

YERO Preliminary PRA Analysis

Prepared by:

Duncan, Gary	281-335-2300
Wilson, Paul	281-335-2291
Teri Hamlin	281-244-0194

Contacts:

Hudson, Robert	281-244-5391
Bommareddy, Sushma	281-335-2260
Tran, To-Tu	281-335-2263
Arnold, C.A.	281-335-2217
Penney, Michael	281-335-2226

Purpose:

The STS-116 flight depending on launch date could be on-orbit when the calendar year transitions from 2006 to 2007 which will result in a problem for the General Purpose Computers (GPCs). That is the first day of the New Year the GPCs will transition from day 365 to day 366 while the Master Timing Unit (MTU) will transition from 365 to 001. A problem would then result when the GPCs request an update from the MTU the delta time would cause an exception to the GPC. The solution is to bring down the GPCs and perform Initial Program Load (IPL) to re-initialize the GPCs. The purpose of this analysis is to document the delta risk of performing this procedure. This paper will analyze two potential hazards. 1) Failure to perform the procedure would result loss of all GPCs and an inability to undock from the ISS. 2) Failures that require an emergency undock while the vehicle is unable to respond could result in Loss of Crew and Vehicle.

Methodology:

A fault tree methodology was chosen for this analysis. Three fault trees were developed (shown in Appendix A). The first fault tree is used to quantify the probability of failure to perform the IPL procedure. It was developed with three branches (1) Orbiter hardware, (2) Ground support and satellite tracking, and (3) human factors. A second fault tree is used to calculate the probability of Loss of Mission due to Failed Redundant Hardware Strings. A third fault tree is used to quantify the probability of having to perform an emergency undock. The top logic of this fault tree is shown in Appendix A. The fault tree logic that supports the top logic is documented in the SPRA Iteration 2.1.

Assumptions:

Failure to Perform the IPL

- 1) Assumed flight rule will be implemented stating if there are failures of hardware critical to performing the IPL the mission will be terminated, to avoid the YERO event. Therefore the exposure window for this analysis limited to the duration of the YERO recovery procedure (4 hours) considered a conservative estimate of the time required to perform the IPL
- 2) Only the delta mission risk is evaluated that is the risk of performing the IPL in space.
- 3) For this iteration it is assumed ground support and Tracking & Data Relay Satellite System (TDRSS) is available.
- 4) Assumed the IPL procedure has been adequately verified and will work.
- 5) Assumed ground operations will be performed nominally.
- 6) Assume Ku-band is backed up by S-band on-orbit
- 7) Assume S-band Switch Beam Control Assembly (SBCA) and Switch assembly are not critical to S-band operation
- 8) Assume S-band preamp and power amp are internally redundant
- 9) Although there is an HRA event “Crew Fails to Perform Procedure” this event is set false because the crew can perform multiple attempts.
- 10) Although the IPL can be performed without the MTU its failure contribution was consider for the analysis. This is because it is assumed the IPL with be developed assuming a functional MTU. That is if the MTU is failed a contingency Load will need to be developed.
- 11) ADD Software assumption here.

Probability of an Emergency Undock

- 1) SPRA Iteration 2.1 was used with the exposure time adjusted from a 9 day mission to 1 and 12 hours.
- 2) The vehicle will be unable to respond for ~45 minutes during the IPL. This was rounded to 1 hour.
- 3) A 12 hour case was included in case the procedure took longer to perform than anticipated.

- 4) The following flight rules were evaluated that would require an emergency undock:
- Loss of Cabin Pressure
 - Loss of Two Cabin Fans
 - Loss of Two Freon Loops
 - Loss of Two Water Loops
 - Loss of PPO2 Control
- 5) Loss of Both A/G voice and CMD and OMS/RCS propellant leaks was considered to be insignificant compared to other contributors.
- 6) Fire in AV Bay or Cabin was not considered
- 7) Impending Loss of ALL APU/HYD was not considered because it is quiescent during the time frame of concern and failure while quiescent is considered to be insignificant compared to other contributors.
- 8) This procedure will not be performed during any critical mission activities.

Reliability Data:

Reliability data was obtained from S&MA Reliability Reports and Shuttle Quick Look (developed from shuttle data) and is presented in Appendix B. Basic events and their associated data for each of the scenarios are listed in Appendix C.

Results:

Table 1 – IPL PRA Results

	Probability	Probability (1 in X)	Comment
Failure to Perform IPL	8.70E-05	11,500	Cut sets provided in Appendix D
Probability of having to perform an Emergency undock during a 1 hour period	1.85E-05	54,000	Cut sets provided in Appendix D
Probability of Loss of Mission (LOM) due to loss of redundant string(s)	1.00E-01	10	Cut sets provided in Appendix D

If these events were conservatively considered to be Loss of Crew then performing this procedure would increase the probability of Loss of Crew by less than 1 percent based on STS-115 probability of Loss of Crew of 1:77.

Failure to perform the IPL is heavily dependent on both crew and mission operations actions. However, since it is assumed that the procedure can be restarted as many times as necessary if until success human error does not end up as a risk driver.

Sensitivity Study

Two sensitivity studies were also run one to document the case were a flight rule is not evoked requiring mission termination upon losing 1 string of 2 string redundant hardware or losing 2 strings of a 3 string redundant hardware system. The exposure time is assumed to 24 hours. That is 12 hours prior the new year and up to 12 hours to implement the procedure post new years.

The second entry presents the probability of an anomaly occurring that would require an emergency undock during a 12 hours window. This would be a case where the IPL did not go as planned and therefore took an extended period of time.

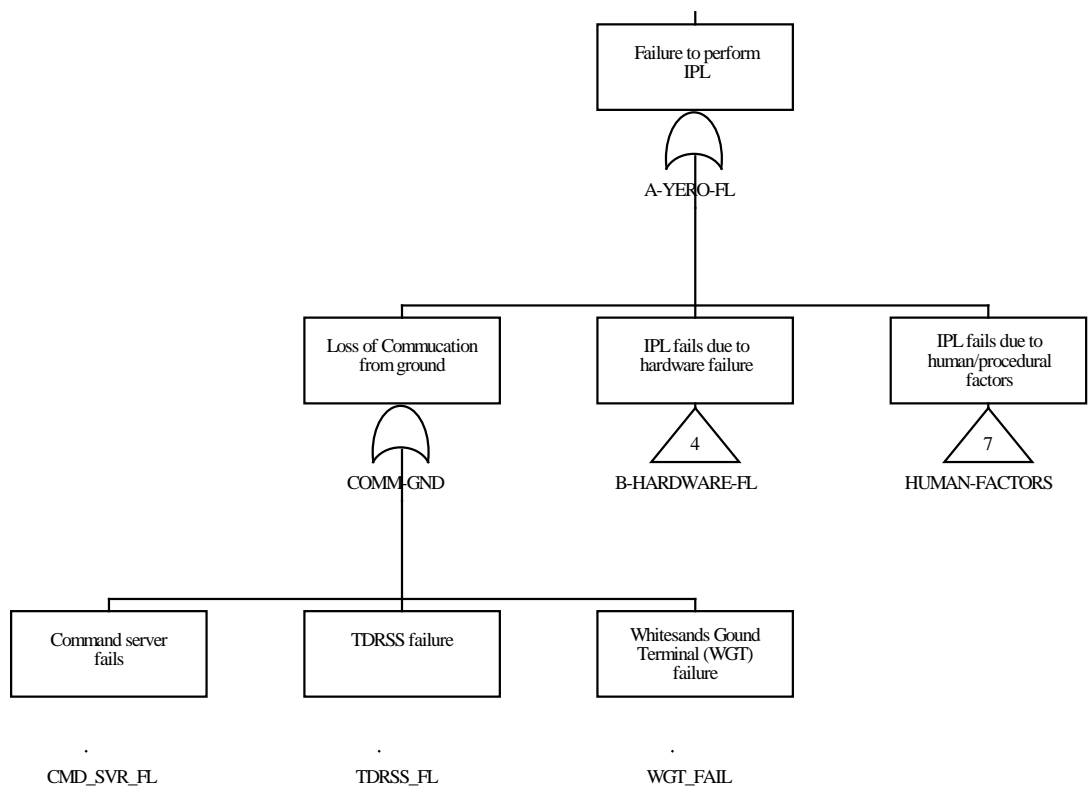
Table 2 – IPL PRA Sensitivity Study Results

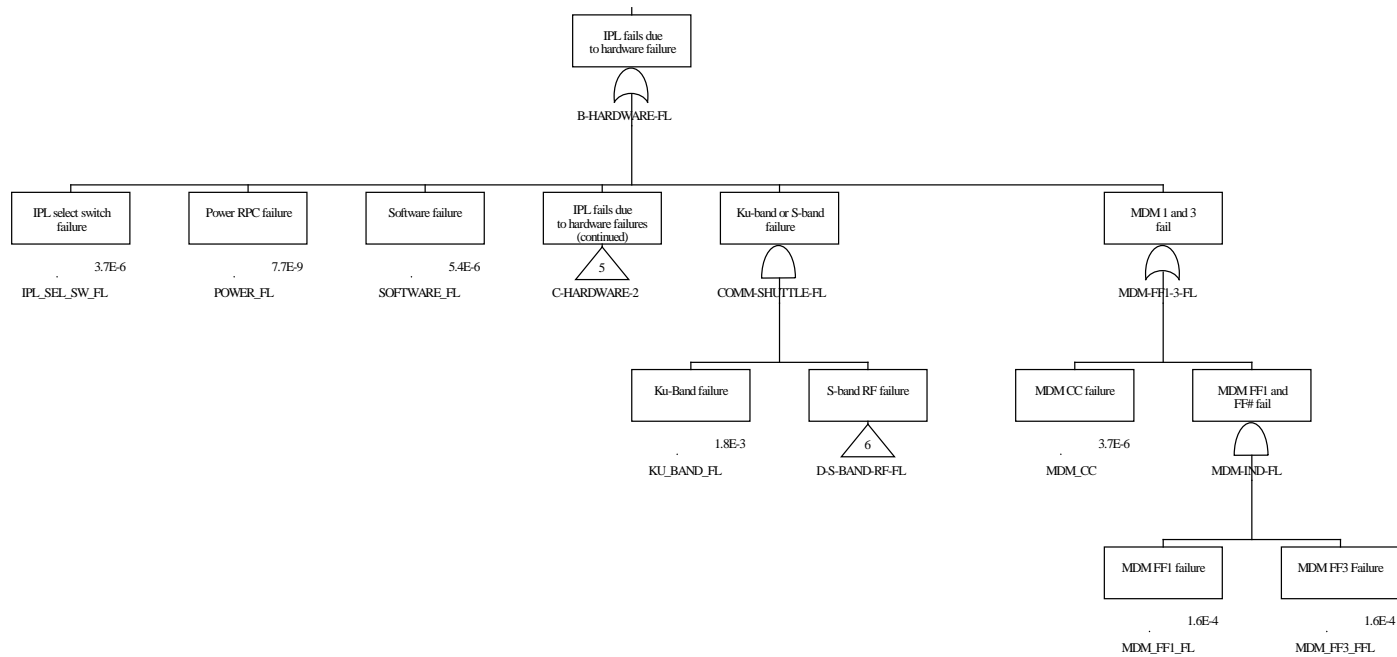
	Probability	Probability (1 in X)	Comment
No Flight Rule Case (24 hours exposure time)	4.20E-04	2,380	Cut sets provided in Appendix D
Probability of having to perform an emergency undock during a 12 hour period	1.85E-04	5,400	Cut sets provided in Appendix D

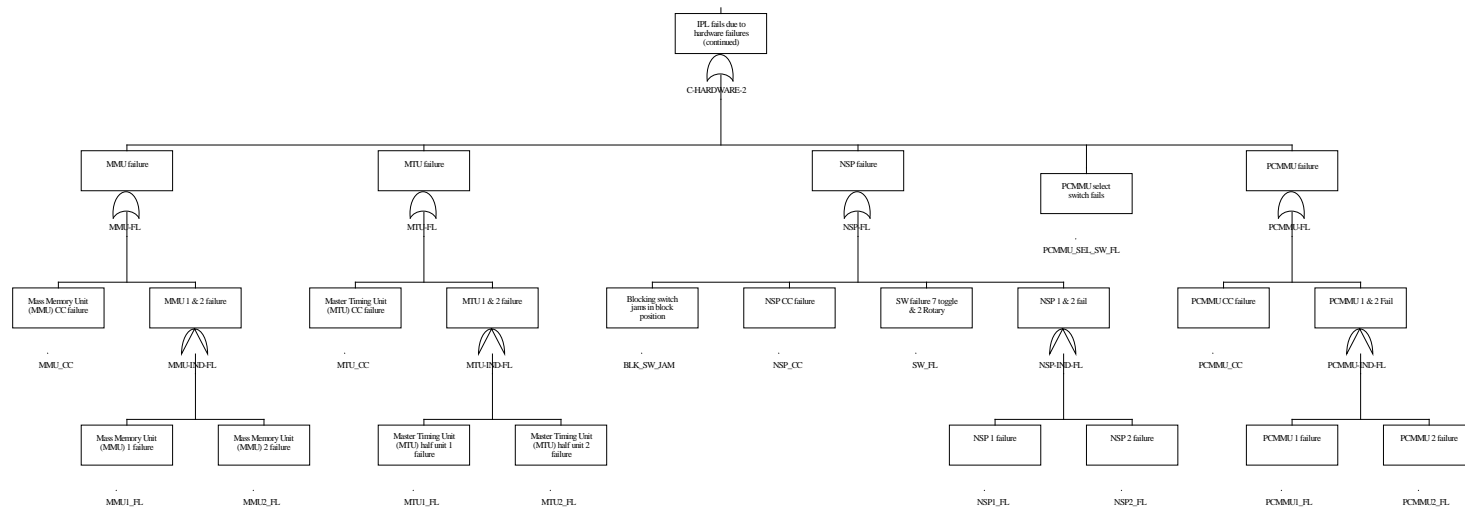
Appendix A: Failure to Perform IPL Fault Tree

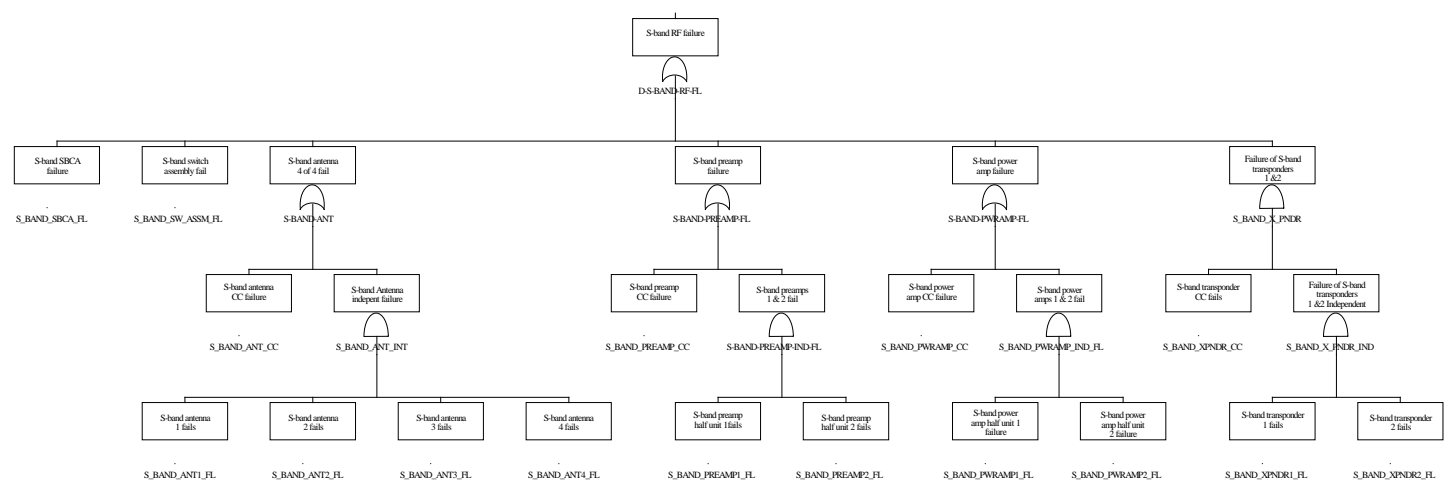
Tree Title	Page Number
Failure to Perform IPL	A-3
Loss of Mission due to Failed Redundant Hardware String	A-9
Probability of Required Undock Procedure	A-15

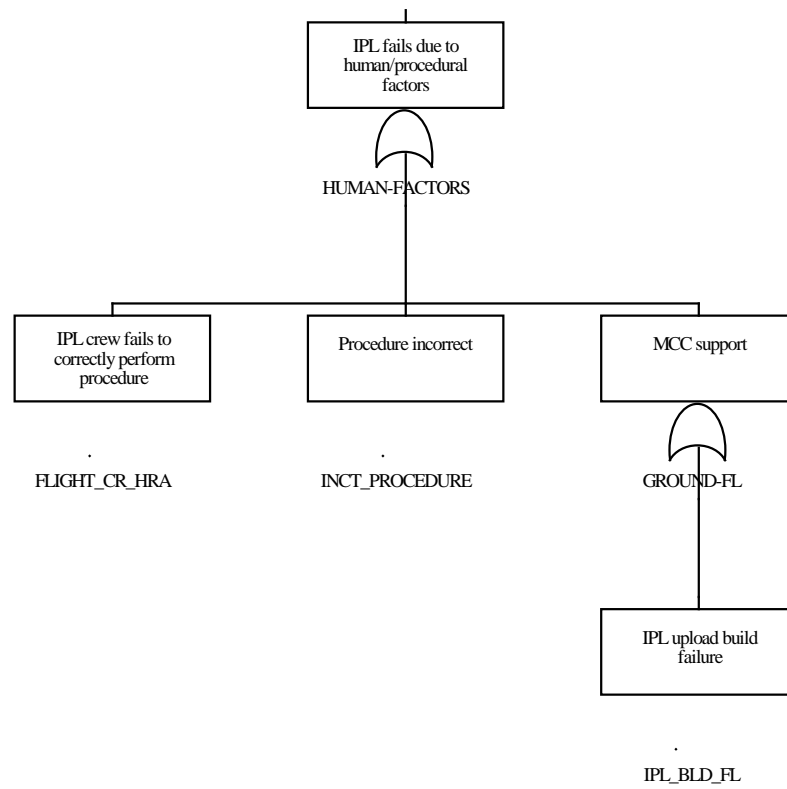
Fault Tree - Failure to Perform IPL



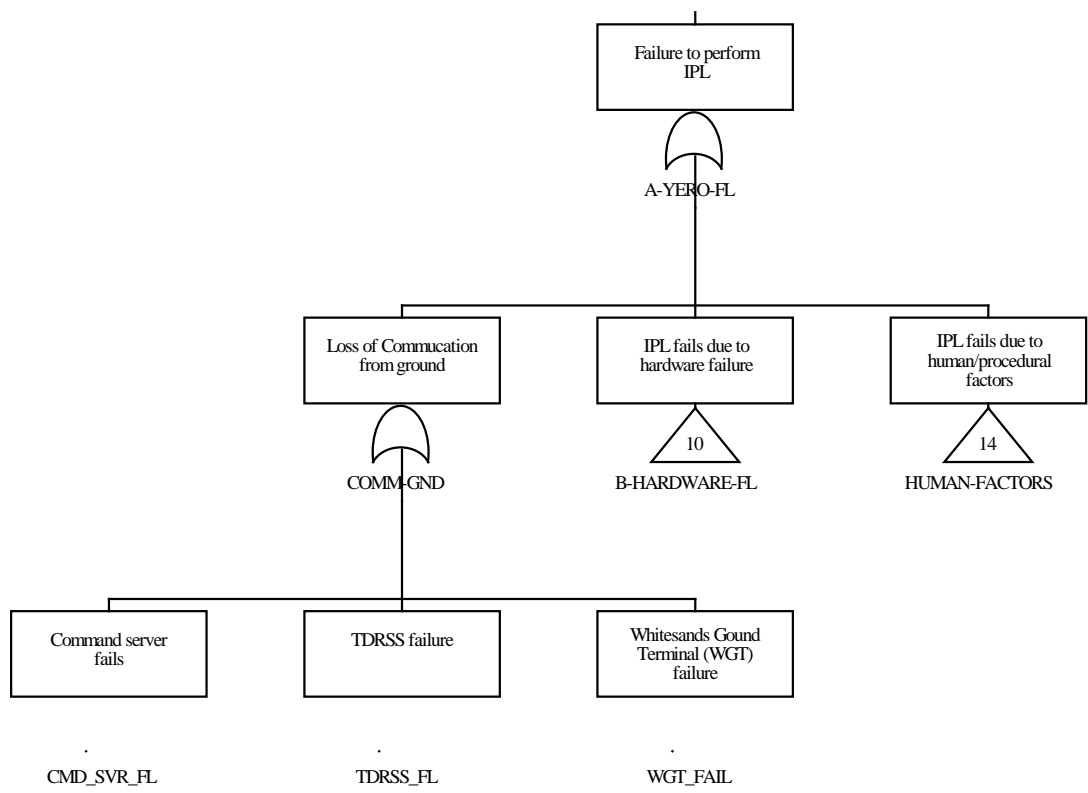


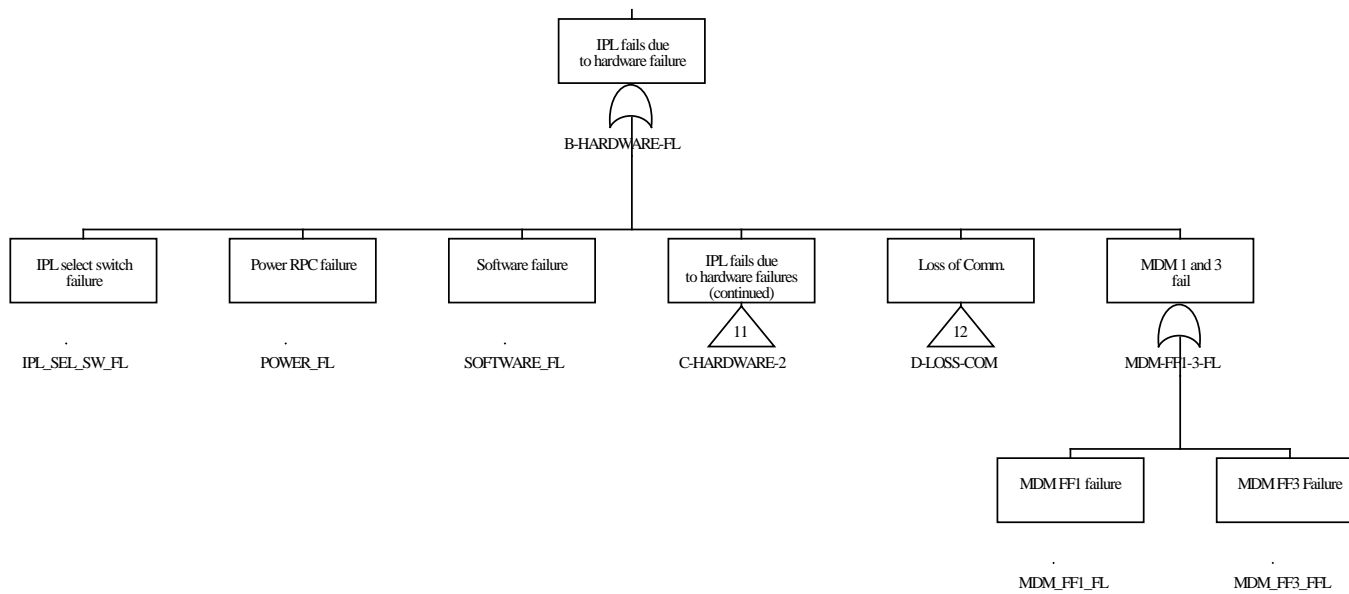


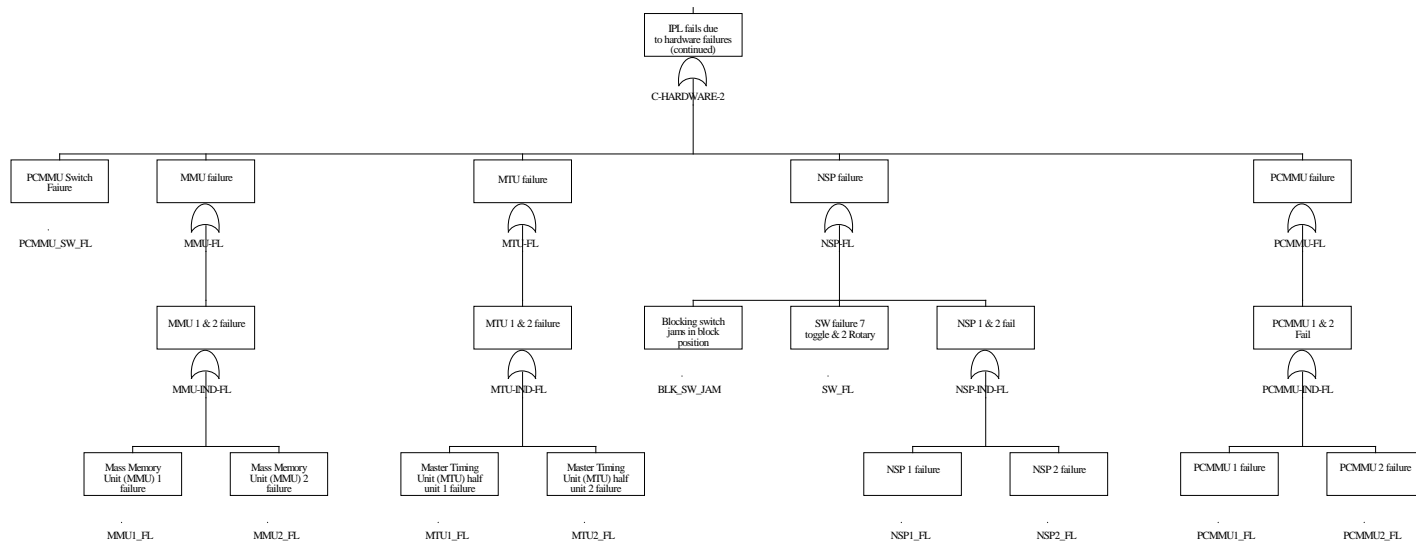


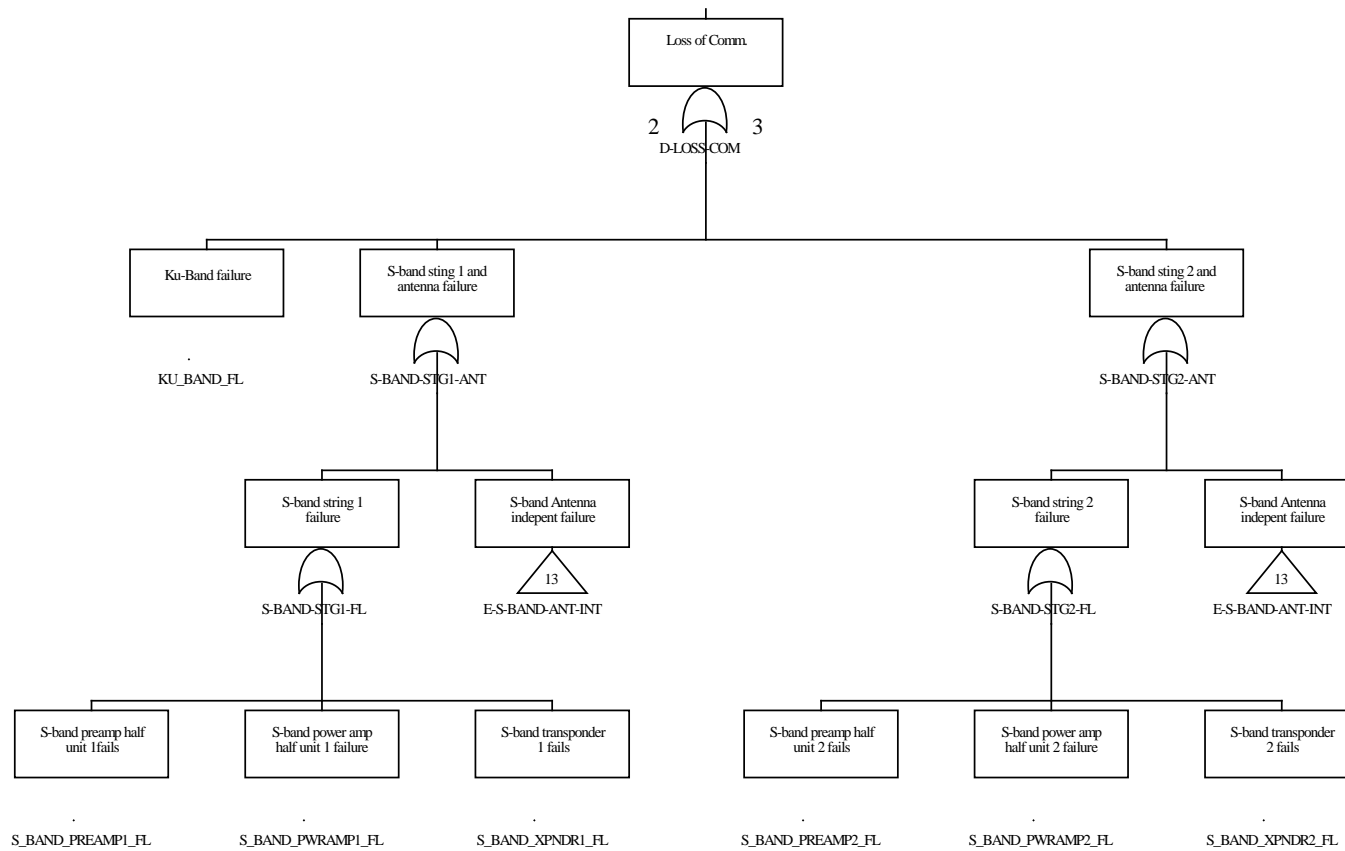


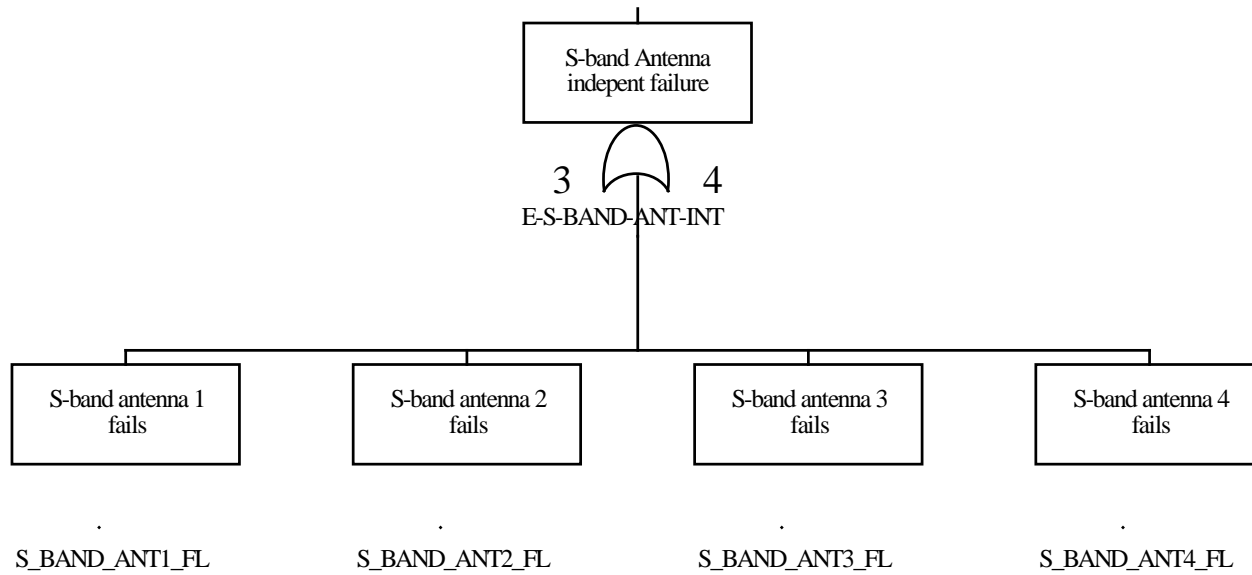
Fault Tree - Loss of Mission due to Failed Redundant Hardware String

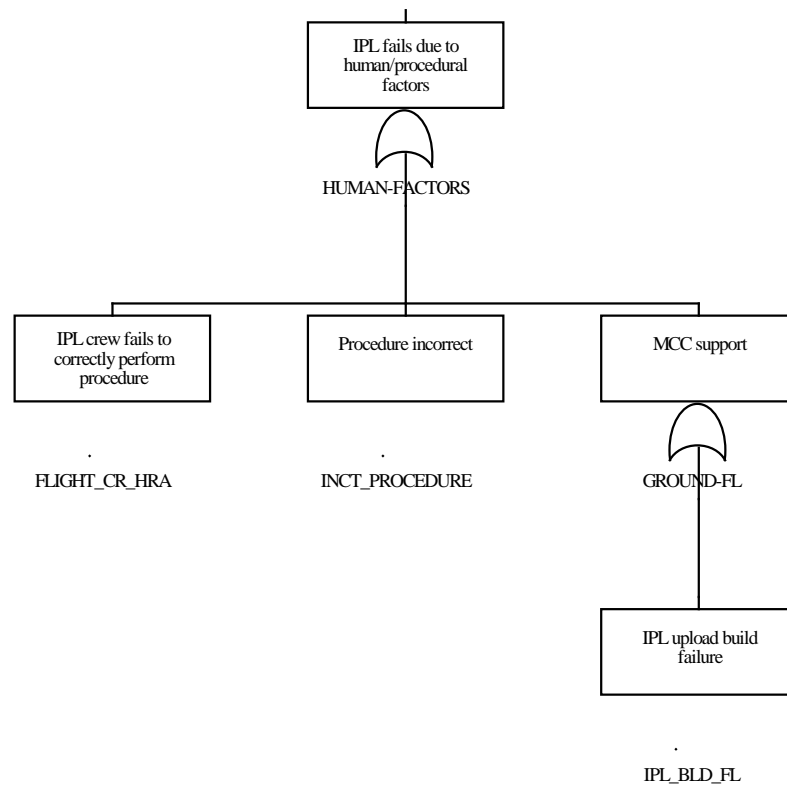




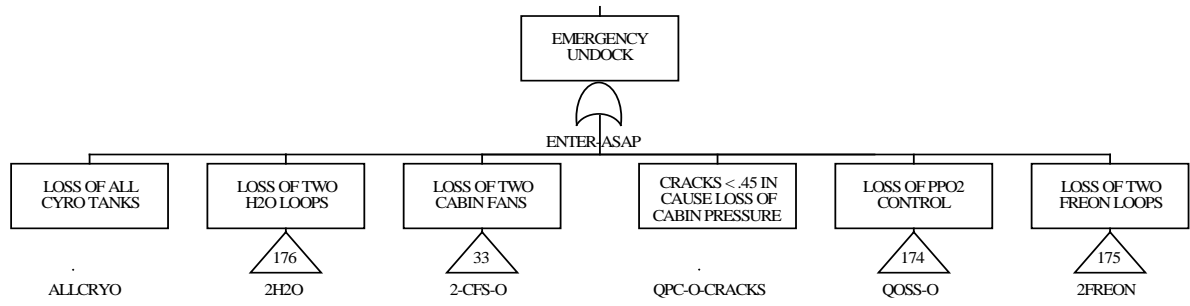








Fault Tree - Probability of Required Undock Procedure



Appendix B – Failure to Perform IPL Reliability Data

Component	Failure Rate (Lambda)	Failure Type	Source	Notes
PCMMU	2.51E-05	Time	PCMMU R&M Report SSMA 00-0058	
NSP	4.38E-05	Time	S-Band R&M Report SSMA 98-0011	
Ku-Band	4.44E-04	Time	Ku-Band R&M Report SSMA 02-001	
S-Band power amp. Half unit failure	2.33E-05	Time	S-Band R&M Report SSMA 98-011	
S-Band pre amp. Half unit failure	2.50E-05	Time	S-Band R&M Report SSMA 98-011	
S-Band antenna	2.19E-05	Time	S-Band R&M Report SSMA 98-011	
S-Band transponder	2.19E-05	Time	S-Band R&M Report SSMA 98-011	
S-Band SBCA	2.33E-05	Time	S-Band R&M Report SSMA 98-011	
S-Band switch assembly	2.33E-05	Time	S-Band R&M Report SSMA 98-011	
MDM	3.90E-05	Time		
MMU	3.00E-07	Time	Shuttle PRA 2.0 assumed similar to MDM MIA card	
MTU	8.79E-05	Time	MTU R&M Report SSMA 00-009	
Software	1.36E-06	Time	Pass FSW Quarterly Quality Report Mar. 31, 2006 (Part 3-14)	Calculated a lambda based on 1 failure per 3,400 flights average 9 day mission. Assumes constant failure rate
Power PRC	1.93E-09	Time	Shuttle Quick Look	
HRA Crew	0			Assumed IPL could be repeated until successful
Command server	N/A			
TDRSS	N/A			
WGT	N/A			
IPL select switch failure	7.99E-06	Demand	Shuttle PRA 1.5	Not in 2.0/2.1 Contact failure .47 = 3.75E-06

Component	Failure Rate (Lambda)	Failure Type	Source	Notes
Rotary Switch short	4.96E-06	Time	Shuttle Quick Look	
Toggle Switch short	8.11E-08	Time	Shuttle Quick Look	
Toggle Switch jam	9.63E-08	Time	Shuttle Quick Look	

Appendix C – Failure to Perform IPL Basic Event Data

Tree Title	Page Number
Failure to Perform IPL 4 hour exposure time	C-2
Failure to Perform IPL 24 Hour exposure time	C-4
Loss of Mission (LOM)	C-6

Failure to Perform IPL 4 hour exposure time – Basic Event Listing

Name	Description	Fail Type	Calc. Prob.	Probability	Lambda	Mission Time
CMD_SVR_FL	Command server fails	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
COMSEC1_FL	COMSEC half unit 1 failure	3	1.752E-004	1.000E+000	4.380E-005	4.000E+000
COMSEC2_FL	COMSEC half unit 2 failure	3	1.752E-004	1.000E+000	4.380E-005	4.000E+000
COMSEC_CC	COMSEC CC failure	C	4.117E-006	1.000E+000	1.030E-006	4.000E+000
D-S-BAND-RF-FL	S-band RF failure	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
FLIGHT_CR_HRA	IPL crew fails to correctly perform procedure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
HUMAN-FACTORS	IPL fails due to human/procedural factors	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
INCT_PROCEDURE	Procedure incorrect	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
IPL_BLD_FL	IPL upload build failure	1	1.500E-005	1.500E-005	0.000E+000	0.000E+000
IPL_SEL_SW_FL	IPL select switch failure	1	3.750E-006	3.750E-006	0.000E+000	0.000E+000
KU_BAND_FL	Ku-Band failure	3	1.774E-003	1.000E+000	4.439E-004	4.000E+000
MDM_CC	MDM CC failure	C	3.666E-006	1.000E+000	0.000E+000	0.000E+000
MDM_FF1_FL	MDM FF1 failure	3	1.560E-004	0.000E+000	3.900E-005	4.000E+000
MDM_FF3_FFL	MDM FF3 Failure	3	1.560E-004	0.000E+000	3.900E-005	4.000E+000
MMU1_FL	Mass Memory Unit (MMU) 1 failure	3	1.200E-006	1.000E+000	3.000E-007	4.000E+000
MMU2_FL	Mass Memory Unit (MMU) 2 failure	3	1.200E-006	1.000E+000	3.000E-007	4.000E+000
MMU_CC	Mass Memory Unit (MMU) CC failure	C	2.820E-008	1.000E+000	7.050E-009	4.000E+000
MTU1_FL	Master Timing Unit (MTU) half unit 1 failure	3	3.515E-004	0.000E+000	8.790E-005	4.000E+000
MTU2_FL	Master Timing Unit (MTU) half unit 2 failure	3	3.515E-004	0.000E+000	8.790E-005	4.000E+000
MTU_CC	Master Timing Unit (MTU) CC failure	C	8.261E-006	0.000E+000	2.070E-006	4.000E+000
NSP1_FL	NSP 1 failure	3	1.752E-004	1.000E+000	4.380E-005	4.000E+000
NSP2_FL	NSP 2 failure	3	1.752E-004	1.000E+000	4.380E-005	4.000E+000
NSP_CC	NSP CC failure	C	8.233E-006	1.000E+000	2.060E-006	4.000E+000
PCMMU1_FL	PCMMU 1 failure	3	1.004E-004	0.000E+000	2.510E-005	4.000E+000
PCMMU2_FL	PCMMU 2 failure	3	1.004E-004	0.000E+000	2.510E-005	4.000E+000
PCMMU_CC	PCMMU CC failure	C	2.359E-006	8.810E-006	0.000E+000	0.000E+000
PCMMU_SEL_SW_FL	PCMMU select switch fails	1	3.750E-006	3.750E-006	0.000E+000	0.000E+000
POWER_FL	Power RPC failure	3	7.720E-009	1.000E+000	1.930E-009	4.000E+000
SOFTWARE_FL	Software failure	3	5.440E-006	1.000E+000	1.360E-006	4.000E+000
SW_FL	SW failure 7 toggle & 2 Rotary	3	4.000E-005	1.000E+000	1.000E-005	4.000E+000
S_BAND_ANT1_FL	S-band antenna 1 fails	3	8.756E-004	1.000E+000	2.190E-004	4.000E+000

Name	Description	Fail Type	Calc. Prob.	Probability	Lambda	Mission Time
S_BAND_ANT2_FL	S-band antenna 2 fails	3	8.756E-004	1.000E+000	2.190E-004	4.000E+000
S_BAND_ANT3_FL	S-band antenna 3 fails	3	8.756E-004	1.000E+000	2.190E-004	4.000E+000
S_BAND_ANT4_FL	S-band antenna 4 fails	3	8.756E-004	1.000E+000	2.190E-004	4.000E+000
S_BAND_ANT_CC	S-band antenna CC failure	C	2.058E-005	1.000E+000	5.150E-006	4.000E+000
S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	3	1.399E-003	1.000E+000	3.500E-004	4.000E+000
S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	3	1.399E-003	1.000E+000	3.500E-004	4.000E+000
S_BAND_PREAMP_CC	S-band preamp CC failure	C	3.288E-005	1.000E+000	8.225E-006	4.000E+000
S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	3	9.320E-005	1.000E+000	2.330E-005	4.000E+000
S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	3	9.320E-005	1.000E+000	2.330E-005	4.000E+000
S_BAND_PWRAMP_CC	S-band power amp CC failure	C	2.190E-006	1.000E+000	5.475E-007	4.000E+000
S_BAND_SBCA_FL	S-band SBCA failure	F	0.000E+000	1.000E+000	4.380E-005	4.000E+000
S_BAND_SW_ASSM_FL	S-band switch assembly fail	F	0.000E+000	1.000E+000	1.750E-004	4.000E+000
S_BAND_XPNDR1_FL	S-band transponder 1 fails	3	8.756E-004	1.000E+000	2.190E-004	4.000E+000
S_BAND_XPNDR2_FL	S-band transponder 2 fails	3	8.756E-004	1.000E+000	2.190E-004	4.000E+000
S_BAND_XPNDR_CC	S-band transponder CC fails	C	2.058E-005	1.000E+000	5.150E-006	4.000E+000
TDRSS_FL	TDRSS failure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
T_BETA	Beta	1	2.350E-002	2.350E-002	0.000E+000	0.000E+000
WGT_FAIL	Whitesands Ground Terminal (WGT) failure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000

Failure to Perform IPL 24 Hour exposure time – Basic Event Listing

Name	Description	Fail Type	Calc. Prob.	Probability	Lambda	Mission Time
CMD_SVR_FL	Command server fails	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
COMSEC1_FL	COMSEC half unit 1 failure	3	1.046E-002	1.000E+000	4.380E-005	2.400E+002
COMSEC2_FL	COMSEC half unit 2 failure	3	1.046E-002	1.000E+000	4.380E-005	2.400E+002
COMSEC_CC	COMSEC CC failure	C	2.457E-004	1.000E+000	0.000E+000	0.000E+000
D-S-BAND-RF-FL	S-band RF failure	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
FLIGHT_CR_HRA	IPL crew fails to correctly perform procedure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
HUMAN-FACTORS	IPL fails due to human/procedural factors	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
INCT_PROCEDURE	Procedure incorrect	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
IPL_BLD_FL	IPL upload build failure	1	1.500E-005	1.500E-005	0.000E+000	0.000E+000
IPL_SEL_SW_FL	IPL select switch failure	1	3.750E-006	3.750E-006	0.000E+000	0.000E+000
KU_BAND_FL	Ku-Band failure	3	1.060E-002	1.000E+000	4.439E-004	2.400E+001
MDM_CC	MDM CC failure	C	2.199E-005	1.000E+000	0.000E+000	0.000E+000
MDM_FF1_FL	MDM FF1 failure	3	9.356E-004	0.000E+000	3.900E-005	2.400E+001
MDM_FF3_FFL	MDM FF3 Failure	3	9.356E-004	0.000E+000	3.900E-005	2.400E+001
MMU1_FL	Mass Memory Unit (MMU) 1 failure	3	7.200E-006	1.000E+000	3.000E-007	2.400E+001
MMU2_FL	Mass Memory Unit (MMU) 2 failure	3	7.200E-006	1.000E+000	3.000E-007	2.400E+001
MMU_CC	Mass Memory Unit (MMU) CC failure	C	1.692E-007	1.000E+000	0.000E+000	0.000E+000
MTU1_FL	Master Timing Unit (MTU) half unit 1 failure	3	2.107E-003	0.000E+000	8.790E-005	2.400E+001
MTU2_FL	Master Timing Unit (MTU) half unit 2 failure	3	2.107E-003	0.000E+000	8.790E-005	2.400E+001
MTU_CC	Master Timing Unit (MTU) CC failure	C	4.952E-005	0.000E+000	0.000E+000	0.000E+000
NSP1_FL	NSP 1 failure	3	1.051E-003	1.000E+000	4.380E-005	2.400E+001
NSP2_FL	NSP 2 failure	3	1.051E-003	1.000E+000	4.380E-005	2.400E+001
NSP_CC	NSP CC failure	C	2.469E-005	1.000E+000	0.000E+000	0.000E+000
PCMMU1_FL	PCMMU 1 failure	3	6.022E-004	0.000E+000	2.510E-005	2.400E+001
PCMMU2_FL	PCMMU 2 failure	3	6.022E-004	0.000E+000	2.510E-005	2.400E+001
PCMMU_CC	PCMMU CC failure	C	1.415E-005	0.000E+000	0.000E+000	0.000E+000
PCMMU_SEL_SW_FL	PCMMU select switch fails	1	3.750E-006	3.750E-006	0.000E+000	0.000E+000
POWER_FL	Power RPC failure	3	4.632E-008	1.000E+000	1.930E-009	2.400E+001
SOFTWARE_FL	Software failure	3	3.264E-005	1.000E+000	1.360E-006	2.400E+001
SW_FL	SW failure 7 toggle & 2 Rotary	3	2.400E-004	1.000E+000	1.000E-005	2.400E+001
S_BAND_ANT1_FL	S-band antenna 1 fails	3	5.242E-003	1.000E+000	2.190E-004	2.400E+001
S_BAND_ANT2_FL	S-band antenna 2 fails	3	5.242E-003	1.000E+000	2.190E-004	2.400E+001

Name	Description	Fail Type	Calc. Prob.	Probability	Lambda	Mission Time
S_BAND_ANT3_FL	S-band antenna 3 fails	3	5.242E-003	1.000E+000	2.190E-004	2.400E+001
S_BAND_ANT4_FL	S-band antenna 4 fails	3	5.242E-003	1.000E+000	2.190E-004	2.400E+001
S_BAND_ANT_CC	S-band antenna CC failure	C	1.232E-004	1.000E+000	0.000E+000	0.000E+000
S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	3	8.365E-003	1.000E+000	3.500E-004	2.400E+001
S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	3	8.365E-003	1.000E+000	3.500E-004	2.400E+001
S_BAND_PREAMP_CC	S-band preamp CC failure	C	1.966E-004	1.000E+000	0.000E+000	0.000E+000
S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	3	5.590E-004	1.000E+000	2.330E-005	2.400E+001
S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	3	5.590E-004	1.000E+000	2.330E-005	2.400E+001
S_BAND_PWRAMP_CC	S-band power amp CC failure	C	1.314E-005	1.000E+000	0.000E+000	0.000E+000
S_BAND_SBCA_FL	S-band SBCA failure	F	0.000E+000	1.000E+000	4.380E-005	4.000E+000
S_BAND_SW_ASSM_FL	S-band switch assembly fail	F	0.000E+000	1.000E+000	1.750E-004	4.000E+000
S_BAND_XPNDR1_FL	S-band transponder 1 fails	3	5.242E-003	1.000E+000	2.190E-004	2.400E+001
S_BAND_XPNDR2_FL	S-band transponder 2 fails	3	5.242E-003	1.000E+000	2.190E-004	2.400E+001
S_BAND_XPNDR_CC	S-band transponder CC fails	C	1.232E-004	1.000E+000	0.000E+000	0.000E+000
TDRSS_FL	TDRSS failure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
T_BETA		1	2.350E-002	2.350E-002	0.000E+000	0.000E+000
WGT_FAIL	Whitesands Ground Terminal (WGT) failure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000

Loss of Mission (LOM)

Name	Description	Fail Type	Calc. Prob.	Probability	Lambda	Mission Time
BLK_SW_JAM	Blocking switch jams in block position	3	2.311E-005	1.000E+000	9.630E-008	2.400E+002
C-HARDWARE-2		1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
CMD_SVR_FL	Command server fails	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
COMSEC1_FL	COMSEC half unit 1 failure	3	1.046E-002	1.000E+000	4.380E-005	2.400E+002
COMSEC2_FL	COMSEC half unit 2 failure	3	1.046E-002	1.000E+000	4.380E-005	2.400E+002
D-LOSS-COM	S-band RF failure	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
E-S-BAND-ANT-INT	S-band Antenna indepent failure	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
FLIGHT_CR_HRA	IPL crew fails to correctly perform procedure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
HUMAN-FACTORS	IPL fails due to human/procedural factors	1	1.000E+000	1.000E+000	0.000E+000	0.000E+000
INCT_PROCEDURE	Procedure incorrect	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
IPL_BLD_FL	IPL upload build failure	1	1.500E-005	1.500E-005	0.000E+000	0.000E+000
IPL_SEL_SW_FL	IPL select switch failure	1	3.750E-006	3.750E-006	0.000E+000	0.000E+000
KU_BAND_FL	Ku-Band failure	3	1.011E-001	1.000E+000	4.439E-004	2.400E+002
MDM_FF1_FL	MDM FF1 failure	3	9.316E-003	0.000E+000	3.900E-005	2.400E+002
MDM_FF3_FFL	MDM FF3 Failure	3	9.316E-003	0.000E+000	3.900E-005	2.400E+002
MMU1_FL	Mass Memory Unit (MMU) 1 failure	3	7.200E-005	1.000E+000	3.000E-007	2.400E+002
MMU2_FL	Mass Memory Unit (MMU) 2 failure	3	7.200E-005	1.000E+000	3.000E-007	2.400E+002
MTU1_FL	Master Timing Unit (MTU) half unit 1 failure	F	0.000E+000	0.000E+000	8.790E-005	2.400E+002
MTU2_FL	Master Timing Unit (MTU) half unit 2 failure	F	0.000E+000	0.000E+000	8.790E-005	2.400E+002
NSP1_FL	NSP 1 failure	3	1.046E-002	1.000E+000	4.380E-005	2.400E+002
NSP2_FL	NSP 2 failure	3	1.046E-002	1.000E+000	4.380E-005	2.400E+002
PCMMU1_FL	PCMMU 1 failure	3	6.006E-003	0.000E+000	2.510E-005	2.400E+002
PCMMU2_FL	PCMMU 2 failure	3	6.006E-003	0.000E+000	2.510E-005	2.400E+002
PCMMU_SW_FL	PCMMU Switch Failure	1	3.750E-006	3.750E-006	0.000E+000	0.000E+000
POWER_FL	Power RPC failure	3	4.632E-007	1.000E+000	1.930E-009	2.400E+002
SOFTWARE_FL	Software failure	3	3.264E-004	1.000E+000	1.360E-006	2.400E+002
SW_FL	SW failure 7 toggle & 2 Rotary	3	2.397E-003	1.000E+000	1.000E-005	2.400E+002
S_BAND_ANT1_FL	S-band antenna 1 fails	3	5.120E-002	1.000E+000	2.190E-004	2.400E+002
S_BAND_ANT2_FL	S-band antenna 2 fails	3	5.120E-002	1.000E+000	2.190E-004	2.400E+002
S_BAND_ANT3_FL	S-band antenna 3 fails	3	5.120E-002	1.000E+000	2.190E-004	2.400E+002
S_BAND_ANT4_FL	S-band antenna 4 fails	3	5.120E-002	1.000E+000	2.190E-004	2.400E+002
S_BAND_ANT_CC	S-band antenna CC failure	3	1.235E-003	1.000E+000	5.150E-006	2.400E+002

Name	Description	Fail Type	Calc. Prob.	Probability	Lambda	Mission Time
S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	3	8.057E-002	1.000E+000	3.500E-004	2.400E+002
S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	3	8.057E-002	1.000E+000	3.500E-004	2.400E+002
S_BAND_PREAMP_CC	S-band preamp CC failure	3	1.972E-003	1.000E+000	8.225E-006	2.400E+002
S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	3	5.576E-003	1.000E+000	2.330E-005	2.400E+002
S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	3	5.576E-003	1.000E+000	2.330E-005	2.400E+002
S_BAND_PWRAMP_CC	S-band power amp CC failure	3	1.314E-004	1.000E+000	5.475E-007	2.400E+002
S_BAND_XPNDR1_FL	S-band transponder 1 fails	3	5.120E-002	1.000E+000	2.190E-004	2.400E+002
S_BAND_XPNDR2_FL	S-band transponder 2 fails	3	5.120E-002	1.000E+000	2.190E-004	2.400E+002
S_BAND_XPNDR_CC	S-band transponder CC fails	3	1.235E-003	1.000E+000	5.150E-006	2.400E+002
TDRSS_FL	TDRSS failure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000
WGT_FAIL	Whitesands Ground Terminal (WGT) failure	F	0.000E+000	1.000E+000	0.000E+000	0.000E+000

Appendix D – Failure to Perform IPL Cut Set Listing

Failure to Perform IPL 4 hour exposure time	D-2
Failure to Perform IPL 10 day exposure time	D-4
Loss of Mission (LOM)	D-6
Emergency Undock Cut Set Listing- Exposure Time 1 Hour	D-8
Emergency Undock Cut Set Listing- Exposure Time 12 Hour	D-10

Failure to Perform IPL 4 hour exposure time – Cut Set Listing

Cut No.	% Total	% Cut Set	Prob./Freq.	Basic Event	Description	Event Prob.
1	46.0	46.0	4.000E-005	SW_FL	SW failure 7 toggle & 2 Rotary	4.000E-005
2	63.2	17.2	1.500E-005	IPL_BLD_FL	IPL upload build failure	1.500E-005
3	72.7	9.5	8.261E-006	MTU_CC	Master Timing Unit (MTU) CC failure	8.261E-006
4	78.9	6.3	5.440E-006	SOFTWARE_FL	Software failure	5.440E-006
5	83.7	4.7	4.117E-006	NSP_CC	NSP CC failure	4.117E-006
6	88.0	4.3	3.750E-006	IPL_SEL_SW_FL	IPL select switch failure	3.750E-006
7	92.3	4.3	3.750E-006	PCMMU_SEL_SW_FL	PCMMU select switch fails	3.750E-006
8	96.5	4.2	3.666E-006	MDM_CC	MDM CC failure	3.666E-006
9	99.2	2.7	2.359E-006	PCMMU_CC	PCMMU CC failure	2.359E-006
10	99.7	0.5	3.852E-007	BLK_SW_JAM	Blocking switch jams in block position	3.852E-007
11	99.8	0.2	1.236E-007	MTU1_FL	Master Timing Unit (MTU) half unit 1 failure	3.515E-004
				MTU2_FL	Master Timing Unit (MTU) half unit 2 failure	3.515E-004
12	99.9	0.1	5.832E-008	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_PREAMP_CC	S-band preamp CC failure	3.288E-005
13	99.9	0.1	3.650E-008	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_ANT_CC	S-band antenna CC failure	2.058E-005
14	99.9	0.0	3.069E-008	NSP1_FL	NSP 1 failure	1.752E-004
				NSP2_FL	NSP 2 failure	1.752E-004
15	100.0	0.0	2.820E-008	MMU_CC	Mass Memory Unit (MMU) CC failure	2.820E-008
16	100.0	0.0	2.433E-008	MDM_FF1_FL	MDM FF1 failure	1.560E-004
				MDM_FF3_FFL	MDM FF3 Failure	1.560E-004
17	100.0	0.0	1.008E-008	PCMMU1_FL	PCMMU 1 failure	1.004E-004
				PCMMU2_FL	PCMMU 2 failure	1.004E-004
18	100.0	0.0	7.720E-009	POWER_FL	Power RPC failure	7.720E-009
19	100.0	0.0	3.885E-009	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_PWRAMP_CC	S-band power amp CC failure	2.190E-006
20	100.0	0.0	3.472E-009	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	1.399E-003
				S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	1.399E-003
21	100.0	0.0	1.541E-011	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	9.320E-005

				S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	9.320E-005
22	100.0	0.0	1.440E-012	MMU1_FL	Mass Memory Unit (MMU) 1 failure	1.200E-006
				MMU2_FL	Mass Memory Unit (MMU) 2 failure	1.200E-006
23	100.0	0.0	2.799E-014	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_XPNDR1_FL	S-band transponder 1 fails	8.756E-004
				S_BAND_XPNDR2_FL	S-band transponder 2 fails	8.756E-004
				S_BAND_XPNDR_CC	S-band transponder CC fails	2.058E-005
24	100.0	0.0	1.043E-015	KU_BAND_FL	Ku-Band failure	1.774E-003
				S_BAND_ANT1_FL	S-band antenna 1 fails	8.756E-004
				S_BAND_ANT2_FL	S-band antenna 2 fails	8.756E-004
				S_BAND_ANT3_FL	S-band antenna 3 fails	8.756E-004
				S_BAND_ANT4_FL	S-band antenna 4 fails	8.756E-004

Failure to Perform IPL 24 Hours exposure time – Cut Set Listing

Cut No.	% Total	% Cut Set	Prob./Freq.	Basic Event	Description	Event Prob.
1	57.3	57.3	2.400E-004	SW_FL	SW failure 7 toggle & 2 Rotary	2.400E-004
2	69.1	11.8	4.952E-005	MTU_CC	Master Timing Unit (MTU) CC failure	4.952E-005
3	76.9	7.8	3.264E-005	SOFTWARE_FL	Software failure	3.264E-005
4	82.8	5.9	2.469E-005	NSP_CC	NSP CC failure	2.469E-005
5	88.1	5.3	2.199E-005	MDM_CC	MDM CC failure	2.199E-005
6	91.6	3.6	1.500E-005	IPL_BLD_FL	IPL upload build failure	1.500E-005
7	95.0	3.4	1.415E-005	PCMMU_CC	PCMMU CC failure	1.415E-005
8	96.1	1.1	4.441E-006	MTU1_FL	Master Timing Unit (MTU) half unit 1 failure	2.107E-003
				MTU2_FL	Master Timing Unit (MTU) half unit 2 failure	2.107E-003
9	97.0	0.9	3.750E-006	PCMMU_SEL_SW_FL	PCMMU select switch fails	3.750E-006
10	97.9	0.9	3.750E-006	IPL_SEL_SW_FL	IPL select switch failure	3.750E-006
11	98.4	0.6	2.311E-006	BLK_SW_JAM	Blocking switch jams in block position	2.311E-006
12	98.9	0.5	2.083E-006	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_PREAMP_CC	S-band preamp CC failure	1.966E-004
13	99.3	0.3	1.305E-006	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_ANT_CC	S-band antenna CC failure	1.232E-004
14	99.5	0.3	1.104E-006	NSP1_FL	NSP 1 failure	1.051E-003
				NSP2_FL	NSP 2 failure	1.051E-003
15	99.7	0.2	8.753E-007	MDM_FF1_FL	MDM FF1 failure	9.356E-004
				MDM_FF3_FFL	MDM FF3 Failure	9.356E-004
16	99.9	0.2	7.415E-007	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	8.365E-003
				S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	8.365E-003
17	100.0	0.1	3.627E-007	PCMMU1_FL	PCMMU 1 failure	6.022E-004
				PCMMU2_FL	PCMMU 2 failure	6.022E-004
18	100.0	0.1	1.692E-007	MMU_CC	Mass Memory Unit (MMU) CC failure	1.692E-007
19	100.0	0.0	1.392E-007	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_PWRAMP_CC	S-band power amp CC failure	1.314E-005
20	100.0	0.0	4.632E-008	POWER_FL	Power RPC failure	4.632E-008
21	100.0	0.0	3.312E-009	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	5.590E-004
				S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	5.590E-004

22	100.0	0.0	5.184E-011	MMU1_FL	Mass Memory Unit (MMU) 1 failure	7.200E-006
				MMU2_FL	Mass Memory Unit (MMU) 2 failure	7.200E-006
23	100.0	0.0	3.588E-011	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_XPNDR1_FL	S-band transponder 1 fails	5.242E-003
				S_BAND_XPNDR2_FL	S-band transponder 2 fails	5.242E-003
				S_BAND_XPNDR_CC	S-band transponder CC fails	1.232E-004
24	100.0	0.0	8.003E-012	KU_BAND_FL	Ku-Band failure	1.060E-002
				S_BAND_ANT1_FL	S-band antenna 1 fails	5.242E-003
				S_BAND_ANT2_FL	S-band antenna 2 fails	5.242E-003
				S_BAND_ANT3_FL	S-band antenna 3 fails	5.242E-003
				S_BAND_ANT4_FL	S-band antenna 4 fails	5.242E-003

Loss of Mission (LOM) – Cut Set Listing

Cut No.	% Total	% Cut Set	Prob./Freq.	Basic Event	Description	Event Prob.
1	10.4	10.4	1.046E-002	NSP1_FL	NSP 1 failure	1.046E-002
2	20.7	10.4	1.046E-002	NSP2_FL	NSP 2 failure	1.046E-002
3	29.9	9.2	9.316E-003	MDM_FF1_FL	MDM FF1 failure	9.316E-003
4	39.1	9.2	9.316E-003	MDM_FF3_FFL	MDM FF3 Failure	9.316E-003
5	47.2	8.1	8.142E-003	KU_BAND_FL	Ku-Band failure	1.011E-001
				S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	8.057E-002
6	55.3	8.1	8.142E-003	KU_BAND_FL	Ku-Band failure	1.011E-001
				S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	8.057E-002
7	61.7	6.4	6.491E-003	S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	8.057E-002
				S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	8.057E-002
8	67.6	6.0	6.006E-003	PCMMU1_FL	PCMMU 1 failure	6.006E-003
9	73.6	6.0	6.006E-003	PCMMU2_FL	PCMMU 2 failure	6.006E-003
10	78.7	5.1	5.174E-003	KU_BAND_FL	Ku-Band failure	1.011E-001
				S_BAND_XPNDR1_FL	S-band transponder 1 fails	5.120E-002
11	83.8	5.1	5.174E-003	KU_BAND_FL	Ku-Band failure	1.011E-001
				S_BAND_XPNDR2_FL	S-band transponder 2 fails	5.120E-002
12	87.9	4.1	4.125E-003	S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	8.057E-002
				S_BAND_XPNDR1_FL	S-band transponder 1 fails	5.120E-002
13	92.0	4.1	4.125E-003	S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	8.057E-002
				S_BAND_XPNDR2_FL	S-band transponder 2 fails	5.120E-002
14	94.6	2.6	2.622E-003	S_BAND_XPNDR1_FL	S-band transponder 1 fails	5.120E-002
				S_BAND_XPNDR2_FL	S-band transponder 2 fails	5.120E-002
15	97.0	2.4	2.397E-003	SW_FL	SW failure 7 toggle & 2 Rotary	2.397E-003
16	98.9	2.0	1.972E-003	S_BAND_PREAMP_CC	S-band preamp CC failure	1.972E-003
17	100.0	1.2	1.235E-003	S_BAND_ANT_CC	S-band antenna CC failure	1.235E-003
18	100.0	1.2	1.235E-003	S_BAND_XPNDR_CC	S-band transponder CC fails	1.235E-003
19	100.0	0.6	5.635E-004	KU_BAND_FL	Ku-Band failure	1.011E-001
				S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	5.576E-003
20	100.0	0.6	5.635E-004	KU_BAND_FL	Ku-Band failure	1.011E-001
				S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	5.576E-003
21	100.0	0.5	4.493E-004	S_BAND_PREAMP1_FL	S-band preamp half unit 1 fails	8.057E-002
				S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	5.576E-003

22	100.0	0.5	4.493E-004	S_BAND_PREAMP2_FL	S-band preamp half unit 2 fails	8.057E-002
				S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	5.576E-003
23	100.0	0.3	3.263E-004	SOFTWARE_FL	Software failure	3.263E-004
24	100.0	0.3	2.855E-004	S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	5.576E-003
				S_BAND_XPNDR1_FL	S-band transponder 1 fails	5.120E-002
25	100.0	0.3	2.855E-004	S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	5.576E-003
				S_BAND_XPNDR2_FL	S-band transponder 2 fails	5.120E-002
26	100.0	0.1	1.342E-004	S_BAND_ANT1_FL	S-band antenna 1 fails	5.120E-002
				S_BAND_ANT2_FL	S-band antenna 2 fails	5.120E-002
				S_BAND_ANT3_FL	S-band antenna 3 fails	5.120E-002
27	100.0	0.1	1.342E-004	S_BAND_ANT1_FL	S-band antenna 1 fails	5.120E-002
				S_BAND_ANT2_FL	S-band antenna 2 fails	5.120E-002
				S_BAND_ANT4_FL	S-band antenna 4 fails	5.120E-002
28	100.0	0.1	1.342E-004	S_BAND_ANT1_FL	S-band antenna 1 fails	5.120E-002
				S_BAND_ANT3_FL	S-band antenna 3 fails	5.120E-002
				S_BAND_ANT4_FL	S-band antenna 4 fails	5.120E-002
29	100.0	0.1	1.342E-004	S_BAND_ANT2_FL	S-band antenna 2 fails	5.120E-002
				S_BAND_ANT3_FL	S-band antenna 3 fails	5.120E-002
				S_BAND_ANT4_FL	S-band antenna 4 fails	5.120E-002
30	100.0	0.1	1.314E-004	S_BAND_PWRAMP_CC	S-band power amp CC failure	1.314E-004
31	100.0	0.1	7.200E-005	MMU2_FL	Mass Memory Unit (MMU) 2 failure	7.200E-005
32	100.0	0.1	7.200E-005	MMU1_FL	Mass Memory Unit (MMU) 1 failure	7.200E-005
33	100.0	0.0	3.110E-005	S_BAND_PWRAMP1_FL	S-band power amp half unit 1 failure	5.576E-003
				S_BAND_PWRAMP2_FL	S-band power amp half unit 2 failure	5.576E-003
34	100.0	0.0	2.311E-005	BLK_SW_JAM	Blocking switch jams in block position	2.311E-005
35	100.0	0.0	1.500E-005	IPL_BLD_FL	IPL upload build failure	1.500E-005
36	100.0	0.0	3.750E-006	IPL_SEL_SW_FL	IPL select switch failure	3.750E-006
37	100.0	0.0	3.750E-006	PCMMU_SW_FL	PCMMU Switch Failure	3.750E-006
38	100.0	0.0	4.632E-007	POWER_FL	Power RPC failure	4.632E-007

Emergency Undock Cut Set Listing- Exposure Time 1 Hour – Cut Set Listing

Cut No.	% Total	% Cut Set	Prob./Frequency	Basic Event	Description	Event Prob.
1	21.6	21.6	4.000E-006	<INIT>	System Generated Initiating Event	1.000E+000
				QPC-O-CRACKS	CRACKS < .45 IN CAUSE LOSS OF CABIN PRESSURE	4.000E-006
2	39.2	17.6	3.250E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_VLMBYPSO1_LKE	EXTERNAL LEAKAGE OF CABIN FAN BYPASS VALVE	3.250E-006
3	51.5	12.3	2.275E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_FANO1_FTS_CC	COMMON CAUSE FAILURE OF BOTH CABIN FANS	2.275E-006
4	63.3	11.7	2.170E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_VLMBYPS_PLG	CABIN FAN HEAT EX BYPASS VALVE PLUGGED	2.170E-006
5	75.0	11.7	2.170E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_VLMBYPSO1_XFC	CABIN FAN BYPASS VALVE TRANSFERS CLOSED (MECH)	2.170E-006
6	83.7	8.7	1.610E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_PIPCANO1_LKE	EXTERNAL LEAKAGE FROM 2 LIHO CANISTERS	1.610E-006
7	87.9	4.2	7.755E-007	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_FCP_FCP_FTR_CCF	COMMON CAUSE FAILURE OF ALL FUEL CELLS (O)	7.755E-007
8	90.2	2.3	4.160E-007	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_HEXMANO1_LKE	CABIN FAN HEAT EXCHANGER MANIFOLD LEAKS	4.160E-007
9	91.7	1.5	2.843E-007	<INIT>	System Generated Initiating Event	1.000E+000
				A_O_FCP_FCP_FTR_CCF	COMMON CAUSE FAILURE OF ALL FUEL CELLS (A)	2.843E-007
10	92.7	1.0	1.878E-007	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_FANO1_FOF_CC	COMMON CAUSE FAILURE OF BOTH CABIN FANS	1.878E-007
11	93.4	0.6	1.174E-007	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_PRSD_VLC2O2_FTC	O2 TANK 2 CHECK VALVE FAILS TO CLOSE (ORBIT)	1.610E-004
				O_O_PRSD_VLS1O2_FTC_HUM	O2 MANIFOLD ISOLATION VALVE 1 FTC CREW ACTION (O)	2.700E-002
				O_O_PRSD_VLS2O2_FTC_HUM	O2 MANIFOLD ISOLATION VALVE 2 FTC CREW ACTION (O)	2.700E-002
12	94.0	0.6	1.174E-007	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_PRSD_VLC2H2_FTC	H2 TANK 2 CHECK VALVE FAILS TO CLOSE (ORBIT)	1.610E-004
				O_O_PRSD_VLS1H2_FTC_HUM	H2 MANIFOLD ISOLATION VALVE 1 FTC CREW ACTION (O)	2.700E-002
				O_O_PRSD_VLS2H2_FTC_HUM	H2 MANIFOLD ISOLATION VALVE 2 FTC CREW ACTION (O)	2.700E-002
13	94.7	0.6	1.174E-007	<INIT>	System Generated Initiating Event	1.000E+000
				A_O_PRSD_VLC2H2_FTC	H2 TANK 2 CHECK VALVE FAILS TO CLOSE (A)	1.610E-004

				A_O_PRSD_VLS1H2_FTC_HUM	H2 MANIFOLD ISOLATION VALVE 1 FTC CREW ACTION (A)	2.700E-002
				A_O_PRSD_VLS2H2_FTC_HUM	H2 MANIFOLD ISOLATION VALVE FTC CREW ACTION (A)	2.700E-002
14	95.3	0.6	1.174E-007	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_EPD_XTIE1_MCT_HUM	CROSS TIE 1 MOTORIZED CONTACTOR FTC CREW ACTION (O)	2.700E-002
				O_O_PRSD_VLC2H2_FTC	H2 TANK 2 CHECK VALVE FAILS TO CLOSE (ORBIT)	1.610E-004
				O_O_PRSD_VLS2H2_FTC_HUM	H2 MANIFOLD ISOLATION VALVE 2 FTC CREW ACTION (O)	2.700E-002

Emergency Undock Cut Set Listing- Exposure Time 12 Hour – Cut Set Listing

Cut No.	% Total	% Cut Set	Prob./Frequency	Basic Event	Description	Event Prob.
1	26.0	26.0	4.800E-005	<INIT>	System Generated Initiating Event	1.000E+000
				QPC-O-CRACKS	CRACKS < .45 IN CAUSE LOSS OF CABIN PRESSURE	4.800E-005
2	47.0	21.1	3.900E-005	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_VLMBYPSO1_LKE	EXTERNAL LEAKAGE OF CABIN FAN BYPASS VALVE	3.900E-005
3	61.1	14.1	2.604E-005	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_VLMBYPS_PLG	CABIN FAN HEAT EX BYPASS VALVE PLUGGED	2.604E-005
4	75.2	14.1	2.604E-005	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_VLMBYPSO1_XFC	CABIN FAN BYPASS VALVE TRANSFERS CLOSED (MECH)	2.604E-005
5	85.7	10.5	1.932E-005	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_PIPCANO1_LKE	EXTERNAL LEAKAGE FROM 2 LIHO CANISTERS	1.932E-005
6	90.7	5.0	9.304E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_FCP_FCP_FTR_CCF	COMMON CAUSE FAILURE OF ALL FUEL CELLS (O)	9.304E-006
7	93.4	2.7	4.992E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_HEXMANO1_LKE	CABIN FAN HEAT EXCHANGER MANIFOLD LEAKS	4.992E-006
8	94.6	1.2	2.275E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_FANO1_FTS_CC	COMMON CAUSE FAILURE OF BOTH CABIN FANS	2.275E-006
9	95.9	1.2	2.253E-006	<INIT>	System Generated Initiating Event	1.000E+000
				O_O_CFS_FANO1_FOF_CC	COMMON CAUSE FAILURE OF BOTH CABIN FANS	2.253E-006