Combustion and Reacting Systems for Exploration

Workshop on

Strategic Research to Enable NASA’s Exploration Missions

June 22 - 23, 2004
Marriott Downtown at Key Center
Cleveland, Ohio USA
The President has redirected NASA’s mission to be exploration-based instead of our traditional science / earth application.
1. Return the Shuttle to safe flight as soon as practical, based on CAIB recommendations
2. Use Shuttle to complete ISS assembly
3. Retire the Shuttle after assembly complete (2010 target)
4. **Focus ISS research to support exploration goals; understanding space environment and countermeasures**
5. Meet foreign commitments
6. Undertake lunar exploration to support sustained human and robotic exploration of Mars and beyond
7. Series of robotic missions to Moon by 2008 to prepare for human exploration
8. Expedition to lunar surface as early as 2015 but no later than 2020
9. **Use lunar activities to further science, and test approaches (including lunar resources) for exploration to Mars & beyond**
10. Conduct robotic exploration of Mars to prepare for future expedition
11. Conduct robotic exploration across solar system to search for life, understand history of universe, search for resources
12. Conduct advanced telescope searches for habitable environments around other stars
13. **Demonstrate power, propulsion, life support capabilities for long duration, more distant human and robotic missions**
14. Conduct human expeditions to Mars after acquiring adequate knowledge and capability demonstrations
15. Develop a new Crew Exploration Vehicle; flight test before end of decade; human exploration capability by 2014
16. Separate cargo from crew as soon as practical to support ISS; acquire crew transport to ISS after Shuttle retirement
17. Pursue international participation
18. Pursue commercial opportunity for transportation and other services
Where does combustion fit in?
--in a variety of reacting systems

1. Spacecraft Fire Prevention, Detection, and Suppression
2. Advanced Life Support
   Air/water revitalization (Sabatier, Bosch), Waste management (Incineration)
3. In Situ Resource Utilization (ISRU)
   Fuel / consumables from regolith / atmosphere
4. Extra vehicular Activity
   Air revitalization, Power systems (MEMS scale combustors)
5. In-situ Fabrication and Repair
   SHS

Of these we have the lead responsibility in Fire Safety
Funding

How will funding work?
How will funding work?

I wish I knew

Anticipate a mixture of curiosity driven research (old NRA model) and directed research to meet roadmap goals

NRA research will focus on research supporting exploration

Directed research will be product driven and aligned with roadmaps and schedules – expect a mixture in intramural and extramural research, funding process will likely involve multiple mechanisms
Fire Safety Research Plan Development

We have long argued relevance to SFPDS

We have now been told to deliver a product (fish or cut bait)

We are constrained by the availability of upmass and test facilities, we need to be resourceful in our approach

Experiments must be carefully developed to make efficient use of flight opportunities and meet schedule milestones

To be efficient, we need to start with a clean plate but we don’t want to throw out good, relevant, work unnecessarily

At this point decisions have not been made, no one is “in” or “out”

Such decisions will be made based upon an integrated plan
Project Constellation (Crew Exploration Vehicle)
Major Milestones

- 2008: Initial flight test of CEV
- 2008: Launch first lunar robotic orbiter
- 2009-2010: Robotic mission to lunar surface
- 2011 First Unmanned CEV flight
- 2014: First crewed CEV flight
- 2012-2015: Jupiter Icy Moon Orbiter (JIMO)/Prometheus
- 2015-2020: First human mission to the Moon
GRC/BPRPO ISS Utilization Traffic Model

Based on POP Assembly Sequence (RTF March 2005) and BPRPO POP 2004 Guidelines 3/15/04

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<th>Year</th>
<th>2004</th>
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<td>HRF-2</td>
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<td>CFE - CLI</td>
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<td>Fluids Integrated Rack Payloads</td>
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<td>Microgravity Science Glovebox Payloads</td>
<td>CIR - FEANICS - 1</td>
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Legend:
- CIR - Combustion Integrated Rack
- FIR - Fluids Integrated Rack
- MSG - Microgravity Science Glovebox
- ER - ExPRESS Rack
- FSL - Fluids Science Laboratory
- FEANICS - Flow Enclosure Accommodating Novel Investigations in Combustion of Solids
- CIR/BPRPO ISS Utilization Traffic Model:
- Advanced Life Support Systems
- Low Gravity & Exploration Research
- Fire Prevention, Detection, & Suppression
- In-Situ Resource Utilization
- Advanced Environmental Monitoring & Control
- In-Situ Fabrication & Repair
- Advanced Extra Vehicular Activity
- Fundamental Science

Notes:
1) FEANICS will conduct additional operations during Increment 9
2) SAMS has a Thinkpad and hard drives going up on ULF 1.1
3) PCS+ has data disks returning on 13A.1, 15A, and ULF-2
4) CIR/BPRPO ISS Utilization Traffic Model:
- Advanced Life Support Systems
- Low Gravity & Exploration Research
- Fire Prevention, Detection, & Suppression
- In-Situ Resource Utilization
- Advanced Environmental Monitoring & Control
- In-Situ Fabrication & Repair
- Advanced Extra Vehicular Activity
- Fundamental Science

GRC Biological & Physical Research Project Office Chief: /s/ Jack A. Salzman 6/15/04
### GRC/BPRPO ISS Utilization Traffic Model

#### 2008
- **Russian Flt.**
  - 16S
- **ATV Flight**
  - UF-4.1
- **ISS Flight**
  - UF-4.A

#### 2009
- **Russian Flt.**
  - 17S-1
- **ATV Flight**
  - UF-5
- **ISS Flight**
  - UF-5

#### 2010
- **Russian Flt.**
  - 18S-1
- **ATV Flight**
  - UF-6
- **ISS Flight**
  - UF-6

#### 2011
- **Russian Flt.**
  - 19S-1
- **ATV Flight**
  - UF-7
- **ISS Flight**
  - UF-7

### Facilities
- CIR - FEANICS-B
- AMS
- CAM

### Combustion Integrated Rack Payloads
- FEANICS-A
- FEANICS-B
- Air-1
- Fab-1

### Fluids Integrated Rack Payloads
- MOBH
- AHLS-1
- Ahl-1
- Fab-1

### ExPRESS Rack or Stand-Alone or FSL Payloads
- FOAM

### Microgravity Science Glovebox Payloads
- CCF-1
- CCF-2
- Waste-1

### Non-GRC Payloads
- CCA-3
- Tarifa

### Acceleration Measurement Payloads
- SE-SAMS F06
- SE-SAMS F08
- SE-SAMS F10
- TSH-FIR
- TSH-MG
- TSH-MG
- TSH-MG
- TSH-MG
- TSH-MG

### Acronyms:
- **CIR** - Combustion Integrated Rack
- **FIR** - Fluids Integrated Rack
- **FOAM** - Flow Enclosure Accommodating Novel Investigations in Combustion of Solids
- **FEANICS** - Flow Enclosure Accommodating Novel Investigations in Combustion of Solids
- **MSG** - Microgravity Science Glovebox
- **ER** - ExPRESS Rack
- **MSRR** - Materials Science Research Rack
- **FSL** - Fluids Science Laboratory
- **TSH** - Thermal Science Facility
- **CCF** - Commercial CIR Apparatus

#### Notes:
- **HRF** - Human Research Facility
- **MELE** - Mice Eighty Laboratory Facility
- **EMCS** - European Modular Cultivation System
- **WOFRS** - Waste Observational Rack Facility
- **Spacetrium** - Space Dynamically Resonating Ultrasonic Module Service
- **HRB** - Radiation Habitat Rack
- **MAKERS** - Microgravity Analysis and Racks for Exploring Systems
- **LMG** - Life Sciences Glovebox
- **BFN** - Bone Fragility Facility
- **Cryogenics-Cryogenic Facility
- **HFR** - Refrigeration Facility
- **AMS** - Alpha Magnetic Spectrometer
- **CAM** - Centrifuge Accommodations Module

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**GRC Biological & Physical Research Project Office Chief:** / Jack A. Salzman 6/15/04
Fire Safety Research Plan Development

We are building a new-comprehensive plan for SFPDS and need to vet it with the community.

At this point we have draft end products and associated questions / objectives.

Approach will be a combination of ground-based testing, modeling and flight validation, we expect integrated teams to address the issues.

We need your input on the validity and completeness of the questions and the associated approaches to address them.