INDEPENDENT ORBITER ASSESSMENT

ANALYSIS
OF THE
BODY FLAP
SUBSYSTEM

21 NOVEMBER 1986

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
HOUSTON DIVISION

SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

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INDEPENDENT ORBITER ASSESSMENT ANALYSIS OF THE BODY FLAP SUBSYSTEM

21 November 1986

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1.0 EXECUTIVE SUMMARY

The McDonnell Douglas Astronautics Company (MDAC) was selected in June 1986 to perform an Independent Orbiter Assessment (IOA) of the Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL). Direction was given by the STS Orbiter and GFE Projects Office to perform the hardware analysis using the instructions and ground rules defined in NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. The IOA approach features a top-down analysis of the hardware to determine failure modes, criticality, and potential critical items. To preserve independence, this analysis was accomplished without reliance upon the results contained within the NASA FMEA/CIL documentation. This report documents (Appendix C) the independent analysis results for the Orbiter Body Flap (BF) subsystem hardware.

The BF is a large aerosurface located at the trailing edge of the lower aft fuselage of the Orbiter. The proper function of the BF is essential during the dynamic flight phases of ascent and entry. During the ascent phase of flight, the BF trails in a fixed position. For entry, the BF provides elevon load relief, trim control, and acts as a heat shield for the main engines.

Specifically, the BF hardware comprises the following components:

- o Power Drive Unit (PDU)
- o Rotary Actuators
- o Torque Tubes

The IOA analysis process utilized available BF hardware drawings and schematics for defining hardware assemblies, components, and hardware items. Each level of hardware was evaluated and analyzed for possible failure modes and effects. Criticality was assigned based upon the severity of the effect for each failure mode.

Figure 1 presents a summary of the failure criticalities for each of the three major divisions of the BF. A summary of the number of failure modes, by criticality, is also presented below with Hardware (HW) criticality first and Functional (F) criticality second.

Summary of IOA Failure Modes By Criticality (HW/F)							
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Number :	9	3	-	15	-	8	35

For each failure mode identified, the criticality and redundancy screens were examined to identify critical items. A summary of Potential Critical Items (PCIs) is presented as follows:

Summary of IOA Potential Critical Items (HW/F)						
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Number :	9	3	-	7	-	19

Of the 35 failure modes analyzed, 19 were determined to be PCIs.

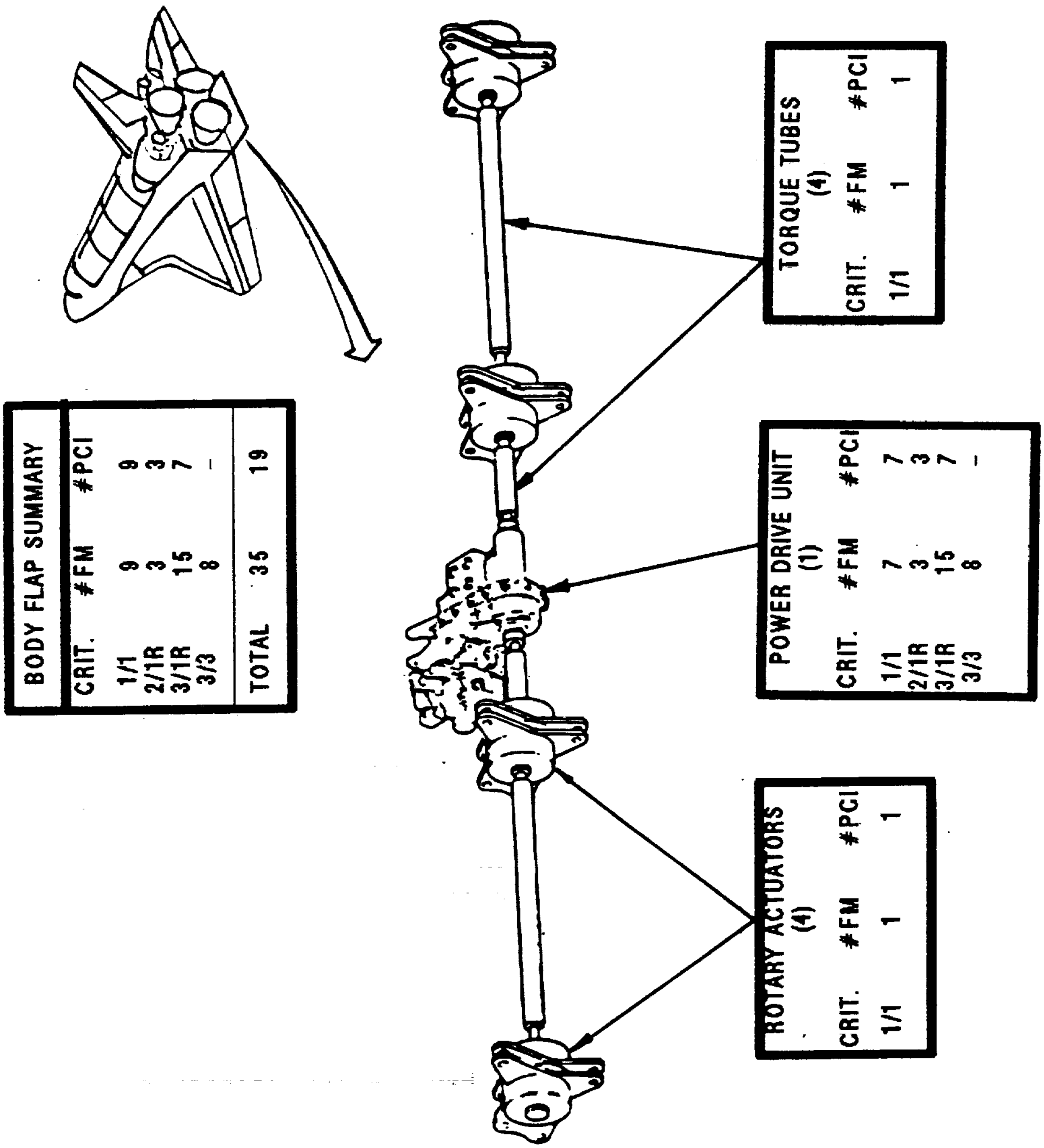

Figure 1 - BODY FLAP OVERVIEW ANALYSIS SUMMARY

2.0 INTRODUCTION

2.1 Purpose

The 51-L Challenger accident prompted the NASA to readdress safety policies, concepts, and rationale being used in the National Space Transportation System (NSTS). The NSTS Office has undertaken the task of reevaluating the FMEA/CIL for the Space Shuttle design. The MDAC is providing an independent assessment of the Orbiter FMEA/CIL for completeness and technical accuracy.

2.2 Scope

The scope of the independent FMEA/CIL assessment activity encompasses those Shuttle Orbiter subsystems and GFE hardware identified in the Space Shuttle Independent FMEA/CIL Assessment Contractor Statement of Work. Each subsystem analysis addresses hardware, functions, internal and external interfaces, and operational requirements for all mission phases.

2.3 Analysis Approach

The independent analysis approach is a top-down analysis utilizing as-built drawings to breakdown the respective subsystem into components and low-level hardware items. Each hardware item is evaluated for failure mode, effects, and criticality. These data are documented in the respective subsystem analysis report, and are used to assess the NASA and Prime Contractor FMEA/CIL reevaluation results. The IOA analysis approach is summarized in the following Steps 1.0 through 3.0. Step 4.0 summarizes the assessment of the NASA and Prime Contractor FMEAs/CILs that is performed and documented at a later date.

Step 1.0 Subsystem familiarization
- 1.1 Define subsystem functions
- 1.2 Define subsystem components
- 1.3 Define subsystem specific ground rules and assumptions

Step 2.0 Define subsystem analysis diagram
- 2.1 Define subsystem
- 2.2 Define major assemblies
- 2.3 Develop detailed subsystem representations

Step 3.0 Failure events definition
- 3.1 Construct matrix of failure modes
- 3.2 Document IOA analysis results

Step 4.0 Compare IOA analysis data to NASA FMEA/CIL

- 4.1 Resolve differences
- 4.2 Review in-house
- 4.3 Document assessment issues
- 4.4 Forward findings to Project Manager

2.4 BF Ground Rules and Assumptions

The BF ground rules and assumptions used in the IOA are defined in Appendix B.

3.0 SUBSYSTEM DESCRIPTION

The following sections describe the BF actuator system hardware. This hardware comprises a PDU, rotary actuators, and torque tubes. An overview of the system components is shown in Figure 2.

3.1 Design and Function

The BF is a large aerosurface at the trailing edge of the lower aft fuselage of the Orbiter. The proper function of the BF is essential during the ascent phases of flight. During ascent, the BF trails in a fixed position. For entry, the BF provides elevon load relief, trim control, and acts as a main engine heat shield.

The BF system design provides a triple redundancy, electronically controlled hydro-mechanical drive system. The Flight Control System (FCS) provides signals to the Aerosurface Servo Amplifier (ASA) which commands valve packs supplying pressurized fluid to power hydraulic motors. These motors drive torque tubes which power rotary actuators and move the BF aerosurface.

The BF PDU comprises three in-line filters, three enable solenoid valves, six pilot solenoid valves, three power spool assemblies, one summing link, three hydraulic motor/brake assemblies, and a PDU geartrain assembly (Figure 3).

Three Orbiter hydraulic loops, each corresponding to an Auxiliary Power Unit (APU), supply fluid pressure for the BF drive system. Each PDU is protected by an in-line hydraulic fluid filter up-stream of the solenoid valves. Nominally, three hydraulic loops are used to drive the BF. Full BF performance can be maintained using two hydraulic systems. One hydraulic drive system can power the BF at full force, but at half rate.

Each enable solenoid valve (Figure 4) controls the flow of hydraulic fluid to the downstream pilot solenoid valves. These solenoids contains a normally closed valve. A coil spring provides the restoring force which maintains a closed valve position. When energized by an ASA signal, the solenoid provides a force which overcomes the return spring and allows fluid to pressurize downstream pilot solenoid valves.

The BF pilot solenoid valves divert hydraulic fluid and pressure to the downstream control actuator or power spool. The upstream enable solenoid valve must be opened before hydraulic fluid and pressure can flow to the pilot solenoid valves. When an up or down pilot solenoid valve is selected and activated, hydraulic fluid flows thru the control actuator and rotates the hydraulic motor in the corresponding direction.

The power spools control the flow of hydraulic fluid and pressure to the hydraulic motor/brake assemblies. The power spools are situated downstream of the hydraulic inlet and the enable/pilot

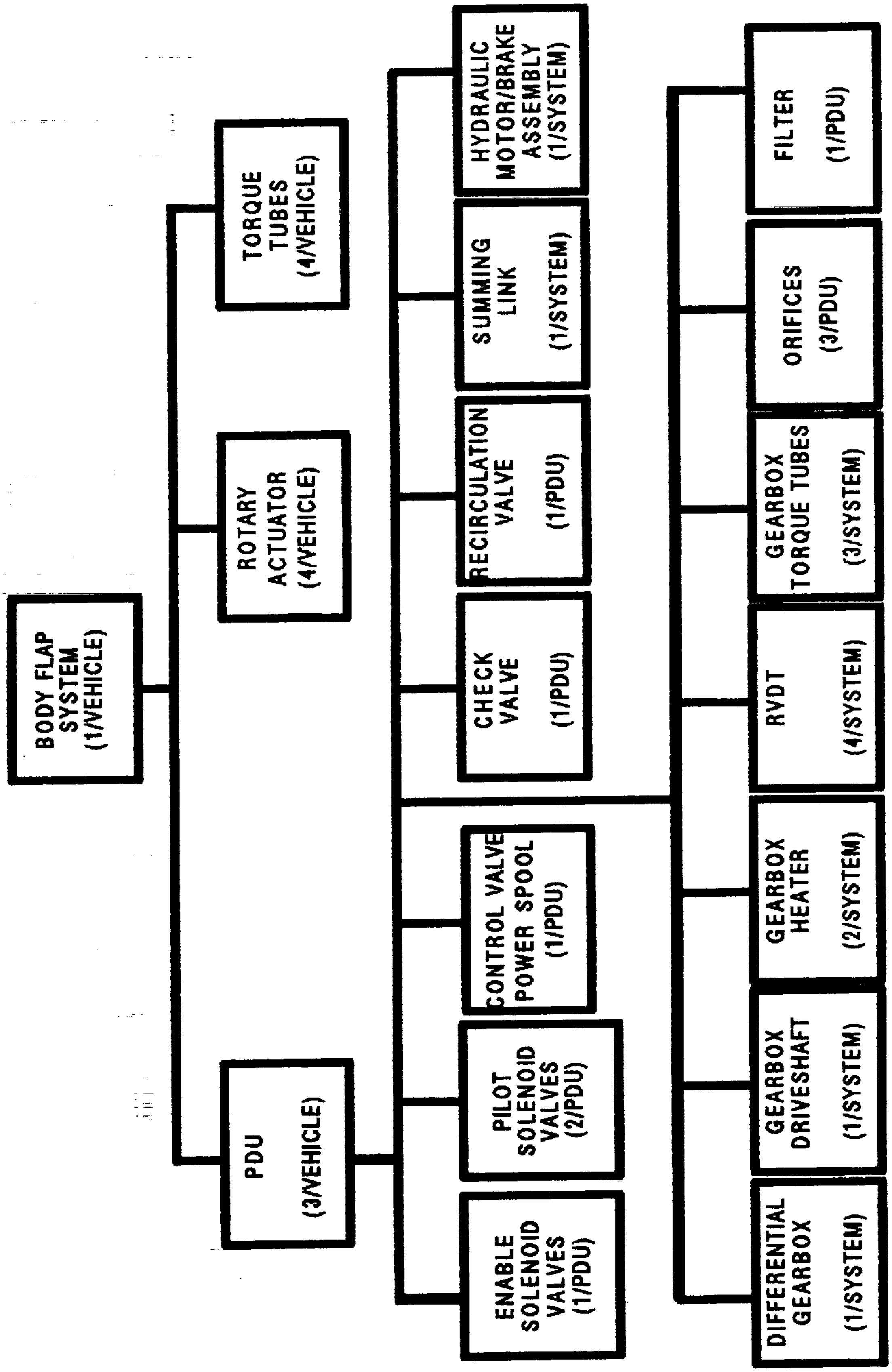

Figure 2 - BODY FLAP SYSTEM OVERVIEW

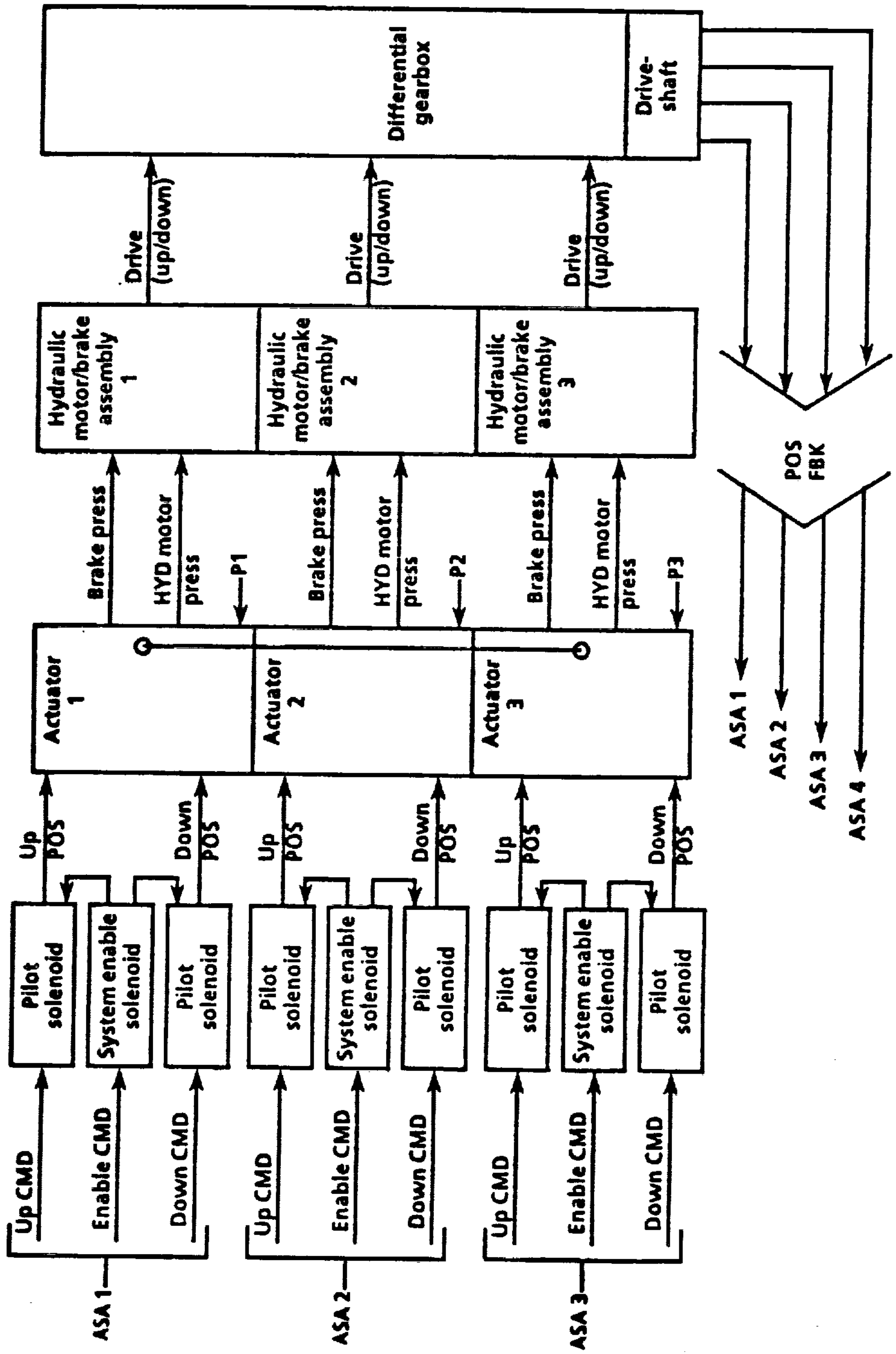

Figure 3 - BODY FLAP POWER DRIVE UNIT (PDU)

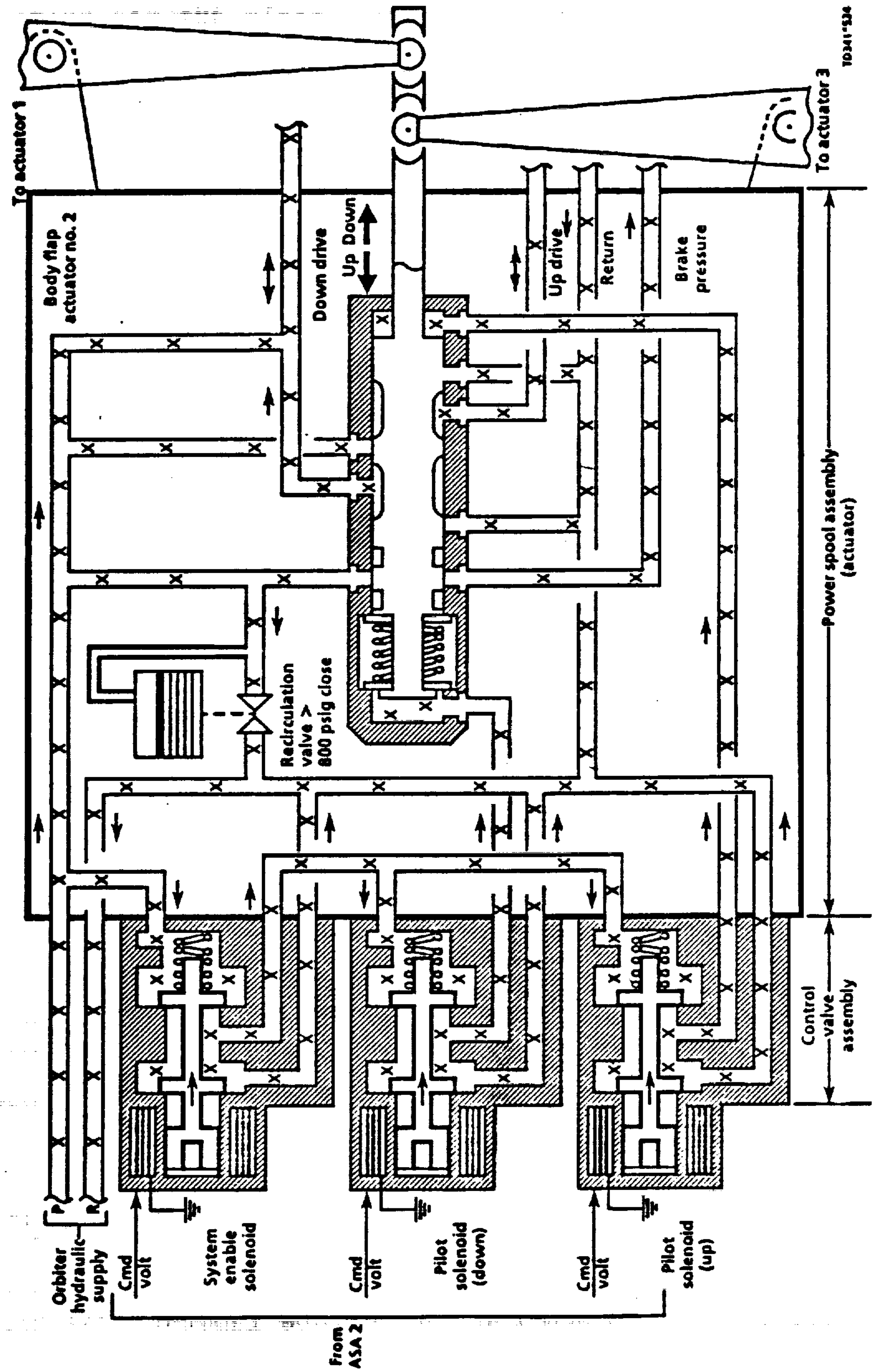

Figure 4 - BODY FLAP SOLENOIDS AND HYDRAULIC ACTUATOR

solenoid valves. The three power spools are mechanically connected by two summing links. The actuators will translate in one direction for an up command and in the opposite direction for a down command.

The BF actuator recirculation valve is used to divert hydraulic fluid around the actuator if system pressure drops below 850 psi. When hydraulic system pressure is in a nominal range (approximately 3000 psi), the recirculation valve is open and fluid pressurizes the BF actuator.

The summing link is designed to mechanically synchronize the movement of the BF power spools. If one power spool fails to operate (i.e. jammed solenoid valve, loss of ASA signal, etc.), one piston is capable of dragging the remaining two systems thru the summing link to their proper positions. This will direct hydraulic fluid to the motor/brake assemblies and permit them to operate nominally.

The hydraulic motor/brake assembly comprises a hydraulic motor and brake (Figure 5). The hydraulic motor and brake share a common centerline shaft. Each of three hydraulic motor/brake assemblies convert 3000 psi fluid pressure to rotary shaft motion. The assemblies also prevent the differential gearbox from back-driving when the systems are unpressurized.

The hydraulic motor converts hydraulic fluid pressure to rotary motion of the differential gearbox input torque tubes. The motor contains a rotating barrel housing multiple pistons. As each piston passes by the inlet, hydraulic pressure forces each piston out of the rotary barrel transferring force to the motor's fixed ramp wobble-plate which rotates the shaft. This shaft extends out of the motor housing into the hydraulic brake portion of the assembly.

The hydraulic brake is situated between the hydraulic motor and the differential gearbox input torque tubes. The brake is normally engaged, preventing the common motor/brake assembly shaft from rotating or back-driving. When fluid pressure is diverted to the hydraulic brake, it disengages and the shaft transmits rotary power to its corresponding torque tube.

The PDU geartrain assembly (Figure 6) comprises three input torque tubes, a differential gearbox, and one output driveshaft. The splined input torque tubes transmit rotary shaft power from the hydraulic motor/brake assembly to the differential gearbox. The differential gearbox sums the input of three hydraulic motor torque tubes into one output shaft. The gearbox uses two sets of planetary gears to sum the torque tube inputs. One driveshaft transmits the output of the differential gearbox to a beveled gear. The full performance of the BF can be maintained with two torque tube inputs. The BF can be driven at half-speed with one torque tube input.

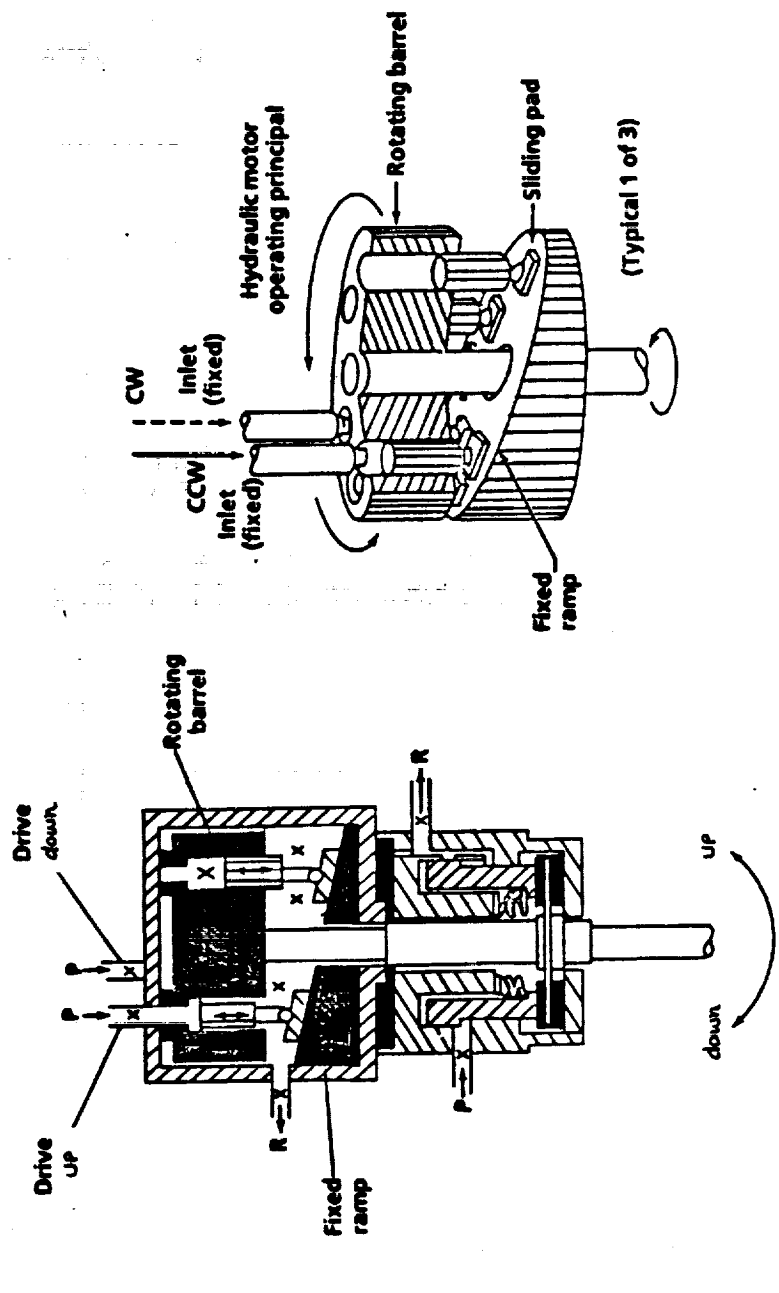

Figure 5 - HYDRAULIC MOTOR/BRAKE ASSEMBLY

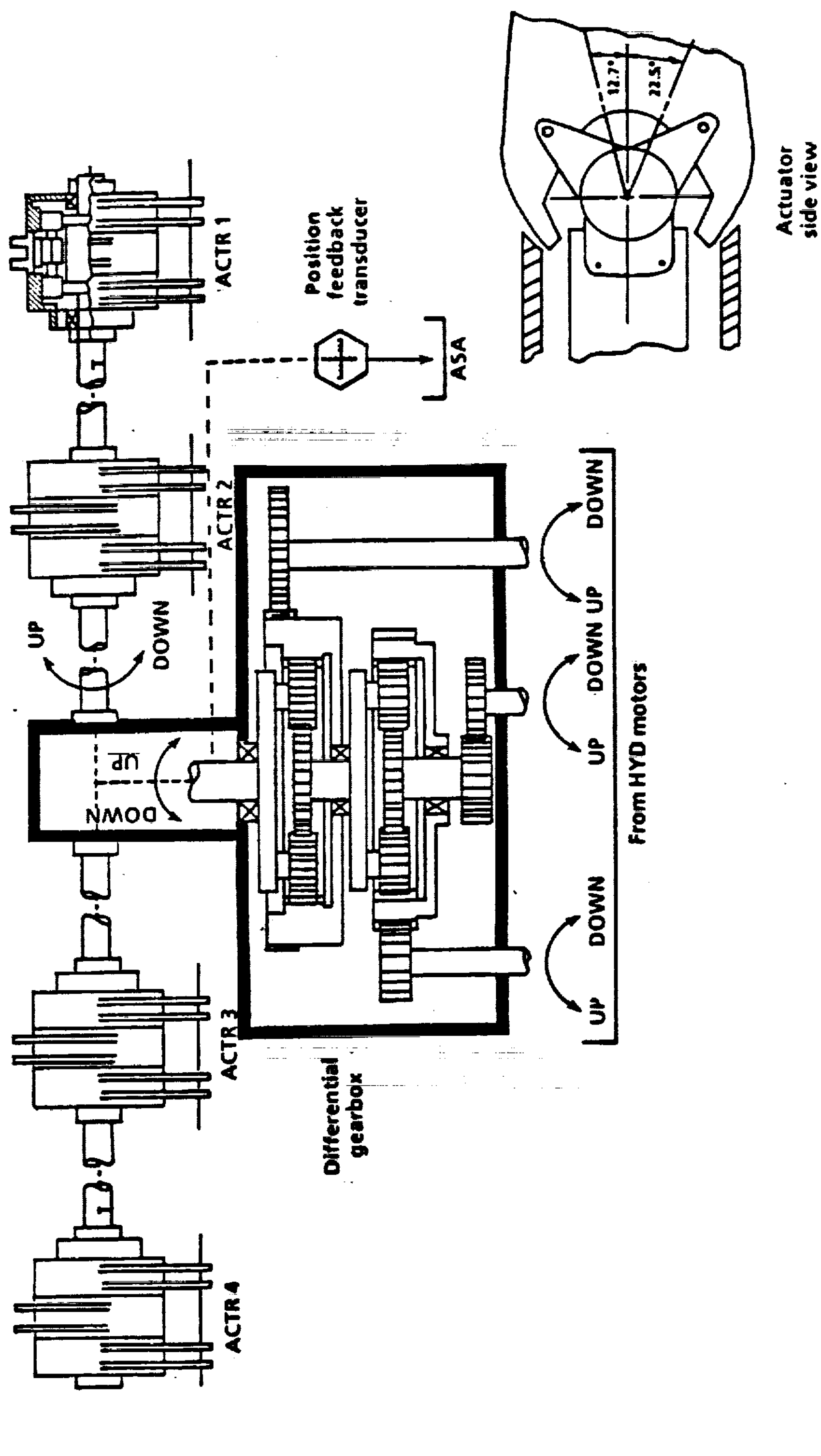

Figure 6 - BODY FLAP DIFFERENTIAL GEARBOX AND ROTARY ACTUATORS

The PDU geartrain assembly contains two 35-watt heaters mounted to the gearbox. These heaters are used when the vehicle's attitude is thermally cold.

The PDU geartrain assembly output driveshaft position is measured by a four Rotary Variable Differential Transformers (RVDTs) mounted on a common bracket. Any one of the four RVDTs is capable of measuring the driveshaft position. ASA channel four receives the RVDTs output and transmits them to the GPCs for determining BF position.

The rotary actuators (Figure 7) connect the BF to the Orbiter and provide the hinge-moment required to move the surface up or down. The rotary actuators receive torque and power from four torque tubes (Figure 8) connected to the beveled gear at the PDU gearbox driveshaft.

3.2 Interfaces and Locations

The BF system hardware is located at the trailing edge of the Orbiter's lower fuselage. The BF system interfaces with the Orbiter's three hydraulic systems (each corresponding to one APU). The BF system hardware interfaces with the ASAs which in turn interface with the FCS portion of the GPCs for system control actuation and feedback.

3.3 Hierarchy

Figure 2 illustrates the hierarchy of the BF hardware components. Figures 3 through 8 depict the functional details of the BF system components.

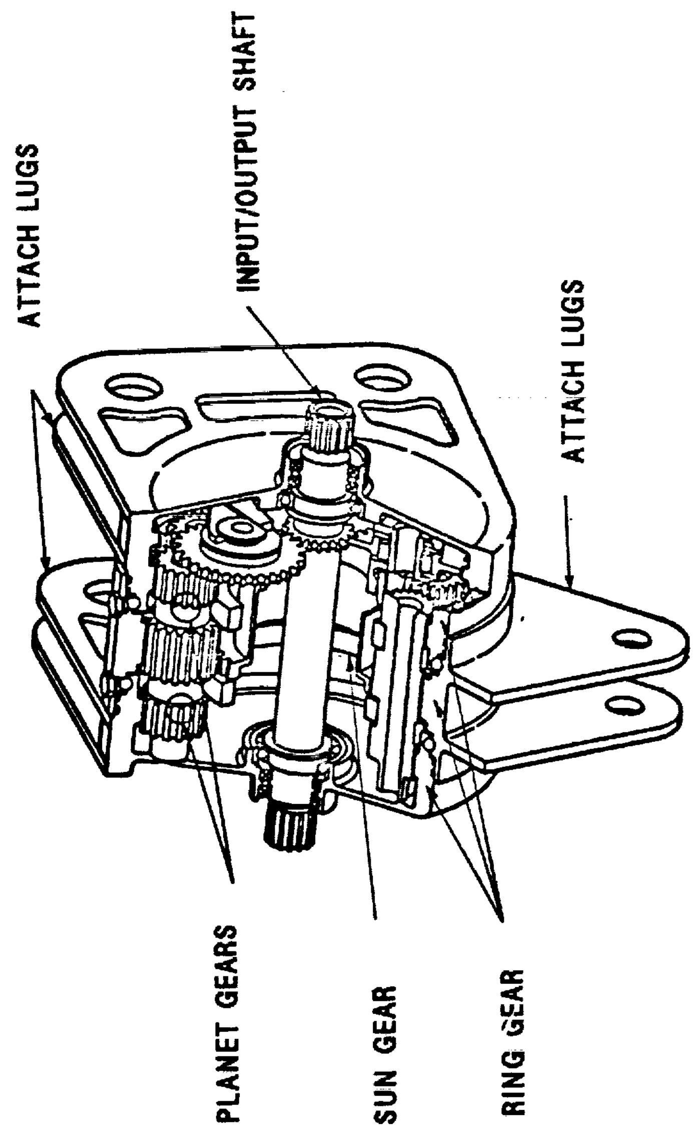

Figure 7 - GEARED ROTARY ACTUATOR

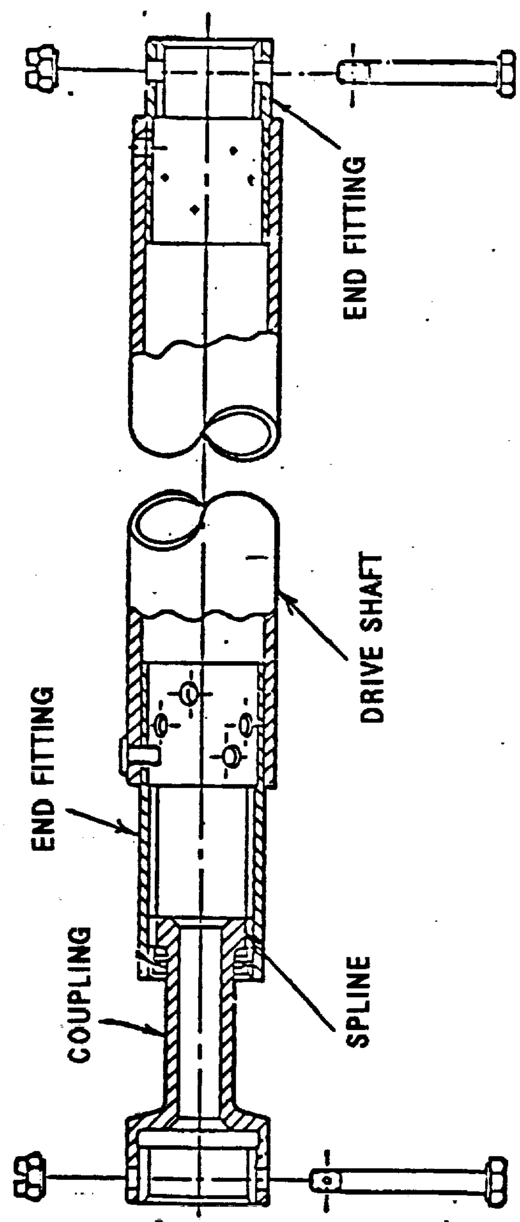

Figure 8 - TYPICAL TORQUE TUBE

4.0 ANALYSIS RESULTS

Detailed analysis results for each of the identified failure modes are presented in Appendix C. Table I presents a summary of the failure criticalities. Further discussion of each of these subdivisions and the applicable failure modes is provided in subsequent paragraphs.

TABLE I Summary of IOA Failure Modes and Criticalities

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
PDU	7	3	-	15	-	8	33
Rotary Act.	1	-	-	-	-	-	1
Torque Tubes	1	-	-	-	-	-	1
TOTAL	9	3	-	15	-	8	35

Of these 35 failure modes analyzed, 19 were determined to be PCIs. A summary of the PCIs is presented in Table II. Appendix D contains a cross reference between each PCI and analysis worksheets in Appendix C.

TABLE II Summary of IOA Potential Critical Items

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
PDU	7	3	-	7	-	17
Rotary Act.	1	-	-	-	-	1
Torque Tubes	1	-	-	-	-	1
TOTAL	9	3	-	7	-	19

4.1 Power Drive Unit

Critical failures of the PDU components can be caused by: plugged filters, jammed or failed control valves, jammed or fractured summing links, plugged supply orifices, failed or fractured hydraulic motor/brake assemblies, and fractured or jammed differential gears and shafts.

4.2 Geared Rotary Actuator

Critical failure modes of the geared rotary actuator can be caused by: a fractured or open shaft, and a fractured or open gear within the rotary actuator.

4.3 Torque Tubes

Critical failure modes of the torque tubes can be caused by a fractured or open torque tube.

5.0 REFERENCES

Reference documentation available from NASA and Rockwell was used in the analysis. The documentation used included the following:

1. NSTS 22206: Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) October 10, 1986

2. FCS/EFF 2102: The FCS/Effectors Training Manual February 1986

3. JSC11174: MOD Drawings - applicable pages

4. VS70-580996: Rockwell Drawings

5. STS82-0039A: Applicable CIL Sections

6. NASA CP-2342: Space Shuttle Technical Conference Part 2, pp 905-19, June 28-30, 1983

7. SD72-SH-0102-9: Requirements/Definition Document Aero Flight Control Mechanisms Rockwell International, Volume 2-9 October 28, 1978

The following references have been ordered, but were unavailable for the independent analysis:

1. SD72-SH-0102-6: Requirements/Definition Document Hydraulic Subsystem Rockwell International

APPENDIX A
ACRONYMS

APU	- Auxiliary Power Unit
ASA	- Aerosurface Servo Amplifier
ASSY	- Assembly
BF	- Body Flap
BRK	- Brake
CIL	- Critical Items List
F	- Functional
FCS	- Flight Control System
FM	- Failure Mode
FMEA	- Failure Modes and Effects Analysis
GPC	- General Purpose Computer
HYD	- Hydraulic, Hydraulics
HW	- Hardware
IOA	- Independent Orbiter Assessment
MDAC	- McDonnell Douglas Astronautics Company
MTR	- Motor
NA	- Not Applicable
NASA	- National Aeronautics and Space Administration
NSTS	- National Space Transportation System
PCI	- Potential Critical Item
PDU	- Power Drive Unit
psi	- Pounds Per Square Inch
psid	- Pounds Per Square Inch Differential
RVDT	- Rotary Variable Differential Transformer
RI	- Rockwell International
VLV	- Valve
xducer	- Transducer

APPENDIX B

DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.1 Definitions
B.2 Project Level Ground Rules and Assumptions
B.3 Subsystem-Specific Ground Rules and Assumptions

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.1 Definitions

Definitions contained in NSTS 22206, Instructions For Preparation of FMEA/CIL, 10 October 1986, were used with the following amplifications and additions.

INTACT ABORT DEFINITIONS:

RTLS - begins at transition to OPS 6 and ends at transition to OPS 9, post-flight

TAL - begins at declaration of the abort and ends at transition to OPS 9, post-flight

AOA - begins at declaration of the abort and ends at transition to OPS 9, post-flight

ATO - begins at declaration of the abort and ends at transition to OPS 9, post-flight

CREDIBLE (CAUSE) - an event that can be predicted or expected in anticipated operational environmental conditions. Excludes an event where multiple failures must first occur to result in environmental extremes

CONTINGENCY CREW PROCEDURES - procedures that are utilized beyond the standard malfunction procedures, pocket checklists, and cue cards

EARLY MISSION TERMINATION - termination of onorbit phase prior to planned end of mission

EFFECTS/RATIONALE - description of the case which generated the highest criticality

HIGHEST CRITICALITY - the highest functional criticality determined in the phase-by-phase analysis

MAJOR MODE (MM) - major sub-mode of software operational sequence (OPS)

MC - Memory Configuration of Primary Avionics Software System (PASS)

MISSION - assigned performance of a specific Orbiter flight with payload/objective accomplishments including orbit phasing and altitude (excludes secondary payloads such as GAS cans, middeck P/L, etc.)

MULTIPLE ORDER FAILURE - describes the failure due to a single cause or event of all units which perform a necessary (critical) function

OFF-NOMINAL CREW PROCEDURES - procedures that are utilized beyond the standard malfunction procedures, pocket checklists, and cue cards

OPS - software operational sequence

PRIMARY MISSION OBJECTIVES - worst case primary mission objectives are equal to mission objectives

PHASE DEFINITIONS:

PRELAUNCH PHASE - begins at launch count-down Orbiter power-up and ends at moding to OPS Major Mode 102 (liftoff)

LIFTOFF MISSION PHASE - begins at SRB ignition (MM 102) and ends at transition out of OPS 1 (Synonymous with ASCENT)

ONORBIT PHASE - begins at transition to OPS 2 or OPS 8 and ends at transition out of OPS 2 or OPS 8

DEORBIT PHASE - begins at transition to OPS Major Mode 301 and ends at first main landing gear touchdown

LANDING/SAFING PHASE - begins at first main gear touchdown and ends with the completion of post-landing safing operations

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.2 IOA Project Level Ground Rules and Assumptions

The philosophy embodied in NSTS 22206, Instructions for Preparation of FMEA/CIL, 10 October 1986, was employed with the following amplifications and additions.

1. The operational flight software is an accurate implementation of the Flight System Software Requirements (FSSRs).

   RATIONALE: Software verification is out-of-scope of this task.

2. After liftoff, any parameter which is monitored by system management (SM) or which drives any part of the Caution and Warning System (C&W) will support passage of Redundancy Screen B for its corresponding hardware item.

   RATIONALE: Analysis of on-board parameter availability and/or the actual monitoring by the crew is beyond the scope of this task.

3. Any data employed with flight software is assumed to be functional for the specific vehicle and specific mission being flown.

   RATIONALE: Mission data verification is out-of-scope of this task.

4. All hardware (including firmware) is manufactured and assembled to the design specifications/drawings.

   RATIONALE: Acceptance and verification testing is designed to detect and identify problems before the item is approved for use.

5. All Flight Data File crew procedures will be assumed performed as written, and will not include human error in their performance.

   RATIONALE: Failures caused by human operational error are out-of-scope of this task.

6. All hardware analyses will, as a minimum, be performed at the level of analysis existent within NASA/Prime Contractor Orbiter FMEA/CILs, and will be permitted to go to greater hardware detail levels but not lesser.

   RATIONALE: Comparison of IOA analysis results with other analyses requires that both analyses be performed to a comparable level of detail.

7. Verification that a telemetry parameter is actually monitored during AOS by ground-based personnel is not required.

   RATIONALE: Analysis of mission-dependent telemetry availability and/or the actual monitoring of applicable data by ground-based personnel is beyond the scope of this task.

8. The determination of criticalities per phase is based on the worst case effect of a failure for the phase being analyzed. The failure can occur in the phase being analyzed or in any previous phase, whichever produces the worst case effects for the phase of interest.

   RATIONALE: Assigning phase criticalities ensures a thorough and complete analysis.

9. Analysis of wire harnesses, cables and electrical connectors to determine if FMEAs are warranted will not be performed nor FMEAs assessed.

   RATIONALE: Analysis was substantially complete prior to NSTS 22206 ground rule redirection.

10. Analysis of welds or brazed joints that cannot be inspected will not be performed nor FMEAs assessed.

    RATIONALE: Analysis was substantially complete prior to NSTS 22206 ground rule redirection.

11. Emergency system or hardware will include burst discs and will exclude the EMU Secondary Oxygen Pack (SOP), pressure relief valves and the landing gear pyrotechnics.

    RATIONALE: Clarify definition of emergency systems to ensure consistency throughout IOA project.

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.3 BF-Specific Ground Rules and Assumptions

None.

APPENDIX C
DETAILED ANALYSIS

This section contains the IOA analysis worksheets generated during the analysis of this subsystem. The information on these worksheets is intentionally similar to the NASA FMEAs. Each of these sheets identifies the hardware item being analyzed, and parent assembly, as well as the function. For each failure mode, the possible causes are outlined, and the assessed hardware and functional criticality for each mission phase is listed, as described in the NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. Finally, effects are entered at the bottom of each sheet, and the worst case criticality is entered at the top.

LEGEND FOR IOA ANALYSIS WORKSHEETS

Hardware Criticalities:
- 1 = Loss of life or vehicle
- 2 = Loss of mission or next failure of any redundant item (like or unlike) could cause loss of life/vehicle
- 3 = All others

Functional Criticalities:
- 1R = Redundant hardware items (like or unlike) all of which, if failed, could cause loss of life or vehicle.
- 2R = Redundant hardware items (like or unlike) all of which, if failed, could cause loss of mission.

Redundancy Screen A:
- 1 = Is Checked Out PreFlight
- 2 = Is Capable of Check Out PreFlight
- 3 = Not Capable of Check Out PreFlight
- NA = Not Applicable

Redundancy Screens B and C:
- P = Passed Screen
- F = Failed Screen
- NA = Not Applicable

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 101

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: ENABLE SOLENOID VALVE
FAILURE MODE: FAILS OPEN

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: BROKEN SPRING, CONTAMINATED HYDRAULIC SYSTEM

EFFECTS/RATIONALE:
PRESSURE LEAKS PAST SOLENOID VALVE AND DOWNSTREAM SOLENOIDS ARE CONTINUOUSLY PRESSURIZED; NOMINAL SYSTEM FUNCTION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	102	ABORT:	3/1R

ITEM: ENABLE SOLENOID VALVE
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/3	ATO:	3/1R
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: LOSS OF ASA CHANNEL

EFFECTS/RATIONALE:
SYSTEM CANNOT BE ACTIVATED; REMAINING TWO SYSTEMS OPERATE BODY FLAP NOMINALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 103

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	3/1R
ABORT:	3/1R

ITEM: ENABLE SOLENOID VALVE
FAILURE MODE: FRACTURED HOUSING

LEAD ANALYST: J. RICCIO   SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2]   B [P]   C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FATIGUE, VIBRATION

EFFECTS/RATIONALE:
SYSTEM PRESSURE DECAYS, HYDRAULIC BRAKE ENGAGES, RECIRCULATION VALVE OPEN DIVERTING FLOW TO RETURN; SYSTEM OPERATES NOMINALLY ON TWO SYSTEMS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	104	ABORT:	3/1R

ITEM: ENABLE SOLENOID VALVE
FAILURE MODE: LOSS OF HYDRAULIC PRESSURE

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3)
4)
5)
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7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: LOSS OF HYDRAULIC PRESSURE

EFFECTS/RATIONALE:
SYSTEM PRESSURE DECAYS, HYDRAULIC BRAKE ENGAGES, RECIRCULATION VALVE OPEN DIVERTING FLOW TO RETURN; SYSTEM OPERATES NOMINALLY ON TWO SYSTEMS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 105

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: PILOT SOLENOID VALVE (UP OR DOWN)
FAILURE MODE: FAILS OPEN

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: BROKEN SPRING, CONTAMINATED HYDRAULIC SYSTEM

EFFECTS/RATIONALE:
ONE PLOT SOLENOID VALVE REMAINS OPEN; OPPOSITE DIRECTION PILOT VALVE IS SELECTED PRESSURIZING BOTH SIDES OF DOWNSTREAM CONTROL VALVE. SUMMING LINK DRAGS POWER SPOOL TO PROPER POSITION. BF SYSTEM OPERATES NOMINALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	106	ABORT:	3/1R

ITEM: PILOT SOLENOID VALVE (UP OR DOWN)
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: LOSS OF ASA CHANNEL

EFFECTS/RATIONALE:
SYSTEM CANNOT BE ACTIVATED; REMAINING TWO SYSTEMS OPERATE BODY FLAP NOMINALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	107	ABORT:	3/1R

ITEM: PILOT SOLENOID VALVE (UP OR DOWN)
FAILURE MODE: FRACTURED HOUSING

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FATIGUE, VIBRATION

EFFECTS/RATIONALE:
SYSTEM PRESSURES DECAYS, HYDRAULIC BRAKE ENGAGES, RECIRCULATION VALVE OPENS DIVERTING FLOW TO RETURN; SYSTEM OPERATES NOMINALLY ON TWO SYSTEMS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	108	ABORT:	3/1R

ITEM: PILOT SOLENOID VALVE (UP OR DOWN)
FAILURE MODE: LOSS OF HYDRAULIC PRESSURE

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: LOSS OF HYDRAULIC PRESSURE

EFFECTS/RATIONALE:
SYSTEM PRESSURES DECAYS, HYDRAULIC BRAKE ENGAGES, RECIRCULATION VALVE OPENS DIVERTING FLOW TO RETURN; BF OPERATES NOMINALLY ON TWO SYSTEMS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	2/1R
MDAC ID:	109	ABORT:	2/1R

ITEM: ACTUATOR-CONTROL VALVE
FAILURE MODE: FAILS NULL POSITION

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) ACTUATOR-CONTROL VALVE
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	2/1R
LIFTOFF:	3/3	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: LOSS OF ASA CHANNEL, GROSS FLUID LEAKAGE, LOSS OF SYSTEM PRESSURE

EFFECTS/RATIONALE:
REMAINING TWO SYSTEMS DRAG ACTUATOR WITH SUMMING LINK-NOMINAL SYSTEM OPERATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 110

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	3/1R
ABORT:	3/1R

ITEM: ACTUATOR-CONTROL VALVE
FAILURE MODE: FAILS TO RETURN

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) ACTUATOR-CONTROL VALVE
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: BROKEN RETURN SPRING

EFFECTS/RATIONALE:
REMAINING TWO SYSTEMS DRAG ACTUATOR WITH SUMMING LINK-NOMINAL SYSTEM OPERATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 111

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: ACTUATOR-CONTROL VALVE
FAILURE MODE: JAMMED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) ACTUATOR-CONTROL VALVE
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC SYSTEM, OVER-TEMPERATURE ACTUATOR

EFFECTS/RATIONALE:
REMAINING TWO SYSTEMS CANNOT OVERCOME JAMMED VALVE; LOSS OF BODY FLAP MOTION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 112

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: CHECK VALVE
FAILURE MODE: FAILS OPEN

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) CHECK VALVE
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINANT IN SYSTEM, SPRING BREAKS OR RELAXES

EFFECTS/RATIONALE:
SYSTEM OPERATES NORMALLY ON TWO SYSTEMS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 113

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: RECIRCULATION VALVE
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) RECIRCULATION VALVE
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: BROKEN SPRING, GROSS FLUID LEAKAGE

EFFECTS/RATIONALE:
FAILS CLOSED-ACTUATOR RECEIVES PRESSURE <800 PSIG, AND MOVES AT REDUCED RATE. REMAINING SYSTEMS DRAG PISTON THROUGH SUMMING LINK. FULL SYSTEM CAPABILITY. FAILS CLOSED-PRESSURE SPILLS TO RETURN; SUMMING LINK DRAGS ACTUATOR AND HYDRAULIC MOTOR OPERATES NORMALLY. LEAK-PRESSURE DECAYS, HYDRAULIC BRAKE ENGAGES, AND RECIRCULATION VALVE OPENS. SUMMING LINK DRAGS ACTUATOR.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	1/1
MDAC ID:	114	ABORT:	1/1

ITEM: SUMMING LINK
FAILURE MODE: JAMMED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC SYSTEM

EFFECTS/RATIONALE:
CONTAMINATION JAMS SUMMING LINK-LOSS OF ALL BODY FLAP MOTION AND CONTROL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 115

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: SUMMING LINK
FAILURE MODE: FRACTURED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FATIGUE

EFFECTS/RATIONALE:
ONE LINK-ARM OR LINK-END FRACTURES, REMAINING TWO SYSTEMS DRIVE THE BODY FLAPS. NO PERFORMANCE DEGRADATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 116

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: HYDRAULIC MOTOR
FAILURE MODE: FAILS TO START

LEAD ANALYST: J. RICCIO
SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) HYDRAULIC MOTOR
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: GROSS FLUID LEAKAGE, LOSS OF HYDRAULIC PRESSURE, MOTOR BEARING FAILURE

EFFECTS/RATIONALE:
HYDRAULIC MOTOR DOES NOT PRODUCE TORQUE/SHAFT OUTPUT; REMAINING TWO LOOPS DRIVE BF NOMINALLY. PRESSURE DECAYS BELOW 850 PSI, ISO-VALVE OPENS, AND REMAINING LOOP PRESSURE BYPASSES CONTROL VALVE ACTUATOR.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	1/1
MDAC ID:	117	ABORT:	1/1

ITEM: HYDRAULIC MOTOR
FAILURE MODE: FRACTURED SHAFT

LEAD ANALYST: J. RICCIO   SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSEMBLY
7) HYDRAULIC MOTOR
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FATIGUE

EFFECTS/RATIONALE:
SHAFT SHEARS; LOSS OF TORQUE/SHAFT OUTPUT. SYSTEM MUST BE ISOLATED AND HYDRAULIC BRAKE APPLIED TO PREVENT TORQUE SPILL-OUT FROM DIFFERENTIAL GEARBOX.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	2/1R
MDAC ID:	118	ABORT:	2/1R

ITEM: HYDRAULIC BRAKE
FAILURE MODE: FAILS TO BRAKE

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSEMBLY
7) HYDRAULIC BRAKE
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	2/1R
LIFTOFF:	3/3	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: GROSS FLUID LEAKAGE; LOSS OF HYDRAULIC PRESSURE; BROKEN RETURN SPRING

EFFECTS/RATIONALE:
HYDRAULIC PRESSURE IS REQUIRED TO DISENGAGE BRAKE. FAILED BRAKE DOES NOT PREVENT TORQUE SPILL-OUT FROM DIFFERENTIAL GEARBOX. TORQUE SPILL-OUT IS PREVENTED BY A POWERED HYDRAULIC MOTOR.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 119

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: HYDRAULIC BRAKE
FAILURE MODE: FRACTURED SHAFT

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSEMBLY
7) HYDRAULIC BRAKE
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FATIGUE

EFFECTS/RATIONALE:
SHAFT FRACTURES INTERNAL TO BRAKE HOUSING-HYDRAULIC SYSTEMS MUST BE SHUT-DOWN TO DETECT FAILED UNIT AND ENGAGE BRAKE TO PREVENT TORQUE SPILL-OUT. REMAINING TWO SYSTEMS DRIVE BODY FLAP NOMINALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	1/1
MDAC ID:	121	ABORT:	1/1

ITEM: DIFFERENTIAL GEARBOX
FAILURE MODE: FRACTURED GEAR

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) DIFFERENTIAL GEARBOX
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FATIGUE

EFFECTS/RATIONALE:
FRACTURED GEAR JAMS GEARBOX OR PREVENTS TRANSMISSION OF POWER.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY		HDW/FUNC
SUBSYSTEM:	BODY FLAP		FLIGHT:	2/1R
MDAC ID:	122		ABORT:	2/1R

ITEM: DIFFERENTIAL GEARBOX
FAILURE MODE: JAMMED GEARS (ONE SET)

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) DIFFERENTIAL GEARBOX
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	2/1R
LIFTOFF:	3/3	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	2/1R	ATO:	2/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FRACTURED GEAR

EFFECTS/RATIONALE:
ONE SET OF DIFFERENTIAL GEARS JAM; TWO INPUT SHAFTS DRIVE REMAINING DIFFERENTIAL AT FULL CAPACITY AND RATE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	123	ABORT:	3/1R

ITEM: DIFFERENTIAL GEARBOX
FAILURE MODE: JAMMED INPUT SHAFT (ONE)

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) DIFFERENTIAL GEARBOX
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: FRACTURED GEAR

EFFECTS/RATIONALE:
SHAFT JAMS; REMAINING TWO INPUTS DRIVE SYSTEM NOMINALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	1/1
MDAC ID:	124	ABORT:	1/1

ITEM: DRIVESHAFT
FAILURE MODE: JAMMED OUTPUT SHAFT

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) DRIVESHAFT
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: DRIVESHAFT BEARING SEIZED, BROKEN GEAR TOOTH

EFFECTS/RATIONALE:
JAMMED SHAFT PREVENTS BODY FLAP MOTION-LOSS OF BF CONTROL.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY		HDW/FUNC
SUBSYSTEM:	BODY FLAP		FLIGHT:	3/3
MDAC ID:	125		ABORT:	3/3

ITEM: PDU GEARBOX HEATER
FAILURE MODE: FAILS ON

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) PDU GEARBOX HEATER
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: THERMOSTAT STUCK-ON.

EFFECTS/RATIONALE:
CREW CAN DISABLE HEATER, PDU GEARBOX DESIGNED TO WITHSTAND OVERTEMPERATURE CONDITION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/3
MDAC ID:	126	ABORT:	3/3

ITEM: PDU GEARBOX HEATER
FAILURE MODE: ERRONEOUS SENSOR READING

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) PDU GEARBOX HEATER
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: THERMOSTAT FAILS TO OPERATE PROPERLY.

EFFECTS/RATIONALE:
PDU GEARBOX HEATERS ARE NOT DETRIMENTAL TO GEARBOX USE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 127

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: PDU GEARBOX HEATER
FAILURE MODE: BROKEN LEAD WIRE

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) PDU GEARBOX HEATER
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	3/3	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: EXCESSIVE VIBRATION

EFFECTS/RATIONALE:
REDUNDANT HEATER OPERATES SYSTEM WITHIN NOMINAL TOLERANCES.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 128

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	3/1R
ABORT:	3/1R

ITEM: RVDT (4-UNITS)
FAILURE MODE: LOSS OF ONE SIGNAL

LEAD ANALYST: J. RICCIO   SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSY
7) PDU GEARTRAIN ASSY
8) RVDT
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: SHOCK, VIBRATION, BROKEN LEAD

EFFECTS/RATIONALE:
ANY OF THE FOUR RVDTs CAN FEEDBACK THE BODY FLAP POSITION-NO PERFORMANCE DEGRATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	9/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	1/1
MDAC ID:	129	ABORT:	1/1

ITEM: ROTARY ACTUATORS
FAILURE MODE: FAILS TO START

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) HYDRAULIC MOTOR/BRAKE ASSY
6) PDU GEARTRAIN ASSY
7) TORQUE TUBE
8) ROTARY ACTUATOR
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: GEARS JAM, GEARS CRACK OR BREAK, BEARING SEIZES

EFFECTS/RATIONALE:
LOSS OF BODY FLAP MOTION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 130

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	1/1
ABORT:	1/1

ITEM: TORQUE TUBE (FOR ROTARY ACTUATORS)
FAILURE MODE: FRACTURED SHAFT

LEAD ANALYST: J. RICCIO   SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) HYDRAULIC MOTOR/BRAKE ASSY
6) PDU GEARTRAIN ASSY
7) TORQUE TUBE
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: MISMATCHED LOADS, FATIGUE, JAMMED ROTARY ACTUATOR

EFFECTS/RATIONALE:
LOSS OF BODY FLAP MOTION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/16/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/1R
MDAC ID:	131	ABORT:	3/1R

ITEM: HYDRAULIC BRAKE
FAILURE MODE: FAILS TO DISENGAGE

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL-CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSEMBLY
7) HYDRAULIC BRAKE
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC SYSTEM

EFFECTS/RATIONALE:
HYDRAULIC PRESSURE IS REQUIRED TO DISENGAGE BRAKE. CONTAMINATION PREVENTS BRAKE FROM DISENGAGING. SYSTEM DOES NOT CONTRIBUTE MOTION AND TORQUE TO DIFFERENTIAL. REMAINING TWO SYSTEMS DRIVE BF NOMINALLY.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/16/86
SUBSYSTEM: BODY FLAP
MDAC ID: 132

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: FILTER
FAILURE MODE: PLUGGED

LEAD ANALYST: J. RICCIO   SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) FILTER
3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/1R
LIFTOFF:	3/3	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	3/1R	ATO:	3/1R
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC SYSTEM

EFFECTS/RATIONALE:
PLUGGED FILTER DECREASES HYDRAULIC PRESSURE TO PDU. RECIRCULATION VALVE OPEN DIVERTING FLUID TO RETURN LINE. BF OPERATES NOMINALLY ON TWO SYSTEMS.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/20/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	1/1
MDAC ID:	133	ABORT:	1/1

ITEM: SUPPLY ORIFICE #1
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) ACTUATOR-CONTROL VALVE
5) SUPPLY ORIFICE #1
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC FLUID

EFFECTS/RATIONALE:
ENABLE AND PILOT VALVES OPEN ALLOWING HYDRAULIC FLUID TO RELEASE BRAKE. HOWEVER, ORIFICE IS PLUGGED AND FLUID CANNOT DRIVE MOTOR. TORQUE FROM TWO REMAINING SYSTEMS SPILLS-OUT OF MOTOR. SYSTEMS MUST BE SHUT-DOWN TO DETECT FAILED PDU.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 10/20/86
SUBSYSTEM: BODY FLAP
MDAC ID: 134

HIGHEST CRITICALITY	HDW/FUNC
FLIGHT:	3/3
ABORT:	3/3

ITEM: ORIFICE #2
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) ACTUATOR-CONTROL VALVE
5) ORIFICE #2
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC FLUID

EFFECTS/RATIONALE:
ENABLE AND PILOT SOLENOIDS OPEN ALLOWING FLUID TO TRANSLATE ACTUATOR - CONTROL VALVE. ORIFICE IS PLUGGED, ACTUATOR - CONTROL VALVE TRANSLATES FASTER THAN THE TWO REMAINING SYSTEMS. NORMAL BODY FLAP OPERATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE:	10/20/86	HIGHEST CRITICALITY	HDW/FUNC
SUBSYSTEM:	BODY FLAP	FLIGHT:	3/3
MDAC ID:	135	ABORT:	3/3

ITEM: ORIFICE #3
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) ACTUATOR-CONTROL VALVE
5) ORIFICE #3
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	3/3
LIFTOFF:	3/3	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	3/3	ATO:	3/3
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: CONTAMINATED HYDRAULIC FLUID

EFFECTS/RATIONALE:
ENABLE AND PILOT SOLENOIDS OPEN ALLOWING FLUID TO TRANSLATE ACTUATOR - CONTROL VALVE. ORIFICE IS PLUGGED, ACTUATOR - CONTROL VALVE TRANSLATES FASTER THAN THE TWO REMAINING SYSTEMS. NORMAL BODY FLAP OPERATION.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 9/17/86
SUBSYSTEM: BODY FLAP
MDAC ID: 136

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: RVDT
FAILURE MODE: LOSS OF SIGNAL

LEAD ANALYST: J. RICCIO SUBSYS LEAD: J. RICCIO

BREAKDOWN HIERARCHY:
1) BODY FLAP
2) ENABLE SOLENOID VALVE
3) PILOT SOLENOID VALVE
4) POWER SPOOL - CONTROL VALVE
5) SUMMING LINK
6) HYDRAULIC MOTOR/BRAKE ASSEMBLY
7) PDU GEARTRAIN ASSEMBLY
8) RVDT
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	3/3	RTLS:	1/1
LIFTOFF:	3/3	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	1/1	ATO:	1/1
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: AFT FUSELAGE
PART NUMBER: MC621-0056-0053

CAUSES: VIBRATION CAUSES BROKEN BRACKET

EFFECTS/RATIONALE:
IF BRACKET SUPPORTING ALL RVDTs FRACTURES, THE BODY FLAP POSITION CAN NOT BE DETERMINED.

REFERENCES:

APPENDIX D
POTENTIAL CRITICAL ITEMS

MDAC ID	ITEM	FAILURE MODE
109	Actuator control valve	Fails null position
110	Actuator control valve	Fails to return
111	Actuator control valve	Jammed
114	Summing link	Jammed
115	Summing link	Fractured
116	Hydraulic motor	Fails to start
117	Hydraulic motor	Fractured shaft
118	Hydraulic brake	Fails to brake
119	Hydraulic brake	Fractured shaft
121	Differential gearbox	Fractured gear
122	Differential gearbox	Jammed gear
123	Differential gearbox	Jammed shaft
124	Driveshaft	Jammed
129	Rotary actuator	Fails to start
130	Torque tube	Fractured
131	Hydraulic brake	Fails to disingage
132	Filter	Plugged
133	Supply orifice #1	Fails closed
136	RVDT	Loss of signal