SPACEHAB

Mr. David Rossi
Vice President
Spacehab, Inc.

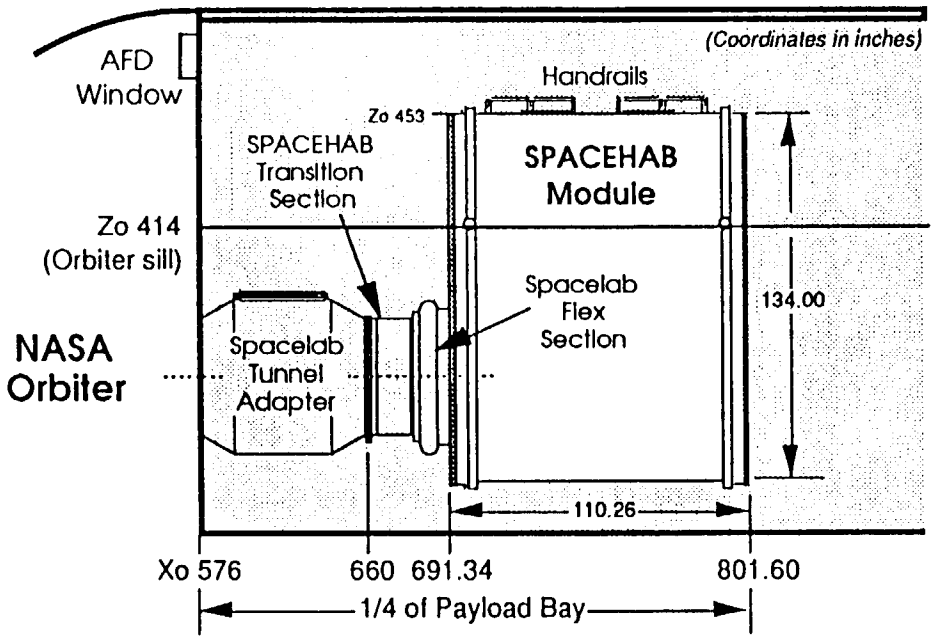
- SPACEHAB, Inc. Is Developing a Pressurized Module to Be Carried Aboard the Space Shuttle which Augments the Shuttle's Capability to Support Man-Tended Microgravity Experiments
- SPACEHAB Augmentation Modules Are Designed to Duplicate the Resources, Such as Power, Environmental Control, and Data Management, That Are Available in the Shuttle's Middeck
- Supported by a Highly Experienced Industry Team, SPACEHAB Is Dedicated to Providing Frequent, Affordable, and Streamlined Access to the Microgravity Environment

- SPACEHAB Is a Program Management, Marketing, and Financing Company That Was Formed in 1984
- Headquartered in Washington, D.C., SPACEHAB Is Managed by an Experienced Group of Space Industry Executives
- Responsible for Marketing Augmentation Module Services in the U.S., SPACEHAB also Directs a Team of International Marketing Organizations
- SPACEHAB Recently Completed a Financing Package Which Assures That Development and Production of the Augmentation Modules Will Be Completed by Late-1991

COMPANY FINANCING

- SPACEHAB Is a Privately Held Company Funded by Equity and Long-Term Debt
  - U.S. Shareholders and Investors in Japan, Taiwan, and Europe Contributed More Than $30 Million in Equity to Date
  - Major Subcontractors Have Provided Over $12 Million of Subordinated Debt and Equity
  - Chase Manhattan Bank Recently Provided a $64 Million Credit Facility

- SPACEHAB Middeck Augmentation Modules provide:
  - Approximately 31.1 cubic meters of additional man-tended pressurized payload accommodations
  - Up to 1360 Kg of combined payload mass allocated between 50 Middeck Locker Volume Equivalent (MLVE) payloads
  - Standard payload interfaces compatible with Orbiter middeck lockers and Spacelab and Space Station racks
  - Power, thermal control, and command/data functions to payloads on a pro rata basis
  - Simplified integration procedures and documentation and minimal lead time commitment of hardware and personnel



Side View

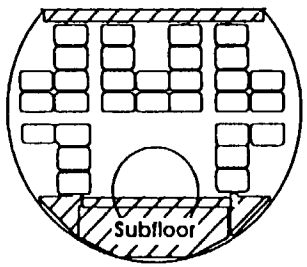
The SPACEHAB truncated module configuration was patented in 1989.

Module:

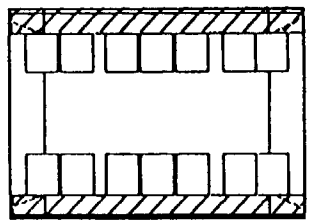
- Characteristics:

	English	Metric
- Length	9.2 ft	28.0 m
- Height	11.2 ft	34.1 m
- Diameter (truncated)	13.5 ft	41.1 m
- Total weight	10,584.0 lb	4800.8 kg

- Allows clearance for EVA with Orbiter payload bay doors closed
- Other features:
  - Flat bulkheads
  - Subsystems mounted in subfloor
  - Volume for two crew operations



Cross Section



Top View

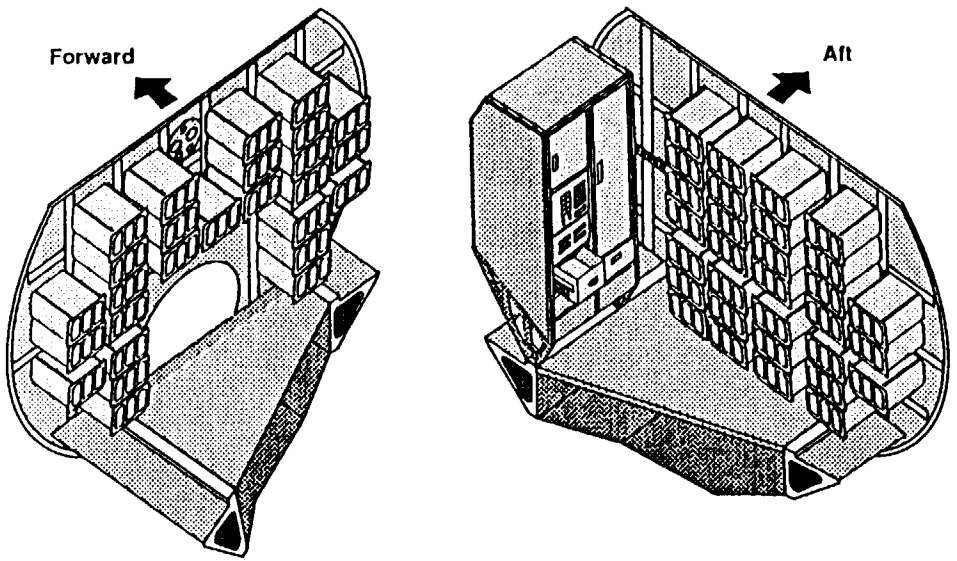
CONFIGURATIONS

All Locker Configuration

61 lockers (max)

Rack & Locker Configurations

1 rack / 51 lockers (max)
2 racks / 41 lockers (max)



TOTAL PAYLOAD RESOURCES

	English	Metric
Mass:	3000 lb	1360 kg
Volume:	1100 ft3	31.1 m3
Power:		
DC*:	1400 or 3150 W	
Asc/Des	300 - 625 W	
AC:	690 VA	
Cooling:		
Total:	4000 W	
Air:	1400 - 2000 W	
*Water***:*	4000 W (if all cooling is water)	
Crew:	2	

Other:

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

* Power dependent on number of Orbiter SMCHs provided.
** Maximum water cooling level includes 2 kW plus whatever air capability is not used.

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

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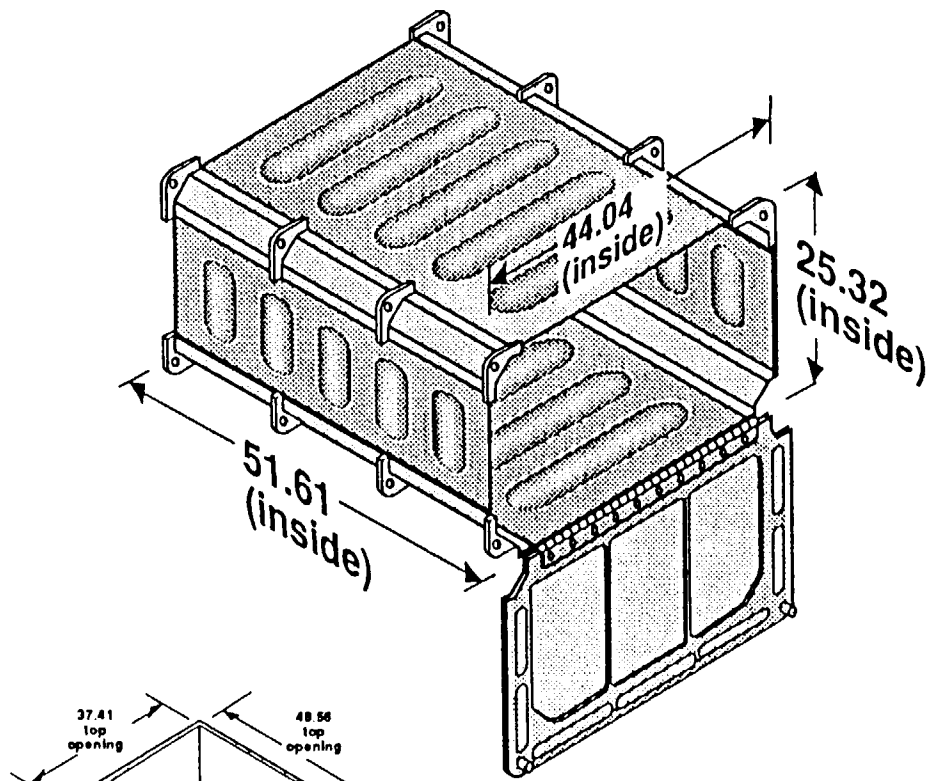
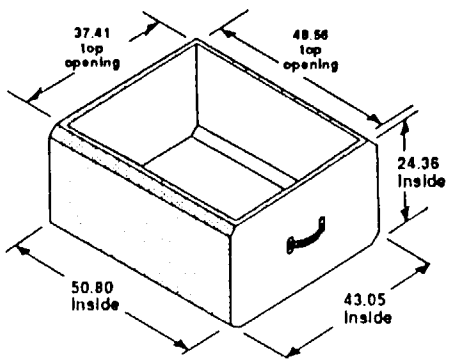
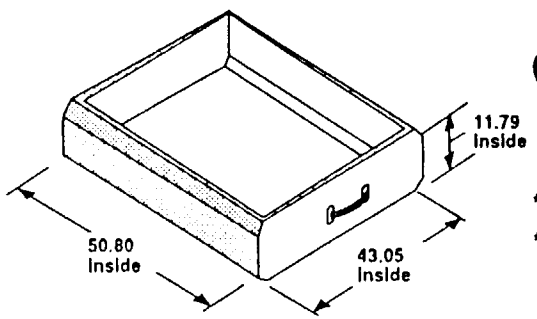
LOCKER ACCOMMODATIONS







Mass:	English	Metric
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.

DC Power:

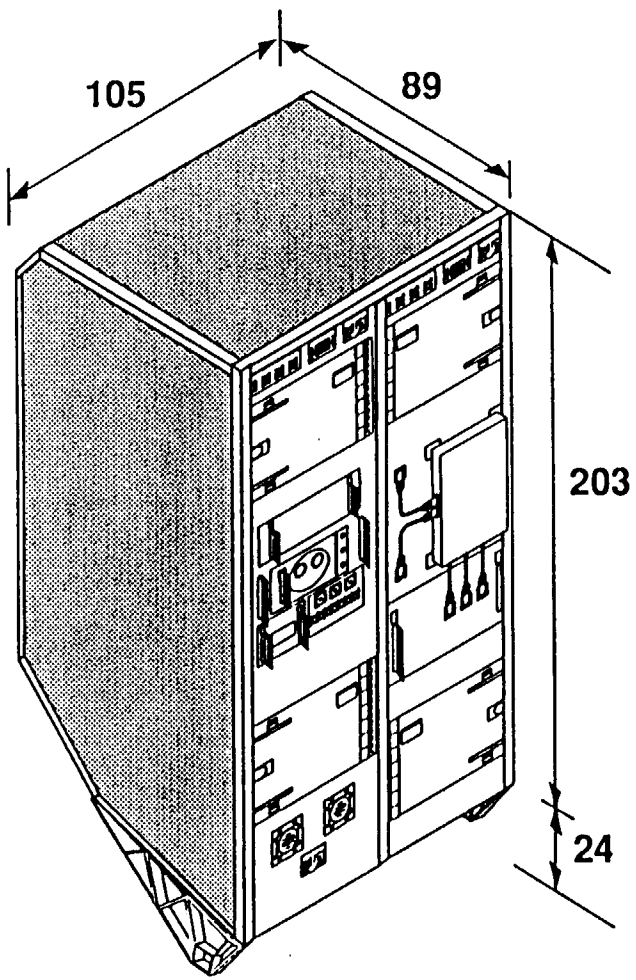
On-orbit: 115 W (Continuous)
180 W (Peak) for TBD min
@ 28 +/- 4 VDC

*Ascent / Descent***:* available

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

* From locker rear panel
** Optional resource

RACK ACCOMMODATIONS



	English	Metric
Mass:		
Standard Accom.	800 lbs	362.9 kg
Design Limit	1250 lbs	567.0 kg
Volume:	45.0 ft3	1.27 m3

Data: Accommodated through manifesting of compatible payloads.

DC Power:

On-orbit: 1000 W (Continuous)
2000 W (Peak) for 15 min
@ 28 +/- 4 VDC

Ascent / Descent:* available

AC Power*: available

Cooling:

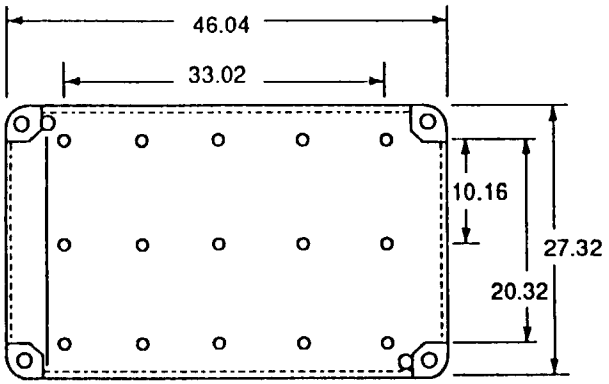
Forced Air: 2000 W (all payloads)
Water:* 1000 W (per rack)

Vacuum Vent*: available**

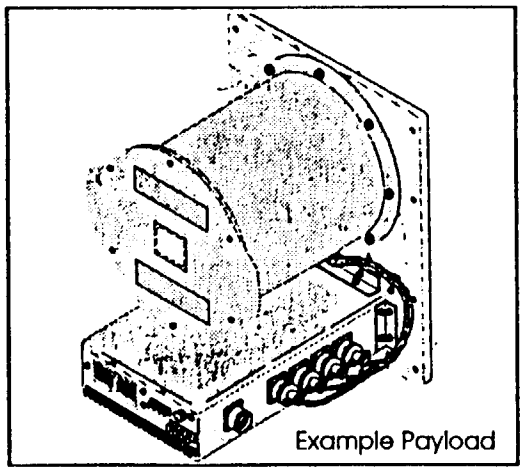
* Optional resource

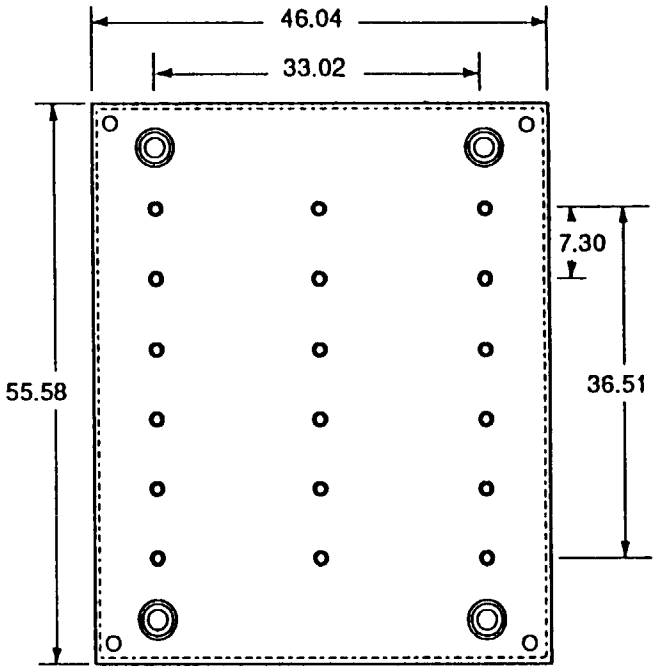
** Venting level is dependent on Orbiter altitude and mission-dependent line routing

ADAPTER PLATE MOUNTING



Single Adapter Plate





Double Adapter Plate

- Payloads can mount directly to optional adapter plate, replacing locker(s).
- Resource allocation would be the same as for standard locker(s).
- Payload must not violate mass, C.G. and envelope of locker(s) replaced.
- Adapter plate included in total mass accommodation.

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ACCOMMODATIONS SUMMARY

ACCOMMODATION	SPACEHAB			REMARKS
	Total	Locker	Rack	
WEIGHT [lbm (kg) payload]	3000 (1360)	60 (27.2)	1250 (567)	Maximum weight per unit
VOLUME [cu. ft. (cu. m)]	1100 (31.1)	2 (0.057)	45 (1.27)	Usable interior volume per unit
POWER DC (W) Ascent / Descent (W) AC (VA)	 1400 or 3150 300 - 625 690	 115 available available	 1000 available available	 Total power dependent on number (1 or 2) NSTS SMCHs available Derived from DC power
HEAT REJECTION (W) Passive Air Forced Air Water Ascent / Descent	4000 (total) 1400 - 2000 4000 (if all water) 300 - 400**	 60 user-provided	 2000* 1000	 Nominal locker capability Rack experiments are air surface-cooled. Cooling constrained by Orbiter
VACUUM VENTING	1 Vent & Line	available	interface at each rack	Capability dependent on system
DATA Serial Input/Output Acquisition Channels Discrete Input Low (0-5V) Discrete Input High (0-28V) Analog Input High (0-5V) Telemetry Downlink Rate via PDI (kbps) Closed Circuit Television Timing Orbiter GMT Signal Orbiter MET Signal Ku-band Signal Processor	 4 60 60 75 8, 16 Ch. - user video 1 1 1	 Mission Dependent Mission Dependent Mission Dependent Mission Dependent 8*, 16* Mission Dependent Mission Dependent Mission Dependent Mission Dependent	 1 15 15 25 8*, 16* 1 1 1 1	 Minimum rack level based on locker rqmts; 2 rack level available to 1 rack on mission- unique basis. Includes subsystem data Orbiter CCTV; Camcorder Orbiter Payload Timing Buffer Interface, additional signals mission-dependent 48 Mbps
MICROGRAVITY LEVEL	Mission Dependent			

* Total module capability

** A level of 625 W is mission dependent

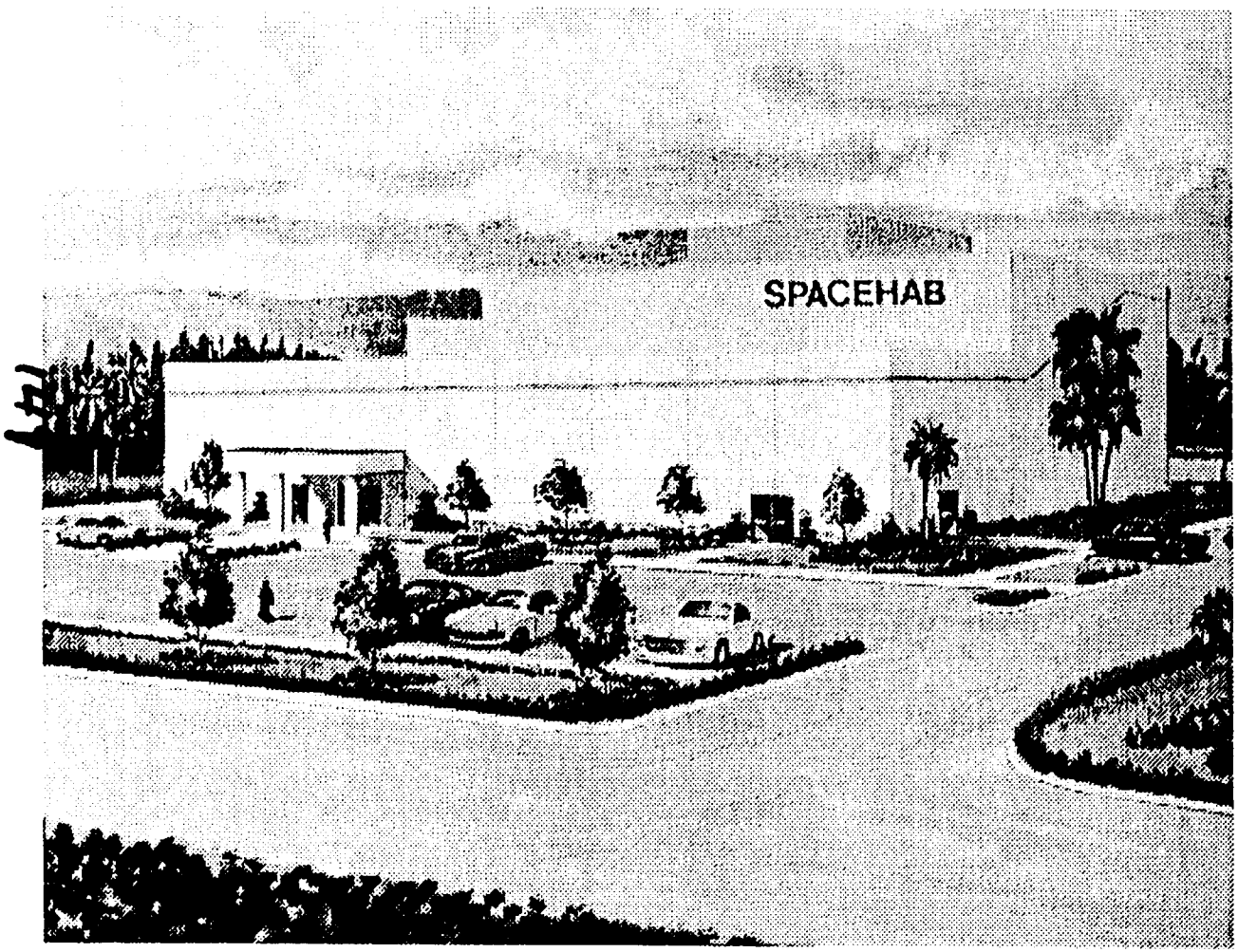
Some of the accommodations above are optional services.

- SPACEHAB Has Successfully Achieved All Initial Programmatic Milestones
  - Two Flight Modules and One Structural Test Module Are Currently in Production
  - Eight SPACEHAB Missions Are Manifested on Shuttle Flights Through 1996
  - Generic Interface Control Documentation (ICD), Payload Integration Plan (PIP), and Phase O and Phase 1 Safety Reviews Completed
  - SPACEHAB's Assembly and Integration Facility (Located Near NASA-KSC) Due for Completion in Late 1991

SYSTEM ADVANTAGES

- Streamlined Payload Integration Process
  - Reservation Required 24 Months Prior to Launch
  - Payload Definition Required 18 Months Prior to Launch
  - Minimal Documentation Requirements
- Limited Dedication of Experiment Hardware & Personnel
  - Hardware Delivery Required 12 Months Prior to Launch
- Frequent Manifested Flight Opportunities
  - Six-Month Experiment Re-Flight Possibilities
  - Additional Missions Will Be Added to Meet Demand
- Dedicated Mission Cost of $77 Million (1991 Dollars) for 3,000 Pounds of Payload

SPACEHAB Payload Processing Facility (SPPF)

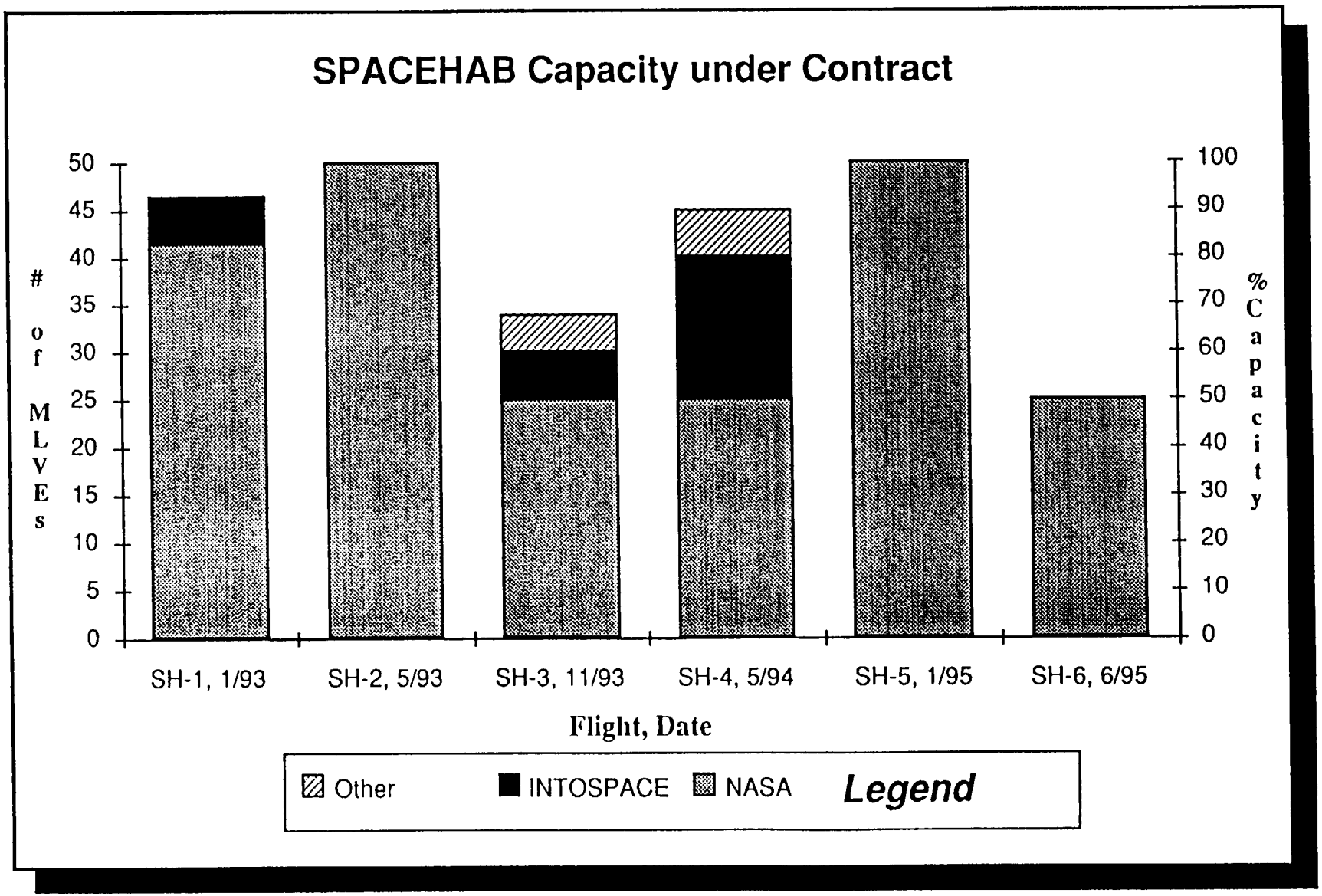


- **35,000** square feet of payload integration, test, training & support facilities
- **6,000** square feet of Customer Work Area (CWA), subdivided into industrial secure rooms
- **Shipping / Receiving** provided for receipt of hardware.
- **Clean Room** - 100K class conditions in shipping / receiving, CWAs, & integration hall
- **General** - classrooms, conference rooms, copiers, and fax machine available for use on shared basis.
- **Availability** date: mid 1991
- **Located** on commercial site near KSC.

USE CONTRACTS

- NASA Code C Selected SPACEHAB as the Commercial Middeck Augmentation Module (CMAM) Service Provider
  - $184 Million, Five-Year Contract Is for Lease and Integration Services for 200 Middeck Locker Volume Equivalent (MLVE) Payloads
  - Services to Be Provided Over the First Six Missions
- Use Contracts Have Been Signed with INTOSPACE, state-affiliated Organizations in Virginia and Florida, and the Government of Canada
- Use Proposals Being Evaluated by Several European and Asian Space Organizations

MISSION RESERVATION STATUS



MISSION ONE STATUS

- SPACEHAB Mission One Currently Manifested for a Late-1992 Launch
- Mission One-Specific ICD and PIP Signed
- Phase 1 Safety Reviews Scheduled for June
- Ascent/Descent Power Allocation Provided by NASA
- NASA Code C Candidate Payloads Identified and Mission Assessment Process Initiated

CODE C CANDIDATE PAYLOADS

Sponsor	Acronym	Payload Name	Mass (lb)	Volume (MLVE)	Ascent Power (W)	Late Access (min)	Average On-orbit DC (W)
3M	GOSAMR	Gelation of Solids: Advanced Microgravity	67.5	1.0	0	0	0
	PM	Polymer Morphology	200.0	3.3	0	0	267
Battelle	IPMP	Investigations into Polymer Membranes Processing	60.0	1.0	0	10	0
	SCG	Solution Crystal Growth	20.0	1.0	0	5	0
	ZCG	Zeolite Crystal Growth	120.0	3.0	0	30	91
Bioserve	BMDA	Bioserve Materials Dispersion Apparatus	70.0	1.0	45	45	45
	CGBA	Commercial Generic Bioprocessing Apparatus	120.5	2.0	50	45	110
Boeing	CVTE	Crystals by Vapor Transport Experiment	453.0	8.3	0	0	830
Clarkson	LEMZ-1	Liquid Encapsulated Melt Zone of Indium	140.0	2.0	0	0	80
LeRC	SAMS	Space Acceleration Measurement System	65.0	1.0	0	0	0
Penn State	PSE	Physiological Systems Experiment	156.0	2.0	34	70	46.5
	PSB	Penn State Biomodule	70.0	1.0	0	5	0
UAB	PCFB	Protein Crystal Growth - Batch	69.0	2.0	110	45	110
	FDB	Protein Crystal Growth - FDB	46.0	0.6	0	5	0
	TES	Thermal Enclosure System	122.0	2.0	110	45	110
UAH	OS	Organic Seperation	55.0	1.0	60	70	60
	SEF	Space Experiment Facility	500.0	8.3	0	30	885
Wisconsin	ASC-2	Astroculture	70.0	1.0	0	20	100
		Totals	2404.0	41.5	409	425	2734.5
		MARGIN	596.0				

SPACE STATION TRANSITION

- Up to 50% of Space Station Payloads May Be Provided by NASA Code C
- SPACEHAB's Short Payload Integration Schedule and Frequently Manifested Missions May Provide an Economical Means to Develop and Transition Code C Payloads to the Space Station
- NASA Requested CMDS to Conduct Evaluation of SPACEHAB Capabilities
  - Interface Control
  - Payload Packaging and Transfer
  - Docking and Berthing
- CMDS Subcommittee Formed and Final Plan to Be Presented at June Annual Meeting