Title of Investigation:

Inflatable Reentry Vehicle Experiment (IRVE)

Principal Investigator:

Michael C. Cropper 548

Other Investigators/Collaborators:

Other In-house Members of the Team: Herbert Morgan 569, Elizabeth L. West 840, and Emmett D. Ransone III 810

Initiation Year:

FY 2004

Aggregate Amount of Funding Authorized in FY 2003 and Earlier Years:

None

FY 2004 Authorized Funding:

$0; 1 Full-Time Equivalent (FTE)

Actual or Expected Expenditure of FY 2004 Funding:

In-house: .15 FTE–Range and Mission Management Office (Code 840); .10 FTE–Sounding Rocket Program Office (Code 810); .375 FTE–Applied Engineering and Technology Directorate Mechanical Systems Branch (Code 548); and .375 FTE–Applied Engineering and Technology Directorate Electrical Systems Branch (Code 569)

Status of Investigation at End of FY 2003:

To be continued in FY 2005.

Expected Completion Date:

September 2005

Purpose of Investigation:

The goal of this project is studying and developing, through flight-testing aboard a sounding rocket, an inflatable atmospheric entry vehicle. The Inflatable Reentry Vehicle Experiment (IRVE) project is a partnership between the NASA Langley Research Center and the NASA Goddard Space Flight Center's Wallop's Flight Faculty. IRVE is a series of test flights conducted on sounding rockets. Each builds on the previous test to achieve increasingly difficult technical objectives. The first flight will demonstrate inflation and survivability of the inflatable aero-shell, an upside-down, cone-shaped covering that protects a spacecraft from the extreme heat generated when entering the atmosphere. The first test flight will occur on a Terrier Improved Orion launch vehicle from Wallops Island, Virginia.

FY 2004 Accomplishments:

Preliminary design of the launch and reentry vehicle has been completed. A detailed Preliminary Design Review for the reentry vehicle was conducted at Langley Research Center. The review

included the associated structural and thermal analysis and the design of the reentry vehicle's electrical and telemetry systems. An overview of the launch vehicle and projected flight trajectories also was provided as part of this review. The launch vehicle itself has completed a Requirements Definition Meeting to verify that all Langley and Wallops requirements can be satisfied. Contracts are in the review process for the development of the inflatable aero-shell structure and associated inflation system. Preliminary sensor and instrumentation testing has also begun at Langley. This progress to date is consistent with conducting a Critical Design Review for the entire project the first part of calendar year 2005.

Johnson Space Center (JSC) and Langley Research Center were successful in winning their collaborative effort for the "Evaluate and Demonstrate Inflatable Aero-shells for Aero-assist Functions for the Exploration Initiative and International Space Station Down-Mass" proposal, which was submitted in response to the Code T Human and Robotic Technology Intramural Call for Proposals. This proposal included the IRVE project as a pathfinder mission. There are three additional sounding rocket missions included in this proposal that will be conducted under Phase II by Wallops Flight Facility.

Planned Future Work:

Upon successful completion of the Critical Design Review, the fabrication and manufacturing phase will begin of the launch vehicle, aero-shell structure and inflation system, and electrical and telemetry systems for the aero-shell. Once this phase is completed, integration and testing of both the reentry vehicle and launch vehicle will begin. Launch operations are currently scheduled for September 2005. Analysis of the flight results will occur shortly thereafter, with the resulting knowledge incorporated into the next follow-on flight as part of this continuing spiral-development effort.

Summary:

IRVE will advance inflatable aero-shell technology toward the ultimate goal of providing a low-mass means of returning payloads or people from Earth orbit and delivering payloads to Mars and other planetary bodies with atmospheres. Inflatable aero-shells could become a low-mass replacement for rigid aero-shells, which provide thermal protection during reentry into the atmosphere. IRVE will demonstrate this concept; establish requirements for inflatable materials, inflation systems, and control systems; and improve design and fabrication techniques. Programmatic innovations in sounding rockets include development of a larger customer base and increased recognition within the Agency of the program's capabilities and potential contributions.

For the Goddard Space Flight Center, the program will demonstrate:

- The potential for using sounding rockets to advance technologies that could apply to the new Vision for Space Exploration.
- How the Wallops Test Range can be used to support low Technology Readiness Level (TRL) atmospheric entry technologies, and
- Inter-center partnerships that can lead to future opportunities.

We will consider the effort successful when the reentry vehicle is launched and deployed at an altitude greater than 80 km; when the reentry vehicle inflates and maintains inflation at an altitude greater than 80 km; and when the reentry vehicle attitude, flight path, thermal, and bladder pressure data be generated and captured throughout reentry.

Several technical risks are associated with this test flight. Since this is the first flight of this style of reentry vehicle, no aerodynamic database exists for reference. To mitigate this risk, ballistic-range testing will be completed on the vehicle shape. The construction of the exterior vehicle material is also a risk due to the possibility of leakage. To mitigate this risk, a ground-test article will be developed to investigate leakage of the inflation gas through the material.

The original launch date for this project was March 2005, but the date slipped to September 2005 because IRVE had become a pathfinder mission to the JSC Code T Human and Robotic Technology Intramural Proposal. This has elevated IRVE from a low-level project to one of considerable importance and visibility. By slipping the launch date, the IRVE mission will undergo additional scrutiny, which ensures an excellent outcome for the Phase I portion of the JSC proposal.