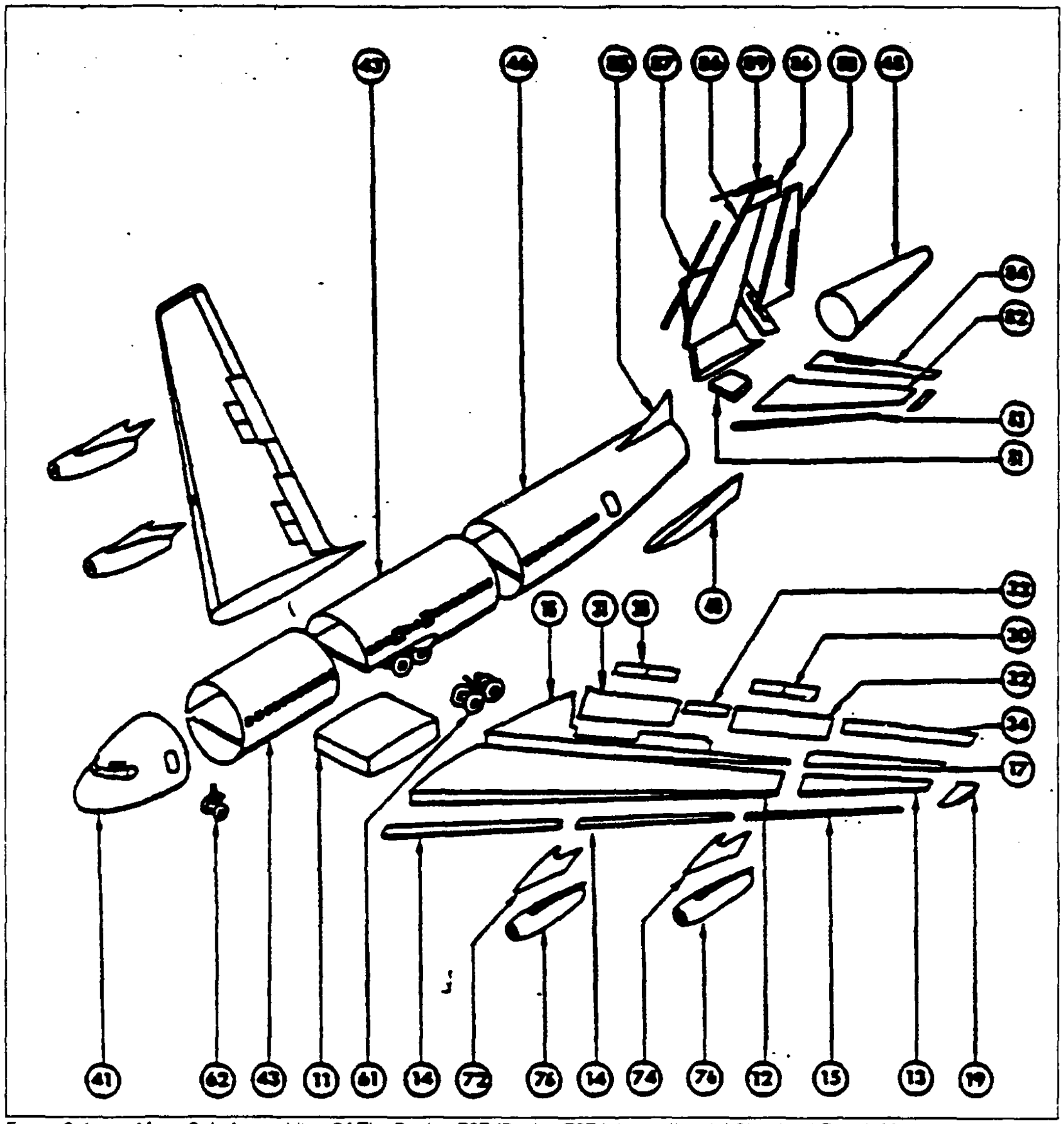


Figure 3.4 - Major Sub-Assemblies Of The Boeing 707 (Boeing 707 Intercontinental Structural Repair Manual)

3.6 PRIMARY AND SECONDARY STRUCTURES

Figure 3.5 depicts the regions of the aircraft containing secondary structures. All non-shaded areas contain primary structures.

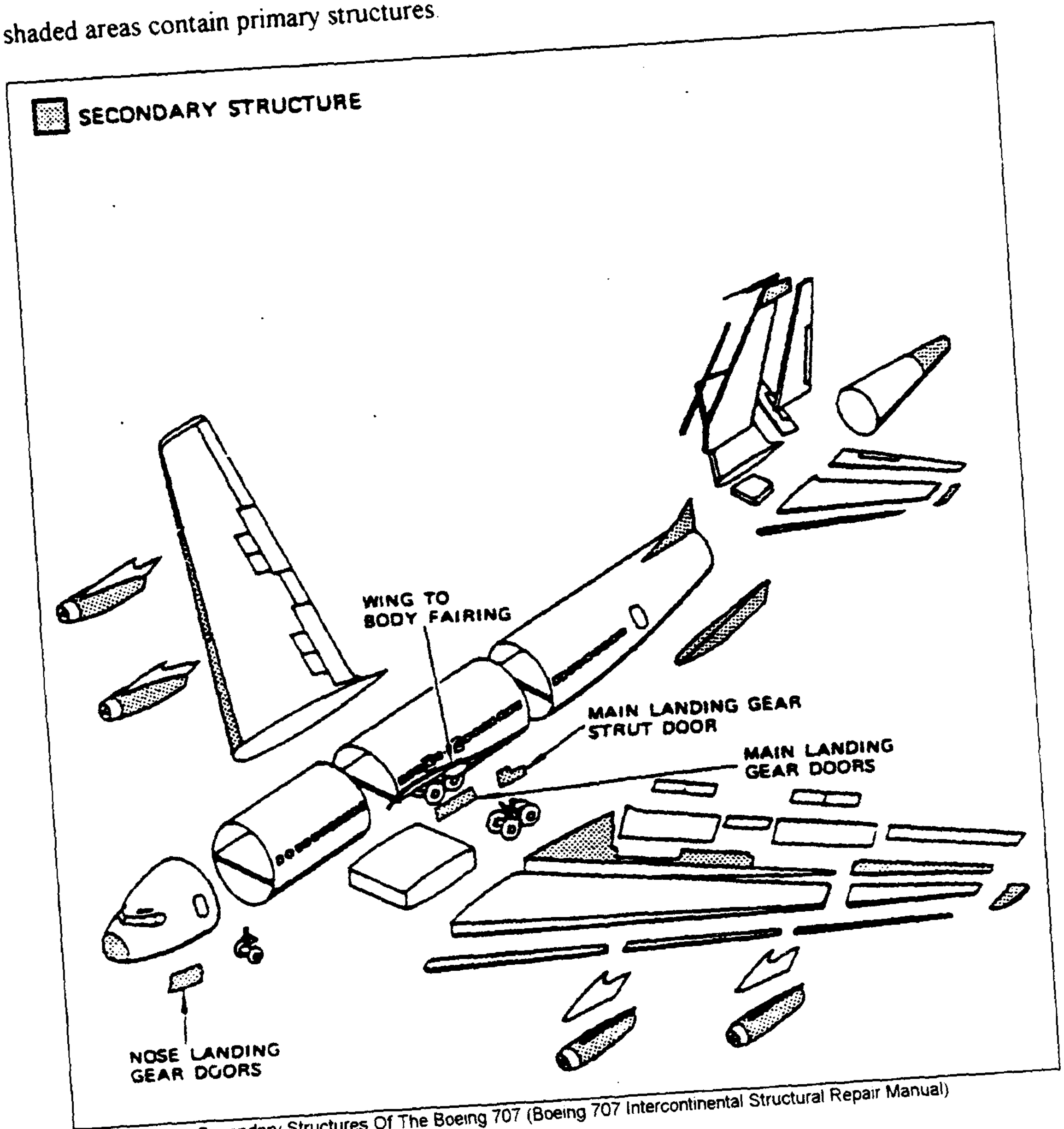


Figure 3.5 - Secondary Structures Of The Boeing 707 (Boeing 707 Intercontinental Structural Repair Manual)

3.7 LIST OF PRINCIPLE STRUCTURAL ELEMENTS

FUSELAGE STRUCTURE

Fuselage Upper Lobe Skin And Stringers

Fuselage Lower Lobe Skin And Stringers

Fuselage Circumferential Splices

Fuselage Lap Splices

Typical Frames

Skin At Corners Of Miscellaneous Access Door Cutouts

Stringer / Frame Attachments

Bulkhead BS 178 (Forward Pressure)

Fuselage BS 227.8 Bulkhead

Fuselage BS 259.5 Bulkhead

Fuselage BS 294.5 Bulkhead

Lower Lobe Frames BS 360 To BS 600J

Fuselage BS 600K / 620 Bulkhead

Fuselage BS 820 Bulkhead

Fuselage BS 960 Bulkhead

Lower Lobe Frames BS 960M To BS 1440

Fuselage BS 1440 Bulkhead (Aft Pressure)

Fuselage BS 1505.87 Bulkhead

Fuselage BS 1592 Bulkhead

Section 48 Skin And Stringers

Floor Beam Structure

Horizontal Pressure Deck

Overwing Stub Frames

Stringer 18A

Skin BS 820 At Stringer 18A

Delta Beam - Under Wing

Fuselage Floor Beams Over Main Landing Gear Wheel Well

Fuselage Keel Beam (BS 820 To BS 960)

Crew Window Cabin Structure

Window Forgings (Passenger Cabin)

Skin At Corners Of Window Forgings

Forward Entry Door

Aft Galley Door

Electronic Bay Access Door

Fuselage Upper Deck Cargo Door

Fuselage Lower Lobe Cargo Compartment Doors

Electronics Access Door Cutout

Fuselage Lower Lobe Cargo Compartment Door Cutouts

Fuselage Upper Deck Cargo Door Cutout

Forward Entry Door Cutout

Aft Entry Door Cutout

Aft Galley Door Cutout

Emergency Exit Door Cutout

Nose Landing Gear Wheel Well

Forward Access Door And Cutout / Doppler Antenna Well

POWER PLANT STRUCTURE

Forward Engine Mount Fitting, Link And Support Structure

Aft Engine Mount Fitting Link And Support Structure

Thrust Link

Front Spar Fitting

Midspar Fittings

Diagonal Brace And Lower Spar Attach Fitting

WING STRUCTURE

Center Section Front Spar Chords, Web, And Stiffeners

Center Section Rear Spar Chords, Web, And Stiffeners

Center Section Lower Panel Stringers And Skin

Center Section Upper Panel Stringers And Skin

Center Section Upper And Lower Skin Splice Stringers

Center Section Spanwise Beams

Overwing Floor Beams

Left And Right Lower Beam - BL 13.0 And 42.0

Wing-To-Body Breather Web Attachment

Front Spar Terminal Fittings And Bottle Pin

Rear Spar Terminal Fittings And Bottle Pin

Lower Surface BBL 70.5 Splice

Upper Surface BBL 70.5 Splice

Lower Surface WS 360 Splice

Upper Surface WS 360 Splice

WS 733 Production Break Joint

Rear Spar Chords, Web, And Stiffeners

Front Spar Chords, Web, And Stiffeners

Lower Panel Stringers And Skin

Upper Panel Stringers And Skin

Upper And Lower Splice Stringers

Lower Panel Cutouts

Typical Ribs

Shear Tied Ribs

BBL 70.5 Ribs

Trailing Edge Flaps - Main Box

Trailing Edge Flap Tracks And Support Structure

Trailing Edge Flap Main Carriages And Sequence Carriages

Floor Beams And Intercostals

Engine Support Structure

Main Landing Gear Support Structure (Including Beavertail)

EMPENNAGE STRUCTURE - FIN

Front Spar Chords, Stiffeners, And Web

Rear Spar Chords, Stiffeners, And Web

Terminal Fitting

Torsion Rib (Fin STA 50 53)

Skin

Typical Ribs

Closure Ribs

EMPENNAGE STRUCTURE - STABILIZER

Front Spar Chords, Stiffeners, And Web

Rear Spar Chords, Stiffeners, And Web

Skin (Exposed Panels)

Front Spar Terminal Fitting

Rear Spar Terminal Fitting

Closure Rib

Typical Inspar Rib

Inspar Elevator Support Rib

Center Section Front Spar

Center Section Rear Spar

Center Section Rear Spar Auxiliary Fail-safe Fitting

Center Section Transverse Rib (-100 / -200)

Center Section BL 0 Rib

Center Section Torque Box

Center Section Closure Rib

Stabilizer Actuator Fitting

Stabilizer Actuator Support Fittings (-100 / -200)

Stabilizer Actuator Arms (-100 / -200)

Hinge Housing And Hinge Bearing

Center Section Jackscrew Support Fitting

Center Section Diagonal Brace

EMPENNAGE STRUCTURE - ATTACH POINTS

Fin To Body Terminal Pins

Stabilizer Center Section To Body Hinge Pins

Stabilizer Center Section Hinge Housing Bearing

Jackscrew Support Fitting To Jackscrew Gimble

MAIN LANDING GEAR

Outer Cylinder

Inner Cylinder

Trunnion

Trunnion / Oleo Pin

Drag Brace

Drag Brace Fuse Pin

Drag Brace / Oleo Pin

Torsion Links

Pins, Torsion Links

Piston Rod (Orifice Support Tube)

Orifice Plate

Metering Pin

Gland Nut

Truck Assembly

Pins, Truck Assembly

NOSE LANDING GEAR

Outer Cylinder

Inner Cylinder

Torsion Links

Pins, Torsion Links

Trunnion Pins

Tow Collar Assembly

Pins, Tow Collar Assembly

Steer Knuckle Assembly

Pins, Steer Knuckle Assembly

Steering Support Plates

Pin, Support Plates

Tow And Steering Link Assembly

Drag Brace Assembly

Pins, Drag Brace

Tube, Piston

Orifice, Piston Tube

Orifice Rod (Metering Pin)

Orifice Rod Bulkhead

Gland Nut

3.8 ZONES AND SUBZONES

The following list is a summary of the aircraft zones and sub-zones. Figure 3.6 illustrates these zones. These zones are used as the location description during production; for instance, the zone and subzone numbers form the first three digits of the over and above (O&A) work request for a given aircraft.

1-1 Lower Fuselage - Lower 41 And E&E Compartment BS 178-360

1-2 Lower Fuselage - Forward Cargo BS 360 - 600K

1-3 Center Wing Cavity - BS 600K - 960

1-4 Lower Fuselage - Aft Cargo BS 960 - 1440

1-5 Lower Fuselage - 48 Section Aft Bay BS 1440 - 1616

1-6 L/H Main Wheel Well BS 820 - 960

1-7 R/H Main Wheel Well BS 820 - 960

2-1 Cockpit BS 178 - 304

2-2 Forward Passenger Cabin BS 304 - 820

2-3 Aft Passenger Cabin BS 820 - 1440

2-4 Seat Tracks And Floor Beams BS 304 - 1440

3-1 Left Horizontal Stabilizer

3-2 Right Horizontal Stabilizer

3-3 Vertical Fin And Rudder

4-1 Number 1 Engine Strut

4-2 Number 2 Engine Strut

4-3 Number 3 Engine Strut

4-4 Number 4 Engine Strut

5-1 Left Outboard Leading Edge

5-2 Left Center Leading Edge

5-3 Left Inboard Leading Edge

5-4 Number 1 Reserve Tank

5-5 Number 1 Main Tank

5-6 Number 2 Main Tank

5-7 Left Outboard Trailing Edge

5-8 Left Center Trailing Edge

5-9 Left Inboard Trailing Edge

6-1 Right Outboard Leading Edge

6-2 Right Center Leading Edge

6-3 Right Inboard Leading Edge

6-4 Number 4 Reserve Tank

6-5 Number 4 Main Tank

6-6 Number 3 Main Tank

6-7 Right Outboard Trailing Edge

6-8 Right Center Trailing Edge

6-9 Right Inboard Trailing Edge

5-0 Left Wing

6-0 Right Wing

8-0 S/B's And A/D's Catchall

9-7 Both Wings

9-8 Whole Fuselage

9-9 Whole Aircraft

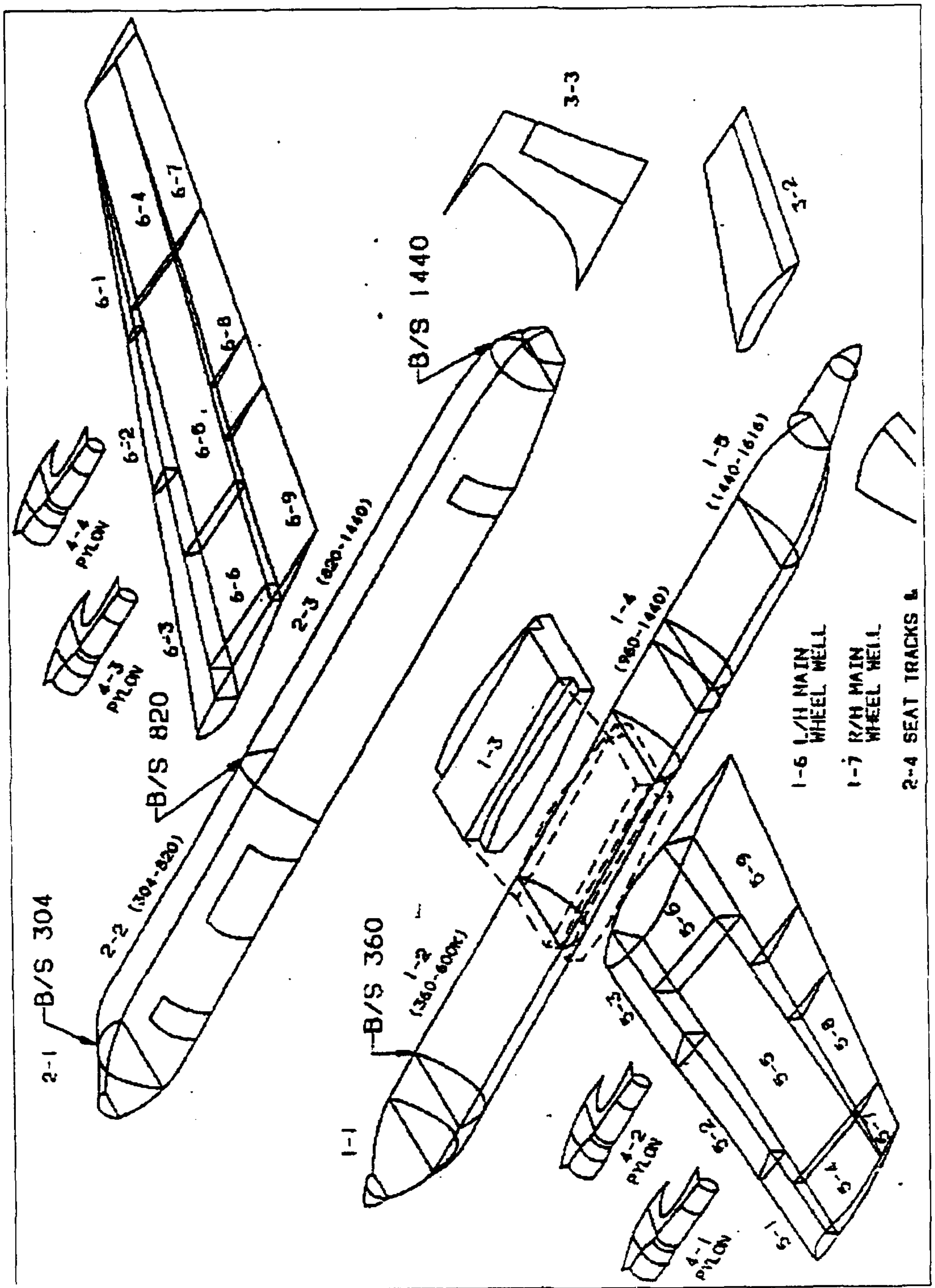


Figure 3.6 - Boeing 707-300 Series Aircraft Zones (Boeing 707 Intercontinental Structural Repair Manual)

3.9 FUSELAGE SKIN DIAGRAMS

The following figures (Figure 3.7 through Figure 3.10) identify the fuselage skin panels. The fuselage skin panels are made of 2024-T3 or 2024-T4 aluminum. The skin substructure stringers are made of 7075-T6 aluminum. Corrosion resistant steel borders are used around door and window cutouts. The tail skin panels aft of BS 1440 are made of 7075-T6. Aft of BS 1616, The tail cone skins are made of fiberglass reinforced plastic.

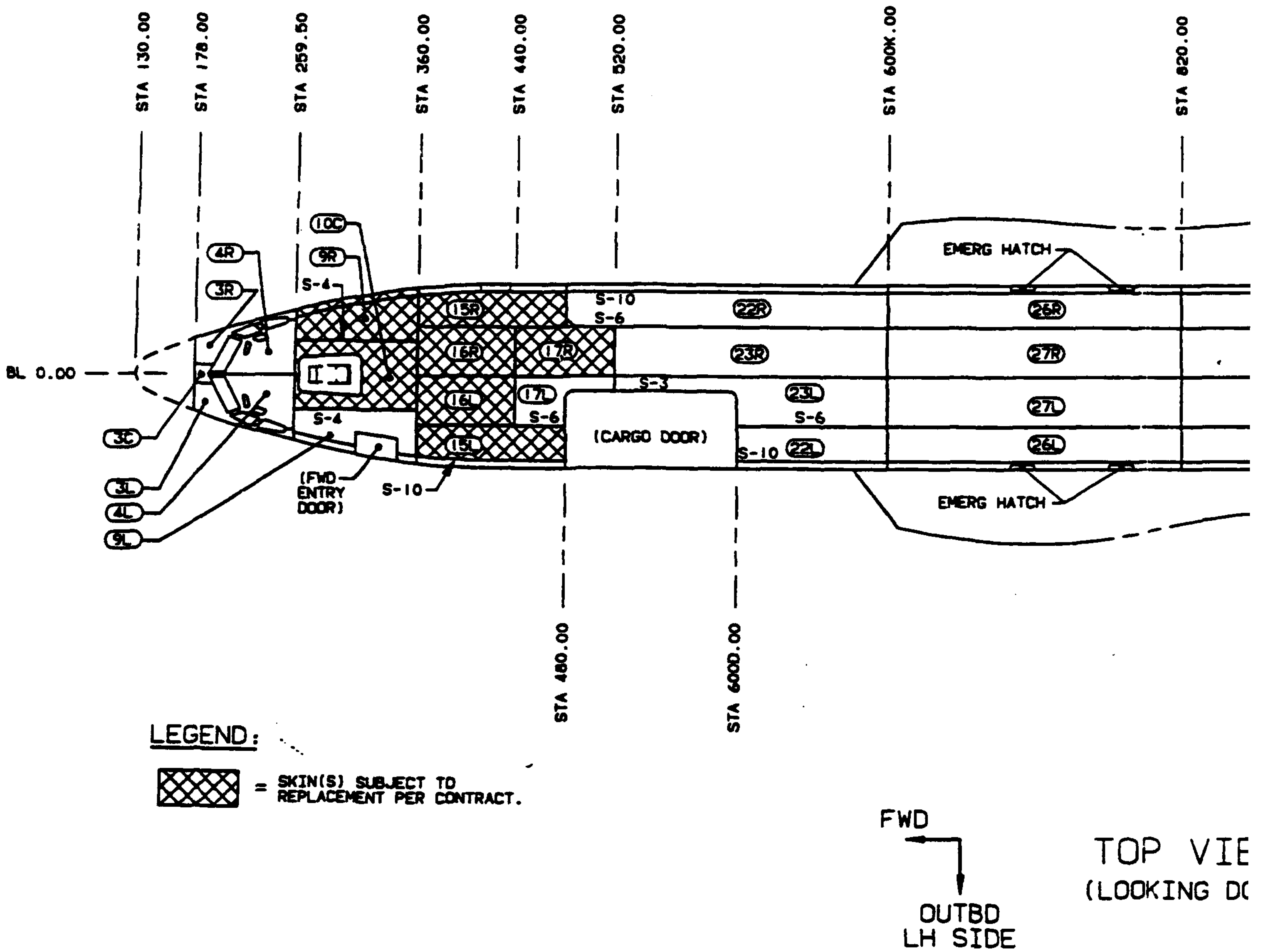
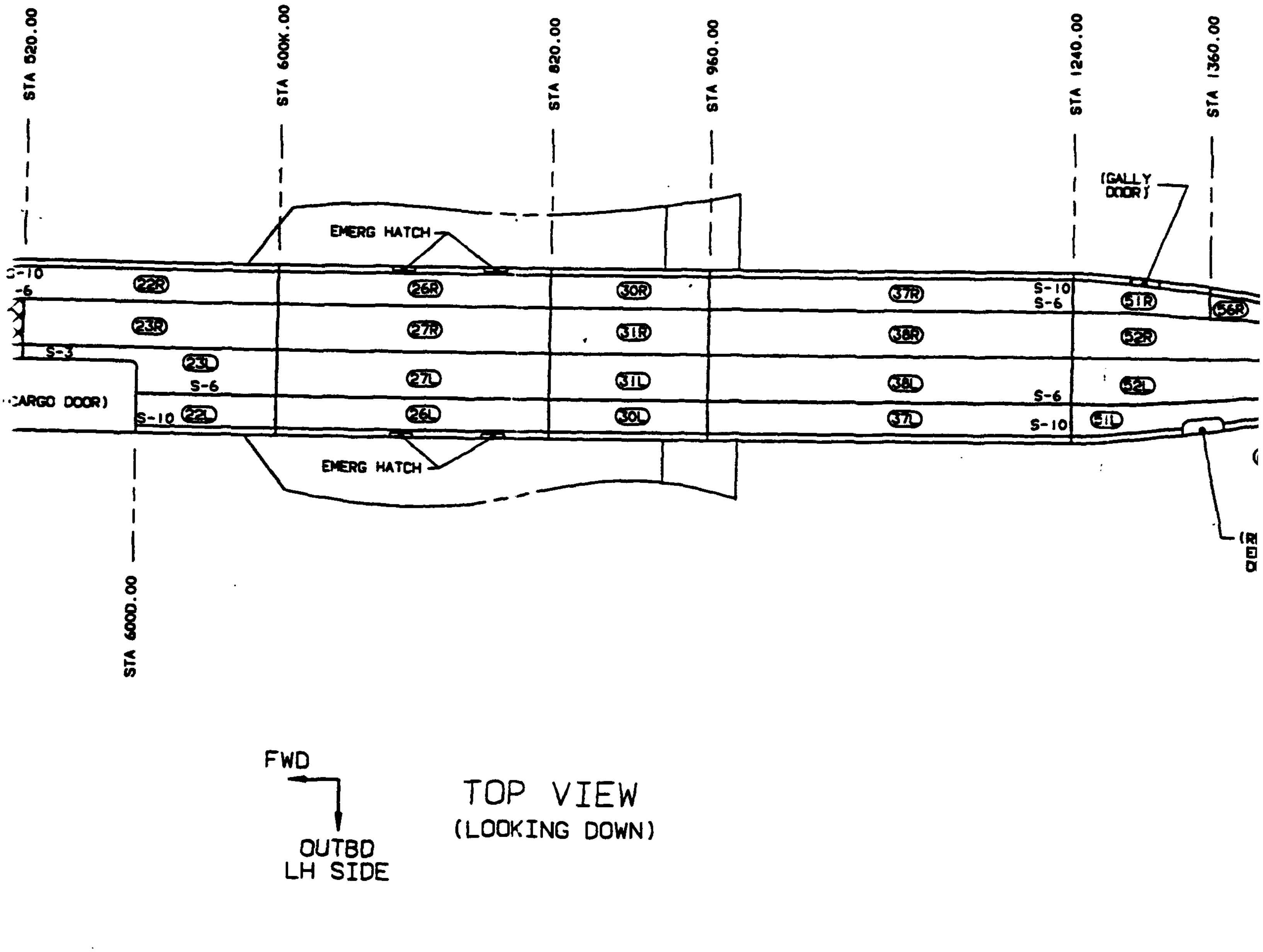
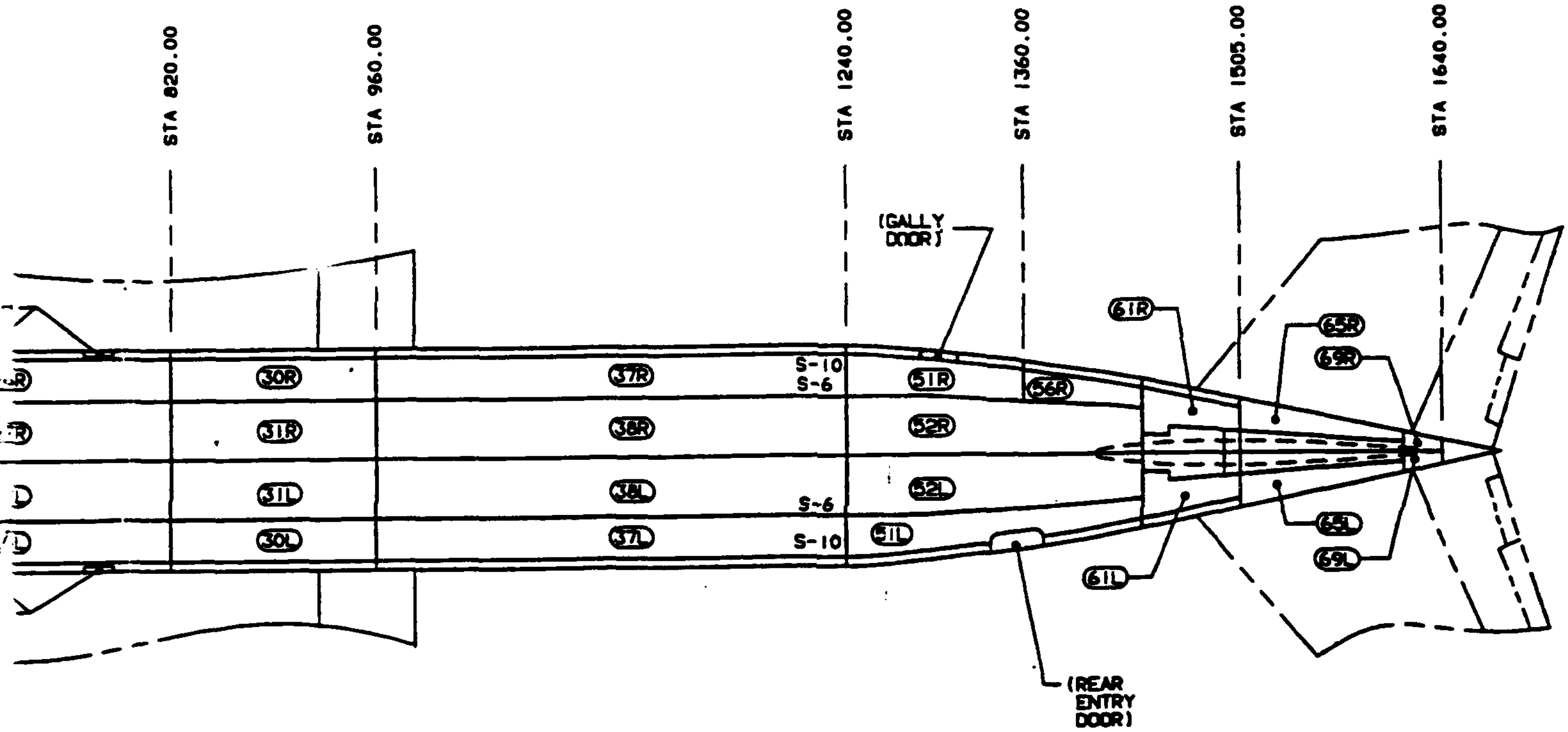


Figure 3.7 - Fuselage Skin Panels - Top View



TOP VIEW
(LOOKING DOWN)



TOP VIEW
(LOOKING DOWN)

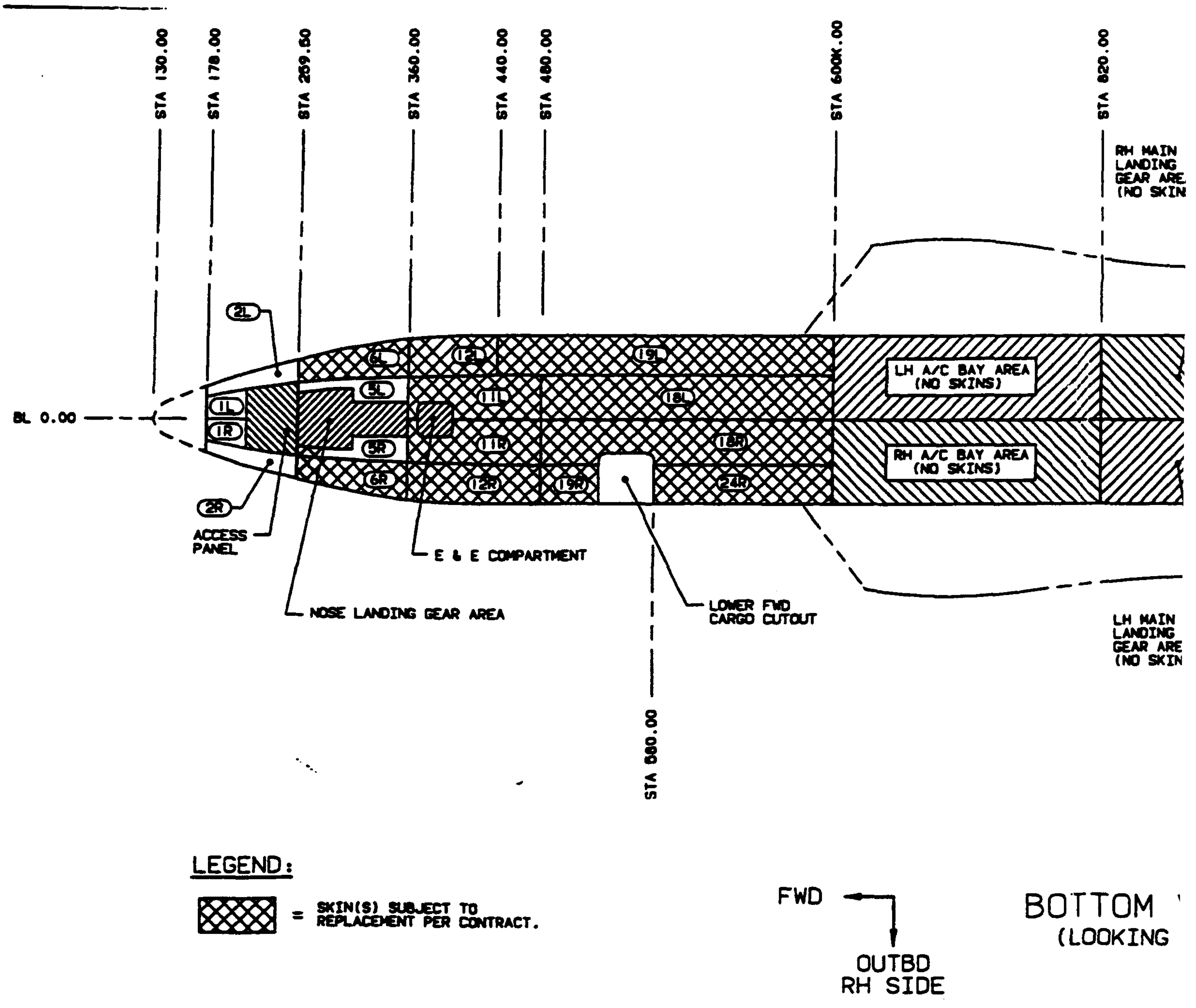
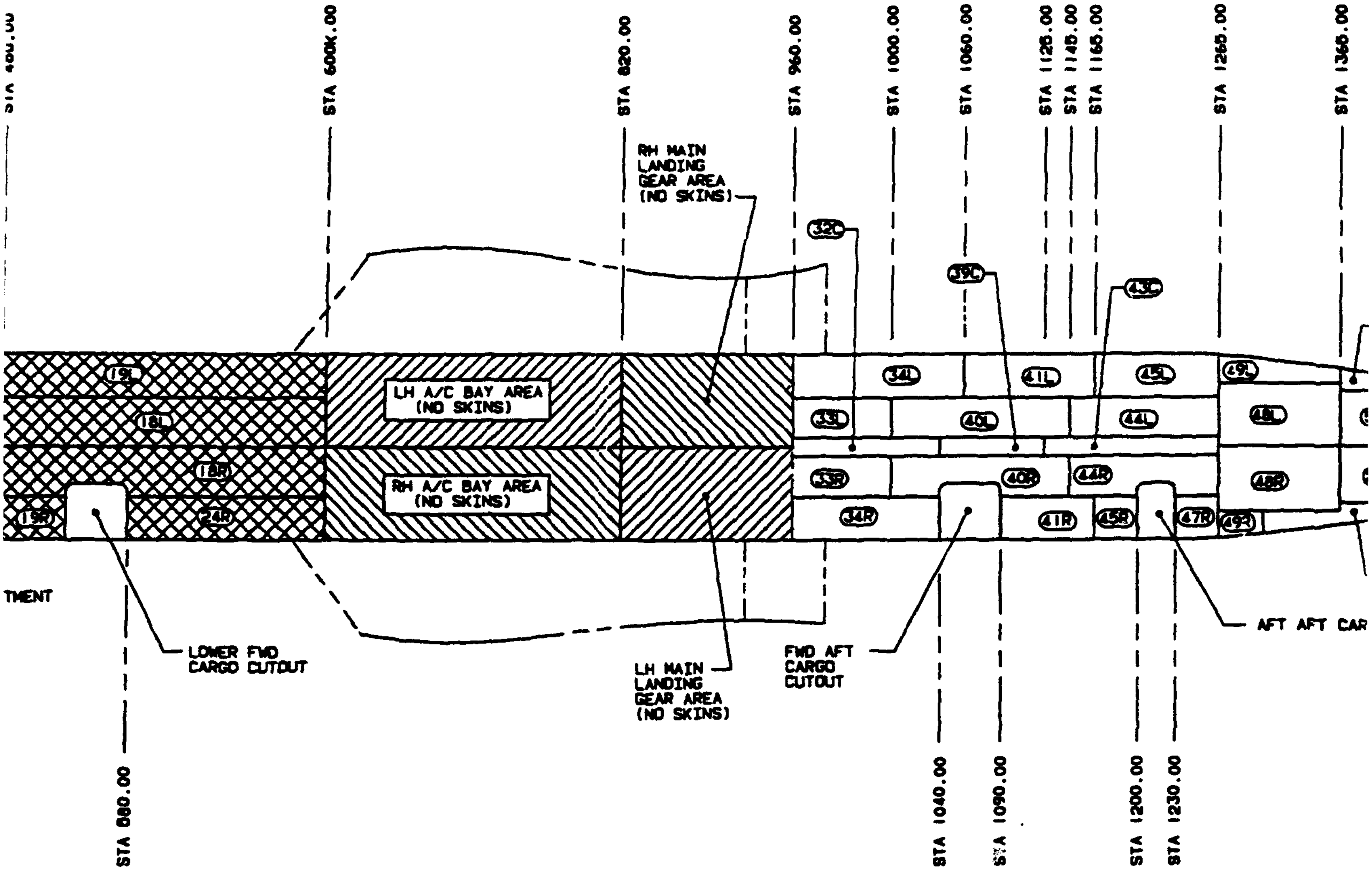


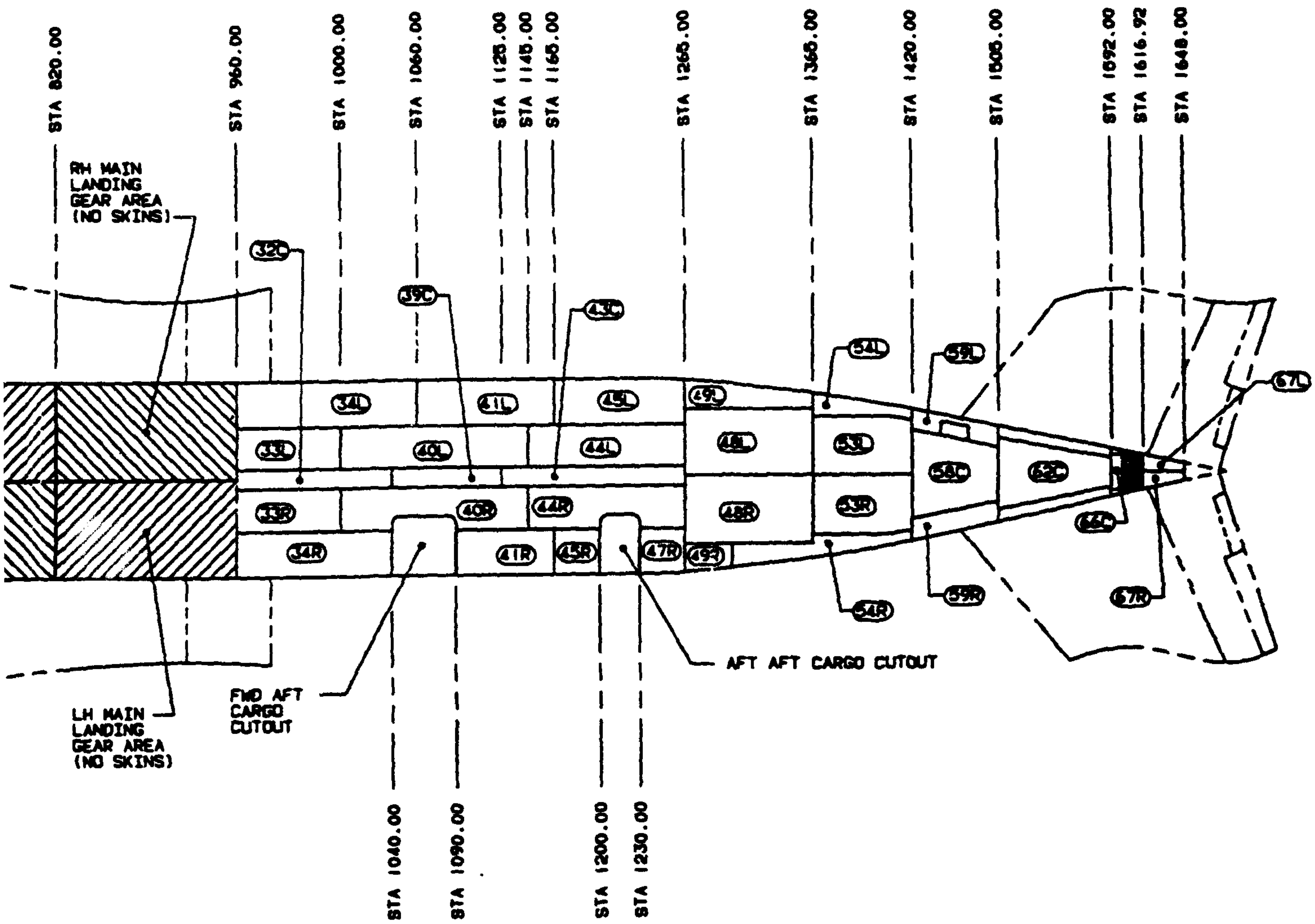
Figure 3.8 - Fuselage Skin Panels - Bottom View



FWD

OUTBD
RH SIDE

BOTTOM VIEW
(LOOKING UP)



ЭTTOM VIEW
(LOOKING UP)

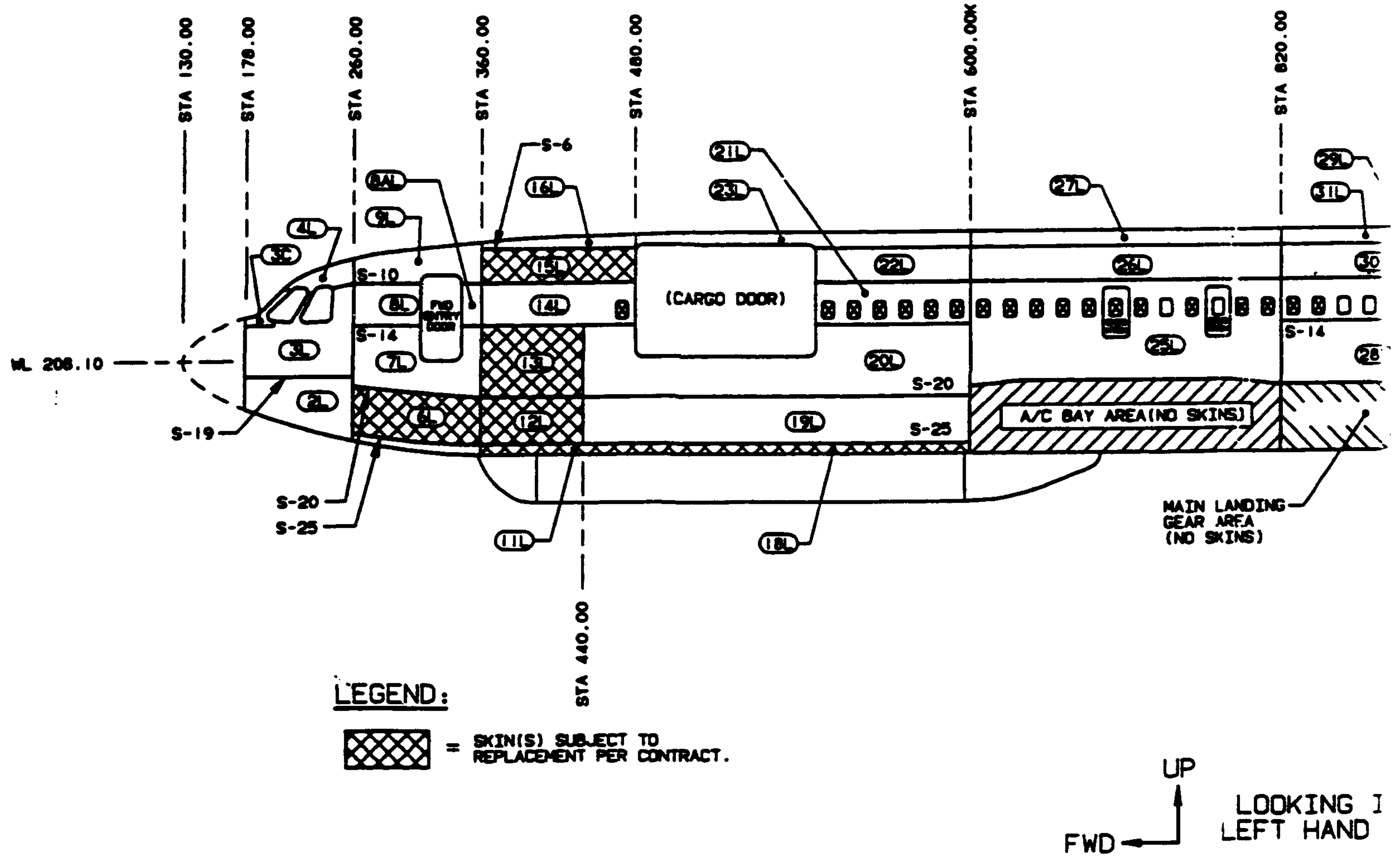
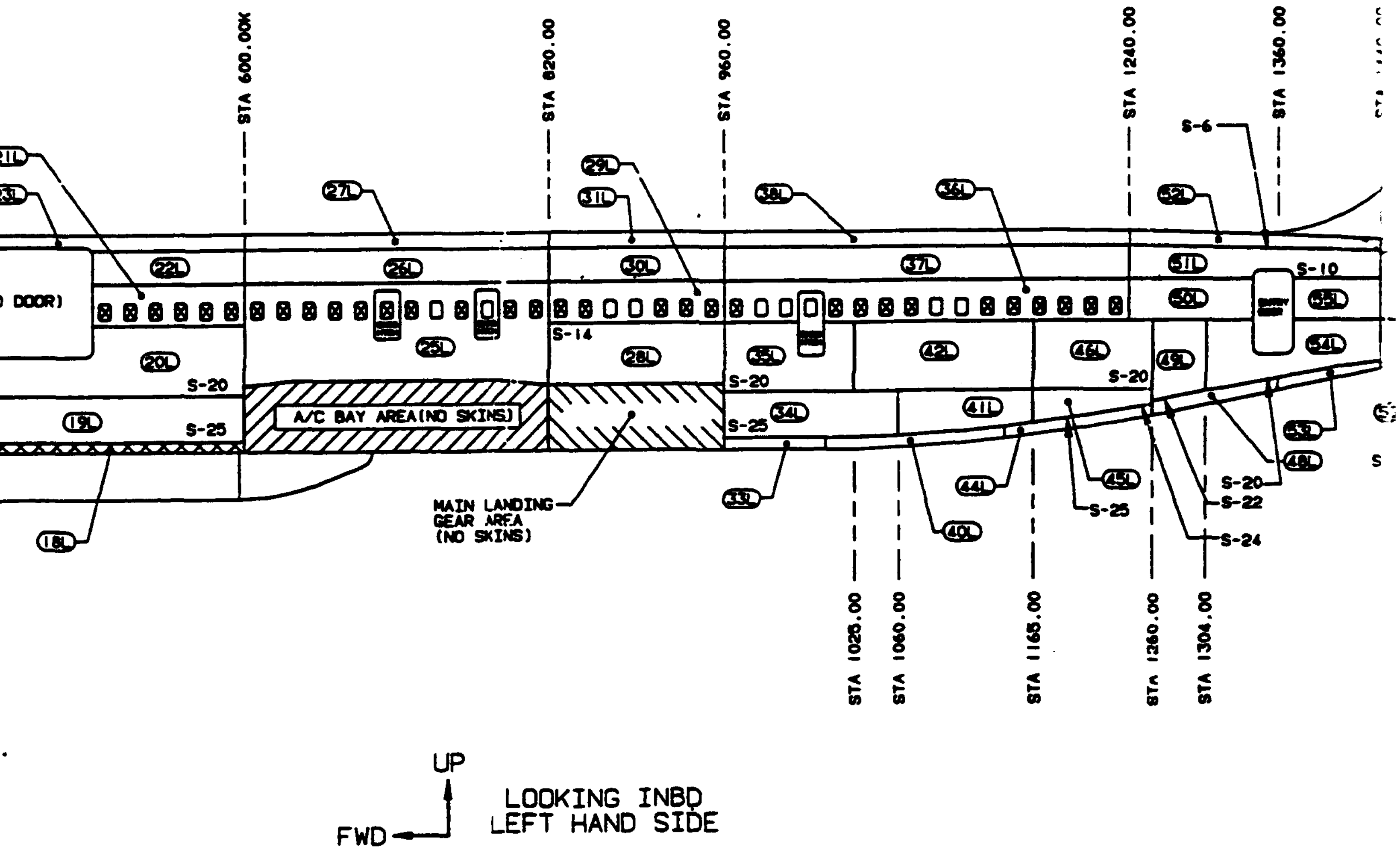
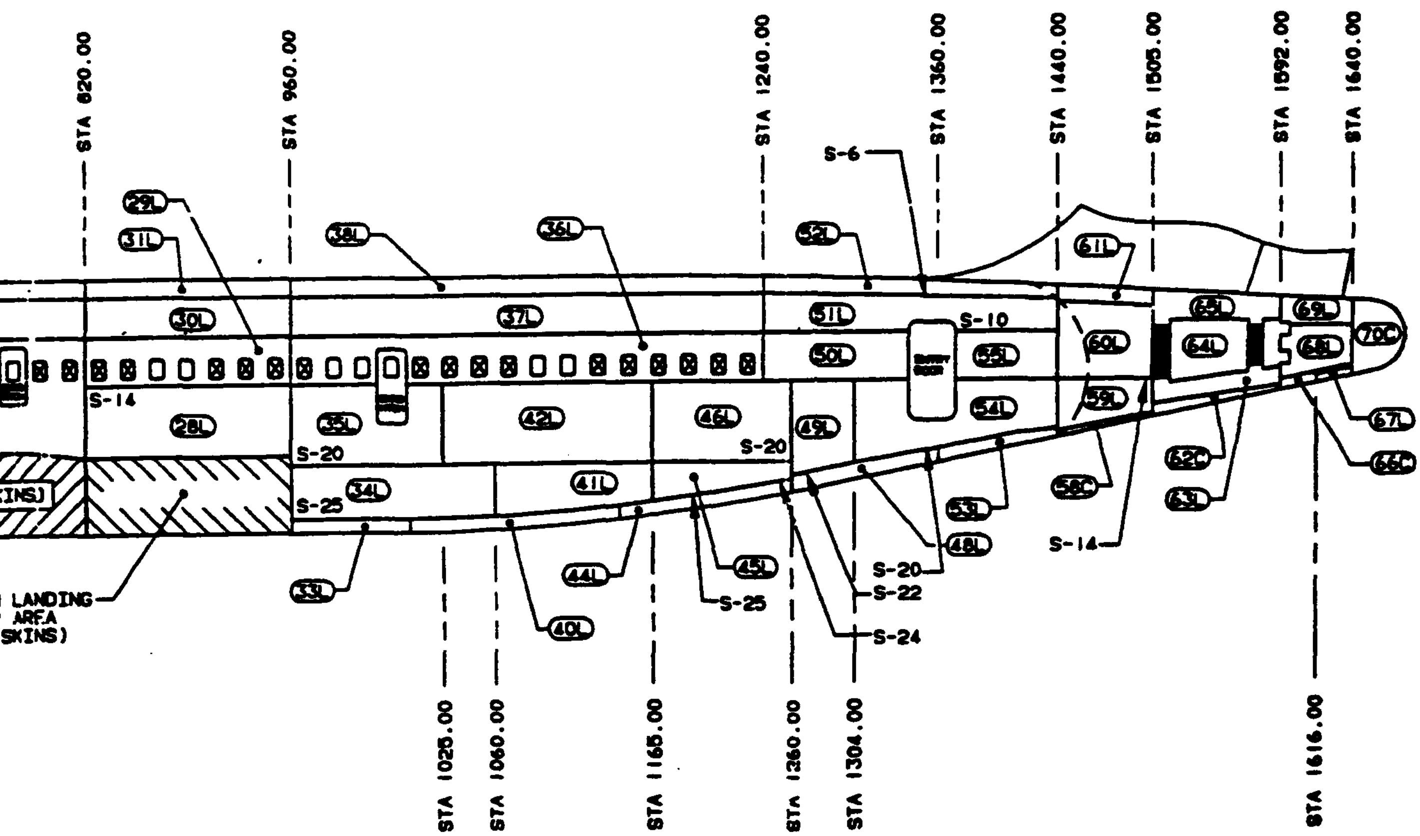


Figure 3.9 - Fuselage Skin Panels - Left Hand Side View


STA 600.00K
STA 820.00
STA 960.00
STA 1240.00
STA 1360.00
S-6
S-10
S-14
S-20
S-25
S-22
S-24
A/C BAY AREA(NO SKINS)
MAIN LANDING GEAR AREA (NO SKINS)
STA 1025.00
STA 1060.00
STA 1165.00
STA 1260.00
STA 1304.00
UP
FWD
LOOKING INBD
LEFT HAND SIDE



LOOKING INBD
LEFT HAND SIDE

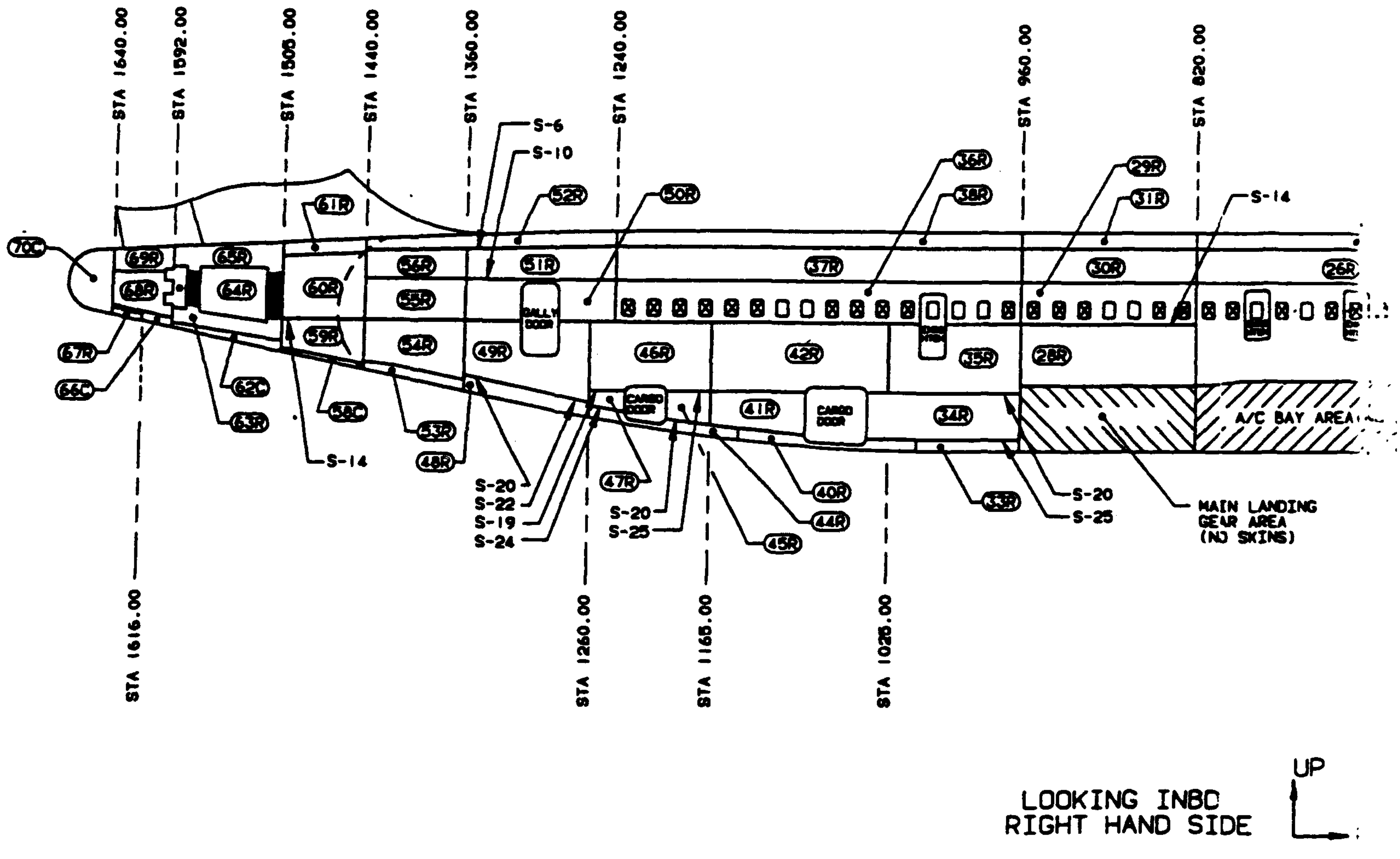
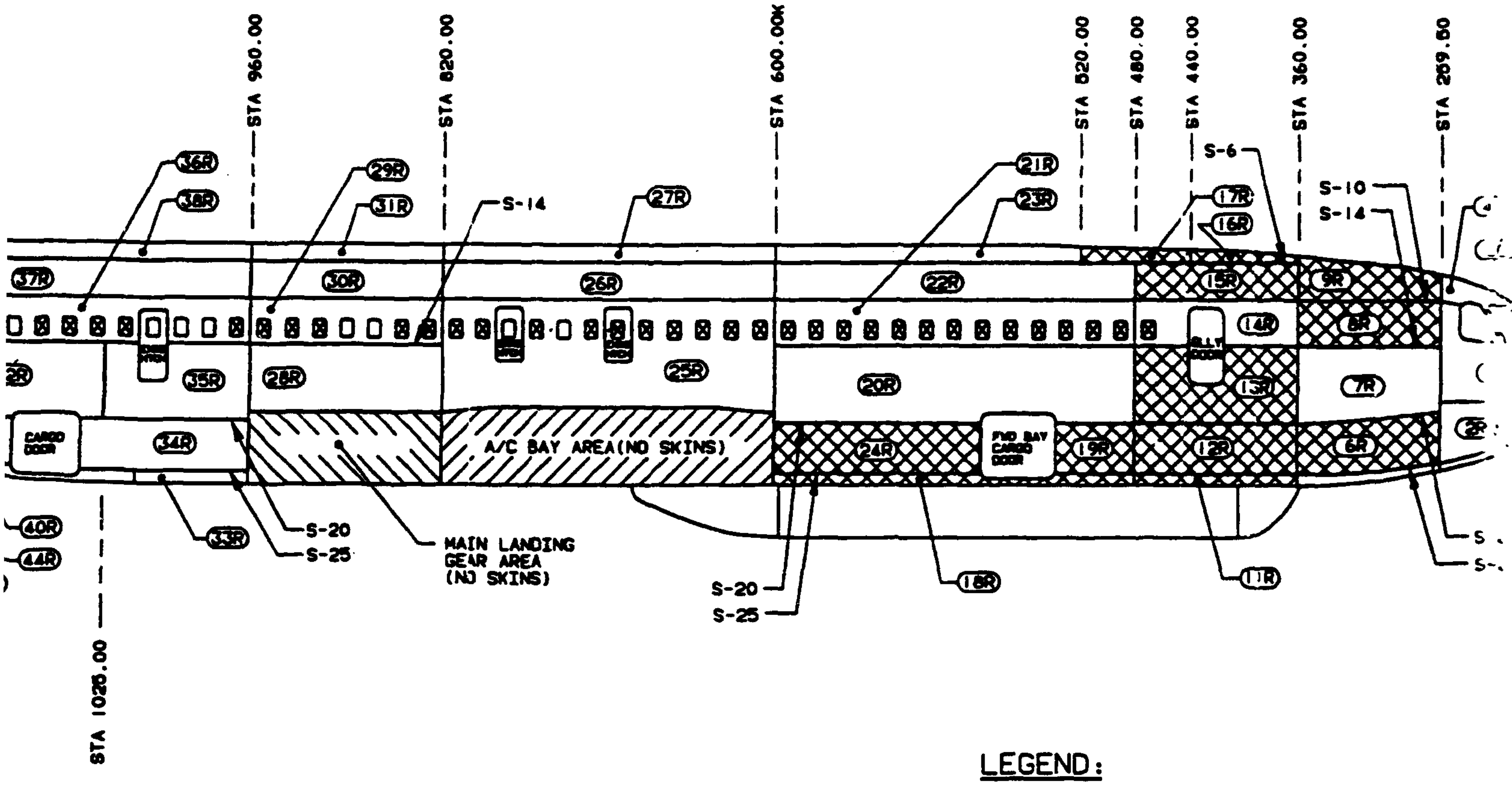


Figure 3.10 - Fuselage Skin Panels - Right Hand Side View

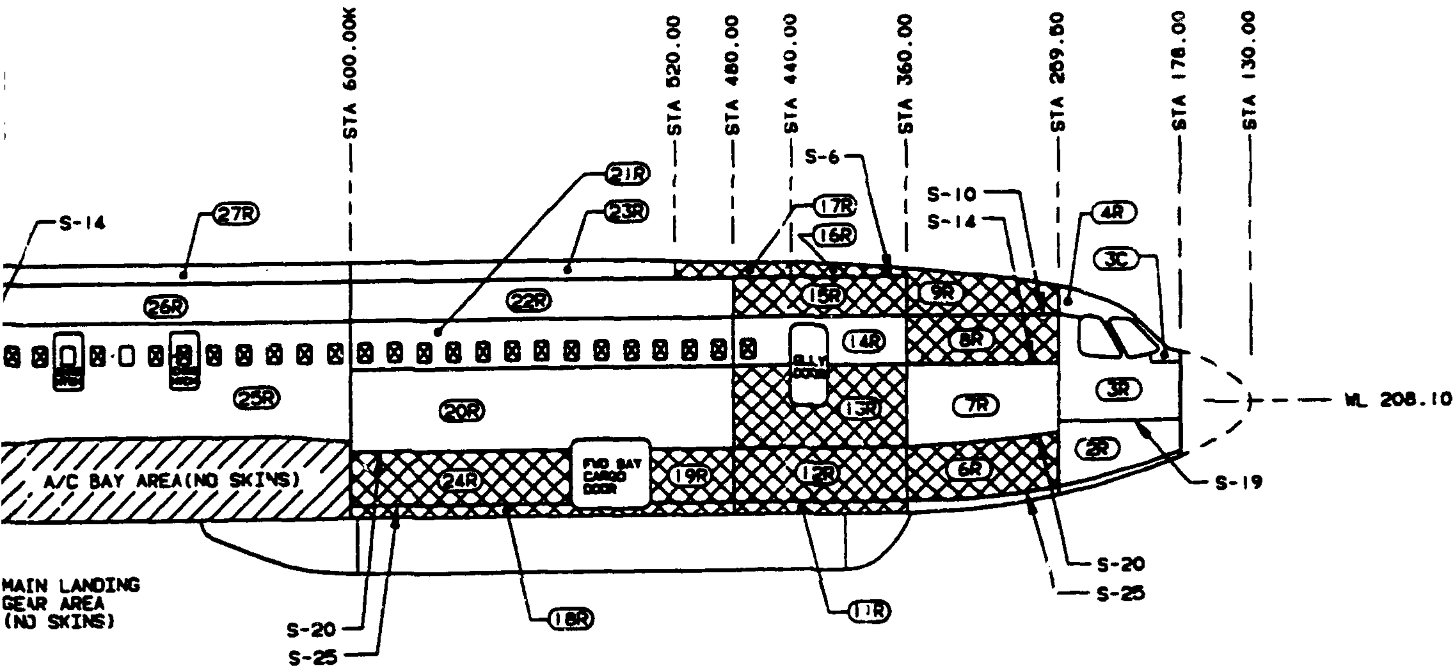


LEGEND:

= SKIN(S) SUBJECT TO REPLACEMENT PER CONTRACT.

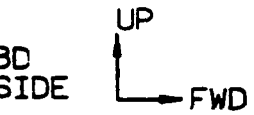
LOOKING INBD
RIGHT HAND SIDE

UP
FWD



LEGEND:

= SKIN(S) SUBJECT TO REPLACEMENT PER CONTRACT.



3.10 WING DIAGRAMS

Figures 3.11 through 3.19 detail the aircraft wing structures. The wing center section upper skins are 7178-T6 or 7075-T6 while the lower skins are 2024-T3 or 2024-T4. The wing planks inboard of WS 360 are made of 2024-T4. Outboard of WS360, the planks are made of 2024-T3. The leading edge of the wings are made of 7075-T6. Interspar structures as well as substructure stringers are made of 7075-T6.

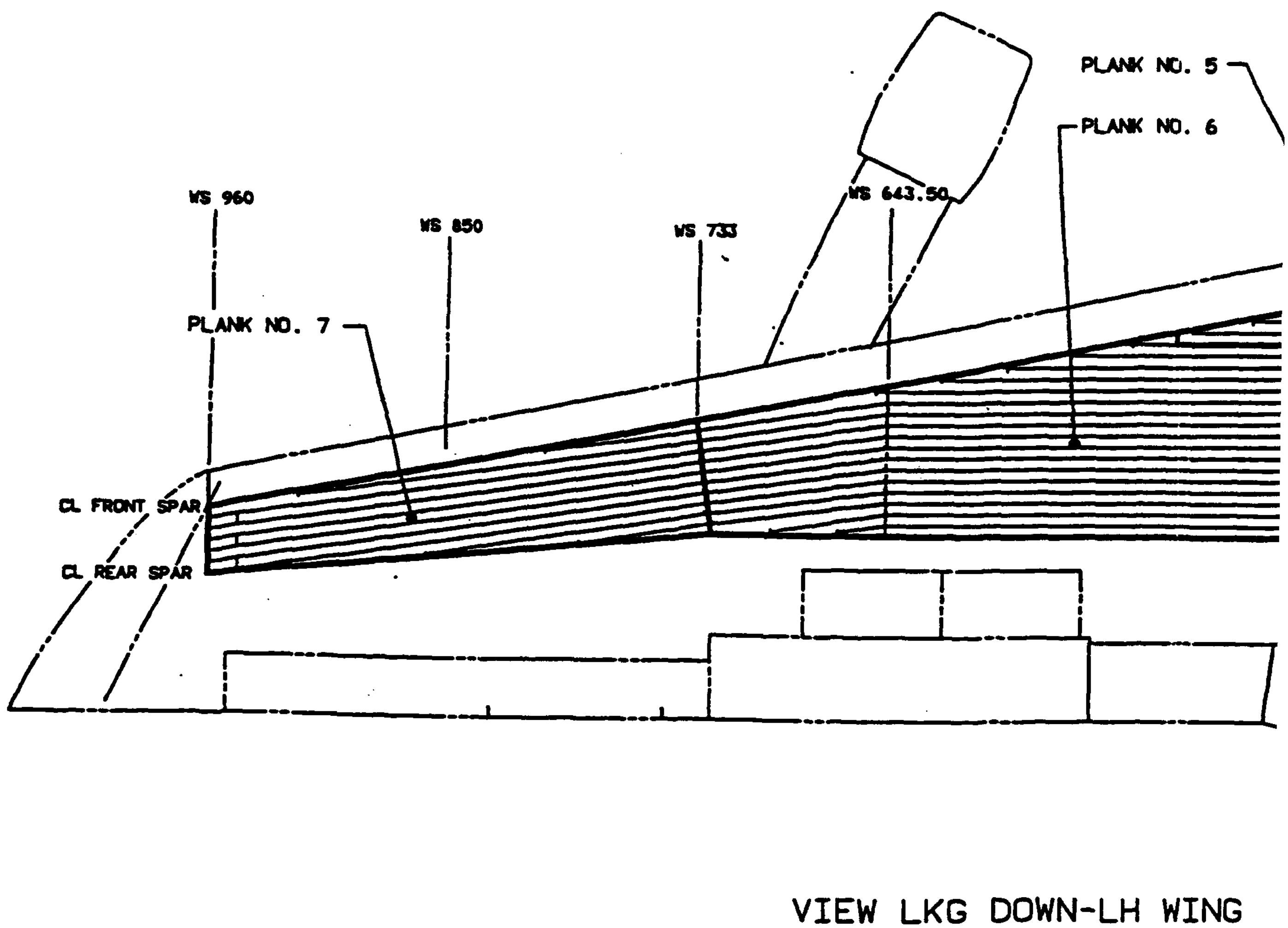
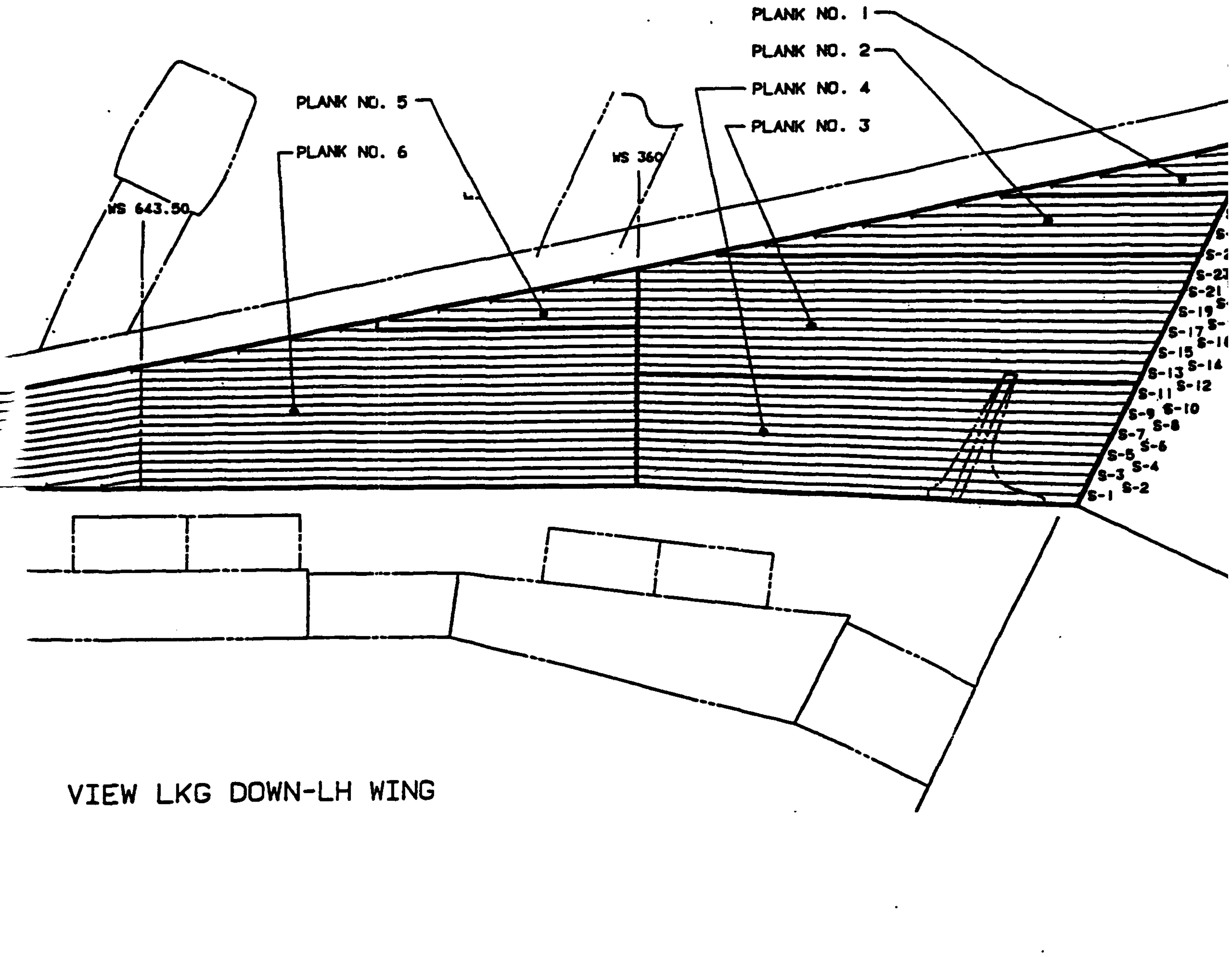
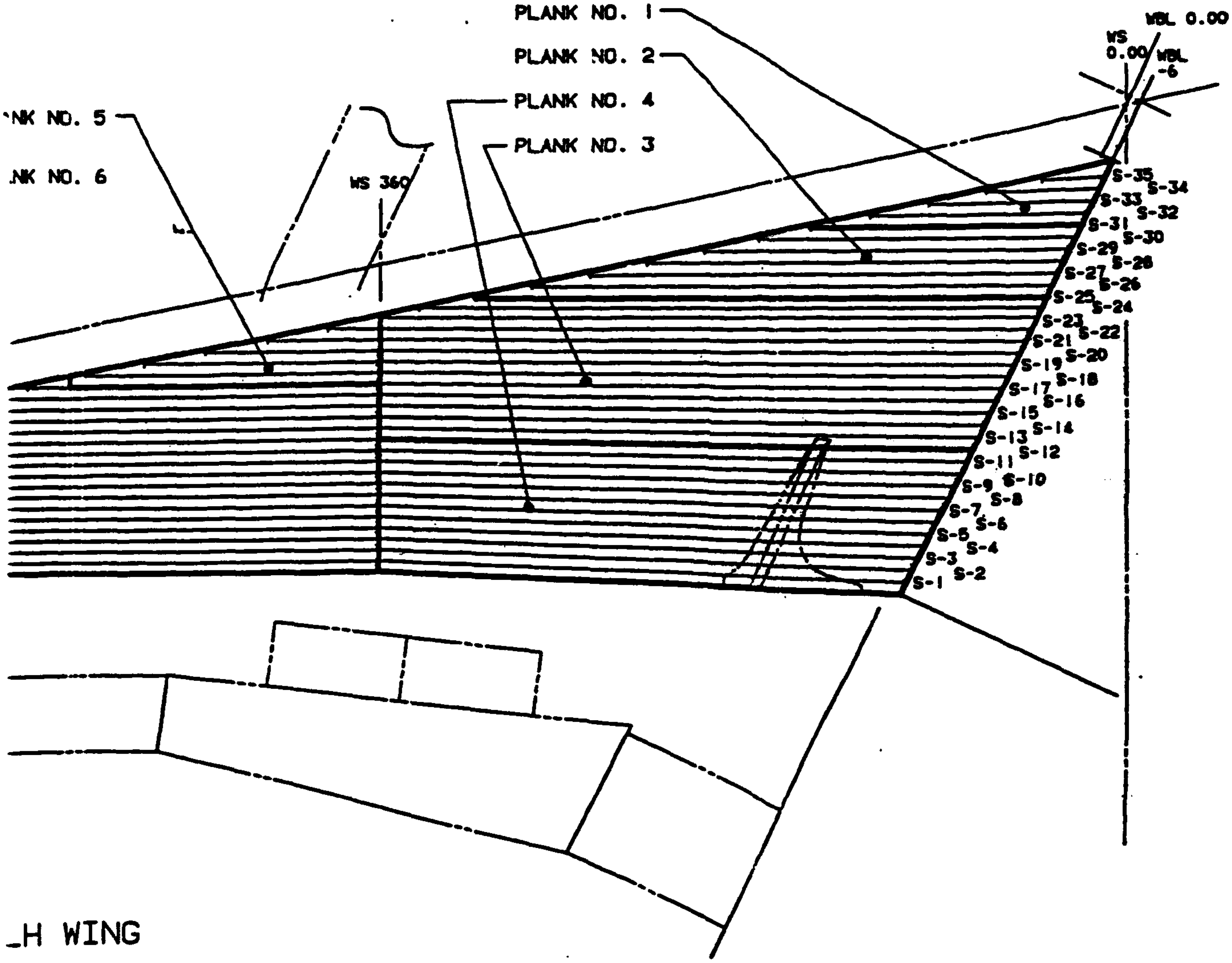


Figure 3.11 - Wing Planks And Stringers, Upper Surface, Left Hand Side Wing.



VIEW LKG DOWN-LH WING


PLANK NO. 1
PLANK NO. 2
PLANK NO. 4
PLANK NO. 3
NK NO. 5
NK NO. 6
WS 360
WBL 0.00
WS 0.00
WBL -6
S-35
S-34
S-33
S-32
S-31
S-30
S-29
S-28
S-27
S-26
S-25
S-24
S-23
S-22
S-21
S-20
S-19
S-18
S-17
S-16
S-15
S-14
S-13
S-12
S-11
S-10
S-9
S-8
S-7
S-6
S-5
S-4
S-3
S-2
S-1

_H WING

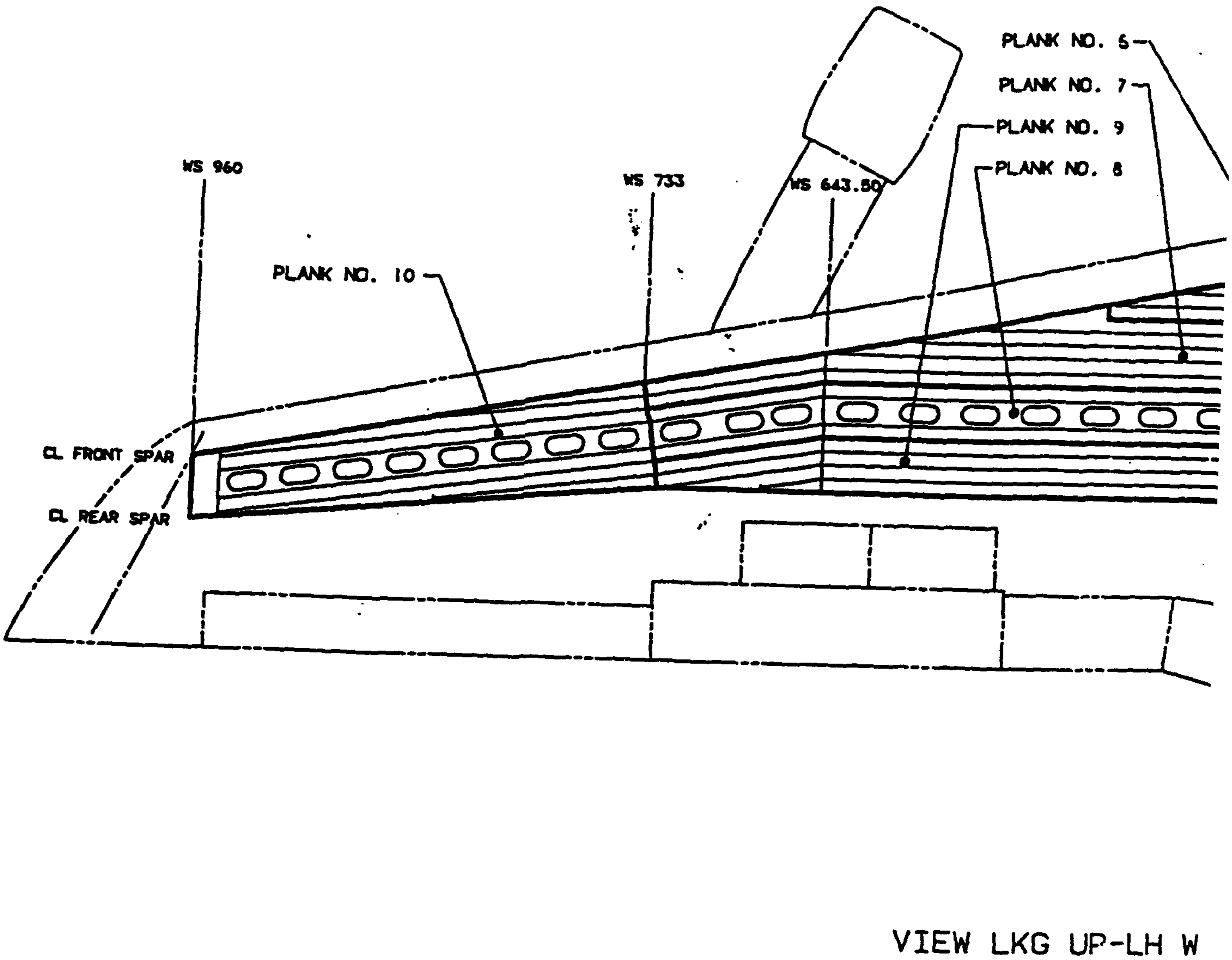
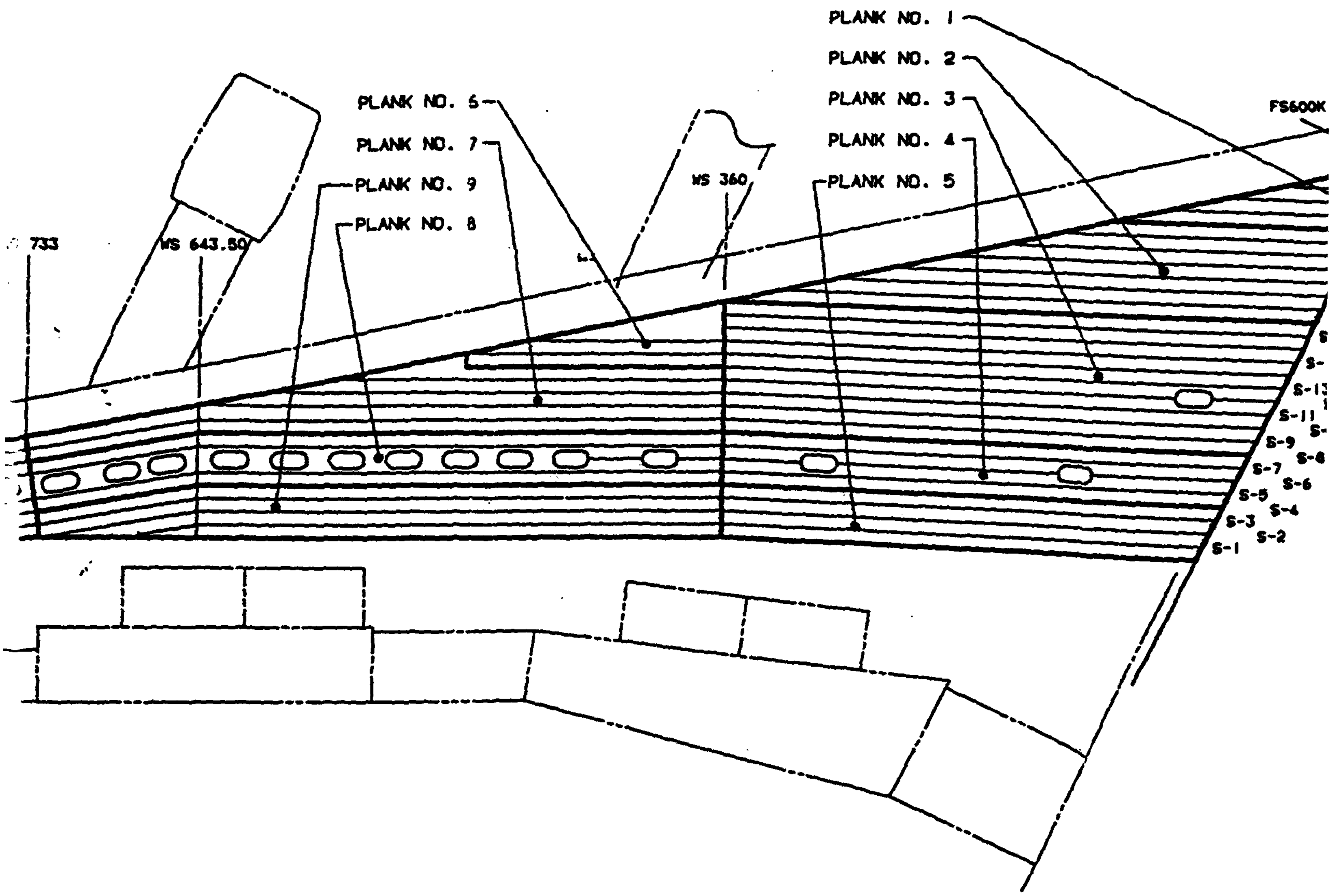
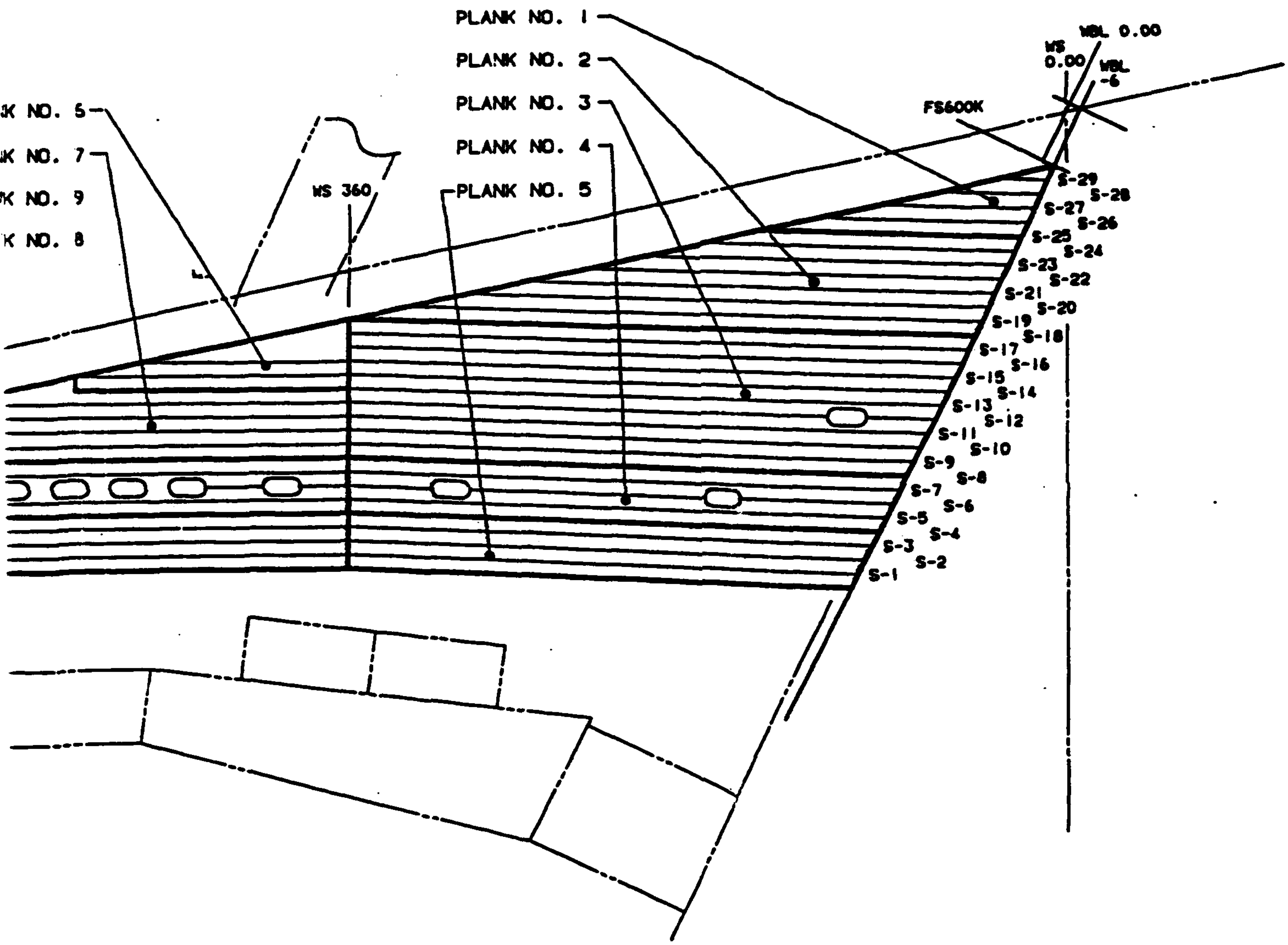


Figure 3.12 - Wing Planks And Stringers, Lower Surface, Left Hand Side Wing.



VIEW LKG UP-LH WING



PLANK NO. 1
PLANK NO. 2
PLANK NO. 3
PLANK NO. 4
PLANK NO. 5
K NO. 5
K NO. 7
K NO. 9
K NO. 8
WS 360
FS600K
WS 0.00
WBL 0.00
WBL -6
S-29
S-28
S-27
S-26
S-25
S-24
S-23
S-22
S-21
S-20
S-19
S-18
S-17
S-16
S-15
S-14
S-13
S-12
S-11
S-10
S-9
S-8
S-7
S-6
S-5
S-4
S-3
S-2
S-1

'G UP-LH WING

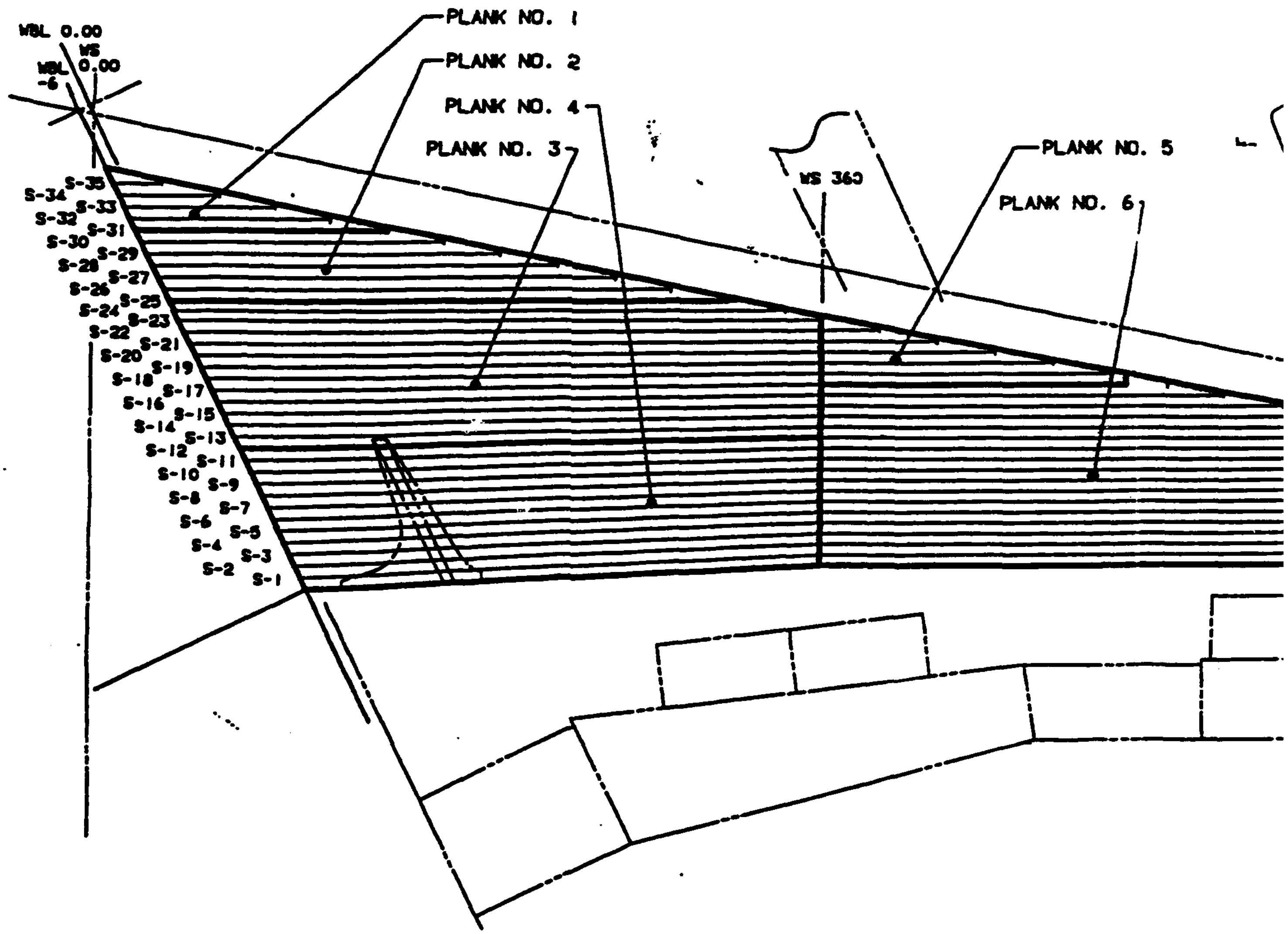
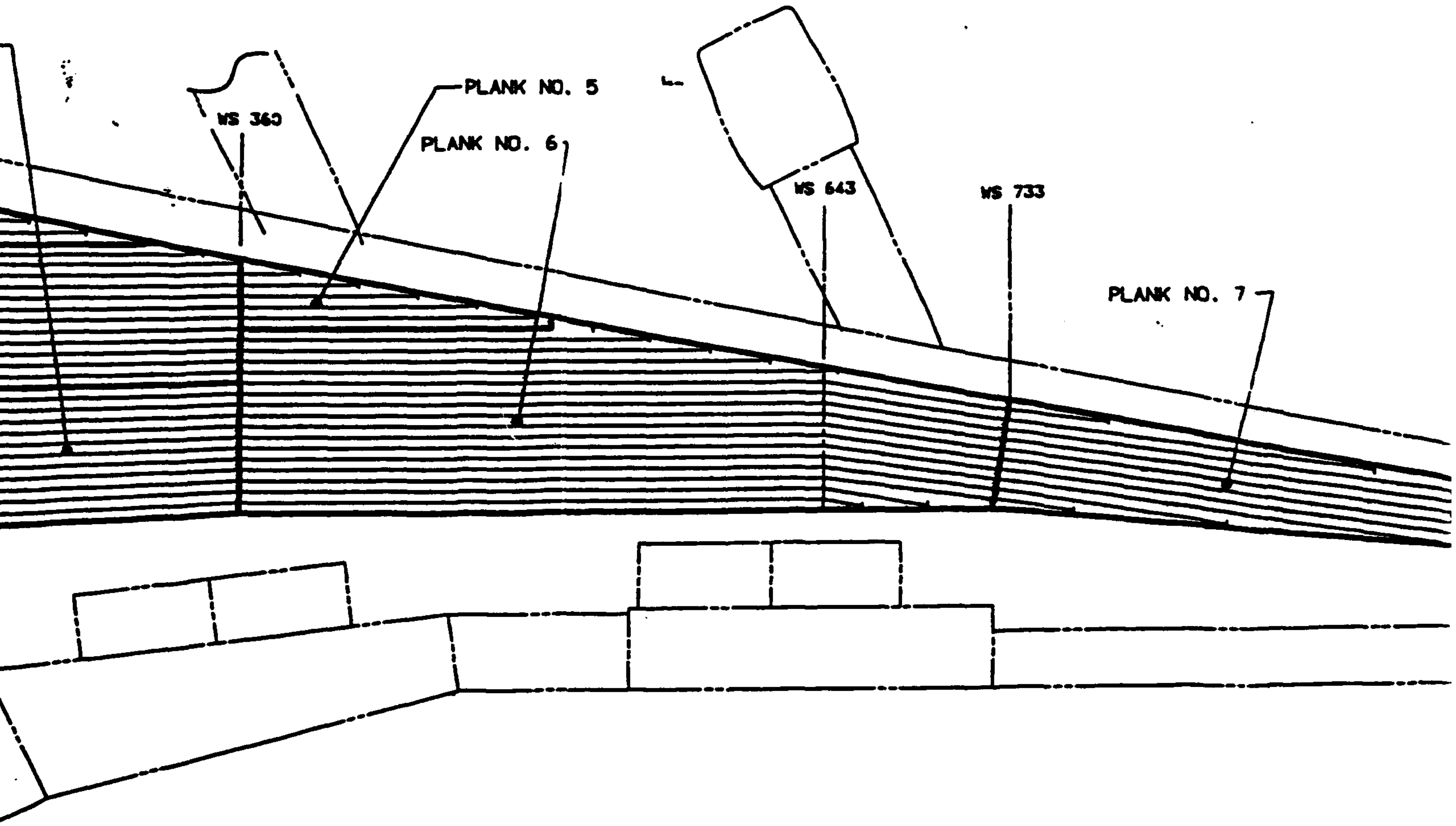
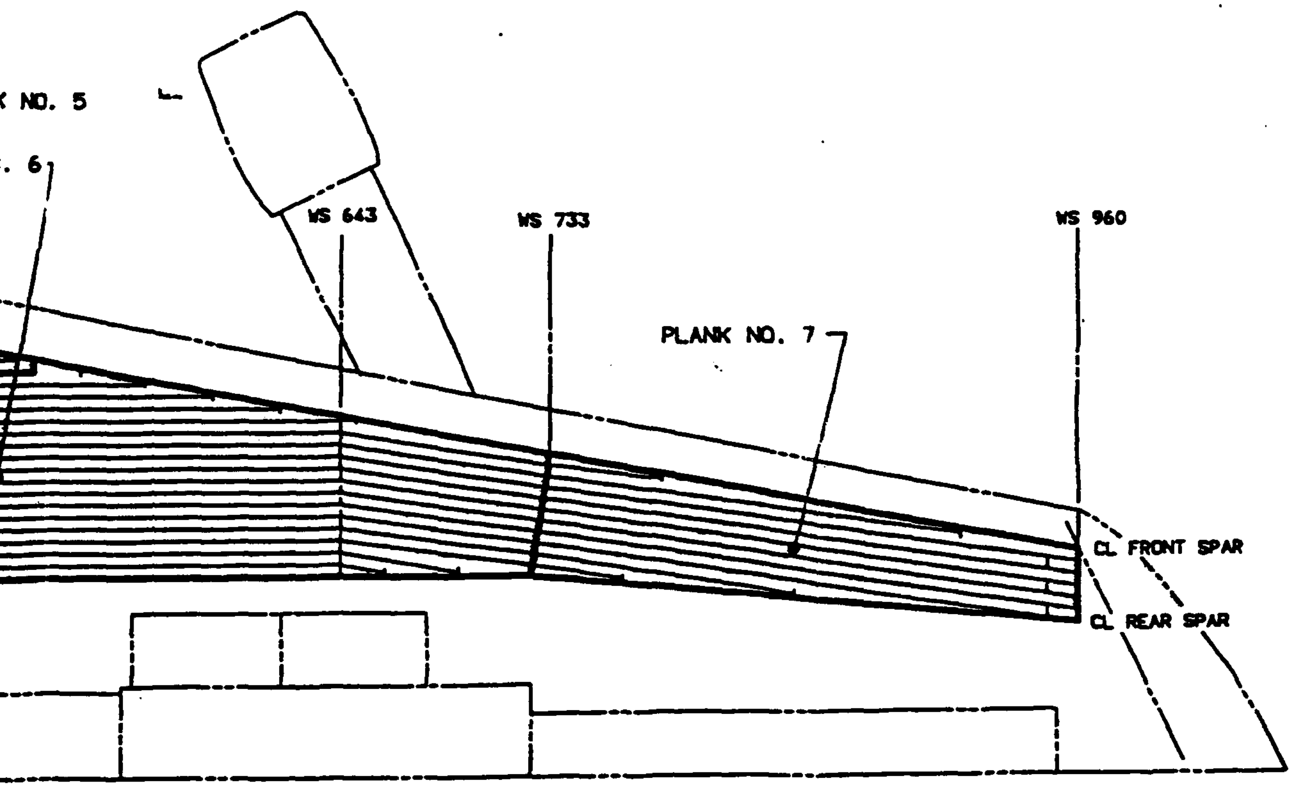


Figure 3.13 - Wing Planks And Stringers, Upper Surface, Right Hand Side Wing.



VIEW LKG DOWN-RH WING

Wing.



LKG DOWN-RH WING

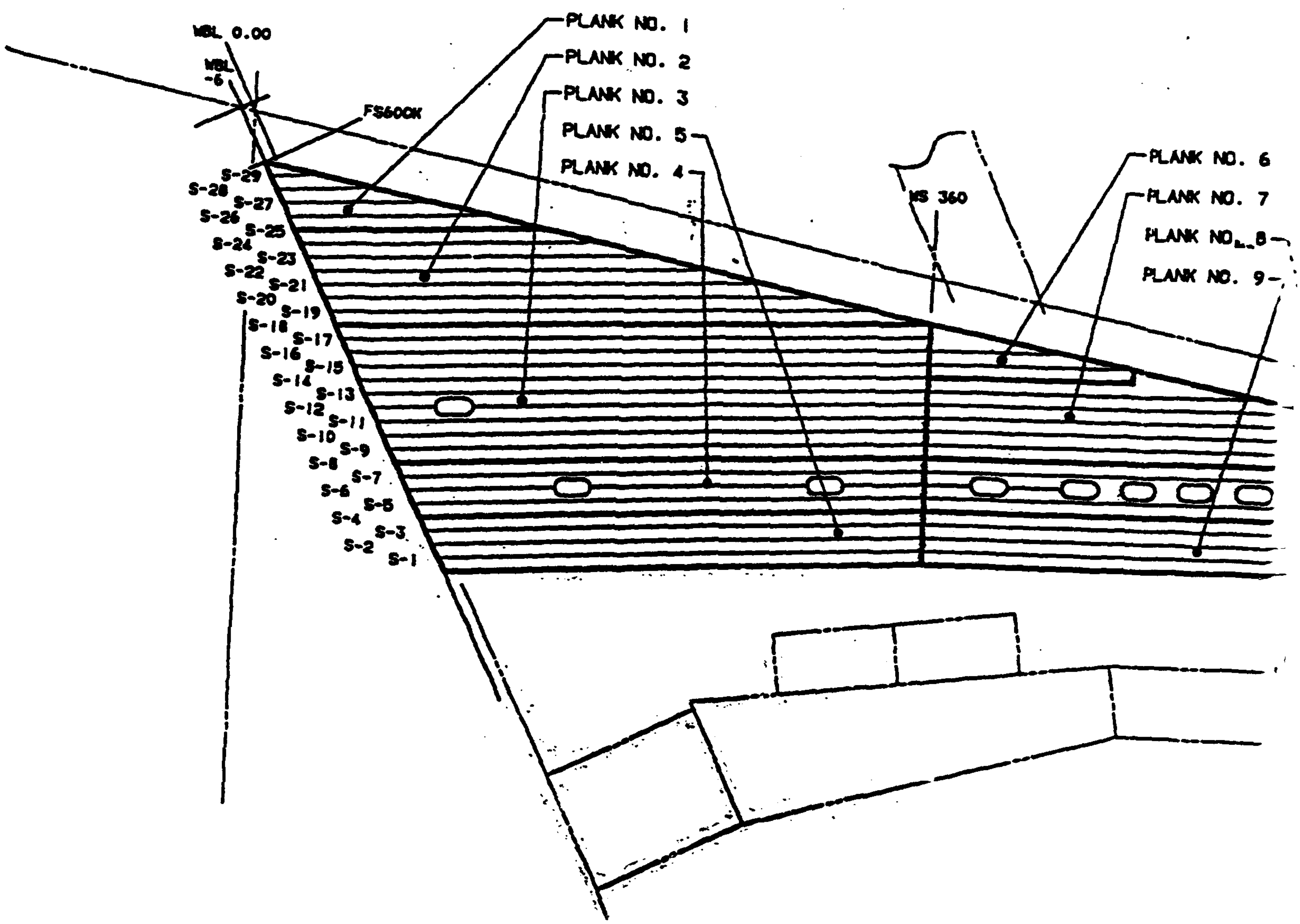
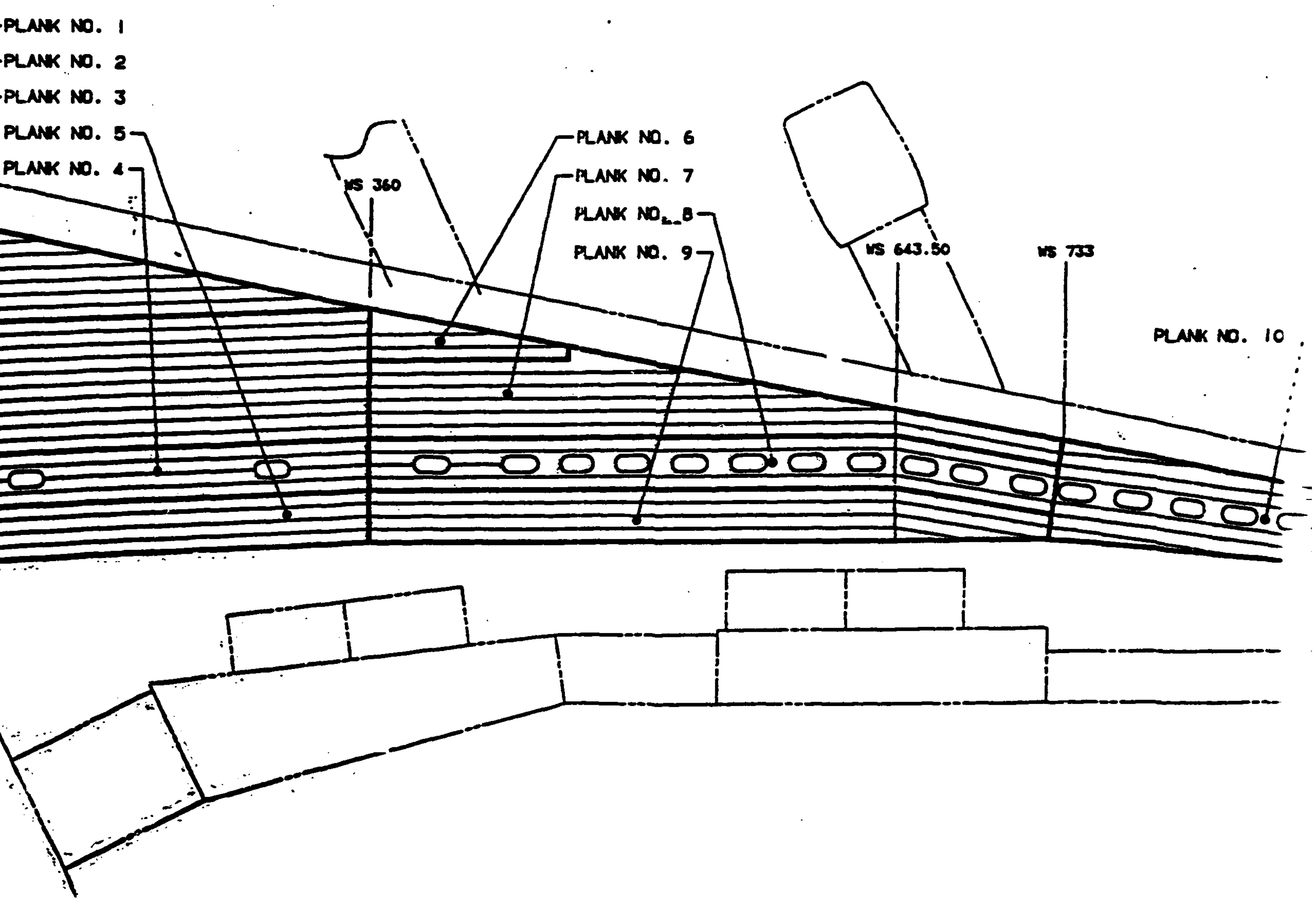


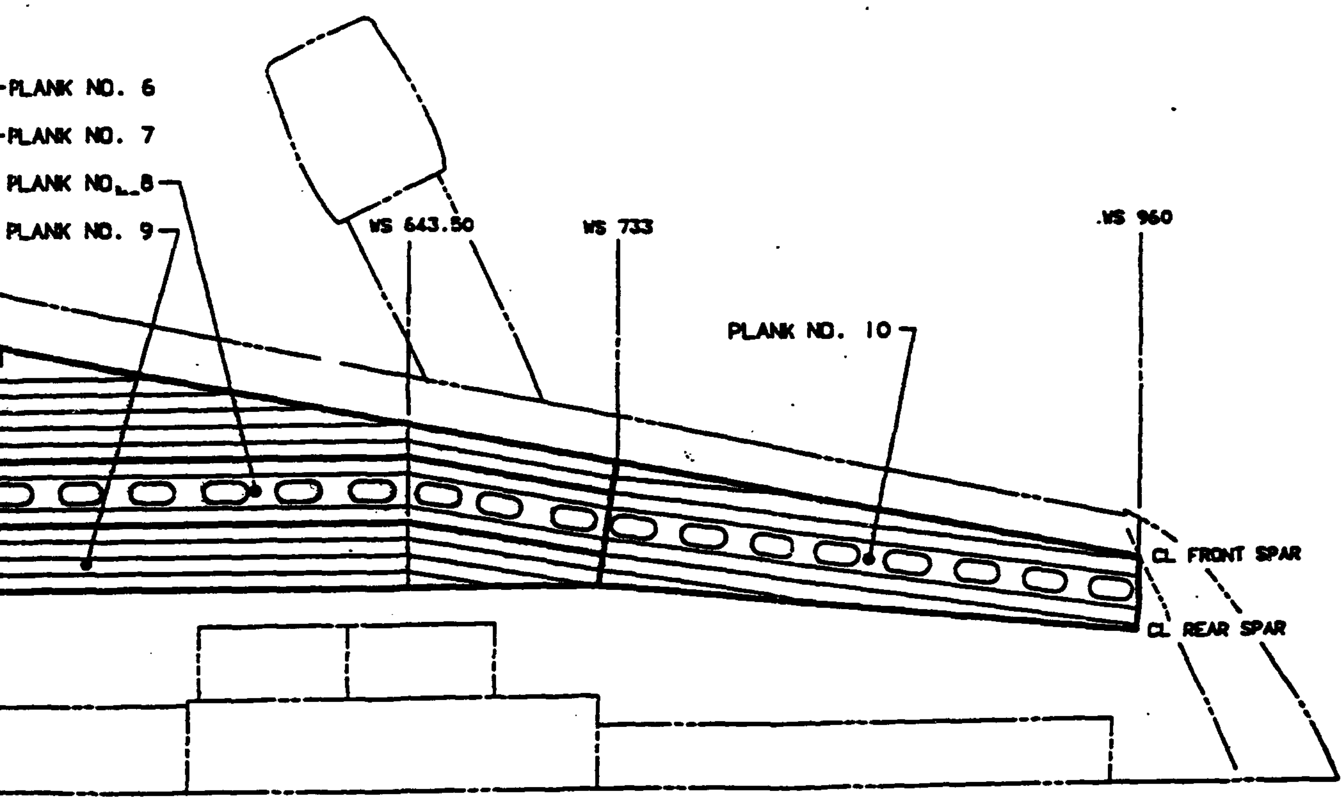
Figure 3.14 - Wing Planks And Stringers, Lower Surface, Right Hand Side Wing.

VIEW LKG UP-RH W



-Hand Side Wing.

VIEW LKG UP-RH WING


PLANK NO. 6
PLANK NO. 7
PLANK NO. 8
PLANK NO. 9
WS 643.50
WS 733
WS 960
PLANK NO. 10
CL FRONT SPAR
CL REAR SPAR

S UP-RH WING

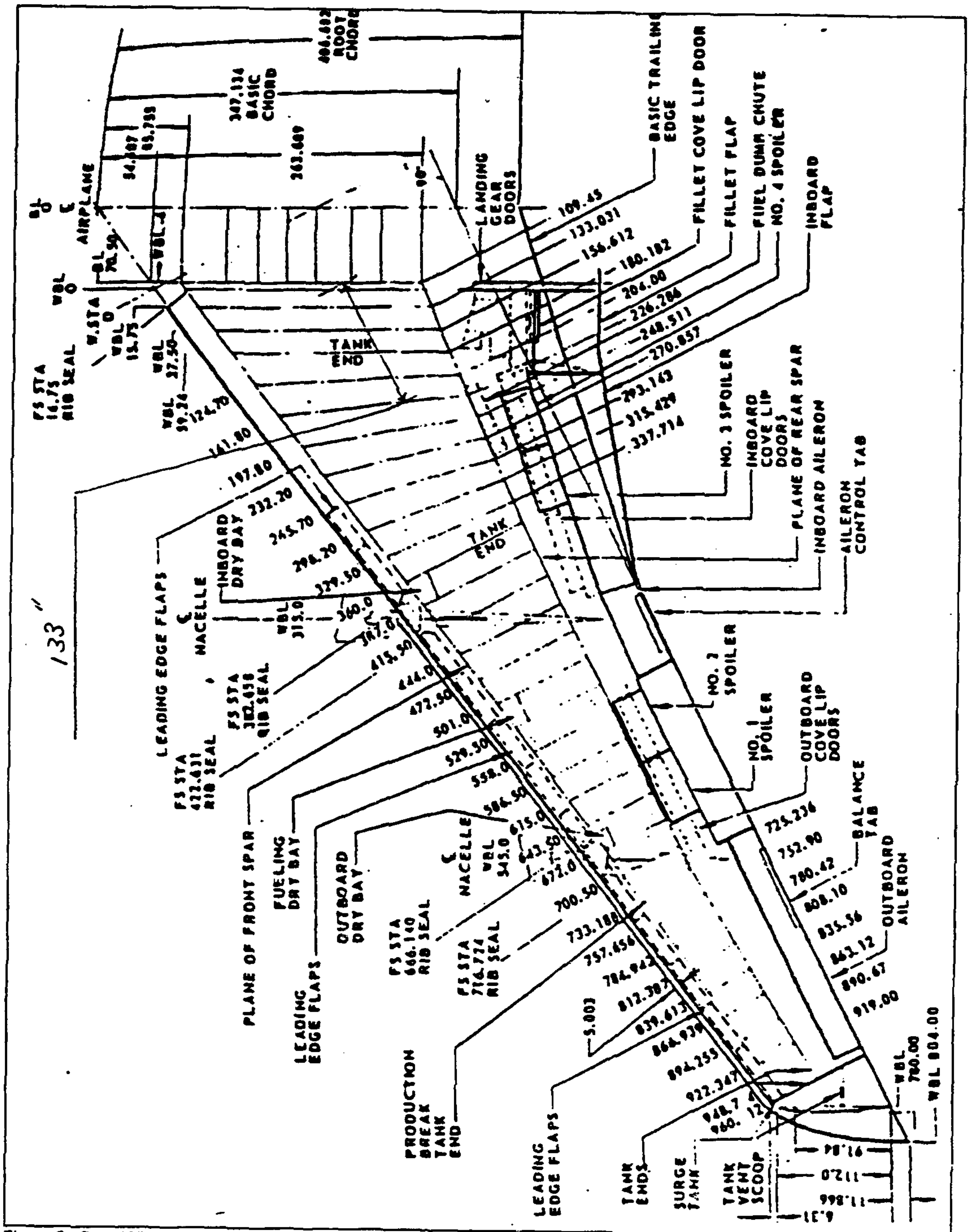


Figure 3.15 - Wing Centerline - Left Hand Side Wing (Boeing 707 Intercontinental Structural Repair Manual)

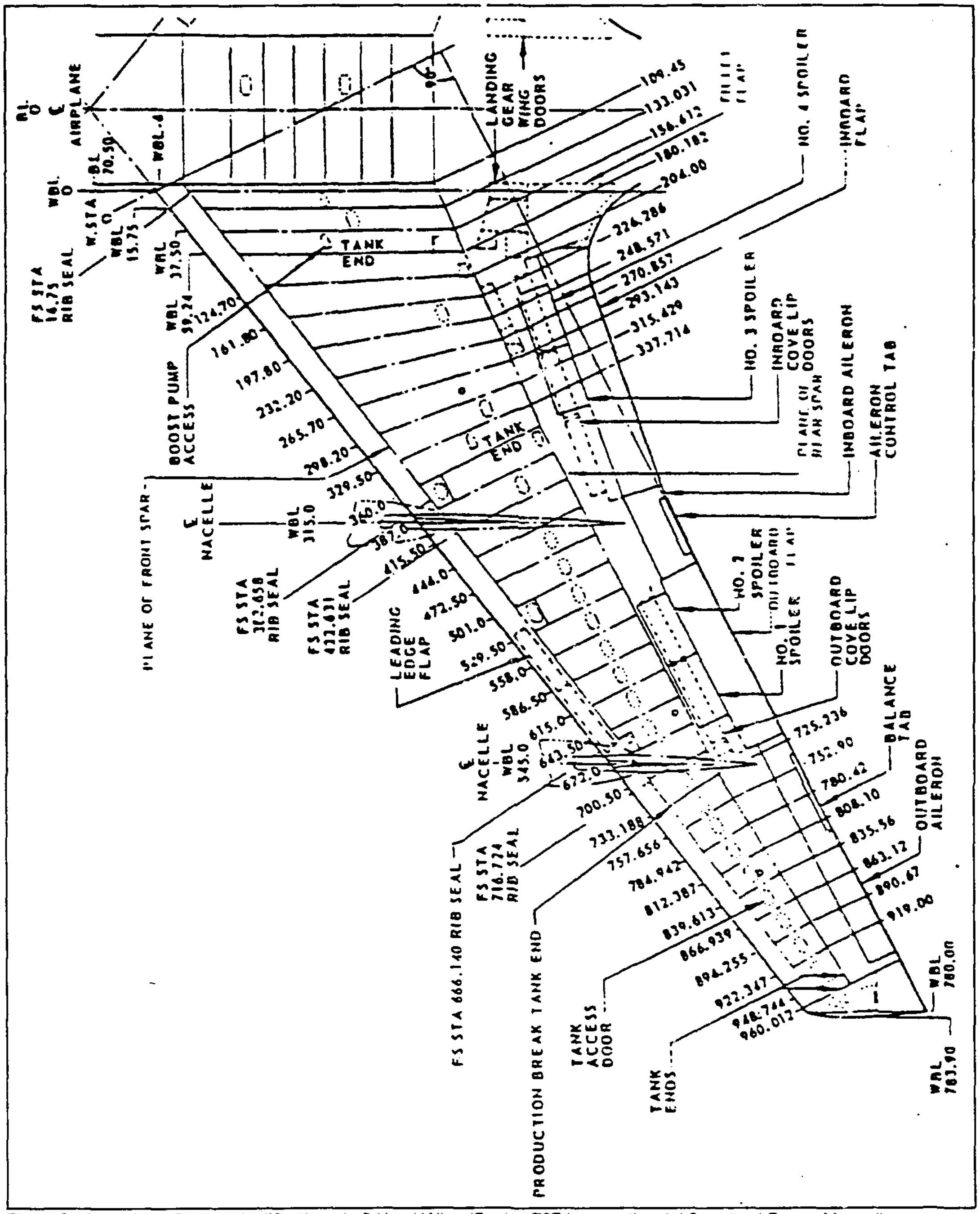


Figure 3.16 - Wing Station Identification - Left Hand Wing (Boeing 707 Intercontinental Structural Repair Manual)

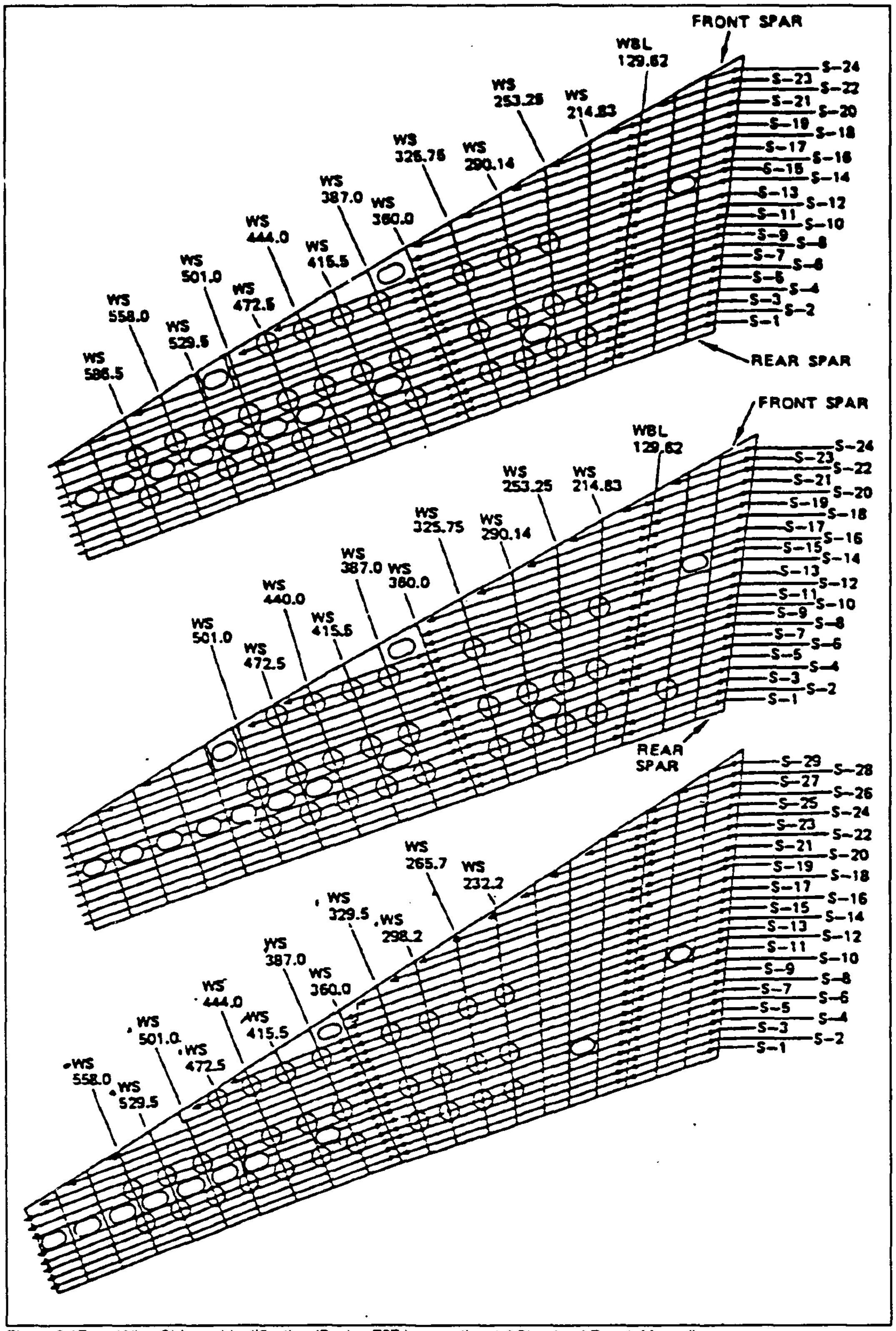


Figure 3.17 - Wing Stringer Identification (Boeing 707 Intercontinental Structural Repair Manual)

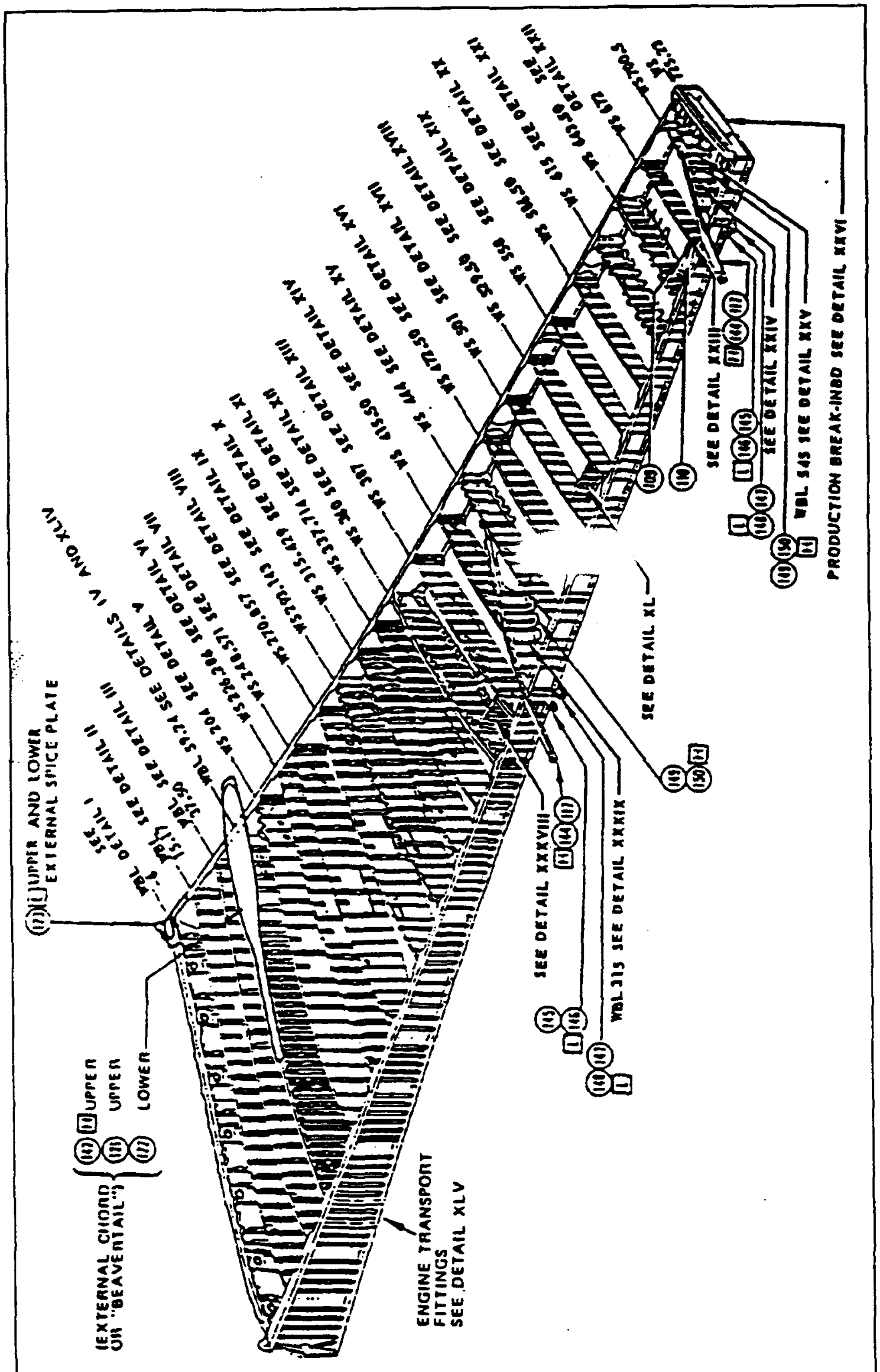


Figure 3.18 - Wing Interspar Structures - WS 0 Through WS 725 (Boeing Structural Repair Manual)

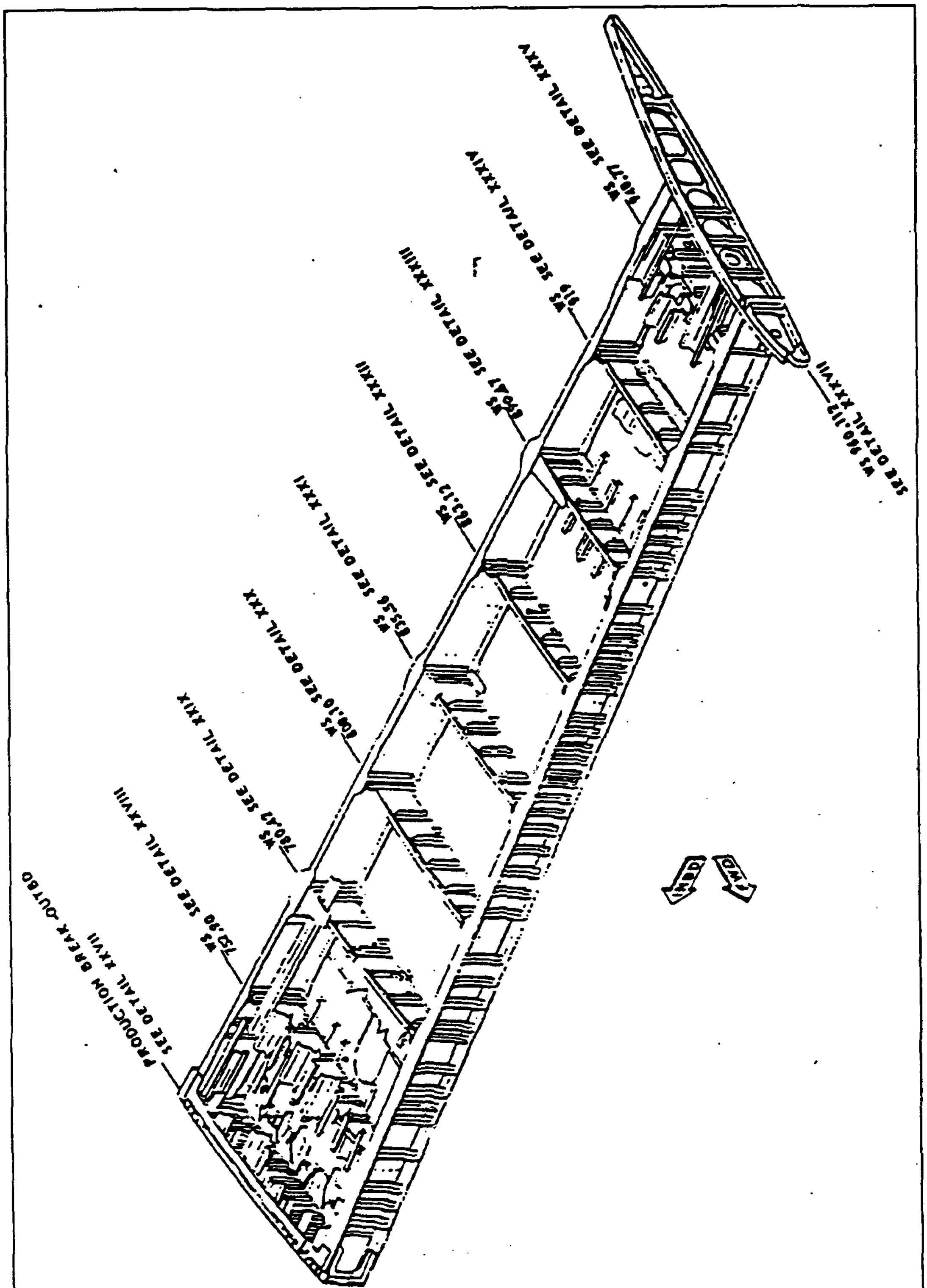


Figure 3.19 - Wing Interspar Structures - WS 725 Through WS 960 (Boeing Structural Repair Manual)

3.11 HORIZONTAL AND VERTICAL STABILIZER DIAGRAMS

Figures 3.20 to 3.22 detail the horizontal and vertical stabilizer structures. The horizontal and vertical stabilizers utilize similar materials. The leading edge is made of 7075-T6 aluminum. The skin panels are made of either 2024-T3 or 2024-T4 except for the horizontal stabilizer upper skins inboard of station 92.55, which are made of corrosion resistant steel. The interspar structures utilize 7075-T6 for upper and lower chords; the webs are CLAD 2024-T3, CLAD 2024-T4 or 7075-T6.

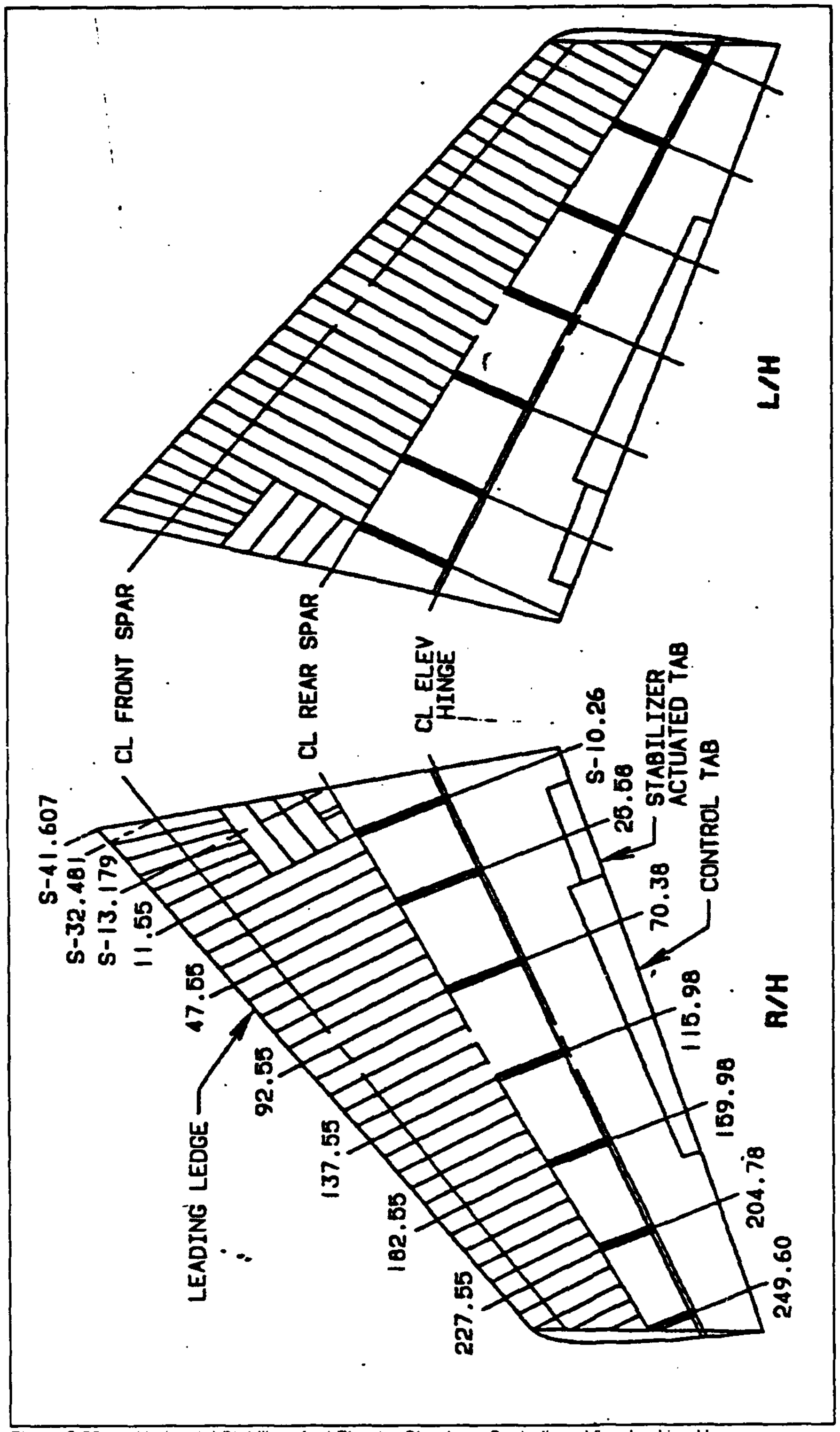


Figure 3.20 - Horizontal Stabilizer And Elevator Structure, Centerline - View Looking Up

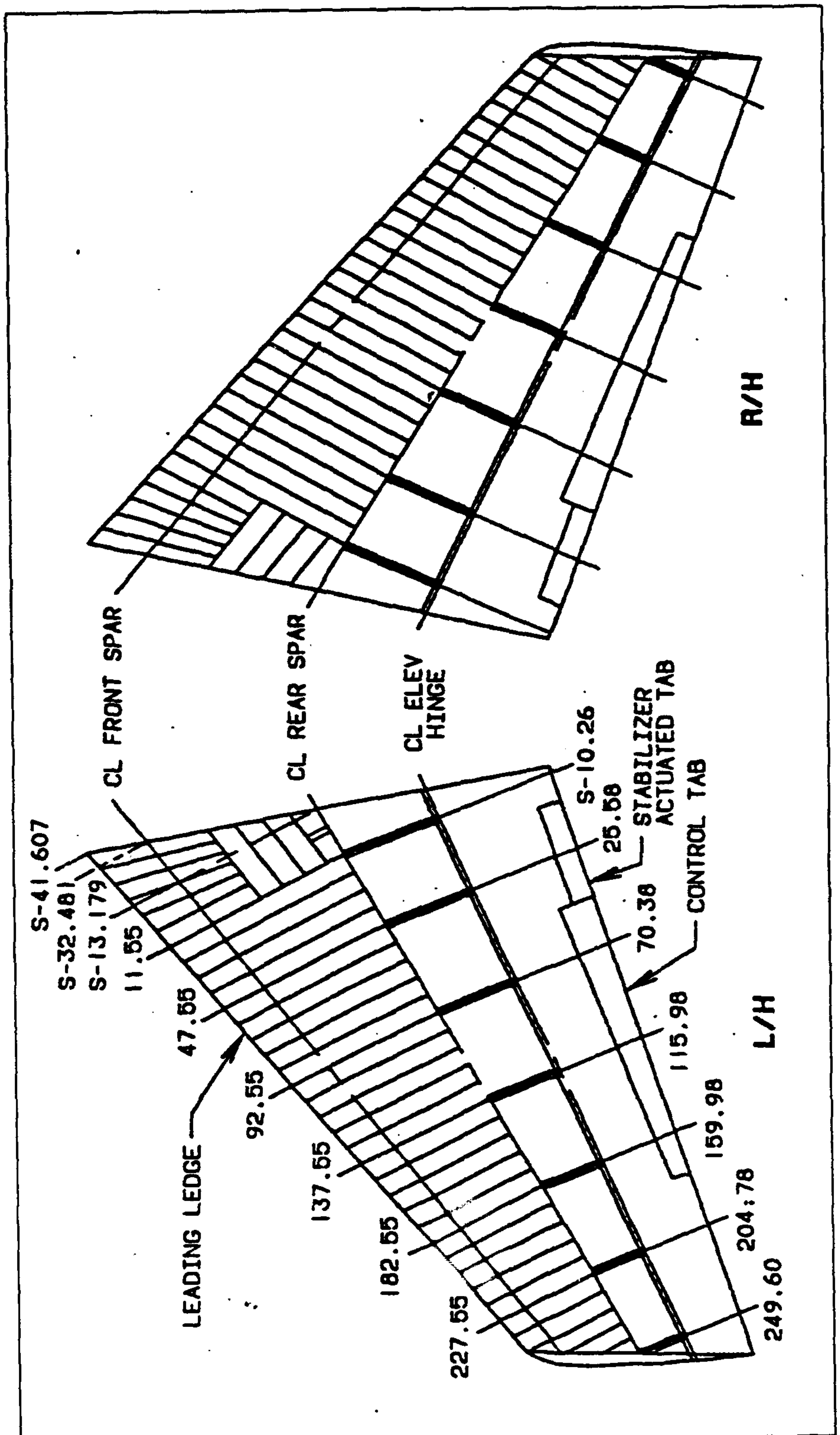


Figure 3.21 - Horizontal Stabilizer And Elevator Structure, Centerline - View Looking Down

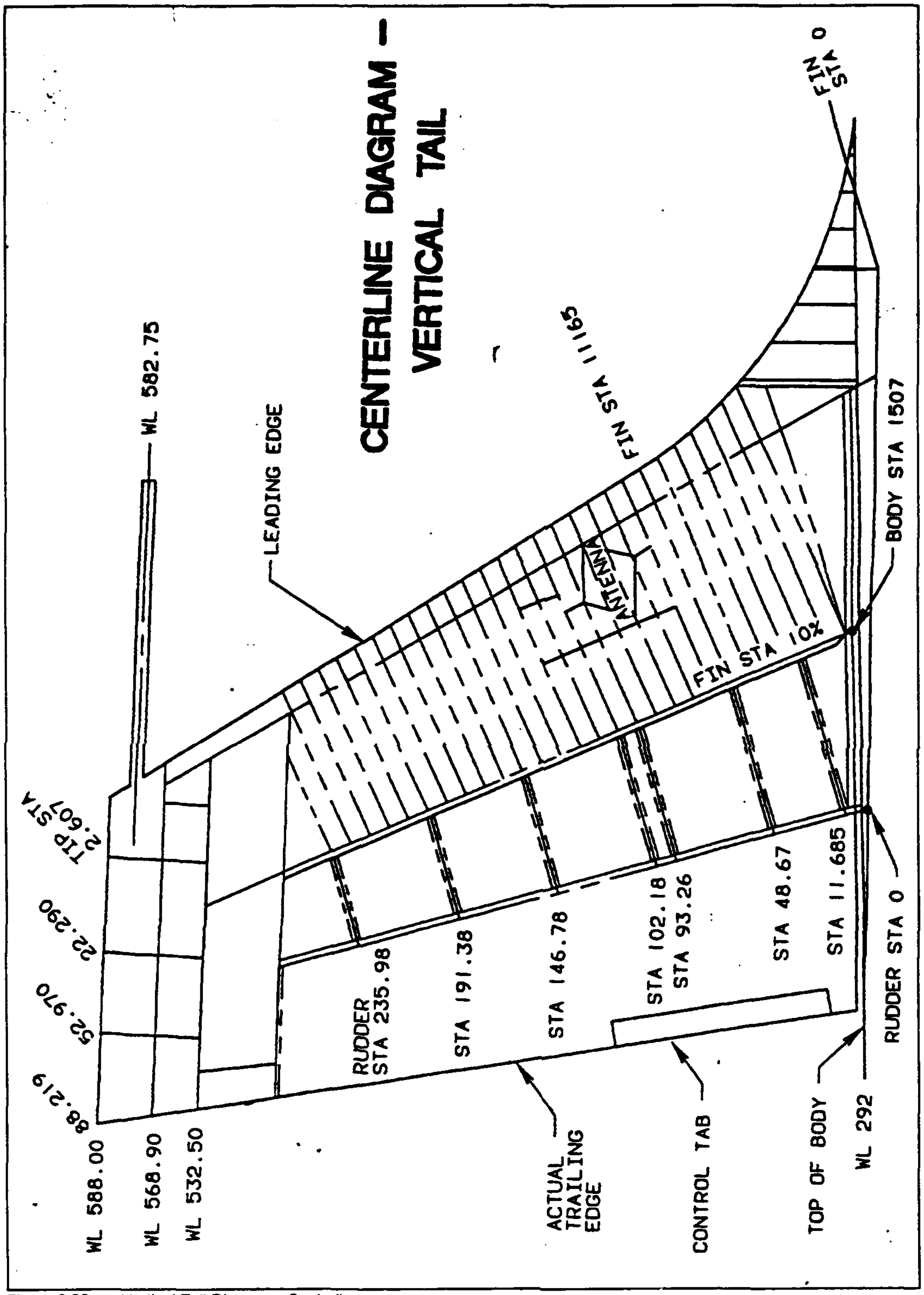


Figure 3.22 - Vertical Tail Diagram - Centerline

SECTION 4

CORROSION AND FATIGUE DAMAGE ANALYSIS

The following section summarizes the corrosion and fatigue survey conducted on the Joint STARS P-3 and P-4 aircraft.

4.1 INTRODUCTION

An executive summary of the analysis of the data is presented in this section. Focused analyses of corrosion and fatigue damage locations specific to the type of structure and location of the aircraft are presented. During aircraft refurbishment, unexpected damage was documented in over and above discrepancy reports (O&As). The subject study entered details of structurally significant O&As into an access database.

The original intent of the study was to use the gathered data on corrosion and widespread fatigue damage (WFD) as a first step to characterizing the interaction of corrosion and fatigue. A lack of stress analyses and durability and damage tolerance (DADT) analyses on the non-modified portions of the Joint STARS aircraft at the time of the study contract prevent an analysis of the effects of surveyed damage on expected life.

4.2 OVERALL AIRCRAFT

Figure 4.1 is an overall summary of corrosion and fatigue damage. This chart encompasses all principle structural elements included in the survey. Codes used for documenting the types of corrosion are shown in the upper right hand corner of this figure and appear in all subsequent figures. Aircraft zone and location information and diagrams can be found throughout section 3.

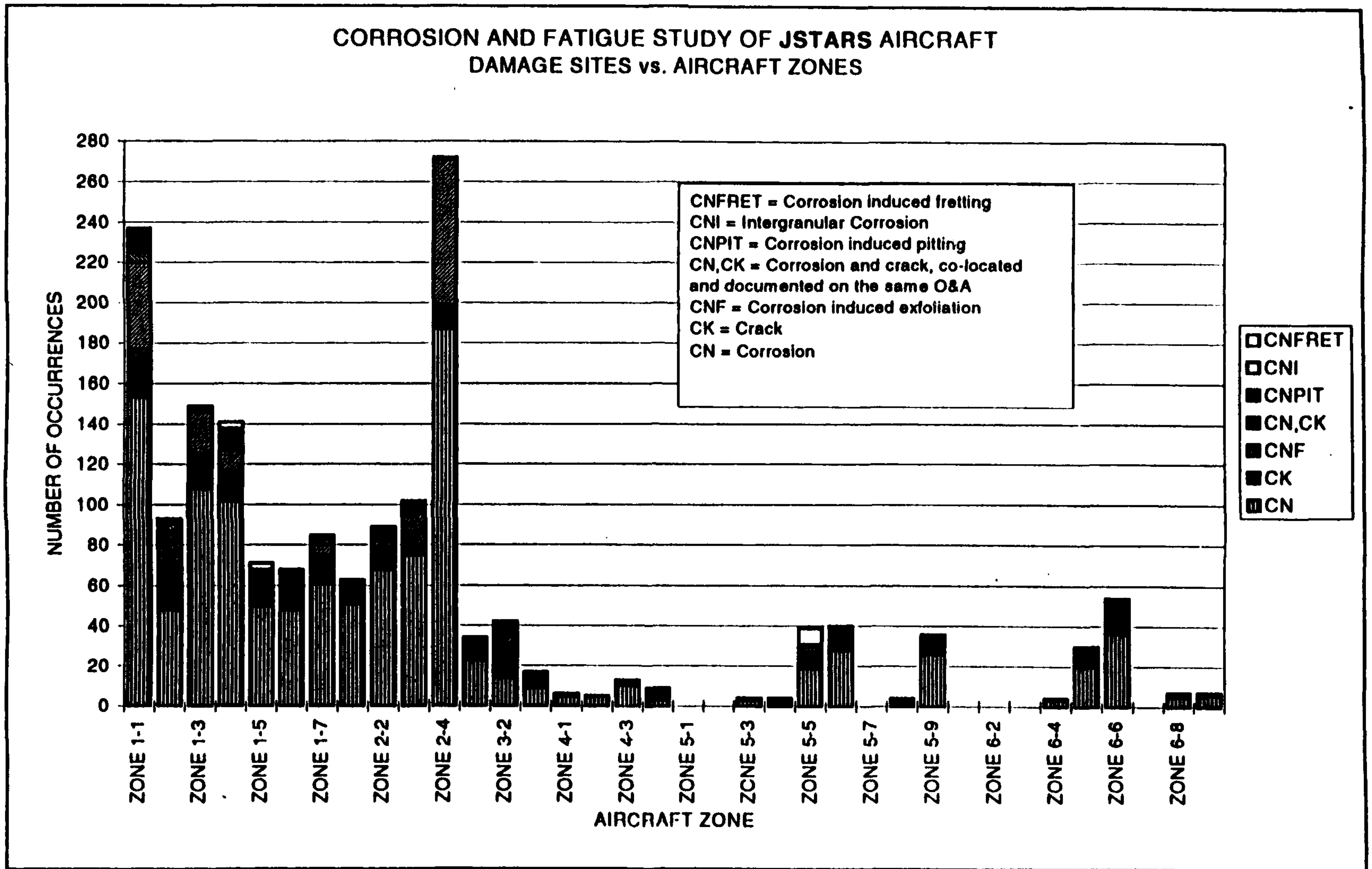


Figure 4.1 - Corrosion And Fatigue Damage Per Aircraft Zone On Joint STARS Aircraft P3 And P4

The areas of highest damage on the fuselage are in the following zones:

1. Zone 1-1 (LOWER FUSELAGE - LOWER 41 SECTION AND ELECTRICAL & ELECTRONICS COMPARTMENT BS 178-360)
2. Zone 1-3 (CENTER WING CAVITY - BS 600K-960)
3. Zone 1-4 (LOWER FUSELAGE - AFT CARGO BS 960-1440)
4. Zone 2-3 (AFT PASSENGER CABIN BS 820-1440). Zone 2-4 (SEAT TRACKS AND FLOOR BEAMS BS 304 - 1440)
5. Zones 1-6 and 1-7 (MAIN LANDING GEAR WHEEL WELLS, BS 820 - 960) are noted for having a high frequency of corrosion and fatigue damage in a relatively small area when compared to the size of the other fuselage zones.

The main wings display, at least numerically, a lesser degree of fatigue and corrosion damage. The damage found in the wings is concentrated in the inboard sections. The specific zones affected are:

1. Zone 5-5 (NUMBER 1 MAIN TANK)
2. Zone 5-6 (NUMBER 2 MAIN TANK)
3. Zone 6-5 (NUMBER 3 MAIN TANK)
4. Zone 6-6 (NUMBER 4 MAIN TANK)
5. Zone 5-9 (LEFT INBOARD TRAILING EDGE).

There is a notable lack of corresponding data to zone 5-9 in zone 6-9 (RIGHT INBOARD TRAILING EDGE). The zone 5-9 damage is a condition specific to the P-3 aircraft.

Verification of this discrepancy with the Lake Charles personnel reveals that the data is accurate.

The Left Horizontal Stabilizer (zone 3-1) and Right Horizontal Stabilizer (zone 3-2) account for the majority of reported damage sites in the aft stabilizers. The vertical tail displays far fewer data points than expected. Once again, this was verified with the Lake Charles personnel and was found to be accurate.

Figure 4.2 and 4.3 report the percentage of over and above (O&A) reports per aircraft zone for P-3 and P-4 respectively. The levels of damage trend consistently between aircraft in zones 1-1, 1-4, 5-5, 5-6, 6-5 and 6-6. The P-4 aircraft has high levels of damage in zones 2-2 and 2-4 which are not present on aircraft P-3. Conversely, the P-3 aircraft has a relatively high level of damage in zone 5-9 not seen on the P-4 aircraft.

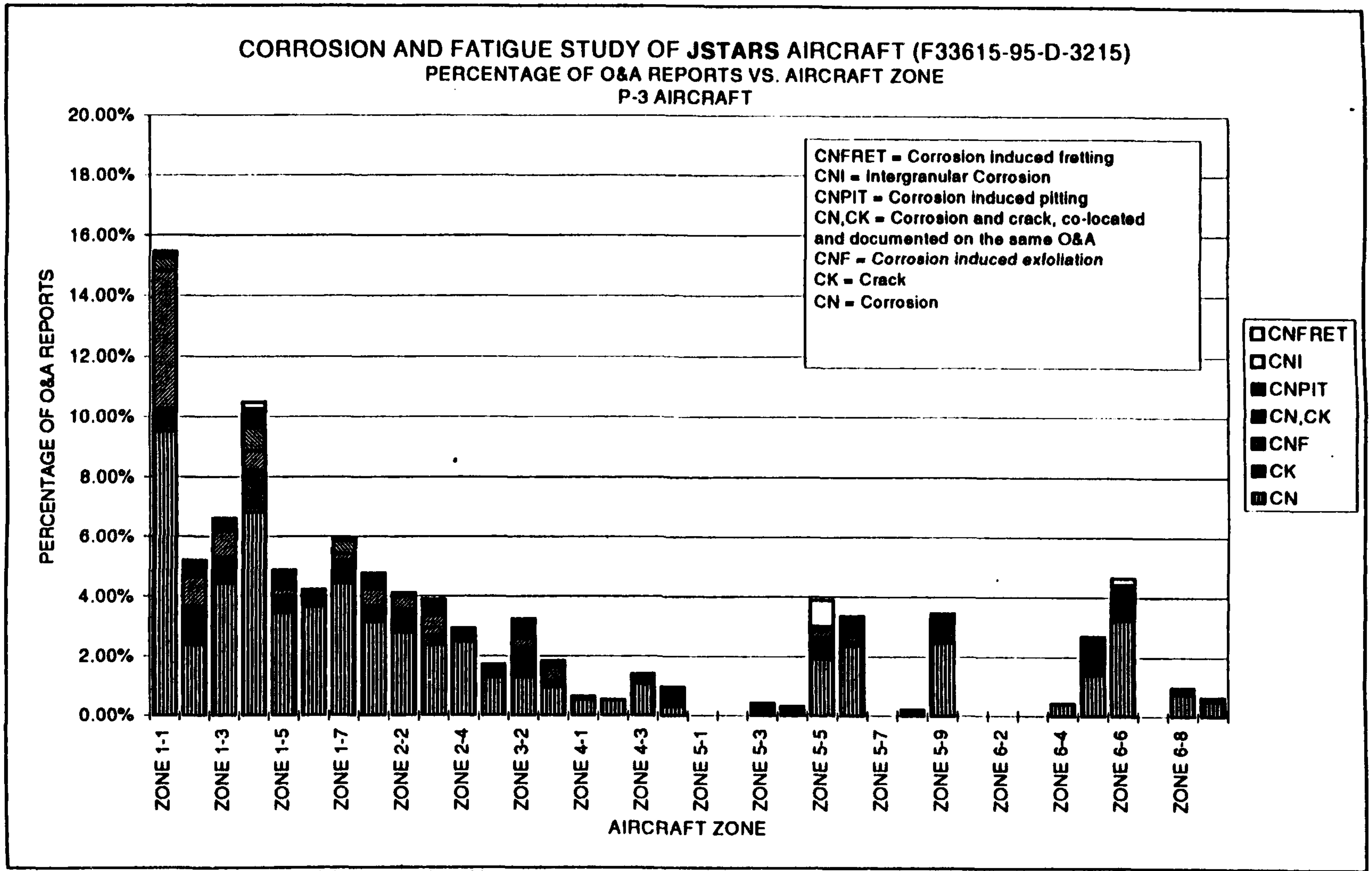


Figure 4.2 - ***Percentage Of O&A Reports Per Aircraft Zone On Joint STARS Aircraft P-3***

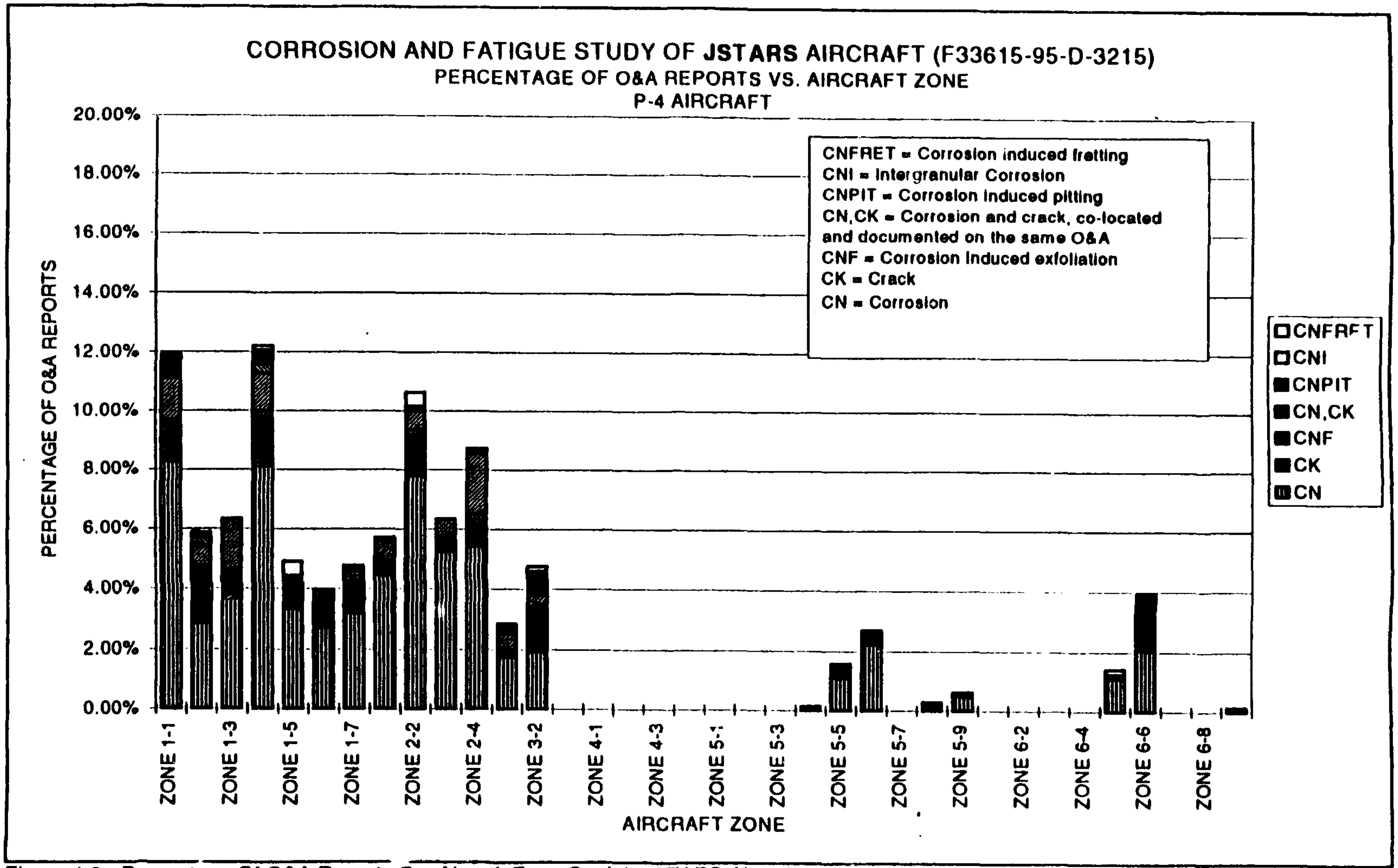


Figure 4.3 - Percentage Of O&A Reports Per Aircraft Zone On Joint STARS Aircraft P-4

4.3 FUSELAGE

Survey data for the fuselage in the following sections has been segregated into four major groups: internal fuselage structural elements, stringers, skin panels, and floor structural elements. Damage on specific structural elements such as the keel beam and the landing gear wheel wells are included in the by-aircraft-zone and by-body station summaries.

4.3.1 FUSELAGE - INTERNAL STRUCTURAL ELEMENTS

As shown in Figure 4.4, the internal structures of the lower fuselage zones of the aircraft surveyed were found to be the areas of highest corrosion and fatigue damage. Zones 1-1 through 1-4 consistently exhibited a higher level of damage than zones 2-1 through 2-3. This seems to disagree with Figure 4.1 which shows zone 2-3 with a higher level of damage than zone 1-2. However, Figure 4.4 only accounts for internal structures while Figure 4.1 includes skin panels and stringers.

Figure 4.5 presents a higher resolution summary of the areas of damage on the internal fuselage structures. The aircraft fuselage is characterized by frame locations, which are spaced at 20 inch intervals. The high end of the segment coincides with the frame, when applicable (i.e. segment 420-440 would include the frame located at BS 440 but would not include the frame at BS 420). Aircraft zones are ignored. This analysis highlights specific areas exhibiting elevated levels of corrosion and fatigue damage. These areas are BS 200 to BS 360, BS 600K to BS 960, BS 1240 to BS 1320 and BS 1440 to BS 1520.

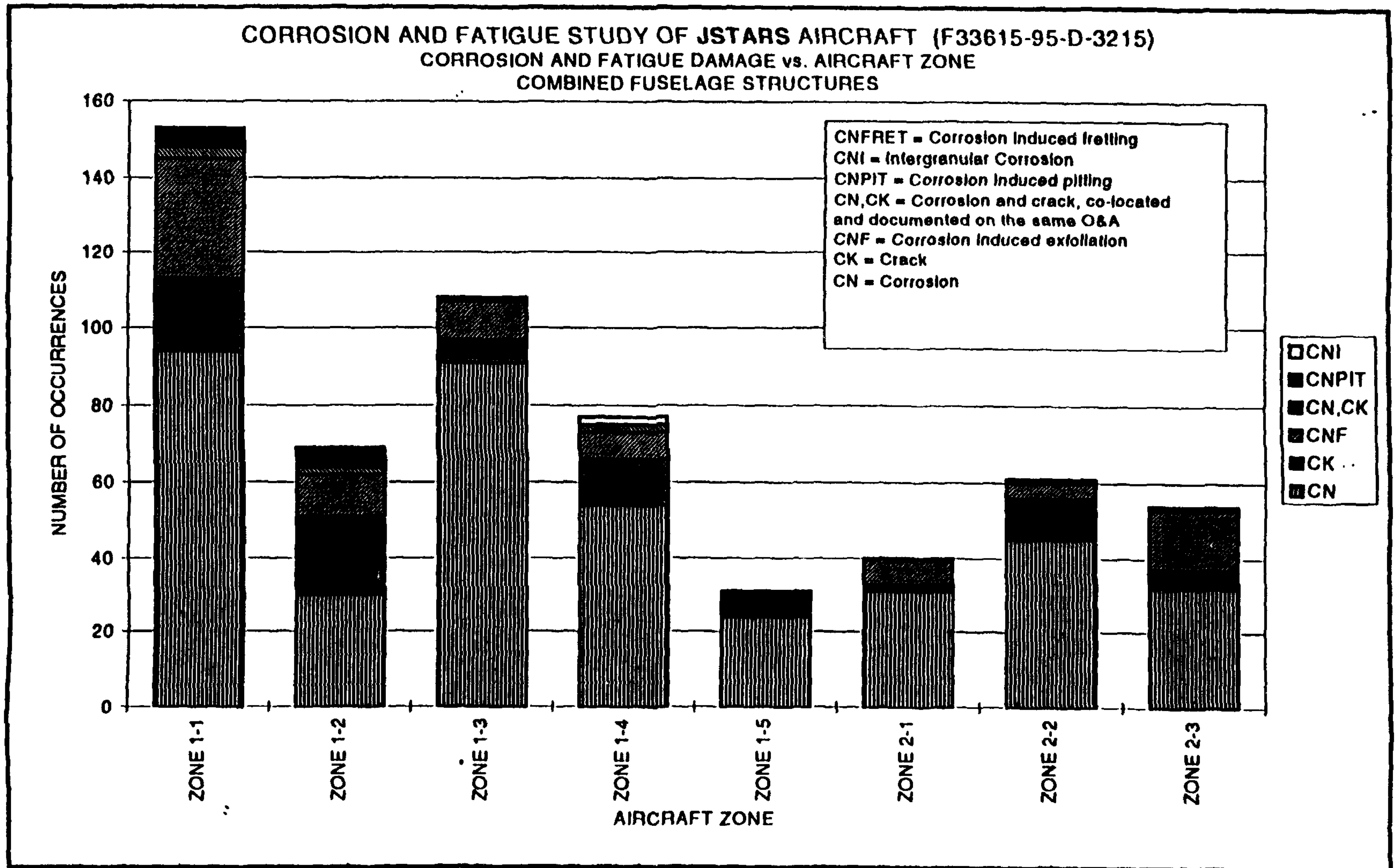


Figure 4.4 - Corrosion And Fatigue Damage On Internal Fuselage Structures Per Aircraft Zone On Joint STARS Aircraft P3 And P4

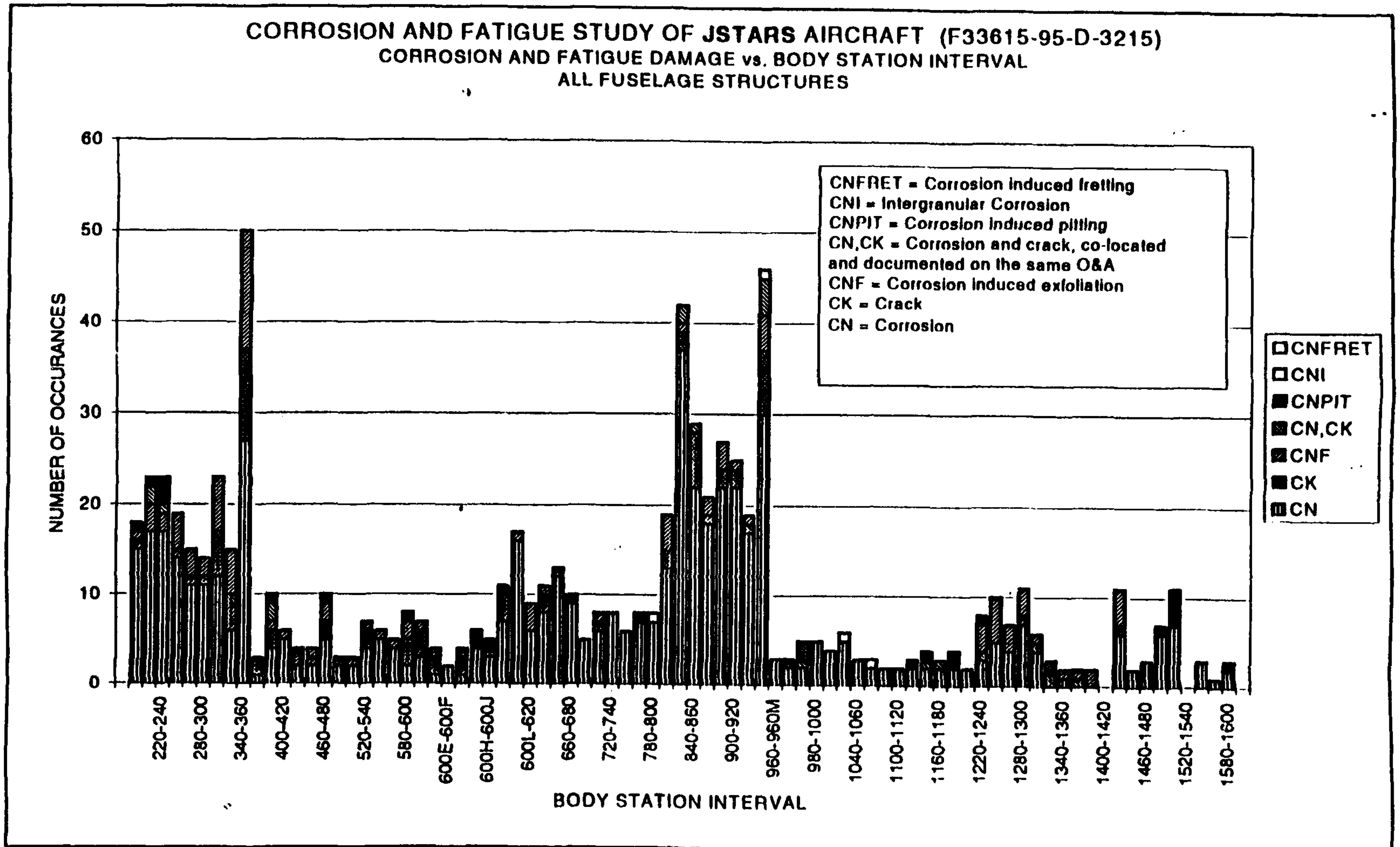


Figure 4.5 - Corrosion And Fatigue Damage On Internal Fuselage Structures Per 20 Inch Fuselage Segment On Joint STARS Aircraft P3 And P4

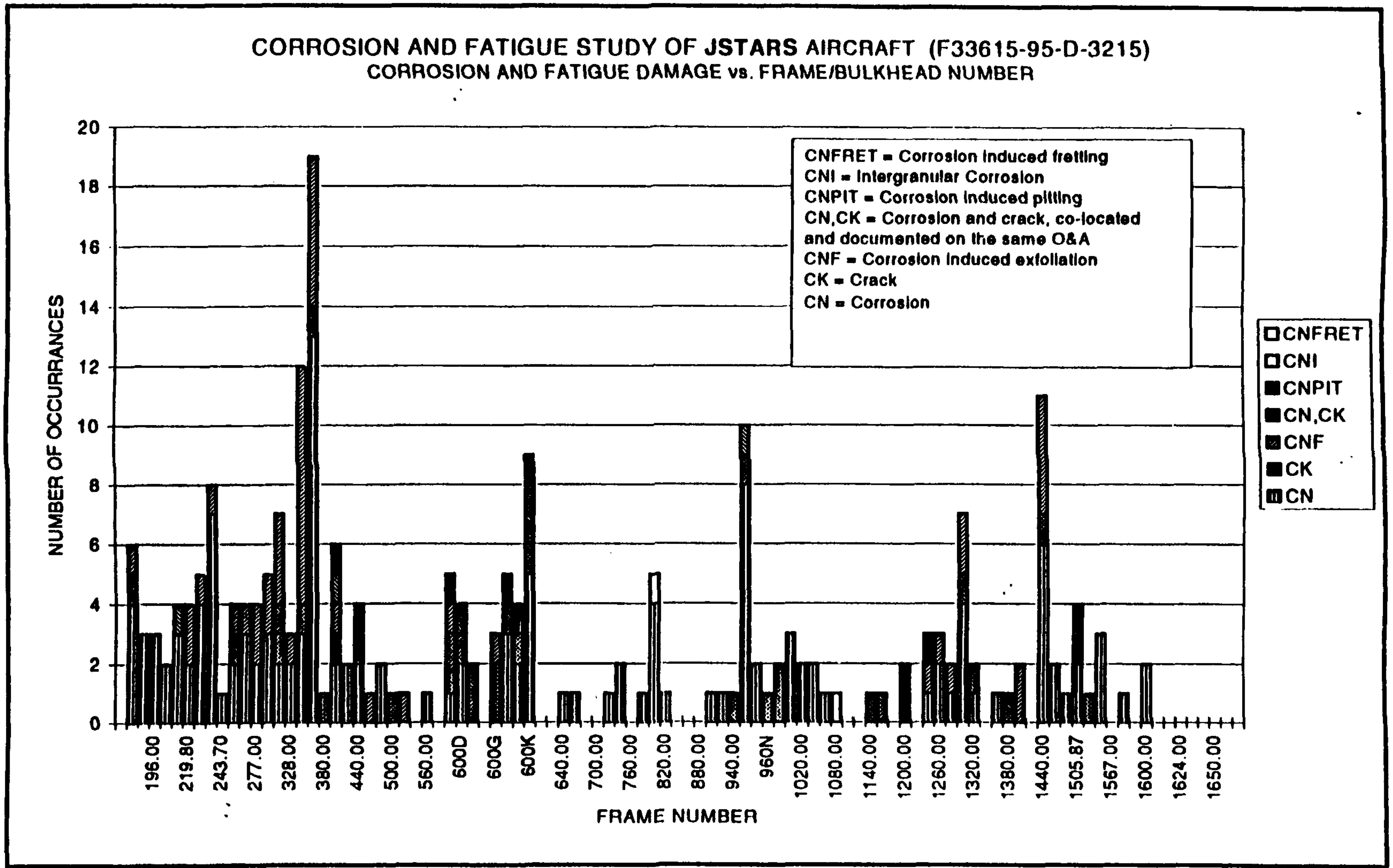


Figure 4.6 - Corrosion And Fatigue Damage Specific To Frames And Bulkheads On Joint STARS Aircraft P3 And P4

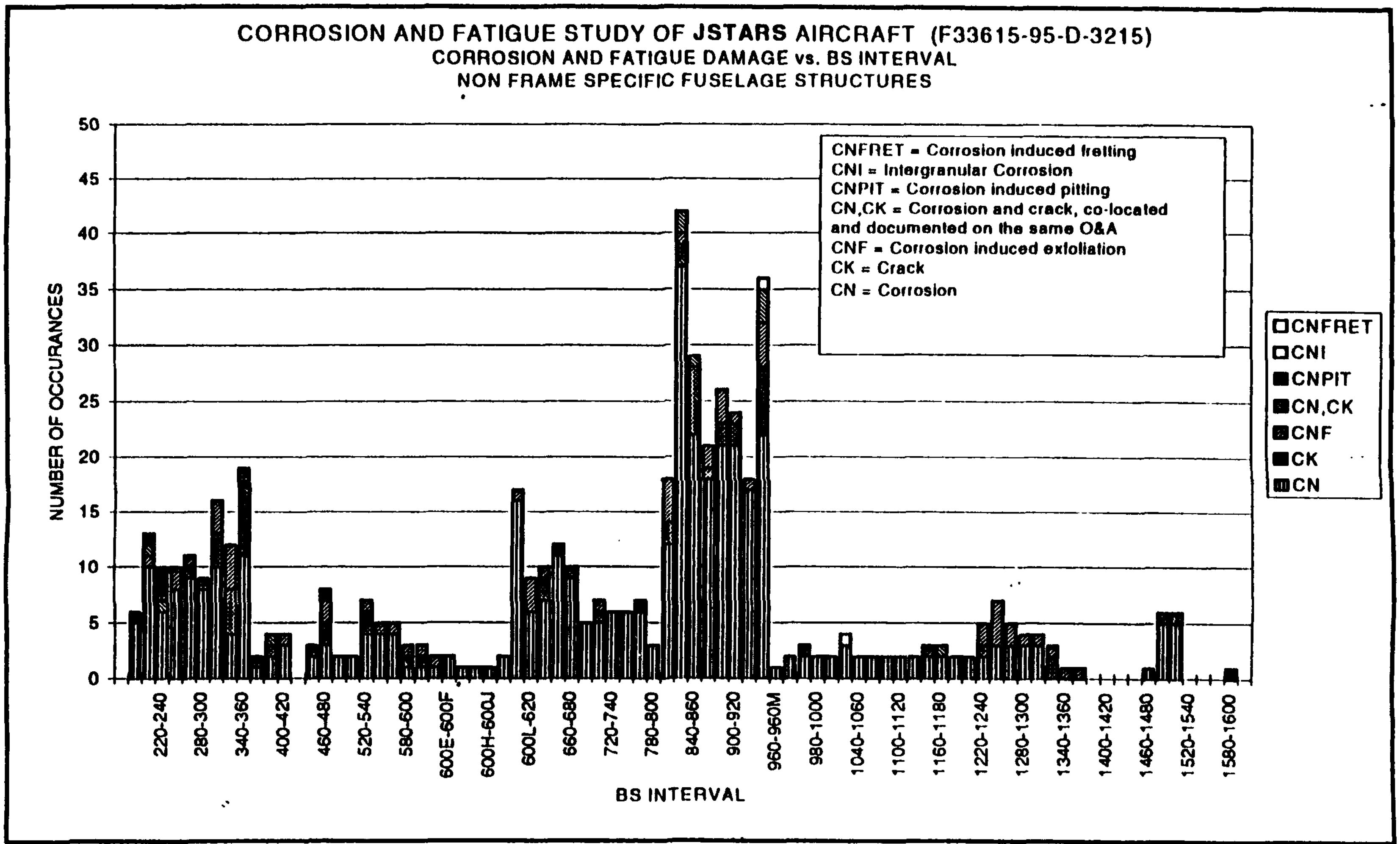


Figure 4.7 - Corrosion And Fatigue Damage Not Specific To Existing Frames And Bulkheads Per 20 Inch Fuselage Segment On Joint STARS Aircraft P3 And P4.

The corrosion and fatigue damage located between BS 200 and BS 360 can be largely attributed to the nose landing gear wheel well. The frames in this area, as shown in Figure 4.6, have a slightly elevated level of damage in comparison to the rest of the aircraft. The notable exceptions are BS 344 and BS 360, which display increased flaw density. As shown in Figure 4.7, the majority of the flaws between BS 200 and BS 360 are not associated with specific frames. Rather, they are located in the inter-frame structures specific to the nose landing gear. The non frame specific damage sites in addition to the flaw density on frames 344 and 360 make the region between BS 200 and BS 360 in zone 1-1 the most severe corrosion and fatigue damage site for internal fuselage structures.

In the area between BS 600K and BS 960, the corrosion and fatigue damage locations are almost exclusively not specific to frames. The notable exceptions are bulkhead 600K, forward of the center wing section, and bulkhead 960, aft of the center wing section. Both these bulkheads exhibited an elevated level of damage. The majority of the damage locations are on the longitudinal structures above the center wing section cut out.

The region between BS 1240 and BS 1320 has a slightly elevated level of corrosion and fatigue damage. In this area, the BS 1300 frame displays the highest flaw density. The remainder of the damage sites are distributed between frame specific and non frame specific elements.

The region between BS 1440 and BS 1520 displays a high level of flaws at the BS 1440 bulkhead and a high level of non frame specific flaws between BS 1480 and BS 1520.

4.3.2 FUSELAGE - STRINGERS

Fuselage stringers display the highest density of corrosion and fatigue damage in zones 1-1, 1-2, and 1-4, the belly of the aircraft. Further inspection within the aircraft zones does not reveal any strong patterns associated with the distribution of damage sites. In any given aircraft zone, the distribution of damage sites is fairly random with respect to body station and stringer number. Zone 1-4 displays the highest density of corrosion and fatigue damage, as indicated in Figure 4.8.

4.3.3 FUSELAGE - SKIN PANELS

As shown in Figure 4.9, zone 1-4, zone 1-5, and zone 2-3 contain elevated levels of corrosion and fatigue damage on the skin panels. In addition to these zones, the nose of the aircraft, forward of BS 259.5, comprising of aircraft zones 1-1 and 2-1, also shows elevated levels of corrosion and fatigue damage.

The distribution of skin panel damage is fairly uniform with the exception of a few skin panels. There is a lack of damage ranging roughly from skin panel 6R/L to 24R/L. This lack of damage sites (Figure 4.10) is due to the fact that these skin panels are subject to replacement per contract. Conversely, skin panels 52L and 52R, located between BS 1240 and BS 1440 in aircraft zone 2-3 exhibit high levels of damage. Similarly, skin panels 65L and 65R located between BS 1505 and BS 1592 also exhibit high damage levels.

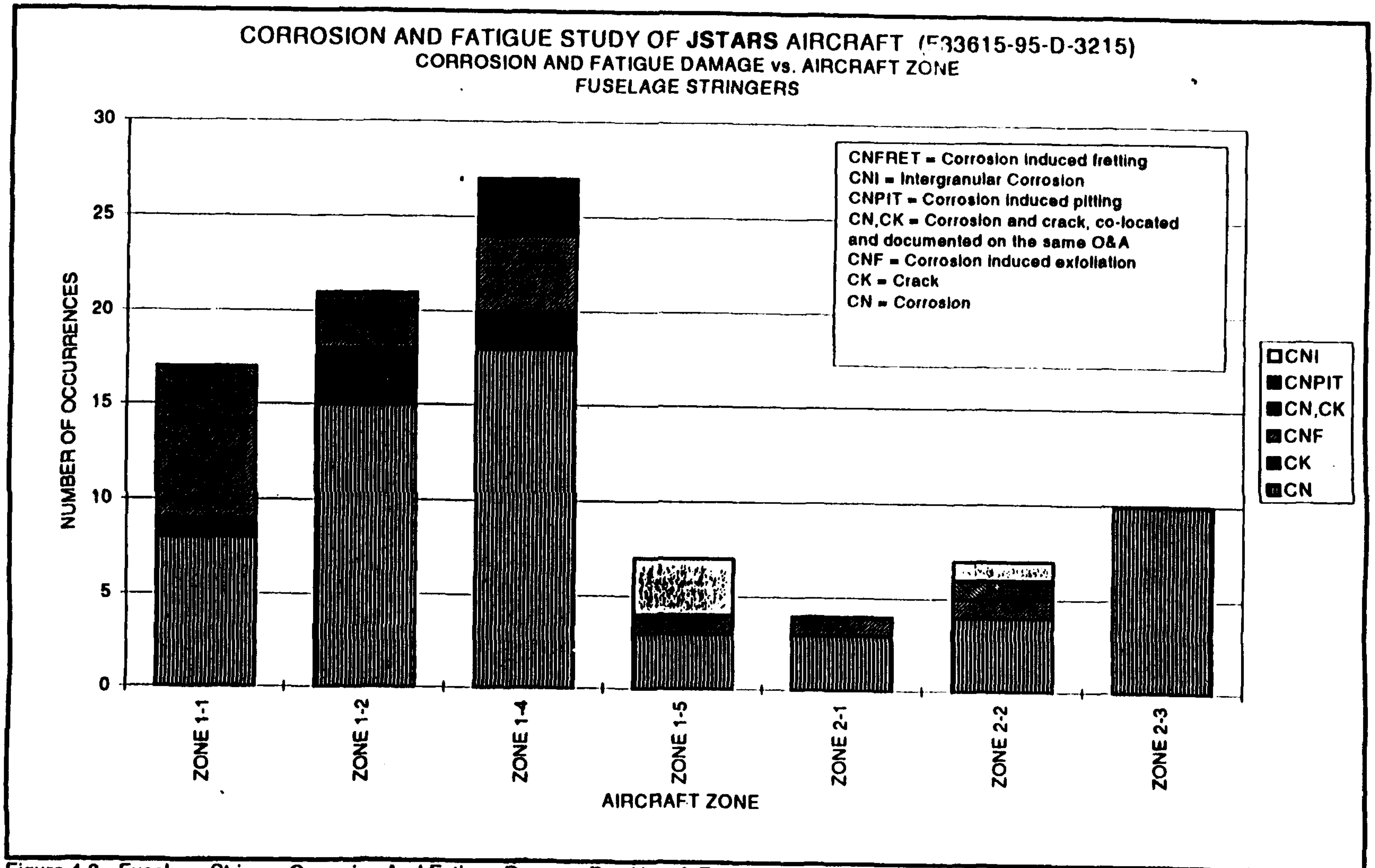


Figure 4.8 - Fuselage Stringer Corrosion And Fatigue Damage Per Aircraft Zone On Joint Stars Aircraft P3 And P4

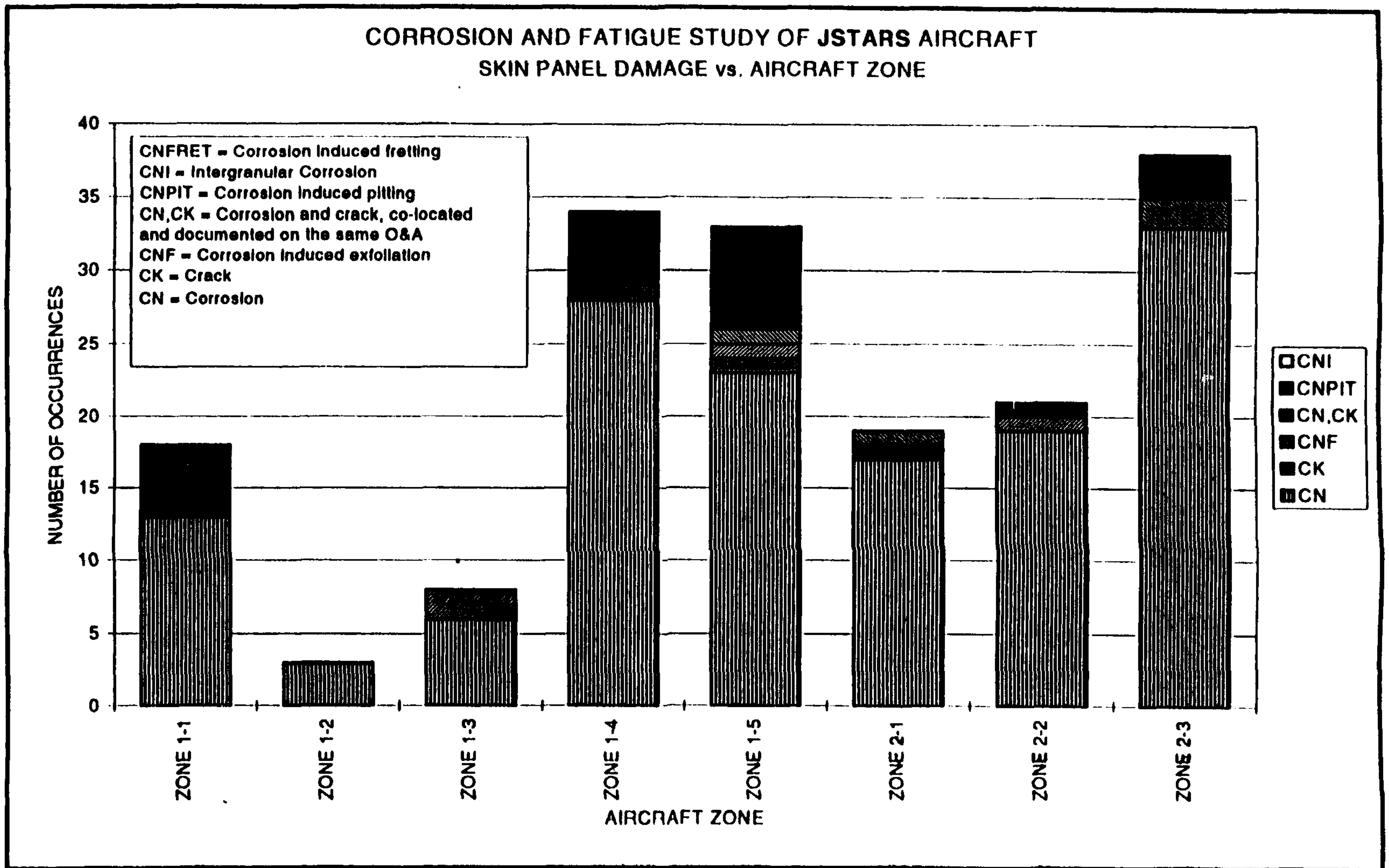


Figure 4.9 - Fuselage Skin Panel Corrosion And Fatigue Damage Per Aircraft Zone On Joint Stars Aircraft P3 And P4

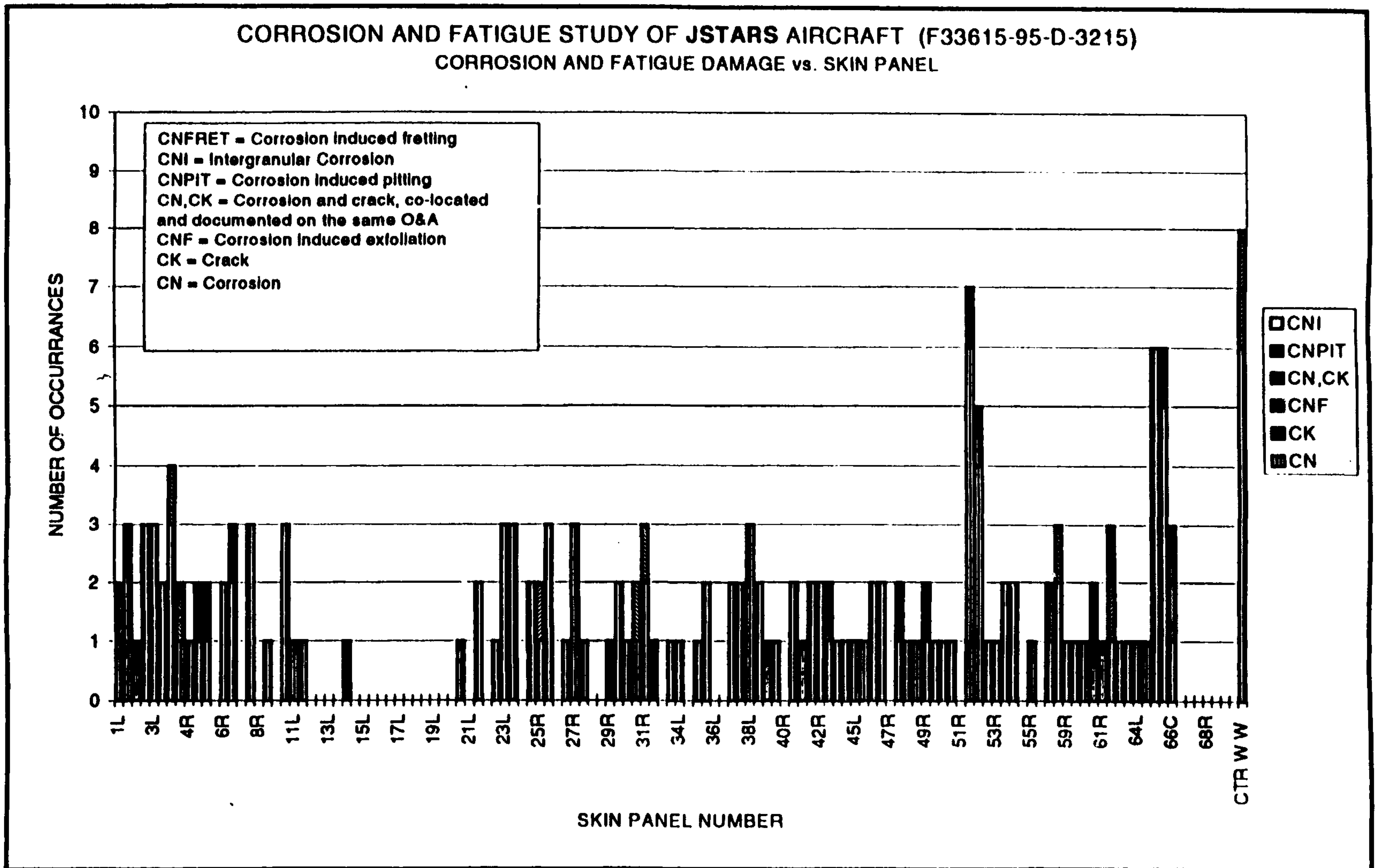


Figure 4.10 - Fuselage Skin Panel Corrosion And Fatigue Damage Per Skin Panel On Joint Stars Aircraft P3 And P4.

4.3.4 FUSELAGE - FLOOR BEAM STRUCTURES

The aircraft zone containing the most defects is zone 2-4. The majority of floor beam corrosion and fatigue damage sites are located forward of BS 600K. Of particular note for the high level of damage sites are the floor structures from BS 200 to BS 400, and the area between BS 440 and BS 580. Further aft, the floor structures between BS 960N and BS 1000 are unique for their elevated levels of exfoliation. To a lesser degree, there is also an elevated level of exfoliation between BS 600J and BS 820, which is the floor above the center wing section. The corrosion and fatigue damage in the floor structures is represented in Figure 4.11.

4.3.5 FUSELAGE - MAIN LANDING GEAR WHEEL WELLS

Aircraft zones 1-6 and 1-7 display high levels of corrosion and fatigue relative to zone size. The locations of the damage sites are presented in Figure 4.12, which segregates the data into 20 inch body station intervals. The level of damage per body station interval remains relatively level between BS 820 and BS 960. There are elevated levels of damage at BS 820 and BS 960, which are the fore and aft bulkheads of the wheel wells.

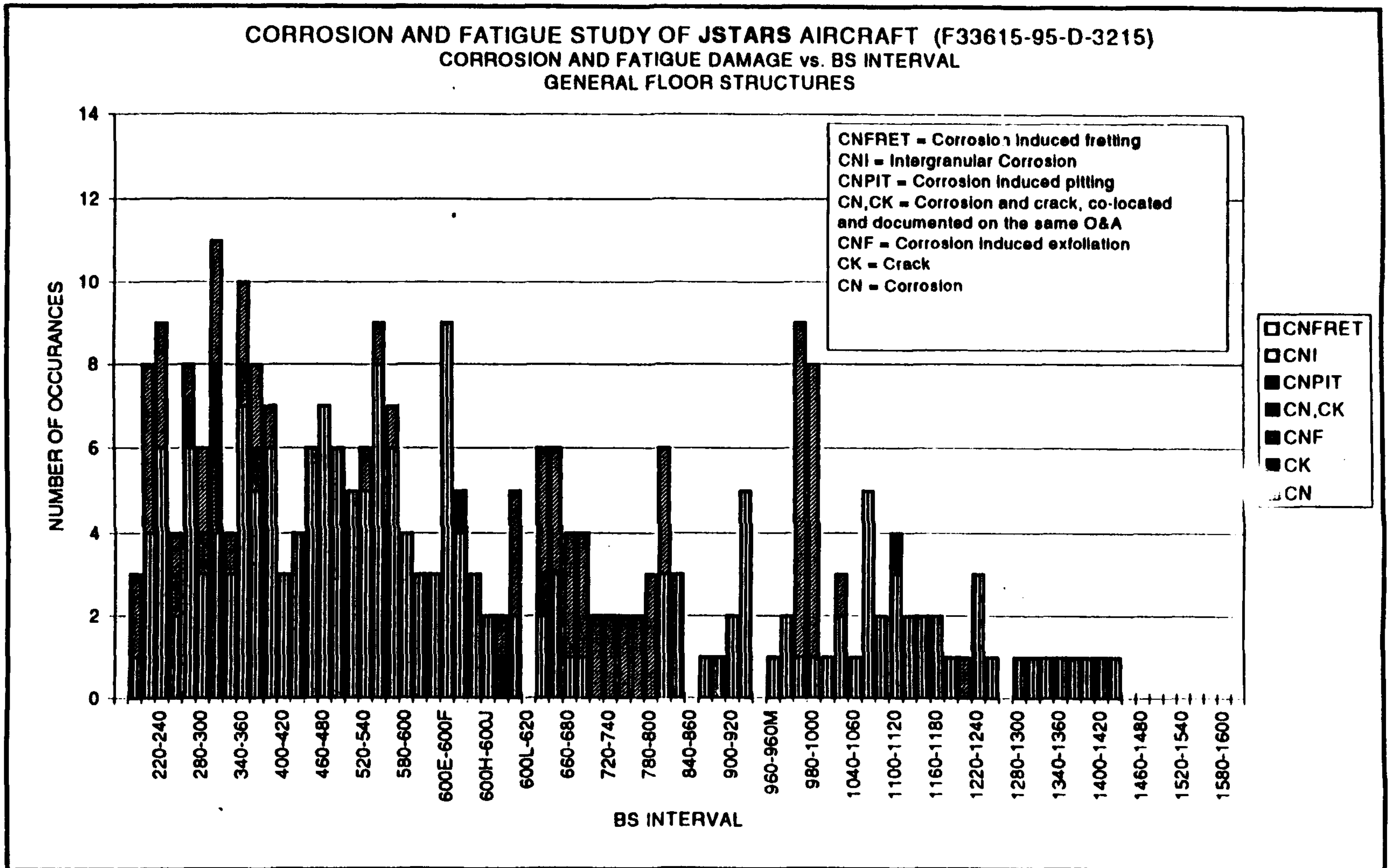


Figure 4.11 - Fuselage Floor Beam Corrosion And Fatigue Damage Per 20 Inch Segment On Joint STARS Aircraft P3 And P4

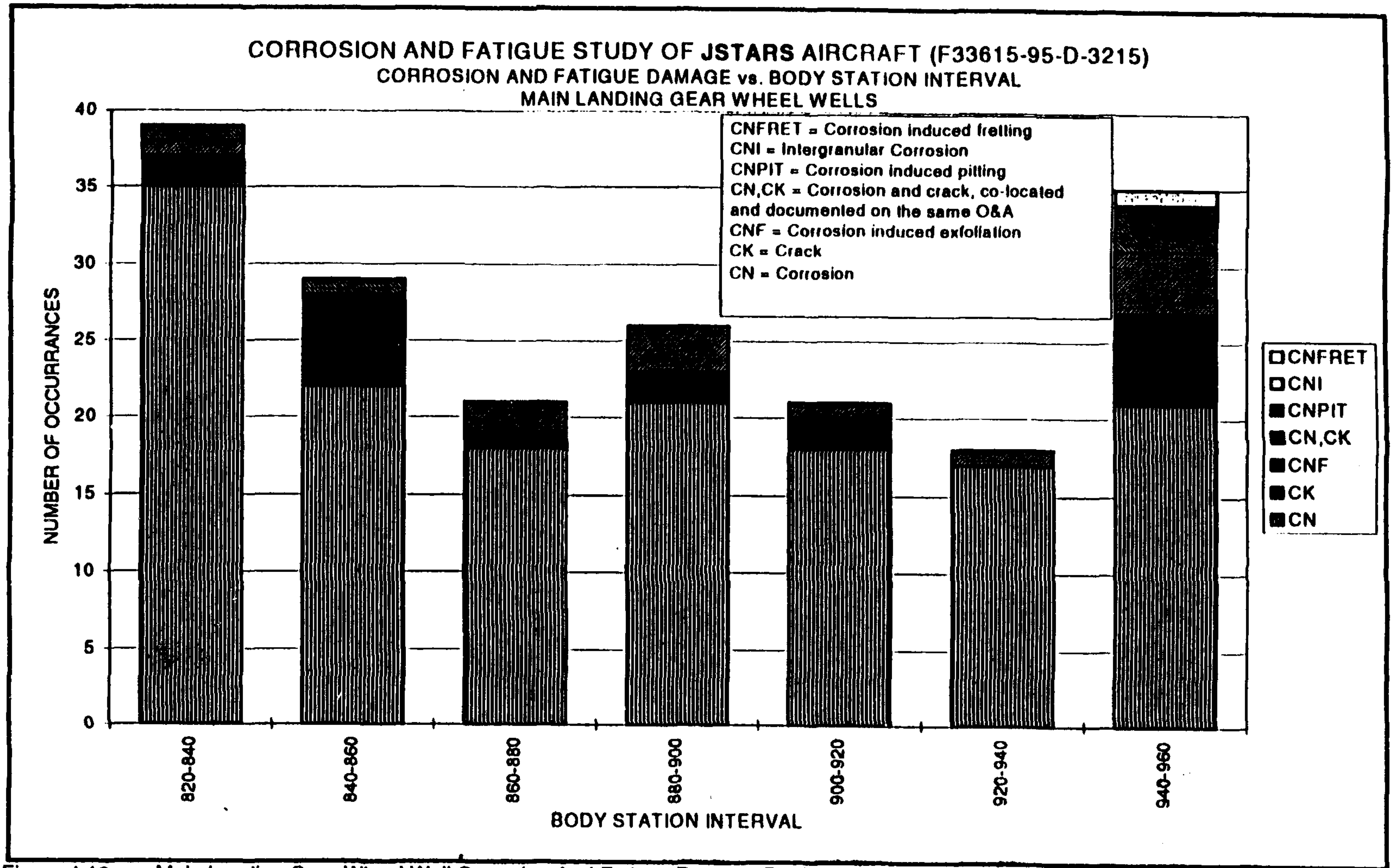


Figure 4.12 - Main Landing Gear Wheel Well Corrosion And Fatigue Damage Per Body Station Interval On Joint STARS Aircraft P3 And P4.

4.3.6 PROBABLE CAUSES FOR FUSELAGE DAMAGE

Investigation into the underlying sources for corrosion damage in the fuselage structures reveals the following potential explanations.

- BS 211 - BS 360. The damage in this region is presented in Figures 4.5 and 4.7. The nose landing gear wheel well is located in this region, and corrosion damage is attributed to the up splash of water and other contaminants during takeoff, landing and taxi. Cracks in these structures are predominantly caused by landing and taxi loads. It is difficult to judge the influence of corrosion on the crack size without a comprehensive DADT analysis.

- BS 360 FRAME. The forward toilet is located at BS 360 - BS 380. This frame is subjected to the corrosive effects of any spillage from the lavatory tanks as well as the nose landing gear wheel well up splash as previously discussed. As evident is Figure 4.6, the combination of these two corrosion sources subjects this frame to an extremely aggressive environment, making this the most corrosion prone frame on the aircraft.

- BS 360 - BS 600K. The O&A reports indicate that this portion of the fuselage is not effected by corrosion damage. However, the skin panels in this region are automatically replaced per contract, indicating that these panels, and possibly local substructures, experience heavy damage which is not captured by the O&A process.

- BS 820 - BS 960 The main landing gear wheel wells experience conditions very similar to those experienced by the nose landing gear wheel well. The up splash from takeoff, landing and taxi introduces the conditions that initiate corrosion. The instances of reported cracking in this area are minimal.

- BS 1260 - BS 1320. The galley is located in the BS 1280 to BS 1300 area of the aircraft. The slight elevation in corrosion incidents in this area may be a direct result of the spillage from the galley.

- LOWER FUSELAGE Increased corrosion in the lower portion of the fuselage is readily explained by that region's exposure to splashed water from the ground and the propensity for external moisture to accumulate there. In addition to these external conditions, the lower regions are also subjected to moisture accumulation from within the aircraft, which gets trapped in the insulation and remains there for extended periods. This mechanism of internally generated corrosion is most evident in Figure 4.8, which shows the elevated corrosion levels of the lower stringers.

- SKINS In addition to external corrosion sources, lower fuselage skin panels experience moisture entrapment conditions as discussed above. The corrosion in the upper aft skins, zone 2-3, may be contributed to the original spot welding methods employed in the aircraft. Spot welding became a source of fatigue and corrosion, and was phased out and replaced with fasteners. The corrosion on these skins as well as the similar condition on the nose skins forward of BS 312 may be the source of the high corrosion levels found.

- ZONES 2-4 OF P-4 The elevated corrosion levels in zones 2-2 and 2-4 on the P-4 aircraft may be attributed to leakage experienced in the crown skins and the cargo carried by the aircraft. The aircraft experienced leakage in the aft fuselage crown skins The moisture introduced through this leak resulted in elevated corrosion in zone 2-2. The aircraft was used, in part, to carry livestock. The higher corrosion levels in the floor structures is believed to be the result of animal waste products in addition to the leakage from the crown skins.

- OVERALL The fuselage of the JSTARS aircraft displays relatively low levels of fatigue damage compared to corrosion. The Boeing 707 was designed with a lower stress level than later aircraft. This "over design" of the fuselage suppresses the advent of WFD.

4.4 WINGS

The survey data for the wings in the following sections is divided into two major groups: wing skin planks and stringers, and internal structural elements. Referring to Figure 4.1, the aircraft wing zones containing the highest levels of corrosion and fatigue damage are:

1. Zone 5-5 (NUMBER 1 MAIN TANK)
2. Zone 5-6 (NUMBER 2 MAIN TANK)
3. Zone 6-5 (NUMBER 3 MAIN TANK)
4. Zone 6-6 (NUMBER 4 MAIN TANK).

The damage in these zones is detailed in the following sections.

4.4.1 WINGS - SKIN PLANKS AND STRINGERS

Over half of the corrosion and fatigue damage on the wings of the P-3 and P-4 aircraft involves the wing planks and stringers. As indicated in Figure 4.13, the highest damage levels are located on the inboard wing planks, in aircraft zones 5-6 and 6-6. The corrosion and fatigue damage levels remain relatively high in zones 5-5 and 6-5, then drastically decrease in the outboard wing zones 5-4 and 5-5. The type of damage found in the wing planks remains symmetric between the left and right sides of the aircraft except for two notable exceptions. Zone 6-6 displays a higher level of fatigue cracks than zone 5-6; this is a condition found on the P-4 aircraft. There is also presence of exfoliation in zone 5-5 which is not present in zone 6-5. This discrepancy is limited to the P-3 aircraft.

A summary of the levels of damage specific to wing plank number is presented in Figure 4.14. This summary does not account for aircraft zones. The level of corrosion and fatigue damage sites remains fairly constant with respect to wing plank number except for wing planks 7 UPR, 1 LWR, 4 LWR and 10 LWR which exhibit relatively low levels of corrosion damage and the absence of fatigue damage.

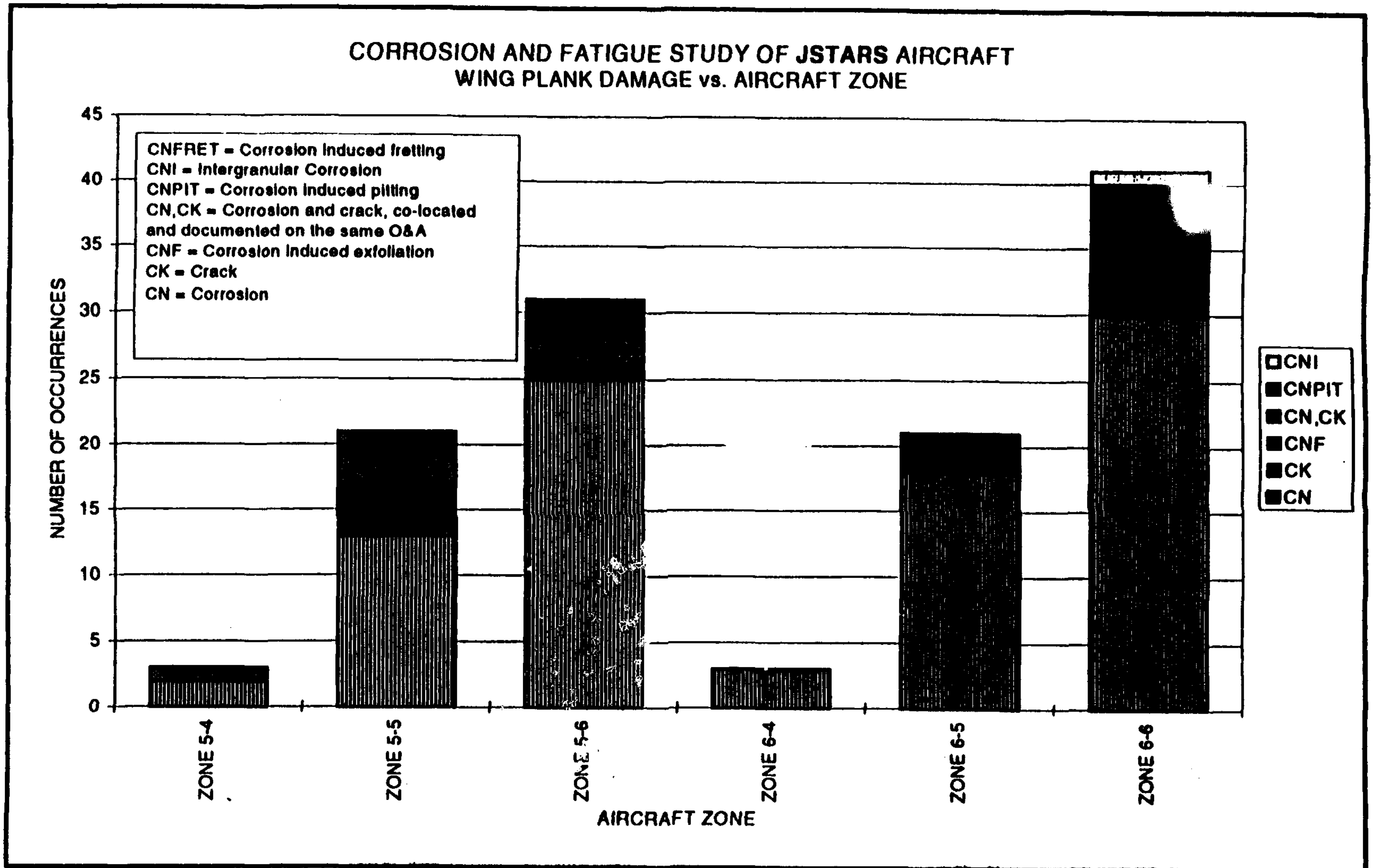


Figure 4.13 - Wing Plank Corrosion And Fatigue Damage Per Aircraft Zone On Joint STARS Aircraft P3 And P4.

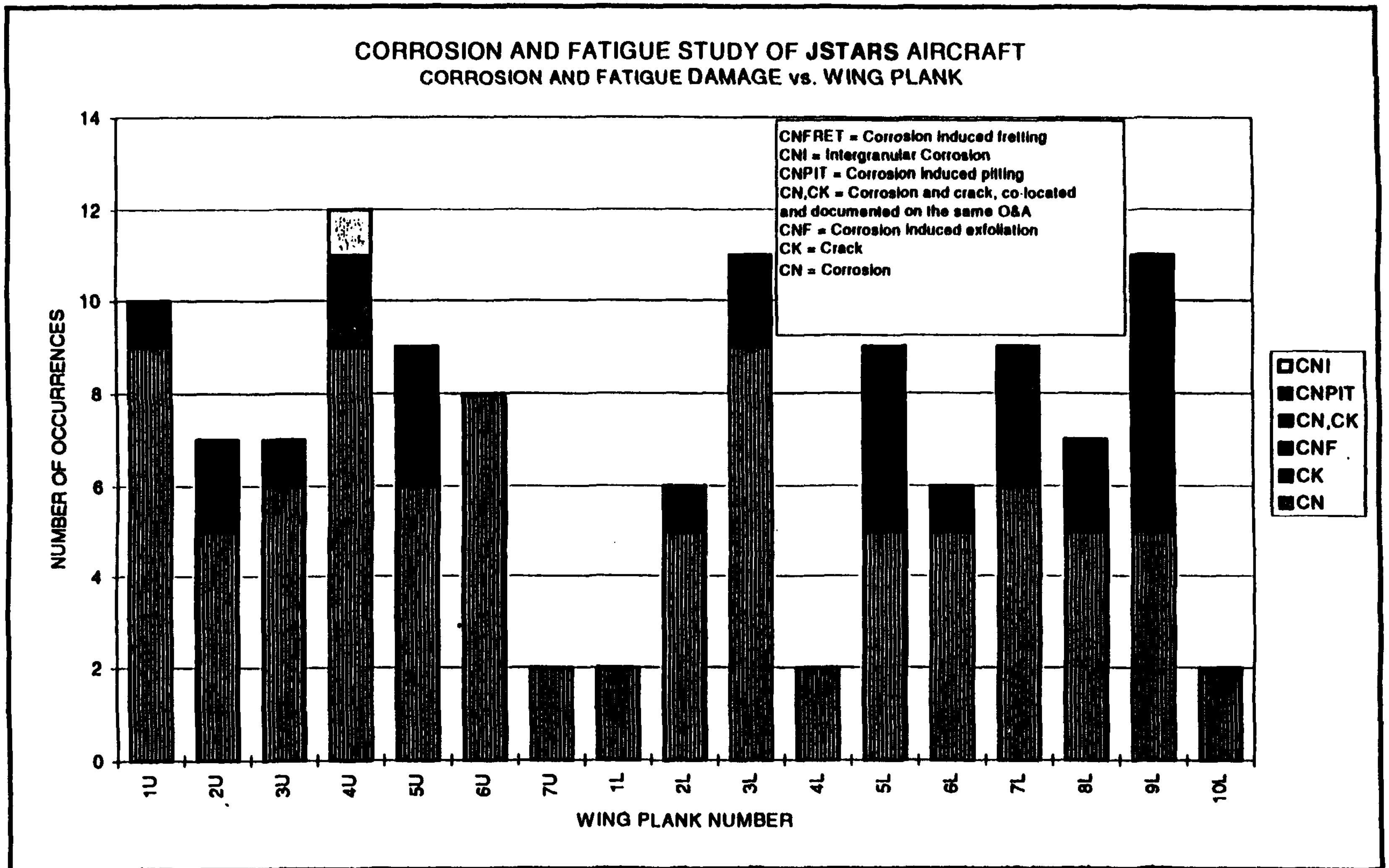


Figure 4.14 - Wing Plank Corrosion And Fatigue Damage Per Wing Plank Number On Joint STARS Aircraft P3 And P4.

A breakdown of the damage locations on the wing stringers with respect to aircraft zones reveals much the same trend observed in the wing planks. The levels of damage remain elevated in the inboard and mid wing interspar areas (zones 5-5, 5-6, 6-5, and 6-6), then drops drastically in the outboard wing zones, where there is a complete absence of damage (Figure 4.15). As noted before, the high level of cracking in zone 6-5 is specific to P-3 only.

4.4.2 INTERNAL WING STRUCTURES

The data on corrosion and fatigue damage of the interspar wing structures does not readily lend itself to an analysis similar to the preceding sections. There was not enough reported data to perform a by-wing-station analysis similar to the fuselage. The absence of data is due to the fact that upper spar chords were replaced by the base contract. The chords are the tee's that attach the web to the upper wing planks. The requirement to replace these chords is indicative of significant damage which is not reflected in the database.

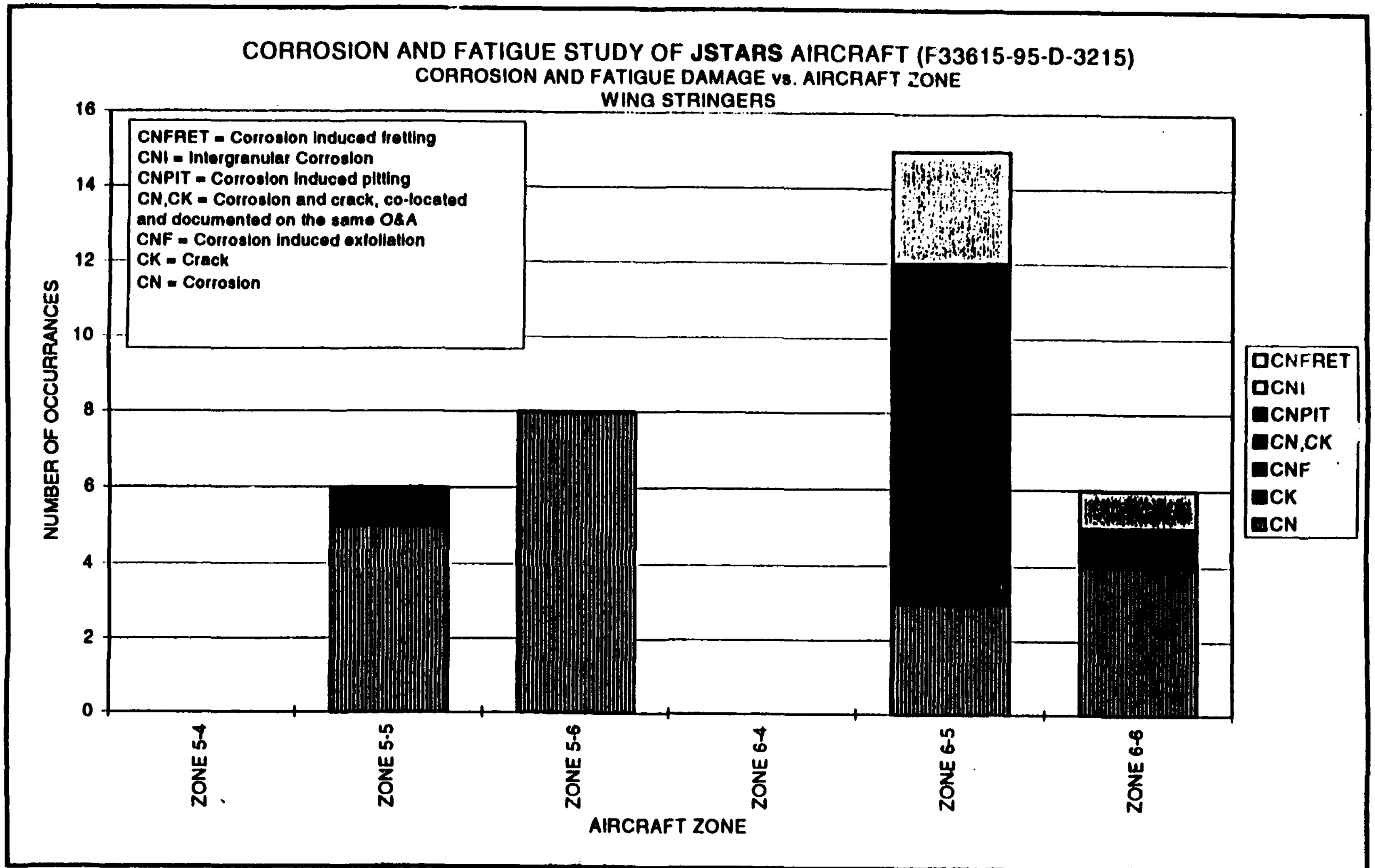


Figure 4.15 - Wing Stringer Corrosion And Fatigue Damage Per Aircraft Zone On Joint STARS Aircraft P3 And P4.

4.4.3 PROBABLE CAUSES OF WING DAMAGE

The corrosion found in the wing planks is generally located in and around the fastener holes. Corrosion in the 2024 - T3 aluminum planks removes material in the fastener holes and develops initiation sites for fatigue cracking. Corrosion damage and material loss around the fastener holes results in a lower load transfer to the 7075-T6 stringers. This leads to elevated stress levels in the 2024-T3 wing planks. The tension dominated spectrum loading and initiation site density are the probable causes for the elevated fatigue damage on the lower wing skins.

Widespread Fatigue Damage (WFD) is defined as the simultaneous presence of cracks at multiple structural details that are of sufficient size and density whereby the structure will no longer meet its damage tolerance requirements. The presence of WFD in the lower inboard wing planks and substructure is strongly suspected but not well documented as part of the repair activity. The inspections performed and O&A data generated were not geared towards identifying WFD. Inspectors focused on identifying the damage and writing the O&A for its removal or correction. Often, holes were iteratively enlarged to eliminate corrosion and fatigue damage. In some instances, hole diameter increases led to a significant enough change in the diameter to edge distance ratio that the plank had to be replaced. The interaction of corrosion and fatigue and the presence of WFD will require a more focused study.

4.5 MATERIAL AND PART FORM

Segregation of the damaged elements by material and part form fails to highlight any significant trends. The two most prominent materials on the aircraft are 2024 and 7075 Aluminum. In both materials, the most prominent type of damage is simple corrosion, accounting for 71.5% of the damage sites identified as 2024 and 64% in 7075. This prevalence of corrosion damage is maintained, though at different percentages, regardless of part form. See Figure 4.16 and Figure 4.17.

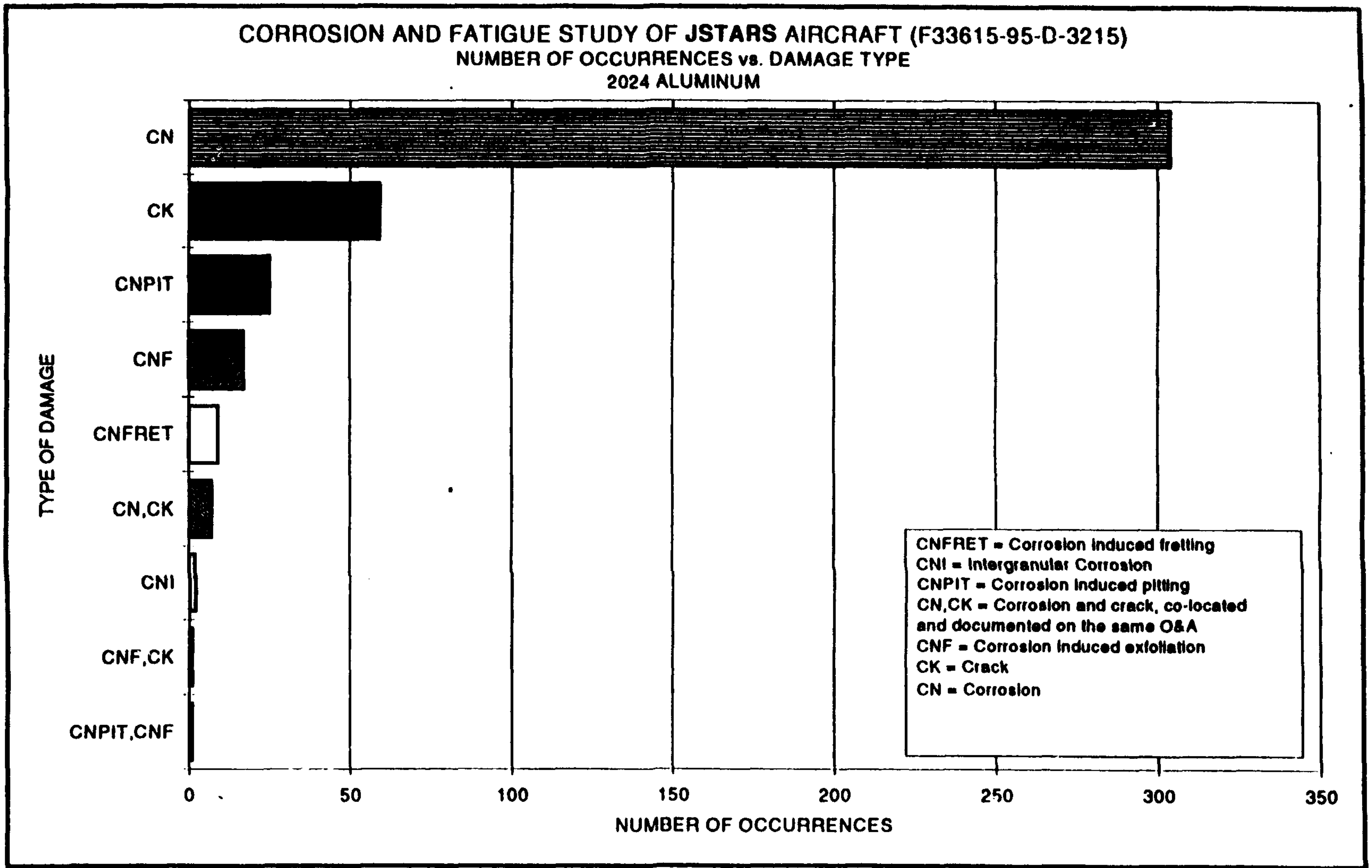


Figure 4.16 - Types Of Damage On 2024 Aluminum Structures On Joint STARS Aircraft P3 And P4

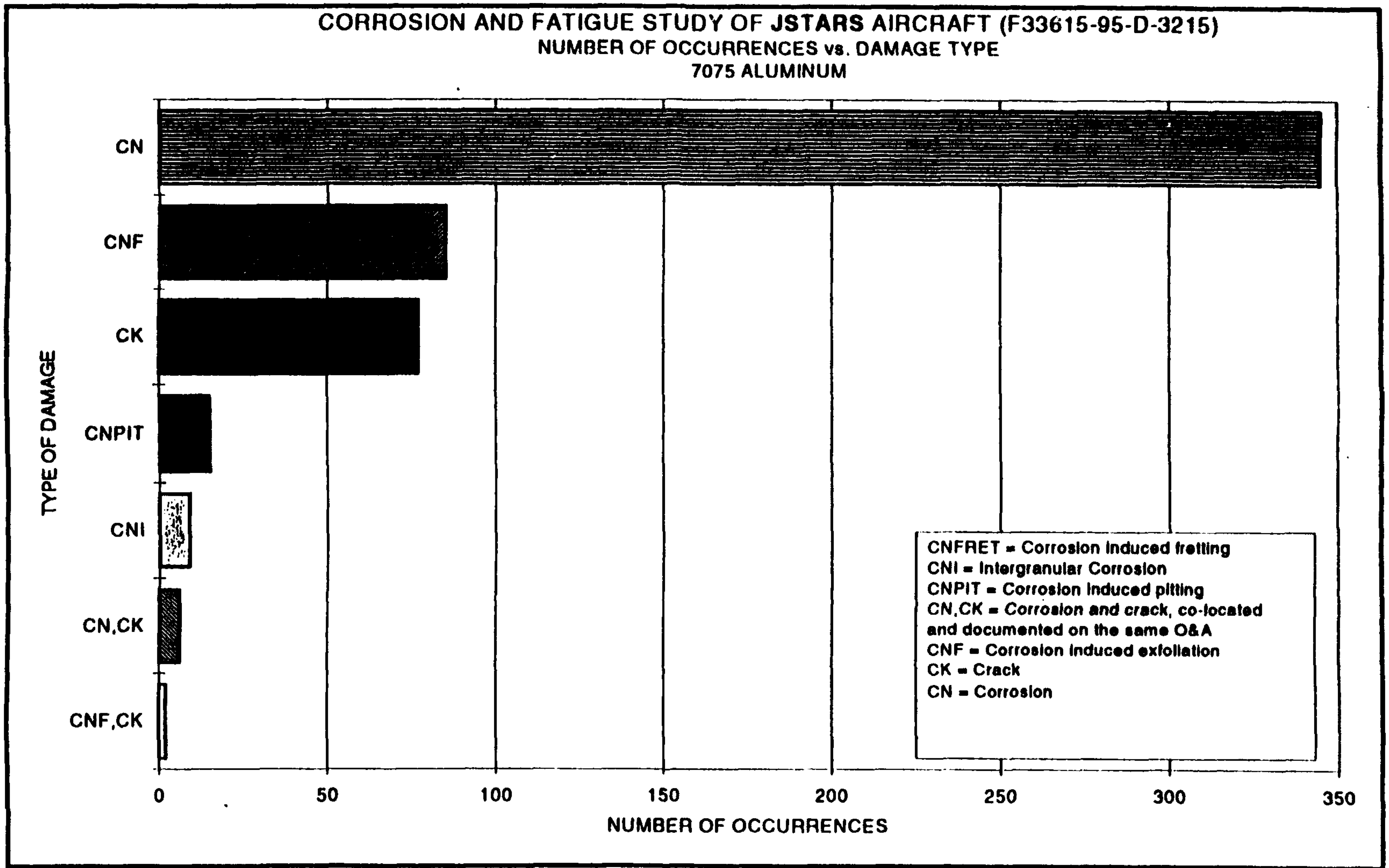


Figure 4.17 - Types Of Damage On 7075 Aluminum Structures On Joint STARS Aircraft P3 And P4

SECTION 5

P3 AND P4 SURVEY DATABASE DESCRIPTION

The over and above (O&A) reports for the P-3 and P-4 aircraft were assembled and compiled into a Microsoft ACCESS database. Any data lending itself to describing the type of damage, location and severity as well as identifying the structural element affected by the damage is included in the database. This input, originating from several different inspectors was often inconsistent in nomenclature and completeness of location, part, and damage description. This inconsistency required the reformatting of the database to standardize the nomenclature, which facilitates meaningful queries and searches.

Included in this section is an overview of the data available in the JSTARS database. This serves to define the database fields and nomenclature used.

The following is a list defining the database fields.

1. AIRCRAFT ID — Designation given to each aircraft in the JSTARS program. This study is based on inspection of the P-3 and P-4 aircraft. Specifics and history of these aircraft can be found in Section 2.

2. WORK REQUEST #	The work request number originally assigned to repair the observed damage. This number is based on the aircraft, zone, and index number. For example, the origin of work request # A3011016: A3 - Aircraft 3 (P-3) 011 - Zone 1-1 016 - Index number
3. AIRCRAFT ZONE	Designation assigned to the portion of the aircraft in which the failure was located. The aircraft zones are displayed in section 3.8.
4. PART/DOC #	Boeing part number of damaged element.
5. NOMENCLATURE	Physical identification of the member on which the damage is located.
6. PART SERIAL #	Serial number of damaged part.
7. PRINCIPAL LOADING DIR.	Designation identifying the primary type of load carried by the element.
8. MATERIAL	Identification of the material that the element is made from.
9. PART FORM	Identification of the type or the method of manufacture of an element.

10. H/M	How Malfunction Code. Appendix A
11. DEFECT TYPE	Identification of the type of damage observed. The observed damage is classified either singularly or as a combination of the following abbreviations:

- CN Corrosion
- CK Crack
- CNF Corrosion induced exfoliation
- CNFRET Corrosion induced fretting
- CNPIT Corrosion induced pitting
- CNI Intergranular Corrosion

12. DEFECT SIZE	Quantification of the length of a crack or the area involved in corrosion, and in some cases, thickness loss.
13. DEFECT LOCATION	Identification of the physical element on or near which the damage is located.
14. DEFECT CAUSE	Identification, when possible, of the root cause of the observed damage.
15. DEFECT ORIENTATION	Description of the direction or area of damage.
16. WFD	Widespread Fatigue Damage (Y/N)

17. INSPECTION TECHNIQUE — The method used to identify damage. The technique used is classified either singularly or as a combination of the following.

- ET — Eddy Current Test
- UT — Ultrasonic Test
- TEARDOWN
- VISUAL

18. PSE — Classification of an element specifying whether the element is or is not a Principle Structural Element

19. DEFECT SEVERITY — Characterization of the extent of corrosion damage based on the following guidelines as specified in the Boeing 707 Intercontinental Structural Repair Manual:

- LIGHT — Light Corrosion: Characterized by discoloration or pitting to a depth of approximately 0.001 inch maximum.
- MOD — Moderate Corrosion: Appears similar to light corrosion except there may be some blisters or evidence of scaling or flaking. Pitting depths may be as deep as 0.010 inch.

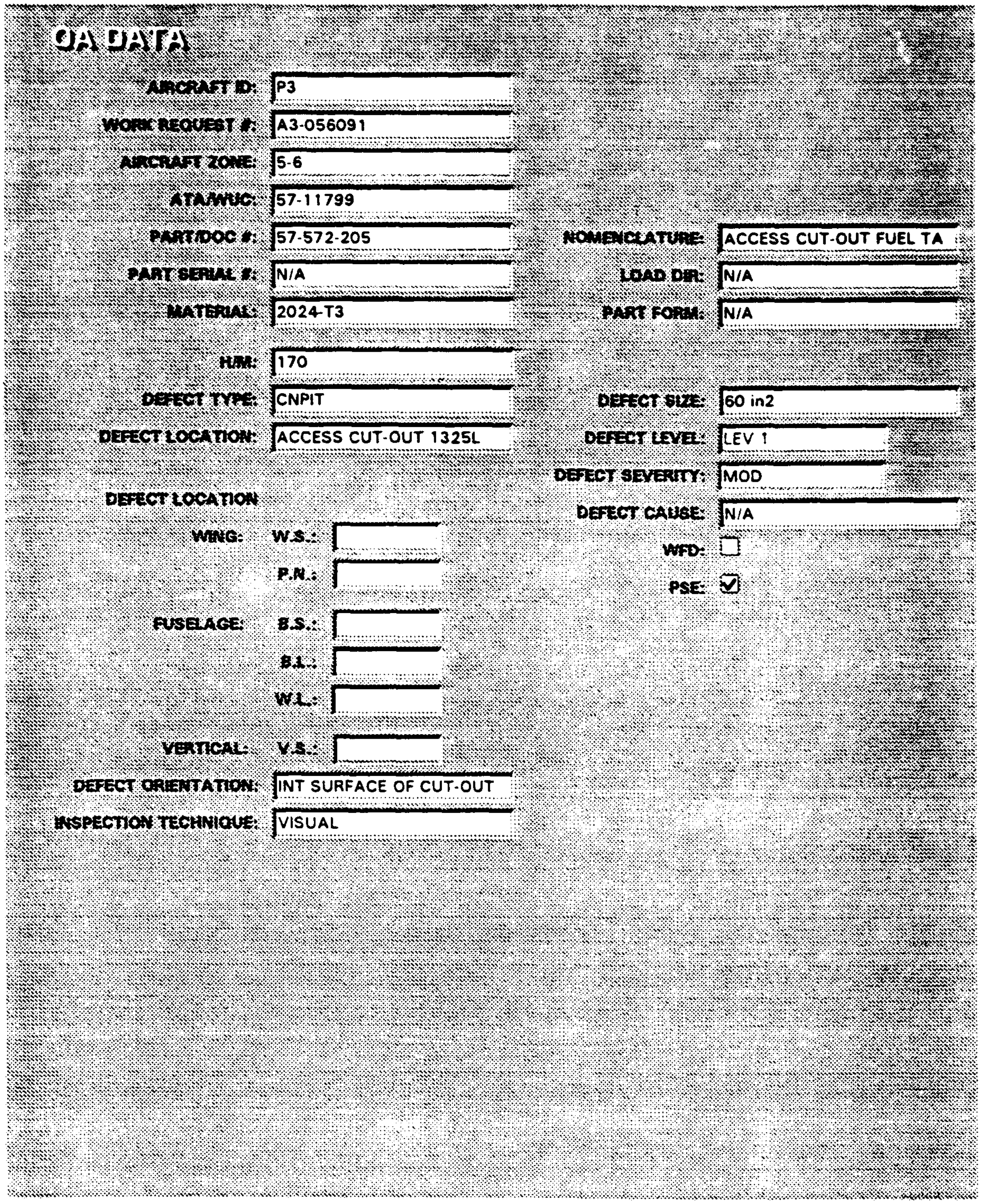
- SEV — Severe Corrosion: General appearance may be similar to moderate corrosion with severe blistering exfoliation and scaling and flaking. Pitting depths will be deeper than 0.010 inch.

20. DEFECT LEVEL	Classification of the level of damage.
21. WING STATION	A plane perpendicular to wing chord plane measured from the intersection of leading edge and WBL 0. Illustrated in section 3.3.
22. PLANK NUMBER	The designation given to the wing skin panel or plank. See section 3.10.
23. BODY STATION	Distance measured parallel to body centerline to a plane perpendicular to body centerline from a point 130 inches forward of the nose. See section 3.3.
24. BUTT LINE	Body Buttock Line (RBL/LBL/BL) - Distance in a horizontal plane measured from body vertical centerline. Wing Buttock Line (WBL) - A plane normal to wing chord plane and parallel to body centerline. It is measured from intersection of wing chord plane and BL 76.45. See section 3.3.

25. WATER LINE — Distance measured perpendicular from a horizontal plane located 136 inches below bottom of body. See section

26. VERTICAL STATION — Rudder station

An example form from the database is shown in figure 5.1. The complete database, file name JSTARS, is stored on the enclosed floppy disk and can be used with ACCESS V7.0. A total of 1536 data records are contained in this database which were primarily derived from O&A records.



QA DATA

AIRCRAFT ID:	P3		
WORK REQUEST #:	A3-056091		
AIRCRAFT ZONE:	5-6		
ATA/WUC:	57-11799		
PART/DOC #:	57-572-205	NOMENCLATURE:	ACCESS CUT-OUT FUEL TA
PART SERIAL #:	N/A	LOAD DIR:	N/A
MATERIAL:	2024-T3	PART FORM:	N/A
H/M:	170		
DEFECT TYPE:	CNPIT	DEFECT SIZE:	60 in2
DEFECT LOCATION:	ACCESS CUT-OUT 1325L	DEFECT LEVEL:	LEV 1
		DEFECT SEVERITY:	MOD
DEFECT LOCATION		DEFECT CAUSE:	N/A
WING: W.S.:		WFD:	☐
P.N.:		PSE:	☑
FUSELAGE: B.S.:			
B.L.:			
W.L.:			
VERTICAL: V.S.:			
DEFECT ORIENTATION:	INT SURFACE OF CUT-OUT		
INSPECTION TECHNIQUE:	VISUAL		

Figure 5.1 - Example Database Form

SECTION 6

TASK DESCRIPTIONS AND SERVICE BULLETINS

The following section contains a listing of the task descriptions (TD) and service bulletins (SB) for the Boeing 707. This listing is intended to give the reader an overview of the teardown steps performed in restoring the Joint STARS aircraft. O&A reports are written as a result of damage detected during these jobs and are the source of the data shown in this report. If required, all SBs and Airworthiness Directives (AD) are brought to a conclusion in the Joint STARS program.

6.1 TD JOB RENUMBERING

The following , Table 6.1, is a listing of the Task Description job renumbering that is applicable to the Boeing 707.

OLD NUMBER	JOB TITLE	NEW NUMBER
TD-0-0-00-00-001	L/H &R/H PLASTIC MEDIA BLAST	TW-0-0-00-001
TD-0-0-00-00-002	ELECTRONICS INSTL - SEC. 57	TW-0-0-24-002
TD-0-0-00-09-001	TOWING AND PARKING	TW-0-0-09-003
TD-0-0-00-10-001	RECEIVE AIRCRAFT	TW-0-0-10-004
TD-0-0-00-28-001	DEFUEL/PURGE A/C	TW-0-0-28-005
TD-0-0-00-53-003	LOWER FUSELAGE PANEL REMOVAL	TW-0-0-53-006
TD-0-0-26-25-001	COMPARTMENT INSTL - ESCAPE SLIDE	TW-0-0-25-007
TD-0-0-26-25-002	SUPPORT INSTL - CARGO RAIL SEAT TRACK	TW-0-0-25-008
TD-1-1-11-00-001	LOWER 41 COMPONENT REMOVAL	TW-1-1-00-009
TD-1-1-11-24-001	SHELF INSTL - ELECTRONIC RACK	TW-1-1-24-010
TD-1-1-31-00-001	NOSE W/W PLASTIC MEDIA BLAST	TW-1-1-00-011
TD-1-1-31-32-001	GEAR INSTL - SECTION 62 NOSE	TW-1-1-32-012
TD-1-1-31-32-002	GEAR INSTL - SECTION 62 NOSE COMPONENT	TW-1-1-32-013
TD-1-1-31-32-003	NLG DOOR REMOVAL	TW-1-1-32-014
TD-1-1-41-34-001	ANTENNA INSTL - WEATHER RADOME	TW-1-1-34-015
TD-1-1-41-52-001	RADOME INSTL - SECT. 41 NOSE	TW-1-1-52-016
TD-1-2-00-52-001	LWR DOOR REMOVAL	TW-1-2-52-017
TD-1-2-13-25-001	FORWARD CARGO LINING REMOVAL	TW-1-2-25-018
TD-1-2-13-25-002	FORWARD CARGO DECKING REMOVAL	TW-1-2-25-019

Table 6.1 - TD Job Renumbering

TD-1-2-13-35-001	OXYGEN SYSTEM REMOVAL	TW-1-2-35-020
TD-1-2-13-38-001	WATER SYSTEM REMOVAL	TW-1-2-38-021
TD-1-2-13-51-001	FORWARD CARGO PANEL REMOVAL	TW-1-2-51-022
TD-1-2-13-53-001	FORWARD CARGO SHELF REMOVAL	TW-1-2-53-023
TD-1-2-14-21-001	A/C SYSTEM REMOVAL	TB-1-2-21-024
TD-1-2-14-27-001	SNAKE PIT REMOVAL	TB-1-2-21-025
TD-1-2-44-52-001	FWD CARGO DOOR LWR SCUFF PLATE REMO	TW-1-2-52-026
TD-1-3-32-52-001	KEEL BEAM ACCESS PANEL REMOVAL	TB-1-3-52-027
TD-1-3-33-21-001	PACK INSTL - ACM A/C	TB-1-3-21-028
TD-1-3-34-21-002	PACK INSTL - ACM A/C	TB-1-3-21-029
TD-1-3-77-12-001	L/H OVER WING & EXT. PANEL REMOVAL	TW-1-3-12-030
TD-1-3-77-12-002	R/H OVER WING & EXT. PANEL REMOVAL	TW-1-3-12-031
TD-1-3-77-12-003	L/H UNDER WING & EXT. PANEL REMOVAL	TW-1-3-12-032
TD-1-3-77-12-004	R/H UNDER WING & EXT. PANEL REMOVAL	TW-1-3-12-033
TD-1-1-11-34-001	LOWER FUSELAGE AVIONIC REMOVAL	TW-1-1-34-034
TD-1-3-77-21-001	A/C DUCT REM. STA 620 - STA 960	TB-1-3-21-035
TD-1-3-77-28-001	BACKING BOARD INSTL - CENTER WING	TW-1-3-28-036
TD-1-3-77-28-002	TANK INSTL - WING CENTER SECTION	TW-1-3-28-037
TD-1-3-77-28-003	CENTER WING FUEL PROBE REMOVAL	TW-1-3-28-038
TD-1-3-77-52-001	DOOR REMOVAL STA 600K TO 820	TW-1-3-52-039
TD-1-4-15-21-001	DUCT INSTL - SEC 57 A/C DIST	TW-1-4-21-040
TD-1-4-15-21-002	CONTROL INSTL - SEC 57 CAB PRESS	TW-1-4-21-041
TD-1-4-15-25-005	SHELF & NET INSTL - SEC 57 AFT CARGO	TW-1-4-25-042
TD-1-4-15-25-006	LINING INSTL - STA 960 AFT CARGO BULKHEAD	TW-1-4-25-043
TD-1-4-15-25-007	LINING INSTL - AFT CARGO COMP BLKHD	TW-1-4-25-044
TD-1-4-15-25-008	LINING & CEILING INSTL. AFT CARGO	TW-1-4-25-045
TD-1-4-15-25-010	DECK INSTL - SEC 57 AFT CARGO COMP	TW-1-4-25-046
TD-1-4-15-34-001	TUBING INSTL - FLT RECORDER	TW-1-4-34-047
TD-1-4-15-35-001	TUBING INSTL - SECT 46 OXYGEN	TW-1-4-35-048
TD-1-4-15-38-001	SYSTEM INSTL - AFT POTABLE WATER	TW-1-4-38-049
TD-1-4-45-52-001	DOOR INSTL - CENTER CARGO	TW-1-4-52-050
TD-1-4-47-52-001	DOOR INSTL - AFT CARGO	TW-1-4-52-051
TD-1-4-47-52-002	PLATE INSTL - AFT & CENTER CARGO DOOR	TW-1-4-52-052
TD-1-5-38-53-001	TAIL CONE REMOVAL	TW-1-5-53-053
TD-1-6-35-00-001	L/H W/W PLASTIC MEDIA BLAST	TW-1-6-00-054
TD-1-6-35-27-001	L/H W/W FLT CONTROL SYS COMP.	TB-1-6-27-055
TD-1-6-35-29-001	HYD INSTL - SEC 43 COMP L/H W/W	TB-1-6-29-056
TD-1-6-35-32-001	GEAR INSTL - SEC 61 COMP	TB-1-6-32-057
TD-1-6-35-32-002	GEAR INSTL - SEC 61 MAIN LANDING L/H	TB-1-6-32-058
TD-1-6-35-32-003	DOOR INSTL - MAIN GEAR	TB-1-6-32-059
TD-1-6-35-34-001	L/H W/W FLT. REC. PITOT COMP.	TW-1-6-34-060
TD-1-7-36-00-001	R/H W/W PLASTIC MEDIA BLAST	TW-1-7-00-061
TD-1-7-36-27-001	FLT CONTROL SYSTEM REM. R/H W/W	TB-1-7-27-062
TD-1-7-36-29-001	HYD POWER SYSTEM REM. R/H W/W	TB-1-7-29-063
TD-1-7-36-32-001	GEAR INSTL - SEC 61 COMP R/H W/W	TB-1-7-32-064
TD-1-7-36-32-002	GEAR INTL - SEC. 61 MAIN LANDING R/H	TB-1-7-32-065
TD-1-7-36-32-003	DOOR INSTL - MAIN GEAR	TB-1-7-32-066
TD-2-0-00-00-002	STAND ASSY - PILOT & COPILOT CONTROL	TW-2-1-27-067
TD-2-0-00-21-001	CONTROL SYS. INSTL CABIN PRESS	TW-2-0-21-068
TD-2-0-00-21-002	OUTLET SYS INSTL - SEC 57 INDIVID AIR	TW-2-0-21-069
TD-2-0-00-25-004	SIDEWALL INSTL PASS/CARGO L/H	TW-2-0-25-070
TD-2-0-00-26-001	DETECTION SYS INSTL UPR CARGO	TW-2-0-26-071
TD-2-0-00-38-001	VENT SYS INSTL TOILET & GALLEY	TW-2-0-38-072
TD-2-0-25-00-001	DOOR MOUNTED ESCAPE SLIDE REM.	TW-2-0-25-073

Table 6.1 (Continued) - TD Job Renumbering

TD-2-1-00-00-001	COCKPIT BLANKET ASSY REMOVAL	TW-2-1-25-074
TD-2-1-00-00-003	COCKPIT C/B PANEL REMOVALS	TW-2-1-24-075
TD-2-1-00-25-001	PANEL INSTL CONTROL CABIN INTR. TRIM	TW-2-1-25-076
TD-2-1-00-35-001	TUBING INSTL - SEC 41 OXYGEN	TW-2-1-35-077
TD-2-1-21-27-001	L/H COCKPIT FLT COMP. REM	TW-2-1-27-078
TD-2-1-21-31-002	NAVIGATION STATION PANEL REMOVAL	TW-2-1-31-079
TD-2-1-21-31-006	COPILOT SIDE PANEL REMOVAL	TW-2-1-31-080
TD-2-1-21-31-007	PILOT SIDE PANEL REMOVAL	TW-2-1-31-081
TD-2-1-21-31-009	PILOT LIGHT SHIELD REMOVAL	TW-2-1-31-082
TD-2-1-21-31-011	PILOT INSTRUMENT PANEL REMOVAL	TW-2-1-31-083
TD-2-1-21-53-001	COCKPIT SEAT REMOVAL	TW-2-1-53-084
TD-2-1-21-53-002	CARPET INSTL - CONTROL CAB	TW-2-1-53-085
TD-2-1-21-56-001	COCKPIT WINDOW REMOVAL	TW-2-1-56-086
TD-2-1-22-25-001	COCKPIT FLYAWAY REMOVAL	TW-2-1-25-087
TD-2-1-22-27-002	R/H COCKPIT FLIGHT COMPONENT REMOVAL	TW-2-1-27-088
TD-2-1-22-31-001	PANEL INSTL - FLIGHT ENGINEER	TW-2-1-31-089
TD-2-1-22-31-003	MODULE INSTL - P13 PILOT OVERHEAD	TW-2-1-31-090
TD-2-1-22-31-004	ENGINE INSTRUMENT PANEL REMOVAL	TW-2-1-31-091
TD-2-1-22-31-010	COPILOT INSTUMENT PANEL REMOVAL	TW-2-1-31-092
TD-2-2-00-25-001	PARTITION INSTL - STA 304	TB-2-2-25-093
TD-2-2-24-25-001	LAVATORY INSTL	TW-2-2-25-094
TD-2-2-26-53-003	FLOOR BOARD REMOVALS	TW-2-2-53-095
TD-2-2-26-53-004	FLOOR BOARD REMOVALS	TW-2-2-53-096
TD-2-2-26-53-005	UPPER FUSELAGE INTERIOR REM	TW-2-2-53-097
TD-2-2-42-52-001	LINING INSTL - STA 304 TO 360	TW-2-2-52-098
TD-2-2-42-52-002	FORWARD GALLEY DOOR REMOVAL	TW-2-2-52-099
TD-2-2-43-52-001	REVEAL INSTL - FWD GALLEY DOOR	TW-2-2-52-100
TD-2-2-43-52-002	DOOR INSTL - FORWARD ENTRY	TW-2-2-52-101
TD-2-2-49-52-001	DOOR INSTL - MAIN CARGO	TW-2-2-52-102
TD-2-3-26-52-001	PLATE INSTL - EMERGENCY EXIT SCUFF	TW-2-3-52-103
TD-2-3-26-52-002	HATCH INSTL - EMERGENCY	TW-2-3-52-104
TD-2-3-26-53-007	UPPER FUSELAGE INTERIOR REM	TW-2-3-53-105
TD-2-3-26-56-001	WINDOW INSTL - SEC 43 & 46	TW-2-0-56-106
TD-2-3-46-52-001	REVEAL INSTL - AFT GALLEY DOOR	TW-2-3-52-107
TD-2-3-46-52-002	DOOR INSTL - AFT ENTRY	TW-2-3-52-108
TD-2-3-48-52-001	REVEAL INSTL - AFT ENTRY	TW-2-3-52-109
TD-2-3-48-52-002	DOOR INSTL - AFT GALLEY	TW-2-3-52-110
TD-3-1-91-55-001	L/H HORIZONTAL STABILIZER REMOVAL	TY-3-1-55-111
TD-3-1-93-12-001	STRUCTURE ASSY STABILIZER	TY-3-1-12-112
TD-3-1-93-27-001	ELEVATOR INSTL - HORIZONTAL TAIL	TY-3-1-27-113
TD-3-1-93-53-001	FAIRING INSTL - STABILIZER	TW-3-1-53-114
TD-3-2-92-12-001	STRUCTURE ASSY - STABILIZER	TY-3-2-12-115
TD-3-2-92-27-001	R/H ELEVATOR REMOVAL	TY-3-2-27-116
TD-3-2-92-53-001	R/H STABILIZER FAIRING REMOVAL	TW-3-2-53-117
TD-3-2-92-55-001	R/H HORIZONTAL STABILIZER REMOVAL	TY-3-2-55-118
TD-3-3-95-12-001	FIN TO FUSELAGE ACCESS PANEL REM	TW-3-3-12-119
TD-3-3-95-55-001	TAIL INSTL - VERTICAL	TY-3-3-55-120
TD-3-3-96-27-001	RUDDER REMOVAL	TY-3-3-27-121
TD-4-0-00-00-001	CLOSE ENGINE 1-4 INTAKE, EXHAUST	TW-4-0-09-122
TD-4-1-51-71-001	NO 1 ENGINE REMOVAL	TW-4-1-71-123
TD-4-1-51-71-004	ENGINE #1 COWLING REMOVAL	TW-4-1-71-124
TD-4-1-55-54-001	STRUT INSTL - OTBD NACELLE NO. 1	TY-4-1-54-125
TD-4-1-55-54-003	FAIRING ASSY - OTBD NACELLE STRUT T/E	TW-4-1-54-126

Table 6.1 (Continued) - TD Job Renumbering

TD-4-2-52-71-001	NO 2 ENGINE REMOVAL	TW-4-2-71-127
TD-4-2-52-71-004	ENGINE #2 COWLING REMOVAL	TW-4-2-71-128
TD-4-2-56-26-002	REM/STORE ENGINE #2 FIRE BOTTLES	TW-4-2-26-129
TD-4-2-56-54-001	STRUT INSTL - OTBD NACELLE NO. 2	TY-4-2-54-130
TD-4-2-56-54-003	FAIRING ASSY - OTBD NACELLE STRUT T/E	TW-4-2-54-131
TD-4-3-53-71-001	NO 3 ENGINE REMOVAL	TW-4-3-71-132
TD-4-3-53-71-004	ENGINE #3 COWLING REMOVAL	TW-4-3-71-133
TD-4-3-57-26-002	REM/STORE ENGINE #3 FIRE BOTTLES	TW-4-3-26-134
TD-4-3-57-54-001	STRUT INSTL - OTBD NACELLE NO. 3	TY-4-3-54-135
TD-4-3-57-54-003	FAIRING ASSY - OTBD NACELLE STRUT T/E	TW-4-3-54-136
TD-4-4-54-71-001	NO 4 ENGINE REMOVAL	TW-4-4-71-137
TD-4-1-54-54-004	ENGINE #4 COWLING REMOVAL	TW-4-4-71-138
TD-4-4-58-54-001	STRUT INSTL - OTBD NACELLE NO.4	TY-4-4-54-139
TD-4-4-58-54-003	FAIRING ASSY - OTBD NACELLE STRUT T/E	TW-4-4-54-140
TD-5-0-00-00-001	L/H T/E & L/E PLASTIC MEDIA BLAST	TW-5-0-00-141
TD-5-0-00-24-001	COMPONENT REMOVAL ELECT. WLE	TW-5-0-24-142
TD-5-0-00-28-001	PUMP INSTL. - MN. WING TANK FUEL BOOST	TW-5-0-28-143
TD-5-0-00-28-002	L/W WING ACCESS DR. & RIB ASSY REM	TW-5-0-28-144
TD-5-1-62-27-003	L/H OUTBOARD SLAT REMOVAL	TB-5-1-27-145
TD-5-1-62-57-007	L/H LEADING EDGE PANEL REMOVAL	TW-5-1-57-146
TD-5-1-62-57-009	COMPONENT REMOVAL WLE L/H	TW-5-1-57-147
TD-5-1-75-28-001	GAGE INSTL - OTB RESERVE FUEL TANK	TW-5-4-28-148
TD-5-1-81-27-001	L/H OUTBOARD AILERON REMOVAL	TY-5-7-27-149
TD-5-1-81-27-002	L/H OUTBOARD AIL. BAL. PANEL REM	TB-5-7-27-150
TD-5-1-81-27-013	L/H TRAILING EDGE COMPONENT REM.	TW-5-7-27-151
TD-5-1-81-57-001	PANEL INSTL. T/E LOWER WING L/H	TW-5-4-57-152
TD-5-1-82-27-001	L/H T/E OUTBOARD FLAP REMOVAL	TY-5-8-27-153
TD-5-2-63-27-002	LAT INSTL - INBOARD WLE L/H	TW-5-2-27-154
TD-5-2-63-27-009	L/H LEADING EDGE COMPONENT REM	TW-5-2-27-155
TD-5-2-63-57-009	PANEL INSTL - INBD WING L/E SLAT SEAL	TW-5-2-57-156
TD-5-2-71-28-001	PROBE INSTL - MAIN FUEL TANK NO. 1	TW-5-5-28-157
TD-5-2-82-27-001	SPOILER INSTL - OUTBOARD L/H	TY-5-8-27-158
TD-5-2-82-27-015	L/H TRAILING EDGE COMPONENT REM.	TW-5-8-27-159
TD-5-2-83-27-002	L/H INBOARD AIL BAL PANEL REM	TB-5-8-27-160
TD-5-2-83-57-003	L/H TRAILING EDGE PANEL REM	TW-5-8-57-161
TD-5-3-64-27-003	FLAP INSTL - FSS 146.76 - 382.66	TB-5-3-27-162
TD-5-3-64-57-011	PANEL INSTL - FSS 16.75 -146.75 - WLE L/H	TW-5-3-57-163
TD-5-3-64-57-015	COMPONENT REMOVAL WLE L/H	TW-5-3-57-164
TD-5-3-72-28-001	PROBE INSTL - MAIN FUEL TANK NO. 1	TW-5-6-28-165
TD-5-3-83-27-001	L/H INBOARD AILERAON REMOVAL	TY-5-8-27-166
TD-5-3-84-27-001	SPOILER INSTL - INBOARD L/H	TY-5-9-27-167
TD-5-3-84-27-002	L/H TRAILING EDGE INBOARD FLAP REM	TY-5-9-27-168
TD-5-3-84-27-017	L/H TRAILING EDGE COMPONENT REM.	TW-5-9-27-169
TD-5-3-84-57-005	PANEL INSTL - TRAILING EDGE LWR WING	TW-5-6-57-170
TD-5-3-85-27-003	L/H FILLET FLAP & FLAPPERATTE REM	TY-5-9-27-171
TD-6-0-00-00-001	R/H T/E & L/E PLASTIC MEDIA BLAST	TW-6-0-00-172
TD-6-0-00-24-002	COMPONENT REMOVAL ELECT. WLE	TW-6-0-24-173
TD-6-0-00-28-001	R/H FUEL BOOST PUMP REMOVAL	TW-6-0-28-174
TD-6-0-00-28-002	R/H WING ACCESS DOOR & RIB ASSY REM	TW-6-0-28-175
TD-6-1-67-27-002	R/H OUTBOARD SLAT REMOVAL	TB-6-1-27-176
TD-6-1-67-57-008	DOOR INSTL - OUTBOARD WLE R/H	TW-6-1-57-177
TD-6-1-67-57-010	COMPONENT REMOVAL WLE R/H	TW-6-1-57-178
TD-6-1-79-28-001	GAGE INSTL - OTBD RES TANK	TW-6-4-28-179
TD-6-1-87-27-001	R/H T/E OUTBOARD FLAP REMOVAL	TY-6-8-27-180

Table 6.1 (Continued) - TD Job Renumbering

TD-6-1-88-27-001	R/H OUTBOARD AILERON REMOVAL	TY-6-7-27-181
TD-6-1-88-27-002	R/H OUTBOARD AIL BAL PANEL REM	TY-6-7-27-182
TD-6-1-88-27-014	R/H TRAILING EDGE COMPONENT REM	TW-6-7-27-183
TD-6-1-88-57-002	PANEL INSTL - T/E LOWER WING R/H	TW-6-7-57-184
TD-6-2-66-27-002	SLAT INSTL - INBOARD WLE R/H	TB-6-2-27-185
TD-6-2-66-27-010	R/H LEADING EDGE COMPONENT REM	TW-6-2-27-186
TD-6-2-66-57-010	R/H LEADING EDGE PANEL REMOVAL	TW-6-2-57-187
TD-6-2-74-28-001	R/H WING FUEL PROBE REMOVAL	TW-6-5-28-188
TD-6-2-83-27-002	R/H INBOARD AIL BAL PANEL REM	TY-6-8-27-189
TD-6-2-86-57-004	R/H TRAILING EDGE PANEL REM	TW-6-8-57-190
TD-6-2-87-27-001	SPOILER INSTL - OUTBOARD R/H	TY-6-8-27-191
TD-6-2-87-27-016	COMPONENT REM T/E R/H	TW-6-8-27-192
TD-6-3-65-27-004	FLAP INSTL - FSS 146.76 - 382.66	TB-6-3-27-193
TD-6-3-65-57-012	PANEL INSTL - WLE R/H	TW-6-3-57-194
TD-6-3-65-57-016	COMPONENT REMOVAL - WLE R/H	TW-6-3-57-195
TD-6-3-73-28-001	R/H WING FUEL PROBE REMOVAL	TW-6-6-28-196
TD-6-3-84-27-003	R/H FILLET FLAP & FLAPPERATTE REM	TY-6-9-27-197
TD-6-3-85-27-001	SPOILER INSTL. - INBOARD R/H	TY-6-9-27-198
TD-6-3-85-27-002	R/H T/E INBOARD FLAP REMOVAL	TY-6-9-27-199
TD-6-3-85-27-018	R/H TRAILING EDGE COMPONENT REM	TW-6-9-27-200
TD-6-3-85-27-006	PANEL INSTL - T/E LOWER WING R/H	TW-6-9-57-201
TD-6-3-86-27-001	R/H INBOARD AILERON REMOVAL	TW-6-8-27-202

Table 6.1 (Continued) - TD Job Renumbering

6.2 SERVICE BULLETINS

The following, Table 6.2, contains a listing of Boeing recommended service bulletins for long term operation of 707s. Table 6.3 lists more service bulletins that were discussed in the aging aircraft study for Boeing 707-300 series aircraft.

SB NUMBER	NOMENCLATURE	EST HRS TO COMPLETE BS WORK
2425	MAIN LANDING GEAR TORQUE BOX DRAIN HOLE INSTALLATION	6
2492	OVERSIZED FASTENER INSTALLATION AT BOOST PUMP SUPPORT FITTINGS	40
2582	WING SKIN SERVICE LIFE IMPROVEMENT AT UPPER FLAP TRACK FITTING	28
2584	KEEL BEAM PRESSURE WEB AND INTERCOSTAL INSPECTION AND REWORK	16
2596	WING CENTER SECTION UPPER SURFACE PAINT APPLICATION	120
2640	OVERSIZE FASTENER INSTALLATION FORWARD OF BEAVERTAIL STRINGER 1 THRU 30	300
2648	STABILIZER CENTER SECTION PIVOT JOINT PIN MODIFICATION	24
2664	ELEVATOR CLOSURE RIB WEB & VERTICAL ANGLE REPLACEMENT	82
2696	HORIZONTAL STABILIZER FRONT SPAR ATTACHMENT FITTING INSPECTION AND BOLT TORQUING	42
2703	OVERSIZE FASTENER INSTALLATION - WBL 59.24 LOWER SPLICE	28
2709	BODY STATION 360 LOWER BULKHEAD REINFORCEMENT	340
2717	FORWARD FIN TERMINAL FITTING REPLACEMENT BODY STATION 1440	500
2753	MAIN CARGO DOOR AFT FRAME SPLICE INSPECTION	6
2792	INTERCOSTAL MODIFICATION - BODY STATION 178 TO 196	14
2804	SEAT TRACK & WING FRONT SPAR BULKHEAD CONNECTION REINFORCEMENT	18
2821	CENTER & AFT CARGO DOOR CUTOUT PROTECTION	4
2824	OVERSIZE END FASTENER INSTALLATION IN STRINGER 6 - LOWER WING SKIN PANEL	6
2901	WING TANK BAFFLE FUEL DRAIN HOLE INSTALLATION	4
2913	LEADING EDGE SLAT CARRIAGE MODIFICATION	3
2957	STRINGER REPLACEMENT BODY STATION 259 TO 303	32
2958	NACELLE STRUT SPAR CHORD MODIFICATION	410
2978	FORWARD CARGO COMPARTMENT LOWER BODY FRAME REINFORCEMENT	480
2982	INBOARD LEADING EDGE SLAT HINGE FITTING INSPECTION / REPLACEMENT	13
2997	HORIZONTAL STABILIZER TRAILING EDGE HINGE RIB WEB DRAIN HOLE INSTALLATION	24
3001	HORIZONTAL STABILIZER CENTER SECTION CLOSURE RIB CHORD INSPECTION AND REPLACEMENT	110
3002	OVERSIZE FASTENER INSTALLATION AT WING UPPER SKIN T/E SPLICE PLATE AND SUPPORT STRAPS	3
3007	RUDDER REAR SPAR INSPECTION & MODIFICATION	26
3027	BODY STATION 360 BULKHEAD DRAIN HOLE AREA INSPECTION & REWORK	1
3035	WING LOWER SKIN T/E INSPECTION & MODIFICATION AT WBL 56.7	14
3059	THERMAL INSULATION BLANKET SUPPORT INSTALLATION	229
3140	AIR CONDITIONING RAM AIR DUCT CORROSION INSPECTION & PROTECTIVE FINISH APPLICATION	456
3145	HORIZONTAL STABILIZER FRONT SPAR SPLICE PLATE INSPECTION & REPLACEMENT	405
3150	NOSE LANDING GEAR LOCK ACTUATOR SUPPORT STRUCTURE REINFORCEMENT	15
3151	HORIZONTAL STABILIZER TRAILING EDGE TO ELEVATOR UPPER SURFACE FAIR ADJUSTMENT	128
3157	WING SKIN SPLICE INSPECTION AT WING STATION 360	6

Table 6.2 - Boeing Recommended Service Bulletins For Long Term Operation of 707s.

SB NUMBER	NOMENCLATURE	EST HRS TO COMPLETE BS WORK
308	SECTION 43 STRUCTURAL REVISION	Unknown Hrs
325	FUSELAGE DOOR STOP FITTING REVISION	20
670	STUB BEAM REINFORCEMENT	60
912	SKIN & FRAME REINFORCEMENT AT AFT FIN TERMINALS	210
979	MAIN LANDING GEAR OUTER CYLINDER REPLACEMENT	36
1662	LOWER WING SKIN INSPECTION, REPAIR, & FATIGUE STRAP INSTALLATION AT WING STATION 501	Unknown Hrs
1783	BODY SKIN REINFORCEMENT AT FIN AFT ATTACHMENT TERMINALS	16
1964	INSPECT WING STRUCTURE	16
1966	STATION 820 BULKHEAD MODIFICATION	12
1995	LOWER WING SKIN INSPECTION - FRONT SPAR STATION 392	448
2014	INSPECTION AND REINFORCEMENT OF BODY FRAMES - BODY STATIONS 780, 790, 800	12
2219	FRAME REINFORCEMENT - BODY STATION 344	24
2300	UPPER BODY SKIN INSPECTION, PREVENTATIVE MODIFICATION & CRACK REPAIR BETWEEN STATION 600F AND 1000	Unknown Hrs
2323	INSPECTION & REPAIR OF DOUBLER - INBOARD DEFUELING DRY BAY CAVITY	96
2352	WING REAR SPAR UPPER CHORD REAR SPAR STATION 241, INSPECTION AND REPAIR	14
2427	WING SKIN INSPECTION, REPAIR AND MODIFICATION UNDER BEAVERTAIL AT REAR SPAR, WING BUTTOCK LINE 59-24 & BETWEEN BODY BUTTOCK LINE 70.5 AND WING STATION 351 AT REAR SPAR	4000
2449	HORIZONTAL STABILIZER JACK SCREW SUPPORT FITTING INSPECTION & MODIFICATION	Unknown Hrs
2485	LOWER WING SKIN INSPECTION, PREVENTATIVE MODIFICATION AND REPAIR AT THE FUEL JETTISON CHUTE PANEL CUTOUT & REAR SPAR	Unknown Hrs
2487	WING LOWER SKIN DRY BAY PANEL REPLACEMENT	600
2489	MAIN LANDING GEAR TRUNNION AFT SUPPORT FITTING INSPECTION, PREVENTATIVE MODIFICATION AND REWORK	Unknown Hrs
2496	OVERSIZE FASTENER INSTALLATION - WING LOWER PANEL WING STATION 360	95
2510	OVERSIZE FASTENER INSTALLATION - WING STATION 260 UPPER WING SKIN	6000
2511	BODY FORWARD FIN TERMINAL FITTING INSPECTION & REWORK	650
2567	RADIO ALTIMETER TRANSMITTING ANTENNA CUTOUT INSPECTION & REINFORCEMENT	Unknown Hrs
2570	OVERSIZE FASTENER INSTALLATION - REAR SPAR INBOARD OF THE BEAVERTAIL	511
2575	WING UPPER & LOWER PANEL INTERSPAR STRINGER OUTBOARD END ATTACHMENT MODIFICATION	Unknown Hrs
2590	WING CENTER SECTION UPPER SKIN INSPECTION AND MODIFICATION	1250
2505	OVERSIZE FASTENER INSTALLATION - LOWER REAR SPAR CHORD	Unknown Hrs
2506	OVERSIZE FASTENER INSTALLATION - WING REAR SPAR UPPER CHORD	240
2507	WING REAR SPAR UPPER CHORD & SKIN REPLACEMENT WING STATION 360 TO BODY BUTTOCK LINE 70.5 & REAR SPAR TO STRINGER 12	6000
2626	OVERSIZE FASTENER INSTALLATION - WING BUTTOCK LINE 59034	390
2700	INSPECTION & OVERSIZE FASTENER INSTALLATION - INBOARD NACELLE FRONT SPAR SUPPORT TEE	20
2729	OVERSIZE FASTENER INSTALLATION - LOWER INSPAR WING SKIN - BODY BUTTOCK LINE 70.5 TO WING STATION 733	Unknown Hrs

Table 6.3 - Service Bulletins Discussed In The Aging Aircraft Study For Boeing 707-300 Series Aircraft

2731	REWORK WING REAR SPAR UPPER CHORD AND SKIN BETWEEN WING STATION 19 & WING STATION 360	300
2765	OVERSIZE FASTENER INSTALLATION - LOWER FRONT SPAR CHORD - INBOARD DRY BAY PANEL	90
2796	MODIFICATION OF STRAP INSTALLATION ON WING SKIN AT REAR SPAR STATION 211 AND 232	16
2797	RADIO ALTIMETER RECEIVING ANTENNA CUTOUT REINFORCEMENT	Unknown Hrs
2828	OVERSIZE FASTENER INSTALLATION - OUTBOARD DRY BAY AREA	6
2837	MAIN LANDING GEAR LOCK SUPPORT FITTING INSPECTION, REPAIR, & REPLACEMENT	480
2838	NOSE WHEEL WELL SIDEWALL FASTENER INSPECTION & MODIFICATION	12
2858	BODY CROWN SKIN SPOT WELD INSPECTION, BODY STATION 259 TO 481 AND 600K TO 880	18
2859	BODY CROWN SKIN SPOT WELD INSPECTION, BODY STATION 259 TO 481 AND 600K TO 880	8
2862	BODY CROWN SKIN INSPECTION & REPLACEMENT, BODY STATION 481 TO 600K AND 960 TO 1241	2000
2863	BODY CROWN SKIN AND STRINGER TO FRAME JOINT INSPECTION AND SKIN PANEL REPLACEMENT, STATION 481 TO 600K	1000
2864	BODY CROWN STRINGER TO FRAME JOINT INSPECTION & TIE CLIP OR FILTER INSTALLATION STATION 259 TO 481, 600K TO 800 AND 1240 TO 1421	750
2867	BODY CROWN STRINGER TO FRAME JOINT INSPECTION & TIE CLIP AND FILLER INSTALLATION STATION 259 TO 481 AND600K	900
2892	OVERSIZE FASTENER INSTALLATION IN FUEL FILLER CAP FITTING - WING STATION 195, WING BUTTOCK LINE 41 & WING BUTTOCK LINE 97	20
2902	OVERSIZE FASTENER INSTALLATION IN WING UPPER SKIN - WING STATION 680	Unknown Hrs
2903	RUDDER ACTUATOR SUPPORT FITTING INSPECTION & REPAIR	188
2904	BODY CROWN STRINGER TO FRAME TIE CLIP OR FILTER	330
2909	BODY CROWN STRINGER TO FRAME TIE CLIP OR FILLER INSTALLATION STATION 481 TO 600K	165
2912	STATION 820 BODY TERMINAL FITTING INSPECTION, MODIFICATION & REPAIR	70
2933	SPLICE PLATE REMOVAL AND FITTING ATTACHMENT MODIFICATION AFT FIN TERMINAL FITTING	80
2937	OVERSIZE FASTENER INSTALLATION WING LOWER SURFACE AT WING STATION 733	40
2951	FORWARD LOWER BODY LIFE IMPROVEMENT MODIFICATION	1458
2952	FORWARD LOWER BODY LIFE IMPROVEMENT MODIFICATION	1458
2959	STABILIZER CENTER SECTION FRONT SPAR TERMINAL FITTING LUG INSPECTION & MODIFICATION	283
2962	SKIN LAP INSPECTION & MODIFICATION	841
2973	WING CENTER SECTION UPPER STIFFENER MODIFICATION & REPAIR	150
2983	CONTROL CABIN E-F WINDOW POST INSPECTION & MODIFICATION	86
2999	MAIN CARGO DOOR SKIN INSPECTION & MODIFICATION	150
3005	MOSE GEAR WALKWAY BEAM WEB BODY STATION 328 INSPECTION AND MODIFICATION	25

Table 6.3 (Continued) - Service Bulletins Discussed In The Aging Aircraft Study For Boeing 707-300 Series Aircraft

3024	KEEL BEAM - FLOOR BEAM ATTACHMENT BODY STATION 880 INSPECTION & REWORK	53
3042	INSTALLATION OF BOLT ON CLEVIS ON RUDDER ACTUATOR AFT SUPPORT FITTING	130
3046	STABILIZER HINGE FITTING REPLACEMENT	153
3056	WING REAR SPAR TRUNNION SUPPORT FITTING INSPECTION & MODIFICATION	72
3066	RUDDER ACTUATOR FORWARD SUPPORT FITTING INSPECTION & REPLACEMENT	25
3067	HORIZONTAL STABILIZER CENTER SECTION FRONT SPAR STRAP INSTALLATION	192
3098	BODY STATION 820 & OVERWING ESCAPE HATCH DOUBLER INSPECTION & REPAIR	134
3106	BODY STATION 820 & OVERWING ESCAPE HATCH DOUBLER INSPECTION & REPAIR	54
3136	WING FRONT SPAR LOWER CHORD CUTOUT INSPECTION & MODIFICATION	Unknown Hrs
3144	OVERSIZE FASTENER INSTALLATION - REAR SPAR INBOARD OF THE BEAVERTAIL	720
3170	WING CENTER SECTION FLOOR BEAM RADIUS FILLER AND TENSION TIE INSTALLATION	100
3173	INBOARD AND OUTBOARD NACELLE STRU OVERWING SUPPORT	232
3183	INBOARD NACELLE STRUT MID-SPAR FITTING REPLACEMENT	230
3216	INSPECTION & REWORK OF AFT FIN TERMINAL FITTING ATTACHMENT HOLES	32
3239	WING UPPER STRINGER FASTENER HOLE OVERSIZING AT WING BUTTOCK LINE 59.24	168
3241	E & E COMPARTMENT DOOR INSPECTION & MODIFICATION	96
3243	HORIZONTAL STABILIZER CENTER SECTION REAR SPAR UPPER CHORD TERMINAL LUG INSPECTION & MODIFICATION	192
3284	BODY STATION 259 BULKHEAD MODIFICATION	24
3300	BODY STATION 1200 AFT CARGO DOORWAY FRAME INSPECTION & REINFORCEMENT	80
3305	STRINGER 1-5 END SPLICE INSPECTION, MODIFICATION & REPAIR	194
3310	LOWER LOBE FORWARD AND CENTER CARGO DOOR STOP FITTING INSPECTION AND MODIFICATION	42
3335	WING LOWER SKIN & REAR SPAR LOWER CHORD INSPECTION & MODIFICATION	176
3349	STABILIZER TO CENTER SECTION JOINT FATIGUE LIFE IMPROVEMENT	123
3358	HORIZONTAL STABILIZER REAR SPAR CHORD INSPECTION MODIFICATION & REPAIR	392
3365	INBOARD AND OUTBOARD NACELLE STRUT OVERWING SUPPORT FITTING INSPECTION & MODIFICATION AT WING FRONT SPAR	96
3376	WING SPAR UPPER CHORD TO SKIN JOINTMODIFICATION, REAR SPAR STATION 170	190
3381	HORIZONTAL STABILIZER REAR SPAR CHORD FORWARD FLANGE INSPECTION	616
3387	MIAN CARGO DOOR CAM SUPPORT FITTING INSPECTION & REPLACEMENT	480
3388	WING CENTER SECTION FRONT SPAR WEB INSPECTION, MODIFICATION AND REPAIR	234
3394	OVERSIZE FASTENER INSTALLATION WING FRONT SPAR LOWER CHORD FORWARD FLANGE FRONT SPAR STATION 370 TO 409	120
3399	HORIZONTAL STABILIZER CENTER SECTION REAR SPAR LOWER CHORD INSPECTION & MODIFICATION	240
3419	HORIZONTAL STABILIZER HINGE FITTING INSPECTION & MODIFICATION	82
3422	WING UPPER SKIN INSPECTION & MODIFICATION	Unknown Hrs
3427	NOSE WHEEL WELL PRESSURE WEB INSPECTION, PREVENTATIVE MODIFICATION OR REPAIR	116
A2421	OUTBOARD DRY BAY LOWER WING PANEL DOUBLER MODIFICATION	30
A2961	LOWER NOSE WALKWAY PRESSURE WEB INSPECTION & MODIFICATION	16

Table 6.3 (Continued) - Service Bulletins Discussed In The Aging Aircraft Study For Boeing 707-300 Series Aircraft

SECTION 7

NON - SURVEY DAMAGE REPORTS

The following section summarizes internal report findings generated as a part of the JSTARS production program. This data was not generated by this survey but is included as an additional and alternate source of damage data on the JSTARS aircraft.

7.1 P-8 WING FINDINGS

After the conclusion of the induction inspections of production aircraft P-8, there was some concern as to the structural condition of the aircraft. As a result a summary report on the condition of the aircraft was generated and related to the condition of the other JSTARS aircraft. The following initial findings were reported for the P-8 aircraft:

- 18 wing planks require removal and replacement or extensive repairs
- Severe exfoliation corrosion
- 90% of Steel fasteners have corrosion on and around heads
- Extensive corrosion rework - Ground out areas
- Suspect crack R/H upper #5 - 3 inch length
- Center wing corroded through (holes)
- Severe corrosion on remainder of center wing skins
- Detailed Inspections of wing planks may drive additional plank replacement based upon the fastener count formula

Table 7.1 shows a tabulation of the wing plank replacement history for production aircraft P-1 to P-7 plus the projected P-8 replacements.

Aircraft	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8 Projected
Wing Planks R/R	0	1	13	10	5	5	1	18

Table 7.1 - Wing Plank Replacement History

7.2 SUMMARY OF SKIN AND SPAR CHORD REPLACEMENT

Tables 7.2 to 7.11 present a summary of the skin and spar chord replacement history for the JSTARS production aircraft from P-1 to P-6. The has been broken down by aircraft zone. Each Table also contains a code which designates the reason for replacement. Causes for replacement include modification to the JSTARS configuration, removal by basic contract agreement, and conformance to service bulletins. Any skins removed due to these three reasons will not be documented in the O&A process. Therefore, damage to these locations would not be recorded in the database developed for this program. Skin panel locations are shown in Section 3.10, Figures 3.8 to 3.11.

Zone 1-1	Code*	P-1	P-2	P-3	P-4	P-5	P-6
1L					X	X	X
1R	M			X	X	X	X
2L					X	X	X
2R	M			X	X	X	X
5L		X	X	X	X	X	X
5R		X	X	X	X	X	X
6L	S/B	X	X	X	X	X	X
6R	S/B	X	X	X	X	X	X

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.2. Zone 1-1 Skin Replacement History

Zone 1-2	Code*	P-1	P-2	P-3	P-4	P-5	P-6
11L	B & M						
11R	B & M						
12L	S/B & M	X	X	X	X	X	X
12R	S/B & M	X	X	X	X	X	X
13L	S/B & M	X	X	X	X	X	X
13R	S/B	X	X	X	X	X	X
18L	B & M						
18R	B & M						
19L	M		X	X	X	X	X
19R	S/B	X	X	X	X	X	X
20L	M			X	X	X	
20R	M		X	X	X	X	
24R	S/B & M	X	X	X	X	X	X

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.3. Zone 1-2 Skin Replacement History

Zone 1-4	Code*	P-1	P-2	P-3	P-4	P-5	P-6
32C	M			X	X	X	X
33L	M				X		X
33R	M				X	X	
34L						X	X
34R	M					X	
39C				X	X	X	X
40L						X	X
40R				X	X		X
41L	M			X	X	X	X
41R				X	X	X	X
43C	M			X	X	X	X
44L	M			X	X	X	X
44R				X	X	X	X
45L	M				X		X
45R						X	X
47R							
48L	M		X	X	X	X	X
48R			X	X	X	X	
53L				X	X	X	X
53R				X	X		X
61C							

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.4. Zone 1-4 Skin Replacement History

Zone 2-1	Code*	P-1	P-2	P-3	P-4	P-5	P-6
3L				X	X		
3R				X	X	X	
3C							
4L	M			X	X		
4R	M			X	X		
7L					X	X	X
7R							
8L					X	X	
8R	S/B	X	X	X	X	X	
9L	M						
9R	S/B & M	X	X	X	X	X	X
10C	S/B & M	X	X	X	X	X	X

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.5. Zone 2-1 Skin Replacement History

Zone 2-2	Code*	P-1	P-2	P-3	P-4	P-5	P-6
8AL							
14L				X		X	
14R							
15L	S/B	X	X	X	X	X	X
15R	S/B	X	X	X	X	X	X
16L	S/B	X	X	X	X	X	X
16R	S/B	X	X	X	X	X	X
17L				X			
17R	S/B & M	X	X	X	X	X	X
21L							
21R		X			X	X	
22L							
22R					X		
23L	M				X		
23R	M					X	X
25L							X
25R							
26L				X		X	
26R							
27L	M			X		X	X
27R	M			X			

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.6. Zone 2-2 Skin Replacement History

Zone 2-3	Code*	P-1	P-2	P-3	P-4	P-5	P-6
28L					X		
28R					X		
29L							
29R							
30L							
30R							
31L	M			X			
31R	M			X			
35L	M			X		X	
35R						X	
36L						X	
36R						X	X
37L							
37R				X			
38L	M			X			
38R				X			
42L					X		
42R						X	
46L	M			X	X		X
46R							
49L	M			X			X
49R	M			X	X	X	
50L							
50R							
51L							
51R							
52L	M			X			
52R				X			
54L	M		X	X	X	X	
54R					X		
55L					X	X	X
55R						X	

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.7. Zone 2-3 Skin Replacement History

Zone 2-3	Code*	P-1	P-2	P-3	P-4	P-5	P-6
56R							
58C				X	X	X	X
59L				X		X	X
59R						X	X
60L						X	X
60R							X
61L							
61R							
62C	M	X		X	X	X	X
63L							X
63R							
64L							
64R						X	
65L				X			
65C					X		
65R				X			
66C		X		X	X	X	
67L							
67C							
67R							
68L		X		X		X	X
68R		X		X			
69L		X					
69C				X	X	X	X
69R		X		X			
70C							
71L	S/B	X	X	X	X	X	X
71R	S/B	X	X	X	X	X	X

* Code: M - Modification, S/B - Service Bulletin, B - Basic Contract

Table 7.8. Zone 2-3 (continued) Skin Replacement History

	P-1	P-2	P-3	P-4	P-5	P-6
Total Skins R/R	26	25	65	62	66	55
% Skins R/R	19%	19%	48%	46%	49%	41%

Table 7.9. Total Skins Replaced

Zone 5	Code*	P-1	P-2	P-3	P-4	P-5	P-6
L/H INBD UPPER	B		X		X	X	X
L/H INBD LOWER					X		
L/H MID UPPER	B	X	X	X	X	X	X
L/H MID LOWER		X		X	X		
Zone 6							
R/H INBD UPPER	B		X		X	X	X
R/H INBD LOWER					X	X	
R/H MID UPPER	B	X	X		X	X	X
R/H MID LOWER		X		X	X	X	

* Code: B - Basic Contract

Table 7.10. Zone 5 and 6 Spar Chord Replacement History

SECTION 8

STRUCTURAL LOADS AND PART FORM

The following section contains a brief description of the loads and part form for the major structural components on the aircraft. This information is presented first for the wing structures and then for the fuselage.

8.1 WING LOADS AND PART FORM

The wing structure data presented in this section was derived from the following Boeing documents:

- D204-10653 E-3A Stress Analysis - Nacelle and Struts (1974)
- D204-10651 E-3A AWACS Wing Stress Analysis (1974)
- D204-10245 E-3A AWACS Design Loads (1974)
- D409-12200 E-6 External Loads (1986)
- D204-10575 E-3A AWACS Service Life Analysis (1978)
- D525-12447 E-8A JSTARS Durability and Damage Tolerance Assessment (1988)

8.1.1 FRONT SPAR

Description

- 7178-T6 Aluminum extruded upper chord
- 7075-T6 Aluminum extruded lower chord
- 2024-T3 and 7075-T6 Aluminum webs
- 7178-T6 Aluminum extruded stiffeners

Loads - Critical design conditions

- Symmetric maneuvers
- Engine nacelles side loads
- Fuel pressure
- Upper and lower chord axial loads and the web shear loads are obtained from the wing internal loads analysis and Wing-Body FEM output
- Web stiffener loads are due to semi-tension field web action and fuel pressures

8.1.2 REAR SPAR

Description

- 7178-T6 Aluminum extruded upper chord
- 7075-T6 Aluminum extruded lower chord
- 2024-T3 and 7075-T6 Aluminum webs
- 7178-T6 Aluminum extruded stiffeners

Loads - Critical design conditions

- Symmetric maneuvers
- Taxi/Take-off
- Landing
- Upper and lower chord axial loads and the web shear loads are obtained from the wing internal loads analysis and wing-body FEM output.
- Loads from Main Landing Gear are obtained from the Wing-Body FEM output.
- Web stiffener loads are due to semi-tension field web action and fuel pressures.

8.1.3 LANDING GEAR SUPPORT STRUCTURE

Description

- Structure consists of torque box assembly
  - Two ribs aft of the rear spar, the inboard WBL 59.24 4330 Steel forging rib and the outboard aluminum rib located at WS 204 at the rear spar.
  - 7178-T6 Aluminum upper skins
  - 2024-T4 Aluminum lower skins
  - Upper and lower 7075-T6 Aluminum forging external rib chords (Beaver Tails) at WBL 59.24
- Associated with the torque box are the following fittings:
  - 4330 Steel forging 220-240 ksi H.T. - Forward & Aft bearing support fittings
  - 7075-T73 Aluminum forging - rear spar support fitting

Loads

- Loads are applied through the forward and aft bearing support fittings
- Internal loads distribution obtained from the Wing-Body FEM output

8.1.4 RIB AT WBL 59.24

Description

- Primary function is to support the main landing gear trunnion located in the torque box aft of the rear spar. Trunnion loads distributed into the wing box structure. The rib upper and lower chords splice all the wing box skin stiffeners. The rib also supports the jack panel fitting and is a fuel tank end.
- 7075-T6 Aluminum forward section

- 7178-T6 Aluminum aft section
- 7178-T6 Aluminum extruded stiffeners (on both sections)
- Upper and lower rib chords are in two parts:
    - Upper two parts 7075-T6 extrusions
    - Lower two parts 2024-T42 extrusions
- Two external chord members, upper and lower run from the torque box aft of the rear spar to halfway between the rear and front spar.
    - 7075-T73 Aluminum forgings (Beaver Tails)

Loads

- Symmetric maneuvers
- Taxi
- Landing
- Upper and lower chord axial loads, stresses and web shear loads are obtained from the Wing-Body FEM output
- Web stiffener loads are column loads due to wing flexure and surface air pressure and beam loads due to fuel pressure

8.1.5 WING BOX JOINTS

Description

- At BBL 70.5, WS 360.0, and WS 729 (a.k.a. WS 733 production break) both the wing skin and skin stiffeners are spliced. Splice plates, angles, and the inspar rib chords are used to make the joints

Loads

- Symmetric maneuvers
- Wing bending and torsion obtained from Wing Internal Loads analysis
- At BBL 70.5 the primary loads come from the Wing-Body FEM output

8.1.6 STIFFENER SPLICE STRUCTURE

- Stiffeners are spliced at all the wing box joints and at BBL 54.24
- At BBL 54.24 the wing is continuous. Splice angles and inspar rib chords are used to make joints

Loads

- Symmetric maneuvers
- Primary loads due to wing bending and torsion obtained from Wing-Body FEM output

8.1.7 NACELLE STRUT RIB

Description

- Two nacelle strut ribs per wing at WBL 315.0 and WBL 545.0, Nacelle rib distributes concentrated loads from the engine power plant into the wing box. The engine nacelle drag support fittings, one on upper and three on lower surface, are part of the nacelle structure. All concentrated loads applied to the rib through these fittings.
- 7178-T6 and 7075-T6 Aluminum 0.090 inch thick webs
- 7178-T6 and 7075-T6 Aluminum extruded stiffeners
- 7075-T6 Aluminum upper and lower extruded inner chord with shear ties to wing skins between stringers

Loads

- Engine nacelle support loads, rib applied loads, are determined from:
- Engine power plant package mass properties and accelerations
- Engine net thrust or drag
- Nacelle attachment geometry

8.1.8 BBL 70.5 RIB

Description

- Wing body closure rib
- With keel beam it distributes body loads into the wing box structure
- Fuselage connections are to the upper chord and at terminal fittings at front and rear spar
- Rib chords splice wing skin and stiffeners to wing center section around corner caused by wing sweep back and dihedral
- Rib serves as a fuel tank end
- Center section spanwise beams, 6 places, tie into rib web
- Front and rear spars tie to rib through terminal fittings that form the rib ends
- Rib web is in two parts - Forward : 7075-T6 sheet and Aft: 7178-T6 tapered sheet
- Web stiffeners : 7178-T6 extrusions
- Upper rib chords: 7075-T6 extrusions
- Lower rib chords: 2024-T4 extrusions

Loads

- Symmetric Maneuvers
- Taxi/Takeoff
- Cabin pressure where applicable
- Applied loads and distribution through rib structure obtained from Wing-Body FEM output

8.1.9 TERMINAL FITTINGS STRUCTURE

Description

- **Front Terminal Fitting**: Machined 7075-T73 forging. Contains the front spar wing body terminal pin, splices the wing inboard and center section front spars and joins the BBL 70.5 rib to the front spar
- **Rear Terminal Fitting**: Machined 7075-T73 or T6 forging. Contains the rear spar wing body terminal pin, splices the wing inboard and center section rear spars and joins the BBL 70.5 rib to the rear spar

Loads

- Dive maneuver
- Ground turn
- Terminal pin loads and the fitting attach loads (to spar caps and webs and webs and rib caps and web) are obtained from Wing-Body FEM

8.1.10 WING PLANK STRUCTURE

Description

- Upper and lower wing skins are machined aluminum plates referred to as wing planks
- Center section upper surface consists of Two planks:
    - One 7075-T6
    - One 7178-T6
- Center section lower surface:
    - Six 2024-T3 or T4
- Outer wing upper surface: Seven 7178-T6 (Planks 1 to 7)
- Outer wing lower surface consists of Ten planks:
    - Two 2024-T3 (Planks 7 & 9)
    - Six 2024-T4 (Planks 1,2,3,4,8 &10)
    - Two 2024-T351 (Planks 5 & 6)
- Plank Stiffeners
    - 7178-T6 extrusions - Upper surface
    - 7075-T6 extrusions - Lower surface
- Spanwise plank splices use "J" type stiffeners
- Chordwise splices - use splice plates, rib chords and in some places also splice angles

Loads

- Symmetric maneuvers
- Taxi/Takeoff

- Applied loads and stresses are obtained from the Wing Internal Loads analysis and Wing-Body FEM output

8.1.11 FRONT AND REAR SPAR STRUCTURE - CENTER WING

Description

- Front and rear spar
- 7178-T6 extruded upper chord
- 7075-T6 extruded lower chord
- 2024-T3 sheet web
- 7075-T6 extruded vertical stiffeners

Loads

Front spar

- Critical chord axial loads - Symmetric maneuvers
- Critical web shears - Asymmetric wing loading
- Emergency landing designs the web vertical stiffeners

Rear spar

- Critical chord axial loads - Symmetric pull up maneuvers
- Critical web shears - Asymmetric wing loading

8.1.12 KEEL BEAM STRUCTURE - CENTER WING

Description

- Keel beam attaches to the wing box lower surface through the breather web and two beams located at left and right BBL 12.78

- Keel beam attaches directly to the breather web that is attached to the two BBL 12.78 beams

Loads

- Critical for symmetric maneuvers
- Loads come from the change in keel beam load between BS 600K and BS 820, cabin pressure and fuel head plus tank vent pressure

8.1.13 SPANWISE BEAMS STRUCTURE

Description

- Six spanwise beams running between the left and right BBL 70.5 rib
    - 7075-T6 sheet - Web connects wing box upper and lower surface stiffeners

Loads

- Critical chord axial loads - Symmetric maneuvers
- Critical web shears - Asymmetric wing loading combined with fuselage cabin pressure, floor and cargo weight, and fuel weight
- Fuel loads from emergency landing designs the web vertical stiffeners

Figure 8.1 shows a bending diagram for the wing for a typical cruise condition.

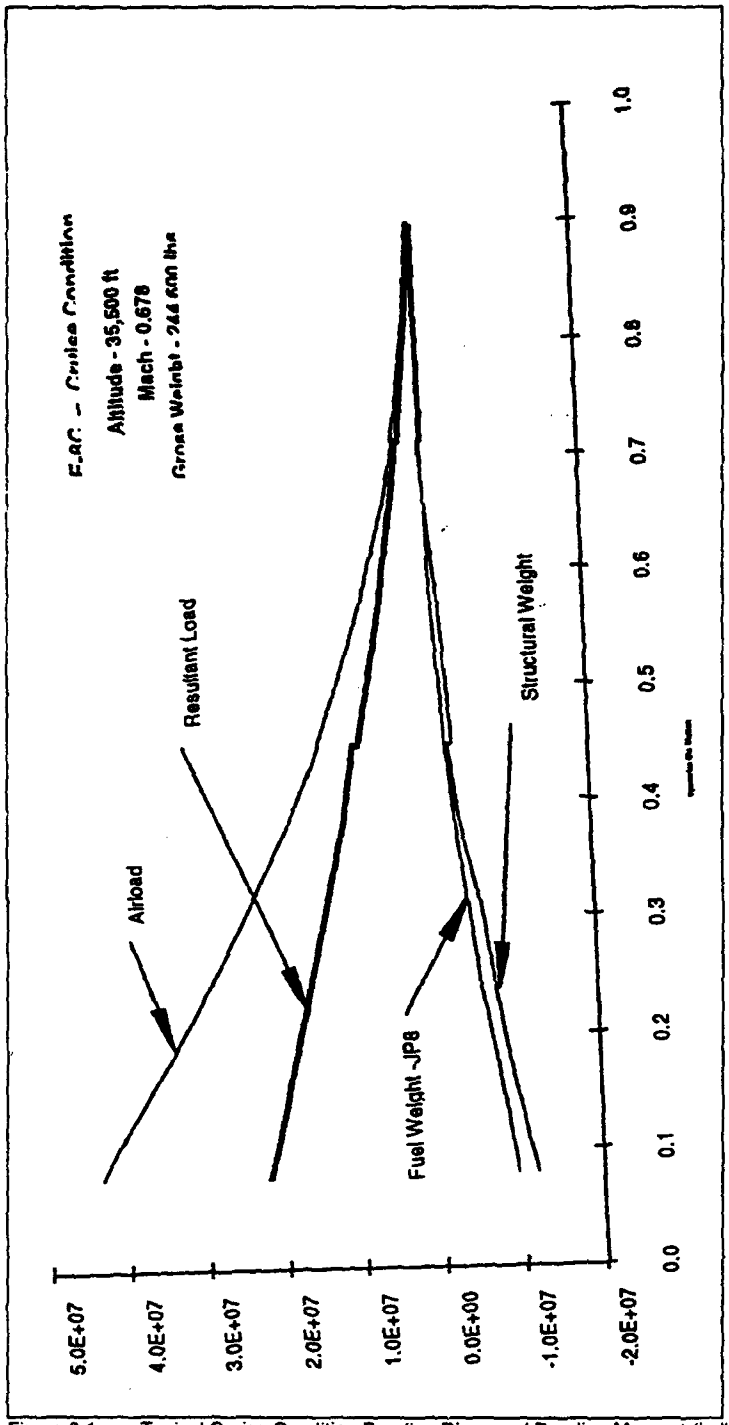


Figure 8.1 - Typical Cruise Condition Bending Diagram (Bending Moment (in lbs) versus Halfspan Ratio)

8.2 FUSELAGE LOADS AND PART FORM

The fuselage shell, a semi-monocoque structure, is composed of stringers and skins stabilized with frames The fuselage structure data presented in this section was derived from the following Boeing documents:

- D204-10245 E-3A AWACS Design Loads (1974)
- D204-10654 E-3A AWACS Fuselage Stress Analysis (1974)
- D204-10575 E-3A AWACS Service Life Analysis (1978)
- D409-12200 E-6A External Loads and Inertia Loads (1986)
- D409-12202 E-6A Fuselage Stress Analysis (1986)
- D525-11585 E-8A JSTARS Design Loads (1987)
- D525-11587 E-8A JSTARS Stress Analysis (1987)

8.2.1 SKIN AND STRINGERS

Description

- Stringers: 7075-T6 Aluminum
- Skins: 2024-T3 Aluminum

Loads - Critical loads

- 3 point braked roll - BS 259 to BS 600K
- Nose gear yaw - BS 259 to BS 600K
- Ground Turn - BS 259 to BS 600K, BS 600K to BS 960
- JSTARS Radome cases - BS 178 to BS600K
- Vertical Gust - BS 259 to BS 600K
- Positive Maneuver - BS 820 to BS 1240

- Vertical fin gust - BS 1240 to 1592
- Rudder maneuver - BS 1240 to BS 1592
- Engine out - BS600K to BS 960
- Internal Pressure - BS 178 to BS 1440

8.2.2 FRAMES AND BULKHEADS

Description

- Typically used to stabilize and distribute the fuselage loads, carry internal pressure loads and support point loads
- Major bulkheads located at BS 259.5, 312, 360, 600K, 820, 960, 1440, and 1505.87
- Frames and Bulkheads
    - 2024-T3 or T4 clad sheet webs
    - 2024-T3 extrusion stiffeners
    - 2024-T3511 extrusion stiffeners
    - 2024-T42 extrusion stiffeners, frame chord
    - 7075-T6 clad sheet webs
    - 7075-T6 extrusion stiffeners, frames
    - 7075-T6511 extrusion stiffeners
    - 7075-T73 forging fittings and frames

Loads - Critical design conditions

Internal pressure - All frames and bulkheads

Ground turn - BS 820 bulkhead, BS 880 and BS 890 floor beams

3 point landing + Spin-up - BS 312 and BS 360 bulkhead

Positive vertical gust - Bs 380 to 600J frames

Positive Maneuver - BS 600K, BS 820, and BS 1440 bulkheads

Engine out - BS 960 bulkhead

JSTARS rudder overyaw - BS 960, BS 1440, and BS 1505.87

Floor Loading - Floor beams

Crash Loading - Frames and floor beams

JSTARS UARRSI - BS 259.5 and BS 312 bulkheads

Towing - BS 312 bulkhead

Un-symmetric braking - BS 360 bulkhead

Nose gear yaw - BS 312 and BS 360 bulkheads

8.2.3 SPECIAL STRUCTURE

Description

- Non-standard structural configuration such as cutouts, doors, nose and main landing gear wheel wells, etc.
    - 2024-T3 clad sheets
    - 2024-T3 and -T3511 extrusion stiffener
    - 2024-T4 clad sheet webs
    - 2024-T42 extrusion stiffeners
    - 7075-T6 clad sheet webs
    - 7075-T6 extrusion stiffeners
    - 7075-T6511 extrusion stiffeners
    - 7075-T73 forging fittings

- 7178-T6 extrusion keel beam
- 7178-T6511 extrusion stiffeners

Loads - Critical design conditions

- Internal pressure - Nose gear wheel well, Forward cargo door and cutout, Main cargo door and cutout, Special stringer S-18A, Cabin window structure, Main gear wheel well, Passenger Cabin window, Aft entry door and cutout
- Un-symmetrical braking - Nose gear wheel well BS 312 to BS 360
- 3 point landing + Spinup - Nose gear wheel well BS 312 to BS 360
- Ground turn - Pressure deck from BS 820 to BS 960
- Fin maneuver - Passenger cabin window
- Engine out - Aft entry door and cutout
- Rudder Maneuver - Aft entry door and cutout
- Positive Maneuver - Keel beam, special stringer S-29 from BS 960 to 1210, special stringer S-18A
- Vertical gust - Main cargo door and cutout
- Cargo and crash loads - Crease beam

Figure 8.2 shows a sketch which summarizes the damage tolerance limit load conditions as they apply to the different regions on the fuselage. Figure 8.3 shows a plot of the cabin pressure loads versus flight altitude.

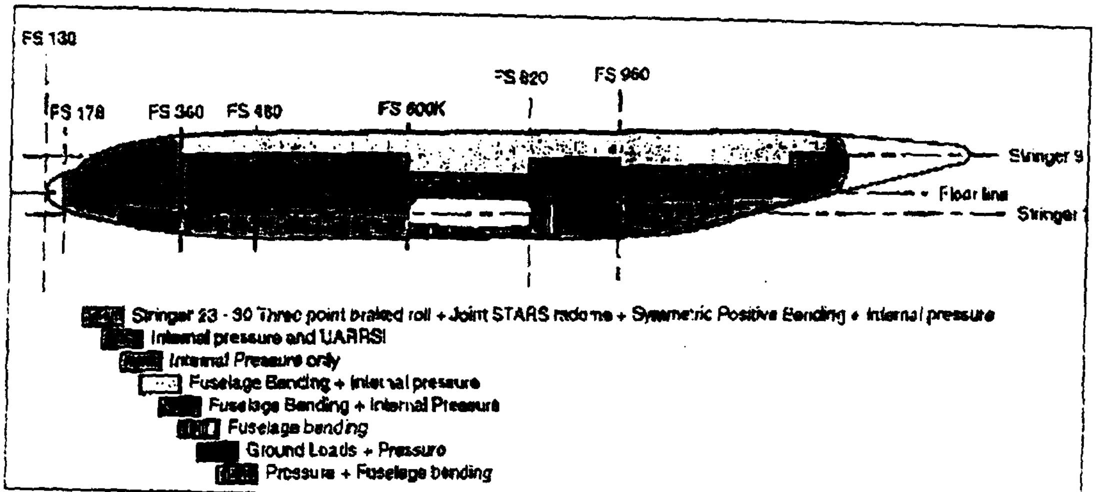


Figure 8.2 - Damage Tolerance Limit Load Conditions for the Fuselage.

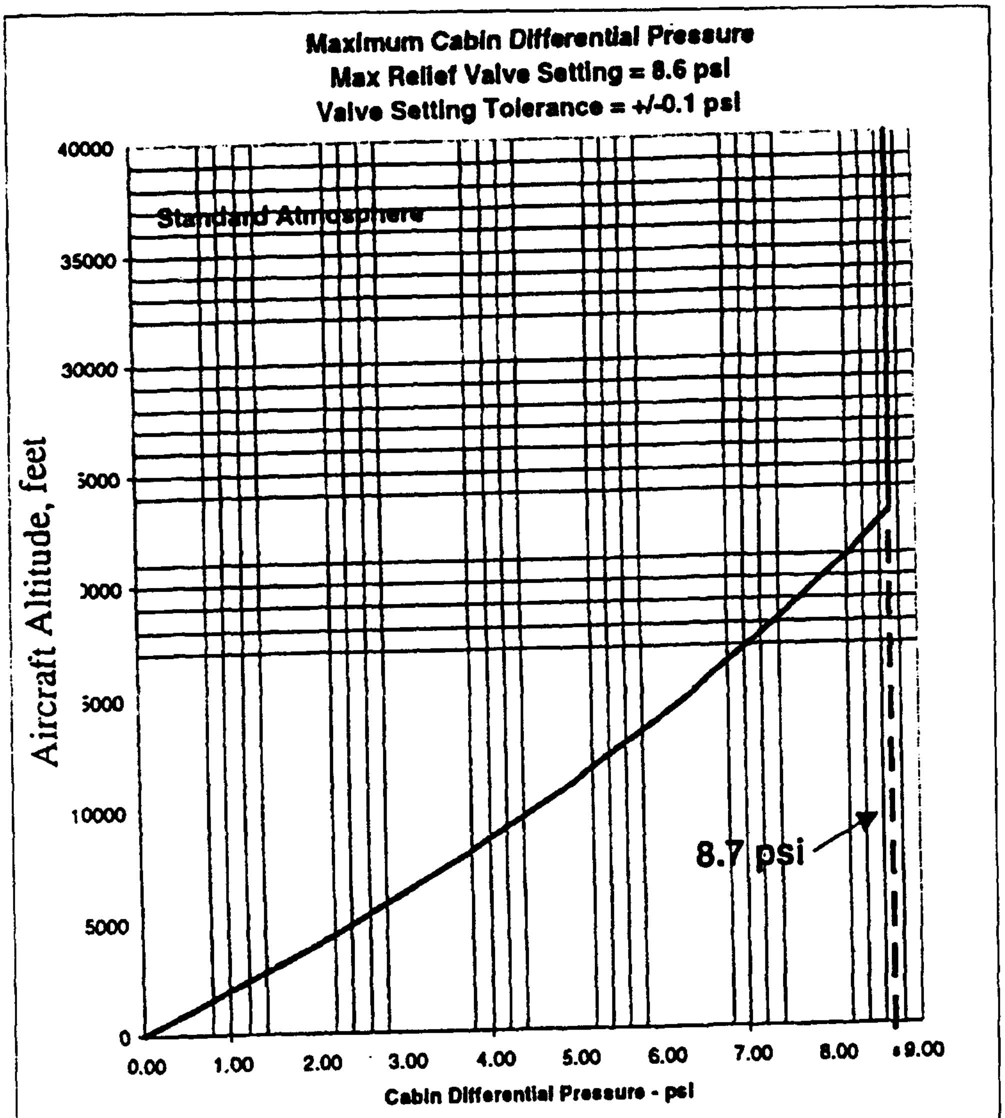


Figure 8.3 - Cabin Pressure Loads

8.2.4 MISSION PROFILES APPLICABLE TO FUSELAGE

Table 8.1 summarizes the different mission segments and their applicability to the fuselage spectrum.

		FUSELAGE	
	FORWARD	CENTER	AFT
UNLOADED	X	X	X
GROUND TURN	X	X	X
BRAKED ROLL	X	X	
TAXI OUT	X	X	X
ROTATION		X	X
LIFT-OFF		X	X
FLAPS DOWN DEPARTURE		X	X
INITIAL CLIMB	X	X	X
FINAL CLIMB	X	X	X
CRUISE	X	X	X
CRUISE TURN	X	X	X
INITIAL DESCENT	X	X	X
FINAL DESCENT	X	X	X
FLAPS DOWN APPROACH		X	X
YAW MANEUVER		X	X
FLARE		X	X
TOUCHDOWN	X	X	X
GROUND ROLLOUT	X	X	X
REVERSE THRUST	X	X	
ENGINE OUT		X	X

Table 8.1 - Spectrum Segments Applicable to Fuselage

8.2.5 TYPICAL FUSELAGE BODY MASS DISTRIBUTION

Figures 8.4 and 8.5 show the typical body mass distribution (shear and moment diagrams) with no gear and no empenage loads. Figures 8.6 and 8.7 show the mass distributions with gear and empenage loads. ARM shown in these figures is the same as BS just displaced by 160 inches such that ARM = -30 when BS = 130.

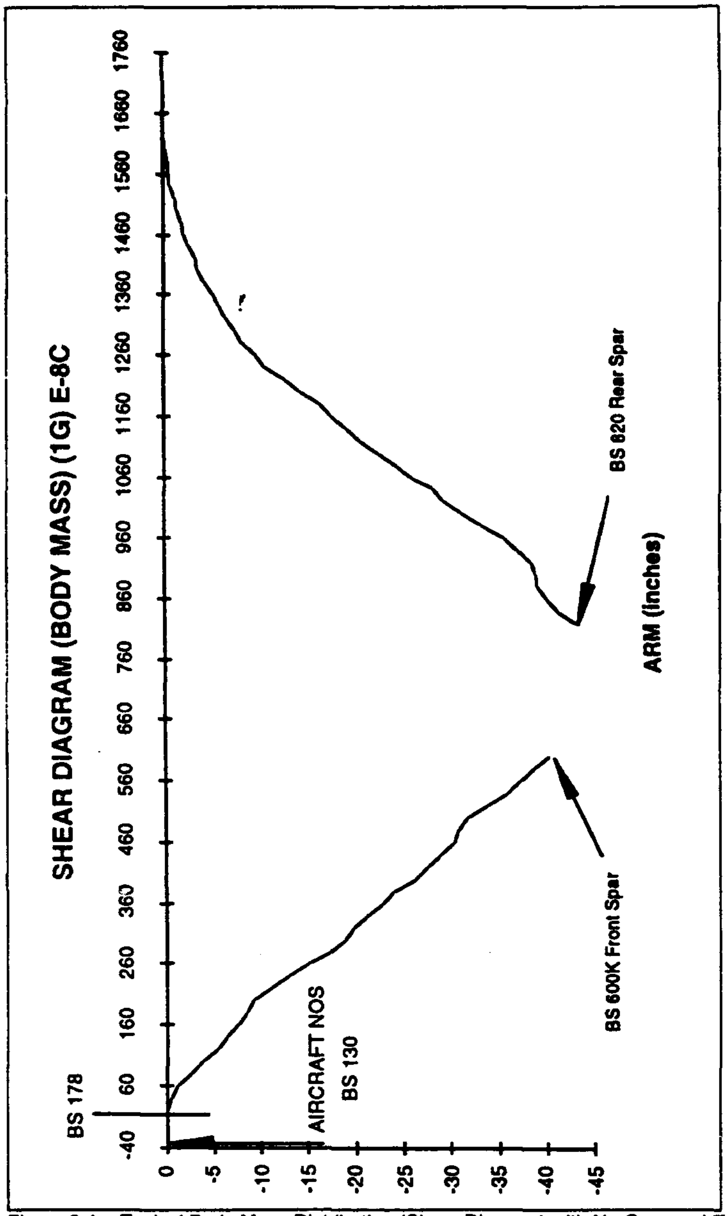


Figure 8.4 - Typical Body Mass Distribution (Shear Diagram) with No Gear and Empenage Loads

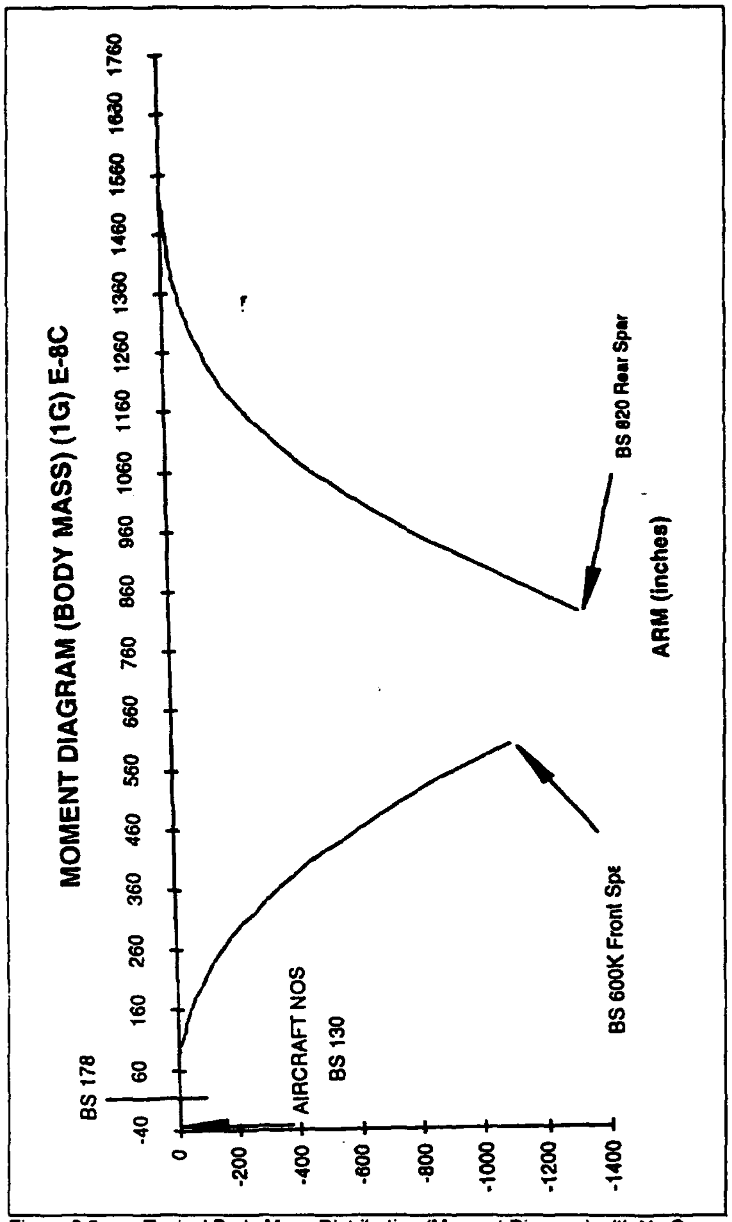


Figure 8.5 - Typical Body Mass Distribution (Moment Diagram) with No Gear and Empenage Loads

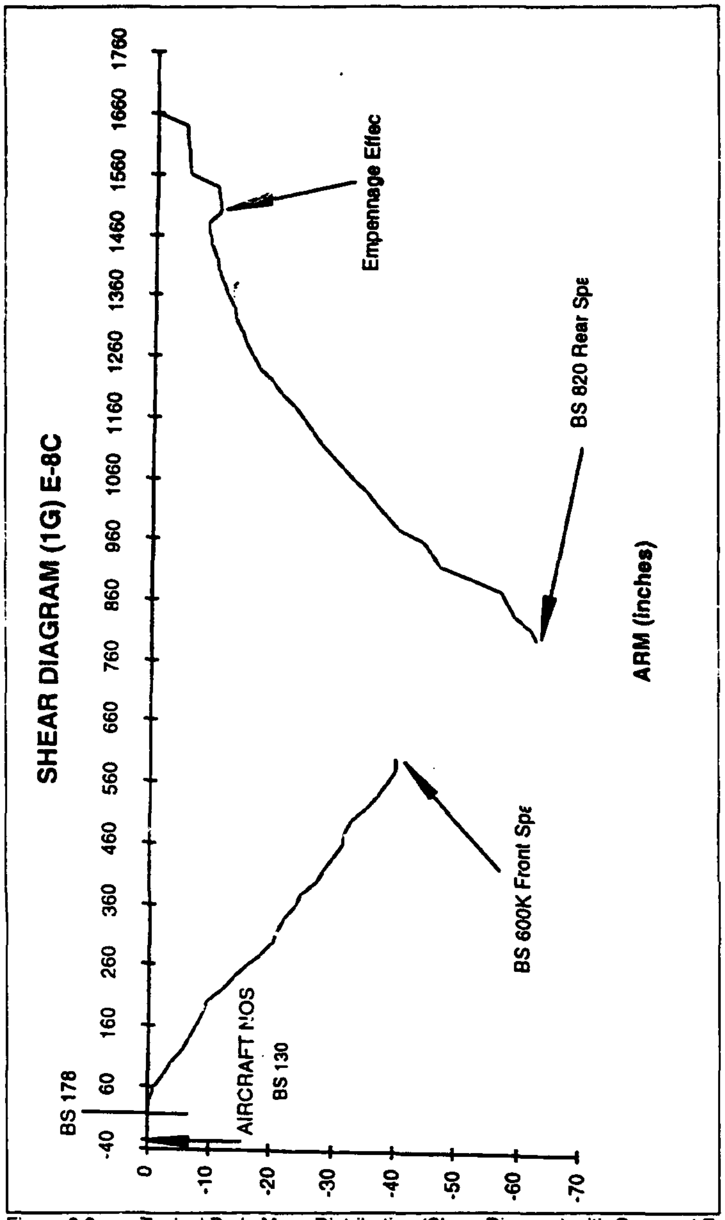


Figure 8.6 - Typical Body Mass Distribution (Shear Diagram) with Gear and Empenage Loads

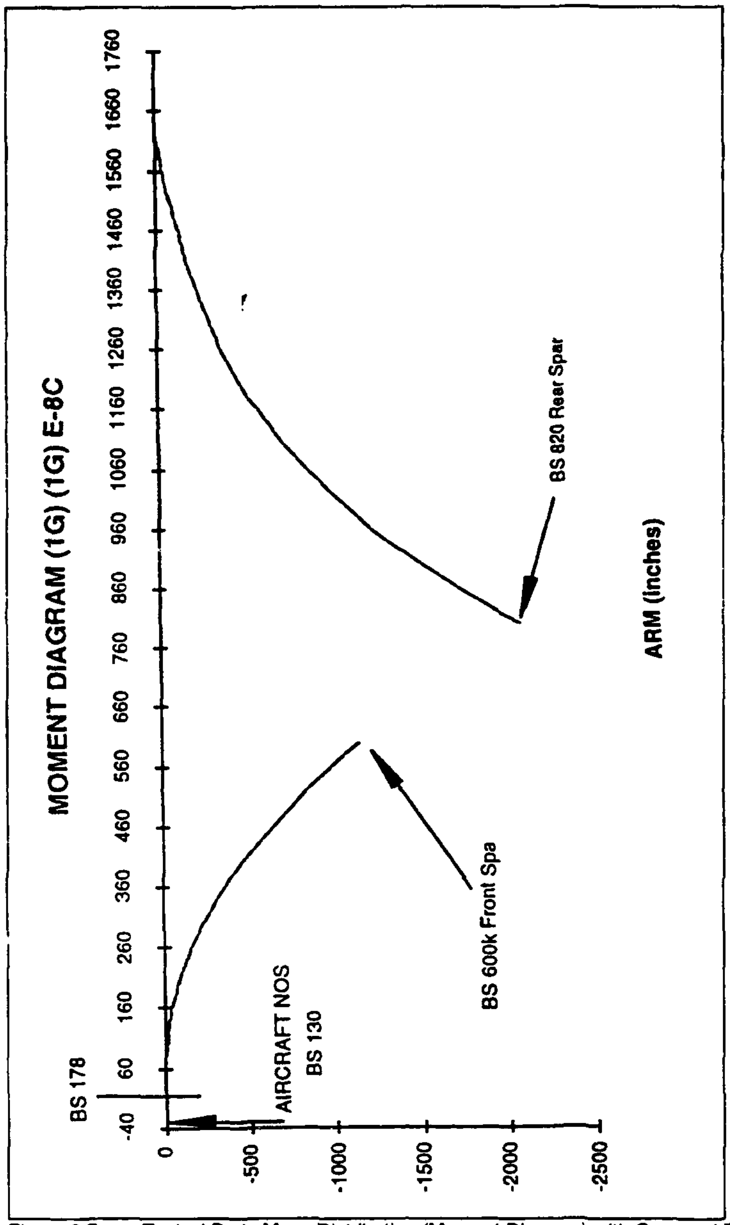


Figure 8.7 - Typical Body Mass Distribution (Moment Diagram) with Gear and Empenage Loads

SECTION 9

DURABILITY AND DAMAGE TOLERANCE ASSESSMENT ANALYSIS

A damage tolerance assessment analysis of the JSTARS aircraft has not been completed as of the date of this report. Boeing developed a durability and damage tolerance (DADT) analysis for the E-8A for nine control points on the aircraft by assessing the change in usage from the standard commercial aircraft. Control points were located on the forward fuselage, 600K and 960 crown, horizontal and vertical stabilizers. The assessment only provides changes in damage growth due to usage and does not provide critical crack length or crack growth life.

The Air Force adjusted this database for the E-8C mission and generated an adjusted spectrum, fatigue crack growth rates, and relative life factors (RLF). RLF is a ratio of the expected life of the E-8C to the expected life of the E-8A. For example, if a given location and condition results in life (L1) for the E-8A and the same location and condition results in life (L2) for the E-8C, the RLF for this situation is (L2/L1). Supplemental Structural Inspection Documents were also adjusted for the new mission profiles.

Northrop Grumman is currently developing DADT analysis for the JSTARS aircraft for all JSTARS modifications and 60 non-standard repairs for each production aircraft. This analysis will not be available until the third quarter of 1997. A finite element model (FEM) for the center fuselage and inboard wing is available or under development and may be extended to other sections of the aircraft. Section 8 briefly discusses how and where DADTA will be developed for the JSTARS aircraft. Table 9.1 shows the JSTARS modifications which will have DADT analysis developed. These modifications are spread across the entire aircraft.

1	Bulkhead BS 259.50	9	In-flight Refueling Receptacle
2	Bulkhead BS 312.00	10	Antennas Installation
3	Frame BS 420.00	11	Hardback
4	Frame BS 580.00	12	Vapor Cycle Machine Installation
5	Frame BS 600.00H	13	APU Installation
6	MLG Support Structure BS 880.00	14	Miscellaneous Installations BS 960.00 BS 451.50 BS 600.00 BS 20.00
7	Crease Beam Modifications BS 600G-600H (Left & Right) BS 1120-1140 (Left) BS 1140-1160 (Left)	15	SDS Fuselage Penetrations AAR-44 MWS BS 1190.00 (Upper) BS 1194.00 (Cutout) BS 990.00 (Lower)
8	Ram Air and Ground Service Inlet	16	BS 1312.00 (Left & Right) BS 1330 and 1350.00 (right) BS 1350.00 (Left)

Table 9.1 - JSTARS Modification Locations

Table 9.2 is a table of relative life factors which show the change in life for the JSTARS spectrum from the original E8A spectrum. This analysis was used as an aid in selecting the most critical non-standard repairs for DADT analysis for the JSTARS.

Spectrum	RLF	Max Spect Stress	Spect Cond	Limit Stress	Limit Condition
Baseline	1.00	18.756	Cruise Maneuver	34.280	+HAA Pos Maneuver
WS 360 upper	8.392	10.629	TO-Roll/Taxi-out	15.500	Taxi
WS 360 lower	0.460	18.756	Cruise Maneuver	34.280	+HAA Pos Maneuver
BS 600K upper	1.542	13.156	Cruise+Gust+Press	26.057	+Gust+Press
BS 600K lower	0.641	29.975	3pt Braked Roll	30.075	3pt Braked Roll
BS 820 upper	3.850	15.730	Approach+Press	26.527	Pos Maneuver+Press
BS 960-1000 lower Shear+Long Press	0.544	25.146	Approach+Press	37.778	Pos Maneuver+ Press
BS 960-1000 lower Shear+HoopPress	0.598	25.351	Approach+Press	41.313	Pos Maneuver+Press
BS 1000 - 1320 lower Shear+Long Press	31.793	9.134	Init Desc+Press	32.538	Pos Maneuver+ Press
BS 1000 - 1320 lower Shear+HoopPress	17.868	12.669	Init Desc+Press	36.073	Pos Maneuver+ Press
BS 1320 - 1420 lower Shear+Long Press	27.940	9.344	Init Desc+Press	15.757	Pos Maneuver+ Press
BS 1320 -1420 lower Shear+HoopPress	16.235	12.879	Init Desc+Press	19.292	Pos Maneuver+ Press
Hoop pressure only	231.606	7.071	1 FP (8.6 psi)	Pr/t	2 Fp (17.2 psi)

Table 9.2 - Relative Life Factors for JSTARS Spectrum

Figures 9.1 to 9.7 and Table 9.3 show the adjustments to RLF for a variety of conditions and materials substitutions. The effects on RLF by factors such as stress level, hole diameter, fracture toughness, edge distance, width, thickness, and material are shown.

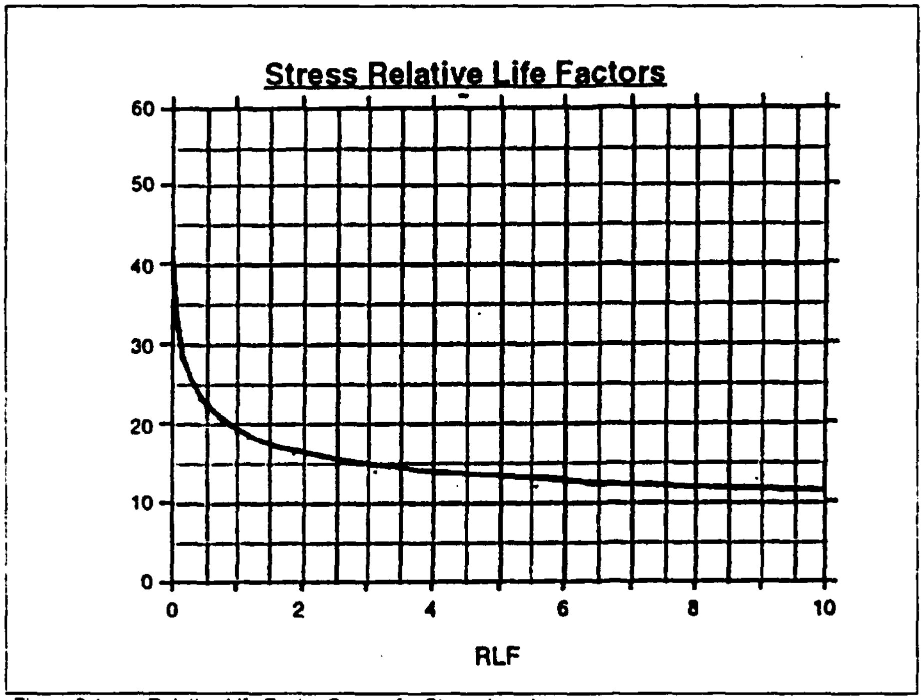


Figure 9.1 - Relative Life Factor Curves for Stress Level

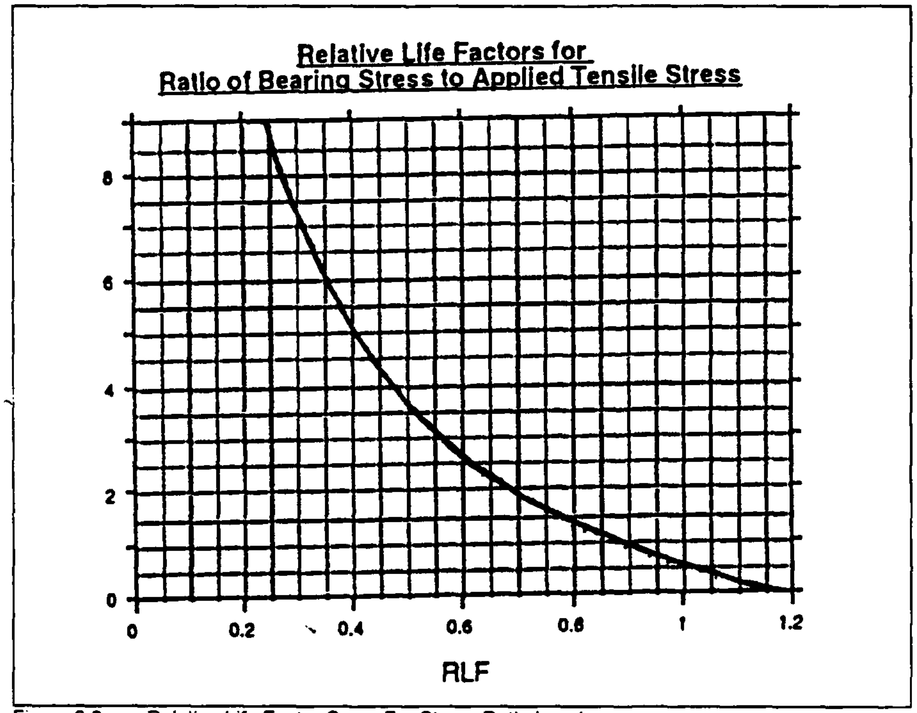


Figure 9.2 - Relative Life Factor Curve For Stress Ratio Levels

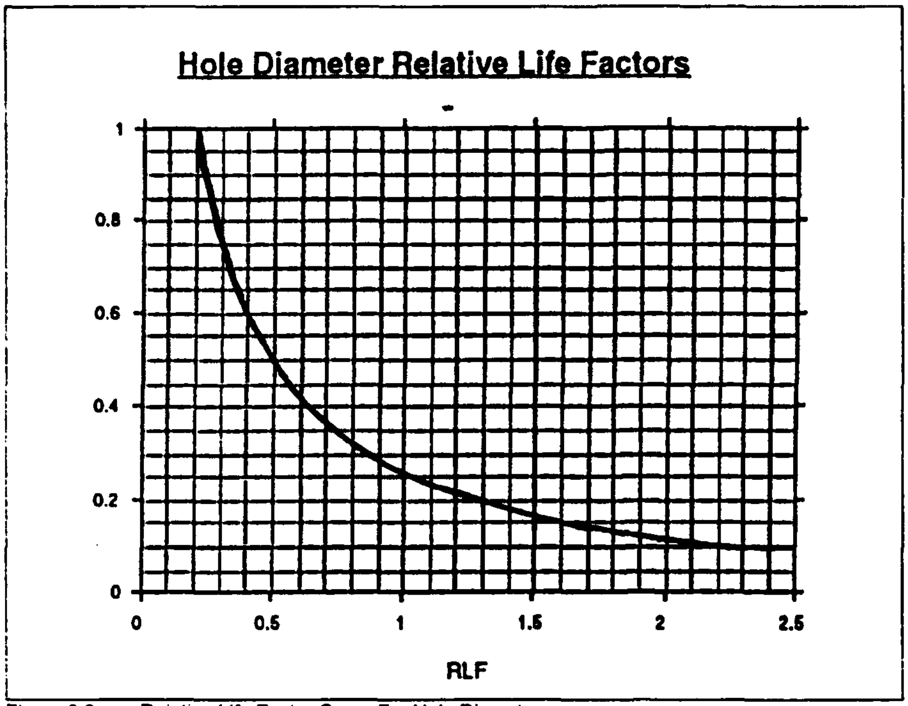


Figure 9.3 - Relative Life Factor Curve For Hole Diameter

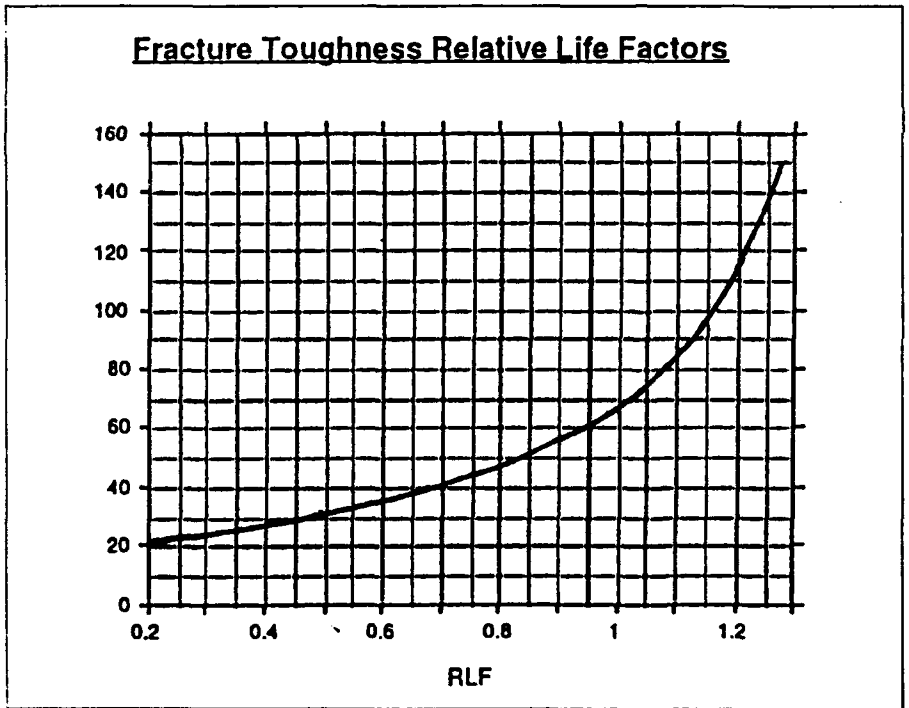


Figure 9.4 - Relative Life Factor Curve For Fracture Toughness

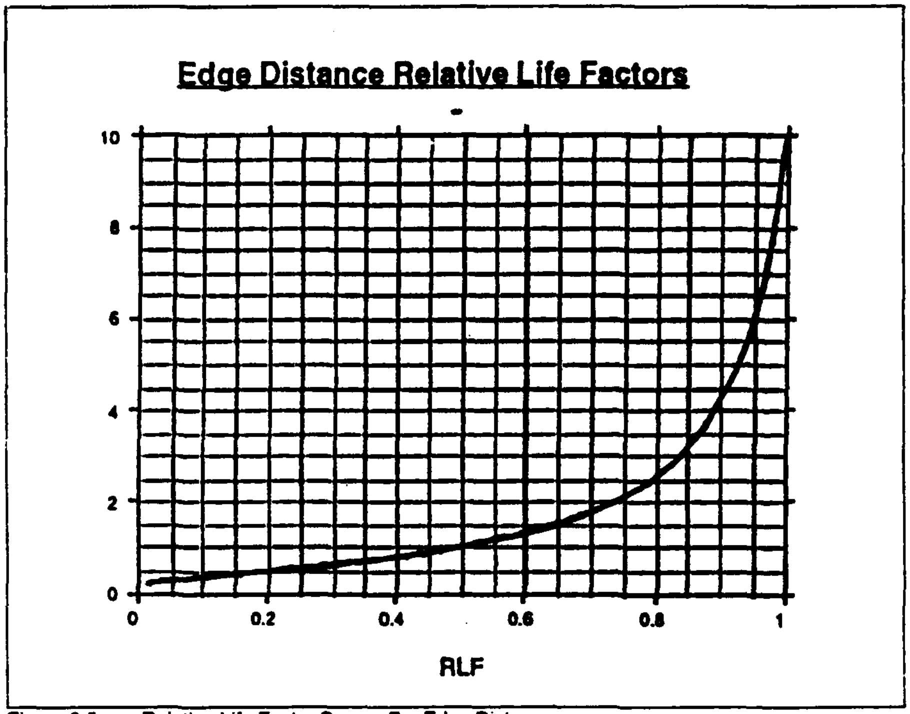


Figure 9.5 - Relative Life Factor Curves For Edge Distance

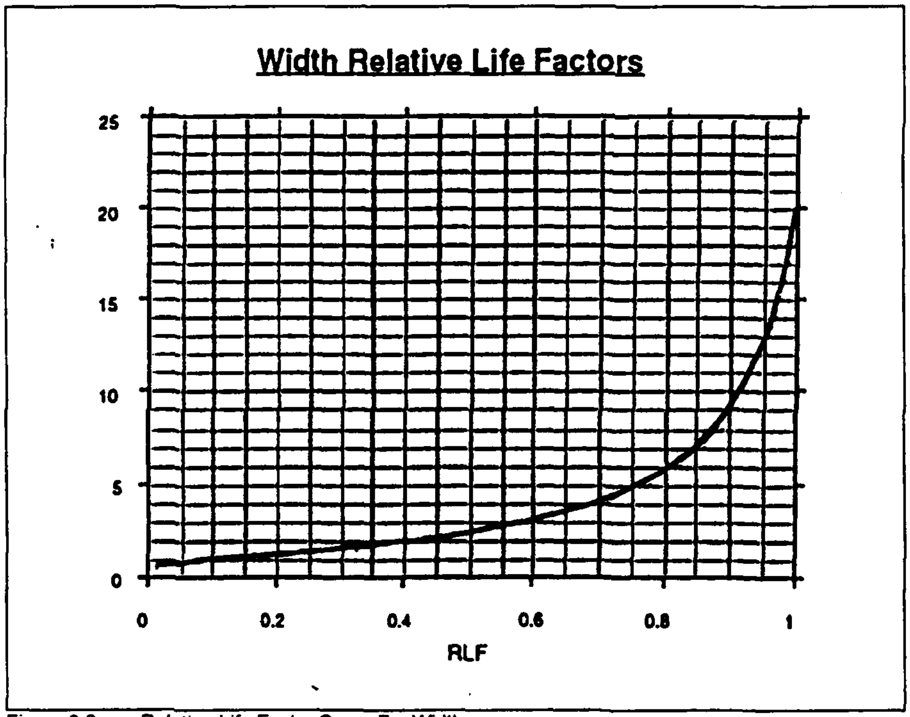


Figure 9.6 - Relative Life Factor Curve For Width

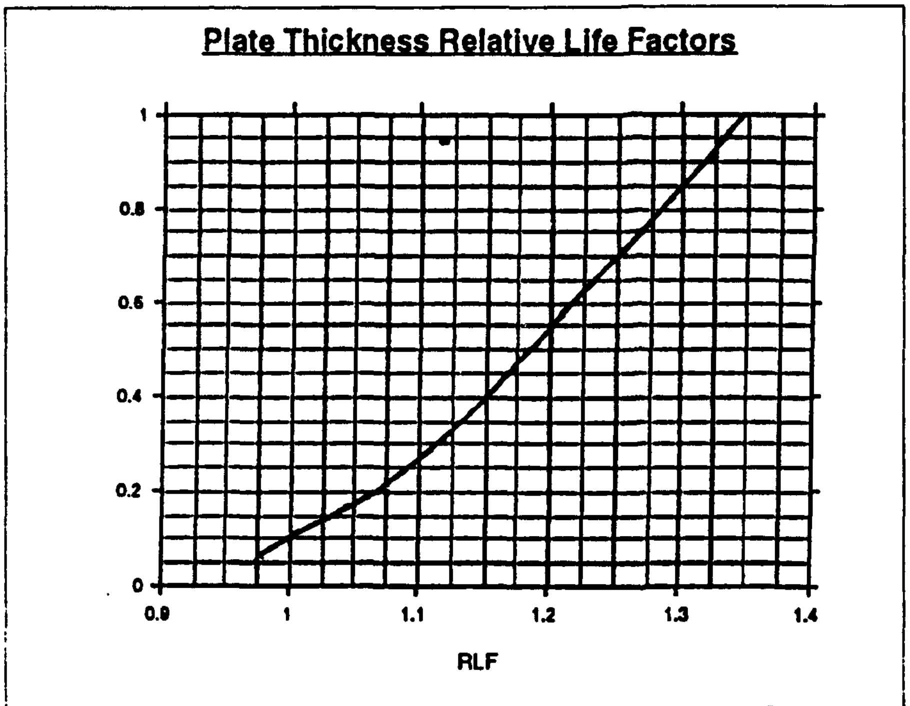


Figure 9.7 - Relative Life Factor Curves For Plate Thickness

Material	Orientation & Environment	RLF
2024-T3	Clad Plt & Sht: L-T, LA & HHA	1.0
2024-T3	Clad Plt & Sht: T-L, LA & HHA	1.05
2024-T351	Plt & Sht: L-T, LA & HHA	0.8
2024-T351	Plt & Sht: T-L, LA & HHA	0.73
2024-T3511	Extr: L-T, LA & HHA	0.95
6061-T6	Plt: T-L	0.47
7075-T6	Plt, Sht & Clad: L-T & T-L; LA	0.5
7075-T651	Plt & Sht: L-T,LA,DA	0.52
7075-T6511	Extr: L-T, LA & HHA	0.54
7075-T6511	Extr: T-L, LA & HHA	0.45
7075-T7352	Plt, Sht & Forg: L-T, LA & DA	0.64
7075-T7352	Plt, Sht & Forg: T-L, LA & DA	0.53
7075-T73511	Extr: L-T, LA, DA, HHA	0.81
7178-T6	Extr: T-L, LA, DA, HHA	0.23
7178-T6	Plt & Sht: T-L, LA & HHA	0.22

Table 9.3 - Relative Life Factors Per Material Type and Form

SECTION 10

FLAW SIZE INFORMATION

Table 10.1 summarizes the critical flaw sizes by inspection used in the aircraft structural integrity program for the JSTARS aircraft and their effect on critical flaw size analysis.

INSPECTION METHOD	TYPICAL INITIAL FLAW SIZE	STRESS INTENSITY FACTORS/ CRITICAL FLAW SIZE
AFGS-87221A Category IA - Component disassembled - Eddy current bolt hole inspection	0.05 inches	Classical fracture mechanics - no load redistribution
AFGS-87221A Category IB - Component not removed - Penetrant, Magnetic Particle, Eddy Current, Ultrasound	0.25 inch	No load redistribution results in relatively small critical flaw size - load redistribution effects can significantly increase critical flaw sizes and extend inspection
AFGS-87221A Category II - Close Visual Inspection	2.0 inch	Include load redistribution

Table 10.1 - Flaw Size Information

The following are some of the general observations relative to inspection activities on the JSTARS program that are relevant to this survey:

- Eddy current inspection of all fastener holes in fuselage lap joint seams - most frames - not many cracks
- Inspection of wing Steel fasteners for corrosion required bolt hole and oversizing operation
- Edge distance measurements became critical acceptance criteria for many reworked skin panels
- Ultrasonic inspection of vertical/horizontal tail required for thickness - corrosion
- Non-standard repair areas inspected with dye penetrant of surrounding structure
- Most structure extensively examined as part of the refurbishment process

SECTION 11

CONCLUSIONS

Analysis of the previous sections reveals that there are a number of areas on the aircraft that display elevated levels of corrosion and fatigue damage. The most affected of these areas are the nose landing gear wheel well and the main landing gear wheel wells. The wheel wells are exposed to water and other contaminants during taxi, landing and takeoff. These portions of the aircraft also are subjected to potentially heavy loads from ground conditions.

The BS 360 frame, located in the aft portion of the nose landing gear wheel well, experienced the highest level of corrosion and fatigue damage. In addition to wheel well up splash as previously discussed, this frame is subjected to the corrosive effects of any spillage from the lavatory tanks that are located at BS 360 - BS 380. These two corrosion sources in addition to heavy ground condition loads result in high damage levels to this frame.

The lower inboard wing planks exhibit a high level of fatigue damage. Although not well documented during the O&A reporting process, the presence of WFD is strongly suspected. Corrosion found on these wing planks is primarily concentrated in the fastener holes. This corrosion removes material and develops initiation sites for fatigue cracking. It is suspected that the fastener hole corrosion lowers the load transfer to the wing stringers. This results in higher stress levels in the wing planks during the tension dominated flight spectrum, which leads to the elevated fatigue damage on the lower wing planks.

In addition to the areas of reported damage are areas of corrosion and fatigue damage that are automatically addressed through aging aircraft service bulletins and are not reported on the O&A forms. These areas include the lower forward fuselage skins, main wing spar chords, horizontal and vertical stabilizers and terminal fittings.

SECTION 12

RECOMMENDATIONS

The Joint STARS program offers an excellent and somewhat unique opportunity for detailed research into corrosion and fatigue interaction on aging aircraft structures. The extensive remanufacturing process involved in the JSTARS program offers an opportunity to conduct a validation of NDI techniques and accurate corrosion and fatigue documentation without incurring the cost of a teardown. A study, unlike the inspections conducted to date, which focuses on accurately documenting widespread fatigue damage and corrosion with respect to material loss, pit morphology, etc. would yield an excellent database.

Future studies to correlate the corrosion and fatigue damage on the JSTARS aircraft could most effectively be achieved by focusing on specific areas that have displayed elevated levels of damage. The most attractive of these is the lower wing planks and substructure. The presence of fatigue damage on these wing structures is suspected to be related to the corrosion of the fastener holes and the subsequent change in load transfer characteristics of the fasteners. The inboard portion of the lower wing also lends itself to further study due to the relative ease of analysis. The majority of flight conditions create a tensile stress field in this area resulting from wing up bending conditions, which could be created with relative ease when compared to fuselage critical conditions.

Tying an accurate and complete damage tolerance analysis to a specific area and concentrating on the collection of corrosion damage data could help in the development of a corrosion fatigue interaction model. For example, if a crack is found in an area that also exhibits corrosion, the crack size could be compared to the expected crack size for the number of flight hours and cycles documented for the aircraft. Differences in crack size could then be used as a metric to develop a corrosion fatigue interaction model.

The Joint STARS program also offers a unique opportunity for the validation of current NDI techniques. Again, focusing on a small area, various inspection techniques could be used to validate the results of a subsequent teardown, which is currently being performed as a part of the Joint STARS contract.

SECTION 13

REFERENCES

1. Boeing 707 Intercontinental Structural Repair Manual, Boeing Corporation

2. Northrop Grumman Joint STARS Web Site:

   www.northgrum.com/Corp_web/products.pages/joint_stars.html

3. D204-10245 E-3A AWACS Design Loads (1974)

4. D204-10575 E-3A AWACS Service Life Analysis (1978)

5. D204-10651 E-3A AWACS Wing Stress Analysis (1974)

6. D204-10653 E-3A Stress Analysis - Nacelle and Struts (1974)

7. D204-10654 E-3A AWACS Fuselage Stress Analysis (1974)

8. D409-12200 E-6A External Loads and Inertia Loads (1986)

9. D409-12200 E-6 External Loads (1986)

10. D409-12202 E-6A Fuselage Stress Analysis (1986)

11. D525-11585 E-8A JSTARS Design Loads (1987)

12. D525-11587 E-8A JSTARS Stress Analysis (1987)

13. D525-12447 E-8A JSTARS Durability and Damage Tolerance Assessment (1988)

APPENDIX A

HOW MALFUNCTION CODES

(PHYSICAL AND MECHANICAL)

CODE	DESCRIPTION
002	SERVICING (MAY BE USED WITH WUC ITEMS)
006	CONTACTS / CONNECTION DEFECTIVE
008	NOISY / CHATTERING
011	LOW FREQUENCY VIBRATIONS
012	MEDIUM FREQUENCY VIBRATIONS
013	HIGH FREQUENCY VIBRATIONS
020	WORN, CHAFED, FRAYED OR TORN
070	BROKEN
105	LOOSE, DAMAGED, OR MISSING HARDWARE (NUTS, BOLTS, SCREWS, CLAMPS, SAFETY WIRE, ETC.)
111	BURST OF RUPTURED
116	CUT
127	ADJUSTMENT OR ALIGNMENT IMPROPER
135	BINDING, STUCK OR JAMMED
167	TENSION OR TORQUE INCORRECT
170	CORRODED MILD / MODERATE
190	CRACKED
300	FOREIGN OBJECT, NO DAMAGE
301	FOREIGN OBJECT, DAMAGE (FOD)
377	LEAKING - CLASS A - SLOW SEEP (T.O. 1-1-3)
378	LEAKING - CLASS B - SEEP (T.O. 1-1-3)
379	LEAKING - CLASS C - HEAVY SEEP (T.O. 1-1-3)
380	LEAKING - CLASS D - RUNNING LEAK (T.O. 1-1-3)
381	LEAKING INTERNAL OR EXTERNAL
525	PRESSURE INCORRECT / FLUCTUATES

553.................DOES NOT MEET SPECIFICATIONS, DRAWING, OR OTHER CONFORMANCE REQUIREMENTS (USE WITH WHEN DISCOVERED CODE Y)

585.................SHEARED

599.................TRAVEL OR EXTENSION INCORRECT

602.................FAILED OR DAMAGED DUE TO MALFUNCTION OF ASSOCIATED EQUIPMENT

622.................WET / CONDENSATION

632.................EXPENDED (THERMAL BATTERY, FIRE EXTINGUISHER, ETC.)

651.................AIR IN SYSTEM

667.................CORRODED SEVERE

669.................POTTING MATERIAL MELTING (REVERSION PROCESS)

710.................BEARING FAILURE OR FAULTY

730.................LOOSE

750.................MISSING

780.................BENT, BUCKLED, COLLAPSED, DENTED, DISTORTED OR TWISTED

782.................TIRE TREAD AREA DEFECTIVE

783.................TIRE SIDEWALL DAMAGED OR DEFECTIVE

784.................TIRE BEAD AREA DAMAGED OR DEFECTIVE

785.................TIRE INSIDE SURFACE DAMAGED OR DEFECTIVE

846.................DELAMINATED

865.................DETERIORATED (FOR PROTECTIVE COATING / SEALANT DEFECTIVE USE WITH ACTION TAKEN CODE Z)

884.................LEAD BROKEN

900.................BURNED OR OVERHEATED

932.................DOES NOT ENGAGE, LOCK OR UNLOCK CORRECTLY

948.................OPERATOR ERROR

976.................DAMAGED PROBE