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
The President’s Vision

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
Combustion and Reacting Systems in Reduced Gravity

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)

Systems Engineering

Nation/NASA Vision

- CEV Demo
- 1st Launch Lunar Robotic Orbiter
- 1st Uncrewed CEV Fit
- 1st Crewed CEV Fit
- 1st Human Moon Mission

Requirements

Level 0, 1, ...

Concept Refinement

Program Initiation

System Integration

System Development and Demonstration

Production & Deployment

Operations & Support

Spiral 1

Crewed Flight

Spiral 2

Moon (2015-2020)

Spiral Nth

Mars (2020+)

Critical Milestones

System Integration

System Demonstration

Non-advocacy Reviews

Independent Cost Reviews
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

### 2008

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**Facilities**

- AMS
- CAM

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**Combustion Integrated Rack Payloads**

- CIR - FEANICS-A
- FEANICS-B

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**Fluids Integrated Rack Payloads**

- MBB
- AHS-1
- MOBI

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**ExPRESS Rack or Stand-Alone Payloads**

- FOAM

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**Microgravity Science Glovebox Payloads**

- CCF-1
- CCF-2

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**Non-GRC Payloads**

- Waste-1

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**Acceleration Measurement Payloads**

- SE-SAMS F06
- SE-SAMS F04
- SE-SAMS F02
- TSH-FIR
- TSH-SMS Spac
- SE-SAMS F03
- SE-SAMS F05
- SE-SAMS F05
- SE-SAMS F06
- SE-SAMS F07
- TSH-FIR

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**Legend:**

- CIR - Combustion Integrated Rack
- FIR - Fluids Integrated Rack
- MSG - Microgravity Science Glovebox
- ER - ExPRESS Rack
- MBB - Materials Science Research Rack
- MOBI - Microgravity Integrated Rack
- AHS-1 - Advanced Rack for Science
- AHLS-1 - Advanced Rack for Science
- AHLS-2 - Advanced Rack for Science
- MOBI - Microgravity Integrated Rack
- CCF-1 - Combustion CCF-1
- CCF-2 - Combustion CCF-2
- Waste-1 - Waste-1
- CCA-3 - CCA-3
- Tarifa
- CCA-1
- TSH-FIR
- TSH-SMS Spac
- SE-SAMS F02
- SE-SAMS F03
- SE-SAMS F05
- SE-SAMS F05
- SE-SAMS F06
- SE-SAMS F07

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**Acronyms:**

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**Notes:**

- Mars Science Rovers
- Iris
- Human Research Facility
- MELFI - Minus Eighty Laboratory Freezer
- EMCS - European Modular Cellulation System
- WOFSC - Waste Observation Rack Facility
- SpaceDURUM - Space Dynamically Responding Ultrasonic Resonant Microsystems
- HHR - Holding Habitat Rack
- MARES - Muscles Atrophy Research and Exercise System
- LSE - Life Sciences Glovebox
- BTF - Biotechnology Facility
- CDF - Cryogenic Facility
- RFR - Refrigerator Facility
- AMS - Alpha Magnetic Spectrometer
- CAM - Centrifuge Accommodations Module
- CCA - Commercial CIR Apparatus

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**GRC Biological & Physical Research Project Office Chief:**  /s/ 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.