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August 10, 2000
Theme Speaker

An Integrated Exploration Strategy

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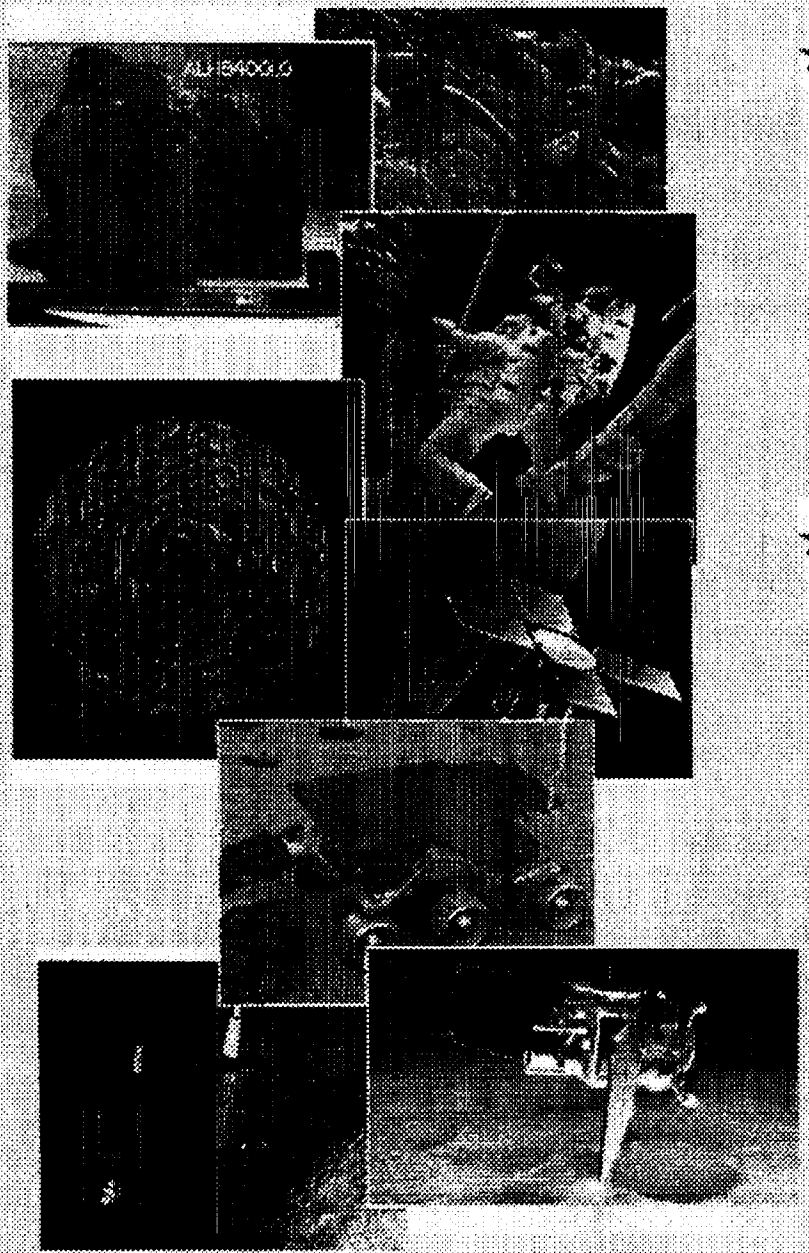
NASA/CP—2000-210470

An Integrated Exploration Strategy

10 August 2000

Michael Conley

Human Deep Space Exploration



- ★ ***The Opportunity*** - An explosion of recent discoveries
  - Allan Hills Meteorite
  - Pathfinder
  - Clementine
  - Lunar Prospector
- ★ ***The Challenge*** - Affordable human exploration
  - Evolving current systems
  - Developing high pay-off technologies
  - Leveraging commercial and other agencies technology programs
  - Developing core capabilities
  - Efficient mission approaches
  - Significant reduction in cost

BGD-98-001

Exploration Strategic Roadmap

Dates dependent on decision to go & available funding

International Space Station

Assembly Complete

Phase 2 | Phase 3 | Operations Transition | Commercial Utilization

Human Support Technology

Lunar / Mars Life Support Testbed | BIO-PLEX | Transhab | Lunar Lander | Mars Lander

Biomedical | Radiation Data Analysis | Zero-G Data Analysis

EVA Development | Next-Generation EVA System | Mars EVA Systems

Space Operations

Communications Initiatives | Commercial Utilization

Lunar and Mars Missions

Lunar Prospector | Surveyor '98 Orbiter and Lander | Mars Sample Return

System Design Go-Ahead | Operational & Technology Tests @ Moon

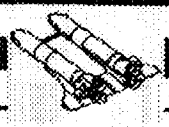
Human Mars Missions

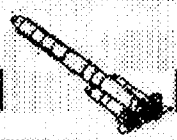
Shuttle Upgrades & Shuttle Transition

System Definition | Commercial Utilization

Implementation

Liquid Flyback Boosters | Mars Launcher





In Situ Resource Utilization

Lunar / Mars Testbed

Mars Flight Demo | Mars Flight Demo | Mars Sample Return | Large Scale Propellant Production

Revolutionary Interplanetary Transportation & Power

High Efficiency Propulsion | In-Space Propulsion Demonstrator | Lunar Propulsion & Power Demo | Full Scale Flight Unit Production

Advanced Space Power

X-38

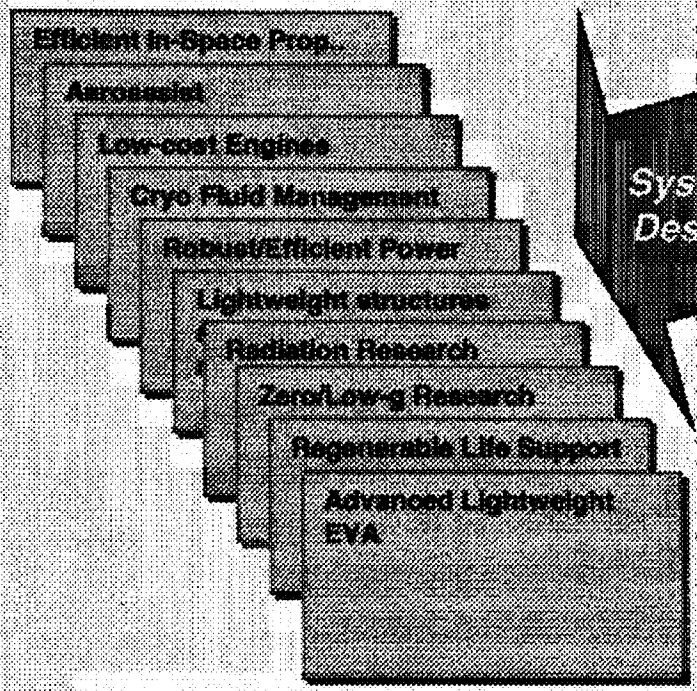
High Speed Aerobraking | Human Aerocapture (Earth) | Human Aerocapture (Mars)

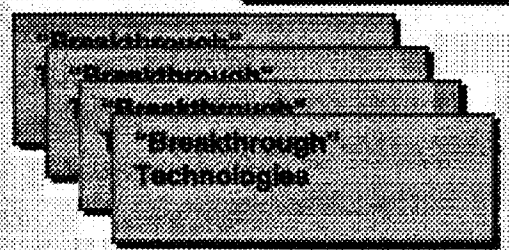
Mars Aerocapture Demo | Mars Aerocapture and Precision Landing Demo

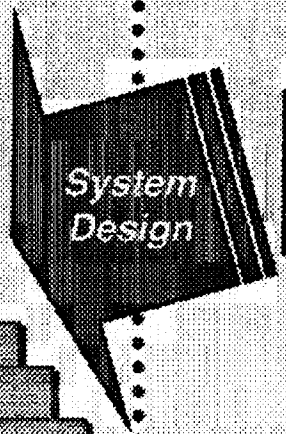
Core Capabilities & Technologies

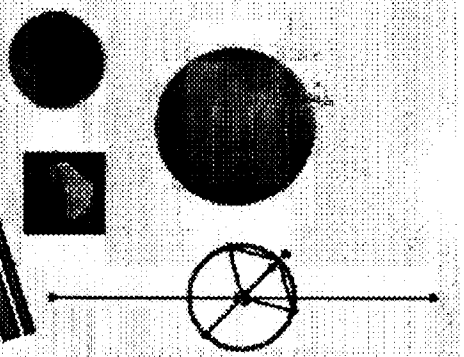
Common Technology Building Blocks (Core Technologies)	Common System Building Blocks (Core Capabilities)	Potential Destinations

Examples









Mission Staging Scenarios

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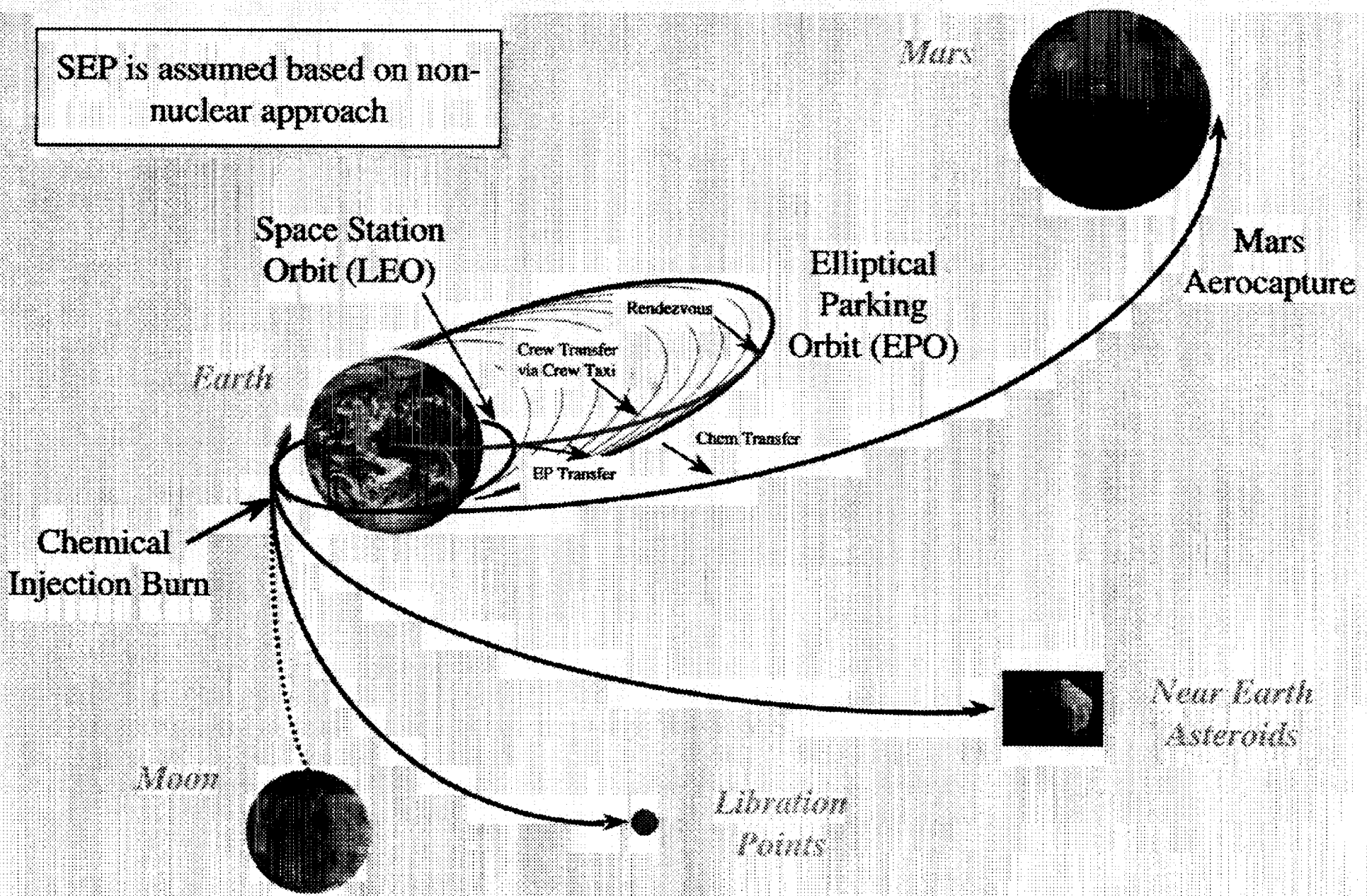
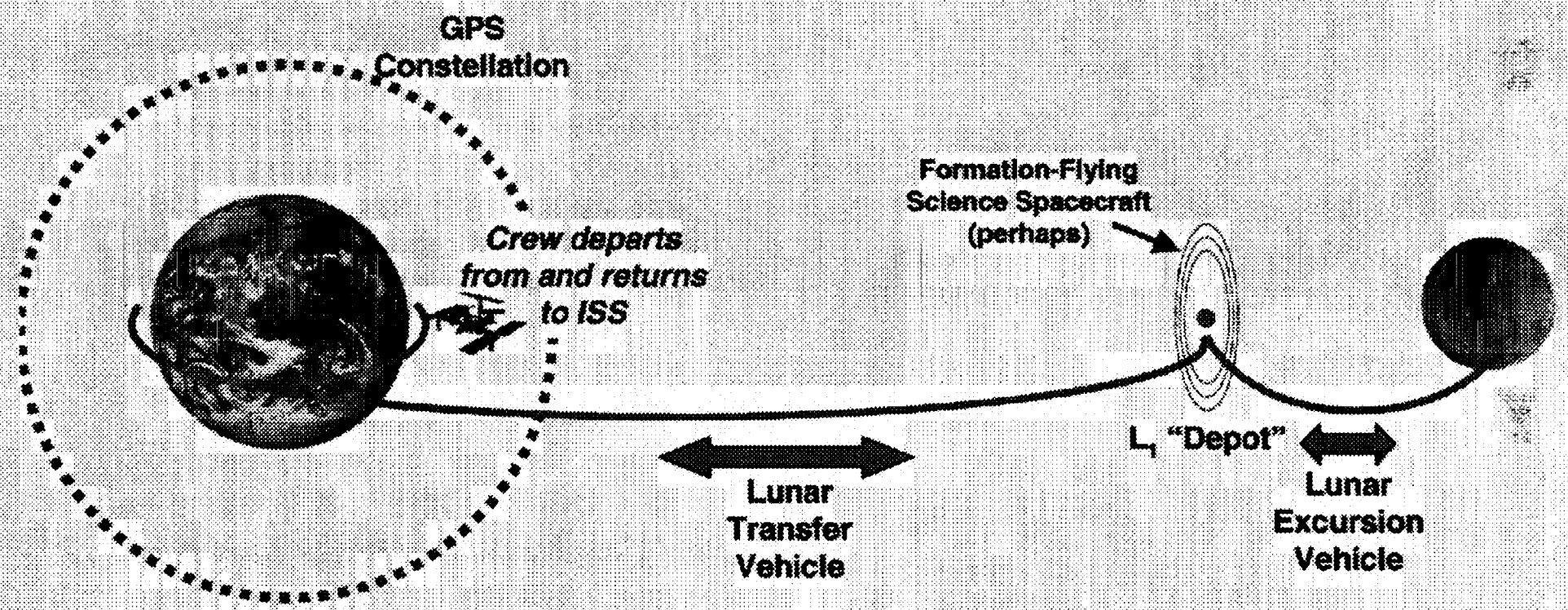
SEP is assumed based on non-nuclear approach



Human Lunar Architecture Concept

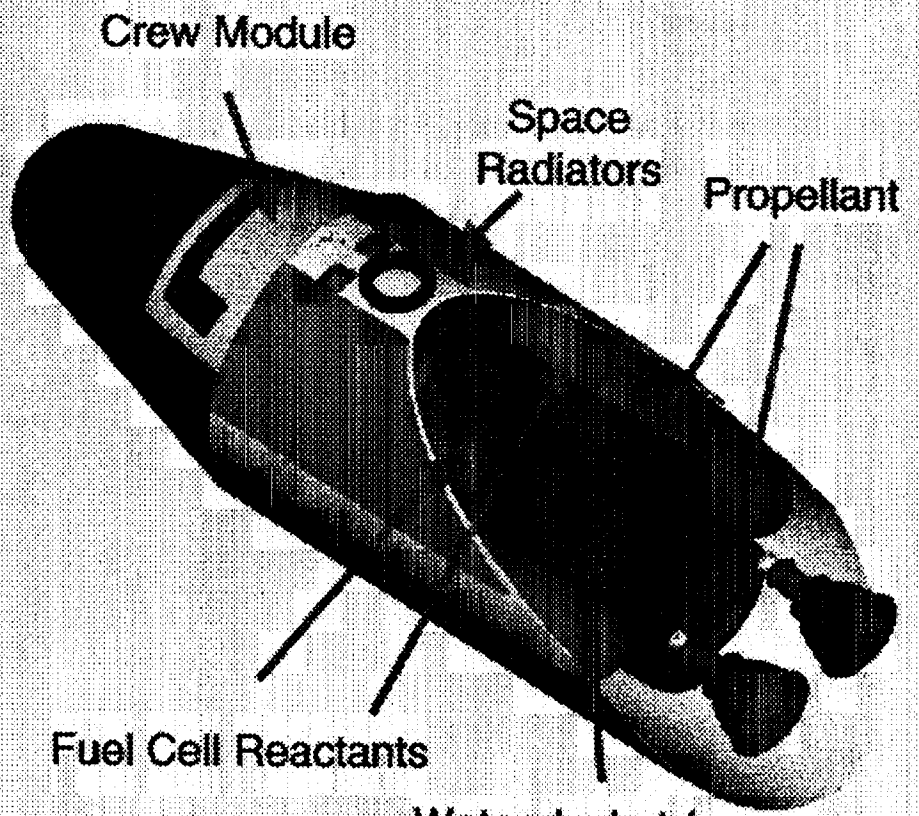
EXPLORATION OFFICE



Lunar Transfer Vehicle

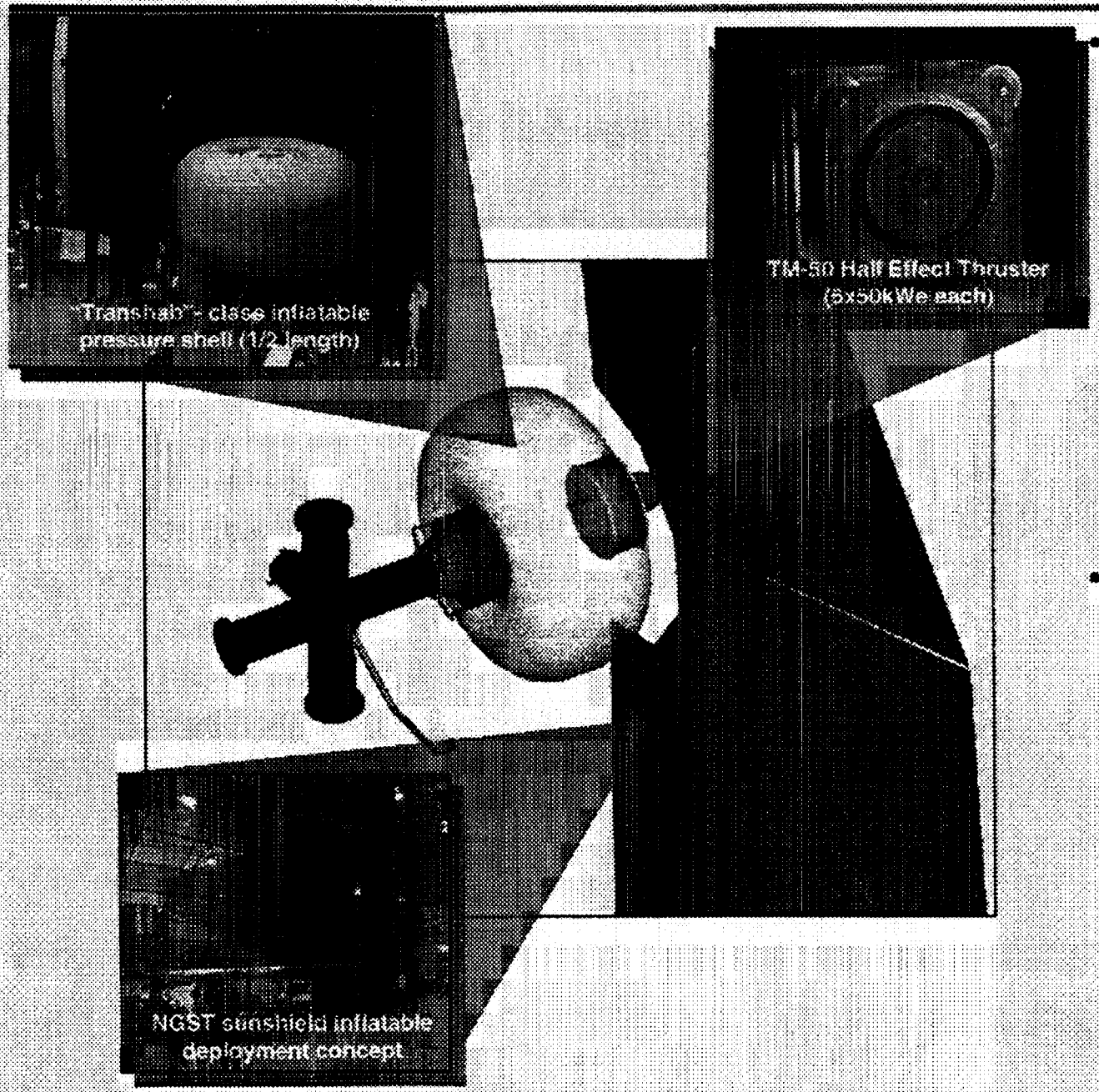
EXPLORATION OFFICE

- "Requirements"
  - Based at ISS for timing flexibility
  - Launch and recovery in Space Shuttle
  - Utilizes space storable propellants
  - Crew of 4 with ΔV capability of >1700 m/s
  - Operations in automated mode, or with crew onboard - automated rendezvous and proximity operations
  - Aerocapture manuevers at lunar return speeds to ISS orbit
- Preliminary Concept
  - Lifting body for crew g reduction
  - Integral LOX/CH_4 propulsion system
  - Eighteen day independent mission capability
  - Lightweight docking system

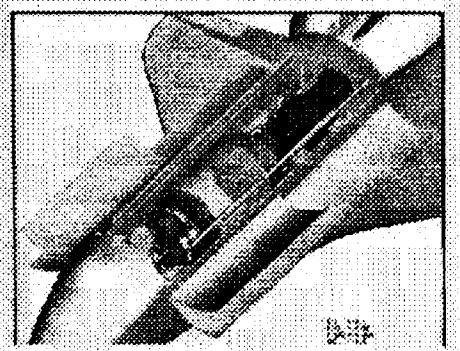


Lunar L_1 "Gateway"

EXPLORATION OFFICE



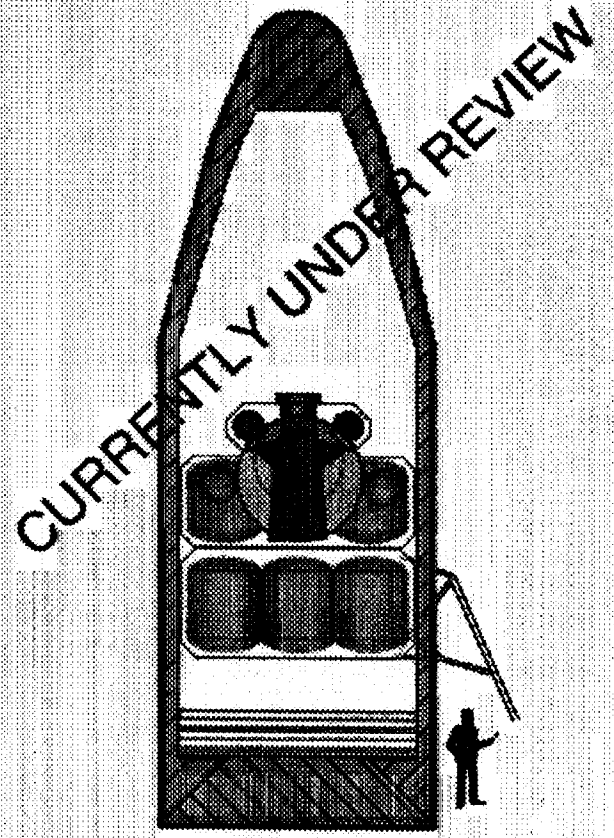
- **"Requirements"**
  - Docking capability for Lunar Transfer Vehicle and Lander and pressurized crew transfer
  - Crew habitation for ≥12 days per lunar mission for return phasing or advanced system testing
  - Vehicle support (power, att. control) for Lunar Transfer Vehicle and Lander
  - Launch on EELV or Shuttle
  - Habitat delivered via solar electric propulsion from LEO to L1
- **Preliminary Concept**
  - "Half-length" inflatable habitat
  - Delivered to L_1 via Solar Electric Propulsion System
  - SEP remains attached to provide power, attitude control



Lunar Excursion Vehicle

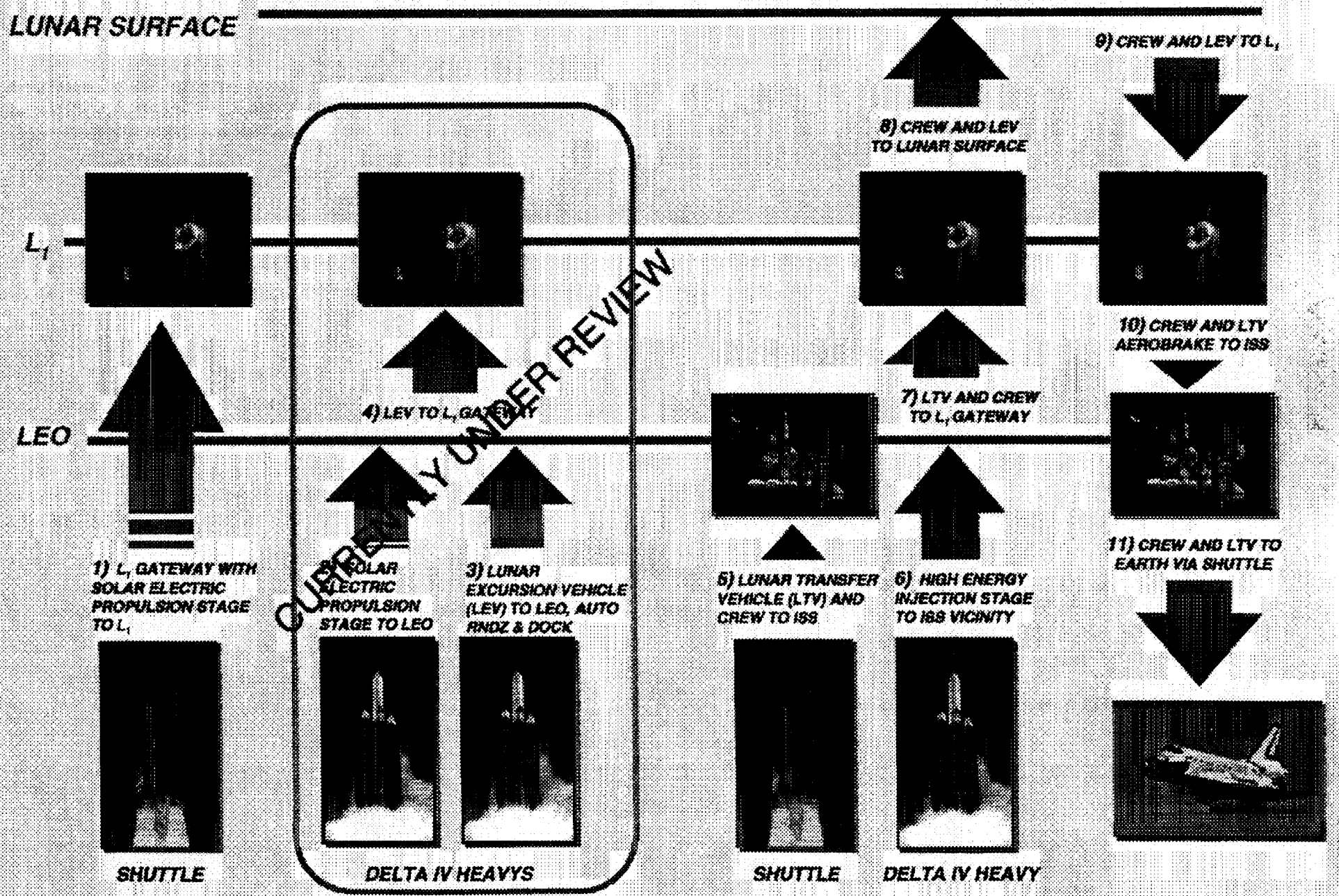
EXPLORATION OFFICE

- "Requirements"
  - LEV will be designed for round-trip piloted missions from L_1 to lunar surface and back to L_1
  - LEV will be delivered to L_1 by transfer stage
  - LEV will be able to remain at L_1 for extended period to allow for delay in crew arrival
  - LEV will interface with L_1 Depot
  - LEV will allow easy lunar surface egress/ingress of suited crewmembers
- Preliminary Concept
  - LOX/CH_4 propulsion stages (ascent and descent)
  - Seven day independent mission capability



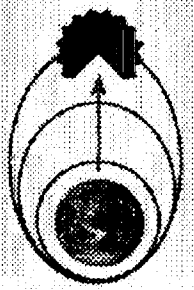
Mission Concept

EXPLORATION OFFICE



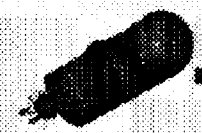
Mars Mission Overview (SEP Option)

EXPLORATION OFFICE

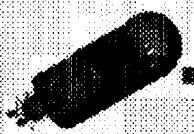


Habitat Lander and Ascent/Descent Vehicles delivered to Low Earth Orbit with "Shuttle Class" launcher. Solar Electric Propulsion stage spirals cargo to High Earth Orbit. Chemical injection used at perigee. SEP spirals back to LEO for reuse.

Surface Habitat and exploration gear aerocaptures into Mars orbit

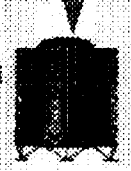


Ascent/Descent Vehicle aerocaptures and remains in Mars orbit for the crew

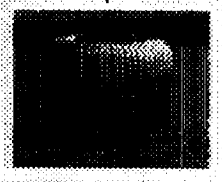


Crew rendezvous with Descent/Ascent Vehicle in Mars Orbit then lands in vicinity of Habitat Lander

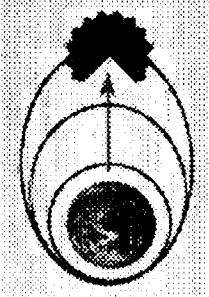
Surface Habitat lands and performs initial setup and checkout - Initial outpost established



30 days provided to satisfy "long-stay" criteria.



Mars Surface



Transit Habitat vehicle delivered to LEO with "Shuttle Class" launcher. SEP spirals Transit Habitat to High Earth Orbit. Crew delivered to vehicle via crew taxi. SEP spirals back to LEO for reuse.

Crew travels to Mars in "fast transit" 180-206 day transfer. Aerobrakes into Mars orbit

Habitat remains in Mars orbit

Crew ascends and rendezvous with waiting Transit Habitat

Crew returns to Earth on "fast transit" 180-206 day transfer. Direct entry at Earth

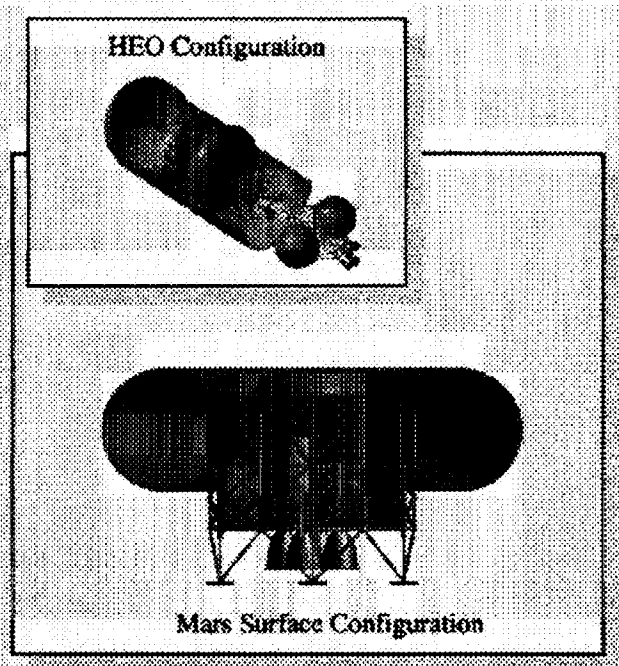
Earth

Mars Mission Vehicles

EXPLORATION OFFICE

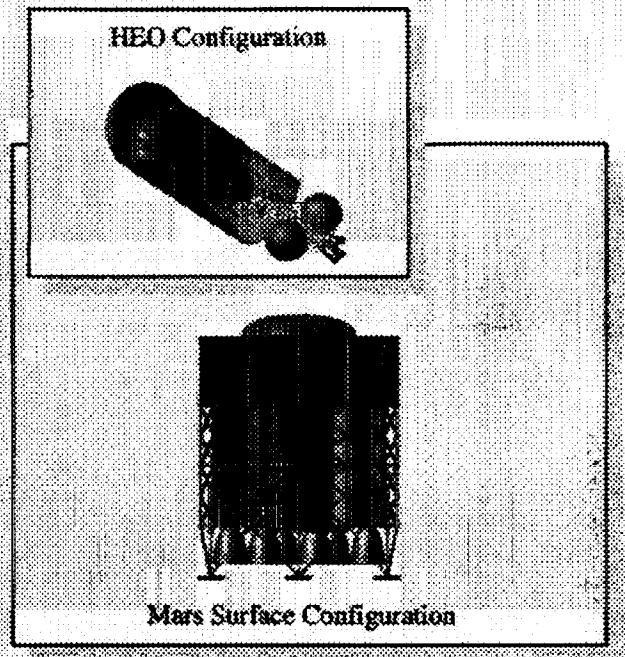
Mars Transit Vehicle

- **Supports mission crew of six for up to 200-day transits to and from Mars**
- **Return propulsion stage integrated with transit system**



Mars Surface Habitat

- **Vehicle supports mission crew of six for up to 18 months on the surface of Mars**
- **Provides robust exploration and science capabilities**

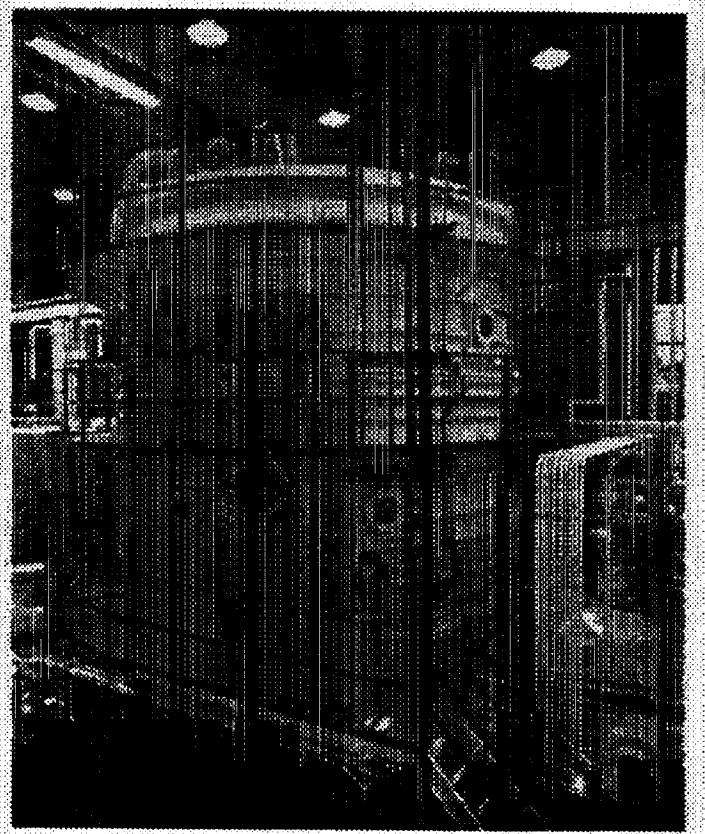


Descent/Ascent Vehicle

- **Transports six crew from Mars orbit to the surface and back to orbit**
- **Provides contingency abort-to-orbit capability**
- **Supports six crew for**

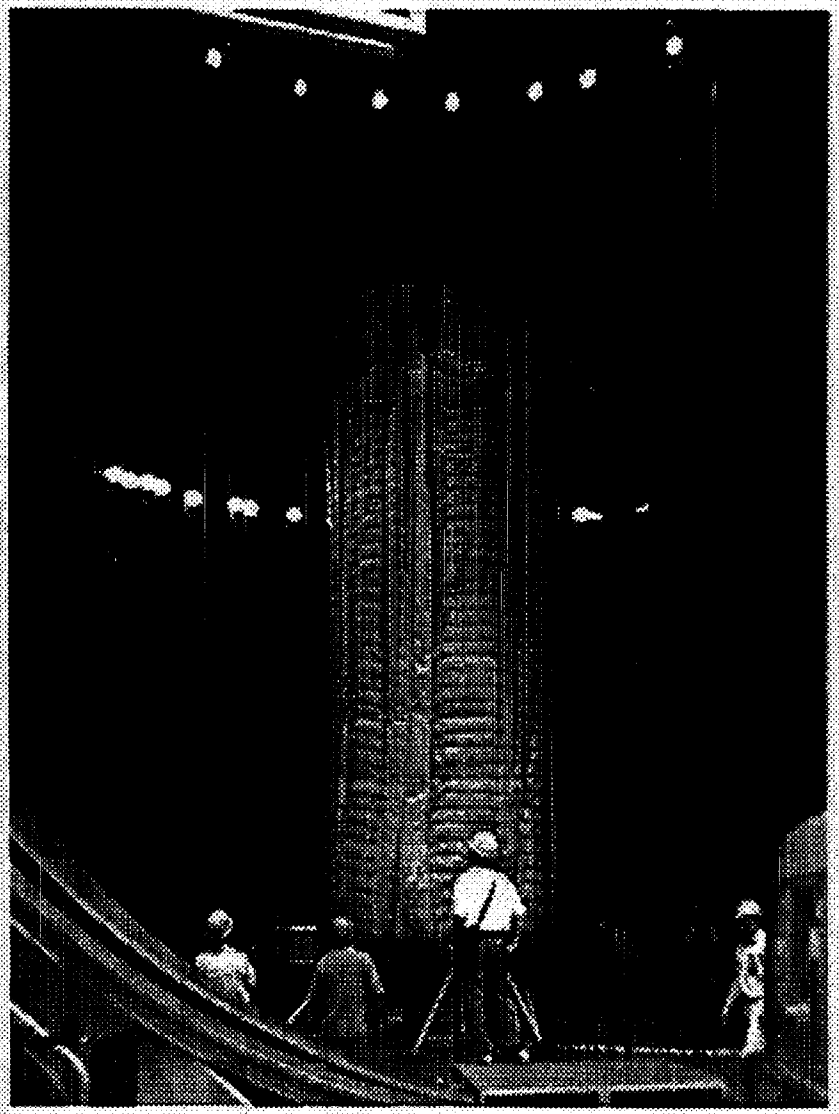
Lunar - Mars Life Support Project

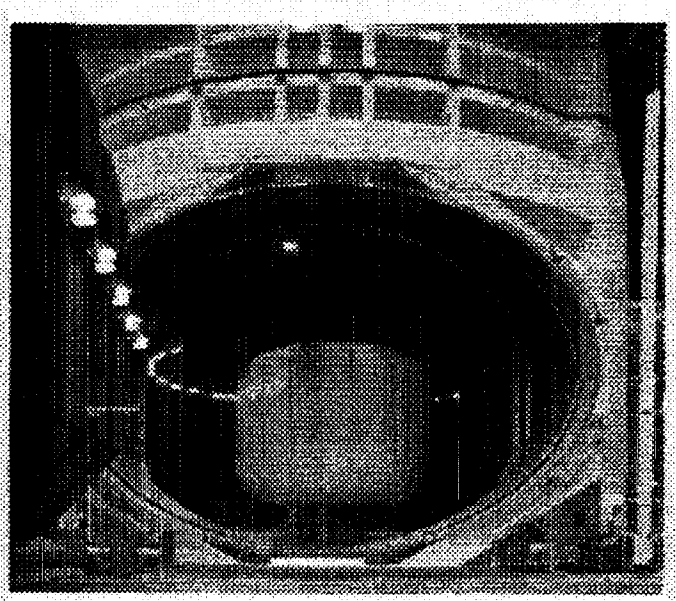
Phase I: 15-day, 1-Person Test
July 1995

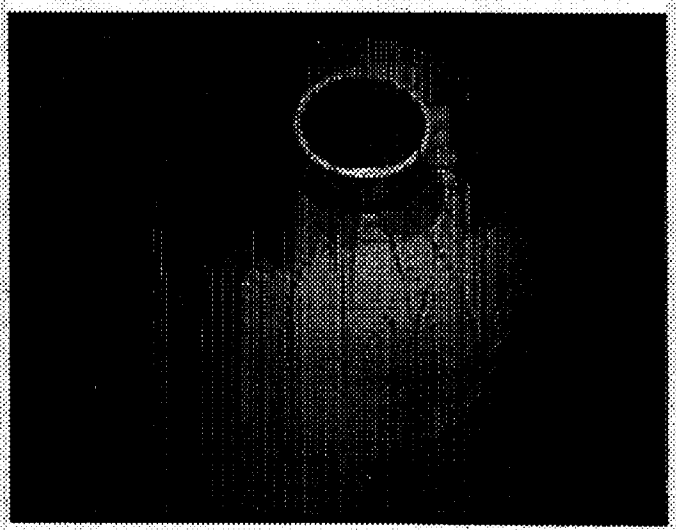


Phase II: 30-day, 4-Person Test - June 1996
Phase IA ISS: 60-day, 4-Person Test - January 1997
Phase III: 90-day, 4-Person Test - September 19, 1997

TransHab Full Scale Shell Development Unit (SDU-3)



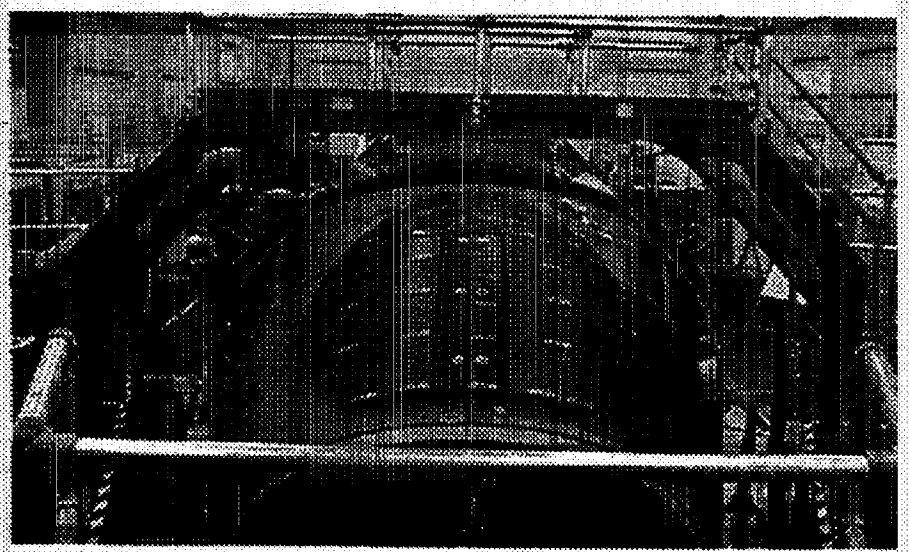


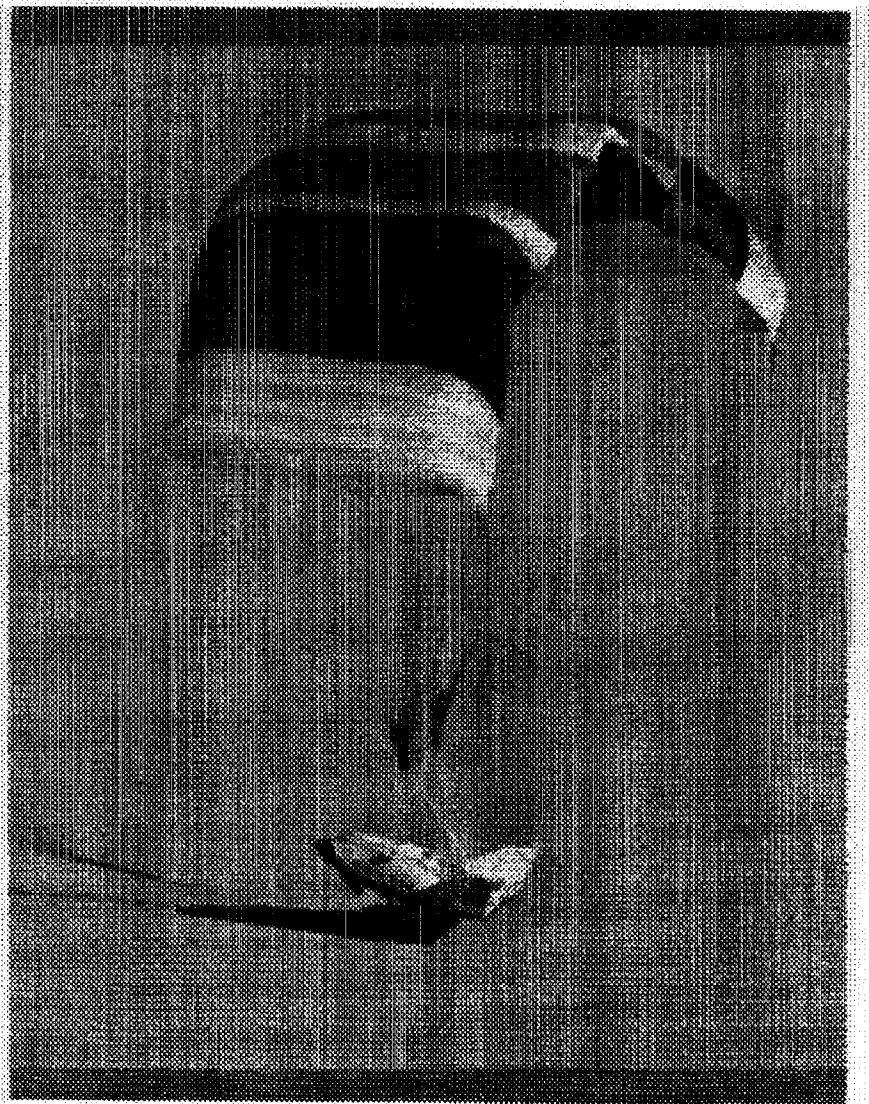


Vacuum Deployment Test 12-21-98

X-38 Technology Testing

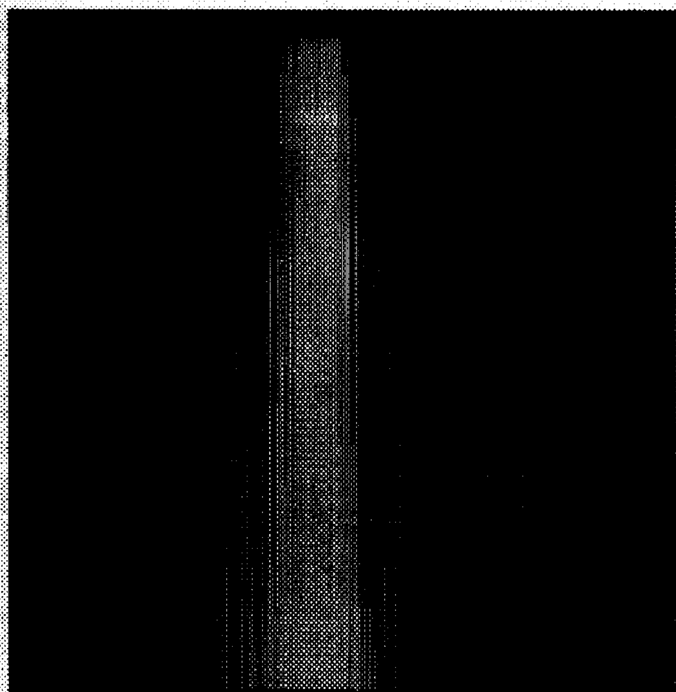
Dryden Flight Research Center EC99 45060-25 Photographed 03JUL1999
The X-38 Step 2, Crew Return Vehicle is released from the B-52 Mothership.
NASA/Dryden Carla Thomas

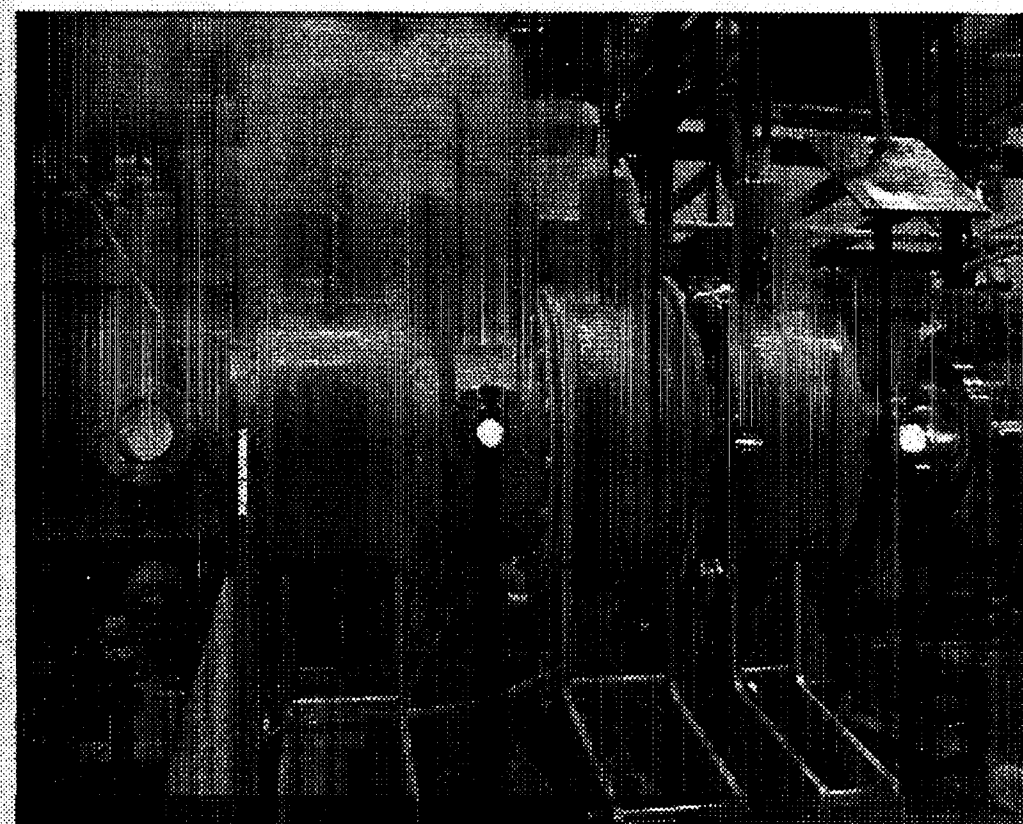




EC99-44923-157 Dryden Flight Research Center 03MAR99
X-38 v132 free flight. NASA photo by Bill Ikeda

VASIMIR Laboratory Experiment





Technologies and Designs to Reduce Costs

Solar Electric Propulsion

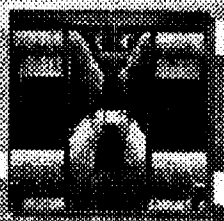
LOW EARTH ORBIT

TEST AND DEMONSTRATION FLIGHTS

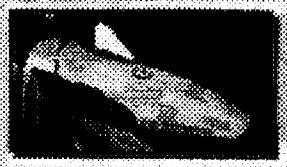
AFFORDABLE HUMAN EXPLORATION

Advanced Life Support

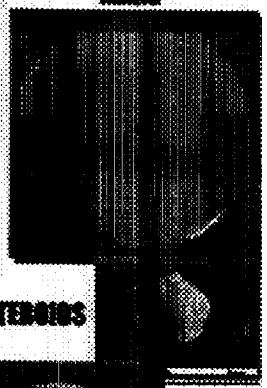
BIO-PLEX



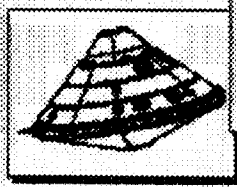
Crew Transfer

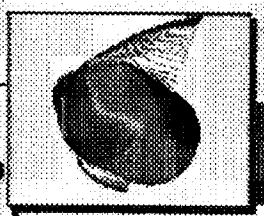


MARS



Aerocapture



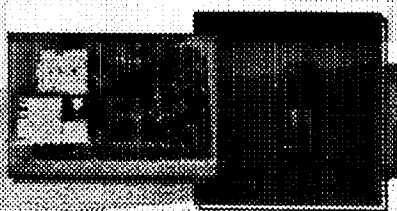


ASTEROIDS

ROBOTIC MISSION TESTS

MOON

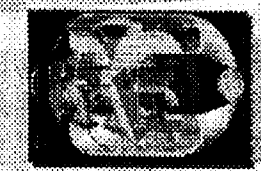
In Situ Resource Utilization



ROBOTIC MISSION TESTS

LIBRATION POINTS

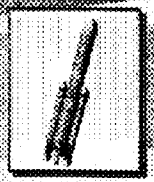
Lightweight Structures and Systems



INFLATABLES

MINIATURIZED AVIONICS

Shuttle - Compatible Heavy Lift



80 METRIC TONS TO LEO