N89-24705

Technology Requirements for Advanced NASA Missions

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Two recent reports, one by the National Commission on Space and the second by the Ride committee, have urged NASA to look at a variety of future missions. Among these are manned missions to Mars and permanent bases on the moon and Mars. This presentation will address a wide variety of technologies needed for such missions as well as areas where power is required. An estimate of power ranges and photovoltaic opportunities will also be presented.

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SPACE STATION EXPLORATION MISSION REQUIREMENTS

- In-space Research Facility
- Assembly Base
- Return Destination

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IN-SPACE ASSEMBLY TECHNOLOGY ISSUES

- Human Performance
  - Working man's space suit
- Robotic Assistants
  - Demonstrate limited capability
- Compatible Hardware
  - On orbit replacement units
  - Design requirements
- Autonomous Checkout
  - Demonstrate 100% reliability

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PROPULSION TECHNOLOGY

- Chemical Systems
  - Isp > 480 sec: LOX/LH_2 high chamber pressure
  - Diagnostic instrumentation, health statusing
- High Performance Sytems
  - Ion - size (thrust)
  - NPD - life and performance
  - Direct thermal nuclear - cost, commitment, schedule
  - Compatible power system

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CRYOGENIC FUEL MANAGEMENT TECHNOLOGIES

- Transfer and Management
  - Tank chill-down
  - Vapor condensation/acquisition device integrity
  - Zero-g mass gauging
- Low-loss Containment
  - Insulation
  - Vents
  - Struts
  - Refrigerators

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AEROBRAKING TECHNOLOGY

- Configuration
  - Validated analysis tools
  - Concepts/capture requirements
  - Mars environment impact
- Navigation, Guidance and Control
  - Autonomous adapting to atmospheric uncertainties
  - Rendezvous error budget
- Thermal Protection Systems
  - Heat load
  - Mars environment
  - In-space assembly

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ARTIFICIAL GRAVITY TECHNOLOGY

- Human comfort zone - radius, rotation, g-level
- Concept - tethers vs structure
  - Spin-up/spin-down approach
  - Control
  - Aerobrake compatibility
  - Rendezvous techniques

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CLOSED-LOOP LIFE SUPPORT TECHNOLOGIES

- Process
  - Performance
  - Power
  - Life
  - Fault-tolerant
  - Autonomous operation
- Bioregenerative processes
- Trace contaminant control
- Food production/storage

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PLANETARY ROVER (UNMANNED) TECHNOLOGIES

- Mobility and navigation
  - Autonomous path recognition
  - Remote driving
  - Hazard recognition and avoidance
- Power
  - 1-5 kW
  - Weight
  - Environment
- Sample selection maintenance
  - In-situ analysis
  - Selection intelligence
  - "Secure" containers
- High-resolution sensors, communication

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LUNAR BASE TECHNOLOGIES

- Power (30 kW → 100's kWs → MW)
- Material processing in reduced gravity
- Closed-loop life support
- Autonomous systems
- Science sensors
- Data/communciation systems

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NEED FOR POWER IS EVERYWHERE

- Electric propulsion
- Earth/Mars and Earth/Lunar vehicles
- Lunar/Mars bases
- Rovers (manned and unmanned)
- Life support
- Assembly at space station
- Permanent manned presence

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POWER SYSTEM ISSUES

- 0 G 1/6 G (Lunar) 1/3 G (Mars) 0-1 G (variable)
- Surface environment
  - Dust
  - Martian atmosphere
- Recharging rovers
- Man rated nuclear
- 43% AM0 at Mars
- Known degradation
- Autonomous operation
- Includes generation, storage, thermal management, conditioning, distribution, and control

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