Advanced Mating System Development for Space Applications

An Overview
Introduction

• **Purpose**: present for discussion work needed in the area of space flight sealing.

• **Technical Area of interest**: *Dynamic Interface Seal for use on space mating systems in support of a “fully” androgynous mating interface*

• **Design Concept**: *To provide a “fully” androgynous mating system will require a Seal-on-Seal Interface.*
Background

Terminology

**Mating** is a generic term used to describe the act of bringing two space vehicles together using an interface mechanism to capture and hold the vehicles together in support of on-orbit assembly and/or crew/cargo transfer.

**Berthing** refers to mating operations where a module/vehicle is placed onto the mating interface using a Remote Manipulator System-RMS.

**Docking** refers to mating operations where an active vehicle flies into the mating interface.

**Existing mating systems:**
1) Modified Russian APAS for Docking the Shuttle to ISS
2) Russian Probe & Drogue for Docking the Soyuz/Progress to ISS
3) US Common Berthing Mechanism (CBM) used for Module to Module/MPLM/HTV (ISS)

"None of these systems meet the requirements for a long duration, Crew Exploration Mission."

James L. Lewis (281) 483-8954

RMS Berthing Illustration

Depictions of ISS Mating Systems

james.l.lewis@nasa.gov
Background

- The Structural Engineering Division at the JSC has had an internal, next-generation, mating system development activity ongoing since the mid-1980's

  - This effort has resulted in the advocacy of developing a standard multipurpose interface for use with all modern modular space architecture.
    * No unique active or passive mechanisms;
    * Support both Docking and Berthing operations;
    * On-orbit assembly or AR&C;
    * Useful for Crew Transfer and Crew Rescue to ISS;
    * Landers, Nodes, & Modules supporting crew exploration;
    * Provide maximum flexibility in inter-connectivity "one system—many uses!"
    * System Level Redundancy
    * On-orbit Re-configurability
Background

FUNCTIONAL REVERSIBILITY

RECONFIGURABILITY

James L. Lewis (281) 483-8954

james.l.lewis@nasa.gov
Background

- Recent efforts supporting the X-38 Program enabled development of a “fully” androgynous interface design
  - Low Impact Docking System-LIDS
    - Full-scale engineering development unit-EDU sized for crew transfer (32" dia)
    - Fully androgynous, integrated, ground based system to show TRL 4 maturity
    - Uses electromagnets & closed-loop force-feedback sys. for soft-capture
- “Fully” androgynous design means “Seal-On-Seal”-SOS
  - SOS not the current implementation standard
  - We typically use the seals on the “visiting” half
  - Cover the seals during exposed periods (CBM)
- Have some limited SOS experience
  - Apollo-Soyuz Test Program (ASTP)
  - APAS (Russian design originally has SOS)
  - LIDS—began some early SOS development

Artist Image of X-38 Crew Return Vehicle

CAD Image of LIDS EDU Design

James L. Lewis (281) 483-8954

James.l.lewis@nasa.gov
"Seal-On-Seal" development

- 2001 a small development effort was initiated to begin determine the feasibility of a seal-on-seal interface and investigate:
  - leak rate
  - seal load force
  - adhesion behavior

- Using some of the historical ASTP seal data, the seal vendor selected two cross-sections each of two different materials
  - Elliptical Crown Section and Flat Top section
  - S383-70 and S1853-50 Silicon materials

Figure of Cross-sections to go here
Seal Testing

• Seal testing descriptions and results to go here.
Seal Testing Conclusions

• Seal Testing Conclusions to go here.