AEROSPACE TESTING SEMINAR

24th Aerospace Testing Seminar

On-Orbit Constraints Test - Performing Pre-Flight Tests with Flight Hardware, Astronauts and Ground Support Equipment to Assure On-Orbit Success

Michael Haddad

**National Aeronautics & Space Administration**
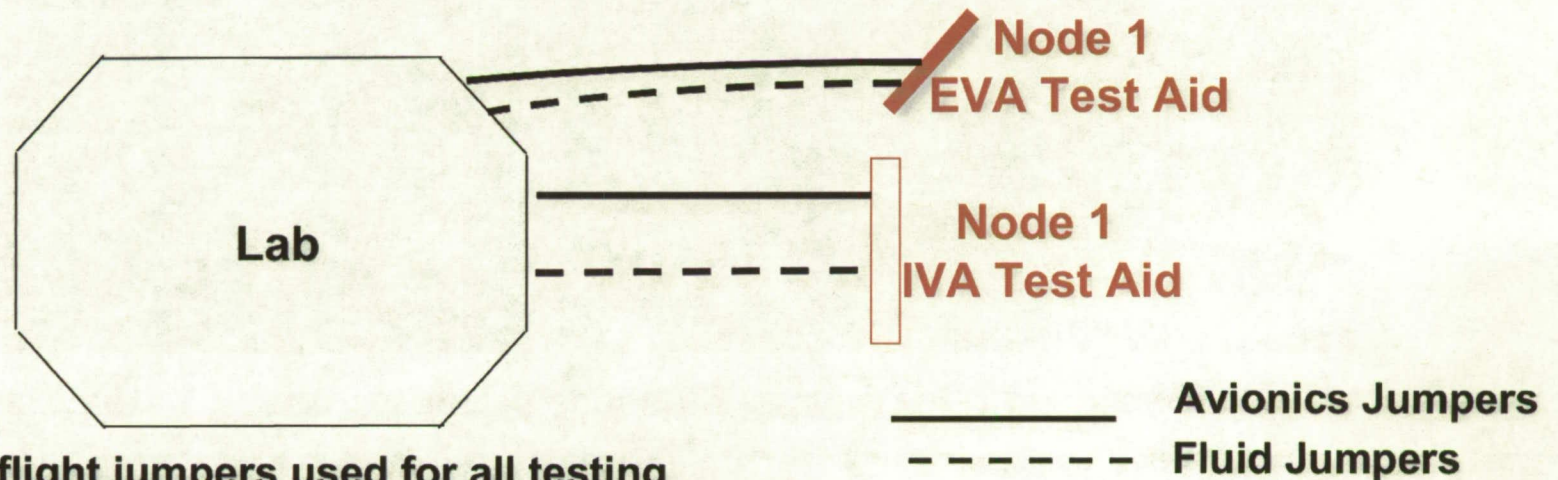
Kennedy Space Center

Background

- Astronauts were concerned about ISS Extra-Vehicular Activity (EVA) & Intra-Vehicular Activity (IVA) hardware integration on-orbit, "How do we verify hardware built and launched on different missions will connect together in orbit?"

- On-Orbit Constraints Test (OOCT) used during KSC ground processing on ISS Flight Hardware to assure EVA & IVA Hardware functions on-orbit. Performing "Dry-runs" of EVA & IVA hardware/operations before launch, OOCT's included connecting cables, fluid umbilical & ducts that would test mating/demating, clocking, routing, etc. OOCT performed by Astronauts/rep with MOD support using Boeing Houston Procedure/Task leader with KSC NASA signature authority. OOCT is a physical check of interfaces, not a functional check.

ISS Fit Check and OOCT Concept

"Today" - <u>Fit check</u> future Lab flight jumpers to Node 1 flight Element

EVA

Future Lab

Node 1

IVA
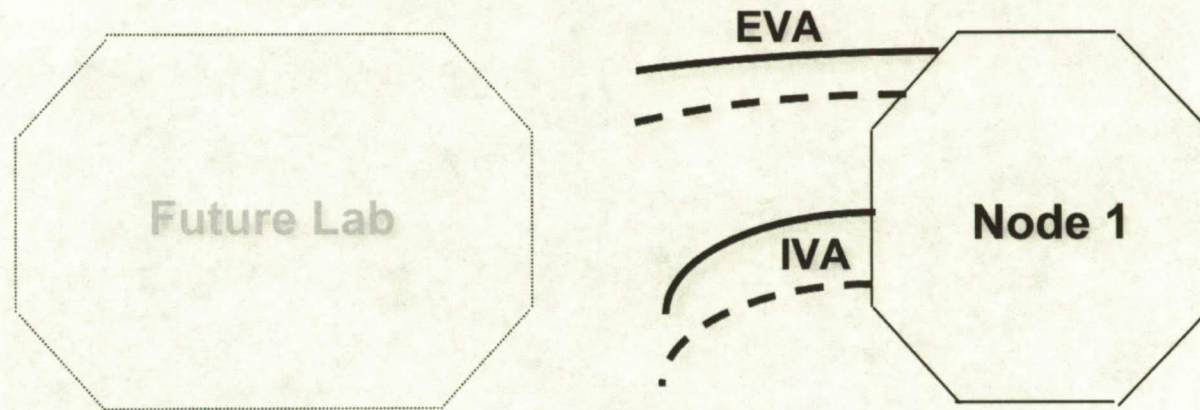
"X time in the future" - <u>OOCT</u> of Lab flight jumpers to Node 1 test aid
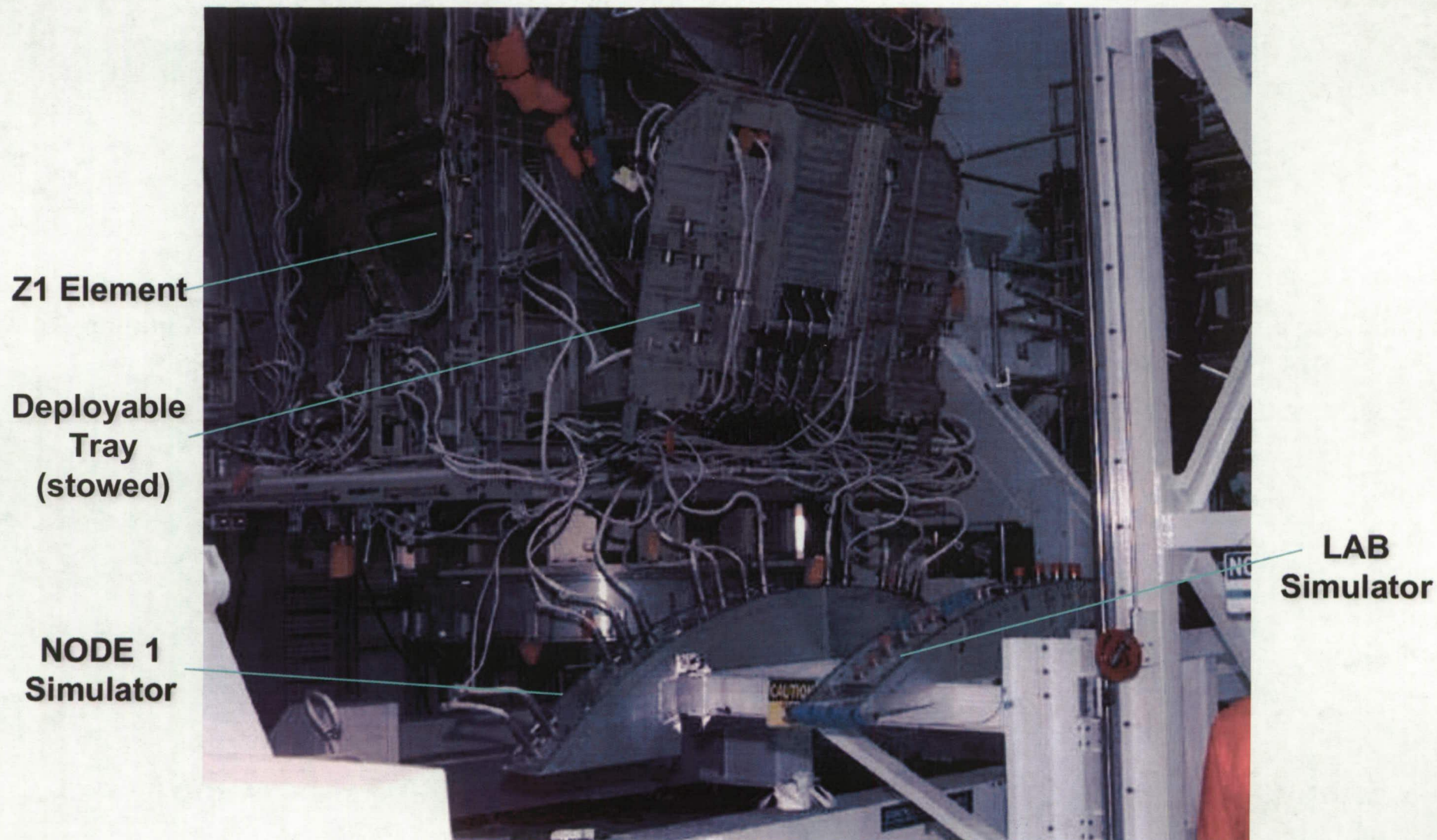**(by default you get <u>fit check</u> to Lab, piggyback on testing so only connect to flight hardware one time)**

Node 1 EVA Test Aid

Node 1 IVA Test Aid

Lab

——————— **Avionics Jumpers**

– – – – – **Fluid Jumpers**

<u>**Note: Same flight jumpers used for all testing**</u>

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Z1 Element

**Deployable Tray (stowed)**

NODE 1 Simulator

LAB Simulator

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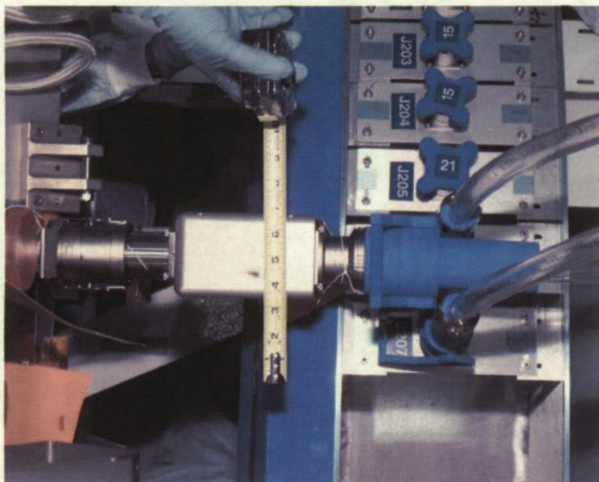# Many Problems Discovered during EVA Z1/Node 1 & Z1/Lab OOCT

Note: Blue foam used to represent adjacent flight hardware
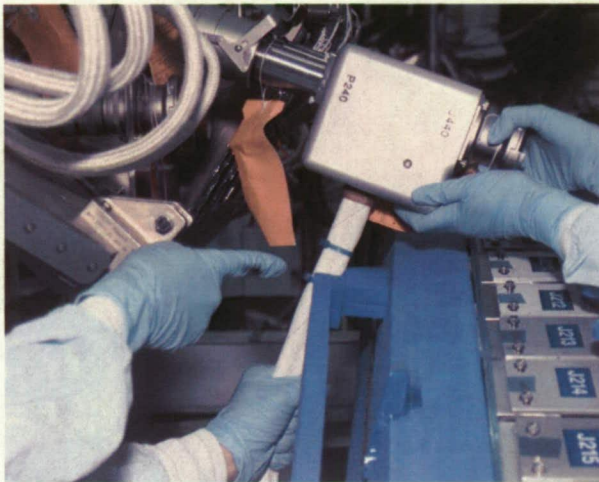
Circuit Interrupt Device (CID) #5 Interferes with handrail
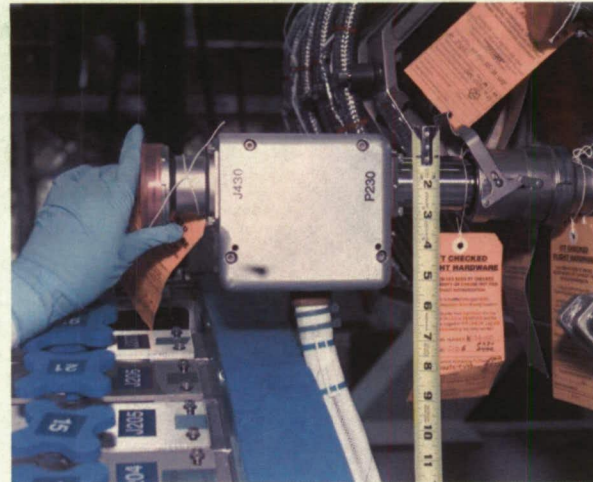
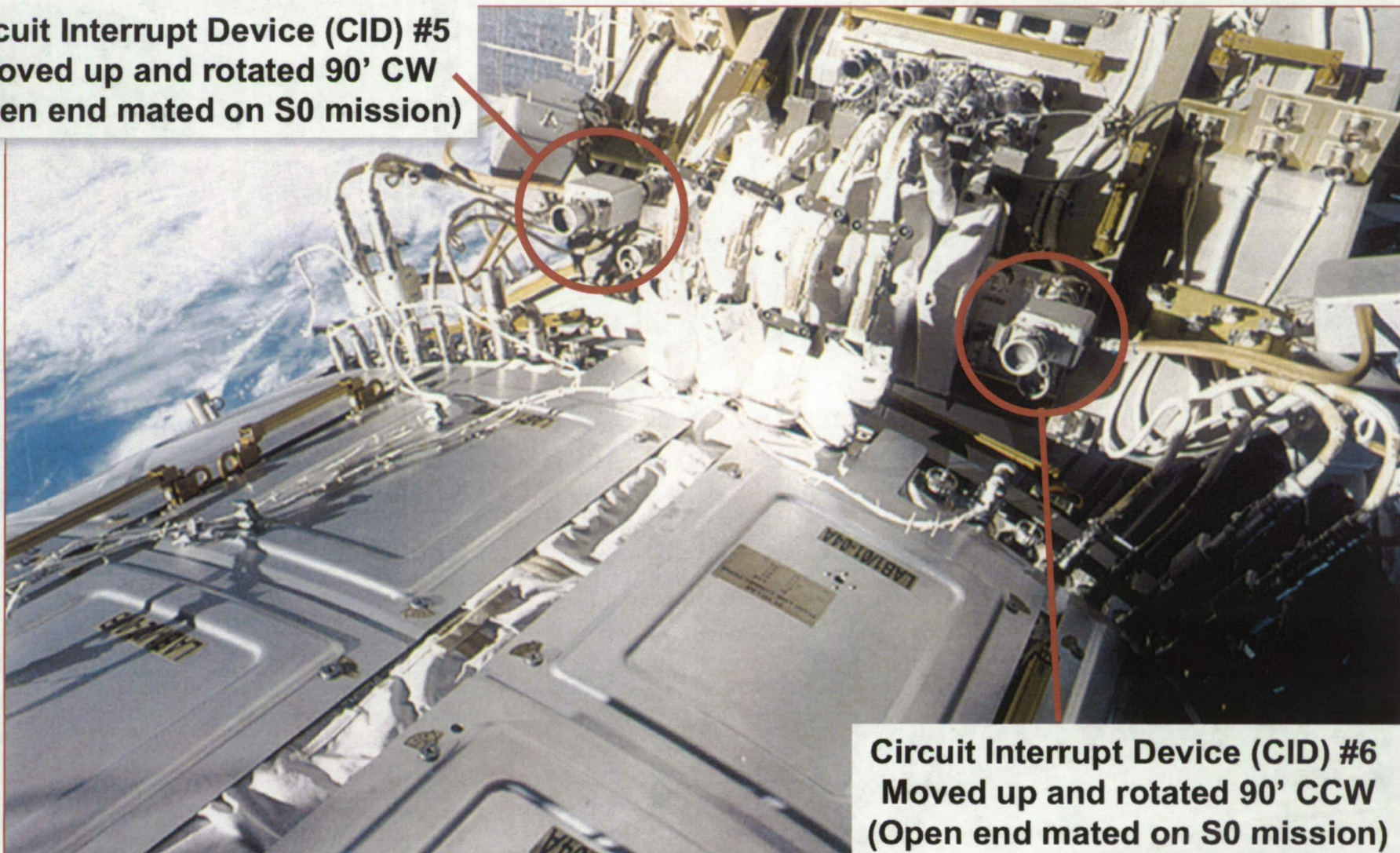**Circuit Interrupt Device (CID) #6 Interferes with hard structure**

Circuit Interrupt Device (CID) #6 Interferes with connectors

CID #5 - 45 deg. "V" Box (Proposed)
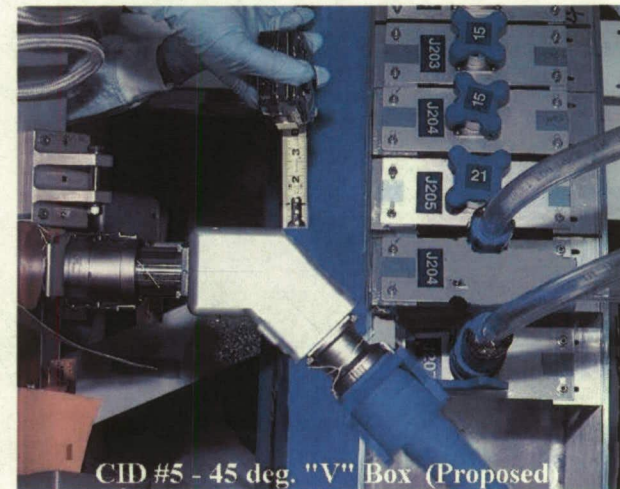
Propose fix, modify Circuit Interrupt Device

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Successful Z1/Node 1 & Z1/Lab On-Orbit

Circuit Interrupt Device (CID) #5
Moved up and rotated 90' CW
(Open end mated on S0 mission)

Circuit Interrupt Device (CID) #6
Moved up and rotated 90' CCW
(Open end mated on S0 mission)

Note: This location was known as the "Rats Nest" do the fact that umbilical's from Node 1, Z1, Lab and SO Truss all came together in one congested area.
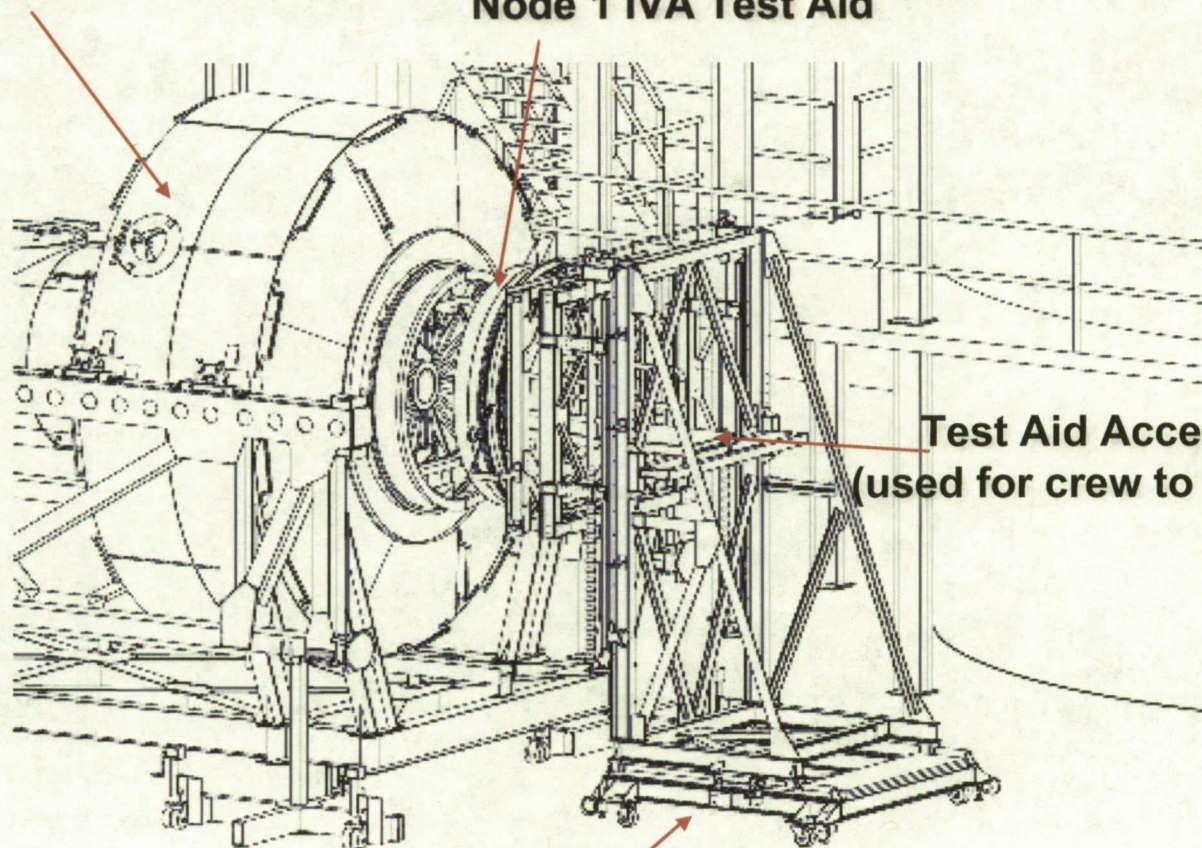
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Airlock to Node 1 Test Aid IVA OOCT
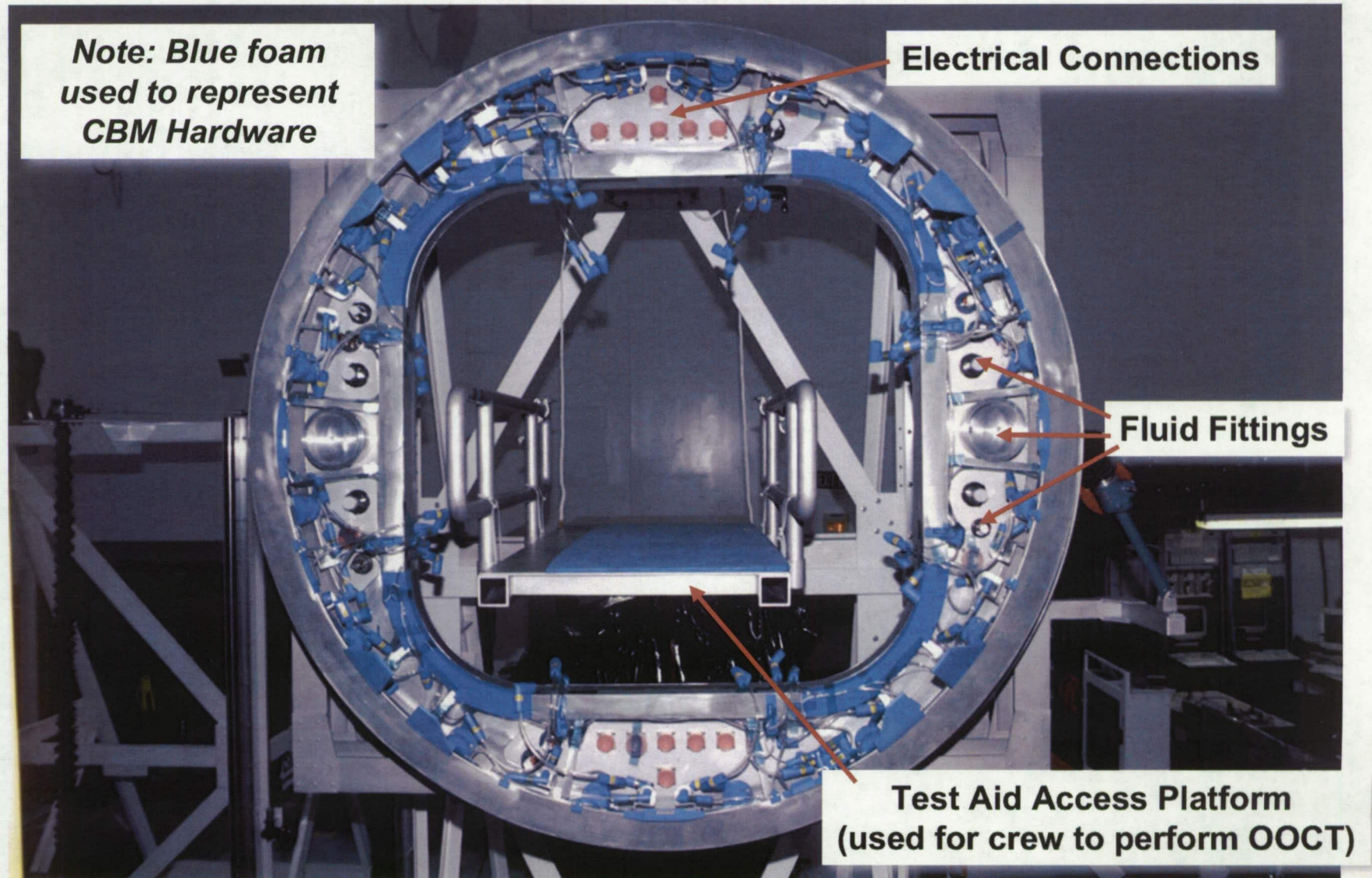
ISS Airlock Element in GSE stand

Node 1 IVA Test Aid

Test Aid Access Platform (used for crew to perform OOCT)

KSC SUPPORT EQUIPMENT - IPT

Test Aid Alignment Fixture

Airlock to Node 1 Test Aid IVA OOCT

Note: Blue foam used to represent CBM Hardware

Electrical Connections

Fluid Fittings

Test Aid Access Platform (used for crew to perform OOCT)

NODE 1 IVA Test Aid

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Problem found during Airlock to NODE 1 Test Aid IVA OOCT

NODE 1 Test Aid

IMV Duct

Fluid line is short

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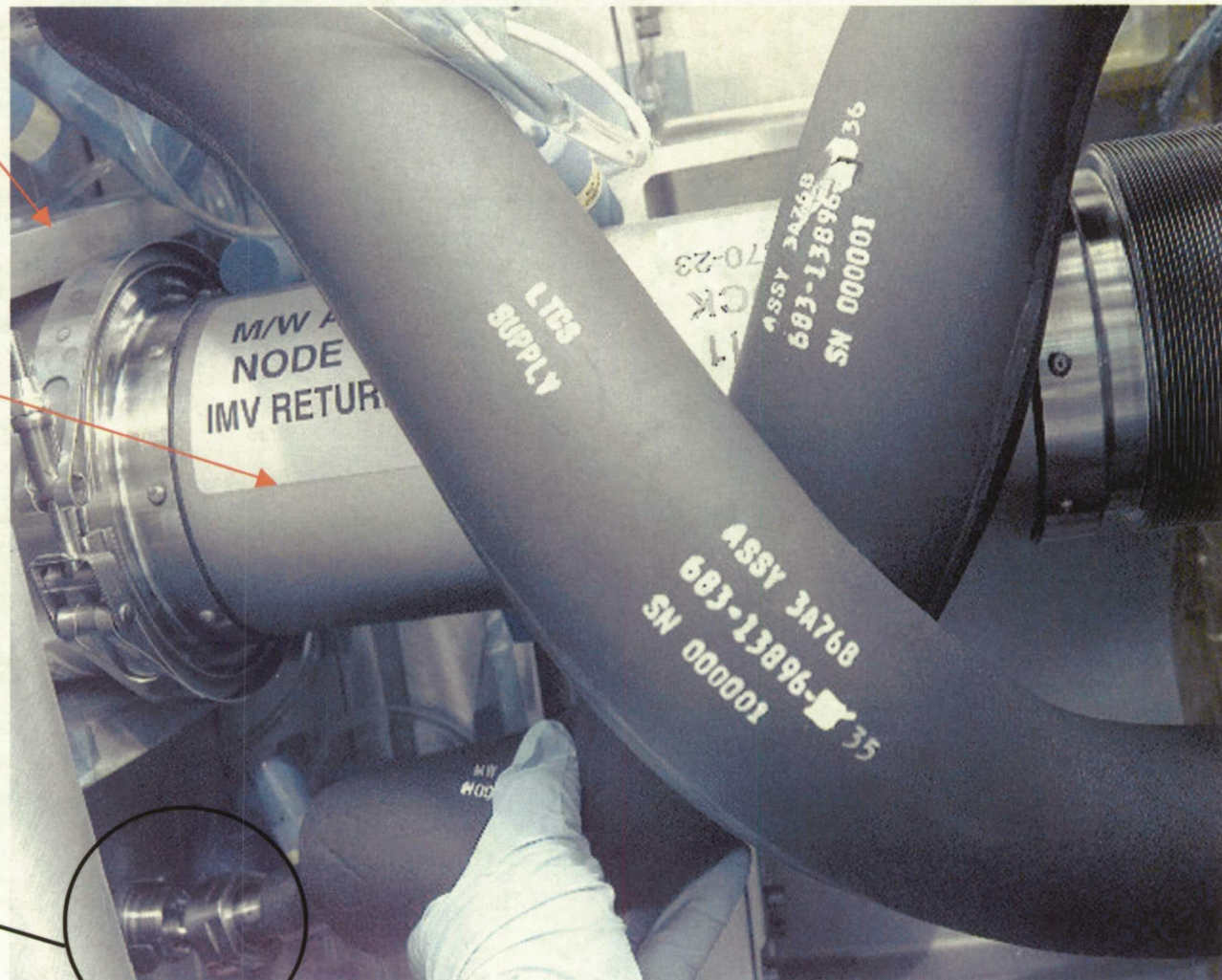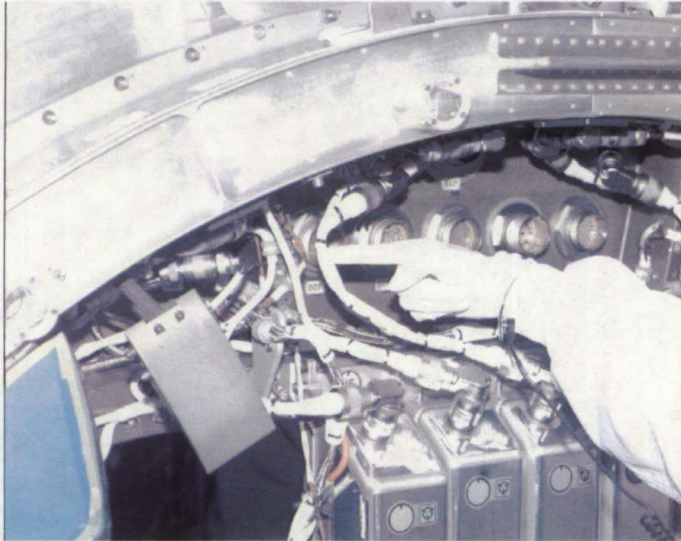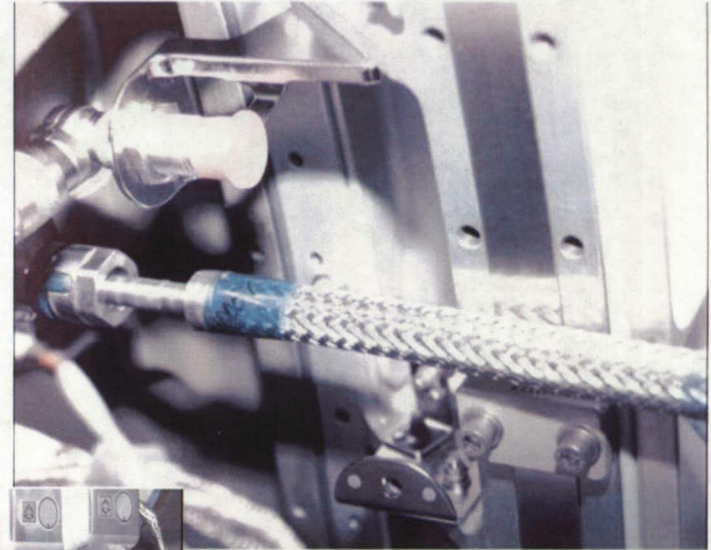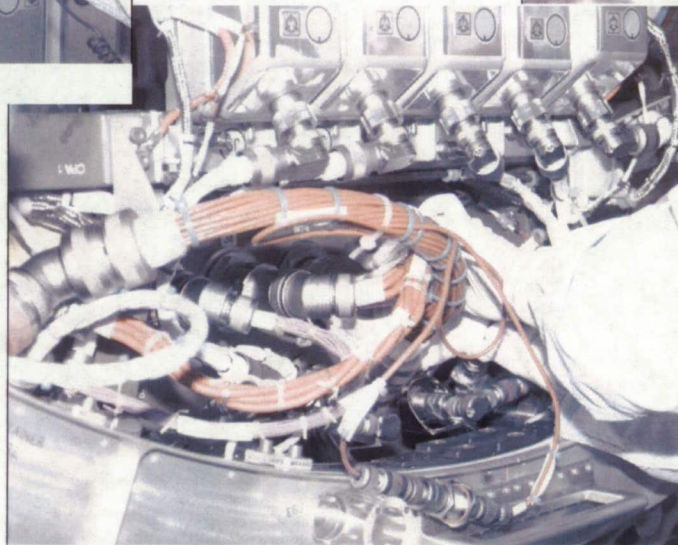
Problems found during other IVA OOCT's

Jumper interference with CBM cable
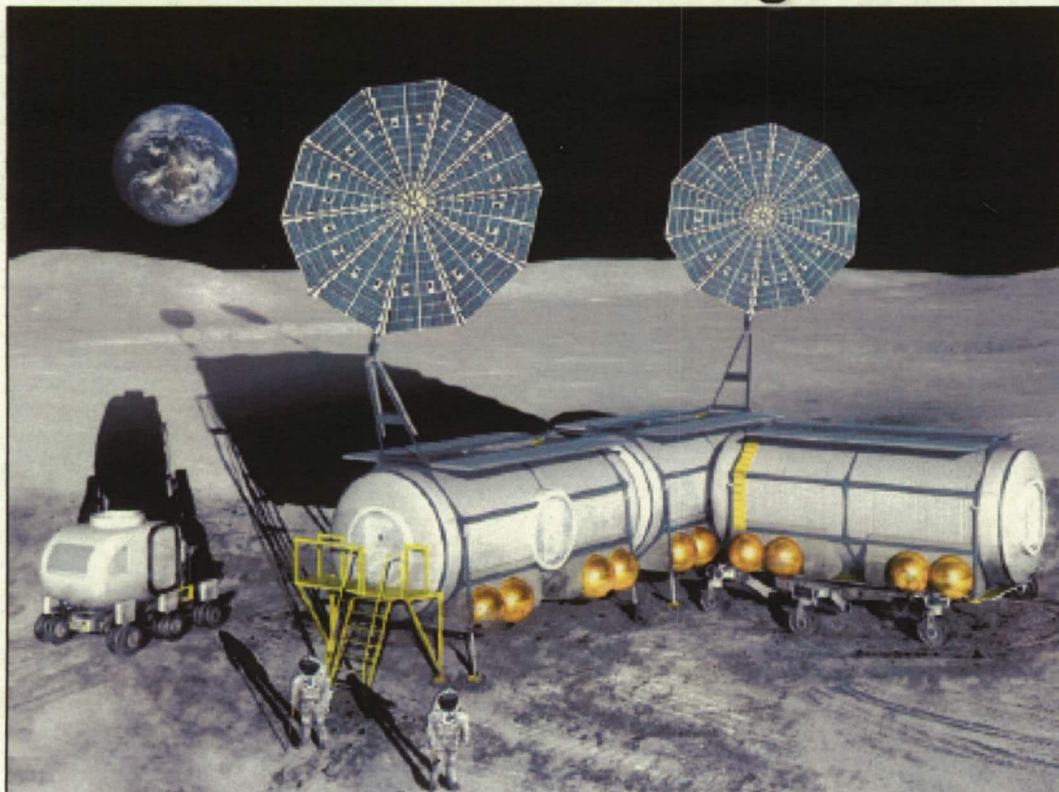
Jumper interference with CBM ring

Hand access problem

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OOCT Applied to Constellation Program
(Rename to Surface Systems Constraints Test SSCT)

Lunar Orbit

Possible Surface Configuration

Surface Carrier

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CxP Fit Check & SSCT Concept

"Today" - <u>Fit check</u> future Hab 2 connectors to Hab 1 flight Element

Future Surface Hab 2

Surface Hab 1

"X time in the future" - <u>SSCT</u> of Hab 2 Flight Element to Hab 1 test aid
(by default you get <u>fit check</u> to Hab 2, piggyback on testing so only connect to flight hardware one time)

Surface Hab 2

Surface Hab 1 Test Aid

Surface Hab1 Test Simulator

<u>Note: Assume use of hard mate connectors instead of jumpers</u>

— · · — **GSE Avionics Jumpers**
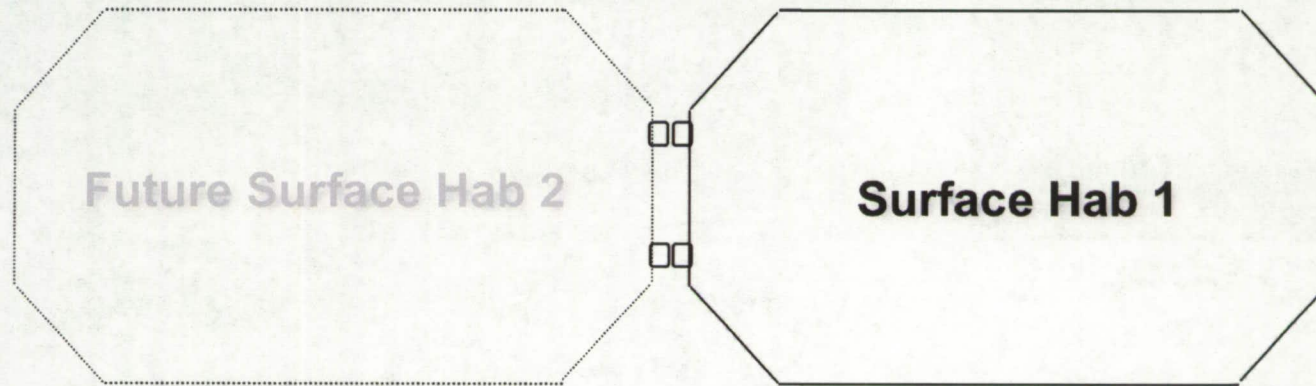··············· **GSE Fluid Jumpers**

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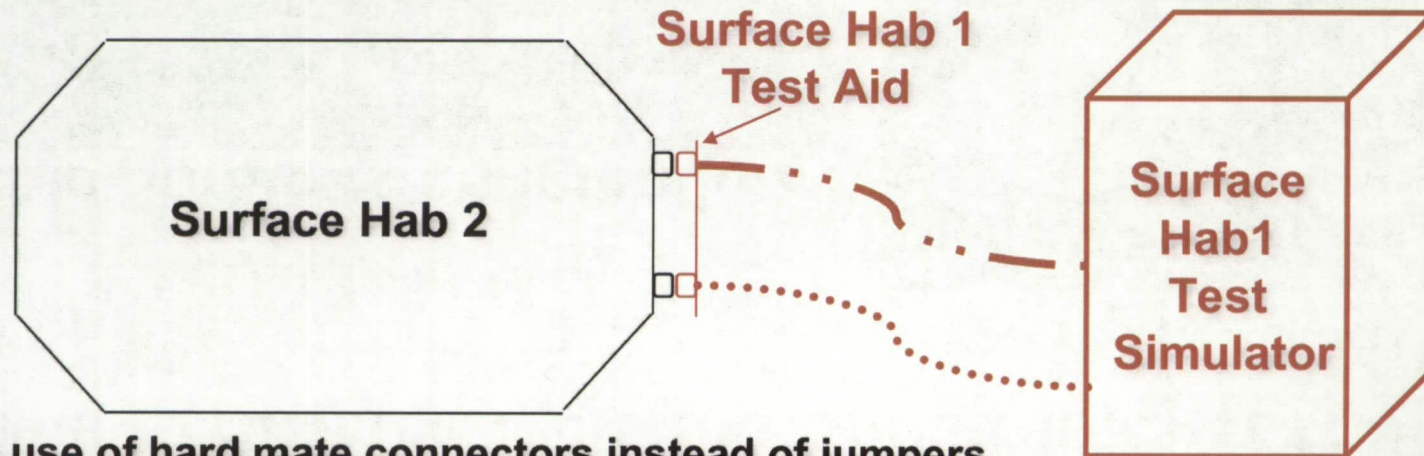
Lessons Learned & How to Apply to CxP

- Design Flight Hardware and supporting GSE to allow physical mating of flight hardware elements together that are on the ground at the same point in time.

- Flight Hardware needs to be in final flight configuration

- Piggy back on MEIT or Integrated Testing. Flight jumpers used for test, test aid supports free end of flight jumpers and satisfies SSCT, free end of Test Aid Connectors use to connect test GSE

- ISS Test Aids designed with change out panels, Limits number of rings built, easy to reconfigure between OOCT's, panels can be maintained in "flight configuration" for specific missions

- Fabricate and assembly test aids in Florida to allow quick turn-around and repair of test aids.

- Early purchase of flight connectors, design and build of flight jumpers

- Flight Crew involved to get familiar with Flight Hardware and On-Orbit/Surface Operations. Flight Procedures verified or generated during OOCT

- Work Authorization Document (WAD) should have NASA KSC signature authority and task leader responsibility or designate Local Contractor as task leader.

- Plan early for CxP SSCT and incorporate into Milestone schedules to allow enough time to obtain hardware required

- Public Lessons Learned Entry: 1216
http://www.nasa.gov/offices/oce/llis/1216.html