HAZARD REPORT NUMBER: APFR-01	DATE: August 24, 1994
REV. LETTER:	REV. DATE:

Title: Impact/Collision/Detached EVA Crewmember

1. **SEVERITY:** Catastrophic

2. **LIKELIHOOD OF OCCURENCE:** Remote

3. **CLASSIFICATION:** Controlled

CAUSE: A. Inadequate structural design for worst-case loads causes structural failure and/or release of APFR hardware.	**REDUNDANCY SCREENS:** A-Pass B-N/A C-Pass
FMEA: #DTO671-64-5-1, Crit 1R/2 **Name/Qty:** Load Limiter Component/1 **Function:** Simulate weight, center of gravity, and flight dimensions of the ISSA APFR. It contains a pitch joint that is attached to a load limiter. The APFR body has receptacles to accommodate the attachment of a STS PFR and an additional mass body. **Failure Mode:** Load limiter separates from APFR mass simulator. **Causes:** 1) Nut at spring retainer comes loose. 2) Vibration. 3) Piece part failure.	**Failure Detection:** Flight: Visual and EVA Operations Ground: None **Corrective Action:** Crew must remain tethered during evaluation of APFR simulator DTO assembly.
EFFECT (End item, mission, crew/vehicle): Force transmitted into APFR due to unloading of spring. Force will act to move APFR in uncontrolled direction. **Time to Effect:** Minutes **Time to Correct:** Seconds	**REMAINING PATHS:** 1) Loctite on nut.
FMEA: #DTO671-64-5-7, Crit. 1R/3 **Name/Qty:** Mass Simulator Components/1 **Function:** Simulate weight, center of gravity, and flight dimensions of the ISSA APFR. It contains a pitch joint that is attached to a load limiter. The APFR body has receptacles to accommodate the attachment of a STS PFR and an additional mass body. **Failure Mode:** Pitch joint lock inadvertently releases. **Cause:** Vibration moves latch to open position.	**Failure Detection:** Flight: Visual Ground: None **Corrective Action:** Crew must verify that pitch joint lock is in locked position and that the slide lock has been engaged prior to PFR ingress.
EFFECT (End item, mission, crew/vehicle): Pitch joint will freely rotate. None. Possible damage of an EMU and/or Orbiter critical hardware from loose equipment/crewmember. **Time to Effect:** Minutes **Time to Correct:** Seconds	**REMAINING PATHS:** 1) Slide Lock. 2) Safety Tether.

CONTROL/RETENTION RATIONALE (see retention rationale information table):

1. APFR components were designed to a minimum factor of safety of 1.4 for ultimate loads if the hardware was proof load tested. A minimum factor of safety of 2.0 was used for hardware that was not proof load tested, with JSC Structural/Mechanical Working Group approval.
2. The APFR mechanisms responsible for latching was operated under thermal conditions during MTV and chamber thermal runs.
3. The APFR was exposed to an AVT to verify manufacturing and assembly of the unit.

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VERIFICATION:

1a. APFR Stress Analysis (LESC-31296) was performed and found that all margins were positive except at the pitch joint.

1b. Load test was performed on the pitch joint per DWS4200660 with positive results.

2. The mass simulator was tested during the MTV per TPS SB9420154 and thermal test ST9420036 with all components working properly.

3. The APFR assembly was successfully tested to AVT levels per FV942081 and the pre test functional indicated that the unit was operating properly per LEVAHS420068.

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RETENTION RATIONAL INFORMATION

I. DESIGN FEATURES TO MINIMIZE THE CHANCE OF THE FAILURE MODE OCCURRENCE

A. Structural Margins: The APFR is designed to take all limit load conditions as identified in section 3.6.3, "Load Requirements" of JSC-38039 (DTO 671 HRD). A factor of safety of 2.0 was implemented during analysis and 1.4 during testing.

B. Thermal Tolerances: The APFR is designed to operate in the thermal environment (-100°F to +250°F) as specified in section 5.3.1, "Temperature" of JSC-38039. All moving parts were analyzed during the design process to determine the clearance and gap values.

C. Material Selection: All of the APFR assembly materials that are considered safety critical are listed in Table 5-2 of JSC-38040 (DTO 671 FMEA). All materials abide by SE-R-0006C and are approved per MATL-94-117.

II. TESTING AND ANALYSIS

A. Testing:

1. Acceptance: The APFR Assembly underwent a PDA as documented in TPS# LEVAH9420000
The APFR hardware was operated in the thermal extremes during MTV (SB940154), and Cmbr T testing per (included pre/post funct.) S79420036 and 50.
PIA will be done prior to flight.
The APFR hardware was exposed to AVT environments per (includes pre/post funct.): FV9420081.

2. Certification: The thermal tests listed above are used for certification as well.
Load test was done on the APFR hardware per: S79420052 (LLC in Cmbr E and DW9420060).
Only one flight unit was built and it was exposed to AVT loads verses an QVT.
Pre/Post test functional were done on the hardware during certification testing.

B. Analysis: Stress analysis LESC-31296 was performed on the APFR.
Thermal analysis (LESC CTSD-1807) was done on the APFR hardware and it did not exceed the certification limits.

III. INSPECTION

A. Manufacturing: The APFR hardware components were inspected for conformance to their applicable drawings at LESC prior to assembly.
The APFR does not contain any fracture critical parts.

B. Assembly: The assembly was inspected to the assembly level drawings during PDAs.
The assemblies were cleaned to level VC after assembly and will be prior to flight.

C. Testing: Pre/Post testing was conducted prior to and after all acceptance and certification testing. The hardware was verified to be working properly before the test began and after the test.

IV. FAILURE HISTORY

A. Ground Testing: DRs were collected during the testing phase of the project but no FIARs were initiated. All DRs shall be closed prior to certification.

B. On-Orbit Use: None

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V. OPERATIONAL USE

A. Effects of Failure: Possible structural overload of the APFR that could transmit in a high load to the MPESS structure.

B. Crew Action: The crew has been made aware of the potential loading conditions with the APFR.

C. Training: WETF runs have been conducted where the crew actions were rehearsed.

D. Mission Constraints: None

E. In-Flight Check-Outs: Operation of all locks and mechanisms prior to use in the Payload Bay.

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CONCURRENCE:		DATE:
DESIGN ENGINEER(S):	JK Brady	8/23/94
PROJECT ENGINEER(S):	Jan Tiala	8/22/94
SAFETY ENGINEER(S)/NS2:	Ronald W. Cook	8/24/94
SAFETY MANAGER(S)/NS2:	N/A	

Courtesy Copies:

Mission Operations Directorate/DF42
Astronaut Office/CB