N93-22647

# OFFICE OF COMMERCIAL PROGRAMS' RESEARCH ACTIVITIES FOR SPACE STATION FREEDOM UTILIZATION

Presented by James A. Fountain
Office of Commercial Programs
NASA Headquarters

ABSTRACT

One of the Objectives of the Office of Commercial Programs (OCP) is to encourage, enable, and help implement space research which meets the needs of the U.S. industrial sector. This is done mainly through seventeen Centers for the Commercial Development of Space (CCDSs) which are located throughout the United States. The CCDSs are composed of members from U.S. companies, universities, and other government agencies. These Centers are presently engaged in industrial research in space using a variety of carriers to reach low Earth orbit. One of the goals is to produce a body of experience and knowledge that will allow U.S. industrial entities to make informed decisions regarding their participation in commercial space endeavors. A total of 32 items of payload hardware have been built to date. These payloads have flown in space a total of 73 times.

The carriers range from the KC-135 parabolic aircraft and expendable launch vehicles to the Space Shuttle. This range of carriers allows the experimenter to evolve payloads in complexity and cost by progressively extending the time in microgravity. They can start with a few seconds in the parabolic aircraft and go to several minutes on the rocket flights, before they progress to the complexities of manned flight on the Shuttle. Next year, two new capabilities will become available: COMET, an expendable-vehicle-launched experiment capsule that can carry experiments aloft for thirty days; and SPACEHAB, a new Shuttle borne module which will greatly add to the capability to accommodate small payloads.

All of these commercial research activities and carrier capabilities are preparing the Office of Commercial Programs to evolve those experiments that prove successful to Space Station Freedom. OCP and the CCDSs are actively involved in Space Station design and utilization planning and have proposed a set of experiments to be launched in 1996 and 1997. These experiments are to be conducted both internal and external to Space Station Freedom and will investigate industrial research topics which range from biotechnology to electronic materials to metallurgy. Some will be designed to make maximum use of the quiescent microgravity conditions in the "ground-tended" phases during the early years of Space Station Freedom operations.

# NASA OFFICE OF COMMERCIAL PROGRAMS' RESEARCH ACTIVITIES FOR SPACE STATION FREEDOM

Presented at the

**Space Station Freedom Utilization Conference**

Session 3: Discipline Perspectives: Microgravity Research and Biotechnology

Von Braun Civic Center
Huntsville, AL

By

James A. Fountain
Marshall Space Flight Center
Huntsville, AL

Program Manager, Commercial Utilization of Space Station Freedom
for the
Office of Commercial Programs
NASA Headquarters
Washington, DC

August 5, 1992

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SPACE STATION FREEDOM

## SPACE STATION FREEDOM PAYLOAD SPONSORS

- JAPAN - NASDA
- EUROPEAN SPACE AGENCY - ESA
- CANADA - CSA
- UNITED STATES - NASA
  - *Office of Commercial Programs - OCP (Code C) - 28%*
  - Office of Space Science and Applications - OSSA (Code S) - 52%
  - Office of Aeronautics and Space Technology - OAST (Code R) - 12%
  - Office of Space Flight - OSF (Code M) - 8%*
  - Office of Space Systems Development - OSSD (Code D) - 8%*

* Shared between OSF and OSSD

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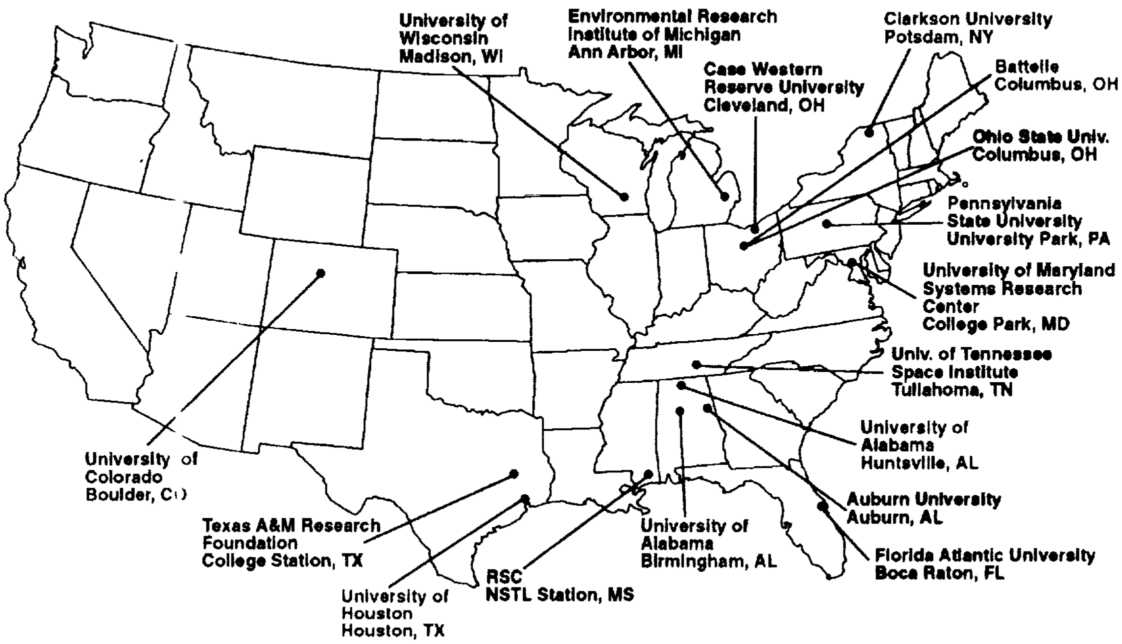
NASA
National Aeronautics and Space Administration
Office of Commercial Programs

# Centers for Commercial Development of Space (CCDS)

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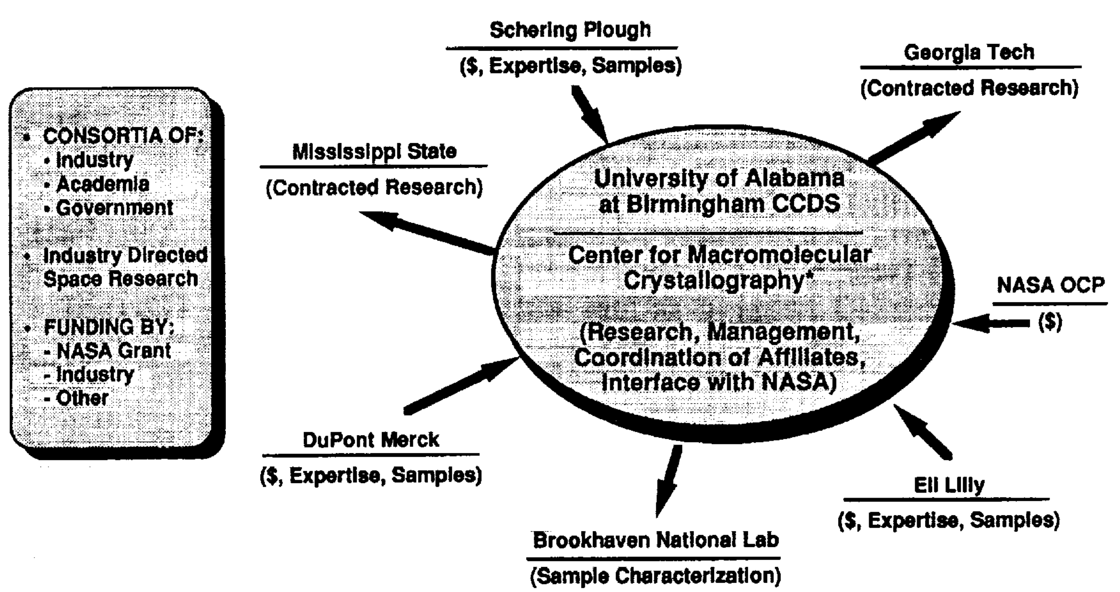
## CENTERS FOR THE COMMERCIAL DEVELOPMENT OF SPACE (CCDS's)

## *HOW DO THEY WORK?*




* For illustration purposes only. Only 6 of the 34 affiliates are shown.

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# Current CCDS Commercial Technologies

***Auburn***
- Solar Furnace Satellite
- Crystal Growth of Electronic Materials
- Computational Modeling of Casting Processes

***Battelle***
- Solution Crystal Growth
- Polymer Composites
- Float Zone Crystal Growth - CdTe
- Zeolite Crystal Growth
- Doped Non-Linear Optic Substrates
- Investigations into Polymer Membranes

***Bioserve***
- Plant Growth Apparatus
- Blood Rheology Experiment
- Generic Bioprocessing Module
- Autonomous Biomedical Test Apparatus

***Case Western***
- Materials Exposure - Basic, Advanced, & Applied

***Clarkson***
- Zeolite Crystal Growth
- Low-Temp Solidification
- Liquid Encapsulated Melt Zone
- Directional Solidification - CdTe
- Chemical Vapor Transport - CdTe
- Commercial Solution Growth Facility

***CSTAR***
- Cryogenic Fluid Management
- Electric, Chemical Propulsion
- Industrial Laser System Applications

***Florida Atlantic***
- Transmission Techniques

***Ohio State***
- Remote Sensing & Mapping

***Penn State***
- Biomodule
- Telemedicine
- Bioseparations
- Bone Densitometry
- Physiological Systems Experiment
- Light Stimulator & Photon Detector
- Commercial Electrophoresis System

***SpARC***
- Autonomous Rendezvous & Docking
- Automated Microgravity Materials Processing

***SRSC***
- Remote Sensing & Applications

***SVEC***
- Chemical, Molecular Beam Epitaxy Growth

***Texas A&M***
- Micro Heat Pipe Evaluation
- Frozen Startup of Heat Pipe
- Microwave Power Transmission

***University of Alabama–Birmingham***
- Protein Crystal Growth

***University of Alabama–Huntsville***
- Polymer Foam
- Atomic Oxygen
- Electrodeposition
- 3-D Accelerometer
- Immiscible Polymers
- Nuclear Track Detectors
- Space Experiment Facility
- Non-Linear Optical Materials
- Sintered & Alloyed Materials
- High-Temp Superconductors
- Materials Dispersion Apparatus

***University of Maryland***
- Hybrid Networks

***WCSAR***
- Astroculture™
- Bioregenerative Water System

CC-2929 2/6/92

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## THE CENTERS FOR THE COMMERCIAL DEVELOPMENT OF SPACE (CCDS)

## A MAJOR OBJECTIVE:

***To produce a body of knowledge and experience that will allow U.S. industrial entities to make informed decisions regarding their participation in commercial space endeavors***

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# COMPARISON OF COMMERCIAL OPTIONS

**A Private Entity May Ask:**

***What options do I have to participate in a commercial space endeavor, and what are the relative comparisons of:***

1. ***Risk to my investment?***
2. ***Cost of participating?***
3. ***Retention of Intellectual Property?***

| | Join a CCDS | Negotiate a Joint Endeavor Agreement | Negotiate A Commercial Reimbursable Agreement |
|---|---|---|---|
| 1. Risk | lower | ◄————► | higher |
| 2. Cost | lower | ◄————► | higher |
| 3. Intel. Prop. | keep some | ◄————► | keep all |

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SPACE STATION FREEDOM

## HOW DO WE GET OUR EXPERIMENTS TO SPACE?

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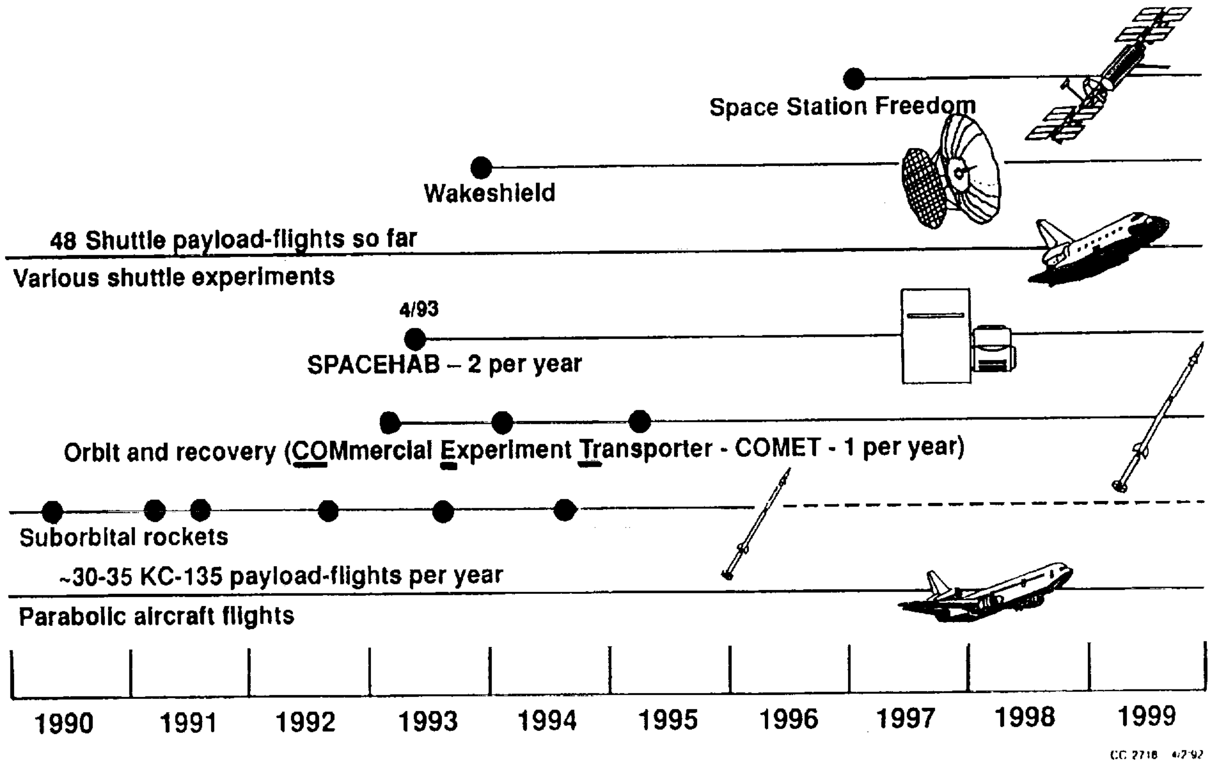
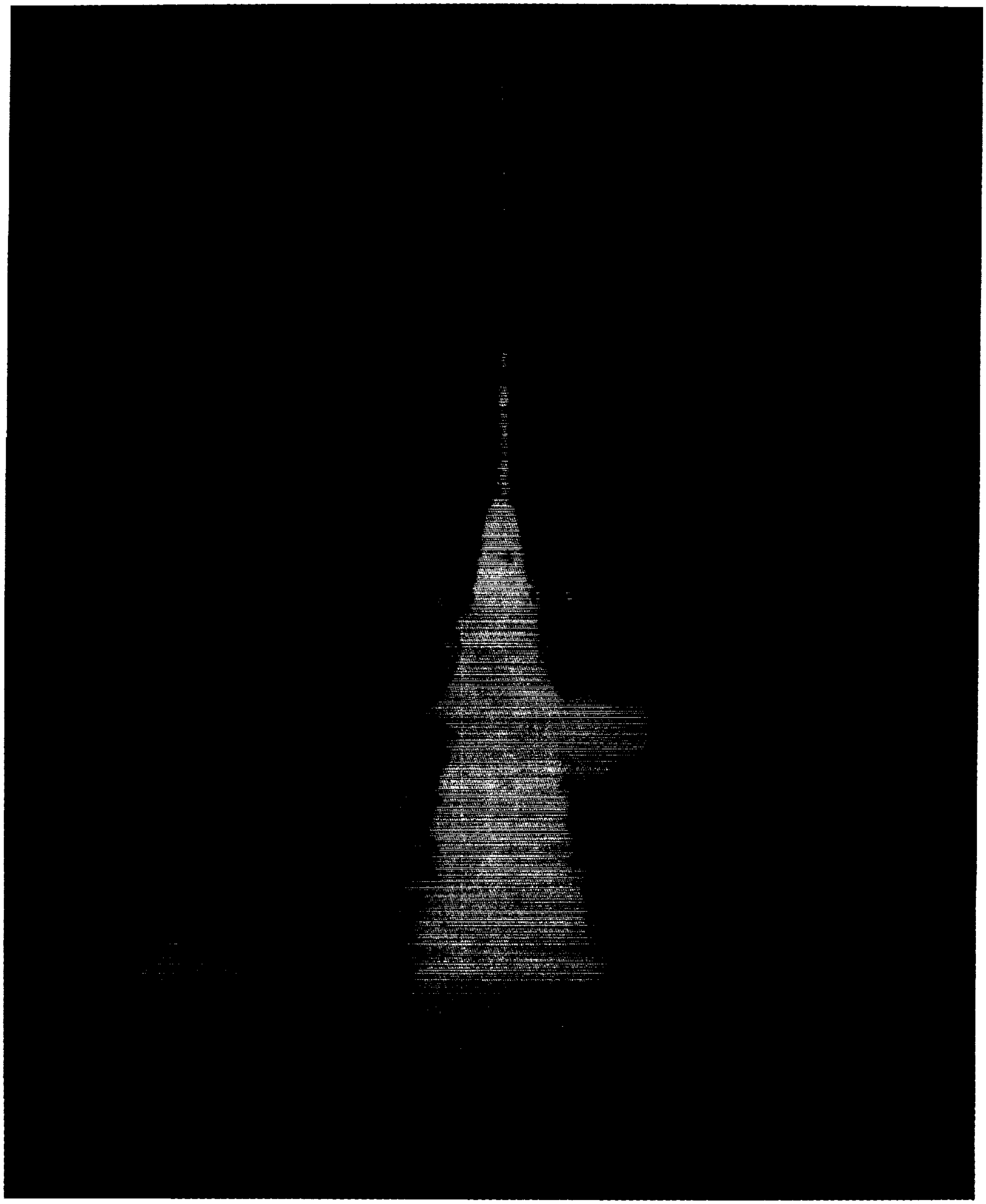
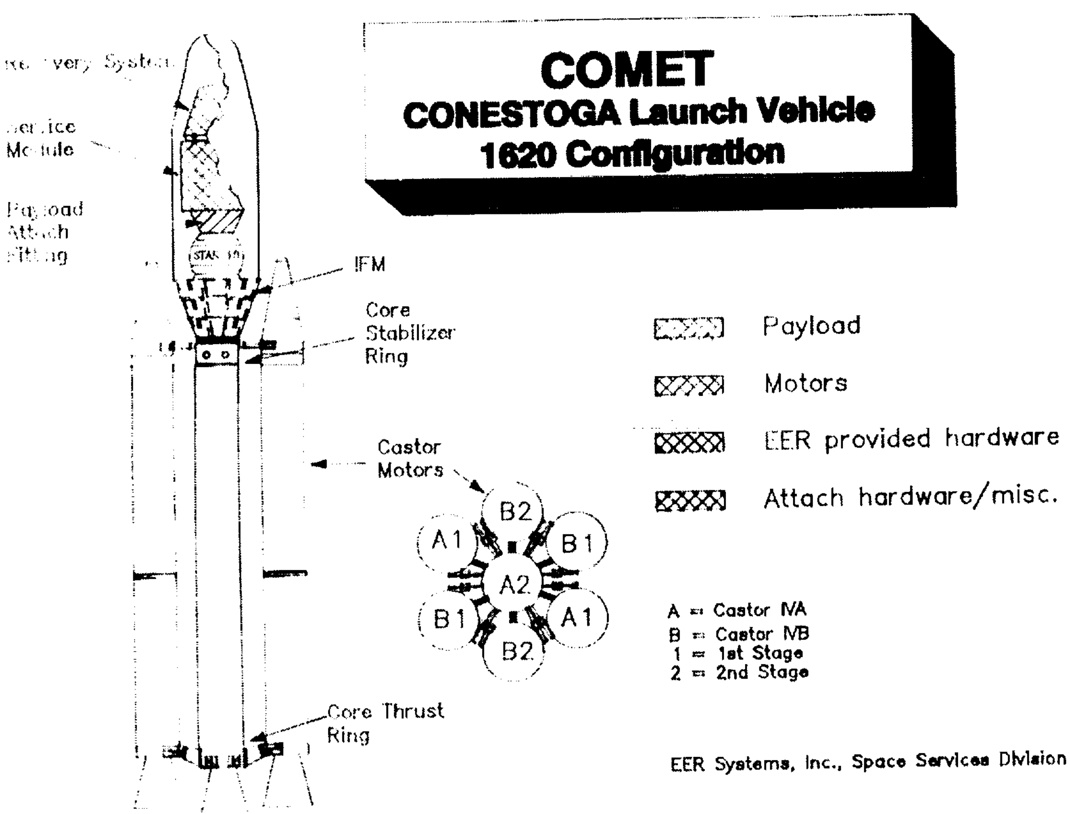
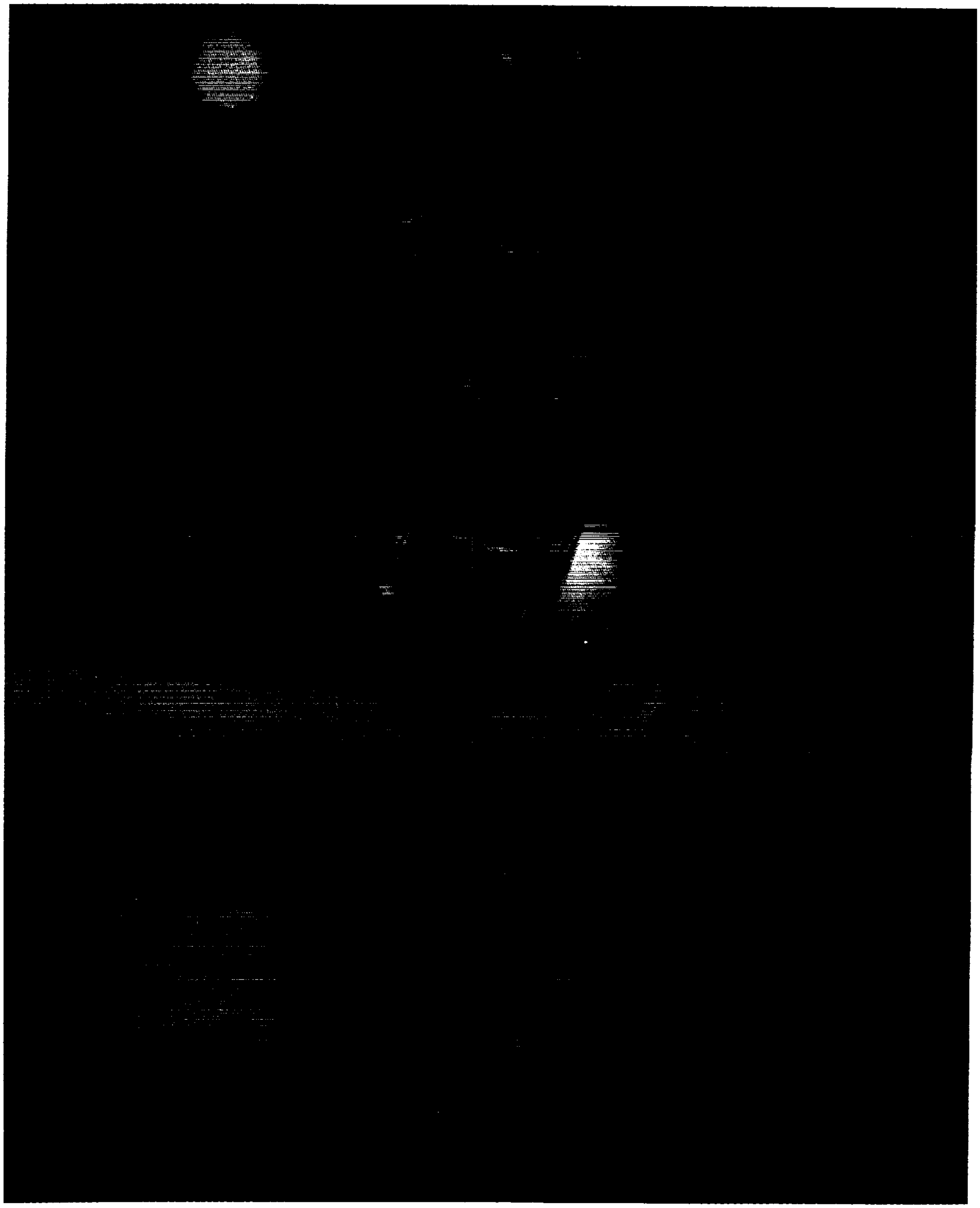
# Commercial Payload Evolution to Space Station






COMET
CONESTOGA Launch Vehicle
1620 Configuration
IFM
Core Stabilizer Ring
Castor Motors
Core Thrust Ring
B2
A1
B1
A2
B1
A1
B2
Payload
Motors
EER provided hardware
Attach hardware/misc.
A = Castor IVA
B = Castor IVB
1 = 1st Stage
2 = 2nd Stage
EER Systems, Inc., Space Services Division



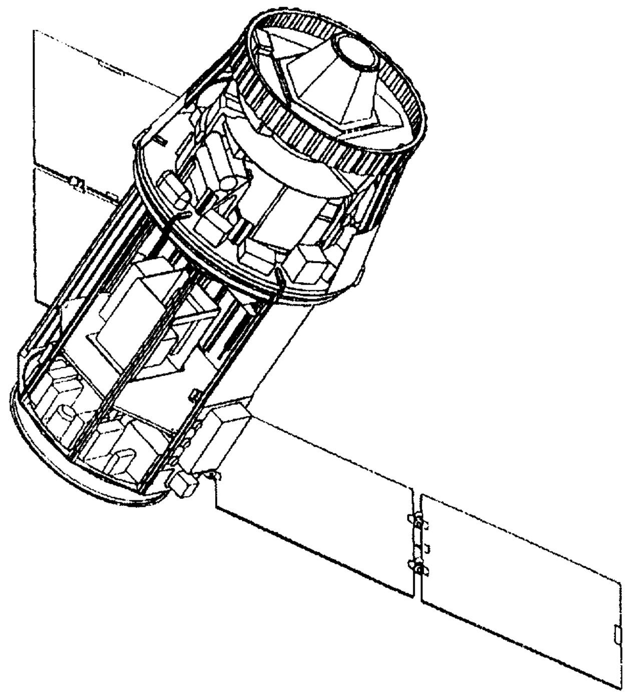
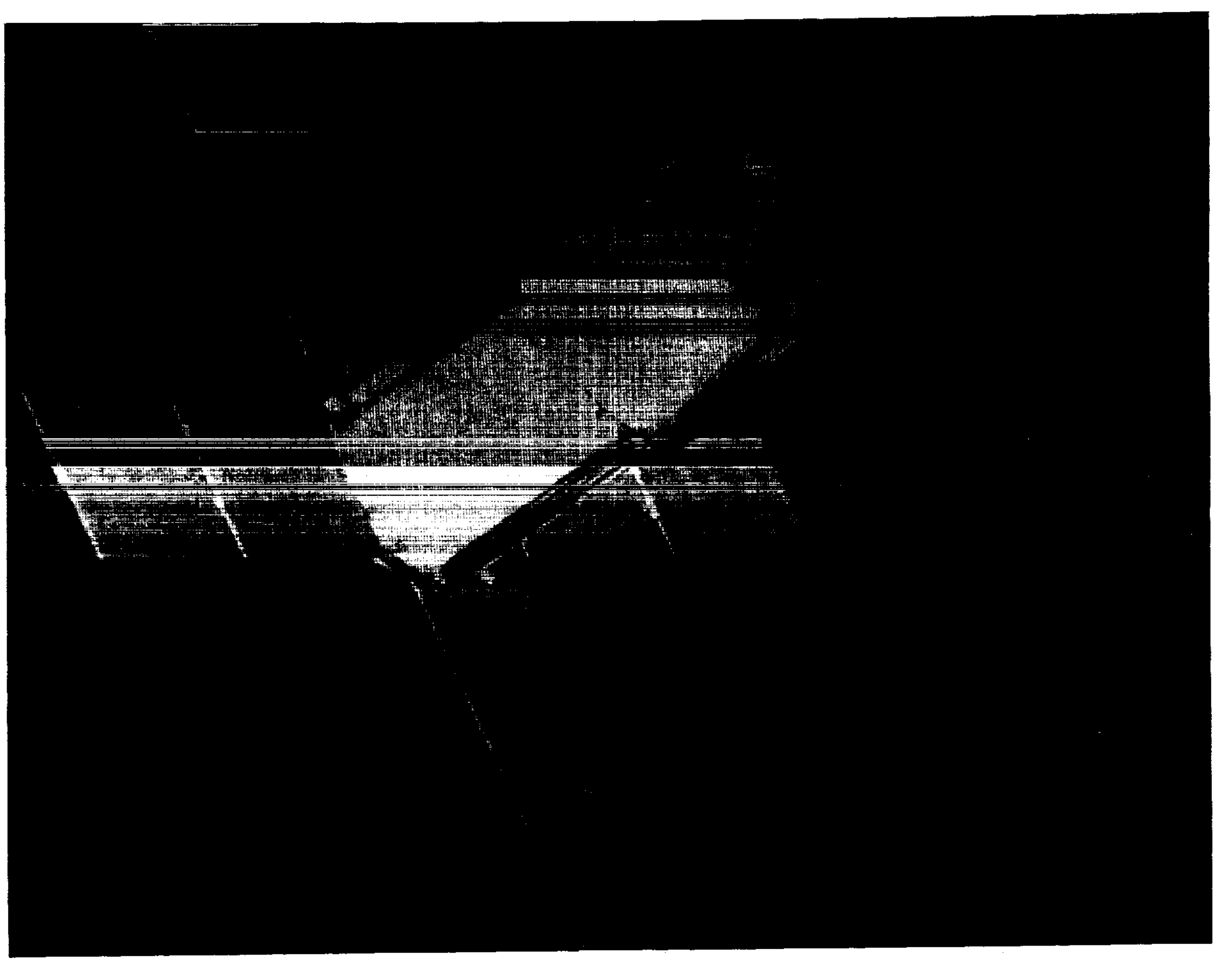
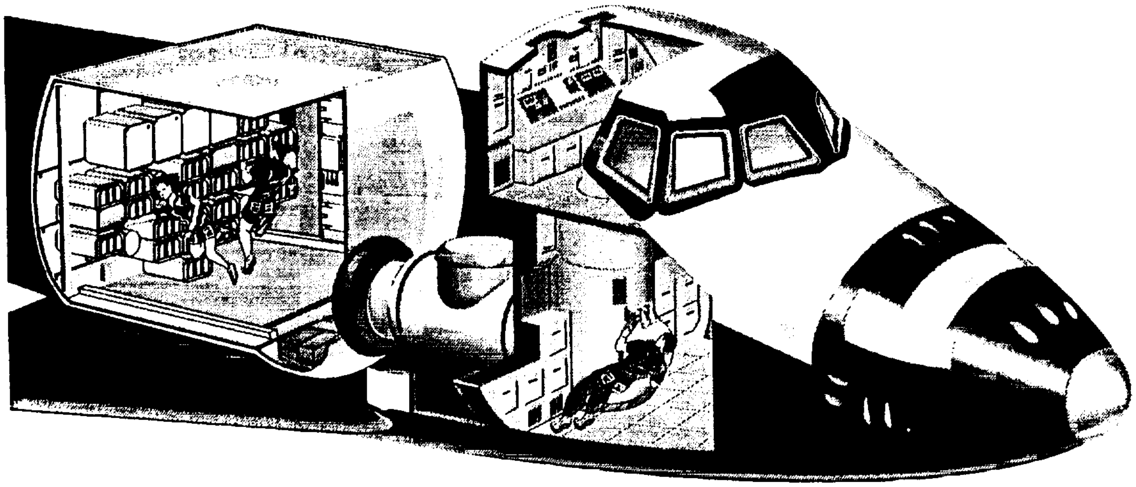


Figure I.4-2 Cutaway View of COMET FreeFlyer



# SPACEHAB Module



# Payload Resources

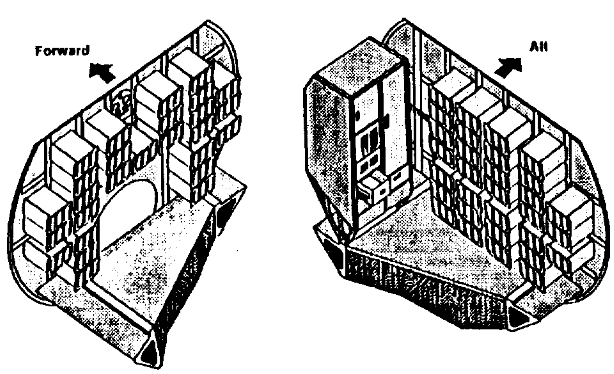
## CONFIGURATIONS

**All Locker Configuration**

71 lockers (max)

**Rack & Locker Configurations**

1 rack / 61 lockers (max)
2 racks / 51 lockers (max)




Mission planning will assess the compatibility of payloads in order to maximize the resources provided to each.

## TOTAL PAYLOAD RESOURCES

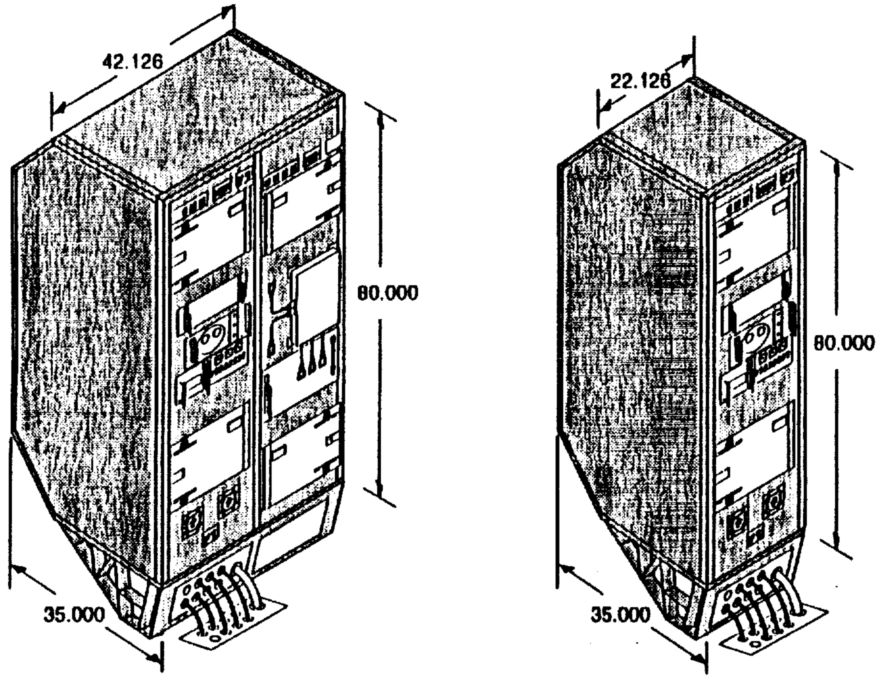
| | English | Metric |
|---|---|---|
| **Mass:** | 3000 lb | 1360 kg |
| **Volume:** | 1100 ft3 | 31.1 m3 |
| **Power*:** | | |
| DC: | 1750 - 3500 W | |
| Asc/Des | 300 - 625 W | |
| AC: | 690 VA | |
| **Cooling:** | | |
| Air: | 2000 W | |
| Water**: | 4000 W | |
| **Crew:** | 2 | |

**Other:**

- Command/data subsystems
- Fire detection/suppression
- Vacuum venting

* With 2 Orbiter Feeders, DC = 3150 W
** Maximum water cooling level includes 2 kW plus whatever air capability is not used. (The orbiter can provide up to 6 kW cooling total on a special case basis.)

# Spacehab Racks




Double Rack
(45 cu. ft., 1209 lb Experiment)

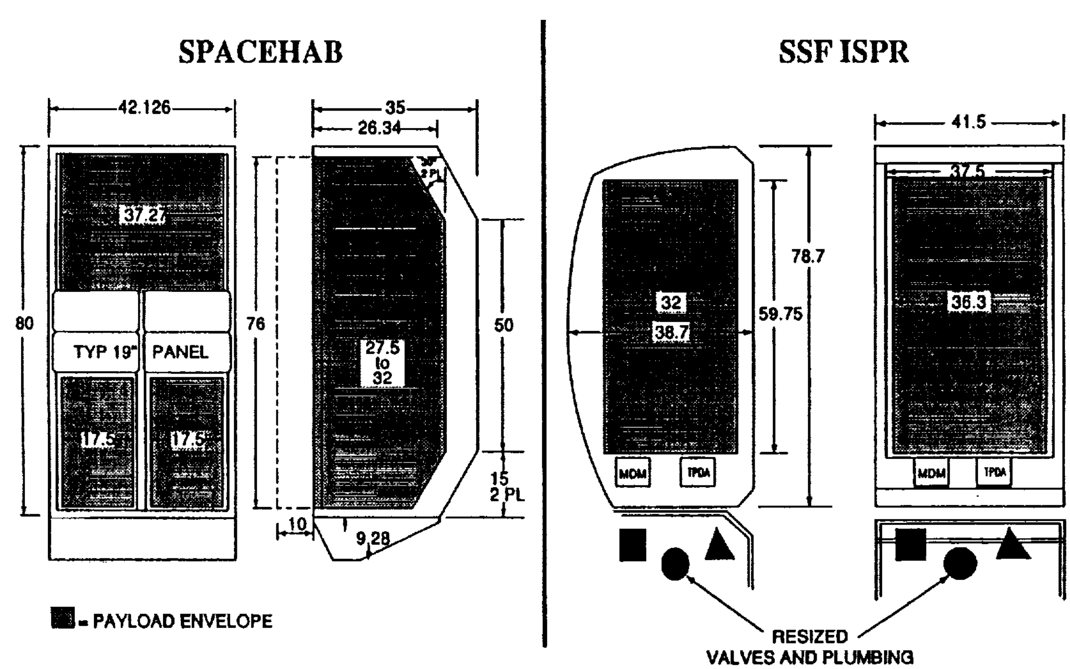
Single Rack
(22.5 cu. ft., 655 lb Experiment)

SPACEHAB®

McDONNELL DOUGLAS

# TRANSITION OF SPACEHAB PAYLOADS TO SSF

## RACK PAYLOAD ENVELOPES



# TRANSITION OF SPACEHAB PAYLOADS TO SSF

## RACK COMPARISON SUMMARY

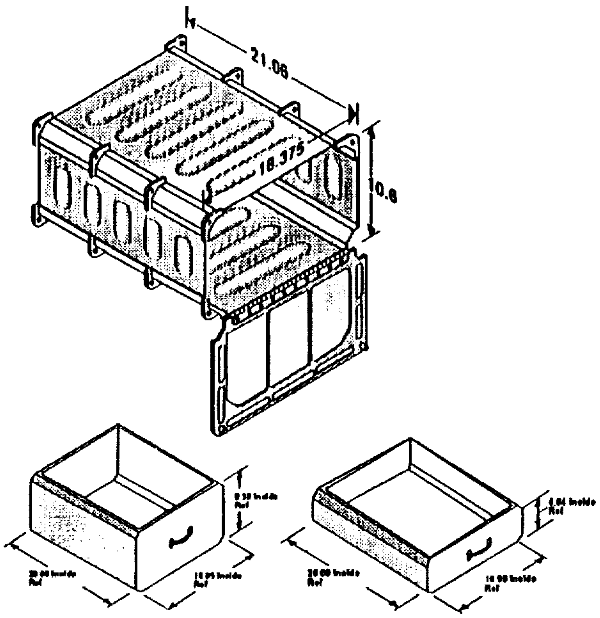
| SPACEHAB | | SPACE STATION FREEDOM |
|---|---|---|
| 80 in. (2032 mm) High<br>42.126 in. (1070 mm) Wide<br>35 in. (889 mm) Deep<br>9.28 in. (235.71 mm) Base | EXTERNAL RACK ENVELOPE | 78.7 in. (1999 mm) High<br>41.5 in. (1054.1 mm) Wide<br>38.7 in. (983 mm) Deep<br>No Base |
| 57 cu. ft (1.61 cu. m)<br>Inside Envelope<br><br>45 cu. ft. (1.27 cu. m)<br>Design Volume | RACK PAYLOAD VOLUME | 55 cu. ft. (1.55 cu, m)<br>Inside Envelope<br><br>40 cu. ft. (1.13 cu. m)<br>Max Rectangular Volume |
| 19.9 sq. ft. (1.85sq. m)<br>Single Bay<br><br>18.7 sq. ft. (1.74 sq. m)<br>Double Bay | FRONT OPENING FOR PAYLOADS | 15.8 sq. ft. (1.47 sq. m)<br>Single Bay<br><br>15.0 sq. ft. (1.39 sq. m)<br>Double Bay |
| EIA-RS-310-C | FRONT PANEL MOUNTING STANDARD | EIA-RS-310-C |
| 17.73 in. (450.34 mm)<br>Single Bay<br><br>37.73 in. (958.34 mm)<br>Double Bay | FRONT FLANGE OPENING | 17.75 in. (450.85 mm)<br>Single Bay<br><br>37.5 in. (952.5 mm)<br>Double Bay |
| 1250 lbs. (567 kg) | LOAD CARRYING CAPABILITY | 882lbs. (400 kg) Standard<br>1534 lbs. (700 kg) Optional |

# TRANSITION OF SPACEHAB PAYLOADS TO SSF

## RACK COMPARISON SUMMARY

| SPACEHAB | | SPACE STATION FREEDOM |
|---|---|---|
| Rack Base, Front | UTILITY INTERFACE PANEL | Pass Through Panel inside Rack, Interface Panel on Rack Standoff |
| 1 kw (average) 2 kw (peak)<br>28 Volts DC | DC POWER | 3, 6, or 12 kw<br>120 Volts DC<br>User provides power conversion |
| 690 VA, 400 hz | AC POWER | None |
| 2, 4, 8, 16 kbps<br>(48 mbps optional)<br>User provides Dedicated Experiment Processor | COMMAND AND DATA | 16 mbps<br>(48 mbps total)<br>1553 Data Bus Standard<br>802.4 FDDI Optional<br>User purchases MDM<br>User Provides Dedicated Experiment Processor if required |
| 1 kw average per rack<br>2 kw total module | RACK AIR COOLING | 1.2 kw max per rack<br>3.6 kw total module |
| 1 kw | PAYLOAD WATER LOOP CAPACITY | 8 kw |
| 1.4 E-5 Torr<br>to<br>1.0 E-6 Torr | VACUUM | 10 E-3 Torr |

# Locker Capacity




| | English | Metric |
|---|---|---|
| Mass: | | |
| Standard Accom | 42 lbs | 20.9 kg |
| Design Limit | 60 lbs | 27.2 kg |
| C.G.: | 14 in* | 35.6 cm |
| Volume: | | |
| Entire Locker | 2.0 ft3 | 0.057 m3 |
| Small Tray | 0-.9 ft3 | 0.025 m3 |
| Large Tray | 1.9 ft3 | 0.054 m3 |

Data: Accommodated through manifesting of compatible payloads.

D.C. Power
On Orbit: 115 W (Continuous)
180 W (Peak) for TBD Min
@ 28 +/-4 VDC

Ascent/Descent**

Cooling: Payload heat generation above 60W requires forced air cooling.

SPACEHAB had the capability of accommodating Middeck locker payloads without modification

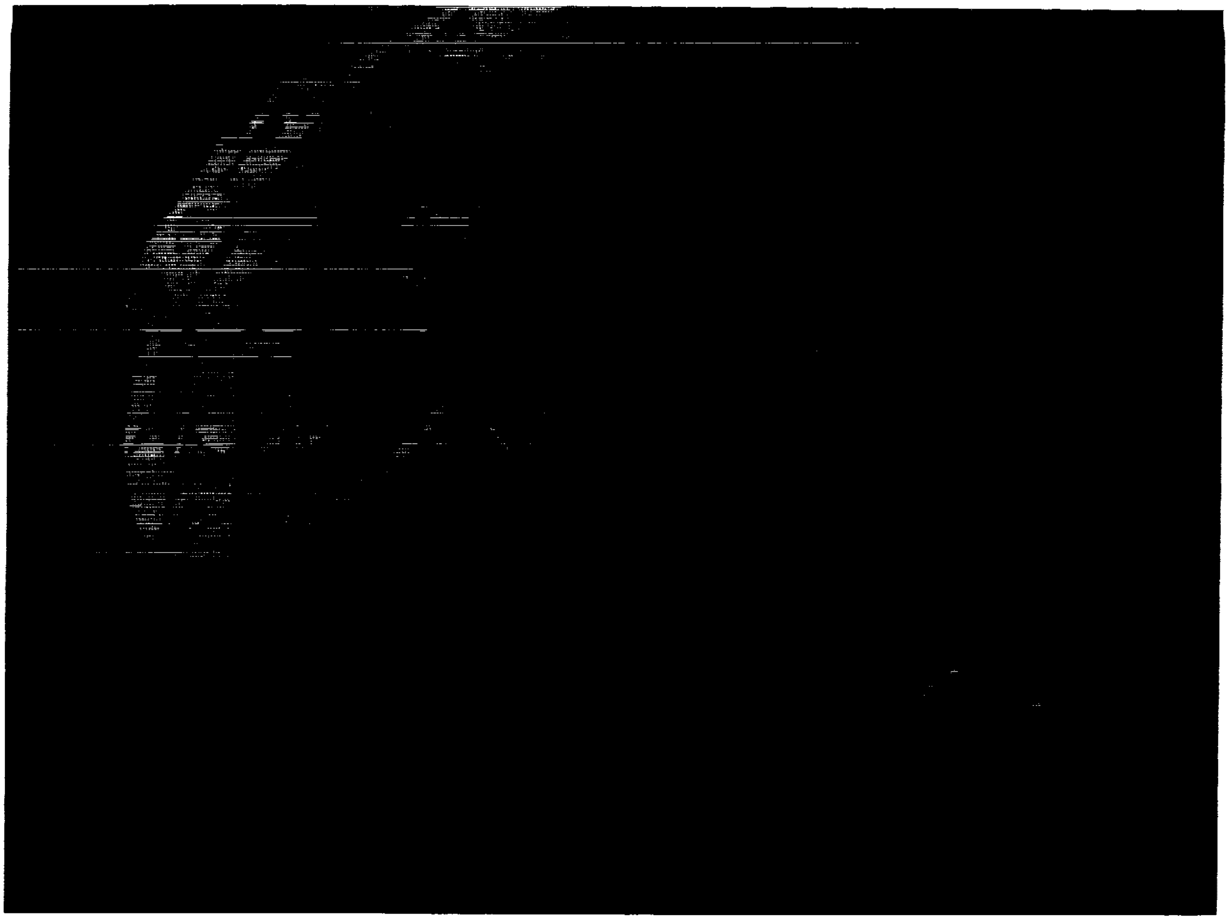


# Flight Schedule

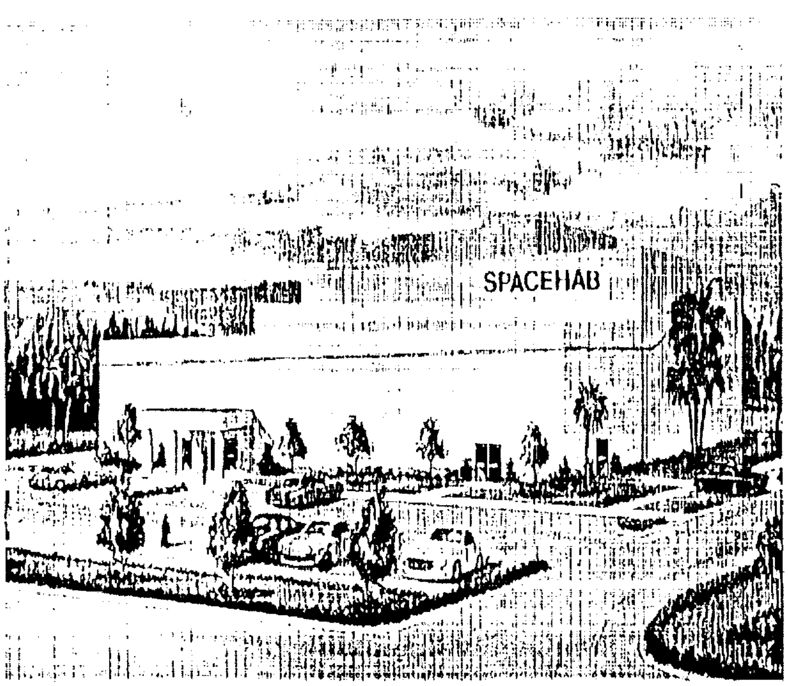
| | |
|---|---|
| Flight 1 | April 1993 |
| Flight 2 | October 1993 |
| Flight 3 | April 1994 |
| Flight 4 | October 1994 |
| Flight 5 | March 1995 |
| Flight 6 | August 1995 |

Subsequent Flights will be Scheduled to Satisfy Market Demands.

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



## SPACEHAB Payload Processing Facility (SPPF)




- **35,000** square feet of payload integration, test, training & support facilities
- **6,000** square feet of Customer Work Area (CWA), subdivided into industrial secure rooms
- **Shipping / Receiving** provided for receipt of hardware.
- **Clean Room** - 100K class conditions in shipping / receiving, CWAs, & integration hall
- **General** classrooms, conference rooms, copiers, and fax machine available for use on shared basis.
- **Availability** date: 3/1/91
- **Located** on commercial site near KSC.

## FLIGHTS OF U.S. COMMERCIAL PAYLOADS

| | PAYLOAD NAME | No. Of FLIGHTS | MISSION(S) |
|---|---|---|---|
| 1 | ASTROCULTURE | 1 | STS 50 |
| 2 | AUTOMATED GENERIC BIOPROCESSING APPARATUS | 2 | Consort 3, 4 |
| 3 | BIOMODULE | 2 | Consort 3, 4 |
| 4 | BIOSERVE INSTRUMENTATION MATERIALS DISPERSION APP. | 2 | STS 37, 43 |
| 5 | CONTINUOUS FLOW ELECTROPHORESIS (I, II, & III) | 7 | STS 4, 6, 7, 8, 12, 16, 23 |
| 6 | DEMIXING OF IMMISCIBLE POLYMERS MIXER | 2 | Consort 1, 3 |
| 7 | DIFFUSIVE MIXING OF ORGANIC SOLUTIONS | 2 | STS 14, 23 |
| 8 | DIRECTED POLYMERIZATION APPARATUS (USML-1 GBX exper.) | 1 | STS 50 |
| 9 | ELASTOMER-MODIFIED EPOXY RESINS HEATERS | 2 | Consort 1, 3 |
| 10 | ELECTRODEPOSITION CELLS | 4 | Consort 1, 3, 4, STS 40 (GAS 105) |
| 11 | EQUIPMENT FOR CONTROLLED LIQUID PHASE SINTERING | 1 | Consort 4 |
| 12 | FLUID EXPERIMENT APPARATUS | 2 | STS 30, 32 |
| 13 | FOAM-FORMATION DEVICE | 2 | Consort 1, 3 |
| 14 | GELATION OF SOLS: APPLIED MICROGRAVITY RESEARCH | 1 | STS 42 |
| 15 | GENERIC BIOPROCESSING APPARATUS | 1 | STS 50 |
| 16 | PROTEIN CRYSTAL GROWTH (Hand-Held, VDA, PCF, CRIM, GBX) | 14* | STS 16, 19, 23, 24, 26, 29, 32, 31, 37, 43, 48, 42, 50 |
| 17 | INVESTIGATIONS INTO POLYMER MEMBRANE PROCESSES | 2 | Consort 3, 4 |
| 18 | INVESTIGATIONS INTO POLYMER MEMBRANE PROCESSING | 7 | STS 31, 41, 43, 48, 42, 45, 50 |
| 19 | MATERIALS DISPERSION APPARATUS | 3 | Consort 1, 3, 4 |
| 20 | METAL SINTERING FURNACE | 1 | Consort 1 |
| 21 | NON-LINEAR OPTICAL CRYSTAL GROWTH (DAN) - UAH/IBM | 1 | STS 40 (GAS 105) |
| 22 | NON-LINEAR OPTICAL CRYSTAL GROWTH (NCA) - UAH/TBE | 1 | STS 40 (GAS 105) |
| 23 | PHYSICAL VAPOR TRANSPORT OF ORGANIC SOLIDS | 2 | STS 20, 26 |
| 24 | PHYSIOLOGICAL SYSTEMS EXPERIMENTS | 1 | STS 41 |
| 25 | PLASMA PARTICLE GENERATION | 1 | Consort 3 |
| 26 | POLYMER CURING EXPERIMENT | 1 | Consort 4 |
| 27 | POLYMER MORPHOLOGY | 1 | STS 34 |
| 28 | POLYMER THIN FILMS | 2 | Consort 3, STS 40 (GAS 105) |
| 29 | SEPARATION OF AQUEOUS PHASES | 1 | STS 40 (GAS 105) |
| 30 | SPACE FORMED STRUCTURAL BEAM (Foam Formation Device) | 1 | Consort 4 |
| 31 | YEAST EXPERIMENT | 1 | STS 40 (GAS-105) |
| 32 | ZEOLITE CRYSTAL GROWTH | 1 | STS 50 |
| | 32 TOTAL PAYLOAD HARDWARE ITEMS | 73 | TOTAL NUMBER OF PAYLOAD FLIGHTS** |

16-Jul-92

* The Protein Crystal Growth experiments were shared between the OCP and OSSA

** A payload-flight = one flight of one payload. Therefore, one flight with 3 payloads = 3 payload-flights

Shuttle - 48
Consort - 25
73

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## SSF RESOURCE ALLOCATIONS

FREEDOM

| | NASA U.S.A. | MOSST Canada | ESA Europe | STA Japan |
|---|---|---|---|---|
| Utilization Resources | 71.4% | 3% | 12.8% | 12.8% |

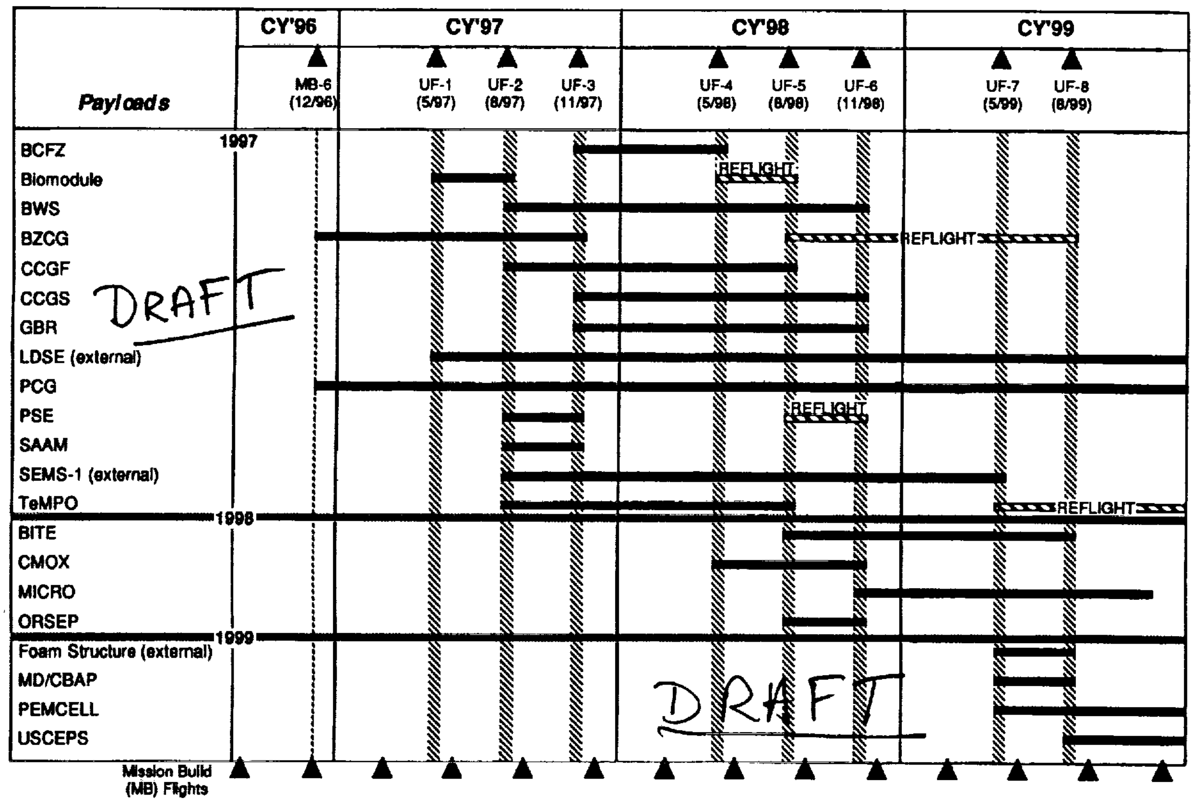
| | |
|---|---|
| OSSA - Science: | 65%* |
| OCP - Commercial: | 35%* |
| OAST - Technology: | 15%* |
| OSF/OSSD - Other: | 10%* |

* Utilization planning guidelines allow the total resources used by NASA's User Sponsors to equal 125%, for the launch minus 5 year timeframe.

**1997 OCP SSF Resources**

- Pressurized Up Mass: 4,352 kg
- Pressurized Down Mass: 3,784 kg
- Unpressurized Up Mass: 4,209 kg
- Unpressurized Down Mass: 7,073
- Volume Up: 9.5 DRE
- Volume Down: 7.1 DRE
- Power: 3 kW
- Downlink: 10,472 kb/s
- Crew Time: 436 hours
- Data Storage: 92 Mbytes
- Racks Occupied On-Orbit: 5 DRE
- Truss Attach Points: 0.7 APs

## DRAFT OCP FLIGHT MANIFEST FOR SSF




OFFICE OF COMMERCIAL PROGRAMS

SPACE STATION FREEDOM

## The Office of Commercial Programs is Producing

- ***A body of applications-oriented scientific knowledge***
- ***An experience base in payload flight hardware development and integration***
- ***A complement of payload hardware***
- ***Transportation systems and carriers***

**that will allow us to transition to Space Station Freedom**