STEREO IMPACT

PROBLEM REPORT
PR-1001
QualBoomDeploy
2003-08-15

PR Numbers: 1xxx=UCB, 2xxx=Caltech/JPL, 3xxx=UMd, 4xxx=GSFC/SEP, 5xxx=GSFC/Mag, 6xxx=CESR, 7xxx=Keil, 8xxx=ESTEC, 9xxx=MPAe

Assembly : IMPACT Boom	**SubAssembly :** Boom Structure
Component/Part Number:	**Serial Number:** 002 (Qual)
Originator: David Curtis	**Organization:** U.C.Berkeley
Phone : 510-642-5998	**Email :** dwc@ssl.berkeley.edu

Failure Occurred During (Check one √)

Functional test | √ Qualification test | S/C Integration | Launch operations

Environment when failure occurred:

Ambient | Vibration | Shock | Acoustic
Thermal | Vacuum | √ Thermal-Vacuum | EMI/EMC

Problem Description

Following 6 thermal vac cycles there was a successful hot deployment of the qual model boom. The chamber was broken, the boom restowed, and reinstalled in the chamber. Following a pump down and cold soak a second deployment was attempted. The actuator fired but the boom did not move. The boom was warmed up and vacuum was broken. The boom was safed and removed for diagnosis; no obvious source of the problem was identified. The test was repeated (cold), and again it failed. The boom was warmed up and the chamber was broken. The boom was diagnosed in place with minimal disturbances (without installing the safing pin).

Analyses Performed to Determine Cause

See attached

Corrective Action/ Resolution

Rework | √ Repair | Use As Is | Scrap

The attachment describes the failure, inspection, design change, and re-test. IMPACT held a qualification test review with Goddard (AETD and Project) following the Boom qualification program. The failure occurred at the end of the qual program, and the project had to determine whether to repeat all qualification testing or to perform only the cold vacuum deploy. The Boom and review teams determined that the new design was sufficiently similar to the previous design that only a cold vacuum deploy was required-- i.e., qualification by similarity. The FM1 and FM2 Booms have successfully completed protoflight-level environmental testing.

Date Action Taken: 2003-08-16 **Retest Results**: Repeated cold deployment test 2003-08-17

Corrective Action Required/Performed on other Units FM1 and FM2 booms not yet built. Corrections have been made to drawings prior to fab.

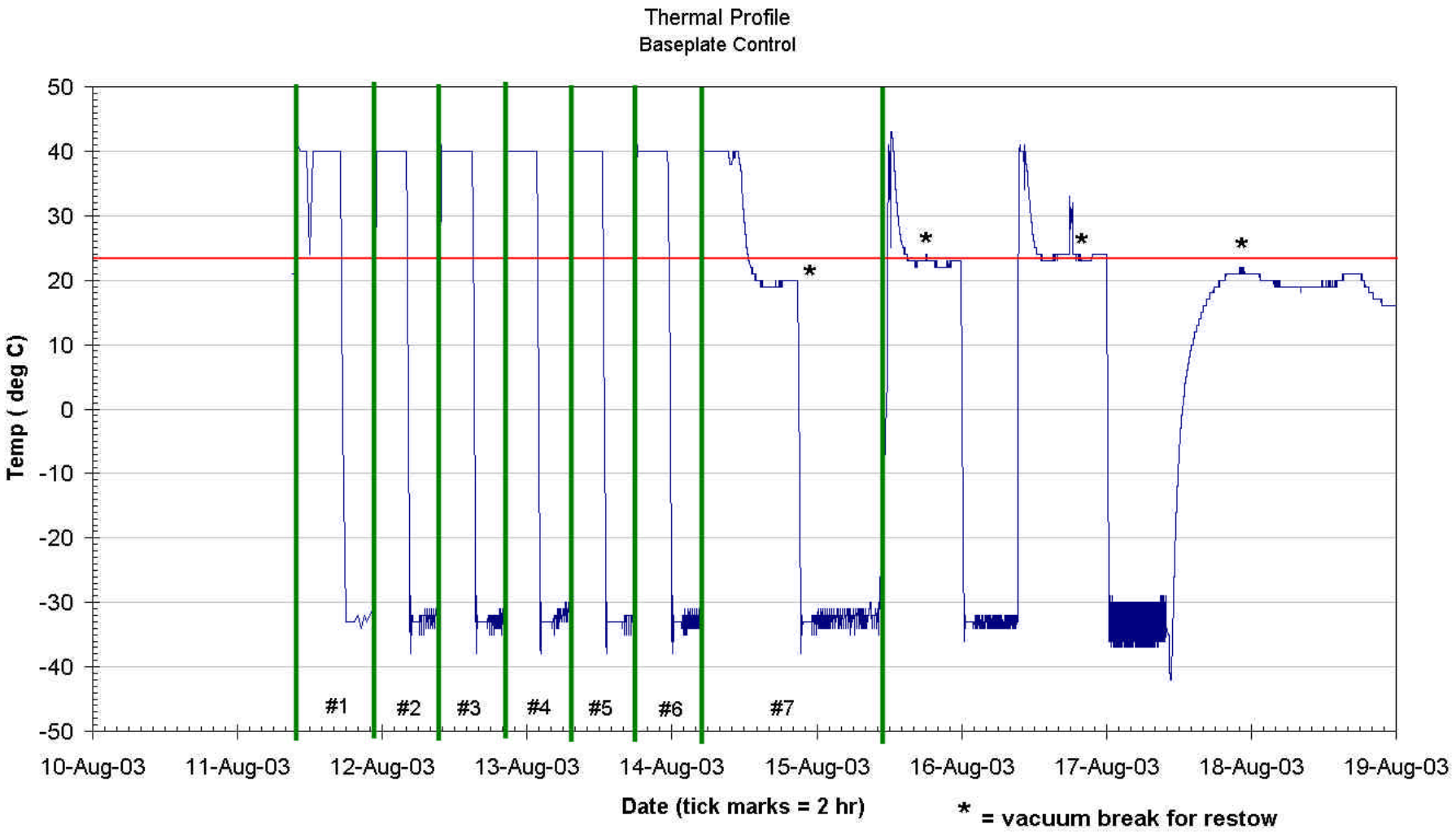
Closure Approvals

Subsystem Lead: _____ Date:_____
IMPACT Project Manager: _____ Date _____
IMPACT QA: _____ Date:_____
NASA IMPACT Instrument Manager: _____ Date:_____

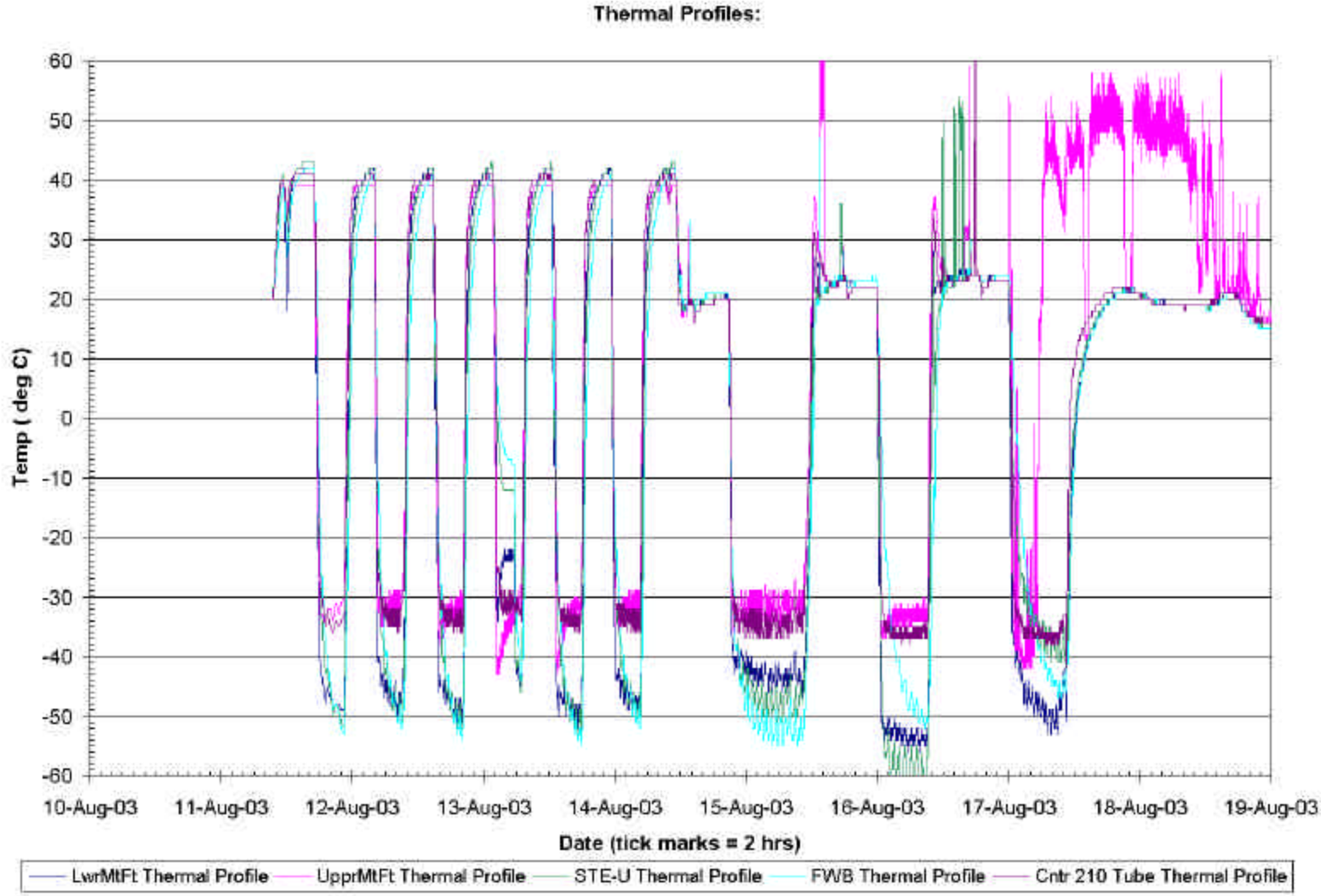
Thermal Vacuum Test

- **Thermal Vacuum testing of the Impact Proto-flight Boom was begun on 11 August 2003 with Proto-flight unit installed in chamber, armed for hot deployment.**
- **The Baseplate Thermocouple was used as the main control for the temperature of the testing. The upper and lower shrouds were set to track the baseplate.**
- **12 additional TCs were positioned at various locations on the Instrument and their outputs recorded.**
- **Chamber pressure ranged from 2.5 X 10^{-5} (hot cycles) to 6.8 X 10^{-6} Torr (cold) during the cycling.**
- **6 cycles from ambient at start (~22 ^{0}C) to hot (40 ^{0}C) , to cold (-33 ^{0}C) and back to ambient, were performed without interruption of the system.**
- **The 7th cycle was split into 2 parts: a hot soak, followed by a deployment using the SMAR primary circuit.**

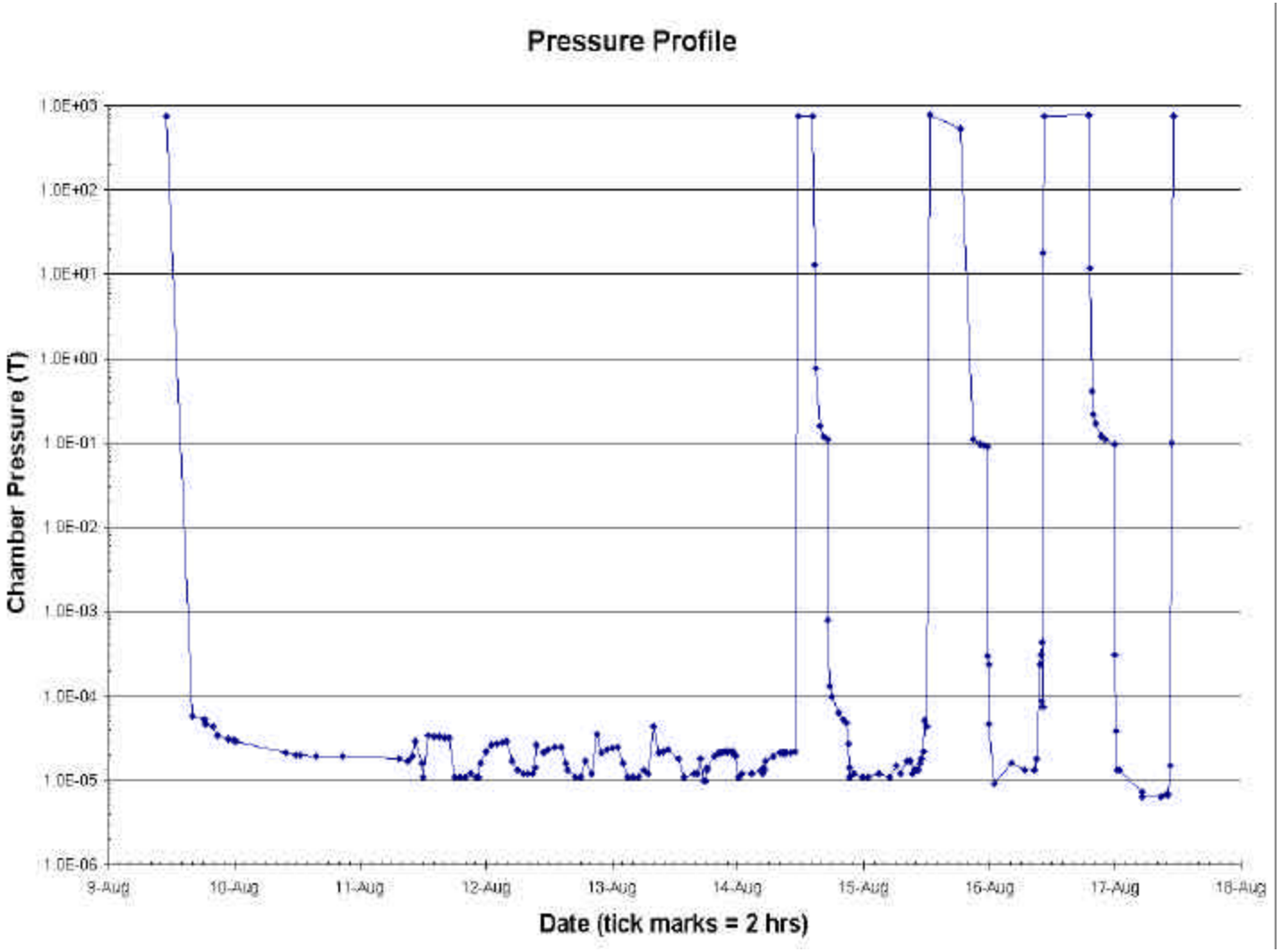
Thermal Vacuum Test



Thermal Vacuum Test



Thermal Vacuum Test



Thermal Vacuum Test

- **The hot deployment was successful, performed at 11:00 on 14 August. The chamber was then vented, and the Impact Proto-flight Boom was restowed, and replaced in the chamber.**

Thermal Vacuum Test

- **The unit was pumped down to vacuum, then given a cold soak. The cold deployment was then scheduled for 10:00 on 15 August, using the SMAR secondary circuit.**
- **The cold deployment did not function. The Thermal Vacuum test was halted, and the chamber vented and opened for investigation of the anomaly.**
- **There were no obvious signs of difficulties with the unit on the test stand, the tubes would not deploy, so the unit was 'safed' by installing the safety pin, and removed from the chamber.**

Thermal Vacuum Test

- After removal, the tubes were free, and were able to be moved manually.
- The unit was then investigated by subsystem to attempt to identify the problem.
  - The flyweight brake (f.w.b.), initially suspected, was operational, and appeared to be assembled correctly.
    - It was removed from the assembly, disassembled and inspected for incorrect operation. No new problems noted.
    - There was sufficient slack on the lanyard to allow the spool lock to release and the lanyard to pay out. (This was verified prior to removal from test stand, and again after).
    - The lanyard and harness were not wrapped around any object, thereby preventing deployment.
  - The bobbin was removed and appeared nominal. Harness was unaffected.
  - SMAR pinpuller appeared to have functioned correctly.
  - The SMAR was reset, and a 'first motion' test was performed successfully. The 50mm tube pushed out normally, lanyard was free to pay out. The deployment was halted by manual restraint of the tubes while the boom was reset.
  - No 'smoking gun' was found. Theories were offered regarding the f.w.b. hanging up, twisted harness and other lower probability scenarios.

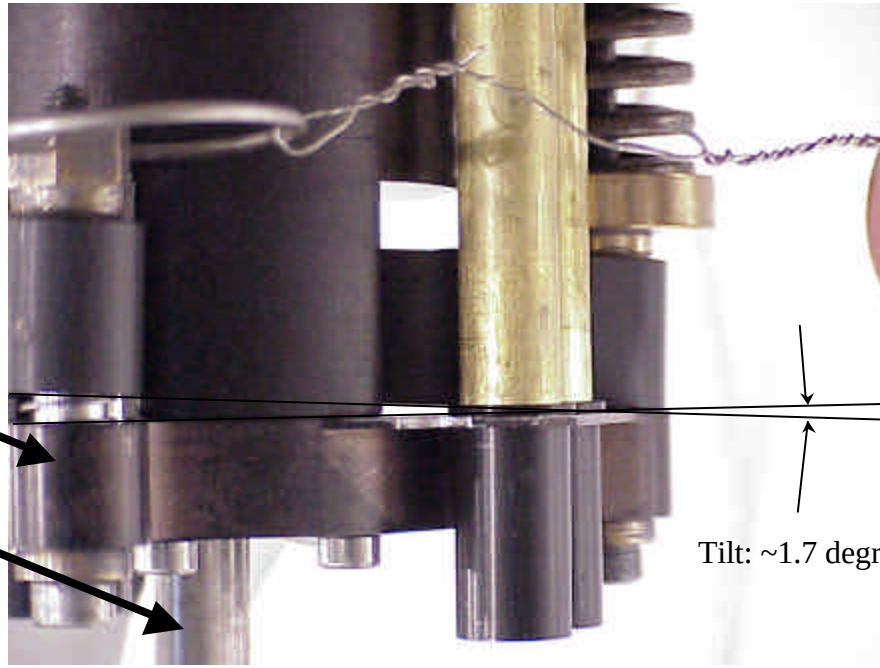
Thermal Vacuum Test

- **The proto-boom was reinstalled on the test stand, carefully inspected for proper assembly and installation.**
- **The chamber was closed, pumped down, and the cold portion of the test repeated. The cold deployment was then scheduled, using the SMAR secondary circuit.**
- **The 2nd cold deployment did not function. The Thermal Vacuum test was halted, and the chamber vented and opened for investigation of the anomaly.**
- **There were no obvious impairment of the unit on the test stand, the tubes would not deploy (or move), so the unit was removed from the test stand. The boom was not 'safed' this time with the safety pin.**
- **The unit was then investigated by subsystem removal, to attempt to identify the problem.**
  - **The flyweight brake (f.w.b.) was operational, and appeared to be assembled correctly.**
  - **The bobbin was nominal. Harness was unaffected.**
  - **SMAR pinpuller appeared to have functioned correctly.**
  - **The source of the anomalous behavior was then able to be seen: The tail of the tip piece was trapped in the SMAR 'floating' mount.**

Thermal Vacuum Test

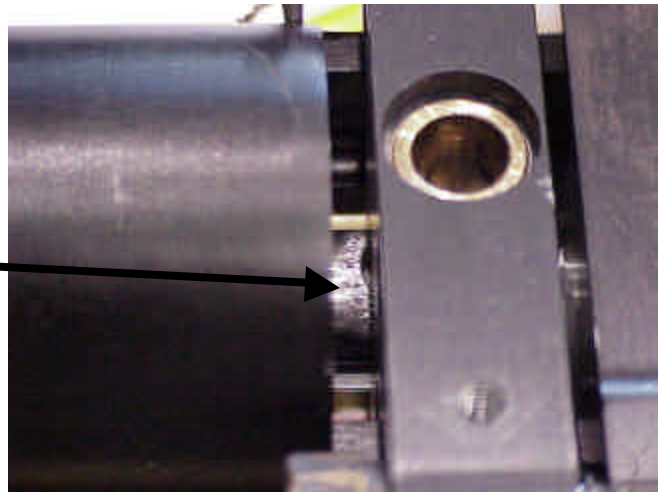
- **The mount is used to preload the tubes for resisting launch loads. There are 2 fixed pivots, and a coil spring used to apply the load to the tip piece tail. The release of the SMAR pinpuller allowed the coil spring to unload faster than the tip piece could clear the floating mount. This induced a tilt to the mount.**

  Due to the tight tolerance required, there was insufficient room for the tip piece to withdraw from the mount, and thus became locked into the SMAR mount.



Thermal Vacuum Test

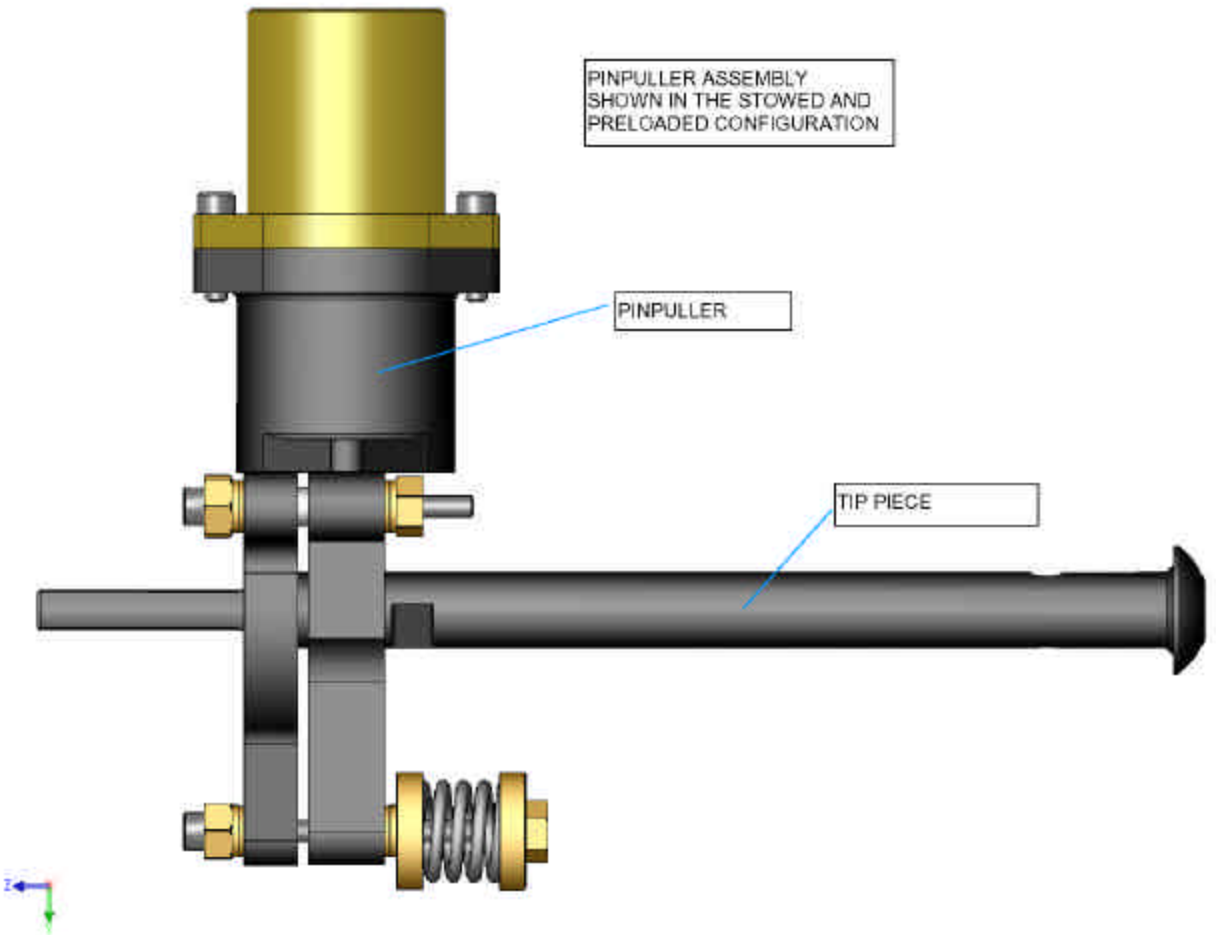
- **This was not seen during the previous anomaly as the latching had been released when the safety pin was installed**
- **Close inspection revealed galling of the Ti tip piece, as wear had accumulated from deploying. The mount functioned as a sliding clamp, with 2 edges grabbing the tip piece. The second picture shows the wear on the mount from hanging up the tip.**



Thermal Vacuum Test

- The solid model was re-examined for verification of the anomalous condition

- This first drawing shows the affected parts, in their stowed, nominal condition



Thermal Vacuum Test

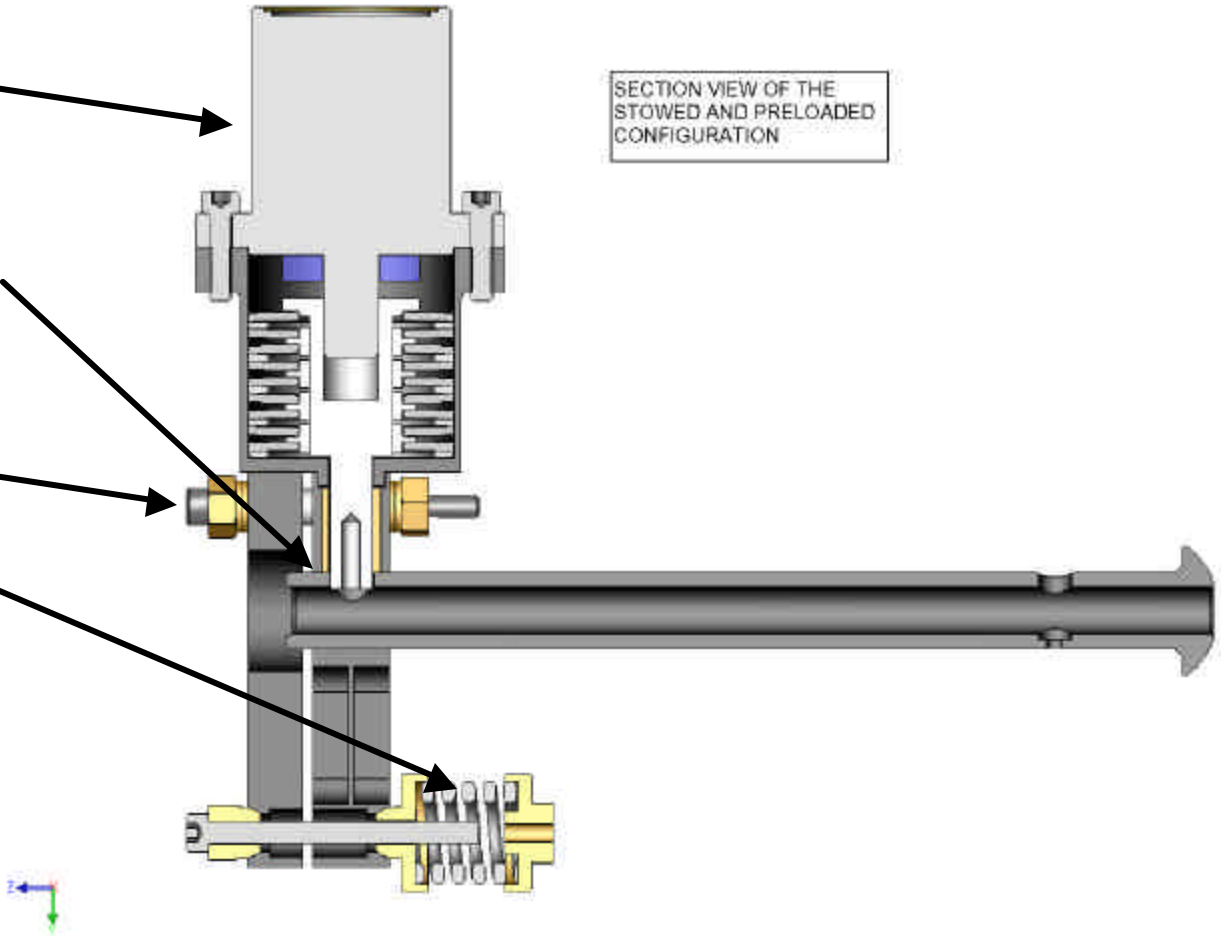
•Same drawing, section view

•SMAR pinpuller

•Note the close fit of the tip piece to the floating mount, where the SMAR pinpuller is inserted into the tip piece.

•Solid pivots

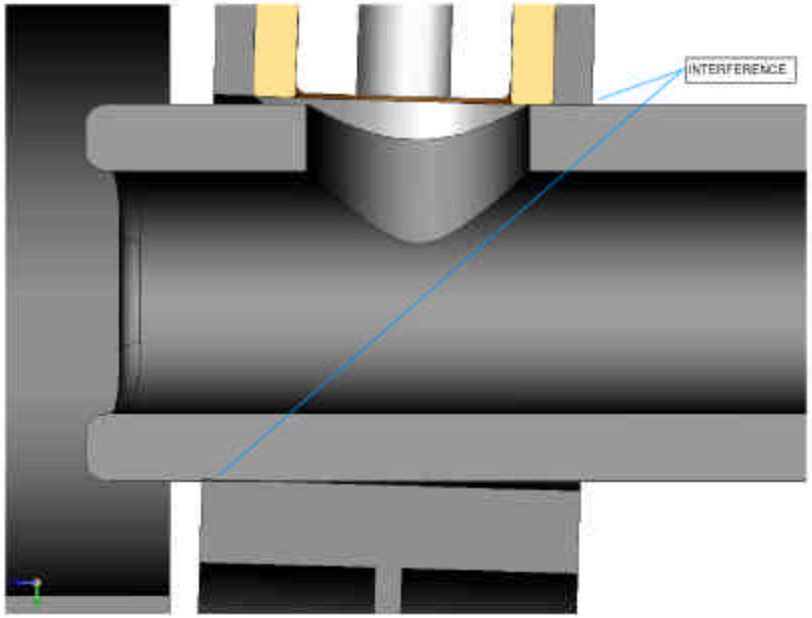
•Coil preload spring

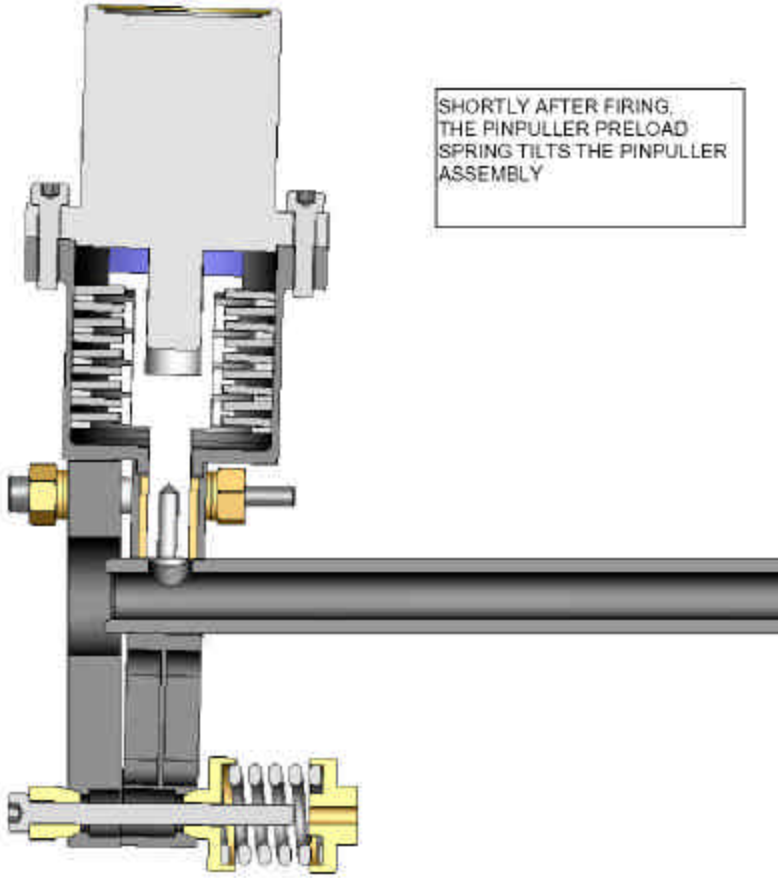


Thermal Vacuum Test

•This drawing is the section view, post SMAR firing

•Coil preload spring has pushed the mount against the housing sooner than the tip piece can clear the through hole.
•The tip piece binds in the mount (detail)

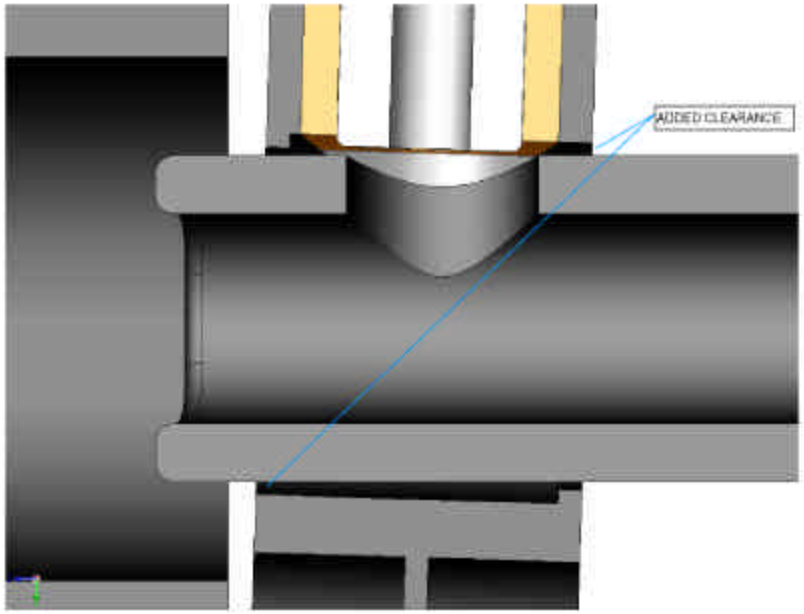


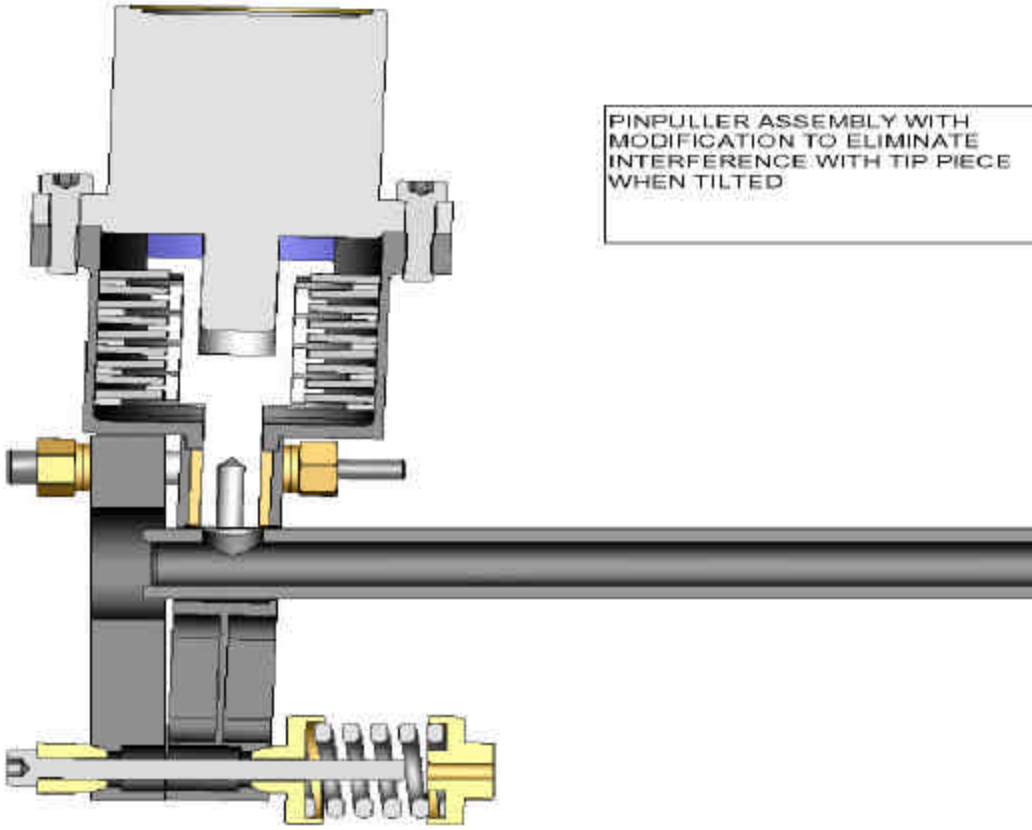


Thermal Vacuum Test

•This drawing is the section view, post SMAR firing

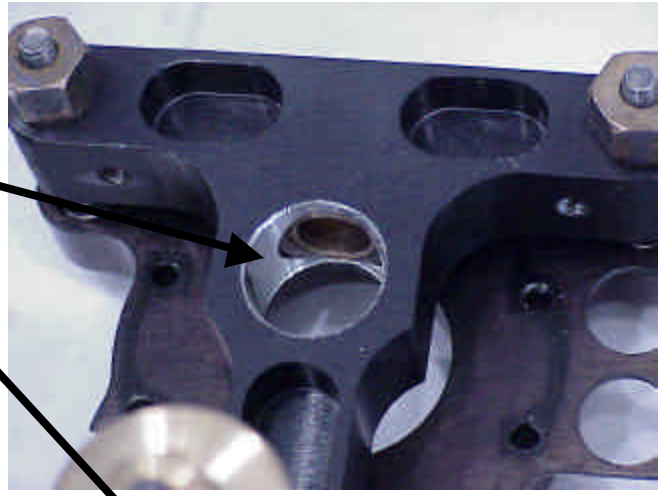
•The hole has been relieved by milling an offset into both sides of the mount, while leaving a lip to guide the tip while the pinpuller is installed and preloaded.
•The tip piece no longer binds in the mount (detail)

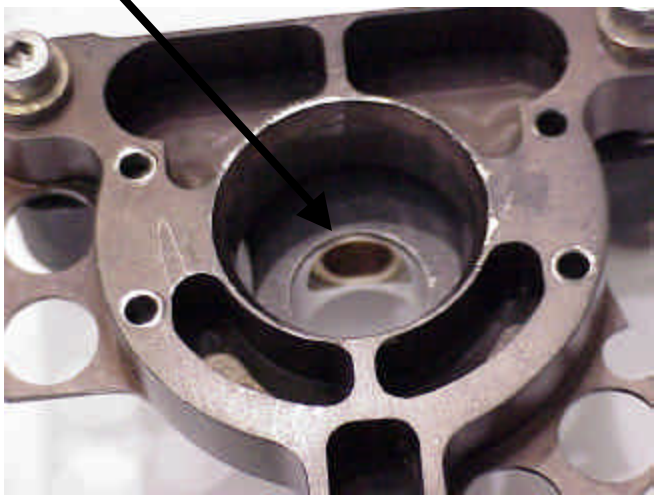


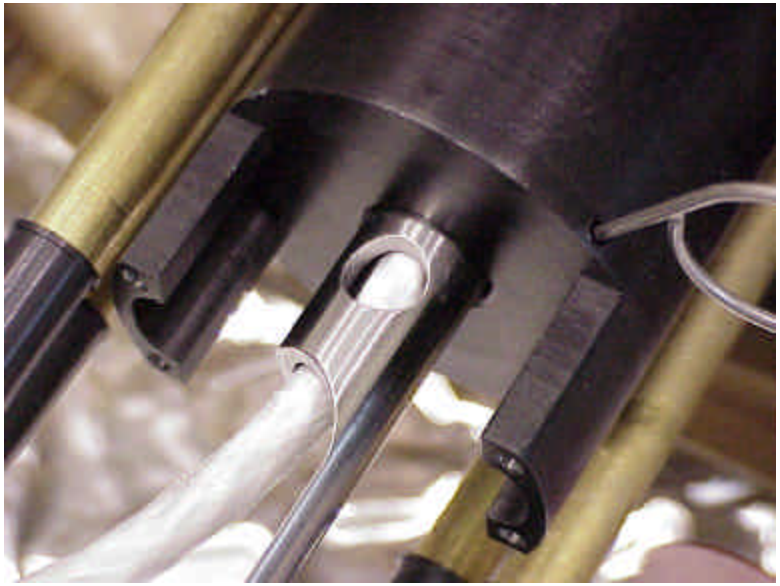


Thermal Vacuum Test

- **Reworking the part, the through hole in the floating mount was relieved to allow free travel of the tip piece, while maintaining the needed tolerances.**
- **The galling was removed from the tip piece tail.**



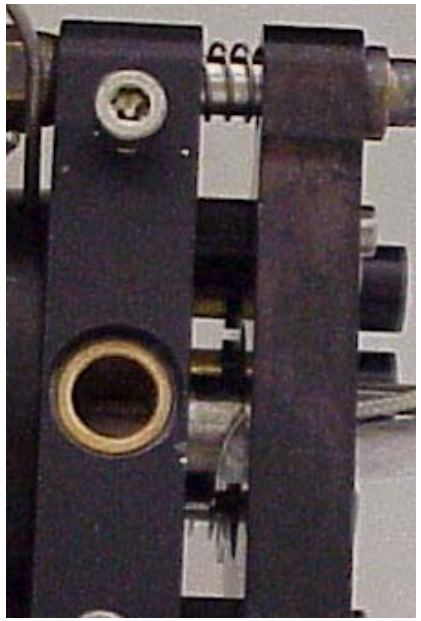


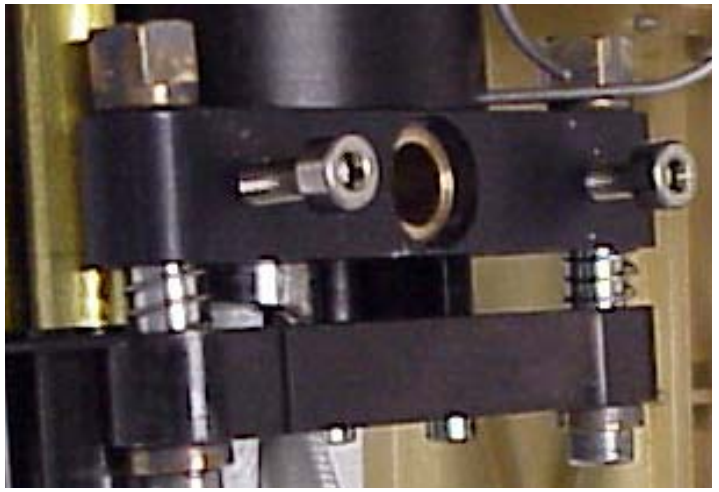


Additional Protoflight Boom Post-Deployment Data

Post Deployment Results

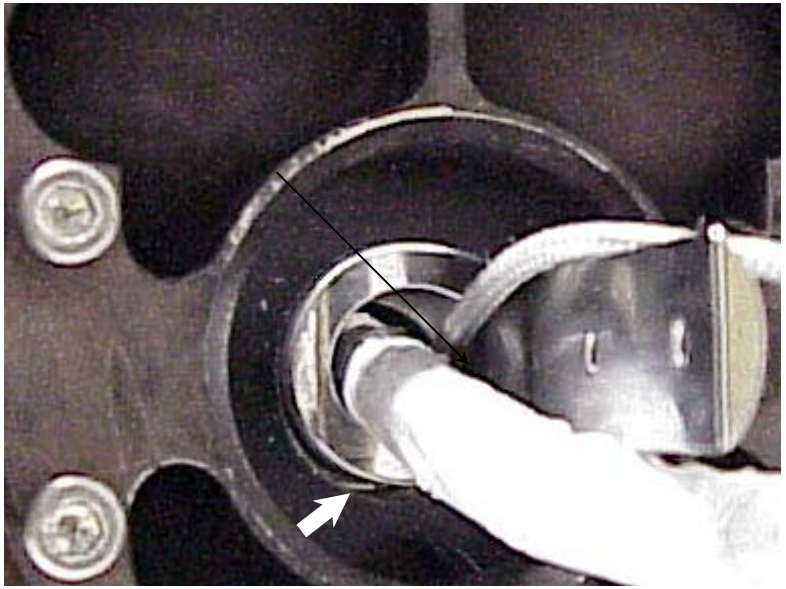
- After successful deployment of the boom (cold) and Thermal Balance, the boom was disassembled and inspected to look for signs of galling
- The pinpuller is removed to increase the viewable area.
- Pictures show the tip piece to be free of the markings associated with galling as previously seen.
- The tip piece previously showed longitudinal streaks from the "teeth" generated by the galled aluminum in the deployment fixture.





Post Deployment Results

- **This picture shows the modification as viewed along the tip piece. The opening that was added to provide clearance is now seen at the bottom of the picture.**



- **These pictures show that the modifications done to the pinpuller mounting ring are sufficient to remove the galling between it and the tip piece.**