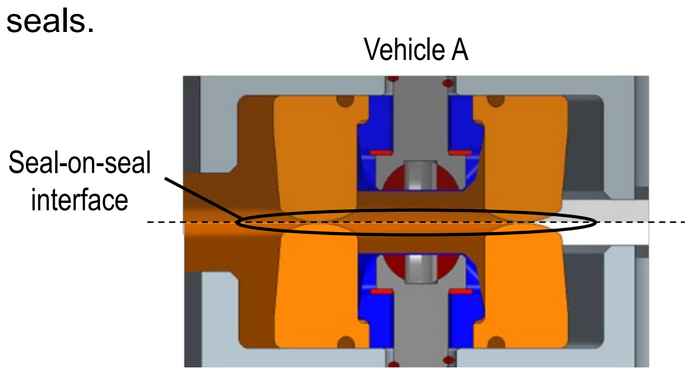
TBD

In-Space and Lunar Surface Attachment Systems – Seals

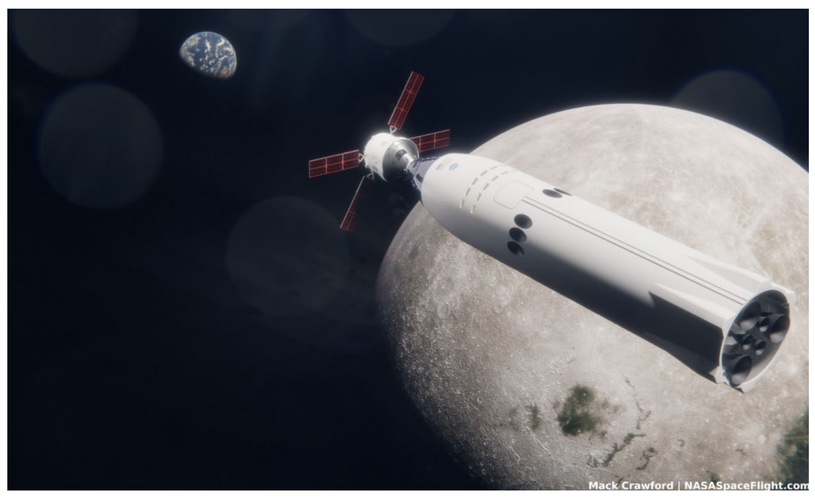
PM / PI Info Pat Dunlap (GRC) patrick.h.Dunlap@nasa.gov &
James Lewis james.l.lewis@nasa.gov

EXECUTIVE SUMMARY

While the International Docking System Standard (IDSS) is specified to enable androgynous docking resulting in a seal-on-seal (SoS) mated configuration, current docking systems and their seals have not yet been certified to do so. As an initial step toward androgynous docking certification, this project characterized SoS performance including leak rates, compression loads, and adhesion loads under aligned and misaligned conditions for subscale seals and contact visualization tests for full-scale seals.



Seal-on-seal docking

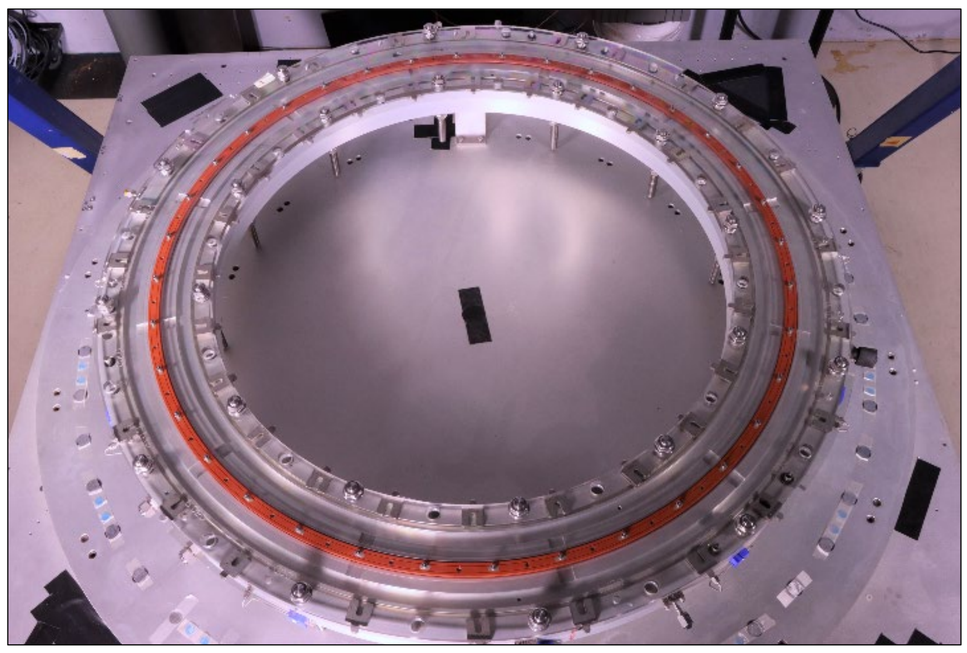


INNOVATION

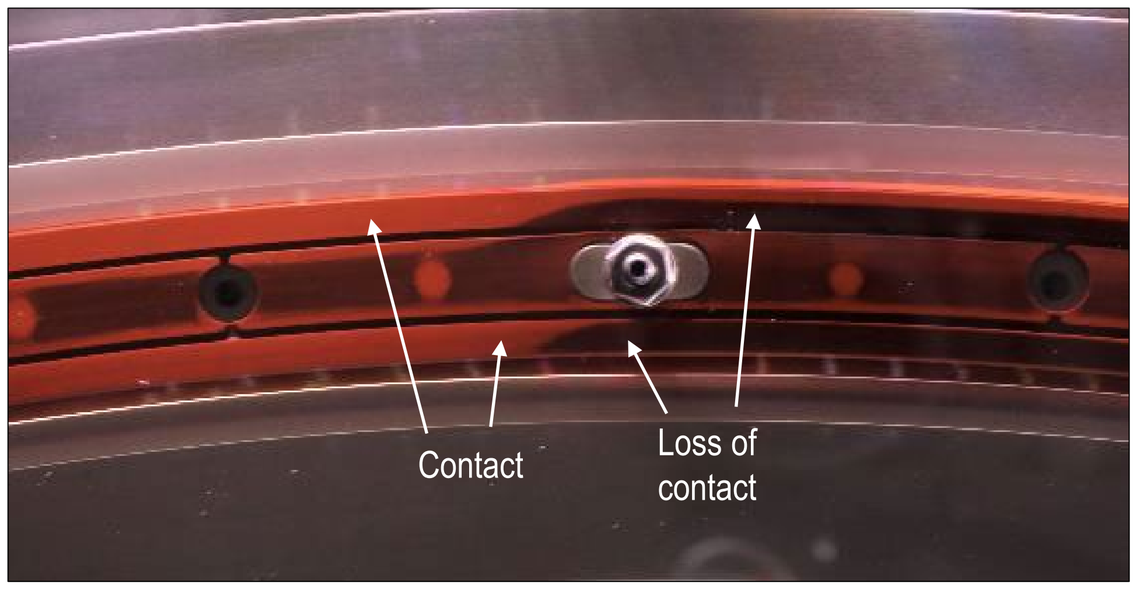
Typically, docking seals are designed to mate against the smooth, flat metal surface on the opposing docking interface (e.g., Starliner docking to the ISS IDA). However, future Artemis missions will benefit greatly from androgynous docking in which both docking systems would have seals on them.

COLLABORATION

This project utilizes collaboration and partnerships between JSC EA, GRC, and the HLS Program. The activity also includes working with SpaceX and is developing an HLS Option A Collaboration Agreement to work on androgynous docking with a focus on seal-on-seal evaluation.



Full-scale seal-on-seal contact visualization tests



Loss of contact on seal backside during full-scale seal-on-seal mating with misaligned, greased seals as seen through polycarbonate plate

OUTCOMES & INFUSION

Key findings from the tests and evaluations that were completed include:

- Seals coated with Braycote grease experienced reduced friction when mated in a SoS configuration resulting in less contact between the seals and higher leak rates when misaligned
- In full-scale contact visualization tests, seals that were pretreated with atomic oxygen (AO) remained in contact for all configurations tested while greased seals lost contact for 0.100 in. misalignment
- Similar compression forces were measured for greased and AO pretreated seals in subscale SoS tests
- Subscale SoS adhesion forces for greased seals were low at all test temperatures, while adhesion forces for AO pretreated seals were higher at cold temperatures
- Subscale AO pretreated seals passed leak tests at all combinations of misalignments and test temperatures that were tested
- Installing seals in a narrower groove helped control seal deflections, deformation, and contact in subscale SoS tests

The infusion plan requires active engagement by stakeholders (Artemis programs and new space partners providing HLS landers, habitation modules, and rovers) through TIMs and working groups. Docking discipline leads have been coordinating with HLS and Agency in-space docking/surface attachment systems cross program DL's, TDL's, and SM's pursuing lunar sustainable and Mars precursor advanced mating interface development. Other areas where this or similar new robust, mate-demate seal solutions are required include: hatches, Suitport, pressurized mobility, habitat, various resource transfer umbilicals and connectors, and logistics containers and carriers.

FUTURE WORK

Future work and next steps include:

- Perform full-scale seal-on-seal tests under representative operating conditions
- Identify optimal seal design configuration for seal-on-seal mating (groove width, surface treatment)
- Continue discussions with Artemis Projects and HLS vendors to establish a plan, options, and responsibility for full certification

DAA# 20230015454

NTR#(s) N/A