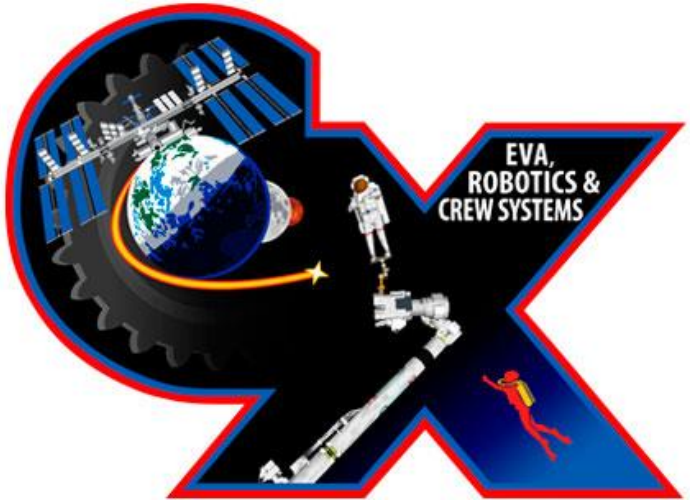
FLIGHT OPERATIONS DIRECTORATE

EVA, ROBOTICS & CREW SYSTEMS

OPERATIONS DIVISION



ISS Internal Maintenance Experience and Needs

CX42 (OSO)/Nick Robbins

2/1/2017

Agenda

- The CX4/OSO Job
- Current imagery and inspection methods
- Examples
- Lessons Learned
- Current/Future Needs

The OSO Job

- Support On-Orbit Maintenance tasks
  - Both scheduled *preventive* maintenance and *contingency/unplanned* maintenance due to failures
  - Provide **Real-time support** to crew as they execute
  - **Write procedures** for all internal volume maintenance
  - Conduct **training** for crew and flight controllers
- Support Atmosphere Leak response: **pinpoint** source, **install** pressure repair patch method
- Common Berthing Mechanism **(CBM) operations**

What does OSO do in MCC?

- More than just ORU level Remove and Replace
  - Aging vehicle means more internal component inspection and repair
  - Mod kit installation for vehicle reconfigs not initially in the designs (Node 3 relocation, PMM installation, etc.)
  - Inspections behind close-outs or inside an ORU to look for damage or tell-tale signs of failure
  - Inspections post-maintenance, to document resulting conditions
- OSO Console tries to be the SPECIALIST of the systems we repair
  - ISS crew cannot be as specialized as the people who train them, operate the vehicle, and design the equipment

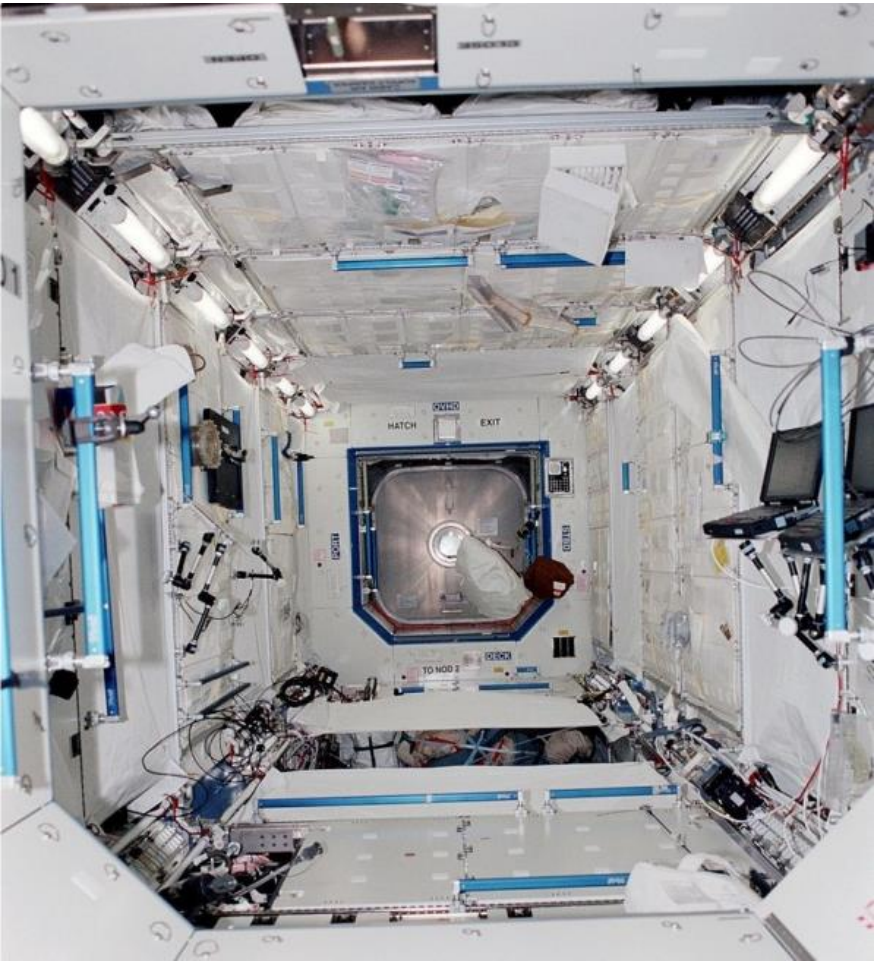
Current inspection methods for maintenance and repair

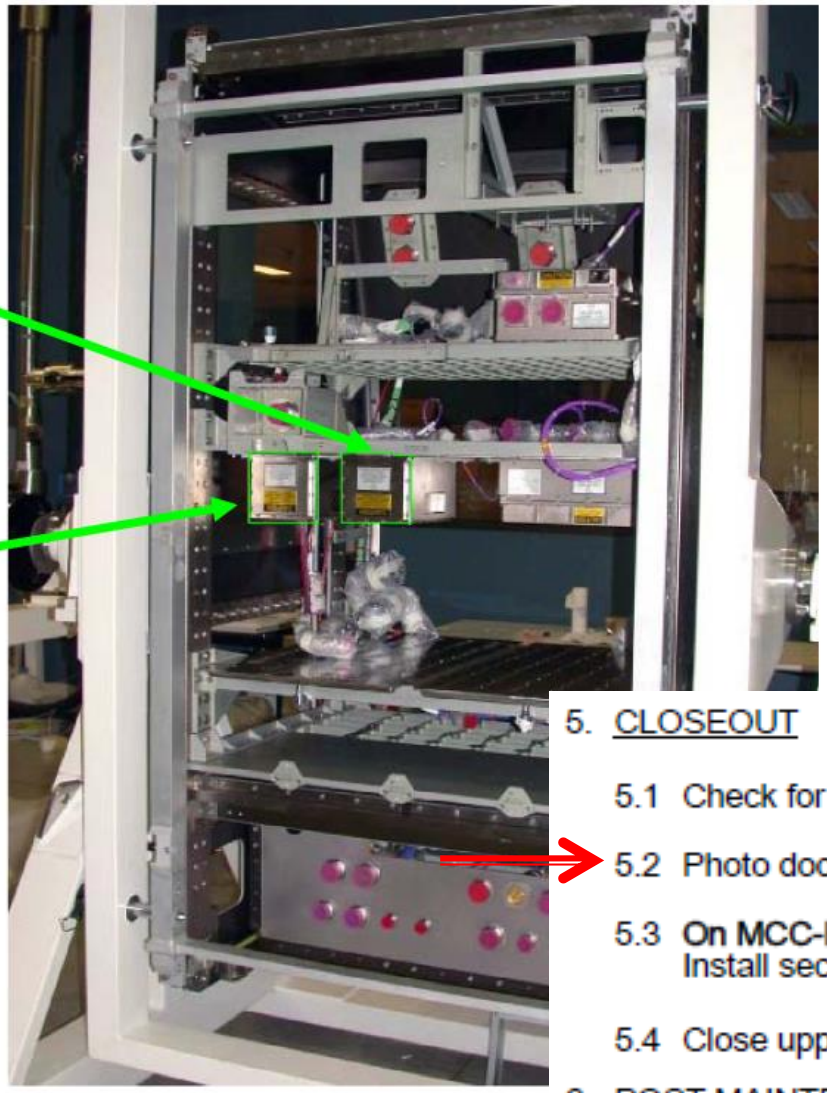
- Real-time crew verbal descriptions
- Crew Notes, written descriptions
- Handheld digital camera (DSLR) imagery
- Downlinked digital video (not always real-time)

Procedures we write for crew execution often include steps to document maintenance (before and after) using digital camera imagery.

On-Orbit Configuration

- Discrepancy between initial drawings and final configuration
- Modifications required to support new and shifting operations


HATCH
EXIT
TO NOD 2



5. CLOSEOUT

5.1 Check for FOD around work area within 1 meter radius.

5.2 Photo document final configuration prior to closeout [Digital Camera].

5.3 **On MCC-H GO**
Install section of insulating blanket covering Gas Trap [Velcro].

5.4 Close upper **[Z]** faceplate of Rack **[Y]**.

6. POST MAINTENANCE

6.1 Stow tools, materials per stowage note.

6.2 Notify **MCC-H** of task completion, S/N of failed Gas Trap.

On-Orbit Configuration

Challenge

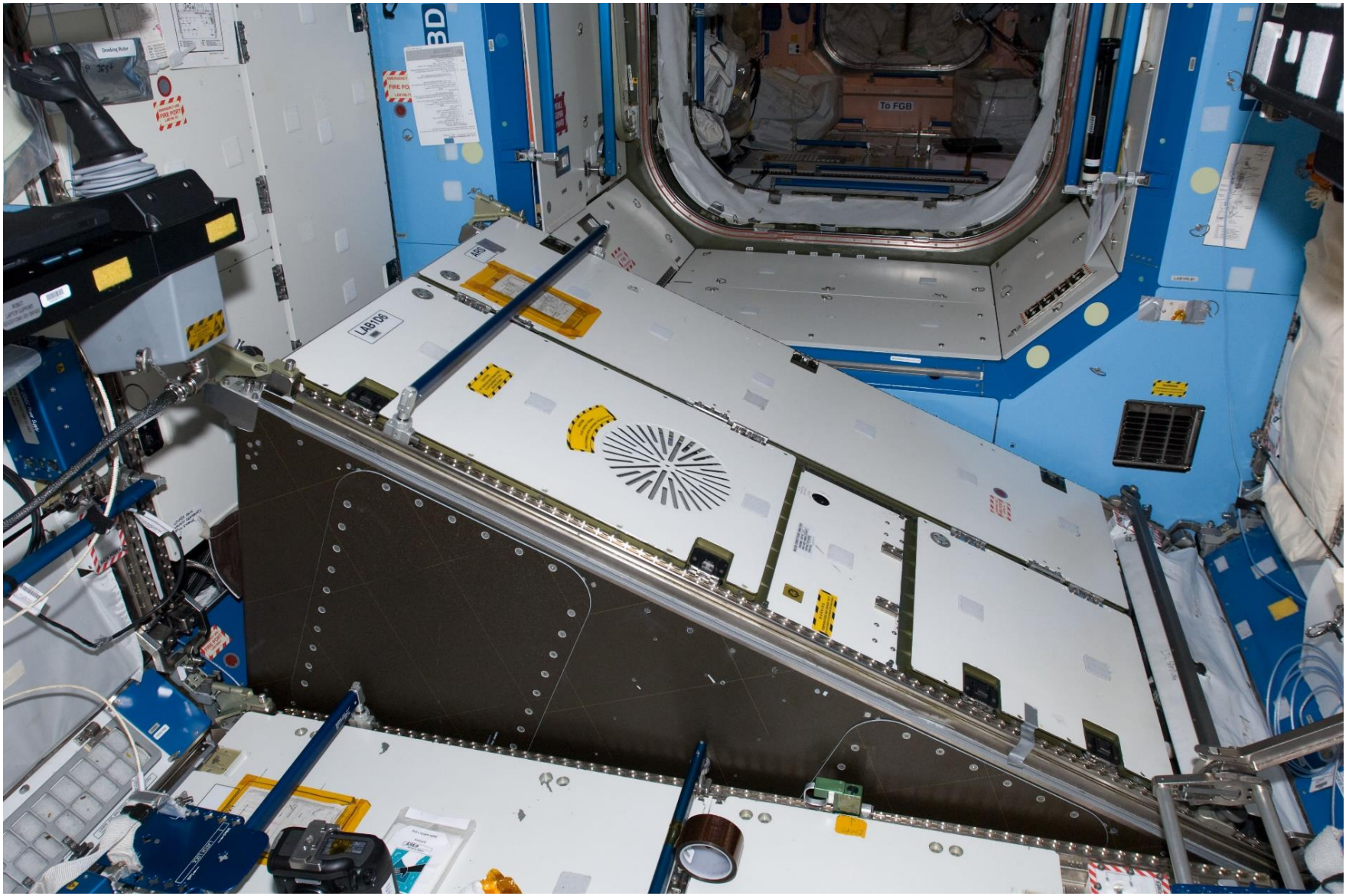
- Keep up with constant change of station configuration
- Crew make adjustments as needed
- Lack full awareness of current configuration

Potential Solution

- Crew-free method to frequently inspect, monitor, and record configuration
- Determine required product changes

Access

- Access to some areas are very limited or time consuming



Up to ~90 min

- Up to ~30 min
- Lost items

Access

Challenge

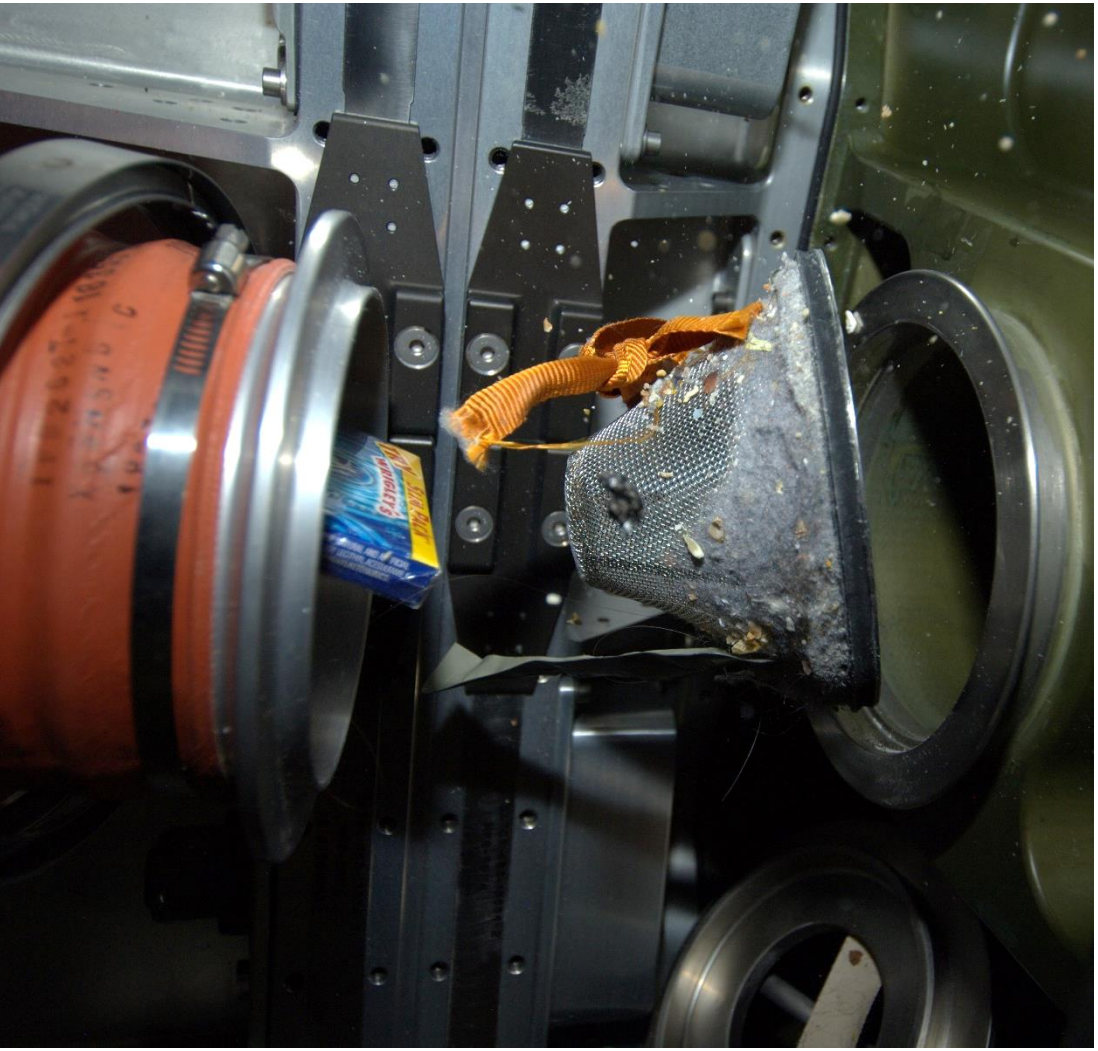
- Access can be very time consuming
- Some areas are very difficult for crew to access

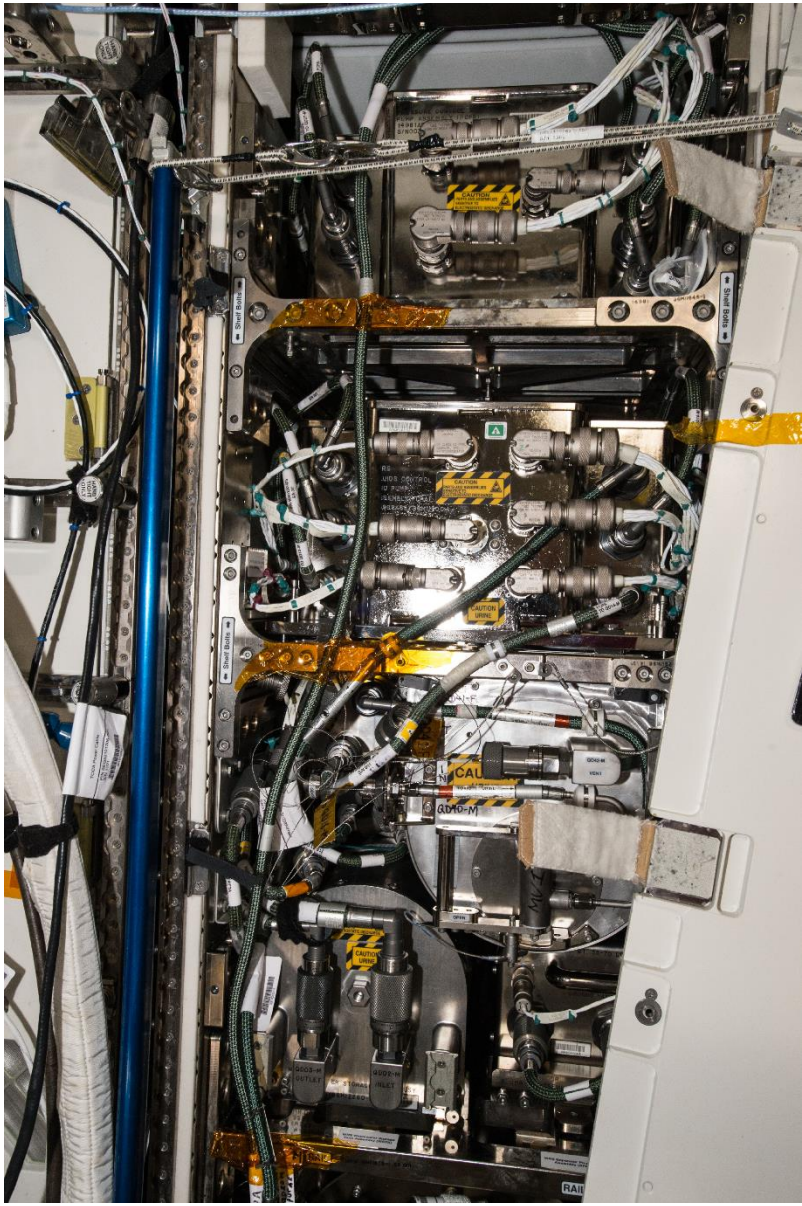
Potential Solution

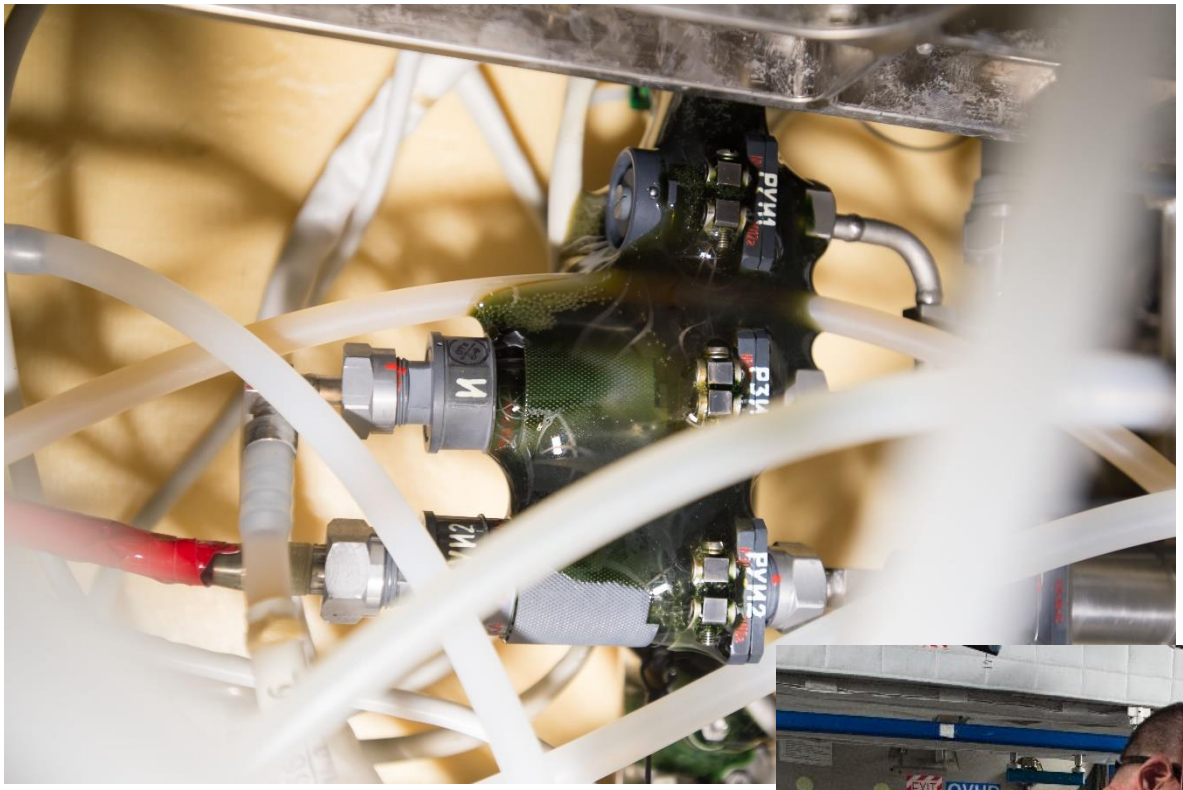
- Inspect stowage and hardware before accessing

Hidden Failures

- Many failures difficult to determine without in-depth inspection or troubleshooting by crew








EXIT
OVHD

Hidden Failures

Challenge

- Crew has limited ability to inspect and troubleshoot hardware
- Troubleshooting can be time consuming and hazardous

Potential Solution

- Ability to inspect behind covers and inside hardware

Leak Pinpoint and Repair

- Leak pinpoint is time consuming due to access and lack of available tools
- MMOD strike damage is difficult to assess

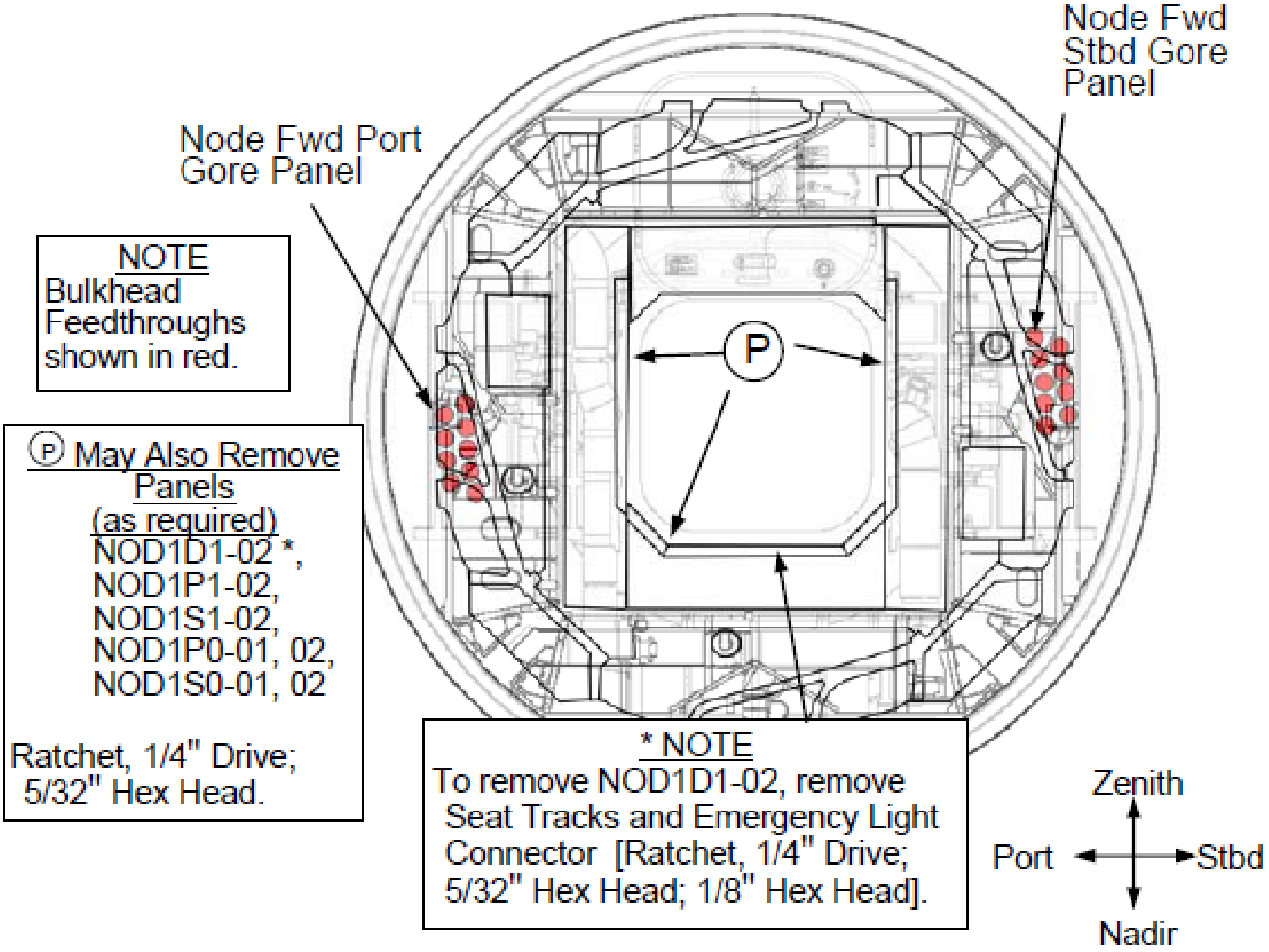
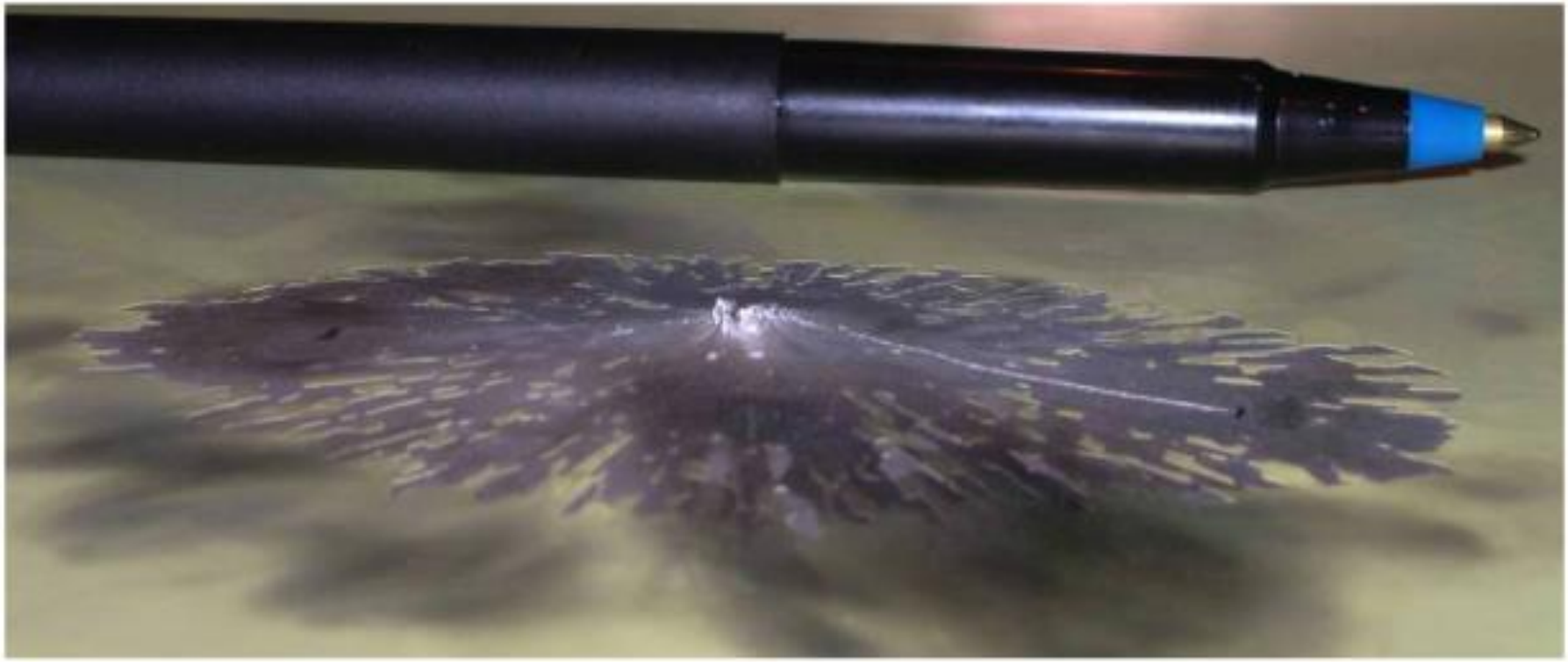
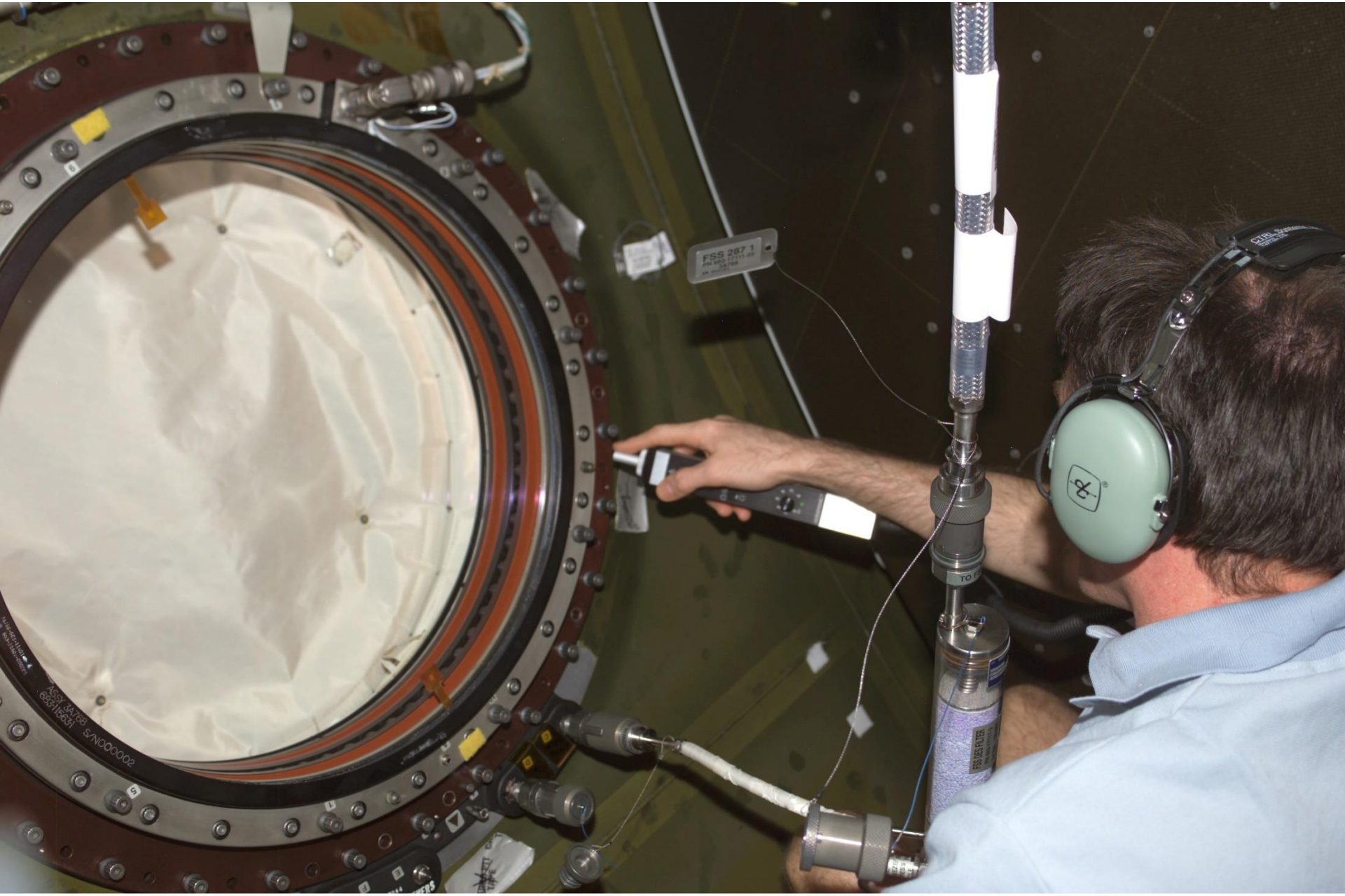


Figure 2.- Node 1 Fwd Endcone.





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Leak Pinpoint and Repair

Challenge

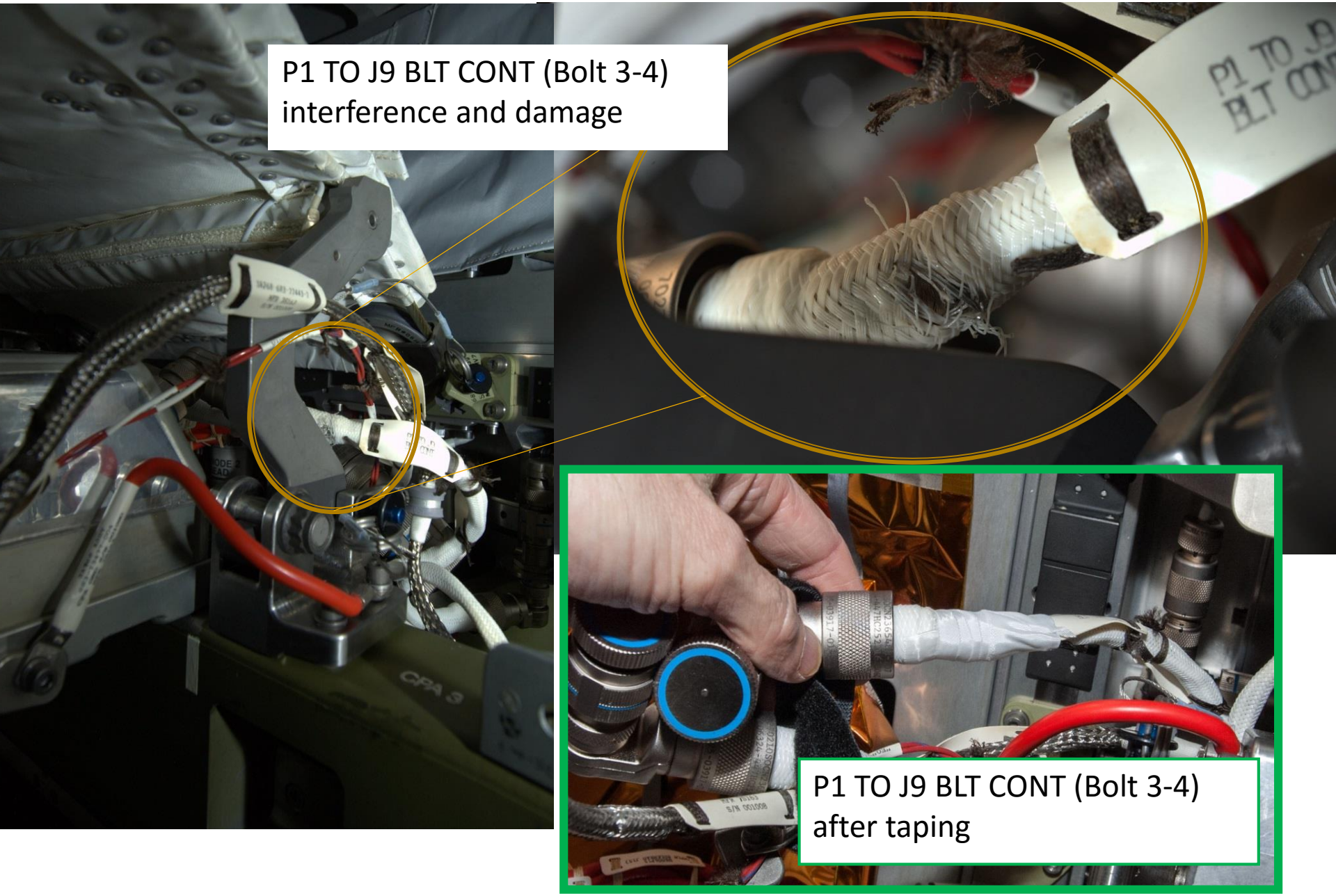
- Hard to pinpoint leak
  - Large area
  - Hard-to-access areas
  - Lots of background noise
- Assessing damage
  - Analysis beyond photo or after repaired

Potential Solution

- System for accurate and timely monitoring and pinpointing of leaks
- Tool for accurate assessment of damage

Unexpected Damage

- Hardware damage often detected through crew inspections and photo documentation


P1 TO J9 BLT CONT (Bolt 3-4)
interference and damage
P1 TO J9 BLT CONT (Bolt 3-4)
after taping

Unexpected Damage

Challenge

- Lack of awareness of incurred damage

Potential Solution

- Inspection techniques that provide more current and regular data on hardware

Lessons Learned

- Importance of Imagery and Inspections to the OSO Console
  - Pre-flight configuration imagery and documentation
    - For writing procedures, conducting training, supporting real-time questions, and comparing to current config imagery
  - In-Flight configuration imagery
    - For writing procedures, planning operations
    - Example: Quick Look (invaluable tool for responding to real-time issues with configuration)
  - Post-maintenance closeout imagery
    - OSO console verifies the work completed on board, and passes as much data as we can to Engineering teams to do the same
  - Generally documenting the vehicle in as much detail as possible
    - Current config, changes, training tools, etc.

Current Needs

- Reliable, high resolution, in-focus, well-lit imagery of all ISS components and subsystems
  - Provides Situational Awareness for supporting real-time environment, as well as writing procedures
- Ability to inspect behind hard to reach areas, without a lot of crew time
  - Rack rotations can be time consuming considering the stowage situation. Crew Time for maintenance is a premium.
- Reliable Before/After imagery
  - Compare pre- and post- maintenance, to verify successful completion, have something to compare against after next failure.

You never know what you might find!

Future Needs/Suggestions

- Enable autonomous/remote inspection or observation of the vehicle interior
  - Equipment that requires minimal crew interaction
  - Inspection devices that can get into hard to reach areas
  - A way to view and record crew during maintenance (over the shoulder, FPV, etc.)
- Inspection tools beyond traditional photos and video

Conclusion

- Crew safety
- Crew time savings
- More accurate understanding of hardware configuration and failures

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