# AUTONOMOUS RENDEZVOUS AND CAPTURE DEVELOPMENT INFRASTRUCTURE

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In the development of the technology for Autonomous
Rendezvous and Docking, key infrastructure capabilities must
be used for effective and economical development. This
involves facility capabilities, both equipment and personnel,
to devise, develop, qualify, and integrate ARD elements and
subsystems into flight programs. One effective way of
reducing technical risks in developing ARD technology is
the use of the ultimate test facility, using a Shuttle-based
reusable free-flying testbed to perform a Technology
Demonstration Test Flight which can be structured to include
a variety of additional sensors, control schemes, and
operational approaches. This conceptual testbed and flight
demonstration will be used to illustrate how technologies and
facilities at MSFC can be used to develop and prove an ARD
system.

## Conceptual Demonstration Testbed

Structured to leverage on flight experiment experience and
qualified equipment, the concept uses the existing Multi
Purpose Experiment Support Structure (MPESS) or Shuttle
PAllet Satellite (SPAS), as a Shuttle deployable /retrievable
target vehicle (with a cold-gas Three-axis stabilization
system) with accommodation for assorted sensors and subsystem
tests. A small automated chase vehicle can be adapted from a
Lightsat to carry ARD equipment and will fly various 6
Degree-of-Freedom separations and approaches. GPS can be
used for rendezvous, MSFC's Video Guidance Sensor for final
approach, the OMV-derived Three Point Docking Mechanism for
docking, and the Automated Fluid Interface system for
umbilical connection. The chase vehicle is docked and locked
onto the pallet after testing and integration, allowing the
shuttle crew and the ground processing to handle the
experiment as a single integrated payload. Using this
demonstration concept as a strawman program, the potential
utilization of various facility capabilities at MSFC will be
discussed.

## Flight Robotics Laboratory

The Flight Robotics Laboratory, also known as the "Flat
Floor", will continue two decades of developing and applying
ARD and servicing technology to various programs. The Lab has

a 26m x 13m precision epoxy flat floor which can support various simulators and low-friction air-bearing platforms to support actual flight hardware with cold-gas thrusters. The Spacecraft Air-bearing Simulator with self-contained power, propulsion, communications, guidance, navigation, and control, will be used for docking Mechanism and video guidance development, calibration, and demonstration. Designed to overcome limitations of air-bearing simulators, the Dynamic Overhead Telerobotic Simulator can dynamically position up to 500Kg of mockups, sensors, or flight hardware through the 50m x 15m x 9m facility with 1cm accuracy at computer-controlled velocities for realtime simulation of orbital dynamics, lighting, and body dynamics. Not only can the DOTS support mechanism and sensor development, orbital operations can be modelled dynamically and flight hardware and software can be evaluated and verified. Final system checkout can be done with both testbed vehicles active by simply floating the actual experiment carrier-target on the flat floor and "flying" the integrated small chase vehicle through simulated approach, station-keeping, docking, and separation operations, mounted on the DOTS and driven by a math model responding to actual vehicle generated thruster commands.


## Space Operations / Mechanisms Test Bed

The Space Operations and Mechanism Test Bed, also known as the "6DOF", plays a critical role in developing and validating docking/berthing/grappling mechanisms and operations from Skylab to Shuttle and Space Station. The 6DOF simulation provides high fidelity simulation of the contact and body dynamics for full-scale docking/berthing mechanism evaluations. The six degree-of-freedom (6DOF) platform which carries the mechanism under evaluation is moved by hydraulics controlled by high-speed computer math models with extremely accurate force-moment sensor feedback. Additionally, video and graphic simulations support manned system operations such as crew monitoring and operations initiation as well as advanced control system analysis.


## Optical Instrumentation Facilities

MSFC has a strong optical infrastructure, with many unique facilities including stray light vacuum tunnel, coherent lidar facility, video/camera laboratory and related development capabilities used to support various programs from Apollo, Skylab, HEAO era to the Great Observatories Program, Laser Atmospheric Wind Sounder, Space Station Freedom assembly, and Launch Systems preparation. These capabilities will be used for video guidance sensor testing and rendezvous laser radar development and evaluation.

## RF System Test Facilities

MSFC's RF capabilities, including a 120/800m antenna range, 108000 cu.ft. microwave anechoic chamber, and various bench laboratories, will be used to support RF radar & tracking analysis-design-development-test-evaluation as well as command/telemetry system design-development-test-sustaining engineering.

## Environmental Testing

The environmental testing using various thermal-vacuum chambers and structural test stands will support system analysis with ARD component qualification, target & chase vehicle testing, structural modal survey, component vibration evaluation, and integral demo vehicle modal-acoustic-vibration testing. Contingency EVA provisions and procedures will be validated and crew training performed in the Neutral Buoyancy Simulator.

These MSFC facilities will utilize their civil servant staff and experts to support the ARD development and check-out activities. Additional support can be obtained from the Army Redstone Arsenal to perform long range airborne rendezvous and tracking evaluation and integrated system tests utilizing local helicopter crews, missile test ranges, and restricted airspace & airstrip.