SI Airwothiness and Certification Procedures Manual
Appendix 501-I Sample Worksheets, FAA Functional Hazard analysis
FORCAST FHA

FORCAST SCIENCE INSTRUMENT FUNCTIONAL HAZARD ANALYSIS

REPORT NO: XXX-XXX

FHA Sample Sheet

1	2	3	4	5	6	7	8	9
FUNCTIONS	**HAZARD DESCRIPTION**	**PHASE**	**EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW**	**FAILURE CONDITION FAR/JAR 25.1309**	**CATEGORY OF EFFECTS**	**FUNCTION CLASS**	**CERTIFICATION APPROACH**	**REMARKS**
Insert the function (purpose) that is performed by this piece of hardware/ electronics subsystem.	Discuss what potential safety hazard might exist and what circumstances could cause this hazard (there may well be more than one hazard for this subsystem).	**List the appropriate code or codes for when the hazard can exist.**	Describe worst case effects such as damage to the Aircraft (A/C), injury or death to personnel.	**Will describe the specific FAA regulation which describes the failure condition. To be entered by the Designated Engineering Representative**	Evaluation of the data will indicate which category 1)catastrophic - IV) Minor most accurately describes the potential hazard.	The function class will be determined based on an assessment of the overall program /mission requirement for the function/system under analysis. Classes are nonessential to critical (see below)	The data provided in this column will describe what method of hazard elimination will be utilized to neutralize the safety risk.	
		This is ground, taxi., inflight or landing				N		
						N		
						N		
						N		

PRELIMINARY

Ground	Takeoff		In Flight	Landing	Effect Class	Functional Class		
G1=Taxi	**T1= Takeoff**		**F1= Climb**	**L1= Landing**	**I= Catastrophic**	**N= Nonessential**		**Prepared by:**
G2=Airplane Static			**F2= Cruise**	**L2=Reverse Thrust/Braking**	**II=Hazardous**	**E= Essential**		
G3=Maintenance			**F3= Descent**		**III= Major**	**C= Critical**		**Checked by:**
					IV= Minor			
								Approved by:

FORCAST SCIENCE INSTRUMENT FUNCTIONAL HAZARD ANALYSIS **REPORT NO: XXX-XXX**

SYSTEM: VACUUM VESSEL

1	2	3	4	5	6	7	8	9
FUNCTIONS	**HAZARD DESCRIPTION**	**PHASE**	**EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW**	**FAILURE CONDITION FAR/JAR 25.1309**	**CATEGORY OF EFFECTS**	**FUNCTION CLASS**	**CERTIFICATION APPROACH**	**REMARKS**
The Vacuum Vessel contains all dewers (or cryostats) and working surfaces in which the detectors mount. Most electronics are mounted external to the vacuum vessel.	a) Unannunciated failure of the window.	**ALL**	Inside of vacuum vessel goes to outside ambient.		IV	N	The vacuum vessel will be designed to withstand the total differential pressure plus the appropriate safety factors.	
	b) Latent failure (closed) of one(1) burst disk during rapid boil-off of either the LHe or LN2 dewer. Additional disk will provide redundancy in the event of a latent failure of one(1) burst disk.	**ALL**	Release of cryogens into the aircraft cabin through the redundant or backup burst disk.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	Burst disks will be be FAA qualified per MIL-STD-810 and/or RTCA 160C.
	c) Ice plug develops in LHe boil-off tube.	**ALL**	The LHe dewer develops pressure and both dewer and vacuum vessel burst disk relieve cryogens into the aircraft cabin.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	
	d) Weld failure of vacuum vessel.	**ALL**	Release of cryogens into the cabin.		IV	N	All welds will pass the required inspections for their appropriate criticality. Additional, the redundant burst disks will provide redundancy to ensure release of pressure.	
	e) Accidental breakage of either LHe or LN2 boil-off neck.	**ALL**	Release of cryogens into the cabin.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	

PRELIMINARY

Ground	Takeoff		In Flight	Landing	Effect Class	Functional Class		
G1=Taxi	**T1= Takeoff**		**F1= Climb**	**L1= Landing**	**I= Catastrophic**	**N= Nonessential**		**Prepared by:**
G2=Airplane Static			**F2= Cruise**	**L2=Reverse Thrust/Braking**	**II=Hazardous**	**E= Essential**		
G3=Maintenance			**F3= Descent**		**III= Major**	**C= Critical**		**Checked by:**
					IV= Minor			
								Approved by:

FORCAST SCIENCE INSTRUMENT FUNCTIONAL HAZARD ANALYSIS

REPORT NO: XXX-XXX

SYSTEM: INSULATION

1	2	3	4	5	6	7	8	9
FUNCTIONS	HAZARD DESCRIPTION	PHASE	EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW	FAILURE CONDITION FAR/JAR 25.1309 Effect on Airplane	CATEGORY OF EFFECTS	FUNCTION CLASS	CERTIFICATION APPROACH	REMARKS
The insulation is situated between the inner side of the vacuum vessel and the LN2 shield. It's primary purpose is to insulated the LN2 shield to reduce the radiation.	The reduction of insulation at a localized point would cause a thermal short, resulting in a rapid boil-off of cryogens. The reduction of insulation would be a result of inproper assembly.	ALL	Slight increase in the normal boil-off of cryogens.		IV	N	None	

PRELIMINARY

Ground	Takeoff		In Flight	Landing	Effect Class	Functional Class		
G1=Taxi	T1= Takeoff		F1= Climb	L1= Landing	I= Catastrophic	N= Nonessential		Prepared by:
G2=Airplane Static			F2= Cruise	L2=Reverse Thrust/Braking	II=Hazardous	E= Essential		
G3=Maintenance			F3= Descent		III= Major	C= Critical		Checked by:
					IV= Minor			
								Approved by:

FORCAST SCIENCE INSTRUMENT FUI

REPORT NO: XXX-XXX

SYSTEM: LN2 SHIELD

1	2	3	4	5	6	7	8	9
FUNCTIONS	HAZARD DESCRIPTION	PHASE	EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW	FAILURE CONDITION FAR/JAR 25.1309 Effect on Airplane	CATEGORY OF EFFECTS	FUNCTION CLASS	CERTIFICATION APPROACH	REMARKS
The LN2 shield provides an insulation barrier for the LHe dewer and other similar components.	Weld Failure of the LN2 shield.	ALL	Slight increase in the normal boil-off of cryogens.		IV	N	None	

PRELIMINARY

Ground	Takeoff		In Flight	Landing	Effect Class	Functional Class		
G1=Taxi	T1= Takeoff		F1= Climb	L1= Landing	I= Catastrophic	N= Nonessential		Prepared by:
G2=Airplane Static			F2= Cruise	L2=Reverse Thrust/Braking	II=Hazardous	E= Essential		
G3=Maintenance			F3= Descent		III= Major	C= Critical		Checked by:
					IV= Minor			
								Approved by:

SYSTEM: LN2 OR LHe DEWER

1	2	3	4	5	6	7	8	9
FUNCTIONS	**HAZARD DESCRIPTION**	**PHASE**	**EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW**	**FAILURE CONDITION FAR/JAR 25.1309 Effect on Airplane**	**CATEGORY OF EFFECTS**	**FUNCTION CLASS**	**CERTIFICATION APPROACH**	**REMARKS**
The LN2 and LHe dewer provides safe storage of cryogens required for cool down of the science instrument.	a) Weld failure of dewer resulting in rapid boil-off of cryogens into space between dewer and LN2 shield.	ALL	Cryogens are released into aircraft cabin.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	
	b) Ice plug develops in the LHe neck tube.	ALL	Cryogens are released into aircraft cabin.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	
	c) Latent failure (closed) of the burst disk during rapid boil-off of either the LHe or dewer.	ALL	Cryogens are released into aircraft cabin.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	
	d) Bellows failure between vacuum can and dewer.	ALL	Release of cryogens into the vacuum vessel, through the LN2 shield and through the vacuum vessel burst disk. Ultimately, cryogens are released into aircraft cabin.		IV	N	The largest cryostat of 70 liters LHe and 70 liters LN2, if vented into the closed cabin of the SOFIA aircraft, was found not to dangerously impact the cabin oxygen level.	
	e) Splashing of cryogens due to turbelence.	ALL	Due to helium's low latent heat of vaporization, it will immediately boil-off upon contact with the aircraft cabin ambient air and will not impose a hazard. Upon contact with metal, liquid nitrogen will create a very thin film of vapor which provides both separation and insulation between the metal and liquid nitrogen.		IV	N	None	
	f) Accumulation of liquid oxygen on uninsulated surfaces. Areas for this potential hazard are the neck or filler tubes of both LN2 and LHe dewers. All filler tubes will be insulated and checked regularly for integrity.	ALL	Localized oxygen rich environments are fire hazards when exposed to carbons - oils, grease, etc.		IV	N	Both LN2 and LHe necks or filler tubes will have insulation and checked on a regular basis.	

PRELIMINARY

Ground	Takeoff		In Flight	Landing	Effect Class	Functional Class		
G1=Taxi	T1= Takeoff Roll		F1= Climb F6=Approach	L1= Landing	I= Catastrophic	N= Nonessential		Prepared by:
G2=Airplane Static	T2= Takeoff		F2=Gear Up F7= Go Around	L2=Reverse Thrust/Braking	II=Hazardous	E= Essential		
G3=Maintenance	T3=Rejected Takeoff		F3= Gear Down F8= 200 ft to TD		III= Major	C= Critical		Checked by:
			F4= Cruise F9= Other		IV= Minor			
			F5= Descent					Approved by:

High Voltage

1	2	3	4	5	6	7	8	9
FUNCTIONS	**HAZARD DESCRIPTION**	**PHASE**	**EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW**	**FAILURE CONDITION FAR/JAR 25.1309 Effect on Airplane**	**CATEGORY OF EFFECTS**	**FUNCTION CLASS**	**CERTIFICATION APPROACH**	**REMARKS**
High Voltage used to provide TBD KV for controlling electronics components on the science instrument	a) Possible fire hazard	ALL	Potential personal injury as well as possible damage to aircraft systems.		IV	N	High voltage boxes to be fit with automatic shut down due to depressurization (perhaps through MCCS). Also, any examination of high voltage supply will require power shut down prior to trouble shooting. Wiring used will have the proper insulation jacket and grounding.	
	b) Voltage level may have potential for dangerous electrical shock.	ALL	Potential for personal injury to crew or science team members.		IV	N	High voltage boxes to be fit with automatic shut down due to depressurization (perhaps through MCCS). Also, any examination of high voltage supply will require power shut down prior to trouble shooting. Wiring used will have the proper insulation jacket and grounding.	

PRELIMINARY

Ground	Takeoff		In Flight	Landing	Effect Class	Functional Class		
G1=Taxi	**T1= Takeoff Roll**		**F1= Climb F6=Approach**	**L1= Landing**	**I= Catastrophic**	**N= Nonessential**		**Prepared by:**
G2=Airplane Static	**T2= Takeoff**		**F2=Gear Up F7= Go Around**	**L2=Reverse Thrust/Braking**	**II=Hazardous**	**E= Essential**		
G3=Maintenance	**T3=Rejected Takeoff**		**F3= Gear Down F8= 200 ft to TD**		**III= Major**	**C= Critical**		**Checked by:**
			F4= Cruise F9= Other		**IV= Minor**			
			F5= Descent					**Approved by:**

Cryostat Mount to Telescope Assembly Flange

1	2	3	4	5	6	7	8	9
FUNCTIONS	**HAZARD DESCRIPTION**	**PHASE**	**EFFECT OF FAILURE CONDT'S ON AIRCRAFT/CREW**	**FAILURE CONDITION FAR/JAR 25.1309 Effect on Airplane**	**CATEGORY OF EFFECTS**	**FUNCTION CLASS**	**CERTIFICATION APPROACH**	**REMARKS**
Cradle attaches the science instrument to the telescope assembly mounting flange	a) If forming the pressure boundary, a catastrophic failure results in loss of cabin pressure.	ALL	Potential personal injury as well as possible damage to aircraft systems.		IV	N	Fasteners are NAS or other TBD certified fasteners.	
	b) Structural failure results in loose objects travelling through the aircraft cabin	ALL	Potential for personal injury to crew or science team members.		IV	N	Necessary structural analysis including appropriate safety margins.	

PRELIMINARY

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G2=Airplane Static	**T2= Takeoff**		**F2=Gear Up F7= Go Around**	**L2=Reverse Thrust/Braking**	**II=Hazardous**	**E= Essential**		
G3=Maintenance	**T3=Rejected Takeoff**		**F3= Gear Down F8= 200 ft to TD**		**III= Major**	**C= Critical**		**Checked by:**
			F4= Cruise F9= Other		**IV= Minor**			
			F5= Descent					**Approved by:**