Capture Latch Assembly for the NASA Docking System

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- Capture Latch Operations
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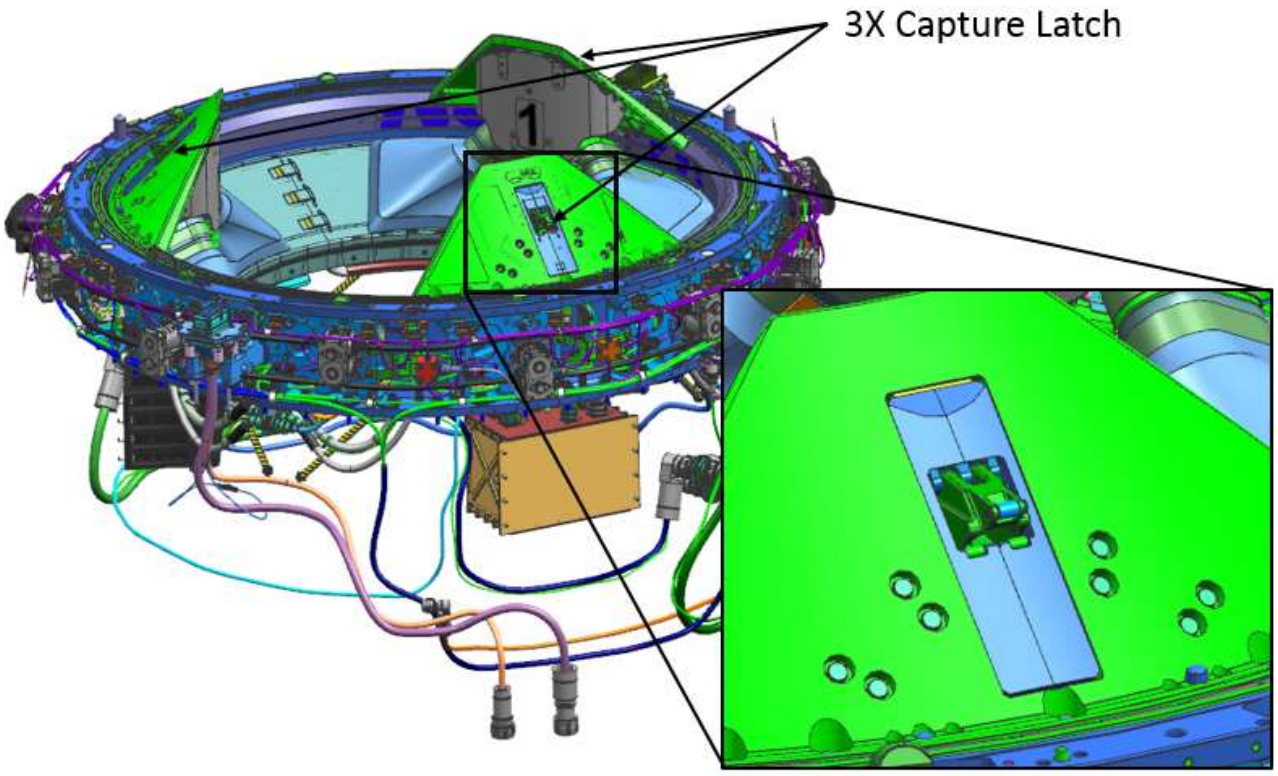
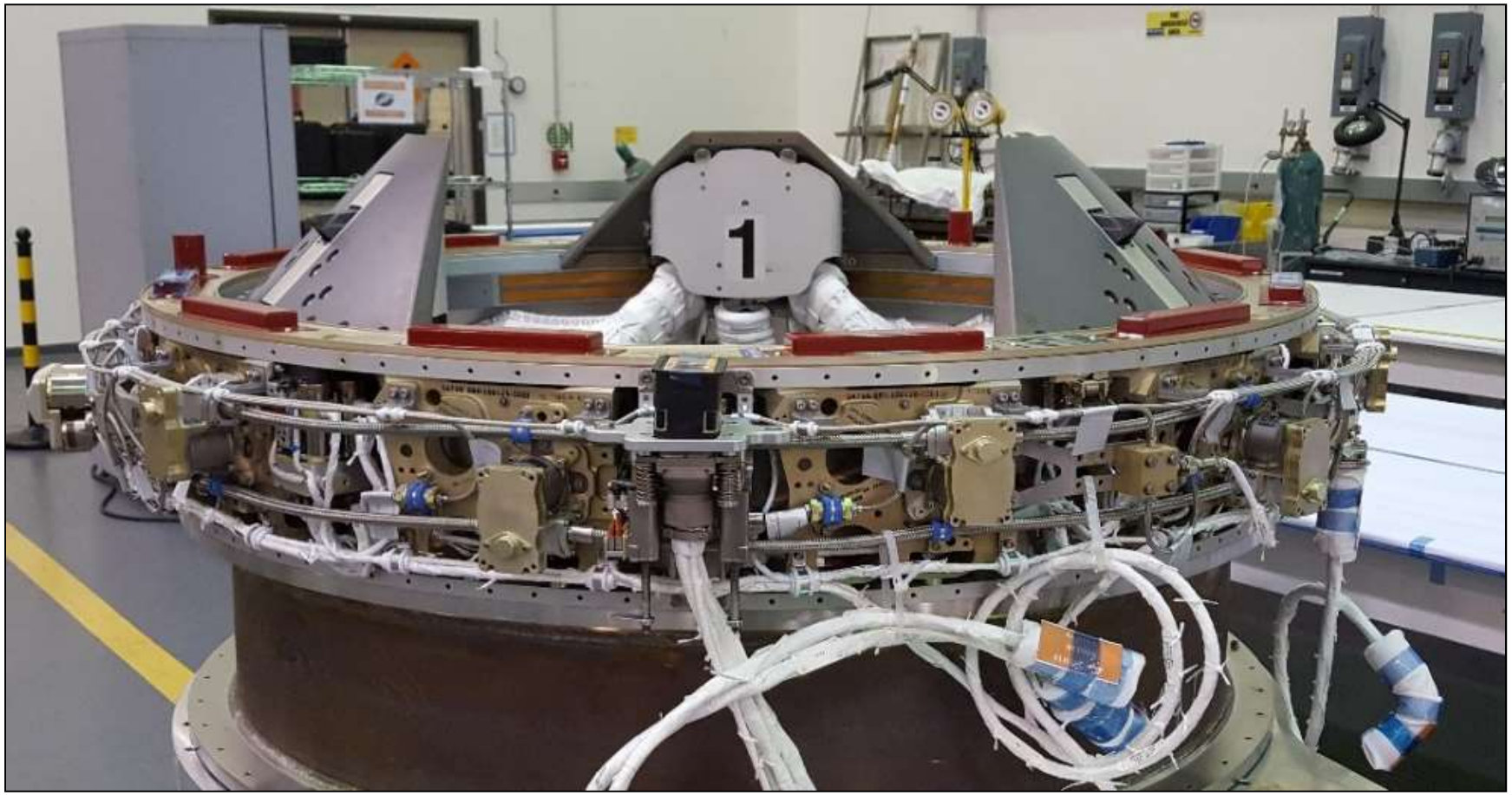
Introduction

- Capture Latch Assembly
  - Part of the NDSB1
  - Connects the docking vehicles during Soft Capture.
  - Releases during Hard Capture
  - Three latches per NDSB1



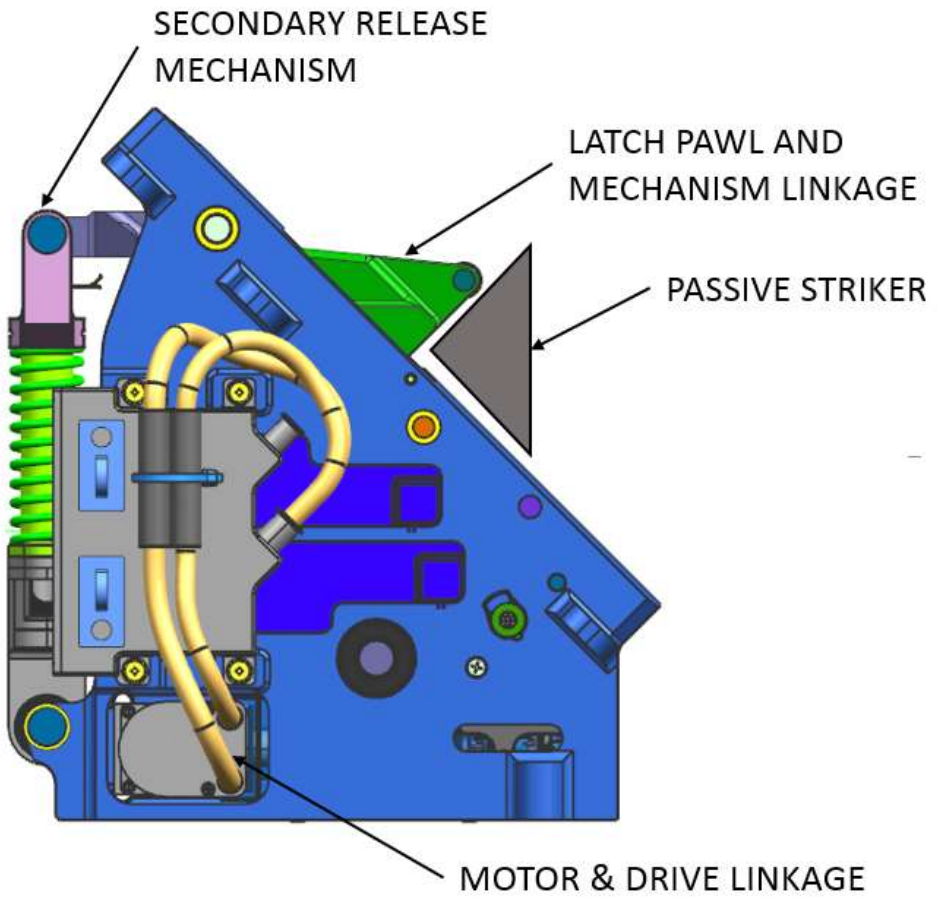
Introduction

- Capture Latches on first Flight NDSB1



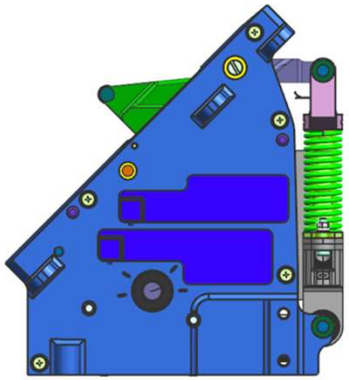
Design Overview

- **Latch Pawl:** Latching feature that reacts load from Passive Striker to attain capture between mating docking systems.
- **Passive latch striker plate:** This is a simplified representation of the stationary latch interface hardware on the passive docking system.
- **Motor:** Provides the nominal actuation for the mechanism.
- **Internal Transmission/Linkage System:** Transmits torque from the motor to the Latch Pawl and retains the pawl in desired position.
- **Secondary Release Mechanism:** Provides for secondary release in the event of a nominal drive system failure.

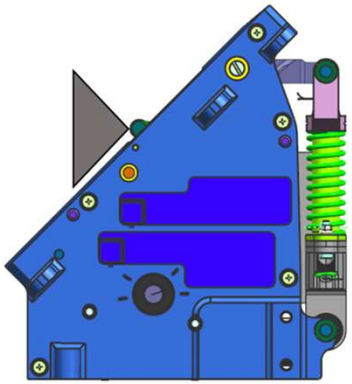


Capture Latch Nominal Operations

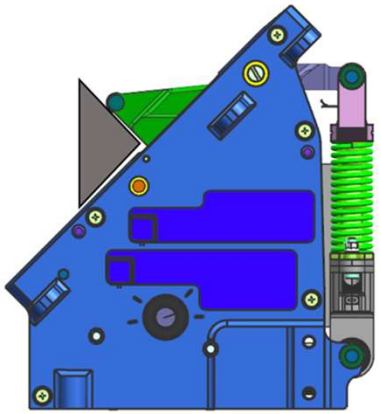
Docking (Capture)



1. Ready to Capture Mode

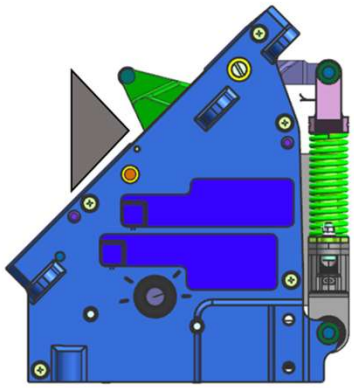


2. Capturing Passive Latch

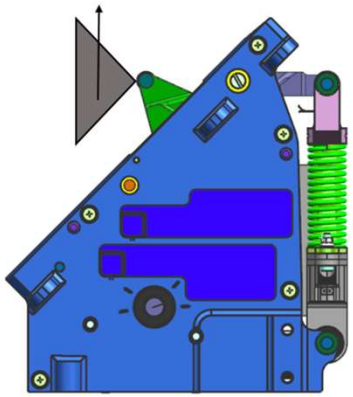


3. Passive Latch Captured

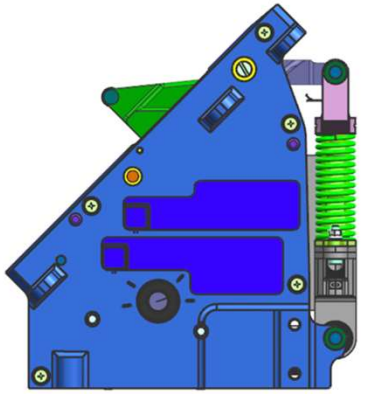
Undocking (Release)



4. Remode to Ready to Release Mode



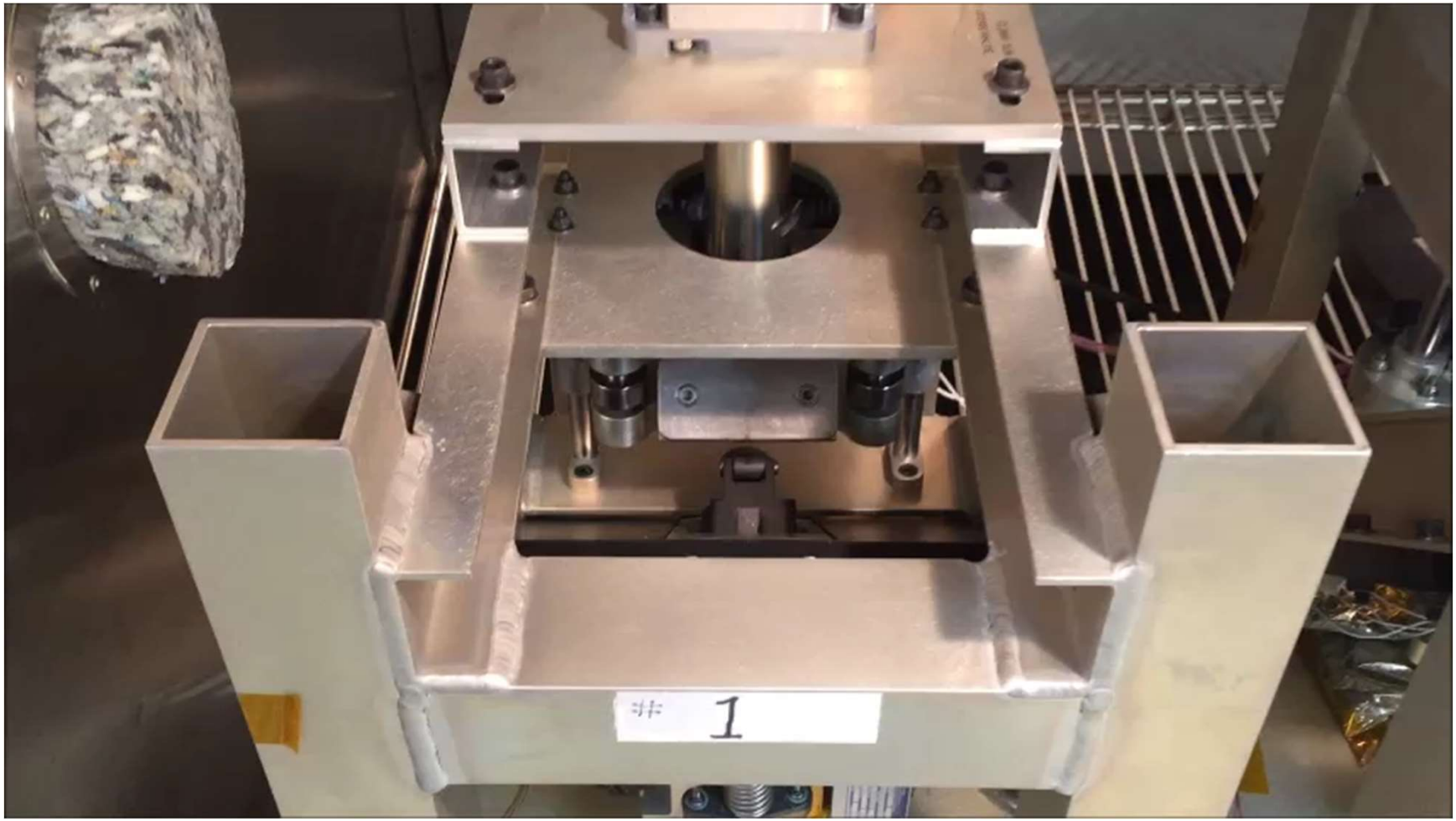
5. Passive Latch is Released



6. Return to Ready to Capture

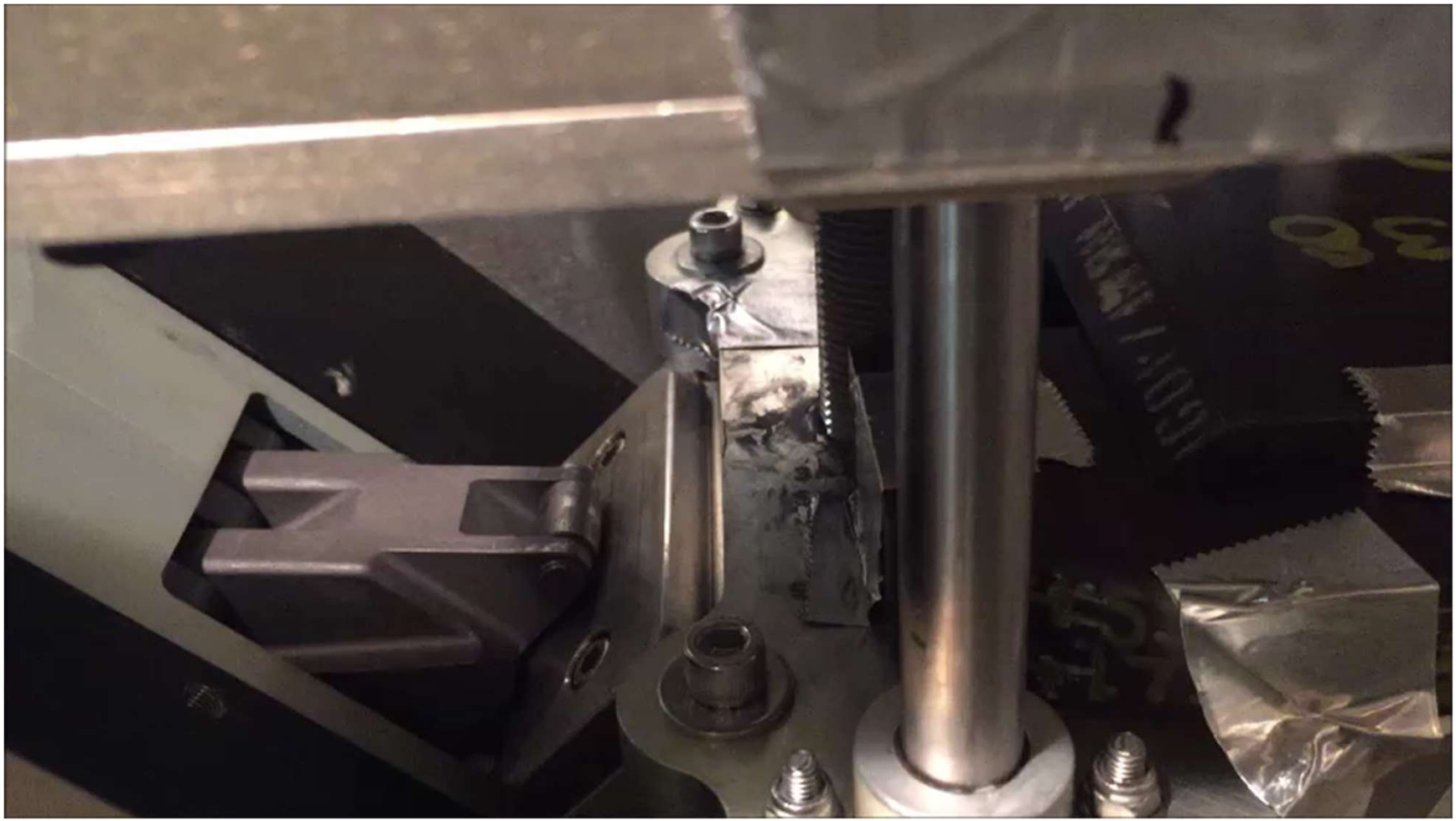
Capture Latch Nominal Operations

Docking Simulation



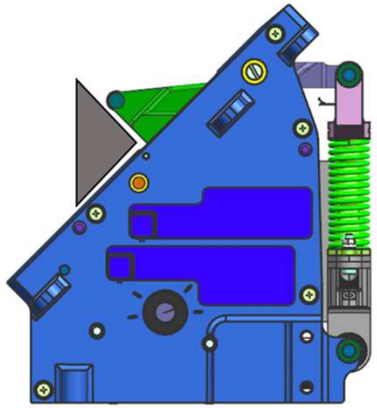
Capture Latch Nominal Operations

Undocking Simulation

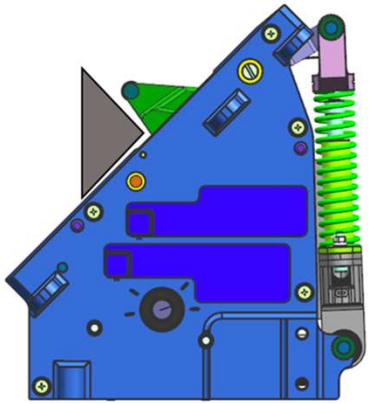


Capture Latch Off-Nominal Operations

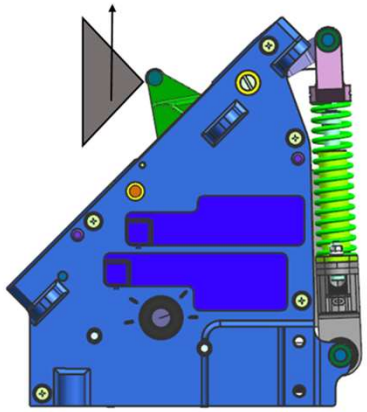
Capture Latch Secondary Release



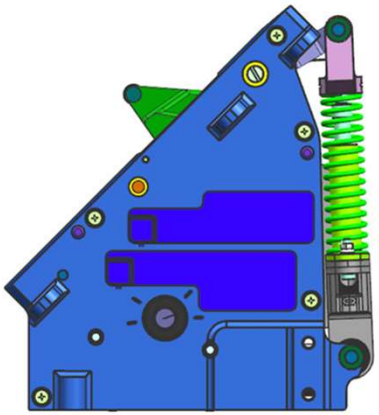
1. Passive Latch Captured



2. Secondary Release (NEA) Activated



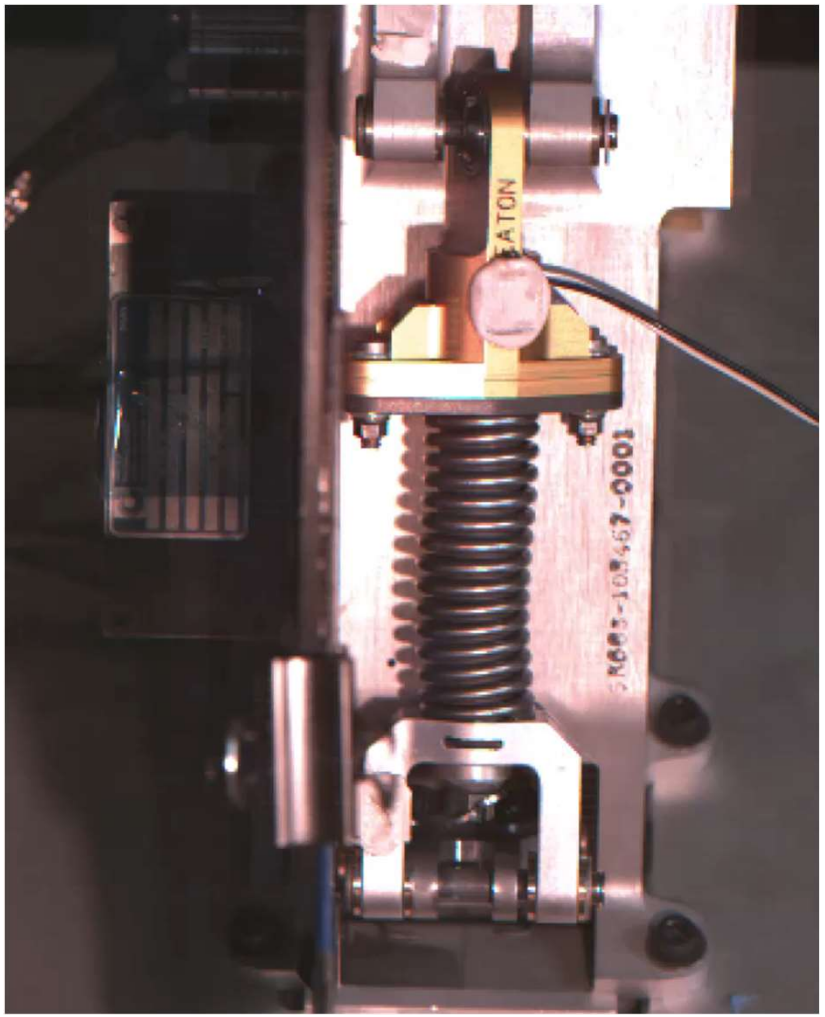
3. Passive Latch is Released

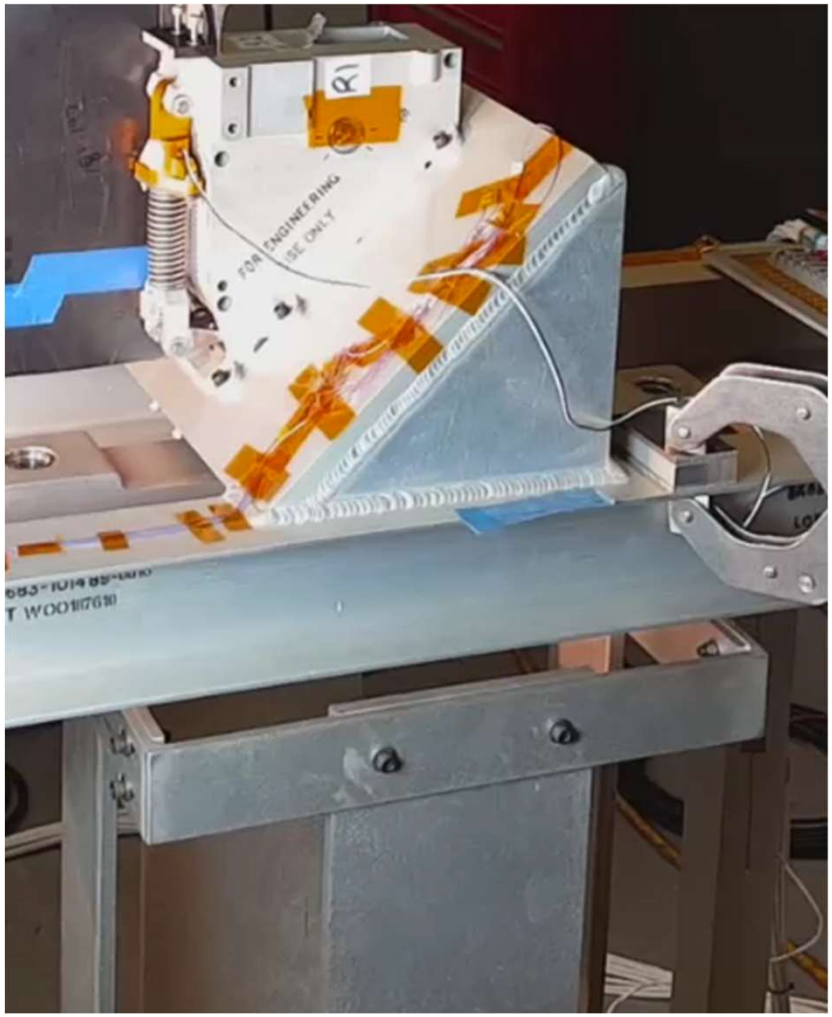


4. CLA is Permanently in Release Mode

Capture Latch Off-Nominal Operations

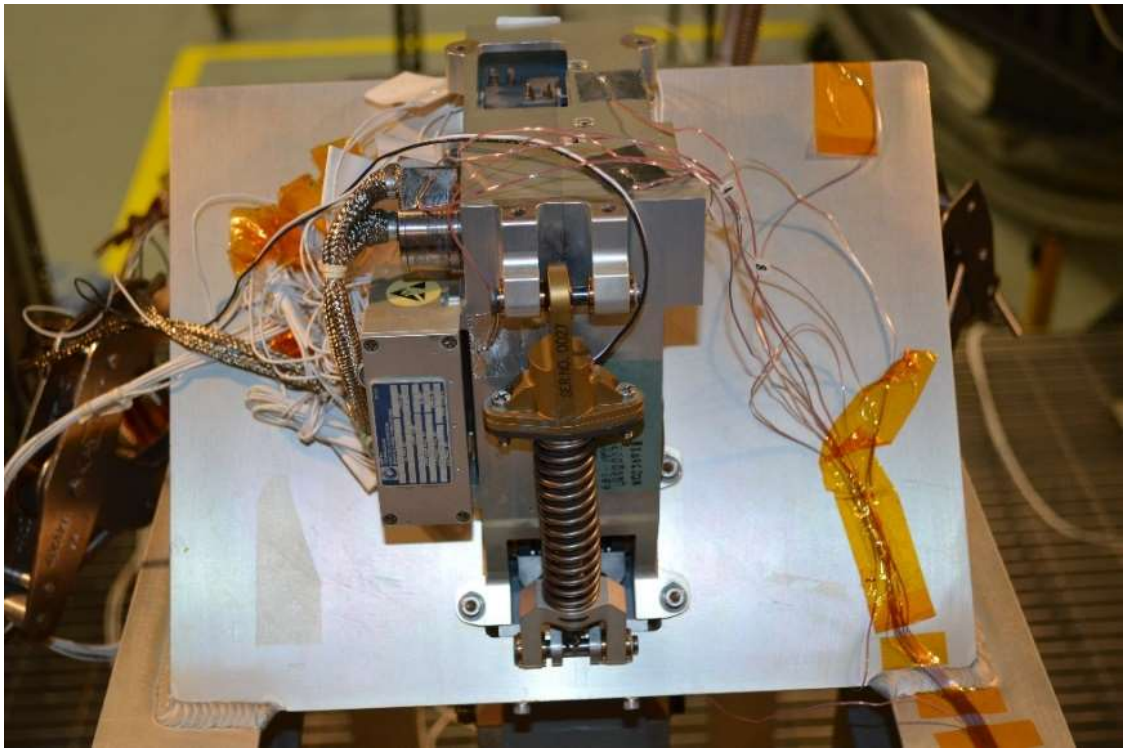
Capture Latch Secondary Release





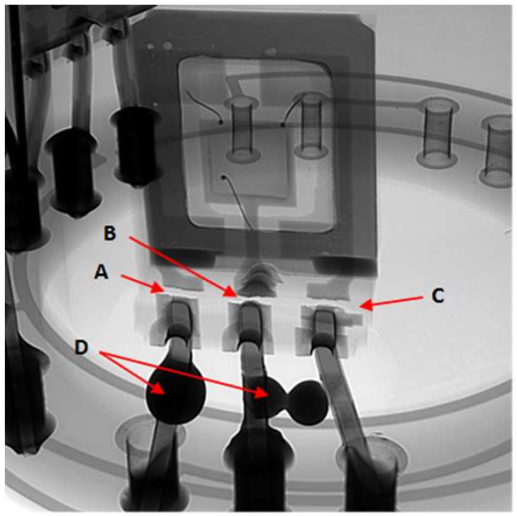
Testing Summary

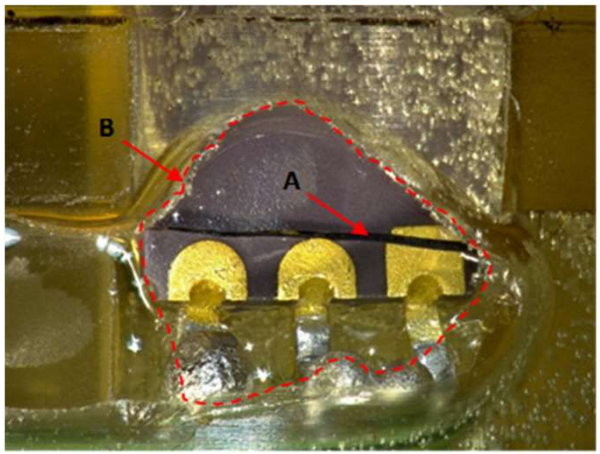
- Test Campaign:
  - Development
  - Qualification
  - Acceptance
- Tests Included:
  - Run-In
  - Functional
  - Random Vibration
  - Thermal Vacuum & Thermal Cycling
  - Primary Release
  - Secondary
  - Static Load



Motor Failures

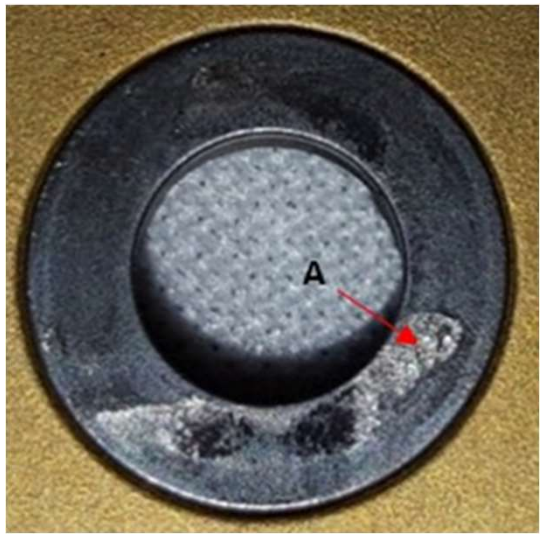
- **Description of Failure:** During the thermal cycling portion of acceptance testing, some motors failed to operate or exhibited erratic/intermittent behavior.
- **Failure Investigation Summary:**
  - Troubleshooting and teardown was performed on the failed units.
  - Ultimately the failure was found to be caused by cracks in the Hall Effect Device (HED) in the motor.
  - The cracks were found to be caused by thermally induced stresses in the potting material, exacerbated by voids.
- **Corrective Action**
  - Potting material was changed to a new material with a more compatible CTE
  - Potting process changed to prevent void generation.
  - All 12 flight motors successfully testing after redesign without issue.

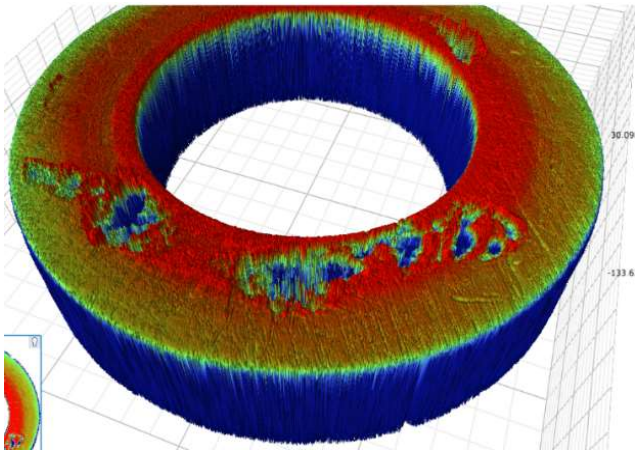




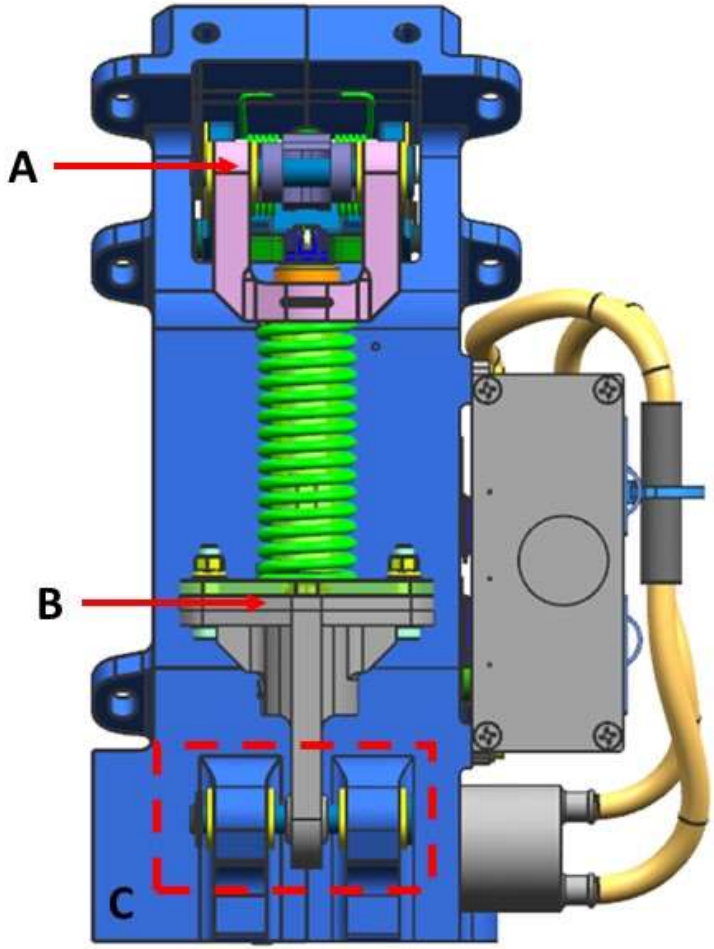
Secondary Release Mechanism Failures

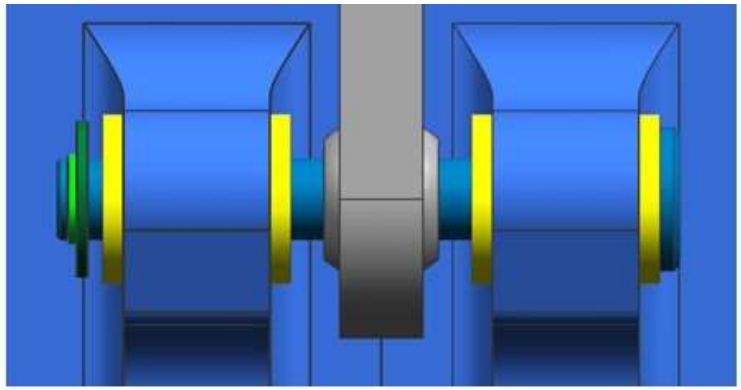
- **Description of Failure:** During development and qualification testing, the secondary release mechanism failed to deploy.
- **Failure Investigation Summary:**
  - Teardown and inspection of the mechanism revealed the presence of galling inside the Non-Explosive Actuator (NEA).
  - Testing was performed which demonstrated that the galling was caused by the motion of the mechanism during vibration testing.
- **Corrective Action:**
  - The mechanism supports were redesigned to eliminate motion during testing.
  - After the redesign, the qualification testing was repeated successfully.



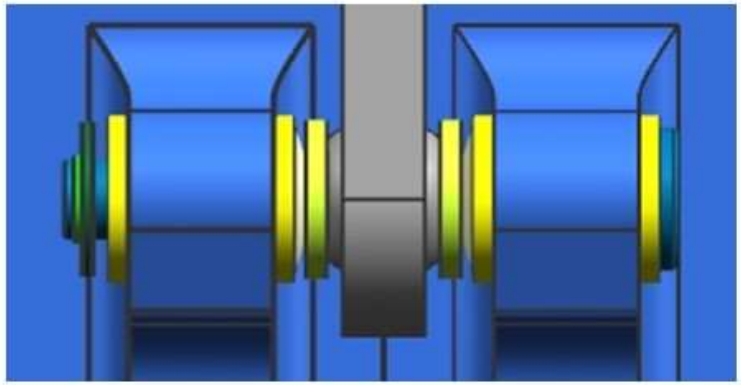


Secondary Release Mechanism Failures





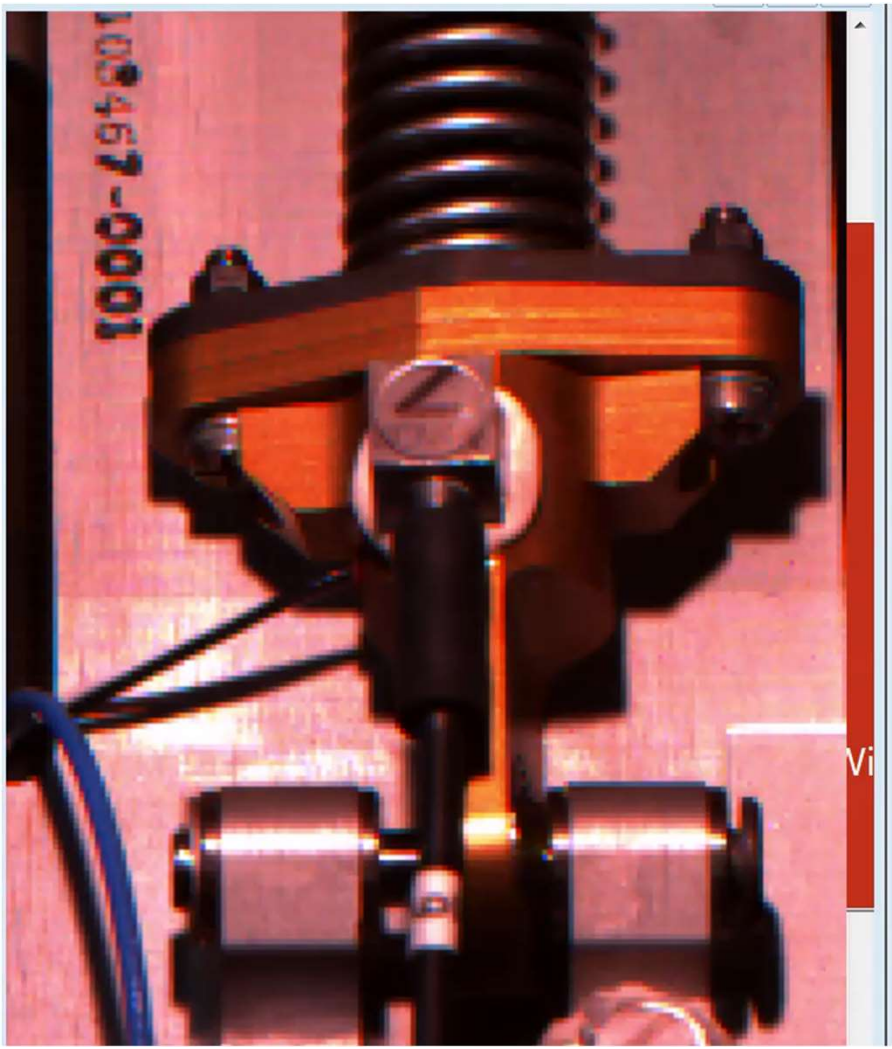
C – NEA Attachment, pre-redesign



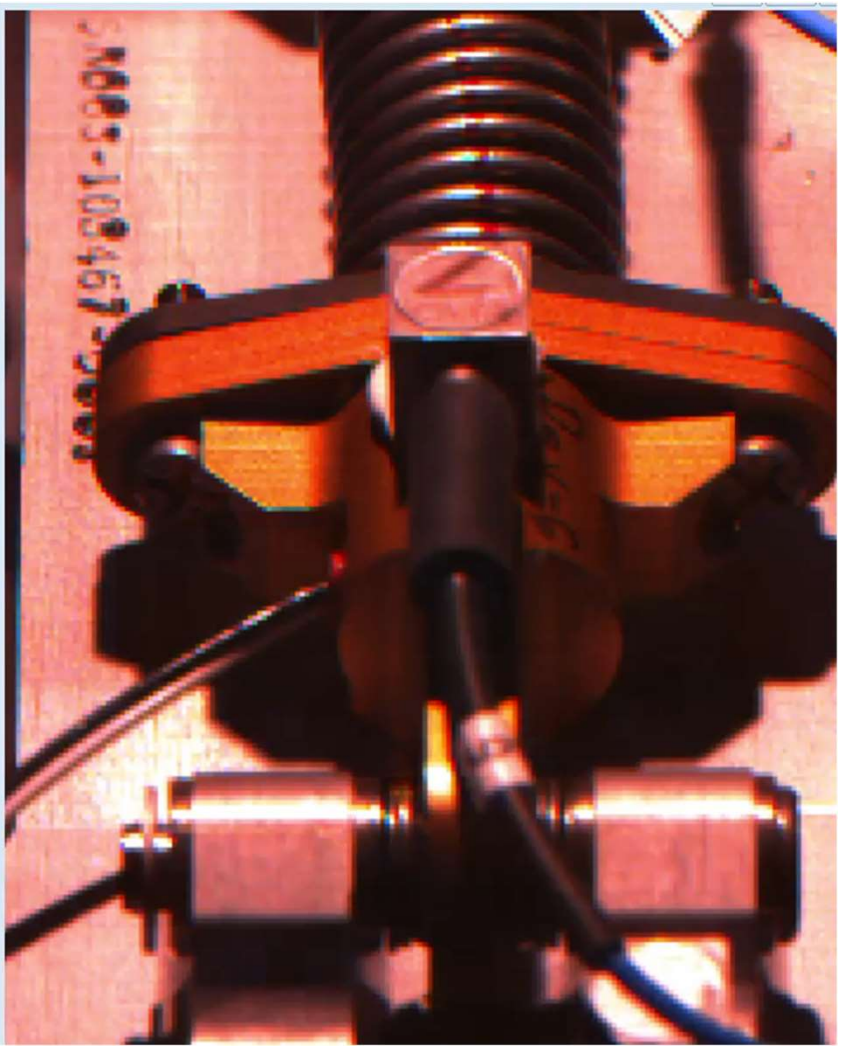
C – NEA Attachment, post-redesign

Secondary Release Mechanism Failures

Pre-Redesign



Post-Redesign



Lessons Learned

- **Avoid Loosely Constrained Parts**
- **Pay Attention to Thermal Stresses In Potted Parts**
- **Fully Address Failures During Development Testing**
- **Watch the Test Whenever Possible**
- **Use Caution with Commercial Off The Shelf (COTS) Parts**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