INDEPENDENT ORBITER ASSESSMENT

ASSESSMENT
OF THE
BACK-UP
FLIGHT
SYSTEM

22 FEBRUARY 1988
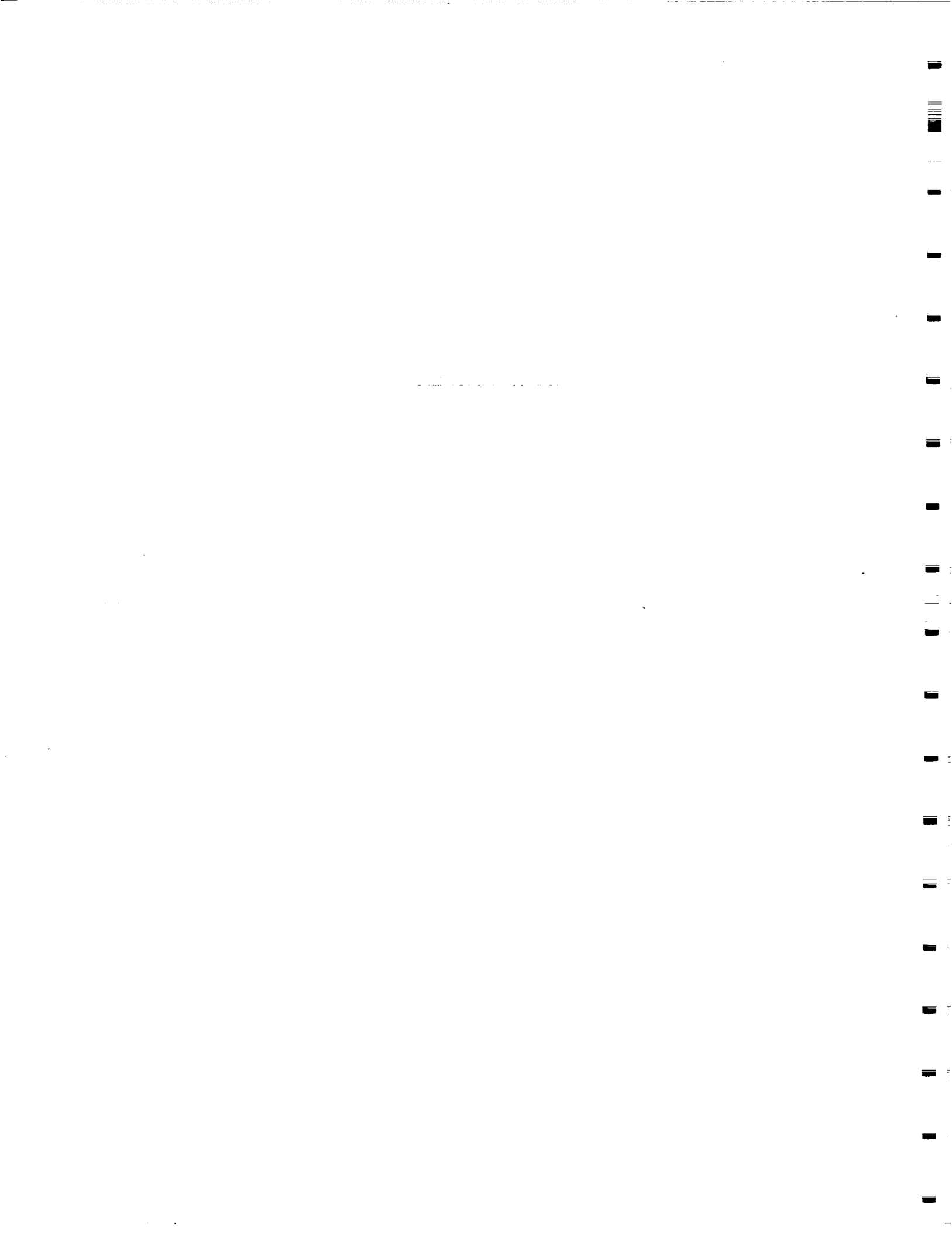
MCDONNELL DOUGLAS ASTRONAUTICS COMPANY -
ENGINEERING SERVICES

SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

WORKING PAPER NO. 1.0-WP-VA88003-17

INDEPENDENT ORBITER ASSESSMENT
ASSESSMENT OF THE BACKUP FLIGHT SYSTEM FMEA/CIL

22 FEBRUARY 1988

This Working Paper is Submitted to NASA under
Task Order No. VA86001, Contract NAS 9-17650

PREPARED BY: _E.E. Prust_   PREPARED BY: _J.J. Ewell, Jr._
E.E. Prust   J.J. Ewell, Jr.
Analyst   BFS Lead
Independent Orbiter   Independent Orbiter
Assessment   Assessment

PREPARED BY: _L.W. Hinsdale_   APPROVED BY: _A.J. Marino_
L.W. Hinsdale   A.J. Marino
Analyst   Section Manager-FMEA/CIL
Independent Orbiter   Independent Orbiter
Assessment   Assessment

APPROVED BY: _G.W. Knori_   APPROVED BY: _J.I. McPherson_
G.W. Knori   J.I. McPherson
Technical Manager   Project Manager
Independent Orbiter   STSEOS
STSEOS

CONTENTS

CONTENTS

List of Figures

List of Tables

Independent Orbiter Assessment
Assessment of the Backup Flight System 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 Backup Flight System (BFS) 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 BFS hardware.

The IOA product for the BFS analysis consisted of 29 failure mode "worksheets" that resulted in 21 Potential Critical Items (PCI) being identified. This product was originally compared with the proposed NASA BFS baseline as of Oct. 1986 and subsequently compared with the applicable (as of Nov. 19, 1987) Data Processing System (DPS), Electrical Power Distribution and Control (EPD&C), and Displays and Controls NASA CIL items. The comparisons determined if there were any results which had been found by the IOA but were not in the NASA baseline.

The original assessment determined there were numerous failure modes and potential critical items in the IOA analysis that were not contained in the NASA BFS baseline. Conversely, the NASA baseline contained three FMEAs (IMU, ADTA, and Air Data Probe) for CIL items that were not identified in the IOA product. The IOA prepared worksheets and agreed with the NASA analysis for the three items. This increased the IOA worksheets from 29 to 32 and the PCIs from 21 to 24 for the original assessment as shown in Figure 1.

The NASA and Rockwell conducted several reviews and completed a substantial rewrite of all CILs between Dec. 1986 and Nov. 1987. This effort included eliminating BFS as a unique subsystem by integrating BFS CILs with primary DPS CILs. The revised NASA baseline contained four more FMEAs for CIL items that were not identified in the original IOA BFS product, deleted the IMU CIL related FMEA mentioned in the previous paragraph, and moved the ADTA and AIR Data Probe CILs also mentioned in the previous paragraph to the GN&C subsystem. Once again, the IOA prepared worksheets and agreed with the NASA analysis of the additional

1

BFS ASSESSMENT OVERVIEW

BFS ASSESSMENT SUMMARY

	ORIGINAL ASSESSMENT *			FINAL RESOLUTION **		
	IOA	NASA	ISSUES	IOA	NASA	ISSUES
FMEA	32	16	16	33	–	–
CIL	24	12	12	25	22	0

BACKUP FLIGHT CONTROLLER

	IOA	NASA	ISSUES	NOTES
FMEA	10	–	–	(1)
CIL	9	2	0	

DISPLAY DRIVER UNIT

	IOA	NASA	ISSUES	NOTES
FMEA	1	–	0	(3)
CIL	1	4	0	

GENERAL PURPOSE COMPUTER

	IOA	NASA	ISSUES	NOTES
FMEA	2	–	–	(2)
CIL	2	4	0	

SWITCHES

	IOA	NASA	ISSUES
FMEA	9	–	–
CIL	5	5	0

CIRCUIT PROTECTORS

	IOA	NASA	ISSUES	NOTES
FMEA	9	–	–	(3)
CIL	8	7	0	

INDICATORS

	IOA	NASA	ISSUES
FMEA	2	–	–
CIL	0	–	0

IMU, ADTA, AD PROBE

	IOA	NASA	ISSUES	NOTES
FMEA	3	3	0	(4)
CIL	3	3	0	
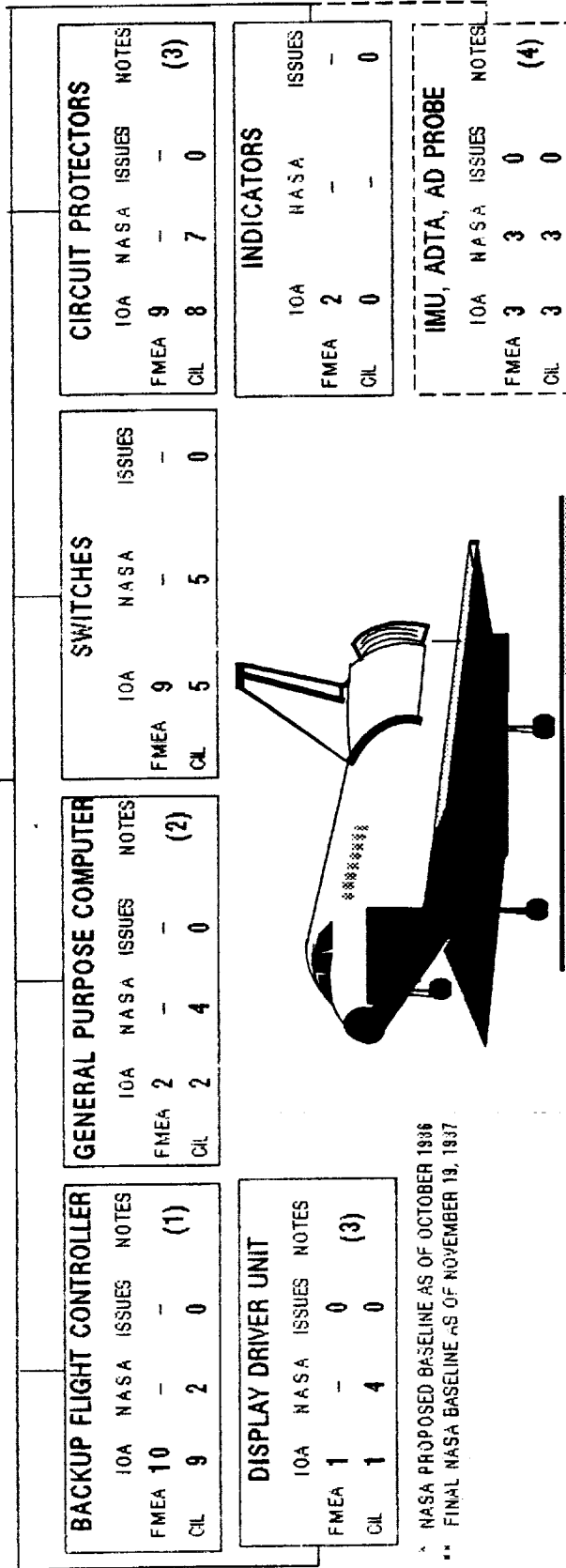
* NASA PROPOSED BASELINE AS OF OCTOBER 1986
** FINAL NASA BASELINE AS OF NOVEMBER 19, 1987

NOTES:
1: THE IOA BFC ANALYSIS WENT ONE LEVEL DEEPER THAN THE ROCKWELL/NASA ANALYSIS; THEREFORE MULTIPLE IOA FAILURES ARE COVERED BY INDIVIDUAL NASA FAILURES.
2: THE IOA TREATED THE GPC AS ONE BLACK BOX. THE ROCKWELL/NASA ANALYSIS CONSIDERED BOTH THE CPU AND IOP.
3: THE IOA AND NASA/ROCKWELL ANALYSES ADDRESS THE SAME FAILURE MODES BUT DOCUMENT THEM DIFFERENTLY.
4: THE IMU FAILURE IMPACT ON BFS CONTAINED IN THE PROPOSED BASELINE OCT 1986 WAS DELETED FROM THE CIL AND THE ADTA AND PROBE CILS WERE MOVED TO GNEC IN THE FINAL NOV. 1987 BASELINE

Figure 1 - BFS FMEA/CIL ASSESSMENT

failures. This increased the IOA worksheets from 32 to 33 and the PCIs from 24 to 25 for the final assessment. The IOA assessment of the final updated baseline (Nov. 19, 1987) results in agreement on all BFS CIL items even though there are differences in number of items and assigned criticalities. Figure 1 presents an overview of the assessment results.

The differences in assigned criticalities are due to different interpretation and application of the FMEA/CIL preparation instructions contained in NSTS 22206. The IOA analyzed BFS hardware failures with the assumption the BFS had been or would be engaged. The NASA analyzed BFS hardware failures as an integral part of the DPS or EPD&C and therefore counted generic PASS failures when assigning criticalities to BFS hardware failure modes. The IOA interpretation neither added to or subtracted from the CIL.

The IOA and NASA analyses differed in level of detail and method of failure mode documentation. As a result, there are some differences in the number of CIL items. Regardless, a complete mapping exists between the IOA and FMEA/CIL items. Multiple IOA failures map into one FMEA for some hardware components and vice versa for other BFS elements.

2.0 INTRODUCTION

2.1 Purpose

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

3.0 SUBSYSTEM DESCRIPTION

The following sections describe the BFS subsystem hardware. This hardware comprises a GPC, DDUs, BFCs, several switches, status indicators, and circuit protectors. An overview of the system components is shown in Figure 2.

3.1 Design and Function

The Backup Flight System provides the flight crew with a vehicle control capability to be used if the primary system malfunctions. The BFS software resides in one General Purpose Computer, normally GPC 5, during ascent and entry. In the event a generic failure occurs in the Primary Avionics Software System (PASS) or three or more primary GPCs fail, the crew will engage the BFS. During dynamic flight phases (all except onorbit), no capability to return to the primary system is provided once the BFS is engaged.

Hardware elements included in this report are those specific to the BFS. Evaluation of components such as nav aids and flight control sensors that are common to the BFS and the PASS and components such as dedicated instrument displays that are driven by the BFS outputs are excluded from this report. Processing schemes differ between PASS and BFS with the result that some component failures become more critical with BFS engaged. It is beyond the scope of this report to present all the software differences between PASS and BFS or to present a comparison of the failure criticalities for non BFS-unique hardware with or without BFS engaged.

The BFS is limited by definition, for this report, to those unique hardware items that function in response to the action taken by the flight crew to engage or disengage the BFS. A schematic diagram of these hardware items is shown in Figure 3. More specifically, the BFS consists of the following components:

1. Two DDUs which supply power to the BFS engage switches on the left and right RHCs and to the Hand Controller Engage Drivers (HCEDs) in the Backup Flight Controller (BFC) modules. Each DDU has three power supplies (A, B and C) redundantly tied through regulators to two of the three Main A, B and C buses.

2. Three BFCs, each with identical modules A and B, which receive inputs from crew configured switches and output discrete signals to their respective GPCs. Logic circuits select which GPCs control flight critical buses and drive CRT displays prior and subsequent to BFS engagement.

3. One GPC loaded with backup flight software. From a hardware standpoint, a GPC consists of a Central Processing Unit (CPU) and an Input/Output Processor (IOP), each with many subcomponents. Since there is
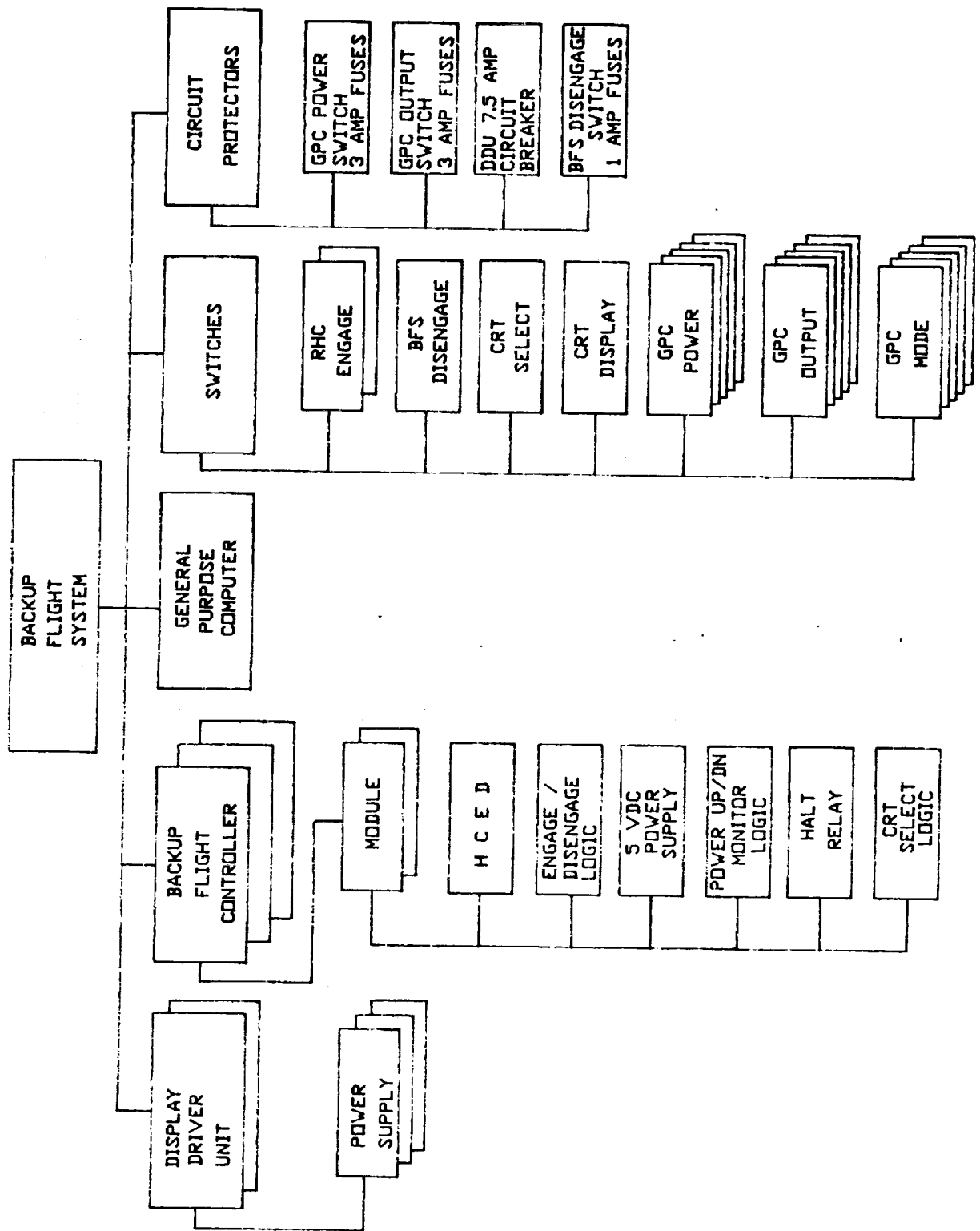
Figure 2 - BFS SUBSYSTEM OVERVIEW
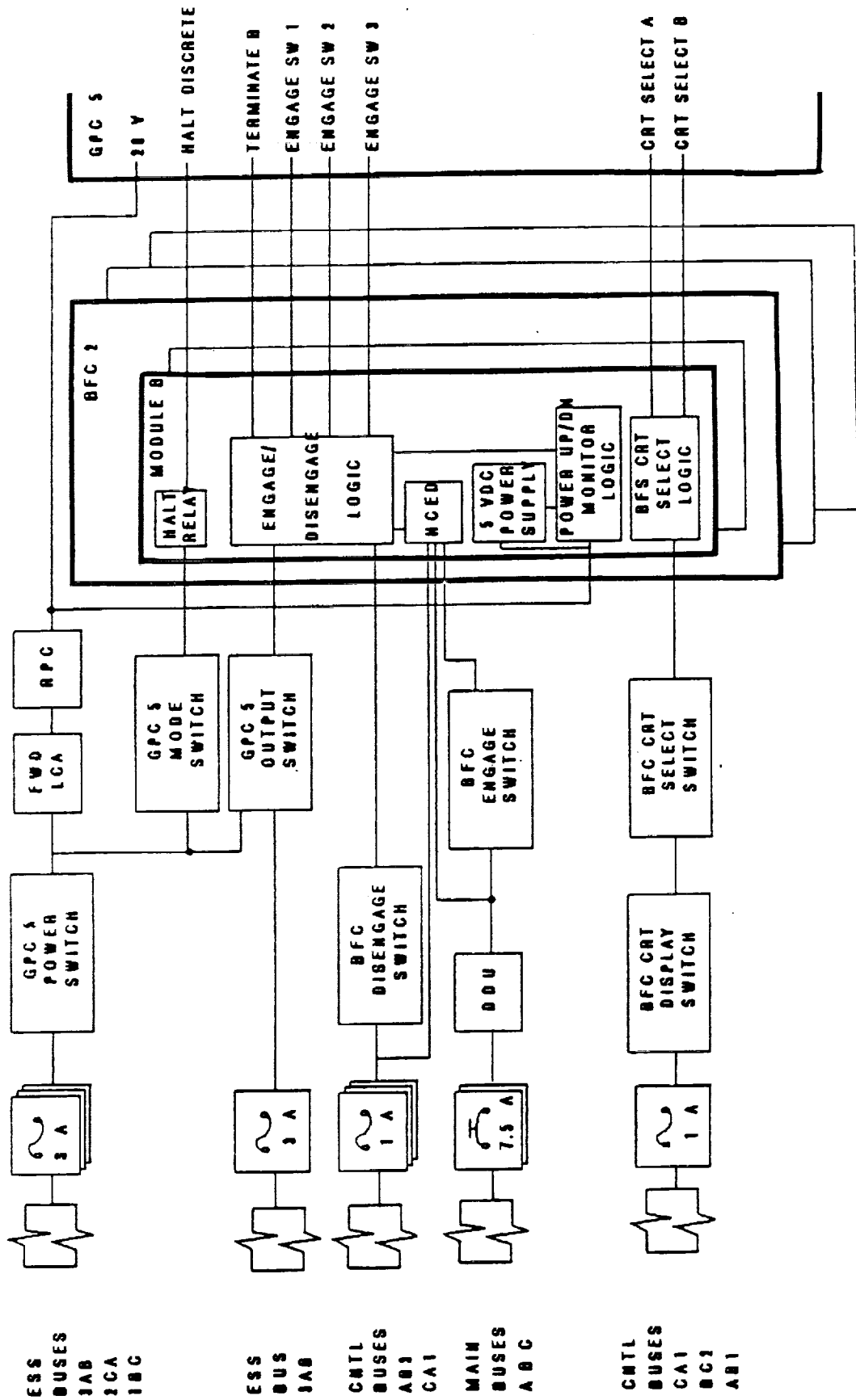
Figure 3 - BFS ENGAGE/DISENGAGE HARDWARE AND DATA INTERFACES

only one GPC to provide the backup control capability it will be treated as a black box. Regardless of what hardware component fails rendering the GPC inoperable, the criticality is the same as a generic black box failure.

4. Twenty crew activated switches (15 GPC, 2 BFS engage, 1 BFS disengage, and 2 CRT) that are used to control GPC operating configuration and CRT interfaces with the BFS GPC.

5. Crew interface with the BFS is through the Multifunction CRT Display System (MCDS). During normal flight operations, one of the cathode ray tubes (CRTs) in the forward station will be commanded by the BFS. BFS MCDS selection in the forward station is governed by the BFS CRT switch on panel C3 or the GPC/CRT key on the keyboard. Current preengage BFS procedures call for CRT 3 to be the BFS CRT in the forward station.

The BFS operates in one of two operating states: engaged or disengaged. The BFS is intended to remain in a disengaged state during routine operations allowing the PASS to control the vehicle. Both the engage and disengage states are provided to the GPCs through a set of three hardware modules called Backup Flight Controllers (BFCs). These BFCs provide interface through a series of discrete signals between the GPCs and associated crew station switches. Engage is accomplished by verifying that the BFS GPC output switch is in the backup position and that the DDU power supply breakers are in, and depressing the engage momentary pushbutton on either the right or the left RHC.

When one of the RHC buttons is depressed, three discretes (A, B, C) of ones are sent to the BFS GPC through the BFC modules. The BFS GPC must receive two of three discretes plus a zero discrete from the I/O terminate B before the BFS can be engaged. After the BFS is engaged, control of the vehicle is assumed by the BFS, and the PASS GPCs go to a state of software halt. The BFS then controls the flight critical and payload data buses and specified display keyboard buses. Indications that the BFS is engaged are that BFC eyebrow panel lights on F2 and F4 will be ON, the BFS output talkback (TB) on panel O6 will be gray, and all PASS GPC output TBs on panel O6 will be barberpole.

In the disengaged state, the BFS GPC processes vehicle control parameters in parallel with the PASS GPCs. The BFS maintains knowledge of the vehicle state by listening on the flight critical data buses commanded by the PASS GPCs. The disengaged BFS GPC also performs limited SM and FDA functions during OPS 1, 3, and 6. To disengage the BFS from the engage state, the BFC disengage switch on panel F6 is positioned to DISENGAGE (up position). The engage discretes to the BFS will be reset to zero and the I/O terminate discrete set to one. Control of the FC and PL data buses will be released to the PASS. This is indicated by the BFC light going OFF, the PASS output TBs going gray, and

9

BFS output TB going barberpole. The PASS GPCs must be re-Initial Program Loaded (re-IPLed) prior to disengage. Thus the BFS disengage capability is provided only during quiescent vehicle flight.

If BFS is engaged it will drive several dedicated instrument displays in the forward station. This is instrumentation needed to safely fly the vehicle during the final phases of entry and landing. Two of the three Attitude Direction Indicators (ADIs) are driven by the BFS in OPS 1 and OPS 3. The four scales (Alpha, Accel, M/Vel, EAS) of the Alpha/Mach Indicator (AMI) are driven by BFS in OPS major modes 304 and 305. Likewise, the four scales (Alt Accel, Alt Rate, Alt, Rad Alt) of the Altitude/Vertical Velocity Indicator (AVVI) are driven by the engaged BFS in major modes 304 and 305. The Horizontal Situation Indicator (HSI) provides magnetic heading, course, course deviation, glide slope deviation, and primary and secondary bearing, and the Surface Position Indicator (SPI), provides elevons, body flap percent, rudder, aileron, and speedbrake percent. The HSI and SPI are driven by the engaged BFS.

3.2 Interfaces and Locations

The BFS GPC and three BFCs are located in Avionics Bays 1 and 2. All other hardware components are located in the forward flight deck. The BFS interfaces with Orbiter subsystems via the flight critical and payload data buses and flight forward and flight aft MDMs.

3.3 Hierarchy

Figure 2 illustrates the hierarchy of the BFS hardware components.

3.4 BFS Sensitivity to Interfacing Subsystem Operation

An exhaustive comparison of the BFS and PASS is beyond the scope of this report. However, a limited investigation of BFS sensitivity to operation in certain guidance, navigation and control subsystems was performed. References 12 and 13 constituted the BFS capability description for this investigation.

Compared to the PASS, the BFS capability for fault detection is limited due to minimum redundancy management capability. As a result, the BFS is substantially more vulnerable to malfunctions in interfacing subsystems. The specific subsystems investigated included the Inertial Measurement Units (IMUs), Air Data System (ADS), Rate Gyro Assemblies (RGA) and Accelerometer Assemblies (AA), Rotational Hand Controller (RHC), Speedbrake Thrust Controller (SBTC), Rudder Pedal Transducer Assembly (RPTA), and a limited collection of cockpit switches.

3.4.1 Inertial Measurement Unit (IMU)

The BFS does not use the Built in Test Equipment (BITE) or
the ECHO features provided by the IMU hardware. The BFS
only faults an IMU when it has detected a Communications Fault
(COM FAULT). In nominal operations, the BFS uses a mid value
select. If one IMU is COM FAULTED, the lowest numbered IMU which
has not been COM FAULTED will be selected. If two IMUs have been
COM FAULTED, then data from the remaining IMU will be processed.
If all three IMUs are COM FAULTED, the system will then try to
reselect the last failed IMU.

This data selection process makes the BFS extremely sensitive and
vulnerable to IMU number 1 malfunctions which do not result in a
COM FAULT on IMU number 1. Without regard to IMU number 1
performance, a simple COM FAULT on either IMU number 2 or 3 will
allow that performance to be immediately propagated throughout
the entire GN&C system.

3.4.2 Air Data System (ADS)

The data from this subsystem is vital to many computations, since
several of the items measured by this subsystem are used
throughout the GN&C software. The main item of concern is the
Nose Landing Gear Uplock Discrete, V51X0300X. This discrete is
used by the BFS software to determine if a correction factor is
applied in the angle of attack calculation, the corrected static
pressure calculation, and the corrected total pressure
calculation. These three terms are then used to determine Mach
number, pressure altitude, dynamic pressure (Q-Bar), equivalent
airspeed (EAS), and estimated true airspeed. The inclusion of
the correction factor in the calculation is due to changes in the
flow around the ADS when the nose gear is down.

Depending on the size of the correction factor being applied, the
corrected static pressure and corrected total pressure values
could be changed by a significant amount. Any calculations which
use these values in either a first order or second order
calculation would be in error, and this error would be factored
into the Guidance and Navigation functions. The errors could be
large enough to cause a loss of the vehicle.

3.4.3 Rate Gyro Assemblies (RGA) and Accelerometer Assemblies (AA)

The BFS uses three of the four RGAs on the Orbiter and three
of four RGAs on the Solid Rocket Boosters (SRB). Similarly, the
BFS uses only three of the four AAs. One set of scale factor and
bias data is used for the three Orbiter RGAs, another set of
scale factor and bias data is used for the RGAs on the SRBs, and
another set of scale factor and bias data is used for all AAs.
The PASS provides scale factor and bias data for each of the RGAs
and AAs.

The use of a single set of scale factor and bias data for a group
of RGAs and AAs is acceptable if the LRUs are very consistent.

If however, the performance of the LRUs is inconsistent, the data coming back could have large, over-compensated variations.

3.4.4 Rotational Hand Controller (RHC)

The BFS does not support RHC processing in ascent modes. The BFS does not validate the RHC inputs by using the data good indicator as in the PASS. There is no requirement to process the left RHC data before or after the right RHC data. The lack of a requirement for the order of processing RHC data is different than that found in the PASS. There may be a need to process the Commander's inputs before the Pilot's, as is done in the PASS.

3.4.5 Speedbrake Thrust Controller (SBTC)

The BFS does not have manual throttling capability in ascent as does the primary. The BFS does process both SBTCs.

3.4.6 Rudder Pedal Transducer Assembly (RPTA)

The BFS processes only the Commander's inputs. There is no redundancy when the BFS is engaged.

3.4.7 Cockpit Switches

The following switches are redundant, one set at the Commander's station and another set at the Pilot's station. The BFS processes only those switches at the Commander's station. Therefore, when the BFS is engaged, the PLT switches can not be considered redundant to the CDR switches.

TACAN source for HSI	F6	S4	V72K8587X
MSBLS source for HSI	F6	S4	V72K8589X
Nav source for HSI	F6	S4	V72K8588X
ADI Attitude Ref PB a	F6	S3	V72K2051X
PB b			V72K2052X
ADI Attitude Inertial	F6	S3	V72K2015X
ADI Attitude LV/LH	F6	S3	V72K2016X
ADI Attitude reference	F6	S3	V72K2017X

4.0 ASSESSMENT RESULTS

The IOA analysis of the BFS hardware initially generated 29 failure mode worksheets and identified 21 Potential Critical Items before starting the assessment process. In order to facilitate comparison, additional worksheets were generated. The analysis results were compared to the proposed NASA Post 51-L baseline. Upon completion of the assessment, there was agreement on all CIL items. The FMEAs for non-CIL items have not yet been revised; therefore, an IOA assessment of non-CIL FMEAs is not included in this report.

A summary of the quantity of NASA CIL items assessed versus the IOA baseline is presented in Table I.

Table I Summary of IOA CIL Assessment			
Component	NASA	IOA	Issues
DDU	4	1	0
BFC	2	9	0
GPC	4	2	0
Switches	5	5	0
Circuit Protectors	7	8	0
Total	22	25	0

The differences in the number of CIL items for a specific component are attributable to differences in the depth of analyses and documentation approach.

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 additional IOA analysis worksheets that were prepared to support the NASA FMEA/CIL assessment. Appendix F provides a cross reference between the NASA FMEA and corresponding IOA worksheets.

Table II presents a summary of the IOA failure criticalities. Further discussion of each of these subdivisions and the applicable failure modes is provided in subsequent paragraphs.

13

TABLE II Summary of IOA Failure Modes and Criticalities							
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
DDU	-	1	-	-	-	-	1
BFC	6	1	-	1	1	1	10
GPC	2	-	-	-	-	-	2
SWITCHES	4	1	-	-	1	3	9
CIRC. PROTECT.	5	-	-	4	-	-	9
INDICATORS	-	-	-	-	-	2	2
TOTAL	17	3	-	5	2	6	33

Of the failure modes analyzed, twenty-five were determined to be critical items. A summary of the IOA critical items is presented in Table III.

TABLE III Summary of IOA Critical Items						
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
DDU	-	1	-	-	-	1
BFC	6	1	-	1	1	9
GPC	2	-	-	-	-	2
SWITCHES	4	1	-	-	-	5
CIRC. PROTECT.	5	-	-	3	-	8
INDICATORS	-	-	-	-	-	-
TOTAL	17	3	-	4	1	25

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

TABLE IV IOA Worksheet Numbers	
Component	IOA ID Number
DDU	BFS-101
BFC	BFS-201 to BFS-210
GPC	BFS-301 to BFS-302
SWITCHES	BFS-401 to BFS-409
CIRC. PROTECT.	BFS-501 to BFS-509
INDICATORS	BFS-601 to BFS-602
IMU	BFS-1001
ADS	BFS-2001 to BFS-2002

4.1 Display Driver Unit

The NASA update documented loss of output and partial output for the left and right DDUs as four separate failures. The IOA documented the same failures on one analysis worksheet. The analyses agree that DDU output failure should be a CIL item.

4.2 Backup Flight Controller

The NASA update considered BFCs as black box components of the Data Processing and Software system. Two BFC CIL failure modes were identified: loss/erroneous output (2/1R) and inadvertent engage (3/1R, fails B screen). The IOA recognized the single point failure potential (criticality 1/1) of several functional components within the BFCs and elected to document failures at lower than black box level of detail. The disparity in criticality assignment is attributed to a philosophical difference between the IOA and FMEA. The IOA criticality is based on the effects of a failure occurring to a BFS component after a generic PASS failure, i.e., when the BFS is required. The NASA analysis considers a generic PASS failure as the first failure when assigning criticality to BFS components. As a result, for many component failure modes, the IOA criticality will appear to be more severe than the FMEA criticality.

The specific IOA BFC failures are mapped into the higher level NASA FMEAs in the final assessment. The IOA agrees with the FMEA criticalities if the PASS failure is considered.

In summary, the IOA makes two recommendations:
1. FMEAs should be generated for functional components within the BFC.
2. Instructions contained in NSTS 22206 should clearly specify whether PASS failures should be considered when assigning criticalities to BFS hardware failure modes.

4.3 General Purpose Computer

The IOA generated two failure mode worksheets for the BFS GPC which correspond to four FMEAs. The IOA treated the GPC as a black box, identified no output and erroneous output as failure modes, and assigned a criticality of 1/1 to each. The NASA update identified the same two failures but treated the GPC as two black boxes i.e., a CPU and an IOP and gave each failure a 2/1R criticality. The analyses agree that GPC output failures should be CIL items. The criticality discrepancy is due to the same philosophical difference discussed in the previous section. The IOA therefore recommends no change to the updated NASA GPC FMEAs.

4.4 Switches

Except for minor criticality differences, the IOA and FMEA agree on five switch failure CIL items. The IOA analysis originally identified a failed open BFC disengage switch (3/2R, fails B

screen) as a sixth CIL candidate. As a result of further review
during the assessment task, the IOA believes the crew can readily
detect the failure and perform a simple work-around procedure if
necessary to disengage the BFS on orbit. Therefore, the IOA
concludes the fail open mode for the BFC disengage switch
contacts should not be considered as a critical item and
recommends the failure be documented in the updated FMEAS for
non-CIL items.

4.5 Circuit Protectors

The IOA identified open circuit of fuses F9, F10, F11, and F49 as
criticality 1/1 failures and documented them as four separate CIL
items. The same four fuses and failure modes are documented as
criticality 2/1R in two updated FMEAs. The IOA concludes that
since both approaches identify the same components and failure
modes as CIL items there are no significant issues.

The NASA update includes two EPD&C-D&C Subsystem FMEAs that
identify open circuit failure of circuit breakers CB29, 30, and
32 as 3/1R criticality and includes them as CIL items because
they fail the B screen. The IOA initially concluded that all
redundancy screens were passed. Upon further review, the IOA
agrees with the NASA update

The IOA prepared three supplemental worksheets for failures
overlooked in the original analysis. These covered open and
short circuit failures in the BFS GPC and BFC main bus isolation
diodes and open circuit failure of fuse F28 in the main bus
supply line to the BFS BFC power monitor logic. The IOA agrees
with the FMEA for these CIL items.

In summary, there are no issues regarding BFS related circuit
protectors between the IOA and updated NASA FMEAs.

4.6 Indicators

There is an exact match between the IOA and the baseline FMEAs
for the BFC engage lights. There are no issues.

5.0 REFERENCES

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

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

2. JSC 18820   Data Processing System Briefs, Basic, Rev. A, PCN-1, 4-20-85

3. VS70-971099   Rockwell Integrated Systems Schematics, OV-99, 103, 104 GNC & DPS, 3-14-85

4. JSC 12770   Shuttle Flight Operations Manual, Volume 5, Data Processing System, 3-21-84

5. JSC 18219   Flight Procedures Handbook, Post Insertion, Final Revision A, 1-18-85

6. JSC 18817   Flight Procedures Handbook, Deorbit Prep, 3-1-83

7. TD123   Backup Flight System Software Workbook, BFS 2102, 8-10-82

8. V72 FILE III   Orbiter Operations and Maintenance Requirements and Specification Document, 6-13-86

9. NSTS 08171 FILE I   Operations and Maintenance Requirements and Specifications Document, 7-14-86

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

11. TD198/A198   GNC Overview Workbook, GNC OV 2102, 8-30-83

12. MGO38101   Backup System Service Program Requirement Document, Seq.1, Rev. H, 3 January 1985

13. MGO38106   Backup Flight System, Hardware Interface Program and GN&C Interface Program Requirements Document, Rev. E, 3 July 1985

APPENDIX A
ACRONYMS

ADTA	—	Air Data Transducer Assembly
AOA	—	Abort Once Around
ATO	—	Abort to Orbit
BFC	—	Backup Flight Controller
BFS	—	Backup Flight System
BSS	—	Backup System Services
CIL	—	Critical Items List
CPU	—	Central Processing Unit
CRIT	—	Criticality
CRT	—	Cathode Ray Tube
C&W	—	Caution and Warning System
DDU	—	Display Driver Unit
DEU	—	Display Electronics Unit
DPS	—	Data Processing System
DU	—	Display Unit
EVA	—	Extra Vehicular Activity
FA	—	Flight Aft
FF	—	Flight Forward
FM	—	Failure Mode
FMEA	—	Failure Mode and Effects Analysis
GPC	—	General Purpose Computer
GSE	—	Ground Support Equipment
HCED	—	Hand Controller Engage Driver
IMU	—	Inertial Measurement Unit
IOA	—	Independent Orbiter Assessment
IOP	—	Input/Output Processor
IPL	—	Initial Program Load
KU	—	Keyboard Unit
LRU	—	Line Replaceable Unit
MCDS	—	Multifunction CRT Display System
MDAC	—	McDonnell Douglas Astronautics Company
MDM	—	Multiplexer/Demultiplexer
MM	—	Major Mode
MMU	—	Mass Memory Unit
NA	—	Not Applicable
NASA	—	National Aeronautics and Space Administration
NSTS	—	National Space Transportation System
OMRSD	—	Operational Maintenance Requirements and Specifications Document
OMS	—	Orbital Maneuvering System
PAS	—	Primary Avionics System
PASS	—	Primary Avionics Software System
PB	—	Pushbutton
PCI	—	Potential Critical Item
RCS	—	Reaction Control System
RHC	—	Rotational Hand Controller
RI	—	Rockwell International
RM	—	Redundancy Management
RPC	—	Remote Power Controller

ACRONYMS

RS	–	Redundant Set
RTLS	–	Return to Landing Site
SFP	–	Single Failure Point
SM	–	Systems Management
STS	–	Space Transportation System
SW	–	Software
		Switch
TAC	–	Tacan
TAL	–	Transatlantic Abort Landing
TD	–	Touch Down
THC	–	Translational Hand Controller

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 <u>NSTS 22206, Instructions For Preparation of FMEA/CIL, 10 October 1986,</u> were used with the following amplifications and additions.

<u>INTACT ABORT DEFINITIONS:</u>

> <u>RTLS</u> - begins at transition to OPS 6 and ends at transition to OPS 9, post-flight

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

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

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

<u>CREDIBLE (CAUSE)</u> - 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

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

<u>EARLY MISSION TERMINATION</u> - termination of onorbit phase prior to planned end of mission

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

<u>HIGHEST CRITICALITY</u> - the highest functional criticality determined in the phase-by-phase analysis

<u>MAJOR MODE (MM)</u> - major sub-mode of software operational sequence (OPS)

<u>MC</u> - Memory Configuration of Primary Avionics Software System (PASS)

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

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

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

OPS - software operational sequence

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

PHASE DEFINITIONS:

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

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

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

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

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

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.2   IOA Project Level Ground Rules and Assumptions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.3 BFS-Specific Ground Rules and Assumptions

1. BFS failures are analyzed assuming that the BFS is (or will be) engaged.

    RATIONALE: Failure analysis and criticality determination is done assuming that the BFS must work when called upon to do so.

2. Failures which resulted in BFS engagement are not identified or analyzed.

    RATIONALE: Except for the PASS, it is assumed that other subsystems are operating within normal limits.

3. Only BFS-specific components and failure modes are analyzed.

    RATIONALE: Failure analysis of PASS/BFS common components is accomplished within the PASS analysis.

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 idendtifies 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   = Pre 51-L FMEA/CIL
     New   = Post 51-L FMEA/CIL (Baseline plus Proposed
                  Changes)
CIL Item:
     X = Included in CIL

Compare Row:
     N = Non compare for that column (deviation)

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-101   BASELINE [   ]
NASA FMEA #:   05-3-12200A-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 101
ITEM: POWER SUPPLY A(B,C) TO L(R) RHC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
THIS HARDWARE ITEM IS COVERED IN THE NASA D&C ANALYSIS.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-101A   BASELINE [   ]
NASA FMEA #:   05-3-12200A-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 101
ITEM: POWER SUPPLY A(B,C) TO L(R) RHC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THIS HARDWARE ITEM IS COVERED IN THE NASA D&C ANALYSIS.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-101B   BASELINE [   ]
NASA FMEA #:   05-3-12200B-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 101
ITEM: POWER SUPPLY A(B,C) TO L(R) RHC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THIS HARDWARE ITEM IS COVERED IN THE NASA D&C ANALYSIS.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-101C   BASELINE [   ]
NASA FMEA #:   05-3-12200B-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 101
ITEM: POWER SUPPLY A(B,C) TO L(R) RHC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                                ADEQUATE   [X]
                                              INADEQUATE   [   ]
REMARKS:
THIS HARDWARE ITEM IS COVERED IN THE NASA D&C ANALYSIS.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-201   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 201
ITEM: HALT RELAY

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT FAILURE OF
THAT HALT RELAY IS COVERED BY THE BFC LOSS OF OUTPUT/ERRONEOUS
OUTPUT FMEA.
THE IOA RECOMMENDS THAT A FUNCTIONAL DESCRIPTION OF THE HALT
RELAY AND AN EXPLANATION OF THE FAILED CLOSED CONSEQUENCES BE
ADDED TO THE FMEA FOR COMPLETENESS.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-202   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 202
ITEM: HALT RELAY

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT FAILURE OF
THE HALT RELAY IS COVERED BY THE BFC LOSS OF OUTPUT/ERRONEOUS
OUTPUT FMEA.
THE IOA RECOMMENDS THAT A FUNCTIONAL DESCRIPTION OF THE HALT
RELAY AND AN EXPLANATION OF THE FAILED OPEN CONSEQUENCES BE ADDED
TO THE FMEA FOR COMPLETENESS.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-203   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 203
ITEM: HAND CONTROLLER ENGAGE DRIVER

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS			CIL ITEM
		A	B	C	
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:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT FAILURE OF
THE HALT CONTROLLER ENGAGE DRIVER IS COVERED BY THE BFC LOSS OF
OUTPUT/ERRONEOUS OUTPUT FMEA.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-204   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 204
ITEM: HAND CONTROLLER ENGAGE DRIVER

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

              CRITICALITY   REDUNDANCY SCREENS   CIL
                 FLIGHT   ITEM
               HDW/FUNC   A   B   C

        NASA [2 /1R]   [F]   [F]   [P]   [X] *
        IOA   [1 /1]   [P]   [P]   [P]   [X]

COMPARE   [N /N]   [N]   [N]   [   ]   [   ]

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                                ADEQUATE   [X]
                                                INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT FAILURE OF
THE HALT CONTROLLER ENGAGE DRIVER IS COVERED BY THE BFC LOSS OF
OUTPUT/ERRONEOUS OUTPUT FMEA.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-205   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 205
ITEM: ENGAGE / DISENGAGE LOGIC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

          CRITICALITY   REDUNDANCY SCREENS   CIL
            FLIGHT   ITEM
          HDW/FUNC   A   B   C

   NASA [2 /1R]   [F]   [F]   [P]   [X] *
   IOA   [1 /1]   [P]   [F]   [NA]   [X]

COMPARE [N /N]   [N]   [   ]   [N]   [   ]

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT FAILURE OF
THE ENGAGE/DISENGAGE LOGIC IS COVERED BY THE BFC LOSS OF
OUTPUT/ERRONEOUS OUTPUT FMEA.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-206   BASELINE [   ]
NASA FMEA #:   NEW   [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 206
ITEM: CRT SELECT LOGIC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [   ]
                                          INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE NASA
ANALYSIS TREATED THE BFC AS A BLACK BOX. IF NASA GENERATES A
NON-CIL BFC FMEA, THE IOA SUGGESTS A FUNCTIONAL DESCRIPTION OF
THE CRT SELECT LOGIC AND AN EXPLANATION OF THE LOSS
OF OUTPUT/ERRONEOUS OUTPUT FAILURE CONSEQUENCES BE INCLUDED FOR
COMPLETENESS.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-207   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 207
ITEM: BFC POWER SUPPLY (5 VDC)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT FAILURE OF
THE 5 VDC BFC POWER SUPPLY IS COVERED BY THE BFC LOSS OF
OUTPUT/ERRONEOUS OUTPUT FMEA.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-208   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 208
ITEM: POWER UP/DOWN MONITOR LOGIC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

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

REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT INADVERTENT
OPERATION OF THE POWER UP/DOWN MONITOR LOGIC IS COVERED BY THE
BFC LOSS OF OUTPUT/ERRONEOUS OUTPUT FMEA.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-209   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 209
ITEM: POWER UP/DOWN MONITOR LOGIC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE IOA IDENTIFIED COMPONENT FAILURES WITHIN A BFC. THE FMEA
TREATED THE BFC AS A BLACK BOX. THE IOA AGREES THAT LOSS OF
OUTPUT FROM THE POWER UP/DOWN MONITOR LOGIC IS COVERED BY THE BFC
LOSS OF OUTPUT/ERRONEOUS OUTPUT FMEA.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/01/87   NASA DATA:
ASSESSMENT ID: BFS-210X   BASELINE [   ]
NASA FMEA #:   05-5-B30-1-3   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 210
ITEM: BACKUP FLIGHT CONTROLLER - BFC 2

LEAD ANALYST: L.W.HINSDALE

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE IOA AGREES WITH THE NASA ASSESSMENT OF THIS FAILURE MODE.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-301   BASELINE [   ]
NASA FMEA #:   05-5-B01-1-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 301
ITEM: BACKUP GPC (USUALLY GPC 5)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                            ADEQUATE   [X]
                                            INADEQUATE [   ]
REMARKS:
NASA PREPARED SEPARATE FMEAs FOR THE CPU AND IOP. THE IOA
TREATED THE GPC AS ONE BLACK BOX.
THE FMEA COUNTED PASS FAILURES IN ADDITION TO THE BFS GPC FAILURE
WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED CRITICALITY BASED
ON THE ASSUMPTION THE BFS WAS OR WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT GPC (CPU AND OR IOP)
LOSS OF OUTPUT IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA
RECOMMENDS THE FMEA CRITICALITIES BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-301A   BASELINE [   ]
NASA FMEA #:   05-5-B02-1-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 301
ITEM: BACKUP GPC (USUALLY GPC 5)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                            ADEQUATE   [X]
                                            INADEQUATE [   ]
REMARKS:
NASA PREPARED SEPARATE FMEAs FOR THE CPU AND IOP. THE IOA
TREATED THE GPC AS ONE BLACK BOX.
THE FMEA COUNTED PASS FAILURES IN ADDITION TO THE BFS GPC FAILURE
WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED CRITICALITY BASED
ON THE ASSUMPTION THE BFS WAS OR WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT GPC (CPU AND OR IOP)
LOSS OF OUTPUT IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA
RECOMMENDS THE FMEA CRITICALITIES BE RETAINED.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-302   BASELINE [   ]
NASA FMEA #:   05-5-B01-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 302
ITEM: BACKUP GPC (USUALLY GPC 5)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                    ADEQUATE   [X]
                                    INADEQUATE [   ]
REMARKS:
NASA PREPARED SEPARATE FMEAs FOR THE CPU AND IOP. THE IOA
TREATED THE GPC AS ONE BLACK BOX.
THE FMEA COUNTED PASS FAILURES IN ADDITION TO THE BFS GPC FAILURE
WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED CRITICALITY BASED
ON THE ASSUMPTION THE BFS WAS OR WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT GPC (CPU AND OR IOP)
ERRONEOUS OUTPUT IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE
IOA RECOMMENDS THE FMEA CRITICALITIES BE RETAINED.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-302A   BASELINE [   ]
NASA FMEA #:   05-5-B02-1-2   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 302
ITEM: BACKUP GPC (USUALLY GPC 5)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
NASA PREPARED SEPARATE FMEAs FOR THE CPU AND IOP. THE IOA
TREATED THE GPC AS ONE BLACK BOX.
THE FMEA COUNTED PASS FAILURES IN ADDITION TO THE BFS GPC FAILURE
WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED CRITICALITY BASED
ON THE ASSUMPTION THE BFS WAS OR WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT GPC (CPU AND OR IOP)
ERRONEOUS OUTPUT IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE
IOA RECOMMENDS THE FMEA CRITICALITIES BE RETAINED.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-401   BASELINE [   ]
NASA FMEA #:   05-5-B32-1-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 401
ITEM: BFS ENGAGE PUSHBUTTON

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

	CRITICALITY FLIGHT HDW/FUNC	REDUNDANCY SCREENS A	B	C	CIL ITEM
NASA	[3 /1R]	[P]	[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:
THE FMEA COUNTED PASS FAILURES IN ADDITION TO BFS ENGAGE SWITCH
FAILURES WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED
CRITICALITY BASED ON THE ASSUMPTION THE BFS WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT OPEN CONTACT FAILURE OF
THE ENGAGE SWITCH IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE
IOA RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-402   BASELINE [   ]
NASA FMEA #:   NEW   [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 402
ITEM: BFS ENGAGE PUSHBUTTON

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                              ADEQUATE   [   ]
                                              INADEQUATE [   ]
REMARKS:
THE FAIL CLOSED MODE FOR THE ENGAGE PUSHBUTTON CONTACTS WOULD
CAUSE INADVERTENT BFS ENGAGEMENT. THIS ALONE IS NOT
JUSTIFICATION FOR INCLUSION ON THE CIL. HOWEVER, THE IOA
CONSIDERS THIS TO BE A HIGHLY UNDESIRABLE FAILURE AND RECOMMENDS
IT BE COVERED IN THE UPDATED FMEAs FOR NON-CIL ITEMS.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-403   BASELINE [   ]
NASA FMEA #:   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 403
ITEM: BFC DISENGAGE SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

            CRITICALITY   REDUNDANCY SCREENS   CIL
              FLIGHT   ITEM
             HDW/FUNC   A   B   C

     NASA [/   ]   [   ]   [   ]   [   ]   [   ] *
     IOA   [3 /2R]   [P]   [F]   [NA]   [   ]

COMPARE   [N /N]   [N]   [N]   [N]   [   ]

RECOMMENDATIONS: (If different from NASA)

           [3 /2R]   [P]   [P]   [NA]   [   ]
                                                      (ADD/DELETE)

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [   ]
                                        INADEQUATE   [   ]
REMARKS:
AS A RESULT OF FURTHER REVIEW, THE IOA CONCLUDES THAT THE B
SCREEN FAILURE SHOULD BE CHANGED TO PASS. THE IOA RECOMMENDS THE
FAIL OPEN MODE FOR THE BFC DISENGAGE SWITCH BE COVERED IN THE
UPDATED FMEA FOR NON-CIL ITEMS.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-404   BASELINE [   ]
NASA FMEA #:   05-5-B31-1-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 404
ITEM: BFC DISENGAGE SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE FMEA COUNTED PASS FAILURES IN ADDITION TO BFC DISENGAGE
SWITCH CONTACTS BEING FAILED CLOSED WHEN ASSIGNING CRITICALITY.
THE IOA ASSIGNED CRITICALITY BASED ON THE ASSUMPTION THE BFS
WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT THE SWITCH FAILURE MODE
IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA RECOMMENDS THE
FMEA CRITICALITY BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-405   BASELINE [   ]
NASA FMEA #:   NEW   [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 405
ITEM: BFC CRT DISPLAY SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [   ]
                                          INADEQUATE [   ]
REMARKS:
THE FAIL OPEN MODE FOR THE BFC CRT DISPLAY SWITCH IS INSUFFICIENT
FOR INCLUSION ON THE CIL.   THE IOA RECOMMENDS IT BE COVERED IN
THE UPDATED FMEAs FOR NON-CIL ITEMS.

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-406   BASELINE [   ]
NASA FMEA #:   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 406
ITEM: BFC CRT SELECT SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                                ADEQUATE   [   ]
                                                INADEQUATE [   ]
REMARKS:
THE FAIL OPEN, FAIL TO SWITCH, AND ERRONEOUS OUTPUT MODES FOR THE
BFC CRT SELECT SWITCH ARE INSUFFICIENT FOR INCLUSION ON THE CIL.
THE IOA RECOMMENDS THEY BE COVERED IN THE UPDATED FMEAs FOR NON-
CIL ITEMS.
3/3.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/24/87   NASA DATA:
ASSESSMENT ID: BFS-407   BASELINE [   ]
NASA FMEA #:   05-6S-BSW7-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 407
ITEM: BFS GPC (USUALLY GPC 5) POWER SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE FMEA COUNTED A GENERIC PASS FAILURE IN ADDITION TO BFS GPC
SWITCH FAILURE WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED
CRITICALITY BASED ON THE ASSUMPTION BFS WAS OR WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT GPC POWER SWITCH FAIL
OPEN CONTACTS IS SUFFICIENT JUSTIFICATION FOR INCLUSION ON THE
CIL, THE IOA RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-408   BASELINE [   ]
NASA FMEA #:   05-5-B15-1-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 408
ITEM: BFS GPC (USUALLY GPC 5) OUTPUT SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
THE FMEA COUNTED PASS GENERIC FAILURE IN ADDITION TO BFS GPC
OUTPUT SWITCH FAILURE WHEN ASSIGNING CRITICALITY. THE IOA
ASSIGNED CRITICALITY BASED ON THE ASSUMPTION THE BFS WOULD BE
ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT ERRONEOUS OPERATION OF
THE GPC OUTPUT SWITCH IS JUSTIFICATION FOR INCLUSION ON THE CIL,
THE IOA RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-409   BASELINE [   ]
NASA FMEA #:   05-5-B17-1-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 409
ITEM: BFS GPC (USUALLY GPC 5) MODE SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable) _____
                                           ADEQUATE   [X]
                                           INADEQUATE [   ]
REMARKS:
THE FMEA COUNTED PASS GENERIC FAILURE IN ADDITION TO BFS GPC MODE
SWITCH FAILURE WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED
CRITICALITY BASED ON THE ASSUMPTION THE BFS WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT ERRONEOUS OPERATION OF
THE GPC MODE SWITCH IS JUSTIFICATION FOR INCLUSION ON THE CIL,
THE IOA RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-501   BASELINE [   ]
NASA FMEA #:   05-6Q-2103A-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 501
ITEM: CIRCUIT BREAKER, 7.5 AMP. - MAIN A (B,C) SUPPLY
TO L(R) DDU

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

              CRITICALITY   REDUNDANCY SCREENS   CIL
                 FLIGHT   ITEM
              HDW/FUNC   A   B   C

      NASA [3 /1R]   [P]   [F]   [P]   [X] *
       IOA [3 /1R]   [P]   [P]   [P]   [X]

COMPARE   [/   ]   [   ]   [N]   [   ]   [   ]

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
     THE IOA BFS ANALYSIS AGREES WITH THE BASELINE FMEA (EPD&C-
D&C SUBSYSTEM).

ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-501A   BASELINE [   ]
NASA FMEA #:   05-6Q-2103B-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 501
ITEM: CIRCUIT BREAKER, 7.5 AMP. - MAIN A (B,C) SUPPLY
TO L(R) DDU

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

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]	[X]
COMPARE	[/]	[ ]	[N]	[ ]	[ ]

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                      ADEQUATE   [X]
                                      INADEQUATE [   ]
REMARKS:
     THE IOA BFS ANALYSIS AGREES WITH THE BASELINE FMEA (EPD&C-
D&C SUBSYSTEM).

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-502   BASELINE [   ]
NASA FMEA #:   05-6S-BFUS4-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 502
ITEM: FUSE F9, 1 AMP. - CNTL BUS AB3 SUPPLY TO
DISENGAGE SWITCH AND BFC MODULES 1A & 1B (HCED & ENGAGE LOGIC)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                         ADEQUATE   [X]
                                         INADEQUATE [   ]
REMARKS:
ONE FMEA COVERS FUSES F9, F10, AND F11. THE IOA PREPARED
SEPARATE ANALYSIS WORKSHEETS FOR EACH FUSE BECAUSE THE FAILURE
EFFECTS ARE DIFFERENT. THE IOA AGREES THAT FAIL OPEN OF FUSE F11
(CIRCUIT PROTECTION FOR CONTROL BUS CA1) RESULTS IN LOSS OF
ABILITY TO ENGAGE BFS. IF EITHER F9 OR F10 (CIRCUIT PROTECTION
FOR CONTROL BUS AB3) FAILS OPEN, THE ABILITY TO ENGAGE BFS EXISTS
BUT THE AUTOMATIC DISENGAGE OF GPCs THAT INTERFACE WITH MODULES A
AND B IN BFC 1 (NORMALLY GPCs 1 AND 4) AND MODULE A
IN BFC 2 (NORMALLY GPC 2) IS LOST, I.E., A FORCE FIGHT BETWEEN
THE BFS GPC AND THREE PASS GPCs COULD DEVELOP.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT OPEN FAILURE OF THE
FUSES IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA
RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-503   BASELINE [   ]
NASA FMEA #:   05-6S-BFUS4-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 503
ITEM: FUSE F10, 1 AMP. - CNTL BUS AB3 SUPPLY TO
DISENGAGE SWITCH AND BFC MODULE 2A - HCED & ENGAGE LOGIC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
ONE FMEA COVERS FUSES F9, F10, AND F11. THE IOA PREPARED
SEPARATE ANALYSIS WORKSHEETS FOR EACH FUSE BECAUSE THE FAILURE
EFFECTS ARE DIFFERENT. THE IOA AGREES THAT FAIL OPEN OF FUSE F11
(CIRCUIT PROTECTION FOR CONTROL BUS CA1) RESULTS IN LOSS OF
ABILITY TO ENGAGE BFS. IF EITHER F9 OR F10 (CIRCUIT PROTECTION
FOR CONTROL BUS AB3) FAILS OPEN, THE ABILITY TO ENGAGE BFS EXISTS
BUT THE AUTOMATIC DISENGAGE OF GPCs THAT INTERFACE WITH MODULES A
AND B IN BFC 1 (NORMALLY GPCs 1 AND 4) AND MODULE A
IN BFC 2 (NORMALLY GPC 2) IS LOST, I.E., A FORCE FIGHT BETWEEN
THE BFS GPC AND THREE PASS GPCs COULD DEVELOP.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT OPEN FAILURE OF THE
FUSES IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA
RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-504   BASELINE [   ]
NASA FMEA #:   05-6S-BFUS4-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 504
ITEM: FUSE F11, 1 AMP. - CNTL BUS CA1 SUPPLY TO
DISENGAGE SWITCH AND BFC MODULES 2B, 3A, 3B - HCED & ENGAGE LOGIC

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
ONE FMEA COVERS FUSES F9, F10, AND F11. THE IOA PREPARED
SEPARATE ANALYSIS WORKSHEETS FOR EACH FUSE BECAUSE THE FAILURE
EFFECTS ARE DIFFERENT. THE IOA AGREES THAT FAIL OPEN OF FUSE F11
(CIRCUIT PROTECTION FOR CONTROL BUS CA1) RESULTS IN LOSS OF
ABILITY TO ENGAGE BFS. IF EITHER F9 OR F10 (CIRCUIT PROTECTION
FOR CONTROL BUS AB3) FAILS OPEN, THE ABILITY TO ENGAGE BFS EXISTS
BUT THE AUTOMATIC DISENGAGE OF GPCs THAT INTERFACE WITH MODULES A
AND B IN BFC 1 (NORMALLY GPCs 1 AND 4) AND MODULE A
IN BFC 2 (NORMALLY GPC 2) IS LOST, I.E., A FORCE FIGHT BETWEEN
THE BFS GPC AND THREE PASS GPCs COULD DEVELOP.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT OPEN FAILURE OF THE
FUSES IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA
RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 11/30/87   NASA DATA:
ASSESSMENT ID: BFS-505   BASELINE [   ]
NASA FMEA #:   05-6S-BFUS3-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 505
ITEM: FUSE F49, 3 AMP. - ESS BUS 3AB SUPPLY TO GPC
OUTPUT SWITCHES (BACKUP & NORMAL DISCRETES)

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [X]
                                        INADEQUATE [   ]
REMARKS:
THE FMEA COUNTED PASS GENERIC FAILURE IN ADDITION TO THE FUSE
FAILURE WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED CRITICALITY
BASED ON THE ASSUMPTION THE BFS WAS OR WOULD BE ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT FUSE F49 FAILED OPEN
MODE IS JUSTIFICATION FOR INCLUSION ON THE CIL, THE IOA
RECOMMENDS THE FMEA CRITICALITY BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/18/86   NASA DATA:
ASSESSMENT ID: BFS-506   BASELINE [   ]
NASA FMEA #:   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 506
ITEM: FUSE, 3 AMP. - ESS BUS SUPPLY TO BFS GPC
(USUALLY GPC 5) POWER SWITCH

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

```
        CRITICALITY    REDUNDANCY SCREENS        CIL
           FLIGHT                                ITEM
          HDW/FUNC     A       B       C

  NASA  [   /   ]    [   ]   [   ]   [   ]      [    ] *
   IOA  [ 3 /1R ]    [ P ]   [ P ]   [ P ]      [    ]

COMPARE [ N /N  ]    [ N ]   [ N ]   [ N ]      [    ]
```

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [   ]
                                        INADEQUATE [   ]
REMARKS:
THE IOA RECOMMENDS A FUNCTIONAL DESCRIPTION OF THE REDUNDANT
FUSES AND AN EXPLANATION OF THE FAIL OPEN CONSEQUENCES BE
INCLUDED FOR COMPLETENESS IN THE UPDATED FMEAs FOR NON-CIL ITEMS.
     THE IOA RECOMMENDS THAT A FMEA BE CREATED FOR THIS FAILURE
MODE.

ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/01/87   NASA DATA:
ASSESSMENT ID: BFS-507X   BASELINE [   ]
NASA FMEA #:   05-6S-BD102-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 507
ITEM: DIODE, MAIN BUS ISOLATION TO BFS GPC AND BFC

LEAD ANALYST: L.W.HINSDALE

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE IOA AGREES WITH THE NASA ASSESSMENT OF THIS FAILURE MODE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/01/87   NASA DATA:
ASSESSMENT ID: BFS-508X   BASELINE [   ]
NASA FMEA #:   05-6S-BD102-3   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 508
ITEM: DIODE, MAIN BUS ISOLATION TO BFS GPC AND BFC

LEAD ANALYST: L.W.HINSDALE

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE IOA AGREES WITH THE NASA ASSESSMENT OF THIS FAILURE MODE.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/01/87   NASA DATA:
ASSESSMENT ID: BFS-509X   BASELINE [   ]
NASA FMEA #:   05-6S-BFUS5-1   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 509
ITEM: FUSE F28, 5 AMP - MAIN BUS SUPPLY TO BFS BFC
POWER MONITOR LOGIC

LEAD ANALYST: L.W.HINSDALE

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
THE FMEA COUNTED PASS GENERIC FAILURE IN ADDITION TO THE FUSE
FAILED OPEN MODE WHEN ASSIGNING CRITICALITY. THE IOA ASSIGNED
CRITICALITY BASED ON THE ASSUMPTION THE BFS HAS BEEN OR WILL BE
ENGAGED.
SINCE BOTH ANALYSIS METHODS CONCLUDE THAT OPEN FAILURE OF THE
FUSE IS JUSTFICATION FOR INCLUSION ON THE CIL, THE IOA RECOMMENDS
THE FMEA CRITICALITY BE RETAINED.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/18/86   NASA DATA:
ASSESSMENT ID: BFS-601   BASELINE [   ]
NASA FMEA #:   05-8-BFS010-0001   NEW [X]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 601
ITEM: BFC ENGAGE LIGHT

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [   ]
                                          INADEQUATE [   ]
REMARKS:
    THE NASA ANALYSIS AND THE IOA AGREE COMPLETELY.

ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/18/86   NASA DATA:
ASSESSMENT ID: BFS-602   BASELINE [X]
NASA FMEA #:   05-8-BFS010-0002   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 602
ITEM: BFC ENGAGE LIGHT

LEAD ANALYST: L.W.HINSDALE/E.E.PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                        ADEQUATE   [   ]
                                        INADEQUATE [   ]
REMARKS:
     THE NASA ANALYSIS AND THE IOA AGREE COMPLETELY.

APPENDIX C
ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/18/86   NASA DATA:
ASSESSMENT ID: BFS-1001X   BASELINE [X]
NASA FMEA #:   05-8-BFS003-0001   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 1001
ITEM: INERTIAL MEASUREMENT UNIT (IMU)

LEAD ANALYST: L.W. HINSDALE/E.E. PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                         ADEQUATE   [X]
                                         INADEQUATE [   ]
REMARKS:
     THE IOA AGREES WITH THE NASA ASSESSMENT OF THE EFFECT OF
THIS FAILURE.
     HOWEVER, THE FAILURE MODE ANALYZED IS A SOFTWARE FAILURE,
AND IS OUTSIDE THE SCOPE OF A HARDWARE ANALYSIS.

ASSESSMENT WORKSHEET

ASSESSMENT DATE: 12/18/86   NASA DATA:
ASSESSMENT ID: BFS-2001X   BASELINE [X]
NASA FMEA #:   05-8-BFS012-1   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 2001
ITEM: AIR DATA TRANSDUCER ASSEMBLY (ADTA)

LEAD ANALYST: L.W. HINSDALE/E.E. PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

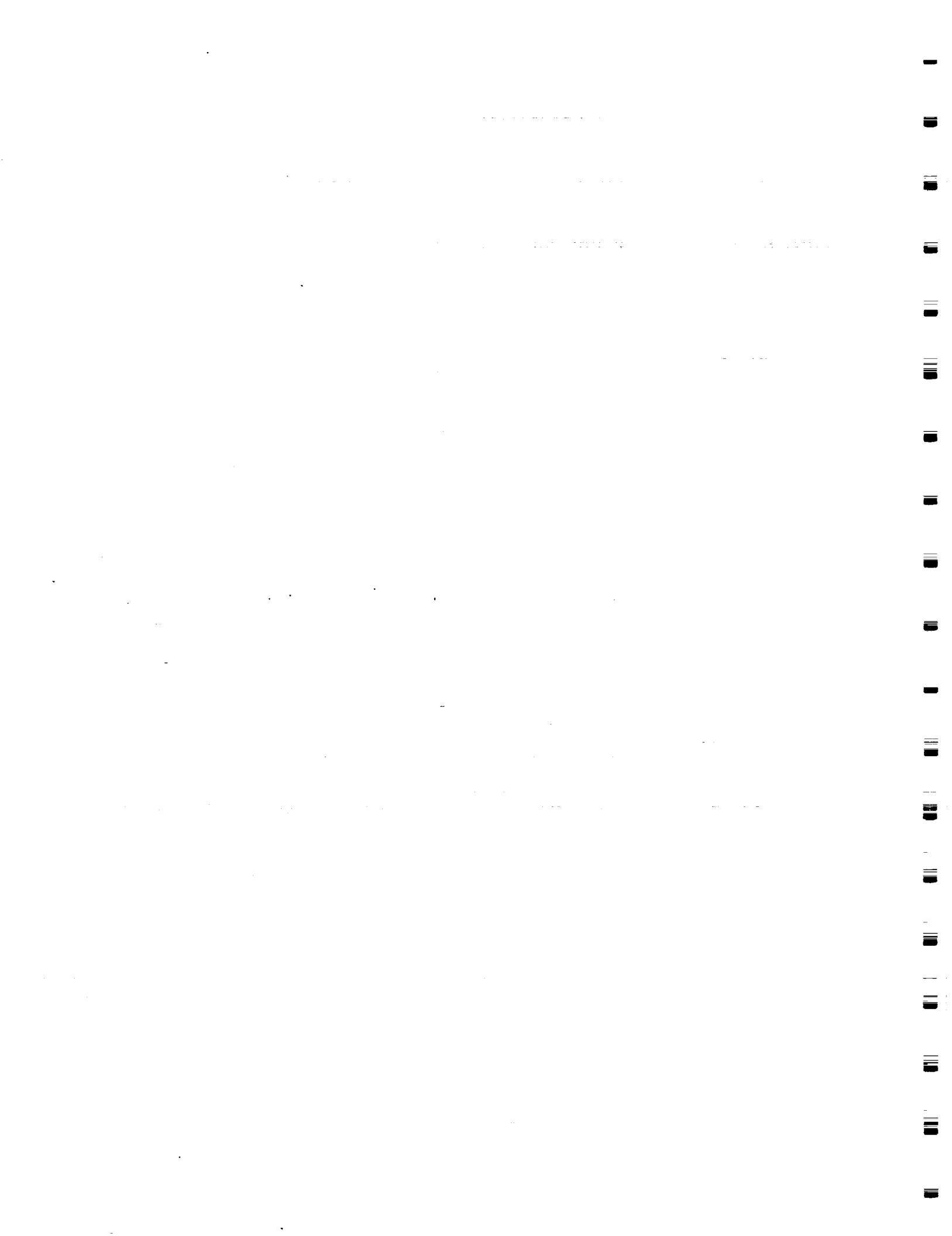* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
     THE IOA AGREES WITH THE NASA ASSESSMENT OF THIS FAILURE.
THE DIFFERENCE IN CRITICALITY IS DUE TO A DIFFERENCE IN
INTERPRETATION OF FMEA/CIL PREPARATION INSTRUCTIONS.
     HOWEVER, THE IOA BELIEVES THAT THIS HARDWARE IS OUTSIDE THE
SCOPE OF THE BACKUP FLIGHT SYSTEM, AND SHOULD INSTEAD BE DEALT
WITH IN THE GN&C SUBSYSTEM FMEAs.

ASSESSMENT DATE: 12/18/86   NASA DATA:
ASSESSMENT ID: BFS-2002X   BASELINE [X]
NASA FMEA #:   05-8-BFS013-1   NEW [   ]

SUBSYSTEM: BACKUP FLIGHT SYSTEM
MDAC ID: 2002
ITEM: PROBE (AIR DATA)

LEAD ANALYST: L.W. HINSDALE, E.E. PRUST

ASSESSMENT:

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

RECOMMENDATIONS: (If different from NASA)

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

* CIL RETENTION RATIONALE: (If applicable)
                                          ADEQUATE   [X]
                                          INADEQUATE [   ]
REMARKS:
     THE IOA AGREES WITH THE NASA ASSESSMENT OF THIS FAILURE.
THE DIFFERENCE IN CRITICALITY IS DUE TO A DIFFERENCE IN
INTERPRETATION OF FMEA/CIL PREPARATION INSTRUCTIONS.
     HOWEVER, THE IOA BELIEVES THAT THIS HARDWARE IS OUTSIDE THE
SCOPE OF THE BACKUP FLIGHT SYSTEM, AND SHOULD INSTEAD BE DEALT
WITH IN THE GN&C SUBSYSTEM FMEAs.

APPENDIX D

CRITICAL ITEMS

APPENDIX D
POTENTIAL CRITICAL ITEMS

NASA FMEA	MDAC-ID	FLIGHT	ITEM	FAILURE MODE
05-3-12200A-1	101	2/1R	POWER SUPPLY A(B,C) TO L(R) RHC	LOSS OF OUTPUT, PARTIAl OUTPUT
05-3-12200A-2	101	2/1R	POWER SUPPLY A(B,C) TO L(R) RHC	LOSS OF OUTPUT, PARTIAL OUTPUT
05-3-12200B-1	101	2/1R	POWER SUPPLY A(B,C) TO L(R) RHC	LOSS OF OUTPUT, PARTIAL OUPUT
05-3-12200B-2	101	2/1R	POWER SUPPLY A(B,C) TO L(R) RHC	LOSS OF OUTPUT, PARTIAL OUTPUT
05-5-B30-1-2	201	1/1	HALT RELAY	INADVERTENT OPERATION, FAILS TO REMAIN OPEN
05-5-B30-1-2	202	3/2R	HALT RELAY	FAILS TO CLOSE
05-5-B30-1-2	203	2/1R	HAND CONTROLLER ENGAGE DRIVER	LOSS OF DISCRETE OUTPUT
05-5-B30-1-2	204	1/1	HAND CONTROLLER ENGAGE DRIVER	LOSS OF 28 VDC OUTPUT
05-5-B30-1-2	205	1/1	ENGAGE / DISENGAGE LOGIC	LOSS OF OUTPUT, ERRONEOUS OUTPUT
05-5-B30-1-2	207	1/1	BFC POWER SUPPLY (5 VDC)	LOSS OF OUTPUT, PARTIAL OUTPUT, FAILS OUT OF TOLERANCE
05-5-B30-1-2	208	1/1	POWER UP/DOWN MONITOR LOGIC	INADVERTENT OPERATION
05-5-B30-1-2	209	1/1	POWER UP/DOWN MONITOR LOGIC	LOSS OF OUTPUT
05-5-B30-1-3	210	3/1R	BACKUP FLIGHT CNTL	INADVERTENT ENGAGE
05-5-B01-1-1	301	1/1	BACKUP GPC (USUALLY GPC 5)	LOSS OF OUTPUT
05-5-B02-1-1	301	1/1	BACKUP GPC (USUALLY GPC 5)	LOSS OF OUTPUT
05-5-B01-1-2	302	1/1	BACKUP GPC (USUALLY GPC 5)	ERRONEOUS OUTPUT
05-5-B02-1-2	302	1/1	BACKUP GPC (USUALLY GPC 5)	ERRONEOUS OUTPUT
05-5-B32-1-1	401	2/1R	BFS ENGAGE PUSHBUTTON	FAILS TO CLOSE
05-5-B31-1-1	404	1/1	BFC DISENGAGE SW	FAILS TO REMAIN OPEN, FAILS TO RE-OPEN
05-6S-BSW7-1	407	1/1	BFS GPC (USUALLY GPC 5) POWER SWITCH	FAILS TO CLOSE, FAILS TO REMAIN CLOSED
05-5-B15-1-1	408	1/1	BFS GPC (USUALLY GPC 5) PWR SW	FAILS OUT OF "BACKUP"

NASA FMEA	MDAC-ID	FLIGHT	ITEM	FAILURE MODE
05-5-B17-1-1	409	1/1	BFS GPC (USUALLY GPC 5) MODE SW	INADVERTENTLY IN "HALT
05-6Q-2103A-1	501	3/1R	CIRCUIT BREAKER, 7.5 AMP	OPEN CIRCUIT
05-6Q-2103B-1	501	3/1R	CIRCUIT BREAKER, 7.5 AMP	OPEN CIRCUIT
05-6S-BFUS4-1	502	1/1	FUSE F9, 1 AMP. - CNTL BUS AB3	OPEN CIRCUIT
05-6S-BFUS4-1	503	1/1	FUSE F10, 1 AMP. - CNTL BUS AB3	OPEN CIRCUIT
05-6S-BFUS4-1	504	1/1	FUSE F11, 1 AMP. - CNTL BUS AB3	OPEN CIRCUIT
05-6S-BFUS3-1	505	1/1	FUSE F49, 3 AMP. - ESS BUS 3AB	OPEN CIRCUIT
05-6S-BD102-1	507	3/1R	DIODE, MAIN BUS ISOLATION TO BFS GPC AND BFC	FAILS TO CONDUCT, OPEN, HIGH RESISTANCE
05-6S-BD102-3	508	3/1R	DIODE, MAIN BUS ISOLATION TO BFS GPC AND BFC	SHORTS, CONDUCTS IN REVERSE DIRECTION
05-6S-BFUS5-1	509	1/1	FUSE F28, 5 AMP - MAIN BUS SUPPLY TO BFS BFC POWER	OPEN
05-8-BFS003-000	1001	1/1	INERTIAL MEASUREMENT UNIT	ERRONEOUS OUTPUT
05-8-BFS012-1	2001	1/1	AIR DATA TRANSDUCER	ERRONEOUS OUTPUT
05-8-BFS013-1	2002	1/1	PROBE (AIR DATA)	ERRONEOUS OUTPUT

APPENDIX E
ANALYSIS WORKSHEETS

This appendix contains the IOA analysis worksheets supplementing previous results reported in STSEOS Working Paper 1.0-WP-VA86001-18, Analysis of the Backup Flight System, (15 December 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 the Instructions for Preparation of FMEA and CIL, NSTS 22206, 10 October 1986. Finally, effects are entered at the bottom of each sheet, and the worst case criticality is entered at the top.

LEGEND FOR IOA ANALYSIS WORKSHEETS

Hardware Criticalities :
    1   = Loss of life or vehicle
    2   = Loss of mission
    3   = Non loss of life or vehicle or mission

Functional Criticalities :
    1R = Redundant identical hardware components or redundant
          functional paths all of which, if failed, could cause
          loss of life or vehicle.
    2R = Redundant identical hardware components or redundant
          functional paths 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: 12/03/87   HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 3/1R
MDAC ID: 210   ABORT: 3/1R

ITEM: BACKUP FLIGHT CONTROLLER - BFC 2
FAILURE MODE: INADVERTENT ENGAGE

LEAD ANALYST: L.W.HINSDALE   SUBSYS LEAD: J.J.EWELL

BREAKDOWN HIERARCHY:
 1) BACKUP FLIGHT CONTROLLER
 2)
 3)
 4)
 5)
 6)
 7)
 8)
 9)

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

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

LOCATION: FWD AVIONICS BAY
PART NUMBER: MC615-0023-0003

CAUSES: PIECE PART FAILURE, VIBRATION, CONTAMINATION

EFFECTS/RATIONALE:
PREMATURE BFS ENGAGE, POSSIBLE FORCE FIGHT IF SOME PASS GPC
OUTPUTS ARE NOT DISABLED, POSSIBLE LOSS OF CONTROL - LOSS OF
VEHICLE AND LOSS OF CREW.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/03/87   HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 3/1R
MDAC ID: 507   ABORT: 3/1R

ITEM: DIODE, MAIN BUS ISOLATION TO BFS GPC AND BFC
FAILURE MODE: FAILS TO CONDUCT. OPEN, HIGH RESISTANCE

LEAD ANALYST: L.W.HINSDALE   SUBSYS LEAD: J.J.EWELL

BREAKDOWN HIERARCHY:
 1) CIRCUIT PROTECTION
 2)
 3)
 4)
 5)
 6)
 7)
 8)
 9)

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

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

LOCATION:
PART NUMBER: JANTX 1N11884

CAUSES: CONTAMINATION, SHOCK, VIBRATION, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE TRIPLE REDUNDANT MAIN BUS POWER PATHS TO EACH IOP, CPU AND
BFC ARE ISOLATED BY DIODES. TWO DIODES CAN FAIL WITH NO EFFECT.
THE THIRD FAILURE CAUSES LOSS OF THE INTERFACING GPC.
THREE FAILURES COULD PREVENT THE BFS FROM BEING ENGAGED. WITH
BFS ENGAGED, THREE FAILURES WOULD CAUSE LOSS OF CONTROL, LOSS OF
VEHICLE, AND LOSS OF CREW.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/03/87   HIGHEST CRITICALITY   HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 3/1R
MDAC ID: 508   ABORT: 3/1R

ITEM: DIODE, MAIN BUS ISOLATION TO BFS GPC AND BFC
FAILURE MODE: SHORTS, CONDUCTS IN REVERSE DIRECTION

LEAD ANALYST: L.W.HINSDALE   SUBSYS LEAD: J.J.EWELL

BREAKDOWN HIERARCHY:
 1) CIRCUIT PROTECTION
 2)
 3)
 4)
 5)
 6)
 7)
 8)
 9)

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

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

LOCATION:
PART NUMBER: JANTX 1N11884

CAUSES: CONTAMINATION, SHOCK, VIBRATION, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE TRIPLE REDUNDANT MAIN BUS POWER PATHS TO EACH IOP, CPU AND
BFC ARE ISOLATED BY DIODES. TWO DIODES CAN FAIL WITH NO EFFECT.
THE THIRD FAILURE CAUSES LOSS OF THE INTERFACING GPC.
THREE FAILURES COULD PREVENT THE BFS FROM BEING ENGAGED. WITH
BFS ENGAGED, THREE FAILURES WOULD CAUSE LOSS OF CONTROL, LOSS OF
VEHICLE, AND LOSS OF CREW.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/03/87   HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 1/1
MDAC ID: 509   ABORT: 1/1

ITEM: FUSE F28, 5 AMP - MAIN BUS SUPPLY TO BFS BFC POWER
MONITOR LOGIC
FAILURE MODE: OPEN

LEAD ANALYST: L.W.HINSDALE   SUBSYS LEAD: J.J.EWELL

BREAKDOWN HIERARCHY:
  1) CIRCUIT PROTECTION
  2)
  3)
  4)
  5)
  6)
  7)
  8)
  9)

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

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

LOCATION:
PART NUMBER: ME451-0018-0500

CAUSES: VIBRATION, SHOCK, STRUCTURAL FAILURE

EFFECTS/RATIONALE:
FAILURE PREVENTS BFS FROM BEING ENGAGED. WITH BFS ENGAGED,
FAILURE CAUSES LOSS OF CONTROL, LOSS OF VEHICLE AND CREW.

REFERENCES:

REPORT DATE 02/22/88   E-5

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/18/86   HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 1/1
MDAC ID: 1001   ABORT: 1/1

ITEM: INERTIAL MEASUREMENT UNIT (IMU)
FAILURE MODE: ERRONEOUS OUTPUT FROM PASS DUE TO GENERIC FAILURE
OF PRIMARY SYSTEM SOFTWARE

LEAD ANALYST: L.W. HINSDALE/E.E. PRUST   SUBSYS LEAD:
J.J.EWELL

BREAKDOWN HIERARCHY:
 1)   IMU
 2)
 3)
 4)
 5)
 6)
 7)
 8)
 9)

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

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

LOCATION:
PART NUMBER: MC409-0004-0010

CAUSES: ERRONEOUS SOFTWARE TORQUING INPUT OR MODING COMMAND

EFFECTS/RATIONALE:
NAVIGATION ERRORS WILL ACCUMULATE CAUSING LOSS OF VEHICLE
CONTROL. SUCCESSFUL BFS TAKEOVER IS PRECLUDED.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/18/86   HIGHEST CRITICALITY   HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 1/1
MDAC ID: 2001   ABORT: 1/1

ITEM: AIR DATA TRANSDUCER ASSEMBLY (ADTA)
FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: L.W. HINSDALE/E.E. PRUST   SUBSYS LEAD:
J.J.EWELL

BREAKDOWN HIERARCHY:
  1) AIR DATA SYSTEM
  2)
  3)
  4)
  5)
  6)
  7)
  8)
  9)

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

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

LOCATION:
PART NUMBER: MC409-0011-0006

CAUSES: HIGH TEMPERATURE, VIBRATION, PIECE PART STRUCTURAL
FAILURE

EFFECTS/RATIONALE:
ERRONEOUS OUTPUT FROM AN ADTA CAN AFFECT CALCULATIONS OF CRITICAL
FIGHT CONTROL PARAMETERS. IF UNDETECTED, LOSS OF CONTROL, LOSS
OF VEHICLE, AND LOSS OF CREW IS PROBABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT
ORBITER SUBSYSTEM ANALYSIS WORKSHEET

DATE: 12/18/86   HIGHEST CRITICALITY   HDW/FUNC
SUBSYSTEM: BACKUP FLIGHT SYSTEM   FLIGHT: 1/1
MDAC ID: 2002   ABORT: 1/1

ITEM: PROBE (AIR DATA)
FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: L.W. HINSDALE, E.E. PRUST   SUBSYS LEAD:
J.J.EWELL

BREAKDOWN HIERARCHY:
 1) AIR DATA SYSTEM
 2)
 3)
 4)
 5)
 6)
 7)
 8)
 9)

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

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

LOCATION:
PART NUMBER: MC432-0206

CAUSES:

EFFECTS/RATIONALE:
FAILURE IN EITHER PROBE (IF UNDETECTED BY ADTA BITE PRIOR TO
ENGAGING BFS) WILL CAUSE LOSS OF CONTROL, LOSS OF VEHICLE AND
CREW.

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). The worksheets include those from the previous results reported in STSEOS Working Paper 1.0-WP-VA86001-18, Analysis of the Backup Flight System, (15 December 1986) and the supplementary worksheets contained in Appendix E of this report. The Appendix F identifies: NASA FMEA Number, IOA Assessment Number, NASA criticality and redundancy screen data, and IOA recommendations.

Appendix F Resolution/Issue/Rationale Codes

Code   Definition

   1   IOA and NASA criticalities differ. IOA does not
        consider PASS as a redundant capability to the BFS.
        NASA counts PASS failure as the first failure when
        assigning BFS failure mode criticalities.

   2   IOA recommends generating a FMEA for the subject
        failure mode.

   3   IOA identified failures within an LRU.

   4   FMEA went one level deeper than the IOA.

   5   IOA and FMEA document same failure mode differently.

   6   NASA deleted failure mode impact on BFS from Nov. '87
        baseline.

   7   NASA moved CIL to GN&C subsystem in Nov. '87 baseline.

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
	BFS-206	/		/		3	
	BFS-402	/		3/3	P P NA	2	
	BFS-403	/		3/2R	P P NA	2	
	BFS-405	/		3/3	P P NA	2	
	BFS-406	/		3/3	P P NA	2	
	BFS-506	/		3/1R	P P P	2	
05-3-12200A-1	BFS-101	3/1R	P P F	/		1, 5	
05-3-12200A-2	BFS-101A	3/1R	P P F	/		1, 5	
05-3-12200B-1	BFS-101B	3/1R	P P F	/		1, 5	
05-3-12200B-2	BFS-101C	3/1R	P P F	/		1, 5	
05-5-B01-1-1	BFS-301	2/1R	P P P	/		1, 4	
05-5-B01-1-2	BFS-302	1/1		/		4	
05-5-B02-1-1	BFS-301A	2/1R	P P P	/		1, 4	
05-5-B02-1-2	BFS-302A	1/1		/		4	
05-5-B15-1-1	BFS-408	2/1R	P F P	/		1	
05-5-B17-1-1	BFS-409	2/1R	P F P	/		1	
05-5-B30-1-2	BFS-201	2/1R	F F P	/		1, 2, 3	
	BFS-202	2/1R	F F P	/		1, 2, 3	
	BFS-203	2/1R	F F P	/		3	
	BFS-204	2/1R	F F P	/		1, 3	
	BFS-205	2/1R	F F P	/		1, 3	
	BFS-207	2/1R	F F P	/		1, 3	
	BFS-208	2/1R	F F P	/		1, 3	
	BFS-209	2/1R	F F P	/		1, 3	
05-5-B30-1-3	BFS-210X	3/1R	P F P	/			
05-5-B31-1-1	BFS-404	2/1R	P F P	/		1	
05-5-B32-1-1	BFS-401	3/1R	P F P	/		1	
05-6Q-2103A-1	BFS-501	3/1R	P F P	/		4	
05-6Q-2103B-1	BFS-501A	3/1R	P F P	/		4	
05-6S-BD102-1	BFS-507X	3/1R	P F P	/			
05-6S-BD102-3	BFS-508X	3/1R	P F P	/			
05-6S-BFUS3-1	BFS-505	2/1R	P F P	/		1	
05-6S-BFUS4-1	BFS-502	2/1R	P F P	/		1, 3	
	BFS-503	2/1R	P F P	/		1, 3	
	BFS-504	2/1R	P F P	/		1, 3	
05-6S-BFUS5-1	BFS-509X	2/1R	P P P	/		1	
05-6S-BSW7-1	BFS-407	2/1R	P P P	/		1	
05-8-BFS003-0001	BFS-1001X	1/1	NA NA NA	/		6	
05-8-BFS010-0001	BFS-601	3/3	P P P	/			
05-8-BFS010-0002	BFS-602	3/3	P P P	/			
05-8-BFS012-1	BFS-2001X	2/1R	NA NA NA	/		1, 7	
05-8-BFS013-1	BFS-2002X	2/1R	NA NA NA	/		1, 7	