ISS FACILITIES HARDWARE CATALOG
for
NASA's Fluids and Combustion Facility

I. Facility

1. Facility Full Name: Fluids and Combustion Facility (FCF) Combustion Rack

2. Sponsoring Agency: NASA

3. Co-Sponsors/Cooperation Agreements:

4. Builder/Main Contractor: NASA Lewis Research Center

5. Project Manager: E. Winsa
   NASA Lewis Research Center
   MS 500-217
   Cleveland, OH 44135

6. Project Scientist: Uday Hegde

Fluids and Combustion Facility- Combustion Rack

II. Facility Characteristics

1. Facility Type: Permanent facility providing a versatile combustion chamber with full range of diagnostic support for multiple users

2. Targeted Research Fields: Combustion science (including laminar flames, droplet and spray combustion, flame spread and fire suppressant measurements, condensed phase fuel combustion, turbulent flow combustion, soot and hydrocarbon generation, material synthesis, and characterization of detonations/explosions)

3. Accommodation: ISS/US Lab; initial capability provided on UF-3

4. Launch Date: 9/01

5. Status: Requirements defined; advanced concept in place

6. Facility Summary: The initial combustion facility will occupy one ISPR rack but full capabilities require nominally an additional half rack (to be shared with the Fluids Facility) . The facility includes a combustion chamber, an optics plate for mounting optical diagnostics, high pressure storage and distribution of fuels and oxidants, a gas mixing system for in situ generation of combustible mixtures, a flow control system, a chemical filtration/clean-up system for scrubbing combustion products, and provisions for gas analysis. The diagnostic systems are easily interchanged and can be customized for special applications. The command and data management capabilities will support near-real time teleoperations and custom software support.

Fluids and Combustion Facility-Combustion Rack

III. Facility Performance Data

The combustion chamber employs a breech-lock hinged front lid, redundant seals, replaceable windows, and interfaces (power, data, etc.) to experiment-specific hardware. The chamber is nominally 40 cm (internal diameter) by 90 cm (overall length) with 100 liters free volume. The chamber is designed to safely sustain a maximum pressure of 10 atmospheres. The chamber has 8 viewing windows (each 12 cm in diameter; 4 opposing pairs) which are replaceable from inside the chamber using no tools. Experiment-specific equipment (providing flame holders, igniters, fuel trays, thermocouples, etc.) is mounted internally and serviced by 3 electronic connectors, 2 water cooling ports, 1 vacuum port, 1 gas delivery port, 1 exhaust vent port, and one sample port. Internally mounted hardware can occupy 40 cm (diameter) by 60 cm (length).

Optical diagnostic systems capabilities include (initially)

- soot volume/soot temperature measurements,
- illumination,
- high frame rate imaging with automatic positioning and tracking,
- low light level ultraviolet imaging, and
- mid-infrared imaging

Experiment-specific measurement tools can be implemented as required. All imaging employs digital camera systems and a minimum of 36 gigabytes of data storage will be provided. Digital images can be selectively replayed and downlinked for analysis.

The flow system is capable of static mixing of up to 3 gases (to approximately 0.1% accuracy with ideal gases on the basis of partial pressures). Dynamic mixing to an accuracy of ~1% is provided using mass flow controllers. The oxidizer can be provided at flow rates to 2910 cc/sec and the fuel at rates to 8.33 cc/sec. Initial capabilities will not provide for through flow of oxidation products. The combustion product filtration system is designed to clean methane, propane, n-heptane, CO, CO_2, SO_2, NO_2, and others. Three 3.8 liter gas bottles (up to 14 MPa (~2000 psi) each) can be safely installed at one time and can include premixed gases.

The data acquisition system will accommodate 48 analog inputs and sample 16 bits at rates of at least 1000 Hz. A minimum of 9 gigabytes of storage and downlink at rates to 20 Mbits/sec will be provided. All facility systems are designed to be teleoperated and operations will be controlled from the

Telescience Support Center of the Lewis Research Center with remote science operations at each scientist’s home-site

Fluids and Combustion Facility-Combustion Rack

IV. Resource Requirements

The facility is expected to be ‘permanently’ installed on the ISS and have a minimum life of 10 years. Initial launch mass will approach 700 kg. It will service 4 to 6 large scale experiments per year. Maintaining this level of usage will require 2 to 4 resupply flights per year carrying up to 300 kg of supplies.

ISS resources required include power (1000 to 2000 watts; as much as 4500 kW-hr/yr), cooling (28 to 56 kg/hr), data downlink (1 to 5 Mbits/sec average), stowage (.25 to 1 rack), and crew time (1 to 4 hr/wk). Direct services received from ISS include GN2, vacuum resource/vent, and cooling water.

ISS FACILITIES HARDWARE CATALOG
for
NASA's Fluids and Combustion Facility-Fluids Rack

I. Facility

1. Facility Full Name: Fluids and Combustion Facility (FCF)
   Fluids Rack

2. Sponsoring Agency: NASA

3. Co-Sponsors/Cooperation Agreements:

4. Builder/Main Contractor: NASA Lewis Research Center

5. Project Manager: Edward Winsa
   NASA Lewis Research Center
   MS 500-217
   Cleveland, OH 44135

6. Project Scientist: Myron Hill

Fluids and Combustion Facility-Fluids Rack

II. Facility Characteristics

1. Facility Type: Permanent facility providing flexible science accommodation for typical fluids experiments with full diagnostic support

2. Targeted Research Fields: Fluid physics (including capillary effects, colloids, thermo-capillary effects, rheology (including polymeric fluids), electro-hydrodynamics, multiphase flow, granular media, critical fluids, and diffusive phenomena)

3. Accommodation: ISS/US Lab; initial capability provided on UF-5

4. Launch Date: 6/02

5. Status: Requirements defined; advanced concept under development

6. Facility Summary: The initial Fluids Rack will occupy one ISPR but full capabilities will require nominally an additional half rack (to be shared with the Combustion Rack). The facility includes reconfigurable, precision optical bench for mounting experiment-specific instrumentation and facility supplied diagnostic capabilities consistent with requirements for forecast fluids experiments. The diagnostic systems are easily interchanged and can be customized for special applications. The command and data management capabilities will support near-real time teleoperations and custom software support.

Fluids and Combustion Facility-Fluids Rack

III. Facility Performance Data

The Fluids Rack provides a flexible environment for mounting experiment-specific sample containers and measurement systems. The facility will provide capabilities for digital control, thermal control and measurement, data acquisition and recording, and recurring optical diagnostics.

Optical diagnostic systems capabilities will include (initially)

- high resolution imaging,
- microscopic imaging,
- laser illumination sources, and
- dynamic light scattering detection sensors

Experiment-specific measurement tools can be implemented as required. All imaging employs digital camera systems and up to 36 gigabytes of data storage will be provided.

The data acquisition system will accommodate 48 analog inputs and sample 16 bits at rates to 1000 Hz. 9 Gbytes of storage and downlink at rates to 20 Mbits/sec will be provided.

Fluids and Combustion Facility-Fluids Rack

IV. Resource Requirements

The facility is expected to be 'permanently' installed and to have a minimum life of 10 years and service 4 to 6 large scale experiments per year. Initial launch mass will approach 700 kg. All facility systems are designed to be teleoperated and operations will be controlled from the Telescience Support Center of the Lewis Research Center with remote science operations, as possible, at each scientist's home-site. Maintaining this level of usage will require 2 to 4 resupply flights per year carrying up to 300 kg of supplies.

ISS resources required include power (1000 to 2000 watts; as much as 4500 kW-hr/yr), cooling (28 to 56 kg/hr), data downlink (1 to 5 Mbits/sec average), stowage (.25 to 1 rack),and crew time (1 to 4 hr/wk). Direct services received from ISS include GN2, vacuum resource/vent, and cooling water.