Concept Defined for the International Space Station's Fluids and Combustion Facility

The Fluids and Combustion Facility (FCF) will occupy three powered racks and one stowage rack on the International Space Station (ISS). It will be a permanent modular, multiuser facility to accommodate microgravity science experiments onboard the ISS's U.S. Laboratory Module. FCF will support NASA Human Exploration and Development of Space program objectives requiring sustained, systematic research in the disciplines of fluid physics and combustion science. The two disciplines share racks and mutually necessary hardware within FCF to dramatically reduce costs and effectively use ISS resources. Even with the cost of FCF development included, experimentation using FCF on the space station will cost only half of what it did on the space shuttles.

Fluid physics processes are ubiquitous. Because the human body is composed predominantly of fluids, creating new drugs and treating disease frequently depend on fluid physics. Numerous high-value commercial processes, such as petroleum production and semiconductor production, rely on fluid physics. Unfortunately, many definitive fluid physics experiments cannot be conducted on Earth because gravitational buoyancy and settling effects interfere. Moreover, many other experiments conducted on ISS require the knowledge of microgravity fluid physics to interpret the results. Microgravity fluid physics experiments in FCF should result in the following benefits:

- Advances in public medicine and treatment of disease
- Improved commercial processes and competitiveness in a wide range of U.S. industries
- Greater success in applying the results of other experiments conducted on ISS to benefit the public

Combustion processes are also ubiquitous. We use combustion to heat our homes, power our cars, manufacture our products, and more. Combustion figures into fire safety; environmental issues, such as acid rain; health issues, such as lung disease; and more. Combustion costs U.S. taxpayers $400 billion a year. If we knew more about combustion, we could lower that cost while improving health and safety. Unfortunately, some definitive combustion science experiments cannot be conducted on Earth because gravitational convection interferes. Microgravity combustion experiments in FCF should result in the following benefits:

- Billions of dollars in energy costs saved every year
- U.S. commercial processes and competitiveness improved
- Incidence of fire and other public health hazards reduced

- Environmental pollution lessened

FCF has been at the forefront of new technical approaches. First, FCF pioneered the concept of low-cost, incremental development and deployment of ISS facilities—one rack at a time. This paradigm is now standard for new ISS multirack facilities. Second, FCF invented the Embedded Web Software Technology (EWT) that won the NASA Software of the Year award in 1998. This software is now recommended for all ISS facilities and has spawned commercial products that may lead to a billion-dollar-a-year industry. Third, FCF developed a practical hybrid-power switch that is now on the commercial market and is being considered for use throughout the aerospace industry (in aircraft, in satellites, and in other ISS applications).

The NASA Glenn Research Center at Lewis Field is developing FCF in partnership with local contractors. Technical feasibility has been demonstrated, the concept has been defined, and an engineering model of the first rack is nearing completion. The first rack and initial experiments will be launched in 2003. Over 100 fluids and combustion experiments are planned during the life of the ISS.

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