INDEPENDENT ORBITER ASSESSMENT

ASSESSMENT
OF THE
NOSE WHEEL STEERING
SUBSYSTEM

11 MARCH 1988

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
HOUSTON DIVISION

SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

WORKING PAPER NO. 1.0-WP-VA88003-22

~~ANALYSIS~~ ASSESSMENT INDEPENDENT ORBITER ASSESSMENT OF THE NOSE WHEEL STEERING SUBSYSTEM

11 MARCH 1988

This Working Paper is Submitted to NASA under
Task Order No. VA88003, Contract NAS 9-17650

PREPARED BY: _____
A.S. Mediavilla
Analyst
Independent Orbiter
Assessment

APPROVED BY: _____
J.M. Compton
Section Manager-FMEA/CIL
Independent Orbiter
Assessment

APPROVED BY: _____
G.W. Knori
Technical Manager
Independent Orbiter
Assessment

APPROVED BY: _____
G.L. Hornback
Project Manager
STSEOS

CONTENTS

		Page
1.0	EXECUTIVE SUMMARY	1
2.0	INTRODUCTION	3
2.1	Purpose	3
2.2	Scope	3
2.3	Analysis Approach	3
2.4	NWS Ground Rules and Assumptions	4
3.0	SUBSYSTEM DESCRIPTION	5
3.1	Design and Function	5
3.2	NWS Modes	5
3.3	NWS Timeline	5
3.4	NWS Effectiveness	6
3.5	NWS Upgrades	6
3.6	NWS Component Description	6
3.7	Interfaces and Locations	8
3.8	Hierarchy	8
4.0	ASSESSMENT RESULTS	19
4.1	The Rudder Pedal Assembly (RPA)	19
4.2	The Steering Control Box (SCB)	20
4.3	The Steering Actuator Assembly	20
4.3.1	Shimmy Damping	20
4.3.2	Pilot Valves and Shutoff Valve	21
4.3.3	E-H Protection Check Valve	22
4.3.4	Anti-Cavitation Check Valves	23
4.3.5	Overload Check Valves	23
4.3.6	Missing Items / Failure Modes	24
4.4	The NWS/EPD&C Failure Annunciation System	25
4.5	The NWS/EPD&C Activation System	26
4.6	Note: Ground Speed Enable - SRB and ET Separation Switches	28
5.0	REFERENCES	29
APPENDIX A	ACRONYMS	A-1
APPENDIX B	DEFINITIONS, GROUND RULES, AND ASSUMPTIONS	B-1
B.1	Definitions	B-2
B.2	Project Level Ground Rules and Assumptions	B-4
B.3	NWS-System Specific Ground Rules & Assumptions	B-6
APPENDIX C	ASSESSMENT WORKSHEETS	C-1
APPENDIX D	CRITICAL ITEMS	D-1
APPENDIX E	ANALYSIS WORKSHEETS	E-1
APPENDIX F	NASA FMEA TO IOA WORKSHEET CROSS REFERENCE/RECOMMENDATIONS	F-1

List of Figures

		Page
Figure 1 -	NWS ASSESSMENT OVERVIEW	2
Figure 2 -	NWS OVERVIEW	9
Figure 3 -	NWS STEERING CONTROL BOX	10
Figure 4 -	NWS RUDDER PEDAL ASSEMBLIES	11
Figure 5 -	NWS STEERING ACTUATOR ASSEMBLY	12
Figure 6 -	NWS FAILURE ANNUNCIATION SYSTEM	13
Figure 7 -	NWS ACTIVATION SYSTEM	14
Figure 9 -	NWS FUNCTIONAL INTERFACES AND LOCATIONS	15

List of Tables

		Page
Table I -	SUMMARY OF IOA FMEA ASSESSMENT ISSUES	16
Table II -	SUMMARY OF IOA CIL ASSESSMENT ISSUES	17
Table III -	SUMMARY OF IOA RECOMMENDED FAILURE MODES AND CRITICALITIES	17
Table IV -	SUMMARY OF IOA RECOMMENDED CRITICAL ITEMS	18
Table V -	IOA WORKSHEET NUMBERS	18

Independent Orbiter Assessment
Assessment of the Nose Wheel Steering FMEA/CIL

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 Mode 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, October 10, 1986.

The IOA effort first completed an analysis of the Nose Wheel Steering (NWS) hardware, generating draft failure modes and potential critical items. To preserve independence, this analysis was accomplished without reliance upon the results contained within the NASA FMEA/CIL documentation. The IOA results were then compared to the proposed NASA post 51-L FMEA/CIL baseline. A resolution of each discrepancy from the comparison is provided through additional analysis as required. This report documents the results of that comparison for the Orbiter NWS hardware.

The IOA product for the NWS analysis consisted of 78 failure mode "worksheets" that resulted in 42 potential critical items being identified. Comparison was made to the NASA baseline (as of 01 January 1988) which consisted of 34 CIL items. The comparison determined if there were any results which had been found by the IOA but were not in the NASA baseline. This comparison produced agreement on only 21 FMEAs which caused differences in 13 CIL items. Reference Figure 1.

Some issues arose due to differences between the NASA and IOA FMEA/CIL preparation instructions and the analysis assumptions. NASA had used an older ground rules document which has been superseded by the NSTS 22206 used by the IOA. After comparison, there were 14 discrepancies found that were not already identified by NASA, and the remaining issues may be attributed to differences in ground rules.

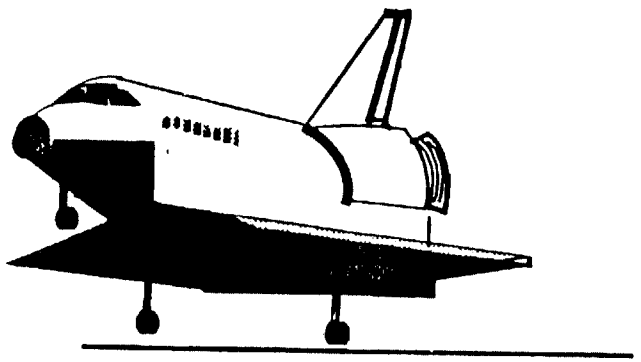
NWS ASSESSMENT OVERVIEW

NWS ASSESSMENT SUMMARY			
	IOA	NASA *	ISSUES
FMEA	68	58	14
CIL	41	34	9

RUDDER PEDAL ASSEMBLY			
	IOA	NASA	ISSUES
FMEA	7	7	-
CIL	5	5	-

NWS CONTROL BOX			
	IOA	NASA	ISSUES
FMEA	6	4	2
CIL	5	4	1

NWS ACTUATOR ASSEMBLY			
	IOA	NASA	ISSUES
FMEA	33	27	9
CIL	25	20	7



NWS EPD&C: FAILURE ANNUNCIATOR SYSTEM			
	IOA	NASA	ISSUES
FMEA	5	5	-
CIL	-	-	-

NWS EPD&C: ACTIVATION SYSTEM			
	IOA	NASA	ISSUES
FMEA	17	15	3
CIL	6	5	1

* FINAL NASA BASELINE AS OF 1 JANUARY 1988

Figure 1 NWS Assessment Overview

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. MDAC is providing an independent assessment of the Orbiter FMEA/CIL reevaluation results 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 divide 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 proposed post 51-L NASA and Prime Contractor FMEA/CIL. 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 FMEA/CIL which is documented in this report.

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 Ground Rules and Assumptions

The ground rules and assumptions used in the IOA are presented in Appendix B. The subsystem specific ground rules were defined to limit the analysis to single-failed-parts for each failure mode. A subset of the failure mode keywords were identified for the NWS team. This allowed for commonality in the analysis results.

3.0 SUBSYSTEM DESCRIPTION

3.1 Design and Function

The NWS hardware provides the primary directional control for the Orbiter during landing rollout. Deflection of the commander's or pilot's rudder pedals transmits an electrical steering signal to the NWS Control Box. These electrical signals meter hydraulic power through the NWS actuator which physically displaces the actuator piston. The actuator piston, which is mechanically linked to the nose wheel collar, can turn the nose wheel as much as +/- 10 degrees for directional control during rollout.

3.2 NWS Modes

The NWS subsystem has three different operational modes. These 3 modes of operation are:

1) General Purpose Computer (GPC) mode,
2) Direct (Manual) mode, and
3) Free Castor (Differential Braking) mode.

The GPC mode of NWS is now the primary directional control mode for the Orbiter during landing rollout. In this mode, the GPC processes the steering signals before sending them to the Steering Control Box (SCB). The GPC mode also employs a triple channel wraparound feedback system that compares the actual nose wheel position with the commanded position. This added capability enabled NWS to be elevated over differential braking as the primary mode of directional control during landing rollout.

In the Direct mode of NWS, steering signals bypass the GPCs and go directly to the SCB by way of the command transducer (xducer).

The free castor mode is a passive mode of NWS where the nose wheel rotates freely and steering is accomplished by differential braking and use of the rudder. During free castor, nose wheel shimmy (oscillations) are prevented by the NWS actuator's internal hydraulic damping capability.

3.3 NWS Timeline

The steering timeline is important to the NWS analysis because some failure modes have different effects and criticalities depending on the time of failure. The GPC mode of NWS is selected during the final approach phase of landing. Between main gear touchdown (MGTD) and nose gear touchdown (NGTD), all directional control is performed by the rudder. Following NGTD, NWS becomes active and operates in tandem with the rudder. As the Orbiter decelerates during landing rollout, the rudder effectiveness decreases leaving NWS and differential braking as the only available means of directional control for the vehicle.

3.4 NWS Effectiveness

Steering the Orbiter with the nose wheel takes advantage of an effective moment arm about 5 times as long as that available when using differential braking. The turning capability of the vehicle using only differential braking is not adequate to maintain directional control of the Orbiter for a landing scenario with blown tires. This inadequacy has contributed to the recent upgrades to the NWS system.

3.5 NWS Upgrades

A 3 phase upgrade was initiated in an attempt to make the NWS system fail operational/fail safe. The Phase I upgrade consisted of rewiring the GPC and Direct positions of the NWS switch, disconnecting the GPC contact, and adding a 2.5 inch extension to the switch toggle. This upgrade inhibited the GPC mode and made the activation of the Direct mode, which must be activated after NGTD, a task requiring less concentration.

The Phase II upgrade was implemented and flown on STS-61A, STS-61C, and STS-51L. It primarily consisted of reconnecting the GPC switch contact and adding a wraparound feedback (FB) system for the GPC mode that included software logic for Redundancy Management (RM) and failure detection. Parabolic signal shaping was also added to the command xducer steering signal used by the Direct mode of NWS. This is the current state of the NWS system and the design considered for the IOA analysis.

The Phase III upgrade is presently in the early design stage. Unless the NWS Phase III redesign eliminates all the remaining single point failures, the NWS system is at best fail safe.

3.6 NWS Component Description

The following sections highlight the major components of NWS: (Reference Figure 2)

1. The Steering Control Box (SCB) has a single electrical power source - Main Bus A. At NGTD the GPC issues enable signals that allow the SCB to ground this power source which then activates the pilot valve solenoids in the steering actuator assembly. The SCB also monitors the nose wheel steering signal current for comparison with the feedback transducer signal. The SCB contains separate failure detection circuits that monitor 5 potential NWS failures:

    1) Command Transducer Broken Linkage
    2) Command Transducer Open/Short
    3) Rate/Direction Error
    4) Electro-hydraulic Valve Open/Short
    5) Feedback Transducer Open/Short

Any 1 failure detection will automatically downmode NWS to the free castor mode and annunciate the NWS fail light. (Reference Figure 3)

2. The Rudder Pedal Assemblies consist of the commander/pilot rudder pedals and linkages, 2 rudder pedal transducer assemblies, 1 command transducer and 4 brake pedal position transducers. The commander and pilot rudder pedals are mechanically linked to one another and to their transducers. Rudder pedal NWS signals are proportional to the translational deflection of the rudder pedals while braking signals are proportional to the rotational deflection of the rudder pedals. * (Reference Figure 4)

3. The NWS Actuator Assembly converts electrical steering signals into a physical displacement of the actuator arm which is mechanically linked to the nose wheel. Hydraulic system No. 1 supplies 3000 psi fluid to the NWS actuator. The fluid is filtered before it reaches the shutoff valve. The actuator has 2 pilot valves. Pilot valve No. 1 opens or closes the shutoff valve. Pilot valve No. 2 opens or closes the bypass valves. Both pilot valves must be open to activate NWS; if either valve closes, the system downmodes to the free castor mode. Once the hydraulic pressure in the actuator reaches 1350 psi, a pressure sensitive switch closes which inhibits the hardwired electrical path to the NWS fail light; however, if the system pressure ever falls below 1000 psi, the pressure switch will open and the NWS fail light will be annunciated.

   Once the system is energized, the electro-hydraulic (E-H) servo valve meters high pressure flow to the piston balance area proportional to the steering signal transmitted by the SCB. The high pressure in the balance area moves the actuator piston/arm back and forth. The motion of the piston, which is attached to the nose gear strut, rotates the torque link and turns the nose wheel.

   The actuator's feedback xducer provides "steering velocity" data to the SCB which is monitored by one of the SCB failure detection circuits. In addition, the GPC mode employs a triply redundant feedback transducer system to provide NW position data to the GPC failure detection logic in the NW Subsystem Operating Program (SOP).

   System protection against high pressure is provided by 2 overload check valves and a return line check valve. The hydraulic fluid and system pressure required for shimmy damping during free castor is provided by the accumulator through the anti-cavitation check valves. (Reference Figure 5)

* Rudder commands are processed independently of NWS commands.

4. The Failure Annunciator System illuminates a NWS fail light which warns the crew that a detectable failure has occurred or that the NWS system may be unreliable. Control Bus AB1 provides power to a Type III hybrid circuit driver which signals the annunciator control assembly to illuminate the NWS fail light. The fail signal may originate in either the hardwired path from the actuator pressure switch or in the NW Position SOP through MDM FF4. In the GPC mode of NWS, the hardwired path is inhibited until NGTD. (Reference Figure 6)

5. The Activation System was included to maintain a more complete NWS analysis. Main Bus A is the single power source for the NWS system. A circuit breaker provides protection against high voltage/current spikes. The NWS toggle switch must be in the GPC or Direct position to power the system. The ROLL/YAW CSS/AUTO PBIs configure a flight control channel that determines whether the steering signals will originate at the rudder pedals or in autoland guidance. The activation system also has a current limit resistor in line with the fail light power source CNTL BUS AB1 and 3 isolation resistors providing circuit protection for MDMs that monitor the power lines. (Reference Figure 7)

6. The Data Processing System (DPS) Flight Critical Forward MDMs were originally included in this analysis because of the strong dependence NWS has on the health of this interfacing subsystem. IOA later decided that determining the effects of failure modes in interfacing subsystems was beyond the scope of the NWS analysis. For this reason, IOA has deleted the MDM analysis from this assessment. The MDM evaluation can be found in the IOA DPS analysis.

Above Items 4 and 5 interface with the Electrical Power and Distribution Control (EPD&C) system. This document contains only a partial analysis of these interfacing components. The analysis examines only the NWS related effects of these component failure modes.

3.7 Interfaces and Locations

Most of the major NWS components are located in 1 of 2 locations on the Orbiter. The Activation System, the Failure Annunciation System, and the Rudder Pedal Assemblies are located on the Flight Deck. The NWS Control Box and Actuator Assembly are both attached to the nose gear strut. The GPCs and the Flight Forward MDMs are all located in Avionics Bays 1, 2, and 3. (Reference Figure 8)

3.8 Hierarchy

Figure 2 illustrates the hierarchy of the NWS hardware. Figures 3 through 7 comprise the detailed system representations.

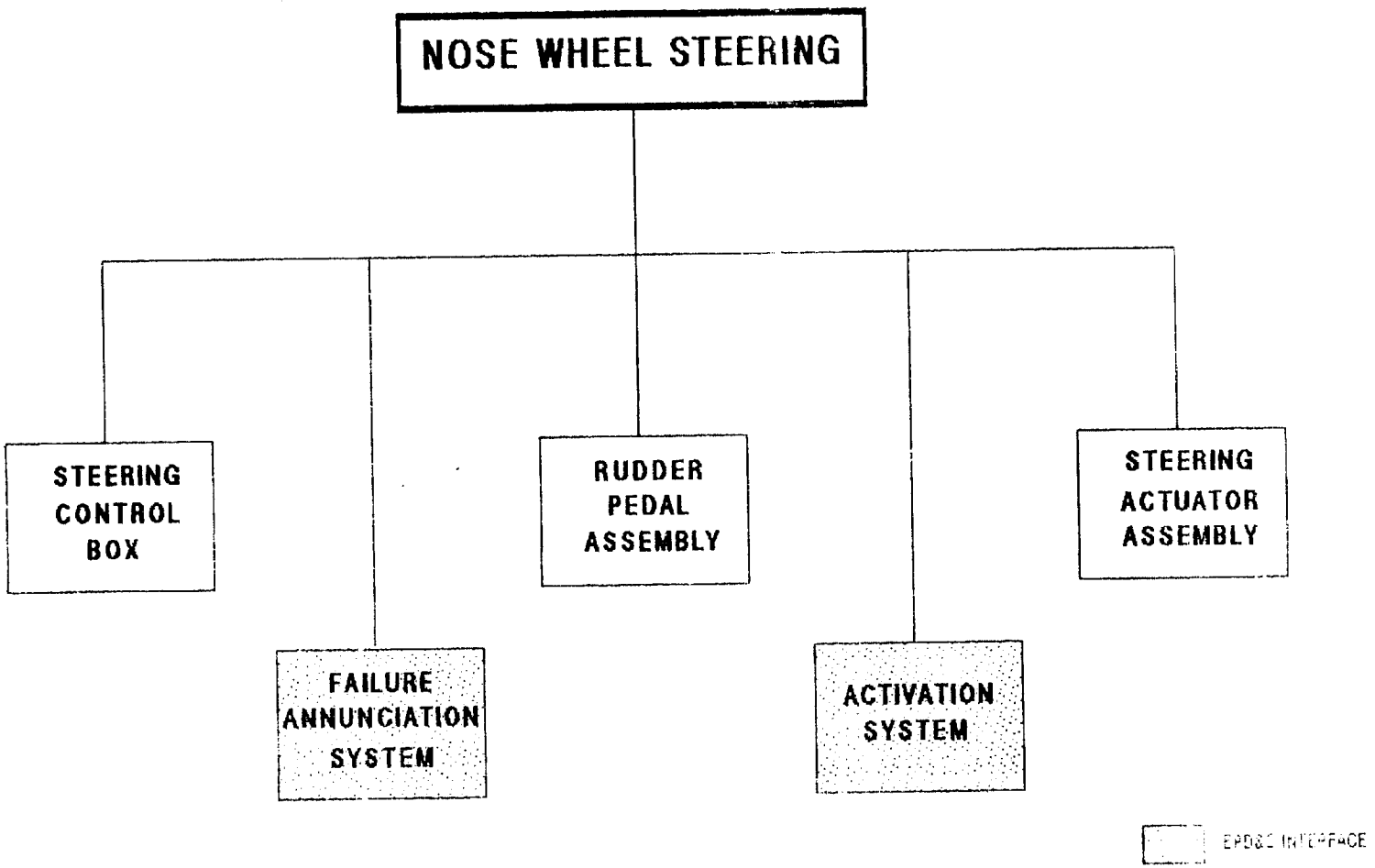


Figure 2 - NWS OVERVIEW

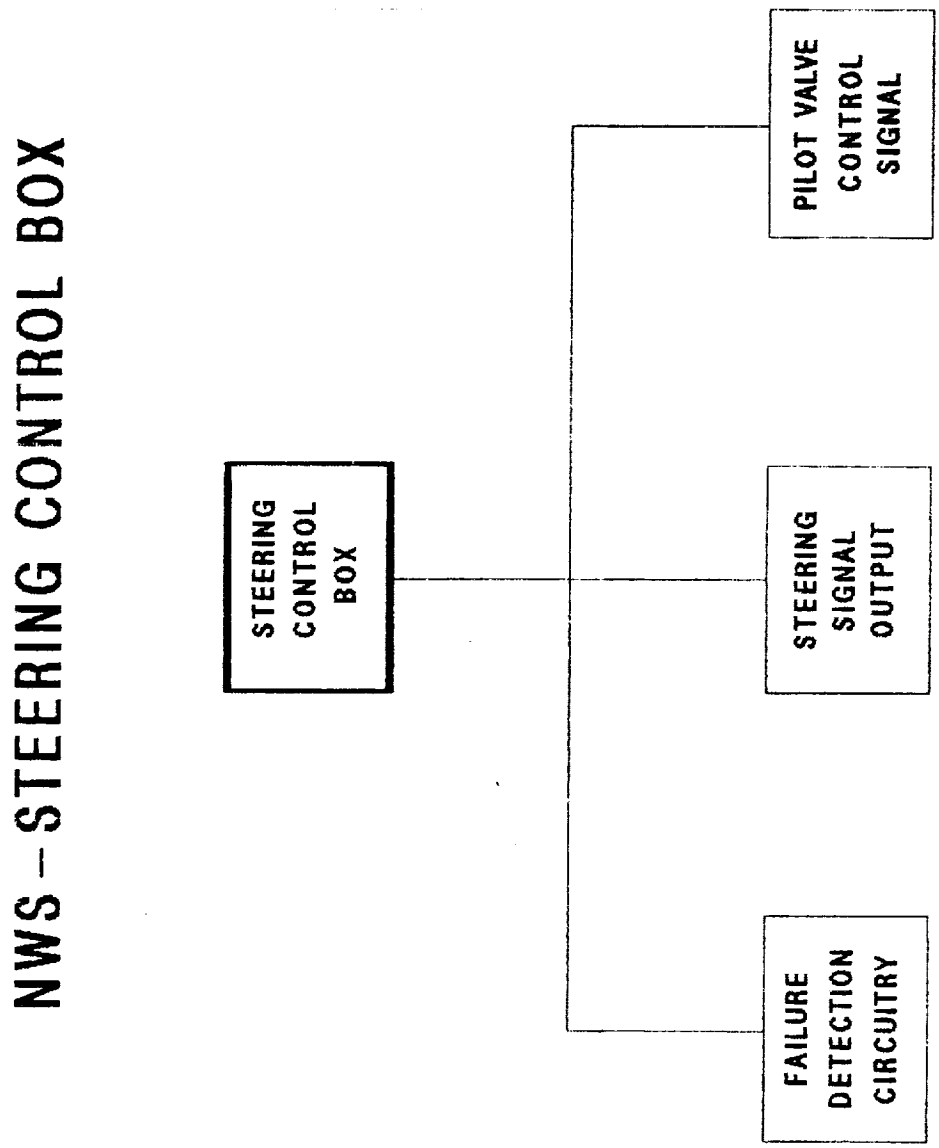


Figure 3 - NWS STEERING CONTROL BOX

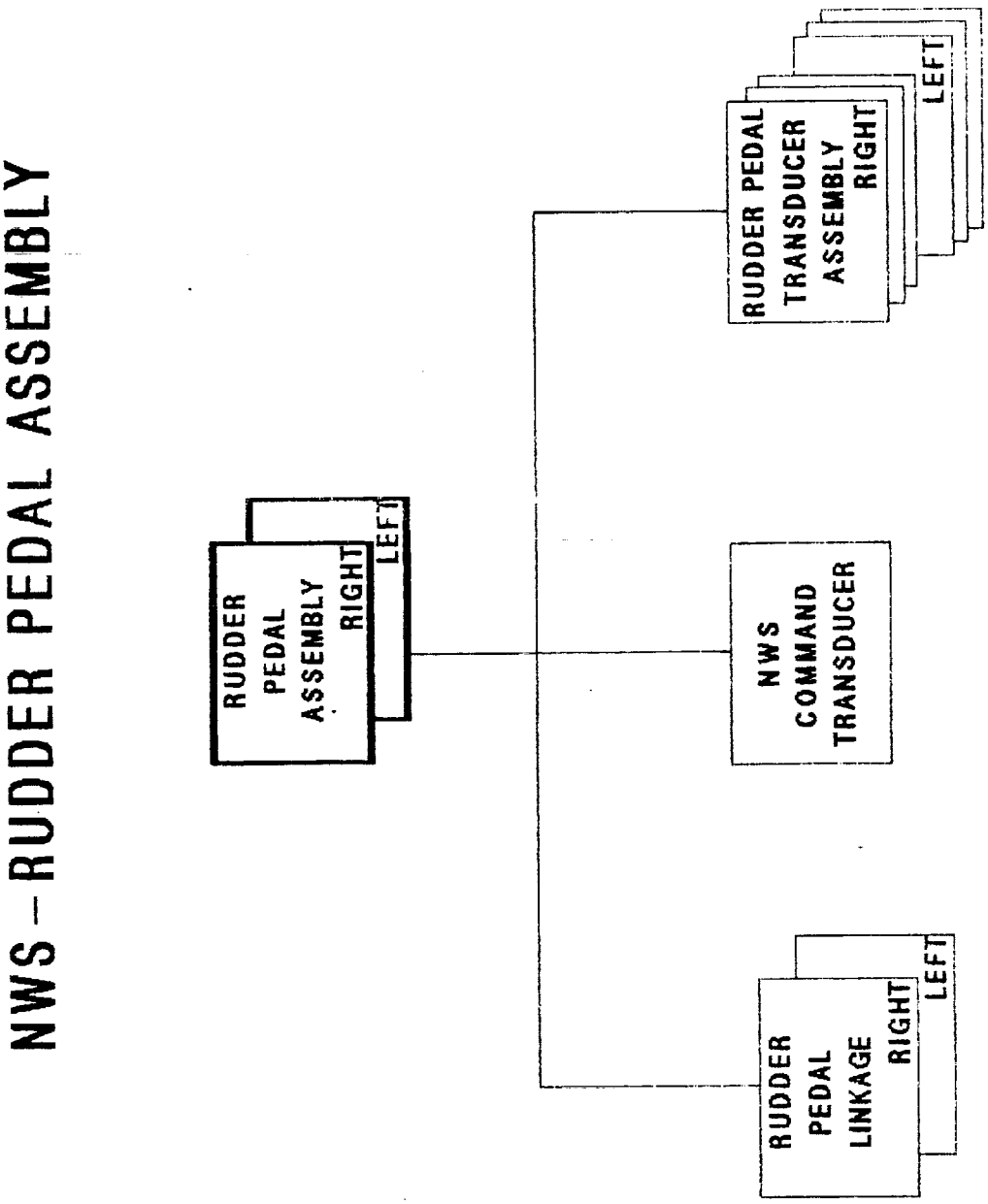


Figure 4 - NWS RUDDER PEDAL ASSEMBLIES

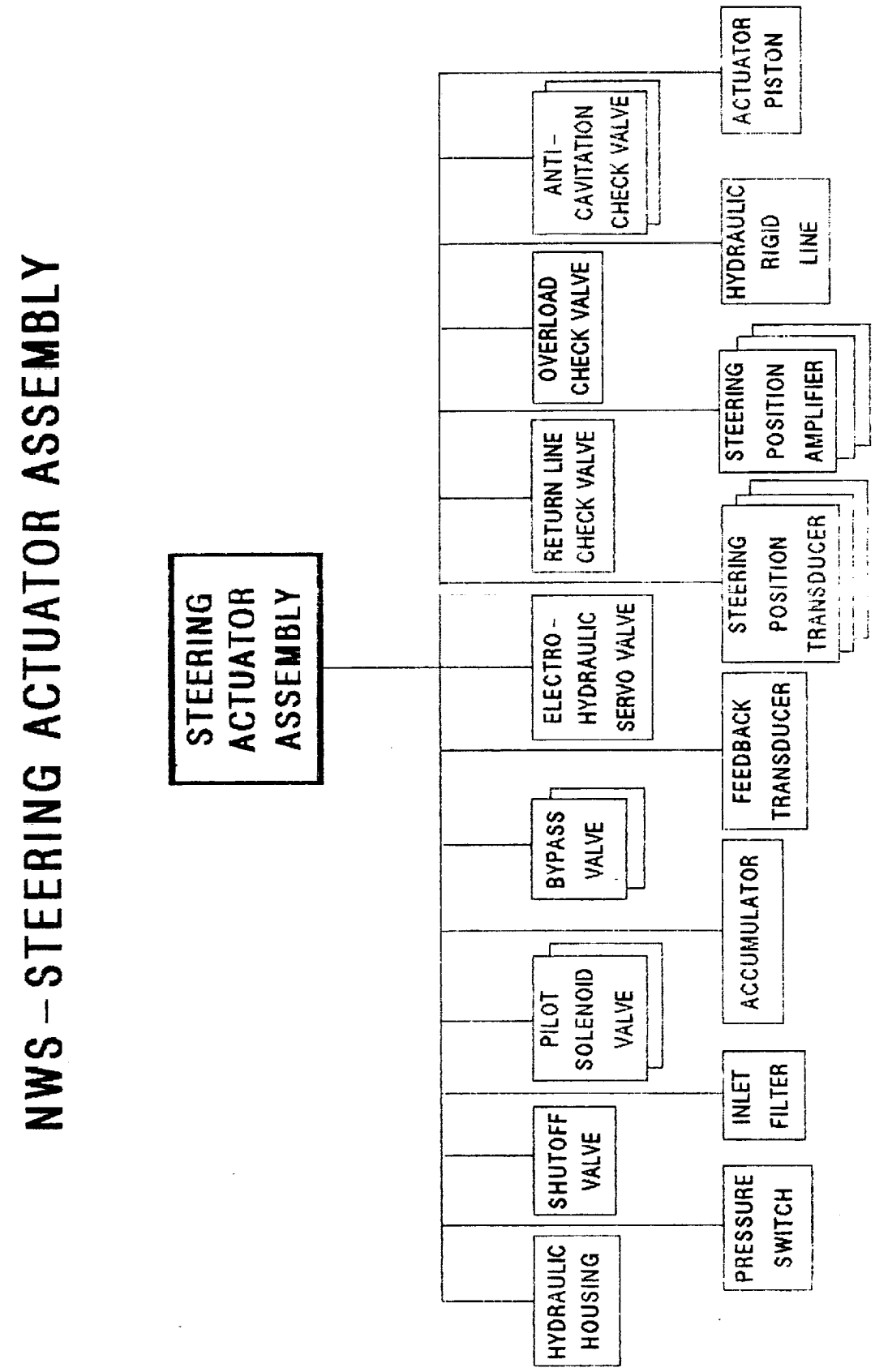


Figure 5 - NWS STEERING ACTUATOR ASSEMBLY

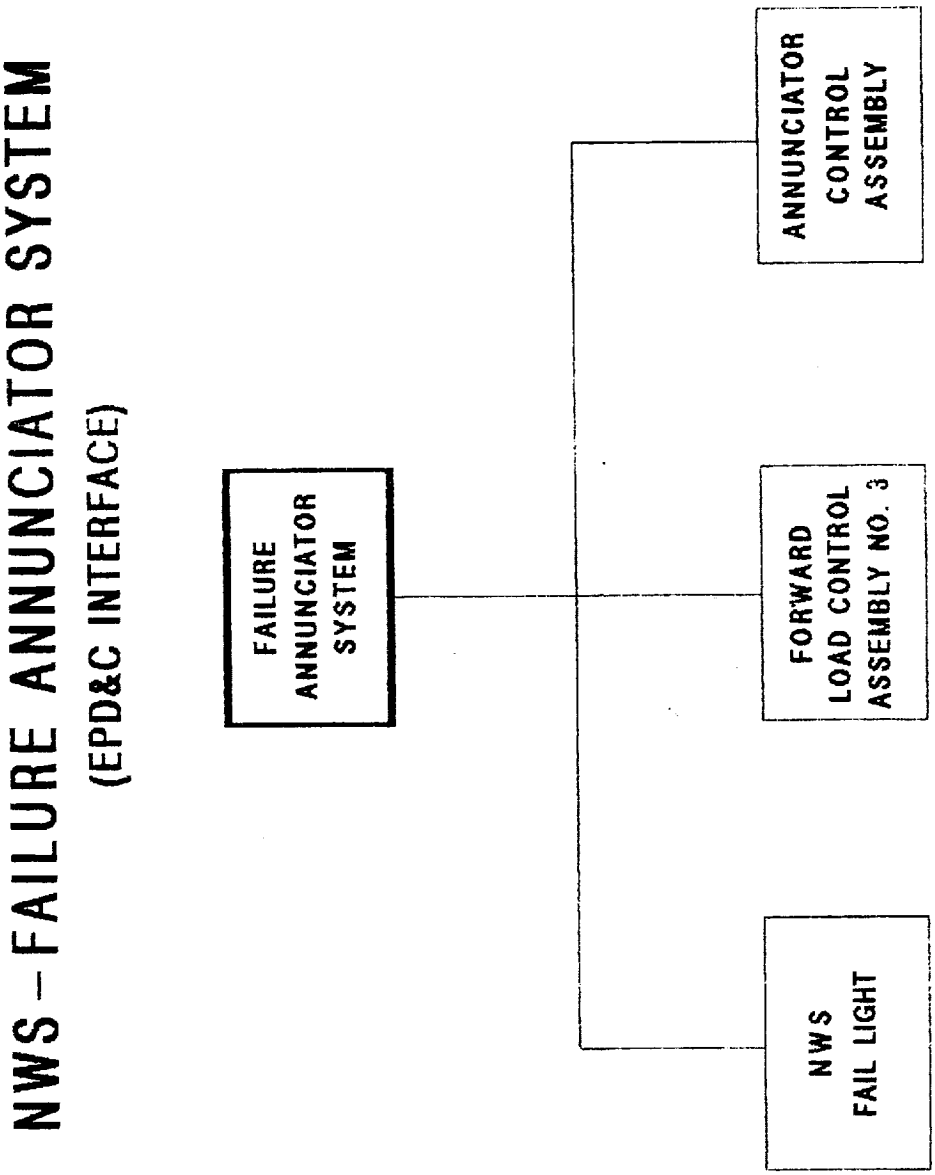


Figure 6 - NWS FAILURE ANNUNCIATION SYSTEM

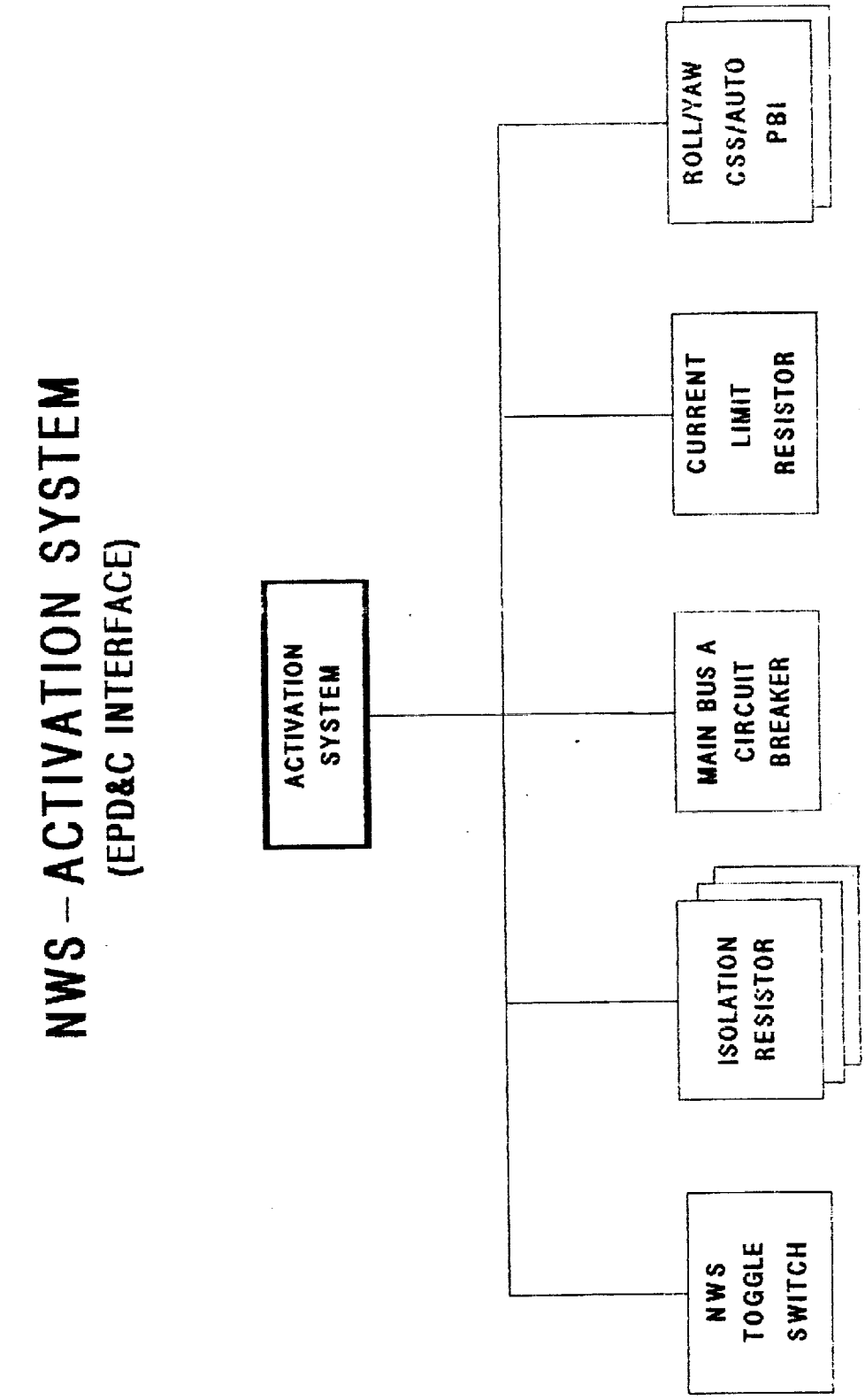


Figure 7 - NWS ACTIVATION SYSTEM

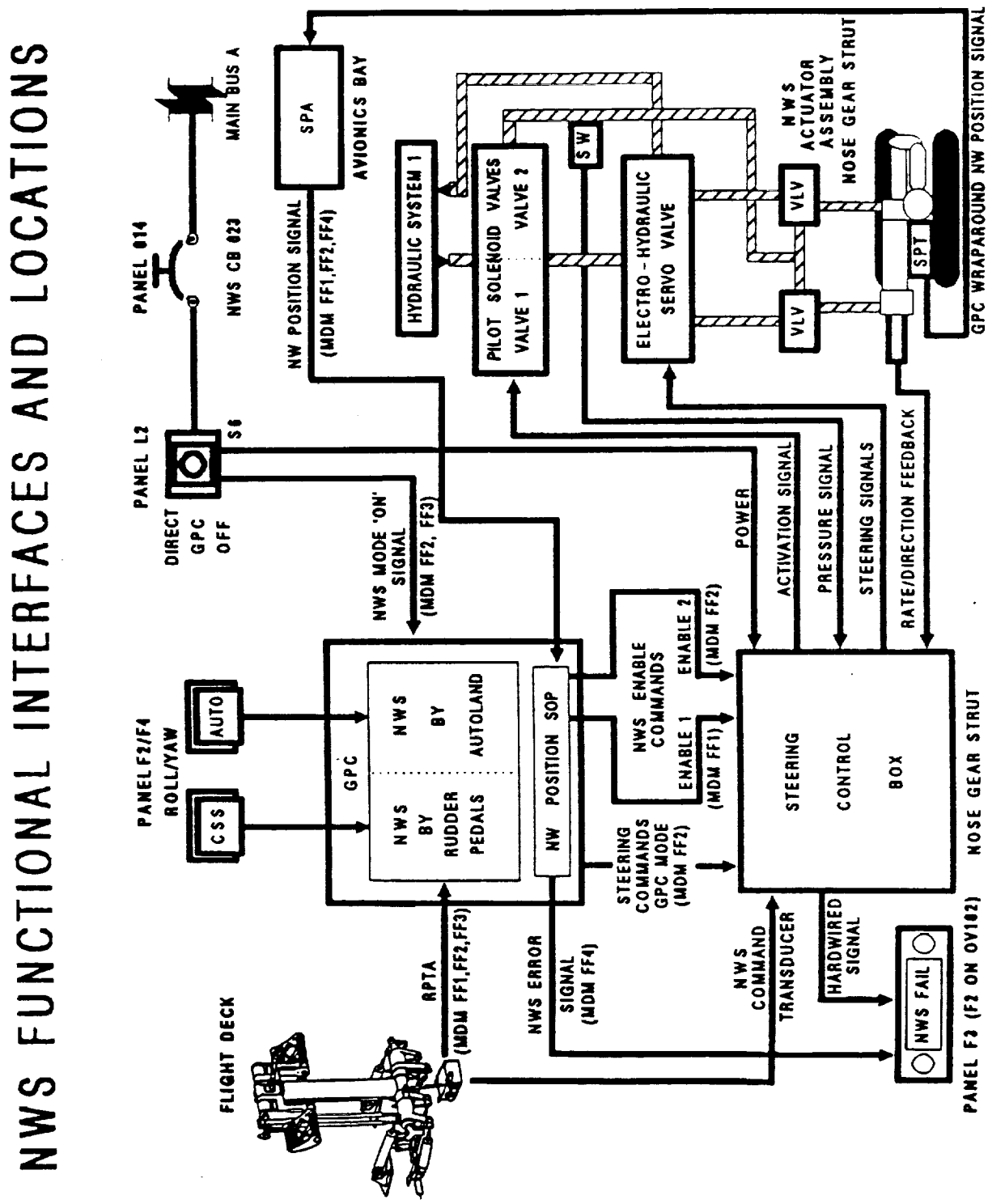


Figure 8 - NWS FUNCTIONAL INTERFACES AND LOCATIONS

4.0 ASSESSMENT RESULTS

The IOA analysis of the NWS hardware initially generated 78 failure mode worksheets and identified 42 Potential Critical Items (PCIs). As a result of the assessment process, 15 NWS failure mode worksheets were deleted and an additional 5 analysis worksheets were generated and added to the assessment package. The assessment comparison also gave rise to 14 issues between the IOA NWS analysis and the corresponding NASA FMEAs.

Of these issues, 9 are the result of failure modes generated by the IOA that did not have corresponding NASA FMEAs. The remainder of the issues are the result of differences in the NWS subsystem failure mode assigned hardware/functional criticalities.

Some of the criticality issues cannot be resolved without performing additional analysis or testing of the NWS system. Other issues can be more easily resolved by establishing official flight rules or crew procedures for certain failure modes. In either case, IOA has recommended upgrading the existing criticalities of the affected NWS components until conclusive test/analysis results or written flight rules/crew procedures are available to support downgrading the criticalities.

Table I presents a summary of firm FMEA assessment issues that exist for each NWS component.

TABLE I Summary of IOA FMEA Assessment Issues

Component	NASA	IOA	IOA Issues
Rudder Pedal Assembly	7	7	-
NWS Control Box	4	6	2
NWS Actuator Assembly	27	33	9
NWS/EPD&C: Failure Annunciator System	5	5	-
Activation System	15	17	3
TOTAL	58	68	14

The IOA assessment of the existing CILs gave rise to 9 issues. Of these issues, 8 are the result of IOA identifying additional Potential Critical Items. One PCI concerns the generation of independent FMEA/CILs for like critical hardware as recommended by NSTS 22206. A second PCI is the result of an IOA recommended criticality upgrade. The remainder of the 8 PCIs concern hardware or failure modes excluded by the NASA analysis. IOA also recommends the deletion of one NASA CIL.

Table II presents a summary of firm CIL assessment issues that exist for each component.

TABLE II Summary of IOA CIL Assessment Issues			
Component	NASA	IOA	IOA Issues
Rudder Pedal Assembly	5	5	-
NWS Control Box	4	5	1
NWS Actuator Assembly	20	25	7
NWS/EPD&C: Failure Annunciator System	-	-	-
Activation System	5	6	1
TOTAL	34	41	9

Appendix C presents the detailed assessment worksheets for each failure mode identified and assessed. Appendix D highlights the NASA Critical Items and corresponding IOA worksheet ID. Appendix E contains the IOA analysis worksheets that were used to assess the NASA FMEA/CIL. Appendix F provides a cross reference between the NASA FMEA and corresponding IOA worksheet.

Table III presents a summary of the IOA failure criticalities for the Post 51-L FMEA baseline. Further discussion of each of these subdivisions and the applicable failure modes is provided in subsequent paragraphs.

TABLE III Summary of IOA Failure Modes and Criticalities							
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Rudder Pedal Assembly	3	2	-	2	-	-	7
NWS Control Box	-	4	-	1	-	1	6
NWS Actuator Assembly	5	17	-	6	-	5	33
NWS/EPD&C: Failure Annunciator System	-	-	-	-	-	5	5
Activation System	1	4	-	7	-	5	17
TOTAL	9	27	-	16	-	16	68

Of the failure modes analyzed, 41 were determined to be critical items. A summary of the IOA critical items is presented in Table IV.

TABLE IV Summary of IOA Critical Items						
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Rudder Pedal Assembly	3	2	-	-	-	5
NWS Control Box	-	4	-	1	-	5
NWS Actuator Assembly	5	17	-	3	-	25
NWS/EPD&C: Failure Annunciator System	-	-	-	-	-	-
Activation System	1	4	-	1	-	6
TOTAL	9	27	-	5	-	41

The scheme for assigning IOA assessment (Appendix C) and analysis (Appendix E) worksheet numbers is shown in Table V.

TABLE V: IOA Worksheet Numbers	
Component	IOA ID Number
RUDDER PEDAL ASSEMBLIES (RPA)	NWS-101 to NWS-108
NWS CONTROL BOX (SCB)	NWS-201 to NWS-206
NWS ACTUATOR ASSEMBLY	NWS-301 to NWS-337
NWS FAILURE ANNUNCIATION SYSTEM	NWS-401 to NWS-405
NWS ACTIVATION SYSTEM	NWS-501 to NWS-510, NWS-001 to NWS-005

4.1 Assessment Results: RUDDER PEDAL ASSEMBLY

The Rudder Pedal Assembly (RPA) analysis performed by IOA examined failure modes for the rudder pedals, the Rudder Pedal Transducer Assemblies (RPTAs), and the command transducer. The RPA is a linkage system whose transducer measured deflections control the rudder and the brakes as well as NWS. The IOA NWS analysis included component failure modes covered by NASA FMEAs from the NWS, the Landing Deceleration, and the Guidance Navigation and Control subsystems. During the assessment comparison process, IOA matched the NWS worksheets to the appropriate subsystem FMEAs but limited the assessment discussion to the failure effects on the Orbiter vehicle's directional control during landing rollout.

IOA generated 8 failure worksheets for the RPA - 2 on the rudder pedal linkage, 2 on the command transducer and 4 on the Rudder Pedal Transducer Assemblies (RPTAs). NASA originally wrote 6 FMEAs for the RPA, generating only 2 failure modes for the RPTAs. During their reevaluation, NASA generated an additional FMEA for the RPTAs. This new failure mode, the 'physical jamming' of the RPTA transducer drive or an RPTA 'linkage failure' (FMEA # 05-1-FC-3442-3), was mapped to the following IOA failure modes:

1) Loss of RPTA output, and
2) Erroneous output of the RPTA

4.2 Assessment Results: STEERING CONTROL BOX

Detailed schematics of the Steering Control Box (SCB) are considered proprietary information by the manufacturer and were not available for the IOA analysis. As a result, the IOA analysis treated the SCB as a black box. The NASA FMEAs took into consideration the failure of 2 of the SCB functions:

1) SCB Failure Detection (FMEA # 02-1-089-1, -2), and
2) SCB Signal Output (FMEA # 02-1-088-1,-2)

The IOA analysis considered the failure of three functions of the SCB:

1) SCB Failure Detection,
2) SCB Steering Control Signal Output, and
3) SCB Pilot Solenoid Activation Signal

The IOA analysis analyzed the failure detection function of the SCB, but treated separately the functions of the two SCB output signals. This produced two more IOA worksheets than the corresponding FMEAs. IOA recommended the writing of 2 additional FMEAs to cover these failure modes because the failure of either SCB output signal is a possible critical item.

4.3 Assessment Results: STEERING ACTUATOR ASSEMBLY

The Steering Actuator Assembly, which contains both electronic and hydraulic hardware, has the largest number of components in the NWS subsystem. The IOA generated 37 analysis worksheets for 16 components in the NWS Actuator Assembly. The comparison between the IOA analysis and the NASA FMEAs resulted in a number of issues that are discussed in the following sections.

4.3.1 NWS Actuator: SHIMMY DAMPING

The issue that affects more of the NWS actuator component criticalities concerns the loss of the nose wheel hydraulic shimmy damping capability. IOA believes that the worst case effect of the loss of the NWS hydraulic shimmy damping is not reflected by the original NASA FMEA criticalities or their effects descriptions. The NASA reevaluation process has brought into consideration the possible worst case effects of the loss of the shimmy damping; however, these new FMEAs are still in review. As a result, IOA has decided not to remove the following discussion presenting its concerns on the shimmy damping issue.

The effects descriptions of the original affected NASA FMEAs reference the co-rotating nose wheels as a stabilizing factor that prevents nose wheel shimmy. IOA believes the presently available test data is not adequate to decisively determine whether the co-rotating nose wheels actually can, without the aid of active hydraulic damping, successfully prevent nose wheel shimmy under all normal loading conditions during landing rollout. IOA is unaware of any shimmy damping tests of the Orbiter nose wheel performed when NWS was in an unpowered state and the actuator hydraulic damping was inactive. Because nose wheel shimmy can lead to nose gear structural damage and the possible loss of the crew/vehicle, IOA assigned all the corresponding NWS actuator components higher criticalities than the original NASA FMEAs.

IOA is concerned about two different failure states of the NWS actuator when the Orbiter is in a free castor mode. The first is a failure resulting in the total loss of the shimmy damping capability of the NWS actuator. The second is a failure that results in a degraded state of shimmy damping in the actuator. A total loss of shimmy damping can occur in two ways:

1) a total loss of the hydraulic fluid from the portion of the actuator that is isolated for shimmy damping during free castor, or

2) a loss of the linkage connecting the NWS actuator to the nose gear strut.

A degraded state of shimmy damping can be the result of cavitation or a partial loss of hydraulic fluid from the isolated portion of the NWS actuator during free castor.

IOA recommended an upgrade in the assigned criticalities for the components affected by the shimmy damping issue until the worst case effects of the loss of shimmy damping are determined. Toward this end, IOA recommends that NASA analyze the operation of the NWS system without hydraulic damping. This might be done using already existing analytical models of the NWS system. If these studies warrant, NASA could then perform dynamic tests of the NWS system without the hydraulic damping. Afterwards, the actuator component criticalities could be adjusted to reflect the results of the analysis/testing.

The FMEAs that are possibly affected by this issue are listed below:

FMEA #	Item	Failure Mode	MDAC ID
02-1-094-2	Accumulator	Open	301
02-1-090-1	Hydraulic Housing	Leakage/Rupture	307
02-1-084-1	Actuator/Piston	Broken Linkage	309
None	Rigid Line/Connectors	Leakage	312
02-1-091-2	Anticav Chk Valve	Closed	323
02-1-101-2	EH Prot Chk Valve	Open	326
02-1-100-2	Bypass Valve	Premature Relief	334

4.3.2 NWS Actuator: PILOT VALVES AND SHUTOFF VALVE

There are 2 issues concerning the actuator pilot valves. The first deals with the separation of FMEAs and the second with an inconsistency in criticality assignment between the pilot valves and the shutoff valve. These issues are discussed in the following 2 sections.

4.3.2a Pilot Valves: SEPARATE FMEA/CILs

IOA recommends writing separate FMEAs on the 2 actuator pilot valves for the following reasons:

1. The Pilot Valve #1 functions to activate/deactivate the actuator shutoff valve; the Pilot Valve #2 functions to activate/deactivate the actuator bypass/relief valves. NSTS 22206 section 2.3.1f states the following:

   "Identical components used for different functions shall be treated separately in the FMEA."

2. The failing closed of either of the pilot valves results in the loss of NWS (Criticality 1R/2). A separate FMEA/ CIL is required for each critical item/failure mode.

4.3.2b Pilot Valve #1 / Shutoff Valve: INCONSISTENCY OF CRITICALITY

The Pilot Valve #1 is activated in order to open the actuator shutoff valve. If the pilot valve fails open, the shutoff valve will open and the actuator will be prematurely subjected to hydraulic pressure. This result is identical to the effect of failing the shutoff valve open. The NASA FMEAs, however, assign different criticalities to these 2 failure modes:

FMEA #	Item	Failure	Criticality Func/Hdw
02-01-096-2	Shutoff Valve	Open	1R / 3
02-01-095-2	Pilot Valve	Open	3 / 3

The IOA analysis assigned criticalities of 3/3 to both of these failure modes. The IOA analysis did not determine that the premature subjection of the actuator to hydraulic pressure was in any way life or vehicle threatening. IOA recommends the downgrading of the shutoff criticality to 3/3 unless this failure is shown to be life/vehicle threatening. In either case, IOA is of the opinion that these 2 failure item/modes should be assigned identical criticalities.

4.3.3 NWS Actuator: E-H PROTECTION CHECK VALVE

The Electro-Hydraulic protection check valve allows hydraulic fluid exiting the NWS actuator piston balance area to return to Hydraulic System 1 while preventing any flow of hydraulic fluid in the reverse direction. If the E-H check valve fails open, the first stage of the E-H servo valve will be subject to back pressure from the hydraulic return line. A pressure spike in the return line at this time will subject the sensitive first stage filament to damage that could result in the possible loss of the NWS system.

Ordinarily, there is no reason to expect any high pressure in the return line; however, IOA discovered that nose gear retraction or deploy may actually produce a high pressure spike in this line. Because the ramifications of this failure scenario were not available to IOA during this assessment, IOA recommends that NASA determine the worst case affects of this failure on both the active modes of NWS and the shimmy damping capability of the Orbiter in the free castor mode. The criticality can then be updated accordingly. The affected FMEA is listed below:

FMEA #	Item	Failure Mode
02-01-101-2	E-H Protection Check Valve	Open

4.3.4 NWS Actuator: ANTI-CAVITATION CHECK VALVES

The anti-cavitation check valves are free floating ball valves that function to prevent cavitation in the NWS actuator during free castor of the nose wheel. During normal operation of NWS, high pressure hydraulic fluid closes the valves anti-cavitation check valves preventing the fluid from entering the return line prematurely.

If the check valves fail open, there will be a resulting degradation in NWS response that will lead to the possible downmoding of NWS to free castor. If the valves fail closed, there is no effect on NWS because closed is the normal position of the valves during NWS operation.

The NASA FMEA effects section for the check valves failing closed (FMEA #02-1D-091-1), states the following:

(B) LOSS OF NOSE WHEEL STEERING (LOSS OF TORQUE)

The FMEA assigns a criticality of 1/1 to this failure mode. IOA does not concur with the FMEA effects and recommends that this failure mode criticality be downgraded to 2/1R (based on degraded shimmy damping during free castor) unless the FMEA effects are proven accurate.

4.3.5 NWS Actuator: OVERLOAD CHECK VALVES

The overload check valves are free floating ball valves that relieve excessive pressure buildup on the operational side (actuator piston side) of the actuator assembly. Each of the two valves protects a separate hydraulic line. The valves failing closed will have no immediate effect on NWS or the Orbiter. However, considering a worst case landing scenario where the nose wheel hits a rut or rock, a pressure spike will surge unrelieved into the NWS actuator. This will cause possible damage to the sensitive first stage of the E-H valve resulting in the loss of NWS. The affected FMEA is listed below:

FMEA #	ITEM	FAILURE
02-1-106-1	Overload Check Valve (2)	Closed

IOA recommends upgrading this failure criticality to 2/1R unless it can be shown conclusively that this failure mode is not credible.

4.3.6 NWS Actuator: MISSING ITEMS / FAILURE MODES

The IOA analysis of the NWS hydraulic actuator produced analysis worksheets on items and failure modes that had no corresponding NASA FMEAs. The following sections describe these items and their failure modes.

4.3.6a NWS Actuator: PISTON

The NWS actuator piston is the actual turning mechanism for the NWS system. One end of the piston is contained inside the NWS actuator balance area while the other end is mechanically linked to the nose wheel steering column. Hydraulic pressure in the actuator piston balance area moves the piston back and forth. This translational motion of the piston linkage rotates the nose gear steering column which turns the nose wheel.

The IOA analysis failed the actuator piston in a "jammed" mode. There is no corresponding NASA FMEA for this failure mode. The manufacturer of the NWS actuator stated that the probability of the actuator piston jamming is very small; however, IOA still recommends the generation of a FMEA/CIL for this item/failure mode for the following reasons:

1. The linkage portion of the piston is exposed to external debris/contamination after nose gear deploy and throughout landing rollout.

2. A jammed piston will result in the possible loss of crew/vehicle (Criticality 1/1).

3. NSTS 22206 section 2.3.1a states the following:

   "An FMEA shall be prepared on all hardware... regardless of the probability of occurrence for each failure mode."

4.3.6b NWS Actuator: EXTERNAL RIGID LINE

The NWS actuator has an external rigid line connecting the retraction side of the actuator piston to the actuator main housing. IOA believes this to be a hydraulic line and that a leak in this line would result in the loss of NWS and the possible loss of all the hydraulic shimmy damping capability of the NWS system.

There are no NASA FMEAs written for this rigid line. NSTS 22206 Section 2.3.1a states the following:

> "NOTE: The following shall not be considered as 'structure'; therefore, an FMEA is required.
>
> 1. Pressure vessels, ... fluid lines, rigid pipes ... Rigid lines and ducts shall be analyzed separately for each different fluid."

IOA recommends that FMEA/CILs be generated for this item and its failure modes.

4.3.6c NWS Actuator: INLET FILTER

The hydraulic fluid that enters the NWS actuator passes through an inlet filter before it reaches the actuator shutoff valve. The NWS system could be lost as a result of this filter becoming blocked or failing to filter contaminants from the hydraulic fluid. During testing, this filter exceeded its specified operational limit which resulted in unacceptable sluggish response from the NWS system. IOA recommends that FMEA/CILs be generated for this item and its failure modes.

4.4 Assessment Results: NWS/EPD&C FAILURE ANNUNCIATION SYSTEM

The NWS EPD&C Failure Annunciation Subsytem is composed of the NWS fail light, an annunciator control assembly, and a type III hybrid driver. An issue that affected the criticality of more than one component failure mode concerns the effect of a premature annunciation of the NWS fail light. Because IOA is not aware of any crew procedures written that define a required crew response to the annunciation of the NWS fail light and informal discussions with crew members showed an inclination to manually shut off NWS in response to the illumination of the fail light, IOA assigned criticalities based on the following groundrule:

> "Any annunciation of the NWS fail light will result in the manual downmoding of NWS to the free castor mode leaving differential braking as the only means for steering the vehicle during landing rollout."

This groundrule resulted in minimum criticalities of 2/1R for all failure modes resulting in the annunciation of the NWS fail light. This result produced differences between IOA and FMEA assigned criticalities for failure modes resulting in the illumination of the NWS fail light without an actual failure of the NWS operating system.

The FMEAs affected by this issue are listed below:

FMEA #	Item	Failure Mode
02-01-093-2	Pressure Switch	Open
05-03-12376-TBD	Annunciator Control Assy.	Premature Output
05-6BC-2200-2	Forward Load Cntl Assy.	Premature Output

IOA originally recommended upgrading the criticalities of these items until such time that crew procedures were signed off that would support downgrading the criticalities. IOA has been assured that the crew will be trained NOT to manually downmode the NWS system in response to the annunciation of the NWS fail light. Based upon this assertion, IOA does not consider this a firm issue; however, NSTS 22206 does require that official crew procedures be defined to support the downgrading of any component criticalities.

4.5 Assessment Results: NWS/EPD&C ACTIVATION SYSTEM

The IOA analysis of the NWS/EPD&C Activation System included FMEAs covered by both the EPD&C subsystem and the GNC subsystem. The analysis included the NWS toggle switch, the CSS/AUTO PBIs, a circuit breaker, and some resistors.

The IOA analysis of the ROLL/YAW CSS and AUTO Push Button Indicators (PBIs) gave rise to a number of issues. The PBIs, their function, and the associated issues are discussed in the following paragraphs.

Because the ROLL/YAW CSS and AUTO PBIs are the only PBIs that affect the NWS System, they were the only PBIs considered in the NWS analysis.* These PBIs configure the Orbiter flight control channel to either manual (CSS) control or Auto Guidance (AUTO/AUTOLAND) control.

The flight control channel is normally configured to AUTO during the early phase of entry but has always been reconfigured to CSS for approach and landing. An autolanding has never been performed by the Orbiter. If an autolanding were to be attempted, Microwave Landing System (MLS) navigation must be available at the landing site because the typical Tactical Air Command and Navigation System (TACAN) navigation position errors are too large to land the Orbiter safely. An MLS is presently only required for night landings and 4 out of the last 7 flights landed without an MLS.

* A complete analysis of the PBIs is located in the IOA GN&C analysis deliverables.

The NASA FMEAs failed these PBIs in 2 modes:

1) Internal Short
2) Fails to Transfer

The IOA recommends failing the PBIs in 3 modes:

1) Internal Shorts
2) Failure to Transfer
3) Stuck Depressed/Jammed

The NASA FMEAs assign criticalities of 3/3 to all the PBI failure modes. IOA believes the loss of all the redundant capability to configure/reconfigure flight control of the Orbiter can be life/vehicle threatening and recommend criticalities of 3/1R for all these failure modes.

In addition, IOA believes the failure of the ROLL/YAW AUTO PBI in a stuck depressed mode should be assigned a criticality of 1/1 based on the following reasons:

1) There are 2 ways to reconfigure flight control from AUTO to CSS:

   a) Pressing 1 of the CSS PBIs
   b) Moving the RHC out of detent (greater than 6°)

   However, a stuck AUTO PBI will automatically reconfigure flight control software to AUTO as soon as the CSS PBI is released or the RHC returns to neutral.

2) The Orbiter cannot land safely in AUTO mode without as MLS and there is no guarantee that an MLS will be available except for night landings.

3) The Orbiter cannot land with the RHC continuously out of detent.

4) The crew can continuously hold a CSS PBI depressed and land successfully. However, this is not an official crew procedure and only official crew procedures may be used to downgrade an item criticality.

This issue was brought before the Shuttle Avionics Software Control Board in the form of a possible software fix (CR #89356A). However, the decision was delayed until the possible effects of this failure mode on all similar DAP switches are determined.

4.6 Ground Speed Enable: SRB AND ET SEPARATION SWITCHES

The NWS system cannot be activated before the SCB receives the ground speed enable command that originates in the Landing SOP. This enable command is sent as a result of the Landing SOP receiving a Weight on Wheels (WOW) signal, a Weight on Nose Gear (WONG) signal, and a signal confirming that the angle of attack of the Orbiter vehicle is less than 0 degrees.

The WOW and WONG signals originate in the landing gear proximity sensor boxes; however, these signals can be superseded by the crew. This is accomplished by actuating the ET separation or the SRB separation switch. The actuation of either switch will generate an initiate discrete satisfying both the WOW and the WONG requirements necessary for the Landing SOP to send the ground speed enable command. (Note that the Orbiter angle of attack signal is still required).

IOA is concerned that the FMEAs generated for the SRB and ET separation switches do not mention this aspect of the switches' function and its effect on the NWS system. IOA recommends that the affected FMEAs (FMEA #05-6-2235 through FMEA #05-6-2239) be updated accordingly.

5.0 REFERENCES

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

1. JSC-11174, Space Shuttle Systems Handbook, Rev C-6, 3 NWS, 10-26-85.

2. DF NO1# DF4/86-14, Nose Wheel Steering Interim Upgrade, 2-24-86.

3. VS70-510219, Rockwell-Schematic Diagram - Nose Wheel Steering Subsystem, 8-6-85.

4. SK54400, Sterer-Schematic-S&D Subsystem Space Shuttle Electric, Rev F, 12-13-75.

5. 54400, Sterer-Steering and Damping Subsystem, Nose Wheel, Rev L, 7-31-80.

6. TD-159-A131, JSC Training Manual - Landing Deceleration 2102, 2-22-83.

7. JSC-12770, Shuttle Flight Operations Manual, Volume 10D - Landing/Deceleration, Revised 7-19-82.

8. KMO-983-62, Sterer-Shuttle Nose Wheel Steering and Damping Subsystem-Rockwell Specification, 9-6-83.

9. V51 File III, Operations and Maintenance Requirements and Specification Document-Landing Gear Subsystem, 5-29-86.

10. MC621-0058, Rockwell Specification - Steering and Damping Subsystem - Nose Landing Gear, Rev B, 11-21-75.

11. JSC-18341, Subsystem Brief - Landing Deceleration, Mech Vol II, Rev A, 2-28-85.

12. NSTS 22206, Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL), 10-10-86.

13. JSC-12820, STS Operational Flight Rules, PCN-1, 2-14-86.

14. STS 83-0007A, Space Shuttle Operational Level C FSSR GN&C Part C - Flight Control Entry- GRTLS, 6-30-85.

15. STS 83-0010A, Space Shuttle Operational Level C FSSR GN&C Part D Redundancy Management, 6-30-85.

16. STS 83-0015A, Space Shuttle Operational Level C FSSR GN&C Part E Subsystem Operating Programs Flight Control Sensor/ Controller, 6-30-85.

APPENDIX A
ACRONYMS

AOA - Abort Once Around
ATO - Abort To Orbit
AUTO - Autoland Guidance Computer Configuration
BFS - Backup Flight System
BITE - Built-In Test Equipment
CHNL - Channel
CIL - Critical Items List
CMD - Command, Commander
CNTL - Control
CRIT - Criticality
CSS - Control Stick Steering
DDU - Display Driver Unit
DPS - Data Processing System
EH - Electro-Hydraulic
ERR - Error
ENA - Enable
EPD&C - Electrical Power Distribution and Control
ET - External Tank
F - Functional
FB - Feedback
FF - Flight Forward
FM - Failure Mode
FMEA - Failure Mode and Effects Analysis
GNC - Guidance Navigation and Control
GPC - General Purpose Computer
HDW - Hardware
HW - Hardware
HYD - Hydraulic
IOA - Independent Orbiter Assessment
LRU - Line Replaceable Unit
MAN - Manual (Direct Mode of NWS)
MDAC - McDonnell Douglas Astronautics Company
MDM - Multiplexer/Demultiplexer
MGTD - Main Gear Touchdown
MM - Major Mode
MSBLS - Microwave Scanning Beam Landing System
NA - Not Applicable
NASA - National Aeronautics and Space Administration
NGTD - Nose Gear Touchdown
NSTS - National Space Transportation System
NW - Nose Wheel
NWS - Nose Wheel Steering
OMRSD - Operational Maintenance Requirements and Specifications Document
PBI - Push Button Indicator
PCI - Potential Critical Item
PLT - Pilot
POS - Position

ACRONYMS

RI - Rockwell International
RM - Redundancy Management
RPA - Rudder Pedal Assembly
RPTA - Rudder Pedal Transducer Assembly
RTLS - Return To Launch Site
SCB - Steering Control Box
SM - Systems Management
SOP - Subsystem Operating Program
SPA - Steering Position Amplifier
SPT - Steering Position Transducer
SRB - Solid Rocket Booster
STS - Space Transportation System
SV - Servo Valve
TAL - Transoceanic Abort Landing
TD - Touch Down
WONG - Weight on Nose Gear
WOW - Weight on Wheels (main gear)
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.

B.3 NWS-Specific Ground Rules and Assumptions

1. The GPC (CSS) mode of NWS will be considered the primary mode of directional control for the Orbiter Vehicle following NGTD during landing rollout.

   RATIONALE: This is the flight rule since the Phase II upgrade of NWS which has flown on 61-A, 61-C and 51-L.

2. The GPC (CSS) mode of NWS will be active (HOT) for all landing sites and all landings: EOM and INTACT ABORTS.

   RATIONALE: This is the flight rule since the Phase II upgrade of NWS which has flown on 61-A, 61-C and 51-L.

3. The Flight Rules will restrict landing conditions (weather, landing surface, and crosswinds) such that the brake energy and rollout margins will fall within their assigned limits when differential braking is used as the primary mode of directional control following NGTD during landing rollout.

   RATIONALE: The NWS system is presently fail safe at best with several single point failure points. Differential braking must be a capable backup system to NWS for directional control of the vehicle during landing rollout until the Phase III upgrade of NWS is completed.

4. Differential braking will be considered an unlike, redundant backup system to NWS for directional control of the Orbiter Vehicle during landing rollout following NGTD.

   RATIONALE: Differential braking applies differential forces to the main gear tires in order to steer the Orbiter but NWS uses an actuator system to turn the nose wheel and steer the vehicle. Current flight rules restrict landings to those conditions that allow a safe rollout using differential braking for directional control.

5. The DIRECT (MANUAL) mode of NWS will be considered a like, redundant backup system to the GPC (CSS) mode of NWS for directional control of the Orbiter Vehicle following NGTD during landing rollout.

   RATIONALE: Both systems use MAIN BUS A power, the rudder pedals, the NWS Control Box, the NWS Actuator, and the nose wheel for directional control of the Orbiter Vehicle.

6. The GPC (AUTO) mode of NWS will not be considered a redundant system to the GPC (CSS) mode of NWS for directional control of the Orbiter Vehicle during landing rollout.

   RATIONALE: The GPC (AUTO) mode of NWS requires an active Microwave Scanning Beam Landing System (MSBLS) which is not available at all runways/landing sites. The crew does not train using this control mode.

7. The crew will respond to the annunciation of the NWS fail light by manually moving the NWS toggle switch to the OFF position.

   RATIONALE: MOD recommended crew procedures dictate that the NWS switch be toggled to OFF when the NWS fail light annunciates; however, the DIRECT mode of NWS may then be selected if conditions warrant the risk.

8. For purposes of determining the functional criticality of an item, the total loss of the NWS Actuator Assembly shimmy damping capability shall result in the possible loss of life/vehicle.

   RATIONALE: Although the co-rotating nose wheels have a stabilizing effect; sufficient test data is not available to determine that the total loss of the nose wheel shimmy damping capability is not life threatening.

9. For purposes of passing Redundancy Screen B, the term "Readily Detectable" shall be satisfied by the pilot's ability to see the lack of Orbiter response to NWS inputs during landing rollout.

   RATIONALE: One of the pilot's primary tasks during landing rollout has been to keep the Orbiter Vehicle on the runway centerline. A loss of NWS response during rollout is almost immediately recognizable by the pilot following a rudder pedal input. Corrective action in the form of differential braking is immediately available.

APPENDIX C
DETAILED ASSESSMENT

This section contains the IOA assessment worksheets generated during the assessment of this subsystem. The information on these worksheets facilitates the comparison of the NASA FMEA/CIL (Pre and Post 51-L) to the IOA detailed analysis worksheets included in Appendix E. Each of these worksheets identifies the NASA FMEA being assessed, corresponding MDAC Analysis Worksheet ID (Appendix E), hardware item, criticality, redundancy screens, and recommendations. For each failure mode, the highest assessed hardware and functional criticality is compared and discrepancies noted as "N" in the compare row under the column where the discrepancy occurred.

LEGEND FOR IOA ASSESSMENT 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 Screens A, B and C:

- P = Passed Screen
- F = Failed Screen
- NA = Not Applicable

NASA Data :

- Baseline = NASA FMEA/CIL
- New = Baseline with Proposed Post 51-L Changes

CIL Item :

- X = Included in CIL

Compare Row :

- N = Non compare for that column (deviation)

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/24/87
ASSESSMENT ID: NWS-001X
NASA FMEA #: 05-6BC-(01)

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 1
ITEM: DIODE (2) (OPEN CIRCUIT/SHORTS)

LEAD ANALYST: A. HOCHSTEIN

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /3]	[ ]	[ ]	[ ]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/24/87
ASSESSMENT ID: NWS-002X
NASA FMEA #: 05-6Q-2203-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 2
ITEM: SWITCH, FLIGHT CONTROLLER POWER TOGGLE (2) (FAILS OFF)

LEAD ANALYST: A. HOCHSTEIN

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[P]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/24/87
ASSESSMENT ID: NWS-003X
NASA FMEA #: 05-6Q-2203-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 3
ITEM: SWITCH FLIGHT CONTROLLER POWER TOGGLE (2) (FAILS ON)

LEAD ANALYST: A. HOCHSTEIN

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /3]	[ ]	[ ]	[ ]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/24/87
ASSESSMENT ID: NWS-004X
NASA FMEA #: 05-6BC-(02)

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 4
ITEM: RESISTOR, ISOLATION (HIGH RESISTANCE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[F]	[P]	[X] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[/]	[ ]	[N]	[ ]	[N]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NASA SEPARATED THE THREE ISOLATION RESISTORS. THE FAIL LIGHT AND GPC MODE RESISTORS WERE LEFT IN 2252-1 AND THE CRITICALITY LEFT AT 3/3. IOA AGREES WITH THE 3/3 FOR THESE TWO. (SEE IOA NWS-505).

B. NASA IS WRITING A NEW FMEA, 05-6BC-(02) FOR THE DIRECT MODE ISOLATION RESISTOR AND ASSIGNING IT A 3/1R CRITICALITY WITH SCREENS A, B, AND C: PASS, FAIL, PASS RESPECTIVELY. IOA AGREES WITH THE HIGHER CRITICALITY. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 2/22/88
ASSESSMENT ID: NWS-005X
NASA FMEA #: 05-6BC-2109-3

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 5
ITEM: SWITCH, NWS TOGGLE (3 POSITION)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[P]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-101
NASA FMEA #: 02-1-044-1

NASA DATA:
BASELINE [X]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 101
ITEM: PEDALS, RUDDER (JAMMED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[1 /1]	[P]	[P]	[P]	[X]
COMPARE	[/]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [X]

REMARKS:

A. CIL EFFECTS:

"(A,B)...IF YAW LOCKUP OCCURRED DURING NWS, IT COULD BE COMPENSATED FOR BY DIFFERENTIAL BRAKING, SINCE FAILURE WOULD OCCUR AT OR NEAR NEUTRAL."

B. THE WORST CASE FAILURE OF THE RUDDER PEDALS DOES NOT OCCUR AT THE NEUTRAL POSITION. LOCKUP AT A HARDOVER POSITION IS THE WORST CASE FAILURE AND SHOULD BE CONSIDERED SUCH AS DEFINED IN NSTS 22206.

C. IOA RECOMMENDS REVISING THE LAST SENTENCE UNDER EFFECTS TO READ: "IF YAW LOCKUP OCCURED DURING NOSE WHEEL STEERING, DIFFERENTIAL BRAKING MAY NOT BE CAPABLE OF COMPENSATING AND THE RESULT MAY BE THE LOSS OF CREW/VEHICLE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-102
NASA FMEA #: 05-1-FC3442-3

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 102
ITEM: PEDALS, RUDDER (LOSS OF LINKAGE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH NASA REEVALUATION OF RUDDER PEDALS-RPTA LINKAGE FAILURE. LOSS OF RUDDER CONTROL BETWEEN MGTD AND NGTD CAN RESULT IN THE POSSIBLE LOSS OF CREW/VEHICLE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-103
NASA FMEA #: 02-1-086-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 103
ITEM: TRANSDUCER, COMMAND (NO OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-104
NASA FMEA #: 02-1-086-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 104
ITEM: TRANSDUCER, COMMAND (ERRONEOUS OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/86
ASSESSMENT ID: NWS-105
NASA FMEA #: 05-1-FC-3442-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 105
ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA) (SINGLE CHANNEL NO OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[P]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-106
NASA FMEA #: 05-1-FC-3442-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 106
ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA) (SINGLE CHANNEL ERRONEOUS OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[P]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-107
NASA FMEA #: 05-1-FC3442-3

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 107
ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA) (LOSS OF RPTA OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH NASA REEVALUATION.

B. NWS 107, NWS 108 BOTH MAPPED TO FMEA 05-1-FC-3442-3.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-108
NASA FMEA #: 05-1-FC3442-3

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 108
ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA)
(ERRONEOUS OUTPUT OF RPTA)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH NASA REEVALUATION.

B. NWS 107, NWS 108 BOTH MAPPED TO FMEA 05-1-FC-3442-3.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-201
NASA FMEA #: 02-1-089-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 201
ITEM: BOX, NWS CONTROL - FAILURE DETECTION CIRCUITRY
(FAILS ON)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-202
NASA FMEA #: 02-1-089-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 202
ITEM: BOX, NWS CONTROL - FAILURE DETECTION CIRCUITRY
(FAILS OFF)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[F]	[F]	[P]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH FMEA.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-203
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 203
ITEM: BOX, STEERING CONTROL - PILOT VALVE CONTROL CIRCUIT (FAILS SHORT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[3 /3]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. THE NWS CONTROL BOX MANIPULATES 3 MAJOR NWS SIGNALS: 1) THE PILOT VALVE ACTIVATION SIGNAL (NWS ACTUATOR HYDRAULIC ACTIVATION), 2) NWS COMMAND SIGNAL, AND 3) THE NWS FAILURE DETECTION SIGNAL. NASA FMEAs ADDRESS THE NWS CONTROL BOX COMMAND SIGNAL FAILURES AND THE FAILURE DETECTION CIRCUIT FAILURES BUT NOT THE PILOT VALVE ACTIVATION SIGNAL FAILURES.
IOA ANALYSIS INCLUDED TWO FAILURE MODES ON THE PILOT VALVE ACTIVATION SIGNALS. NEITHER OF THESE FAILURES WOULD RAISE THE EXISTING CRITICALITY OF THE SCB [2/1R].

C. IOA RECOMMENDS THAT THIS FAILURE MODE BE ADDED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-204
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 204
ITEM: BOX, STEERING CONTROL - PILOT VALVE CONTROL CIRCUIT (FAILS TO PROVIDE A GROUND)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[2 /1R] [P] [P] [P] [A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. THE NWS CONTROL BOX MANIPULATES 3 MAJOR NWS SIGNALS: 1) THE PILOT VALVE ACTIVATION SIGNAL (NWS ACTUATOR HYDRAULIC ACTIVATION), 2) NWS COMMAND SIGNAL, AND 3) THE NWS FAILURE DETECTION SIGNAL. NASA FMEAs ADDRESS THE NWS CONTROL BOX COMMAND SIGNAL FAILURES AND THE FAILURE DETECTION CIRCUIT FAILURES BUT NOT THE PILOT VALVE ACTIVATION SIGNAL FAILURES.
IOA ANALYSIS INCLUDED TWO FAILURE MODES ON THE PILOT VALVE ACTIVATION SIGNALS. NEITHER OF THESE FAILURES WOULD RAISE THE EXISTING CRITICALITY OF THE SCB [2/1R].

C. IOA RECOMMENDS THAT THIS FAILURE MODE BE ADDED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-205
NASA FMEA #: 02-1-088-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 205
ITEM: BOX, STEERING CONTROL - STEERING SIGNAL OUTPUT (LOSS OF OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-206
NASA FMEA #: 02-1-088-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 206
ITEM: BOX, STEERING CONTROL - STEERING SIGNAL OUTPUT (ERRONEOUS OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-301
NASA FMEA #: 02-1-094-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 301
ITEM: ACCUMULATOR/COMPENSATOR (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[F]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[F]	[P]	[X]
COMPARE	[/]	[N]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN A ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-302
NASA FMEA #: 02-1-094-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 302
ITEM: ACCUMULATOR/COMPENSATOR (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-303
NASA FMEA #: 02-1-SPA-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 303
ITEM: AMPLIFIER, STEERING POSITION (SPA) (ERRONEOUS OUTPUT ON ONE CHANNEL)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[P]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH FMEA.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-304
NASA FMEA #: 02-1-SPA-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 304
ITEM: AMPLIFIER, STEERING POSITION (SPA) (LOSS OF OUTPUT ON ONE CHANNEL)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[P]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA).					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH FMEA.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-305
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 305
ITEM: AMPLIFIER, STEERING POSITION (SPA) (ERRONEOUS OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. ERRONEOUS OUTPUT OF THE WHOLE SPA MAY BE NON-CREDIBLE. THE SEPARATE CHANNELS ARE INDIVIDUALLY ENCASED IN PLASTIC PREVENTING CHANNEL TO CHANNEL SHORTS. A JAMMED STREERING POSITION TRANSDUCER DRIVE MAY RESULT IN ERRONEOUS/LOSS OUTPUT OF THE SPA BUT SHOULD BE ADDRESSED AS A FAILURE OF THE SPT.

C. IOA RECOMMENDS NO UPDATE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-306
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 306
ITEM: AMPLIFIER, STEERING POSITION (SPA) (LOSS OF OR PARTIAL OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. ERRONEOUS OUTPUT OF THE WHOLE SPA MAY BE NON-CREDIBLE. THE SEPARATE CHANNELS ARE INDIVIDUALLY ENCASED IN PLASTIC PREVENTING CHANNEL TO CHANNEL SHORTS. A JAMMED STREERING POSITION TRANSDUCER DRIVE MAY RESULT IN ERRONEOUS/LOSS OUTPUT OF THE SPA BUT SHOULD BE ADDRESSED AS A FAILURE OF THE SPT.

C. IOA RECOMMENDS NO UPDATE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-307
NASA FMEA #: 02-1-090-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 307
ITEM: ASSEMBLY, ACTUATOR - HYDRAULIC HOUSING (RUPTURE/LEAKAGE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[1 /1]	[P]	[P]	[P]	[X]
COMPARE	[/]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-308
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 308
ITEM: PISTON, ACTUATOR ARM (JAMMED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[1 /1]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[1 /1]	[ ]	[ ]	[ ]	[A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. A JAMMED ACTUATOR ARM CAN OCCUR AS THE RESULT OF DEBRIS EXTERNAL TO THE ORBITER BECOMING LODGED BETWEEN THE PISTON AND THE NOSE WHEEL STEERING COLUMN.

C. A JAMMED ACTUATOR ARM WILL RESULT IN THE ORBITER POSSIBLY LEAVING THE RUNWAY AND THE POSSIBLE LOSS OF CREW/VEHICLE.

D. IOA RECOMMENDS A FMEA BE WRITTEN FOR THIS ITEM REGARDLESS OF THE PROBABILITY OF OCCURENCE DUE TO THE SERIOUSNESS OF THE FAILURE MODE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-309
NASA FMEA #: 02-1-084-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 309
ITEM: PISTON, ACTUATOR ARM (BROKEN LINKAGE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[1 /1]	[P]	[P]	[P]	[X]
COMPARE	[/]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-310
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 310
ITEM: FILTER, INLET (SHUTOFF VALVE) (FAILS TO FILTER)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[F]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[2 /1R]	[P]	[P]	[P]	[A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. FAILURE TO FILTER WILL RESULT IN THE CONTAMINATION OF THE NWS ACTUATOR VALVE AND THE LOSS OF NWS.

C. A FAILURE REPORT (FPR A4640-01) HAS ALREADY BEEN WRITTEN FOR THIS FAILURE MODE.

D. IOA RECOMMENDS NASA WRITE A FMEA FOR THIS FAILURE MODE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-311
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 311
ITEM: FILTER, INLET (SHUTOFF VALVE) (BLOCKED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[2 /1R] [P] [P] [P] [A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. CONTAMINATION OF THE FILTER WILL RESTRICT THE HYDRAULIC FLOW TO THE ACTUATOR RESULTING IN THE LOSS OF NWS.

C. A FAILURE REPORT (FPR A4640-01) FOR THE FILTER DISCUSSES THE FAILURE OF THE ACTUATOR TO MEET THE STEERING RATE REQUIREMENT AS A RESULT OF CONTAMINATION TO THE FILTER.

D. IOA RECOMMENDS NASA WRITE A FMEA FOR THIS FAILURE MODE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-312
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 312
ITEM: HYDRAULIC SYSTEM - CONNECTORS, HOSE ASSEMBLY (RUPTURE/LEAKAGE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[1 /1]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[1 /1]	[ ]	[ ]	[ ]	[A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. THERE IS A NON-FLEXIBLE HYDRAULIC LINE LEADING FROM THE RETRACTION SIDE OF THE ACTUATOR PISTON TO THE ACTUATOR MAIN HOUSING. LEAKAGE FROM THIS LINE OR ITS CONNECTORS COULD CAUSE THE TOTAL LOSS OF NWS AND THE SHIMMY DAMPING CAPABILITY OF THE ACTUATOR. THE SUBSEQUENT SHIMMY OF THE NOSE WHEEL WOULD RESULT IN THE POSSIBLE FAILURE OF THE NOSE GEAR AND LOSS OF THE VEHICLE. NO TEST DATA ON THE EFFECTS OF SHIMMY WITH NO HYDRAULIC DAMPING IS AVAILABLE. THE FACT THAT THE COROTATING NOSE WHEELS HAVE SOME STABILIZING EFFECT IS NOT ENOUGH TO DISMISS THE SHIMMY ISSUE.

C. IOA RECOMMENDS THAT NASA WRITE A FMEA FOR THIS FAILURE MODE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-313
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 313
ITEM: HYDRAULIC SYSTEM - CONNECTORS, HOSE ASSEMBLY (FAILS CLOSED-BLOCKED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NO FMEA WRITTEN.

B. HIGHLY PRESSURIZED HYDRAULIC LINES FAILING BLOCKED MAY BE CONSIDERED A NON-CREDIBLE FAILURE MODE.

C. IOA RECOMMENDS NO UPDATE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-314
NASA FMEA #: 02-1-093-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 314
ITEM: SWITCH, PRESSURE (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [X]

REMARKS:
A. NWS SUBSYSTEM GROUND RULE #7: "THE CREW WILL MANUALLY RESPOND TO THE ANNUNCIATION OF THE NWS FAIL LIGHT BY MANUALLY MOVING THE NWS TOGGLE SWITCH TO THE OFF POSITION".

B. IOA EFFECTS: WORST CASE, LOSS OF CREW/VEHICLE WITH 2 FAILURES, 1) LOSS OF NWS CAPABILITY (FAIL LIGHT ON RESULTING IN DOWNMODING TO FREE CASTOR, SEE NWS GROUNDRULE NO. 7), 2) LOSS OF DIFFERENTIAL BRAKING CAPABILITY. CRITICALITY IS DEPENDENT UPON PROCEDURES FOR NWS FAIL LIGHT 'ON'.

C. CREW IS BEING TRAINED NOT TO MANUALLY DOWNMODE NWS IN RESPONSE TO THE ANNUNICATION OF THE NWS FAIL LIGHT. AS A RESULT, IOA WILL REMOVE ITS RECOMMENDATION FOR A CRITICALITY UPGRADE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-315
NASA FMEA #: 02-1-093-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 315
ITEM: SWITCH, PRESSURE (CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-316
NASA FMEA #: 02-1-087-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 316
ITEM: TRANSDUCER, FEEDBACK (NO OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-317
NASA FMEA #: 02-1-087-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 317
ITEM: TRANSDUCER, FEEDBACK (ERRONEOUS OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-318
NASA FMEA #: 02-1-SPT-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 318
ITEM: TRANSDUCER, STEERING POSITION (SPT) (SINGLE CHANNEL NO OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[F]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[N]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH FMEA.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-319
NASA FMEA #: 02-1-SPT-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 319
ITEM: TRANSDUCER, STEERING POSITION (SPT) (SINGLE CHANNEL ERRONEOUS OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[F]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA CONCURS WITH FMEA.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-320
NASA FMEA #: 02-1-SPT-3

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 320
ITEM: TRANSDUCER, STEERING POSITION (SPT) (LOSS OF SPT OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[P]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. BOTH NWS-320 AND NWS-321 MAPPED TO FMEA #02-1-SPT-3.

B. IOA RECOMMENDS NO UPDATE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-321
NASA FMEA #: 02-1-SPT-3

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 321
ITEM: TRANSDUCER, STEERING POSITION (SPT) (ERRONEOUS OUTPUT OF THE SPT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[P]	[P]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. BOTH NWS-320 AND NWS-321 MAPPED TO FMEA #02-1-SPT-3.

B. IOA RECOMMENDS NO UPDATE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-322
NASA FMEA #: 02-1-091-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 322
ITEM: VALVE, ANTI-CAVITATION CHECK (FAILS OPEN/LEAKAGE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-323
NASA FMEA #: 02-1-091-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 323
ITEM: VALVE, ANTI-CAVITATION CHECK (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[1 /1]	[NA]	[NA]	[NA]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[N /N]	[ ]	[ ]	[ ]	[N]

RECOMMENDATIONS: (If different from NASA)

[3 /1R]	[F]	[F]	[P]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [X]

REMARKS:
A. CIL EFFECTS: "(B) LOSS OF NWS (LOSS OF TORQUE)...."

B. FAILING THE CHECK VALVES CLOSED DOES NOT RESULT IN THE LOSS OF NWS TORQUE.

C. IOA RECOMMENDS A CRITICALITY OF 3/1R. FAILURE OF BOTH ANTI-CAVITATION CHECK VALVES IS NOT LIFE/VEHICLE THREATENING. BUT THE FAILURE OF BOTH VALVES AND THEN A NWS FAILURE THAT FORCES THE FREE CASTOR MODE COULD RESULT IN CAVITATION. THE IOA ANALYSIS ORIGINALLY DID NOT CONSIDER CAVITATION LIFE/VEHICLE THREATENING BUT A CONSERVATIVE APPROACH WOULD BE TO ASSIGN THE FAILURE MODE A 3/1R.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-324
NASA FMEA #: 02-1-092-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 324
ITEM: VALVE, E-H SERVO (FAILS TO RESPOND)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-325
NASA FMEA #: 02-1-092-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 325
ITEM: VALVE, E-H SERVO (ERRATIC RESPONSE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-326
NASA FMEA #: 02-1-101-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 326
ITEM: VALVE, E-H PROTECTION CHECK (RETURN LINE ISOLATION) (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[F]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[F]	[P]	[X]
COMPARE	[N /]	[N]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[2 /]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [X]

REMARKS:
A. IF THE VALVE FAILS OPEN JUST PRIOR TO LANDING GEAR (LG) RETRACTION, HIGH PRESSURE BUILDUP DURING RETRACTION COULD DAMAGE THE SERVO VALVE FIRST STAGE. MUCH LATER, DURING THE ACTUAL FLIGHT WHEN NWS IS ACTIVATED, THE DAMAGED E-H SERVO VALVE COULD RESULT IN A DOWNMODE TO FREE CASTOR. THE OPEN CHECK VALVE ALSO RESULTS IN THE DEGRADATION OF SHIMMY DAMPING PROTECTION.

B. IOA RECOMMENDS AN UPGRADE IN CRITICALITY TO 2/1R.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-327
NASA FMEA #: 02-1-101-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 327
ITEM: VALVE, E-H PROTECTION CHECK (RETURN LINE ISOLATION) (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-328
NASA FMEA #: 02-1-106-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 328
ITEM: VALVE, OVERLOAD CHECK (2 OF) (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [X]

REMARKS:
A. CIL EFFECTS: "(B)...CHECK VALVE FAILING OPEN AGAINST SYSTEM PRESSURE IS NOT CREDIBLE."

B. CONTAMINATION OF THE VALVE CAN PREVENT THE BALL IN THE VALVE FROM SEATING AND CAUSE LEAKAGE.

C. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

D. IOA RECOMMENDS REVISING THE EFFECTS/RATIONALE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-329
NASA FMEA #: 02-1-106-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 329
ITEM: VALVE, OVERLOAD CHECK (2 OF) (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[F]	[F]	[P]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[ ]	[N]

RECOMMENDATIONS: (If different from NASA)

[2 /1R]	[ ]	[ ]	[ ]	[A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. THE IOA EFFECTS ASSUME THE WORST CASE: A FAILED-CLOSED VALVE AND THEN THE NOSE WHEEL HITTING A RUT OR FOREIGN OBJECT CAUSING AN UNRELIEVED HIGH PRESSURE SPIKE THAT DAMAGES THE FIRST STAGE OF THE EH VALVE RESULTING IN THE LOSS OF NWS.

B. IOA RECOMMENDS AN UPGRADE IN CRITICALITY TO 2/1R.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-330
NASA FMEA #: 02-1-095-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 330
ITEM: VALVE, PILOT SOLENOID 1 (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)
ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NASA COMBINED PILOT SOLENOID VALVES 1 AND 2 FOR FAILURE MODE ANALYSIS. IOA AGREES WITH THE 3/3 CRITICALITIES FOR PILOT SOLENOID VALVES 1 AND 2 "FAIL OPEN".

B. IOA RECOMMENDS THE WRITING OF SEPARATE FMEA/CILs FOR THE TWO PILOT SOLENOID VALVES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-331
NASA FMEA #: 02-1-095-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 331
ITEM: VALVE, PILOT SOLENOID 1 (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. NASA COMBINED PILOT SOLENOID VALVES 1 AND 2 FOR FAILURE MODE ANALYSIS. IOA AGREES WITH THE 2/1R CRITICALITIES GIVEN EACH VALVE FOR THE "FAIL CLOSED" MODE.

B. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

C. IOA RECOMMENDS THE WRITING OF SEPARATE FMEA/CILs FOR THE TWO PILOT SOLENOID VALVES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-332
NASA FMEA #: 02-1-095-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 332
ITEM: VALVE, PILOT SOLENOID 2 (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NASA COMBINED PILOT SOLENOID VALVES 1 AND 2 FOR FAILURE MODE ANALYSIS. IOA AGREES WITH THE 3/3 CRITICALITIES FOR PILOT SOLENOID VALVES 1 AND 2 "FAIL OPEN".

B. IOA RECOMMENDS THE WRITING OF SEPARATE FMEA/CILs FOR THE TWO PILOT SOLENOID VALVES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-333
NASA FMEA #: 02-1-095-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 333
ITEM: VALVE, PILOT SOLENOID 2 (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. NASA COMBINED PILOT SOLENOID VALVES 1 AND 2 FOR FAILURE MODE ANALYSIS. IOA AGREES WITH THE 2/1R CRITICALITIES GIVEN EACH VALVE FOR THE "FAIL CLOSED" MODE.

B. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

C. IOA RECOMMENDS THE WRITING OF SEPARATE FMEA/CILs FOR THE TWO PILOT SOLENOID VALVES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-334
NASA FMEA #: 02-1-100-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 334
ITEM: VALVE, RELIEF/CONTROL/BYPASS (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[N]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA RECOMMENDS NO UPDATES.

B. IOA RECOMMENDS THIS FMEA/CIL BE RECONSIDERED UNDER THE SHIMMY DAMPING ISSUE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-335
NASA FMEA #: 02-1-100-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 335
ITEM: VALVE, RELIEF/CONTROL/BYPASS (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-336
NASA FMEA #: 02-1-096-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 336
ITEM: VALVE, SHUTOFF (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[F]	[F]	[P]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[3 /3]	[NA]	[NA]	[NA]	[D] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE EFFECTS OF 1) FAILING THE SHUTOFF VALVE 'OPEN' AND 2) FAILING PILOT VALVE #1 'OPEN' ARE IDENTICAL; HOWEVER, THE NASA FMEAS ASSIGN THE FAILURE MODES DIFFERENT CRITICALITIES.

B. IOA RECOMMENDS DOWNGRADING THIS ITEM'S CRITICALITY UNLESS THE FAILURE OF ALL LIKE/UNLIKE REDUNDANCY CAN BE SHOWN TO BE LIFE THREATENING.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-337
NASA FMEA #: 02-1-096-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 337
ITEM: VALVE, SHUTOFF (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[F]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
A. THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-401
NASA FMEA #: 05-6BC-2112-1 & 05-3-1234

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 401
ITEM: LIGHT, NWS FAIL (FAILS OFF)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-402
NASA FMEA #: 05-03-12376-TBD

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 402
ITEM: ASSEMBLY, ANNUNCIATOR CONTROL (PREMATURE ON)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NWS SUBSYSTEM GROUNDRULE #7: "THE CREW WILL MANUALLY RESPOND TO THE ANNUNCIATION OF THE NWS FAIL LIGHT BY MANUALLY MOVING THE NWS TOGGLE SWITCH TO THE OFF POSITION".

B. IOA EFFECTS: WORST CASE, LOSS OF CREW/VEHICLE WITH 2 FAILURES, 1) LOSS OF NWS CAPABILITY (FAIL LIGHT ON RESULTING IN DOWNMODING TO FREE CASTOR, SEE NWS GROUNDRULE NO. 7), 2) LOSS OF DIFFERENTIAL BRAKING CAPABILITY. CRITICALITY IS DEPENDENT UPON PROCEDURES FOR NWS FAIL LIGHT 'ON'.

C. CREW IS BEING TRAINED NOT MANUALLY DOWNMODE NWS IN RESPONSE TO THE ANNUNCIATION OF THE NWS FAIL LIGHT. AS A RESULT, IOA WILL REMOVE ITS RECOMMENDATION FOR A CRITICALITY UPGRADE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-403
NASA FMEA #: 05-3-012376-1

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 403
ITEM: ASSEMBLY, ANNUNCIATOR CONTROL (LOSS OF OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-404
NASA FMEA #: 05-6BC-2200-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 404
ITEM: ASSEMBLY, FORWARD LOAD CONTROL (TYPE III HYBRID DRIVER CONTROLLER) (PREMATURE OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NWS SUBSYSTEM GROUNDRULE #7: "THE CREW WILL MANUALLY RESPOND TO THE ANNUNCIATION OF THE NWS FAIL LIGHT BY MANUALLY MOVING THE NWS TOGGLE SWITCH TO THE OFF POSITION".

B. IOA EFFECTS: WORST CASE, LOSS OF CREW/VEHICLE WITH 2 FAILURES, 1) LOSS OF NWS CAPABILITY (FAIL LIGHT ON RESULTING IN DOWNMODING TO FREE CASTOR, SEE NWS GROUNDRULE NO. 7), 2) LOSS OF DIFFERENTIAL BRAKING CAPABILITY. CRITICALITY IS DEPENDENT UPON PROCEDURES FOR NWS FAIL LIGHT 'ON'.

C. CREW IS BEING TRAINED NOT TO MANUALLY DOWNMODE NWS IN RESPONSE TO THE ANNUNCIATION OF THE NWS FAIL LIGHT. AS A RESULT, IOA WILL REMOVE ITS RECOMMENDATION FOR A CRITICALITY UPGRADE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-405
NASA FMEA #: 05-6BC-2200-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 405
ITEM: ASSEMBLY, FORWARD LOAD CONTROL (TYPE III HYBRID DRIVER CONTROLLER) (LOSS OF OUTPUT)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-501
NASA FMEA #: 05-6BC-2245-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 501
ITEM: CIRCUIT BREAKER (CB 023) (FAILS OPEN)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[P]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-502
NASA FMEA #: 05-6BC-2245-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 502
ITEM: CIRCUIT BREAKER (CB 023) (FAILS CLOSED)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-503
NASA FMEA #: 05-1-FC7248-0001

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 503
ITEM: INDICATOR, PUSH BUTTON: ROLL/YAW (CSS/AUTO) (JAMMED IN AUTO)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[ ]	[ ]	[ ]	[ ] *
IOA	[1 /1]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[1 /1] [ ] [ ] [ ] [A] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
NASA'S REVISED "WORK AROUND" IS STILL CONSIDERED BY IOA AS OFF NOMINAL CREW PROCEDURES WHICH CANNOT BE USED TO DOWNGRADE CRITICALITY (PER 22206).

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-504
NASA FMEA #: 05-1-FC7248-0001 & 05-1-F

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 504
ITEM: INDICATOR, PUSH BUTTON: ROLL/YAW (CSS/AUTO) (FAILS TO RESPOND)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/1R]	[P]	[P]	[P]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. THE NASA EFFECTS DON'T ADDRESS THE LOSS OF ALL REDUNDANCY (LIKE AND/OR UNLIKE) TO PERFORM THIS FUNCTION.

B. IOA RECOMMENDS UPGRADING THE CRITICALITY TO 3/1R.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/24/87
ASSESSMENT ID: NWS-505
NASA FMEA #: 05-6BC-2252-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 505
ITEM: RESISTORS, ISOLATION (3)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. NASA SEPARATED THE THREE ISOLATION RESISTORS. THE FAIL LIGHT AND GPC MODE RESISTORS WERE LEFT IN 2252-1 AND THE CRITICALITY LEFT AT 3/3. IOA AGREES WITH THE 3/3 FOR THESE TWO.

B. NASA IS WRITING A NEW FMEA, 05-6BC-(02) FOR THE DIRECT MODE ISOLATION RESISTOR AND ASSIGNING IT A 3/1R CRITICALITY WITH SCREENS A, B, AND C: PASS, FAIL, PASS RESPSECTIVELY
IOA AGREES WITH THE HIGHER CRITICALITY (SEE IOA NWS-9). THE SCREEN B ISSUE IS THE RESULT OF DIFFERENCES IN GROUND RULES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-506
NASA FMEA #: 05-6BC-2252-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 506
ITEM: RESISTORS, ISOLATION (3) (LOW RESISTANCE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]
RECOMMENDATIONS: (If different from NASA)	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. FMEA #05-6BC-2252-1 LISTS FAILURE MODES FOR THE ISOLATION RESISTORS AS FOLLOWS: ALL CREDIBLE MODES, ELEMENT OPENS, HIGH RESISTANCE.

B. IOA RECOMMENDS NO UPDATES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-507
NASA FMEA #: 05-6BC-2251-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 507
ITEM: RESISTOR, CURRENT LIMIT (HIGH RESISTANCE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
BOTH NWS 507 AND NWS 508 ARE MAPPED TO FMEA #05-6BC-2251-1 WHICH LIST FAILURE MODES FOR CURRENT LIMIT RESISTOR AS FOLLOWS: ALL CREDIBLE MODES, ELEMENT OPENS, HIGH RESISTANCE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-508
NASA FMEA #: 05-6BC-2251-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 508
ITEM: RESISTOR, CURRENT LIMIT (LOW RESISTANCE)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /3]	[NA]	[NA]	[NA]	[ ] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
BOTH NWS 507 AND NWS 508 ARE MAPPED TO FMEA #05-6BC-2251-1 WHICH LIST FAILURE MODES FOR CURRENT LIMIT RESISTOR AS FOLLOWS: ALL CREDIBLE MODES, ELEMENT OPENS, HIGH RESISTANCE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-509
NASA FMEA #: 05-6BC-2109-2

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 509
ITEM: SWITCH, NWS TOGGLE (3 POSITION) (FAILS TO ACTIVE CONTACT:GPC POSITION)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[F]	[P]	[X] *
IOA	[3 /3]	[NA]	[NA]	[NA]	[ ]
COMPARE	[/N]	[N]	[N]	[N]	[N]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
THE GPC MODE OF NWS IS THE PRIMARY MODE OF DIRECTIONAL CONTROL FOR THE ORBITER DURING LANDING ROLL OUT AND THE NWS TOGGLE SWITCH IS SET TO THE 'GPC' POSITION BEFORE MGTD. FAILURE OF THE NWS TOGGLE SWITCH TO THE 'GPC' POSITION HAS NO EFFECT BEYOND THE LOSS OF THE CAPABILITY TO MANUALLY DESELECT THE GPC MODE OF NWS.

ANY FAILURE OF THE NWS SYSTEM COULD STILL LEAD TO NWS BEING AUTOMATICALLY DOWNMODED TO FREE CASTOR AND THE ANNUNCIATION OF THE NWS FAIL LIGHT.

FMEA EFFECTS DO NOT ADEQUATELY SUBSTANTIATE CRITICALITY.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 3/17/87
ASSESSMENT ID: NWS-510
NASA FMEA #: 05-6BC-2109-1

NASA DATA:
BASELINE [ ]
NEW [X]

SUBSYSTEM: NWS
MDAC ID: 510
ITEM: SWITCH, NWS TOGGLE (3 POSITION) (FAILS OFF)

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[2 /1R]	[P]	[P]	[P]	[X] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[/]	[ ]	[ ]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [X]
INADEQUATE [ ]

REMARKS:
NO DIFFERENCES.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-601
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 601
ITEM: MDM FF1

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-602
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 602
ITEM: MDM FF1

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-603
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 603
ITEM: MDM FF1

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-604
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 604
ITEM: MDM FF2

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-605
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 605
ITEM: MDM FF2

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-606
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 606
ITEM: MDM FF2

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/] [ ] [ ] [ ] [ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-607
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 607
ITEM: MDM FF3

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)
ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-608
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 608
ITEM: MDM FF3

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)
ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-609
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 609
ITEM: MDM FF3

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-610
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 610
ITEM: MDM FF4

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-611
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 611
ITEM: MDM FF4

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[3 /1R]	[P]	[P]	[P]	[ ]
COMPARE	[N /N]	[N]	[N]	[N]	[ ]

RECOMMENDATIONS: (If different from NASA)

[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)

ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/03/86
ASSESSMENT ID: NWS-612
NASA FMEA #:

NASA DATA:
BASELINE [ ]
NEW [ ]

SUBSYSTEM: NWS
MDAC ID: 612
ITEM: MDM FF4

LEAD ANALYST: A.S. MEDIAVILLA

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[/]	[ ]	[ ]	[ ]	[ ] *
IOA	[2 /1R]	[P]	[P]	[P]	[X]
COMPARE	[N /N]	[N]	[N]	[N]	[N]
RECOMMENDATIONS: (If different from NASA)					
	[/]	[ ]	[ ]	[ ]	[ ] (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)
ADEQUATE [ ]
INADEQUATE [ ]

REMARKS:
A. IOA HAS DECIDED TO DELETE THE MDM FAILURE MODE ANALYSIS FROM THE NWS ASSESSMENT. ALL OF THE MDM ANALYSIS IS COVERED IN THE DATA PROCESSING SYSTEM (DPS) ASSESSMENT.

APPENDIX D

CRITICAL ITEMS

APPENDIX D
POTENTIAL CRITICAL ITEMS

NASA FMEA	MDAC-ID	ITEM	FAILURE MODE
05-6Q-2203-1	2	SWITCH, FLIGHT CONTROL	FAILS CLOSED
05-6BC-(02)	4	RESISTOR, ISOLATION	HIGH RESISTANCE
05-6BC-2109-3	5	SWITCH, NWS TOGGLE	FAILS TO DIRECT
02-1-044-1	101	PEDALS, RUDDER	JAMMED
05-1-FC3442-3	102	PEDALS, RUDDER	LOSS OF LINKAGE
02-1-086-1	103	TRANSDUCER, COMMAND	NO OUTPUT
02-1-086-2	104	TRANSDUCER, COMMAND	ERRONEOUS OUTPUT
05-1-FC3442-3	107	TRANSDUCER, RUDDER	LOSS OF OUTPUT
05-1-FC3442-3	108	TRANSDUCER, RUDDER	ERRONEOUS OUTPUT
02-1-089-2	201	BOX, NWS CONTROL	FAILS ON
02-1-089-1	202	BOX, NWS CONTROL	FAILS OFF
	204	BOX, STEERING CONTROL	FAILS OPEN
02-1-088-1	205	BOX, STEERING CONTROL	LOSS OF PARTIAL
02-1-088-2	206	BOX, STEERING CONTROL	ERRONEOUS OUTPUT
02-1-094-2	301	ACCUMULATOR	FAILS OPEN
02-1-094-1	302	ACCUMULATOR	FAILS CLOSED
02-1-090-1	307	ASSEMBLY, ACTUATOR	RUPTURE/LEAKAGE
	308	PISTON, ACTUATOR ARM	FAILS JAMMED
02-1-084-1	309	PISTON, ACTUATOR ARM	FAILS TO RESPOND
	310	FILTER, INLET	FAILS TO FILTER
	311	FILTER, INLET	FAILS CLOSED
	312	HYDRAULIC SYSTEM	RUPTURE/LEAKAGE
02-1-087-1	316	TRANSDUCER, FEEDBACK	NO OUTPUT
02-1-087-2	317	TRANSDUCER, FEEDBACK	ERRONEOUS OUTPUT
02-1-SPT-1	318	TRANSDUCER, STEERING	SINGLE CHANNEL
02-1-SPT-2	319	TRANSDUCER, STEERING	SINGLE CHANNEL
02-1-091-2	322	VALVE, ANTI-CAVITATION	FAILS OPEN/LEAKAGE
02-1-091-1	323	VALVE, ANTI-CAVITATION	FAILS CLOSED
02-1-092-1	324	VALVE, E-H SERVO	FAILS TO RESPOND
02-1-092-2	325	VALVE, E-H SERVO	ERRATIC RESPONSE
02-1-101-2	326	VALVE, E-H PROTECTION	FAILS OPEN
02-1-101-1	327	VALVE, E-H PROTECTION	FAILS CLOSED
02-1-106-2	328	VALVE, OVERLOAD CHECK	FAILS OPEN/LEAKAGE
02-1-106-1	329	VALVE, OVERLOAD CHECK	FAILS CLOSED
02-1-095-1	331	VALVE, PILOT SOLENOID	FAILS CLOSED
02-1-095-1	333	VALVE, PILOT SOLENOID	FAILS CLOSED
02-1-100-2	334	VALVE, RELIEF/CONTROL	FAILS OPEN
02-1-100-1	335	VALVE, RELIEF/CONTROL	FAILS CLOSED
02-1-096-1	337	VALVE, SHUTOFF	FAILS CLOSED
05-6BC-2245-1	501	CIRCUIT BREAKER	FAILS OPEN
05-1-FC7248-0001	503	INDICATOR, PUSH BUTTON	JAMS TO ACTIVE
05-6BC-2109-2	509	SWITCH, NWS TOGGLE	FAILS TO GPC
05-6BC-2109-1	510	SWITCH, NWS TOGGLE	FAILS OFF

APPENDIX E
DETAILED ANALYSIS

This appendix contains the IOA analysis worksheets supplementing previous results reported in STSEOS Working Paper 1.0-WP-VA86001-03, Analysis of the Nose Wheel Steering, (21 November 1986). Prior results were obtained independently and documented before starting the FMEA/CIL assessment activity. Supplemental analysis was performed to address failure modes not previously considered by the IOA. Each sheet identifies the hardware item being analyzed, parent assembly and function performed. For each failure mode possible causes are identified, and hardware and functional criticality for each mission phase are determined as described in NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. Failure mode effects are described at the bottom of each sheet and worst case criticality is identified 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: 3/24/87 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 1 ABORT: 3/3

ITEM: DIODE (2) (OPEN CIRCUIT/SHORTS)
FAILURE MODE: OPEN CIRCUIT/SHORTS

LEAD ANALYST: A. HOCHSTEIN SUBSYS LEAD: A. HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) FAILURE ANNUNCIATOR ASSEMBLY (EPD&C)
3) DIODE (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: AREA B3 FORWARD AVIONICS BAY NO. 3A
PART NUMBER: V070-763430-004

CAUSES: THERMAL STRESS, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
THESE DIODES ISOLATE THE NWS FAIL SIGNAL TO THE TYPE III HYBRID DRIVER CONTROLLER; ONE ON THE HARDWIRED CIRCUIT FROM THE SCB, AND ONE FROM THE NW POSITION SOP VIA MDM FF4. THIS FAILURE TO ALLOW THE NWS FAIL SIGNAL TO ANNUNCIATE THE FAIL LIGHT RESULTS IN A LOSS OF EARLY DETECTION OF A NWS FAILURE. CREW RECOGNITION OF A SECOND NWS FAILURE WOULD BE AFTER THE FACT - RESULTING IN THE NEED FOR A MORE TIME CRITICAL CORRECTIVE ACTION.

THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 3/24/87 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 2 ABORT: 2/1R

ITEM: SWITCH, FLIGHT CONTROLLER POWER TOGGLE (2) (FAILS OFF)
FAILURE MODE: FAILS CLOSED IN OFF POSITION

LEAD ANALYST: A. HOCHSTEIN SUBSYS LEAD: A. HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C-D&C)
3) FLIGHT CONTROLLER POWER TOGGLE SWITCH: ON/OFF (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: D&C PANEL F8
PART NUMBER: ME452-0102-7352

CAUSES: PIECE PART FAILURE, CONTAIMINATION, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
ONLY THE RIGHT (DDU2) SWITCH POWERS THE NWS SPA/SPT. ONLY VEHICLE STEERING EFFECTS WILL BE ADDRESSED IN THIS ANALYSIS. FLIGHT CONTROL ANALYSIS HAS COVERED THE OTHER COMPONENTS THIS SWITCH POWERS-UP. THERE IS NO REDUNDANCY TO POWER UP THE NWS SPA/SPT. FAILING THE SWITCH IN THE OFF POSITION INHIBITS THE GPC MODE OF NWS. THE DIRECT MODE OF NWS IS STILL AVAILABLE AFTER WONG. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS BUT FAILING THE LEFT AND RIGHT DDU SWITCHES WOULD INHIBIT BOTH RHCs AND RPTAs. SO FOR THE PERIOD OF TIME BETWEEN WOW AND WONG, FAILING BOTH SWITCHES WOULD BE LIFE AND VEHICLE THREATENING (NO DIRECTIONAL CONTROL). DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS AVAILABLE AFTER WONG.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 3/24/87 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 3 ABORT: 3/3

ITEM: SWITCH FLIGHT CONTROLLER POWER TOGGLE (2) (FAILS ON)
FAILURE MODE: FAILS CLOSED IN ON POSITION

LEAD ANALYST: A. HOCHSTEIN SUBSYS LEAD: A. HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C-D&C)
3) FLIGHT CONTROLLER POWER TOGGLE SWITCH: ON/OFF (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: D&C PANEL F8
PART NUMBER: ME452-0102-7352

CAUSES: PIECE PART FAILURE, CONTAMINATION, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
DURING THE LANDING PHASE, THIS SWITCH IS NORMALLY ON AND FAILING CLOSED IN THE "ON" POSITION WOULD HAVE NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 3/24/87 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 4 ABORT: 3/1R

ITEM: RESISTOR, ISOLATION (HIGH RESISTANCE)
FAILURE MODE: HIGH RESISTANCE

LEAD ANALYST: A.S. MEDIAVILLA SUBSYS LEAD: A. HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) ISOLATION RESISTOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 31V73A2A1-A6R2
PART NUMBER: RLR070512GR

CAUSES: VIBRATION, MECAHNICAL SHOCK, THERMAL STRESS

EFFECTS/RATIONALE:
THIS ISOLATION RESISTOR PROVIDES NW-MAN-ON STATUS MONITORING CIRCUIT PROTECTION FROM THE MAIN POWER BUS. IF A GPC FAILURE OCCURS FIRST, SETTING THE ERROR FLAG TO TRUE, AND THEN WHEN DIRECT IS SWITCHED TO BUT THE RESISTOR HAS FAILED, THE ERROR FLAG WILL NOT BE RESET, THUS NWS DIRECT CANNOT BE ACTIVATED. RUDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: 05-6BC-(02)

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 5 ABORT: 2/1R

ITEM: SWITCH, NWS TOGGLE (3 POSITION)
FAILURE MODE: FAILS TO ACTIVE CONTACT: DIRECT POSITION

LEAD ANALYST: A.S. MEDIAVILLA SUBSYS LEAD: A. HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) NWS 3 POSITION TOGGLE SWITCH: OFF/GPC/DIRECT
4)
5)
6)
7)
8)
9)

CRITICALITIES

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

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

LOCATION: 31V73A21A1-S6; PANEL L2A1
PART NUMBER: ME452-0102-7373

CAUSES: PIECE PART FAILURE, CONTAMINATION, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
THE NWS TOGGLE SWITCH SELECTS THE MODE OF NWS TO BE ACTIVATED.

IF THE SWITCH FAILS TO DIRECT, THEN THERE EXISTS THE POSSIBILITY OF THE LOSS OF NWS AT NGTD.

IF THE RUDDER PEDALS ARE NOT CENTERED AT NGTD, NWS SIGNALS WILL BE IMMEDIATELY TRANSMITTED VIA THE COMMAND TRANSDUCER. THIS SCENARIO COULD LEAD TO A COMMAND/ACTUAL MISCOMPARE AND THE LOSS OF NWS. CYCLING THE SWITCH MAY DO NO GOOD IF THE SWITCH HAS FAILED TO DIRECT, HOWEVER, IF BOTH GPC AND DIRECT ARE ON, NWS IS DEFAULTED TO GPC MODE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECT SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

APPENDIX F

NASA FMEA TO IOA WORKSHEET CROSS REFERENCE/RECOMMENDATIONS

This section provides a cross reference between the NASA FMEA and corresponding IOA analysis worksheet(s) included in Appendix E. The Appendix F identifies: NASA FMEA Number, IOA Assessment Number, NASA criticality and redundancy screen data, and IOA recommendations.

Appendix F Legend

Code	Definition
1	IOA recommends generating a FMEA for the item/failure mode.
2	IOA recommends generating a CIL for the item/failure mode.
3	IOA recommends a criticality change.
4	IOA recommends deletion of the CIL.
5	IOA recommends generating separate FMEA/CILs for the items/failure modes.
6	IOA generated a non-credible failure mode.
7	IOA deleted this failure mode from the NWS analysis.

APPENDIX F

NASA FMEA TO IOA WORKSHEET CROSS REFERENCE / RECOMMENDATIONS

IDENTIFIERS		NASA				IOA RECOMMENDATIONS					
NASA FMEA NUMBER	IOA ASSESSMENT NUMBER	CRIT HW/F	SCREENS A	B	C	CRIT HW/F	SCREENS A	B	C	OTHER (SEE LEGEND CODE)	ISSUE
	NWS-203	/				3/3				1	X
	NWS-204	/				2/1R	P	P	P	1, 2	X
	NWS-305	/				/				6	
	NWS-306	/				/				6	
	NWS-308	/				1/1				1, 2	X
	NWS-310	/				2/1R	P	P	P	1, 2	X
	NWS-311	/				2/1R	P	P	P	1, 2	X
	NWS-312	/				1/1				1, 2	X
	NWS-313	/				/				6	
	NWS-601	/				/				7	
	NWS-602	/				/				7	
	NWS-603	/				/				7	
	NWS-604	/				/				7	
	NWS-605	/				/				7	
	NWS-606	/				/				7	
	NWS-607	/				/				7	
	NWS-608	/				/				7	
	NWS-609	/				/				7	
	NWS-610	/				/				7	
	NWS-611	/				/				7	
	NWS-612	/				/				7	
02-1-044-1	NWS-101	1/1	NA	NA	NA	/					
02-1-084-1	NWS-309	1/1	NA	NA	NA	/					
02-1-086-1	NWS-103	2/1R	P	F	P	/					
02-1-086-2	NWS-104	2/1R	P	F	P	/					
02-1-087-1	NWS-316	2/1R	P	F	P	/					
02-1-087-2	NWS-317	2/1R	P	F	P	/					
02-1-088-1	NWS-205	2/1R	P	F	P	/					
02-1-088-2	NWS-206	2/1R	P	F	P	/					
02-1-089-1	NWS-202	3/1R	F	F	P	/					
02-1-089-2	NWS-201	2/1R	P	F	P	/					
02-1-090-1	NWS-307	1/1	NA	NA	NA	/					
02-1-091-1	NWS-323	1/1	NA	NA	NA	3/1R	F	F	P	3	X
02-1-091-2	NWS-322	1/1	NA	NA	NA	/					
02-1-092-1	NWS-324	2/1R	P	F	P	/					
02-1-092-2	NWS-325	2/1R	P	F	P	/					
02-1-093-1	NWS-315	3/3	NA	NA	NA	/					
02-1-093-2	NWS-314	3/3	NA	NA	NA	/					
02-1-094-1	NWS-302	2/1R	P	F	P	/					
02-1-094-2	NWS-301	2/1R	F	F	P	/					
02-1-095-1	NWS-331	2/1R	P	F	P	/				5	X
	NWS-333	2/1R	P	F	P	/				5	X
02-1-095-2	NWS-330	3/3	NA	NA	NA	/				5	X
	NWS-332	3/3	NA	NA	NA	/				5	X
02-1-096-1	NWS-337	2/1R	P	F	P	/					

IDENTIFIERS		NASA				IOA RECOMMENDATIONS *				
NASA FMEA NUMBER	IOA ASSESSMENT NUMBER	CRIT HW/F	SCREENS A	B	C	CRIT HW/F	SCREENS A	B	C	OTHER (SEE LEGEND CODE)	ISSUE
02-1-096-2	NWS-336	3/1R	F	F	P	3/3	NA	NA	NA	2, 4	X
02-1-100-1	NWS-335	2/1R	P	F	P	/					
02-1-100-2	NWS-334	2/1R	P	F	P	/					
02-1-101-1	NWS-327	2/1R	P	F	P	/					
02-1-101-2	NWS-326	3/1R	F	F	P	2/				3	X
02-1-106-1	NWS-329	3/3	F	F	P	2/1R				2, 3	X
02-1-106-2	NWS-328	2/1R	P	F	P	/					
02-1-SPA-1	NWS-304	3/1R	P	P	P	/					
02-1-SPA-2	NWS-303	3/1R	P	P	P	/					
02-1-SPT-1	NWS-318	3/1R	P	F	F	/					
02-1-SPT-2	NWS-319	3/1R	P	P	F	/					
02-1-SPT-3	NWS-320	3/1R	P	P	P	/					
	NWS-321	3/1R	P	P	P	/					
05-03-12376-T9D	NWS-402	3/3				/					
05-1-FD-3442-1	NWS-105	3/1R	P	P	P	/					
05-1-FD-3442-2	NWS-106	3/1R	P	P	P	/					
05-1-FD3442-3	NWS-102	1/1	NA	NA	NA	/					
	NWS-107	1/1	NA	NA	NA	/					
	NWS-108	1/1	NA	NA	NA	/					
05-1-FD7248-0001	NWS-503	3/3				1/1				2, 3	X
05-1-FD7248-0001 & 0	NWS-504	3/3				/1R	P	P	P	3	X
05-3-012376-1	NWS-403	3/3	NA	NA	NA	/					
05-6BC-(01)	NWS-001X	3/3				/					
05-6BC-(02)	NWS-004X	3/1R	P	F	P	/					
05-6BC-2109-1	NWS-510	2/1R	P	P	P	/					
05-6BC-2109-2	NWS-509	3/1R	P	F	P	/					
05-6BC-2109-3	NWS-005X	2/1R	P	P	P	/					
05-6BC-2112-1 & 05-3	NWS-401	3/3	NA	NA	NA	/					
05-6BC-2200-1	NWS-405	3/3	NA	NA	NA	/					
05-6BC-2200-2	NWS-404	3/3	NA	NA	NA	/					
05-6BC-2245-1	NWS-501	2/1R	P	P	P	/					
05-6BC-2245-2	NWS-502	3/3	NA	NA	NA	/					
05-6BC-2251-1	NWS-507	3/3	NA	NA	NA	/					
	NWS-508	3/3	NA	NA	NA	/					
05-6BC-2252-1	NWS-505	3/3				/					
	NWS-506	3/3	NA	NA	NA	/					
05-6Q-2203-1	NWS-002X	2/1R	P	P	P	/					
05-6Q-2203-2	NWS-003X	3/3				/					