NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-57

PRESS KIT
JUNE 1993

SPACEHAB/EURECA RETRIEVAL MISSION

STS-57 INSIGNIA

STS057-S-001 -- *Designed by the crewmembers, the STS-57 insignia depicts the space shuttle Endeavour maneuvering to retrieve the European Space Agency's microgravity experiment satellite EURECA. Spacehab, the first commercial space laboratory, is depicted in the cargo bay, and its characteristic shape is represented by the inner red border of the insignia. The three gold plumes surrounded by the five stars trailing EURECA are suggestive of the U.S. astronaut logo. The five gold stars together with the shape of the orbiter's mechanical arm form the mission's numerical designation. The six stars on the American flag represent the U.S. astronauts who comprise the crew. With detailed input from the crewmembers, the final artwork was accomplished by artist Tim Hall.*

The NASA insignia design for space shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize. Public availability has been approved only in the form of illustrations by the various news media. When and if there is any change in this policy, which we do not anticipate, it will be publicly announced.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

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FIRST SPACEHAB FLIGHT HIGHLIGHTS STS-57 SHUTTLE MISSION

The beginning of a new era in the commercial development of space and the retrieval of a European satellite highlight NASA's Shuttle Mission STS-57. The mission, scheduled for early June 1993, also will see Space Shuttle Endeavour and her six-person crew use experiments designed by and for students, operate a payload which may improve crystal growth techniques and demonstrate possible on-orbit refueling techniques.

A rendezvous with the European Space Agency's European Carrier (EURECA) satellite is scheduled to take place on the fourth day of the mission. The Shuttle's robot arm will be used to grapple the satellite. It then will be lowered into Endeavour's cargo bay and stowed so it can be returned to Earth. The EURECA satellite has been on-orbit collecting data since its deployment during Shuttle Mission STS-46 in July 1992.

On STS-57, NASA will be leasing a privately-developed mid-deck augmentation module known as SPACEHAB. The primary objective is to support the agency's commercial development of space program by providing additional access to crew-tended, mid-deck locker or experiment rack space. This access is necessary to test, demonstrate or evaluate techniques or processes in microgravity.

NASA's secondary objective is to foster the development of space infrastructure which can be marketed by private firms to support commercial microgravity research payloads. In this instance, SPACEHAB, Inc., has the capability of leasing SPACEHAB facility space to other commercial customers on upcoming flights of the module.

The experiments flying inside this first SPACEHAB include investigations ranging from drug improvement, feeding plants, cell splitting, the first soldering experiment in space by American astronauts and high-temperature melting of metals.

Included are 13 commercial development of space experiments in material processing and biotechnology, one NASA biotechnology experiment and five other NASA investigations related to human factors and the Endeavor's environment and a space station environmental control system test.

Three other payloads, the Get Away Special (GAS), the Consortium for Materials Development in Space Complex Autonomous Payload-IV (CONCAP-IV) and the Superfluid On-Orbit Transfer (SHOOT) payload will be carried in Endeavour's cargo bay.

The GAS system, which has flown many times on the Space Shuttle, allows individuals and organizations around the world access to space for scientific research. During the STS-57 mission, 10 GAS payloads from the United States, Canada, Japan and Europe will perform a variety of microgravity experiments.

The CONCAP-IV payload is the fourth area of investigation in a series of payloads. It will investigate the growth of nonlinear organic crystals by a novel method of physical vapor transport in the weightlessness of the space environment. Nonlinear optical materials are the key to many optical applications now and in the future with optical computing being a prime example.

The SHOOT payload is designed to develop and demonstrate the technology required to re-supply liquid helium containers in space. Because so little experience exists with cryogen management in microgravity, SHOOT is designed to gather data about how the liquid feeds to pumps, the behavior of the liquid/vapor discriminators and the slosh and cool down of the liquid.

Middeck Experiments

Two experiments which previously have flown aboard the Shuttle will be carried in Endeavour's middeck area. The Fluid Acquisition and Resupply Experiment (FARE), which last flew on Shuttle Mission STS-53 in November 1992, will continue to investigate the fill, refill and expulsion characteristics of simulated propellant tanks. It also will study the behavior of liquid motion in microgravity.

The Air Force Maui Optical System (AMOS) is an electro-optical facility located on the Hawaiian Island of Maui. The primary objectives of AMOS are to use the orbiter during flights over Maui to obtain imagery and/or signature data from the ground-based sensors.

Spacewalk on STS-57

STS-57 crew members David Low and Jeff Wisoff will perform a 4-hour extravehicular activity (EVA) on the fifth day of the flight as a continuation of a series of spacewalks NASA plans to conduct to prepare for construction of the space station.

The spacewalk tests, the first of which was performed on STS-54 in January 1993, are designed to refine training methods for spacewalks, expand the EVA experience levels of astronauts, flight controllers and instructors, and aid in better understanding the differences between true weightlessness and the ground simulations used in training.

In addition, since the Shuttle's remote manipulator system mechanical arm will be aboard Endeavour to retrieve EURECA, the STS-57 spacewalk will assist in refining several procedures being developed to service the Hubble Space Telescope on mission STS-61 in December.

Education

NASA's on-going educational efforts will be represented by two payloads. The Get-Away Special (GAS) #324 - CAN DO experiment is designed to take 1,000 photos of the Earth allowing students to make observations and document global change by comparing the CAN DO photos with matched Skylab photos.

The primary payload of CAN DO, known as GEOCAM, contains four Nikon 35 mm cameras equipped with 250 exposure film backs. The GEOCAM system will match closely the larger Skylab film format in both coverage and quality allowing direct examination and comparison of the changes that have occurred to the planet in the last 20 years. The canister also contains 350 small, passive, student experiments.

STS-57 crew members will take on the role of teacher as they educate students from around the world about their mission objectives and what it is like to live and work in space by using the Shuttle Amateur Radio Experiment (SAREX) experiment. Brian Duffy and Janet Voss will operate SAREX. Operating times for school contacts are planned into the crew's activities.

Mission Summary

Leading the six-person STS-57 crew will be Mission Commander Ronald Grabe who will be making his fourth space flight. Pilot for the mission is Brian Duffy, making his second flight. Leading the science team will be Payload Commander David Low who also is designated as Mission Specialist 1 (MS1) and is making his third flight. The three other mission specialists for this flight are Nancy Sherlock (MS2), Jeff Wisoff (MS3) and Janice Voss (MS4), all of whom will be making their first flight.

The mission duration for STS-57 is planned for 6 days, 23 hours, 19 minutes. However, the mission may be extended by 1 day immediately after launch if projections calculated at that time for energy and fuel use during the EURECA rendezvous permit. If for some reason STS-57 remains a 7-day flight, the extravehicular activity scheduled for flight day five would be canceled. The STS- 57 mission will conclude with a landing at Kennedy Space Center's Shuttle Landing Facility.

This will be the fourth flight of Space Shuttle Endeavour and the 56th flight of the Space Shuttle system.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

STS-57 MEDIA SERVICES INFORMATION

NASA Select Television Transmission

NASA Select television is available on Satcom F-2R, Transponder 13, located at 72 degrees west longitude; frequency 3960.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Ames-Dryden Flight Research Facility, Edwards, Calif.; Johnson Space Center, Houston and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483- 5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern time.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter.

Briefings

A mission press briefing schedule will be issued prior to launch. During the mission, status briefings by a Flight Director or Mission Operations representative and when appropriate, representatives from the science team, will occur at least once per day. The updated NASA Select television schedule will indicate when mission briefings are planned.

STS-57 QUICK LOOK

Launch Date/Site:	June 3, 1993/Kennedy Space Center - Pad 39A
Launch Window:	6:13 p.m. - 7:24 p.m. EDT
Orbiter:	Endeavour (OV-105) - 4th Flight
Orbit/Inclination:	250 nautical miles/28.45 degrees
Mission Duration:	6 days, 23 hours, 19 minutes
Landing Date:	June 10
Primary Landing Site:	Kennedy Space Center, Fla.
Abort Landing Sites:	Return to Launch Site - KSC, FL Trans-Atlantic Abort landing - Banjul, The Gambia Ben Guerir, Morocco Moron, Spain Abort Once Around - Edwards AFB, Calif.
Crew:	Ronald Grabe, Commander (CDR) Brian Duffy, Pilot (PLT) David Low, Payload Commander/Mission Specialist 1 (MS1) Nancy Sherlock, Mission Specialist 2 (MS2) Jeff Wisoff, Mission Specialist 3 (MS3) Janice Voss, Mission Specialist 4 (MS4)
Cargo Bay Payloads:	EURECA-1R (European Retrievable Carrier - Retrieval) SPACEHAB (Space Habitation Module) SHOOT (Super-fluid Helium On-Orbit Transfer) CONCAP-IV (Consortium for Materials Development in Space Complex Autonomous Payload-IV) GAS Bridge (Get-Away Special Bridge)
In-Cabin Payloads:	AMOS (Air Force Maui Optical Site) FARE (Fluid Acquisition and Resupply Experiment) SAREX-II (Shuttle Amateur Radio Experiment-II)

DTOs/DSOs:

DTO 412:	On-orbit Fuel Cell Shutdown
DTO 623:	Cabin Air Monitoring
DTO 700-2:	Laser Range, Range-Rate Device
DSO 603B:	Orthostatic Function During Entry, Landing and Egress
DSO 604 OI-1:	Visual Vestibular Integration as a Function of Adaptation
DSO 618:	Effects of Intense Exercise During Space Flight on Aerobic Capacity and Orthostatic Function
DSO 624:	Pre-Flight and Post-Flight Measurement of Cardiorespiratory Response
DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography

STS-57 VEHICLE AND PAYLOAD WEIGHTS

	Pounds
Orbiter (Endeavour) empty and 3 Shuttle Main Engines	173,023
Spacehab-1/support hardware	9,628
EURECA (berthed)	9,800
GAS bridge, cans	5,652
SHOOT/support hardware	3,570
FARE	126
SAREX-II	46
Total Vehicle at solid rocket booster Ignition	4,516,091
Orbiter Landing Weight	224,111

STS-57 SUMMARY TIMELINE

NOTE: The STS-57 mission is planned to be 6 days, 23 hours, 19 minutes long. However, it may be extended by 1 day immediately after launch if projections calculated at that time for energy and fuel use during the EURECA rendezvous permit. If STS-57 remains a 6-day (MET) flight, the extravehicular activity scheduled for flight day five would be canceled. Activities planned for the first four flight days would be unchanged. Flight control system checkout, reaction control system hot-fire and Spacehab deactivation would take place on flight day seven. Entry and landing would be on flight day eight.

The following is a schedule for the extended, 7-day, 23-hour (MET) mission:

Flight Day 1
Ascent
OMS-2 (251 n.m. x 169 n.m.)
Spacehab activation
Spacehab operations
NC-1 burn (251 n.m. x 174 n.m.)

Flight Day 2
Remote manipulator system checkout
Spacehab operations
SHOOT operations
Spacehab operations
NC-2 burn (251 n.m. x 178 n.m.)

Flight Day 3
SHOOT operations
Spacehab operations
NC-3 burn (251 n.m. x 184 n.m.)

Flight Day 4
EURECA retrieval
NSR burn (251 n.m. x 248 n.m.)
NH-4 burn (257 n.m. x 250 n.m.)
TI-burn (259 n.m. x 256 n.m.)
EURECA grapple
EURECA berth
Spacehab operations

Flight Day 5
Extravehicular activity preparations
Extravehicular activity (4 hours)

Flight Day 6
Spacehab operations
FARE operations

Flight Day 7
FARE operations

Flight Day 8
Spacehab operations
Flight control systems checkout
Reaction control system hot-fire
Spacehab deactivation
Cabin stow

Flight Day 9
Spacehab deactivation completed
De-orbit preparations
De-orbit burn
Entry
Landing

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, orbiter and its payload. Abort modes include:

- Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit around before landing at Edwards Air Force Base, Calif.

- Trans-Atlantic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Banjul, The Gambia; Ben Guerir, Morocco; or Moron, Spain.

- Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, and without enough energy to reach Banjul, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-57 contingency landing sites are the Kennedy Space Center, Edwards Air Force Base, Banjul, Ben Guerir and Moron.

STS-57 ORBITAL EVENTS SUMMARY (FOR 1-DAY EXTENDED MISSION)

Event	Start Time (dd/hh:mm:ss)	Velocity Change	Orbit (n.m.)
OMS-2	00/00:44:00	241 fps	251 x 169
NC-1(adjusts rate at which Endeavour is closing on EURECA)	00/05:21:00	8 fps	251 x 174
SH-1 (performed as part f Super Fluid Helium On-Orbit Transfer experiment)	00/22:18:00	3.4 fps	251 x 176
NPC (aligns Endeavour's orbit directly below EURECA's orbit)	01/03:04:00	6.2 fps	251 x 175
NC-2 (adjusts rate at which Endeavour is closing on EURECA)	01/04:28:00	4 fps	251 x 178
SH-2 (performed for the SHOOT experiment)	01/19:53:00	3.6 fps	251 x 180
SH-3 (performed as part of the SHOOT experiment)	01/21:26:00	3.6 fps	251 x 182
NC-3 (adjusts rate at which Endeavour is closing on EURECA)	02/03:36:00	4 fps	251 x 184
NSR (circularizes Endeavour's orbit)	02/19:03:00	109 fps	251 x 248
NH (adjusts altitude of Endeavour's orbit)	02/21:27:00	15 fps	257 x 250
NC-4 (adjusts rate at which Endeavour is closing on EURECA)	02/21:27:00	8.6 fps	258 x 255
TI (begins Endeavour's proximity operations with EURECA)	03/00:35:00	3.1 fps	258 x 256
GRAPPLE	03/02:50:00		259 x 256
DE-ORBIT	07/21:36:00	414 fps	
LANDING	07/23/19:00		

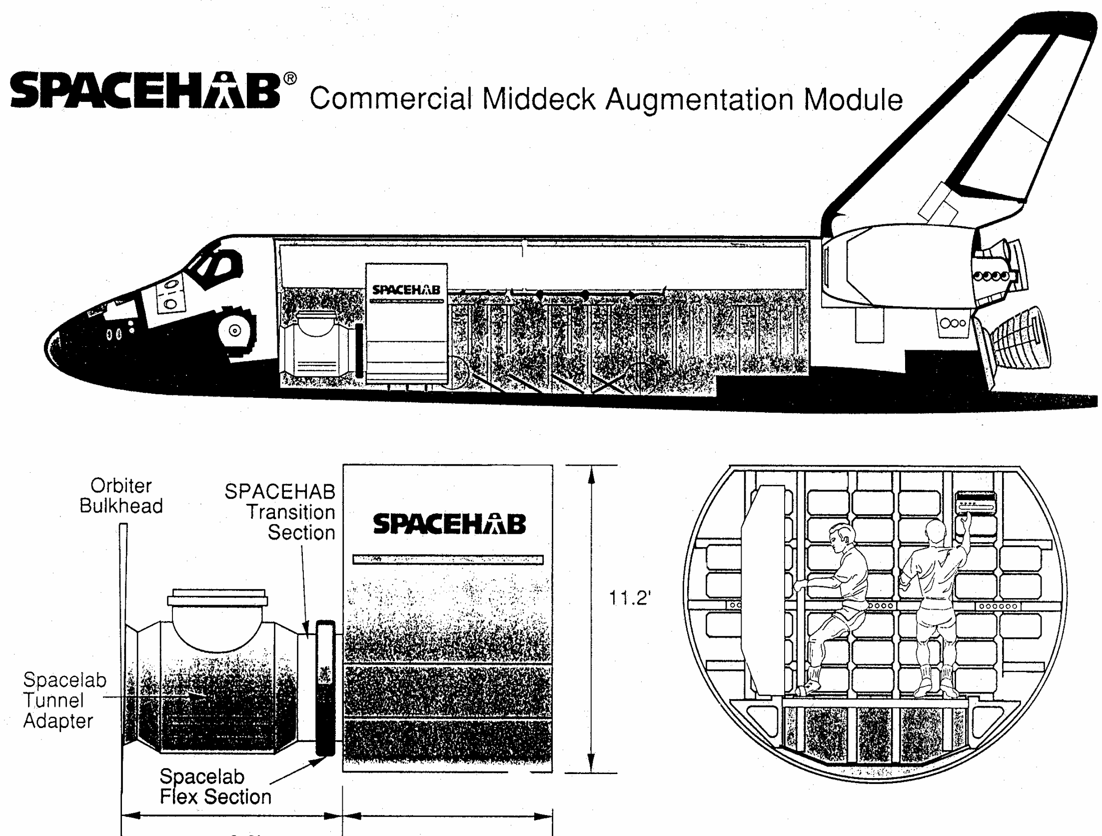
NOTE: Engine firings are likely to change slightly after launch as they are recalculated by flight controllers. In addition, some of the smaller firings may be deleted altogether if navigation information during the rendezvous allows. However, the time frame and other information regarding the larger burns is unlikely to change dramatically.

STS-57 CREW RESPONSIBILITIES

Task/Payload	Primary	Backup
EURECA-RMS	Low	Sherlock
EURECA systems	Sherlock	Duffy
EURECA rendezvous	Grabe	Duffy, Wisoff
EVA	Low, Wisoff	N/A
EVA-RMS	Sherlock	Voss
Spacehab systems	Low	Voss
SHOOT	Voss	Wisoff
FARE	Wisoff	Duffy
GBA	Sherlock	Grabe
SAREX	Duffy	Voss

SPACEHAB experiments:

ASPECS	Wisoff	Sherlock
BPL	Sherlock	Wisoff
CR/IM-VDA	Low	Voss
HFA: EPROC	Voss	Sherlock
HFA: Light, sound	Grabe	Duffy
HFA: Trans	Sherlock	Grabe
NBP	Duffy	Grabe
PSE	Grabe	Voss
SCG	Voss	Low
TES-COS	Voss	Grabe
APCF	Voss	Low
ASC-2	Sherlock	Duffy
CGBA	Wisoff	Voss, Low
CPDS	Voss	Low
3DMA	Voss	Low
ECLiPSE-HAB	Voss	Low
EFE	Low	Sherlock
GPPM	Voss	Low
IPMP	Grabe	
LEMZ-1	Voss	Wisoff
ORSEP	Voss	Low
SAMS	Voss	Low
ZCG	Voss	Low


SPACEHAB® Commercial Middeck Augmentation Module
SPACEHAB
Orbiter
Bulkhead
SPACEHAB
Transition
Section
SPACEHAB
Spacelab
Tunnel
Adapter
Spacelab
Flex Section
9.6'
9.2'
11.2'

SPACEHAB-01

Why The Need For SPACEHAB?

During the last decade, the commercial development of space became one of NASA's primary objectives, as directed by legislation and national policy. Through the many facets of its commercial development of space program, NASA has developed and maintains a high level of commitment to this objective. To that end, NASA has actively invested in the continued technological leadership of the United States and her future economic growth through the direct promotion and support of private sector space-related activities.

As a result of NASA's objective, in the late 1980's, its commercial development of space program identified a significant number of payloads to be flown to further program objectives. To viably sustain this program, the Office of Commercial Programs -- now the Office of Advanced Concepts and Technology (OACT) -- had to provide a level of flight activity necessary to support the various payload requirements.

In September 1989, the office conducted an analysis which revealed that planned Space Shuttle flight activity would not meet its needs for middeck-class accommodations. Mission experience has clearly demonstrated that the orbiter middeck is a very cost-effective area to conduct "crew-tended" scientific and commercial microgravity research. However, the size and number of experiments that can be accommodated in the middeck are severely limited and have conflicting requirements from Shuttle operations and other NASA programs.

To provide the necessary support for commercial development of space payloads, the Commercial Middeck Augmentation Module (CMAM) procurement was initiated in February 1990, through NASA's Johnson Space Center (JSC). Consequently, in November 1990, NASA awarded a 5-year contract to SPACEHAB, Inc., of Arlington, Va., for the lease of their pressurized modules, the SPACEHAB Space Research Laboratories. These laboratories provide additional space for "crew-tended" payloads as an extension of the Shuttle orbiter middeck into the Shuttle cargo bay.

This 5-year lease arrangement will cover several Shuttle flights and requires SPACEHAB, Inc., to provide for the physical and operational integration of the SPACEHAB Space Research Laboratories in the Space Shuttle orbiters, including experiments and integration services, such as safety documentation and crew training.

NASA's primary objective for leasing the SPACEHAB Space Research Laboratory is to support the agency's commercial development of space program by providing the access to space. This access is necessary to test, demonstrate or evaluate techniques or processes in the environment of space and thereby reduce risks to a more feasible level.

NASA's secondary objective is to foster the development of space infrastructure which can be marketed by private firms to support commercial microgravity research payloads. NASA is only partially using the SPACEHAB Space Research Laboratory multi-flight capacity, therefore, SPACEHAB, Inc., is marketing the additional portion to other commercial users. It is expected that significant commercial demand will result from the successful demonstration of SPACEHAB capabilities on this first flight.

SPACEHAB Accommodations

The SPACEHAB Space Research Laboratory is located in the forward end of the Shuttle orbiter cargo bay and is accessed from the orbiter middeck through a tunnel adapter connected to the airlock. SPACEHAB weighs 9,628 pounds, is 9.2 feet long, 11.2 feet high and 13.5 feet in diameter. It increases pressurized experiment space in the Shuttle orbiter by 1100 cubic feet, quadrupling the working and storage volume available. Environmental control of the laboratory's interior maintains ambient temperatures between 65 and 80 degrees Fahrenheit.

The laboratory has a total payload capacity of 3000 pounds and in addition to facilitating crew access, provides experiments with services such as power, temperature control and command/data functions. Other services, such as late access/early retrieval, also are available.

The SPACEHAB Space Research Laboratory can provide various physical accommodations to users based on size, weight and other requirements. Experiments are commonly integrated into the laboratory in Shuttle middeck- type lockers or SPACEHAB racks. The laboratory can accommodate up to 61 lockers, with each locker providing a maximum capacity of 60 pounds and 2.0 cubic feet of volume.

The laboratory also can accommodate up to two SPACEHAB racks, either of which can be a "double-rack" or "single-rack" configuration, but each rack used reduces the number of usable locker locations by 10 lockers. A "double- rack" provides a maximum capacity of 1250 pounds and 45 cubic feet of volume, whereas a "single-rack" provides half of that capacity. The "double-rack" is similar in size and design to the racks planned for use in the space station.

The use of lockers or racks is not essential for integration into the SPACEHAB Space Research Laboratory. Payloads also can be accommodated by directly mounting them on the laboratory.

SPACEHAB Operations Philosophy

By its very nature, the Office of Advanced Concepts and Technology (OACT) flight programs assume a certain level of risk in order to approach the payloads from the commercial standpoint, including payload development costs incurred by industry partners. Each of the investigators is aware of and accepts a self-established level of risk for mission success. However, crew and orbiter safety requirements are always fully met.

The preparations for the flight of SPACEHAB-1 have included the development of a number of backup and contingency operations for each payload appropriate to that payload's relative design simplicity. These backup procedures include scenarios which might possibly affect crew or orbiter safety and each payload has procedures associated with it and which the crew has been trained in which will deactivate and/or safe the payload.

The SPACEHAB-01 Payload Complement

From improving drugs to feeding plants, from cell splitting to intergalactic particles, from the first soldering experiment in space by American astronauts to high-temperature melting of metals, the SPACEHAB-01 payloads represent a wide range of space experimentation.

Included are 13 commercial development of space experiments in material processing and biotechnology, 12 of which are sponsored by NASA Centers for the Commercial Development of Space (CCDS) and one by the NASA Langley Research Center, Hampton, Va. There is one NASA biotechnology experiment and five other NASA investigations related to human factors and the Endeavour's environment. Finally, there is a space station environmental control system test and as supporting hardware, two accelerometers -- one from a CCDS and one from the NASA Lewis Research Center, Cleveland.

Each of the 13 commercial development of space payloads has been screened by OACT to review the viability of the commercial aspects of the proposed

activity as well as the technical soundness. Some of the SPACEHAB-01 CCDS payloads have flown on the Shuttle before, with the SPACEHAB-01 flight representing the continuation of industry-driven research toward a new or improved commercial product or process. Many of the CCDS payloads, including the

CCDS-sponsored accelerometer, have participated in the NASA OACT Consort series of suborbital sounding rocket flights to test hardware operation and gain flight worthiness.

The five investigations sponsored by the NASA Johnson Space Center, involving biotechnology and human factors, were included to assure full utilization of the first flight of the SPACEHAB Space Research Facility and have been reviewed for their support to commercial objectives. These experiments include equipment testing for future uses on the space station such as the first- ever American soldering experiment performed in space.

Also on-board the SPACEHAB Space Research Laboratory is an investigation sponsored by the NASA space station office in Reston, Va., on closed systems to improve water recycling in the future space station environment.

The experiments, housed in the SPACEHAB Space Research Laboratory on this its maiden voyage to space, represent a tremendous effort by government and industry to stretch the possibilities of space as the final frontier -- an effort focused on fostering economic growth.

NASA Centers for the Commercial Development of Space

The CCDS program is the cornerstone of NASA's commercial development of space activities, generating 13 of the 21 total flight hardware packages on this SPACEHAB Space Research Laboratory. NASA's nationwide CCDS network represents a unique example of how government, industry and academic institutions can create partnerships which combine resources and talents to strengthen America's industrial competitiveness.

The CCDSs are designed to increase private sector investment and interest in commercial space-related activities, while encouraging U.S. economic leadership and stimulating advances in promising areas of research and development. The CCDSs are based at universities and research institutions across the country and benefit from links with each other and with NASA field centers.

Since 1985, OACT has issued four proposal solicitations in various areas of promising space-related commercial research and development. From the solicitations, 17 centers have been established in eight industry-driven, space- based, high-technology research areas such as materials processing, biotechnology, remote sensing, communications, automation and robotics, space propulsion, space structures and space power.

NASA OACT provides annual funding of up to $1 million to each center, with additional funding to those centers to cover specific programs or flight activities, as appropriate. NASA offers the CCDSs its scientific and technical expertise through NASA field centers, opportunities for cooperative activities and other forms of continuing assistance. A key facet of the CCDSs is the additional financial and in-kind contributions from industry affiliates, state and other government agencies, which, on the average, exceed the NASA funding level.

Through creative and enterprising partnerships with industry, the CCDS program helps move emerging technologies from the laboratory to the marketplace with speed and efficiency. The accomplishments of CCDS participants include significant advances in a number of scientific fields and hundreds of Earth- and space-based applications.

As an incubator for future commercial space industries, the CCDS program, since its inception, has facilitated a number of new commercial space ventures and supported a wide range of ongoing efforts. The CCDS program continues to be the key facilitator for U.S. industry involvement in commercial development of space activities, encouraging and supporting new and ongoing space- related ventures, as well as spawning research and development advancements that promise enormous social and economic benefits for all.

1993 - The Year of Commercial Space

Since late 1988, 37 commercial development of space payloads have successfully flown on the Space Shuttle including the outstanding performance of four payloads as part of the first United States Microgravity Laboratory (USML- 1) mission in June 1992. Additionally, 27 commercial space research payloads have flown on several suborbital sounding rockets.

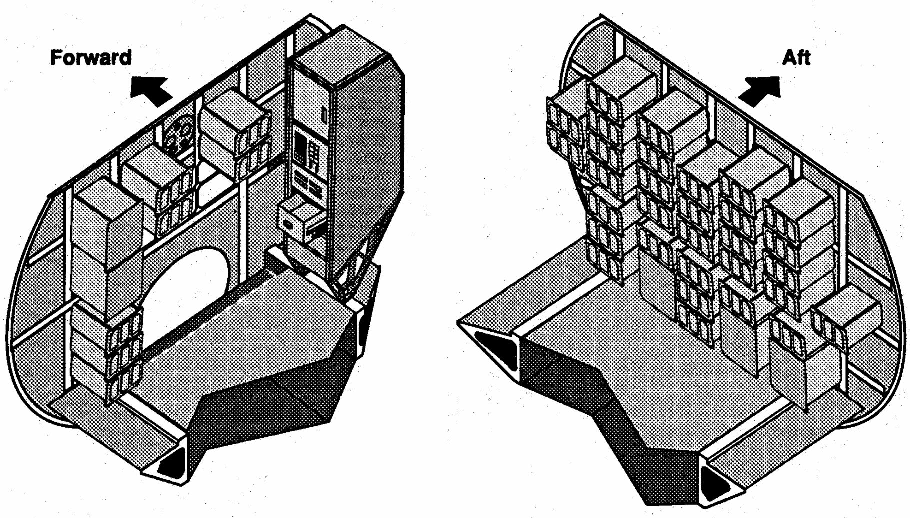
During 1993, 56 research payloads are planned, including those on the first two flights of the SPACEHAB Space Research Laboratory and the first flight of the Commercial Experiment Transporter (COMET). The same period also will mark the first flight of a commercial free-flyer research facility, the Wake Shield Facility, as well as several Space Shuttle secondary payloads and the launch of the Advanced Communications Technology Satellite (ACTS). Another suborbital sounding rocket flight in the Consort series already has been successfully accomplished with nine payloads on-board in February 1993.

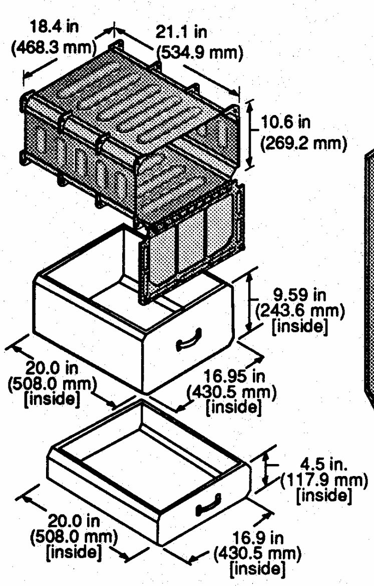
Two attributes of these innovative programs are the relatively small amount of federal funds expended and the low number of NASA personnel involved. The associated development of additional spaceflight services has spurred commercial space infrastructure capabilities while reducing a considerable backlog and reliance upon the Space Shuttle.

In citing 1993 as The Year of Commercial Space, Greg Reck, Acting Associate Administrator for the OACT said, "The success of the Centers for the Commercial Development of Space and their many industry and academic affiliates should be recognized."

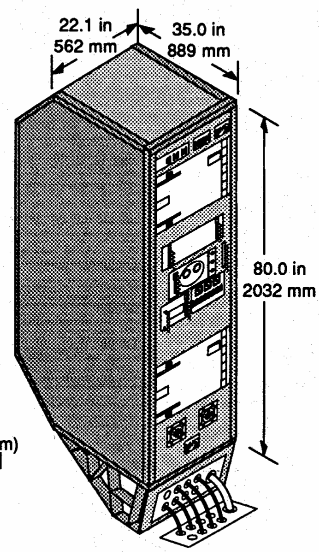
"They are entrepreneurial visionaries, formulating and implementing an industry-driven program to identify and capitalize on the real possibilities in space-related commerce," Reck said. "The bright outlook for 1993 will stand as a landmark for the realization of the commercial potentials of space and as a benchmark for the development of the space frontier. The ultimate benefits for all of us will be more than we can now imagine."

SPACEHAB® Typical Interior Configuration

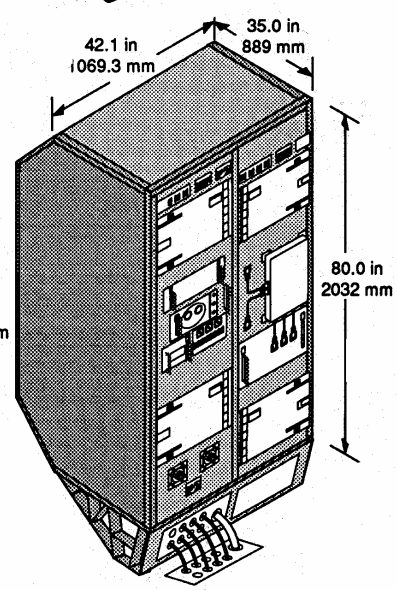




Locker & Trays

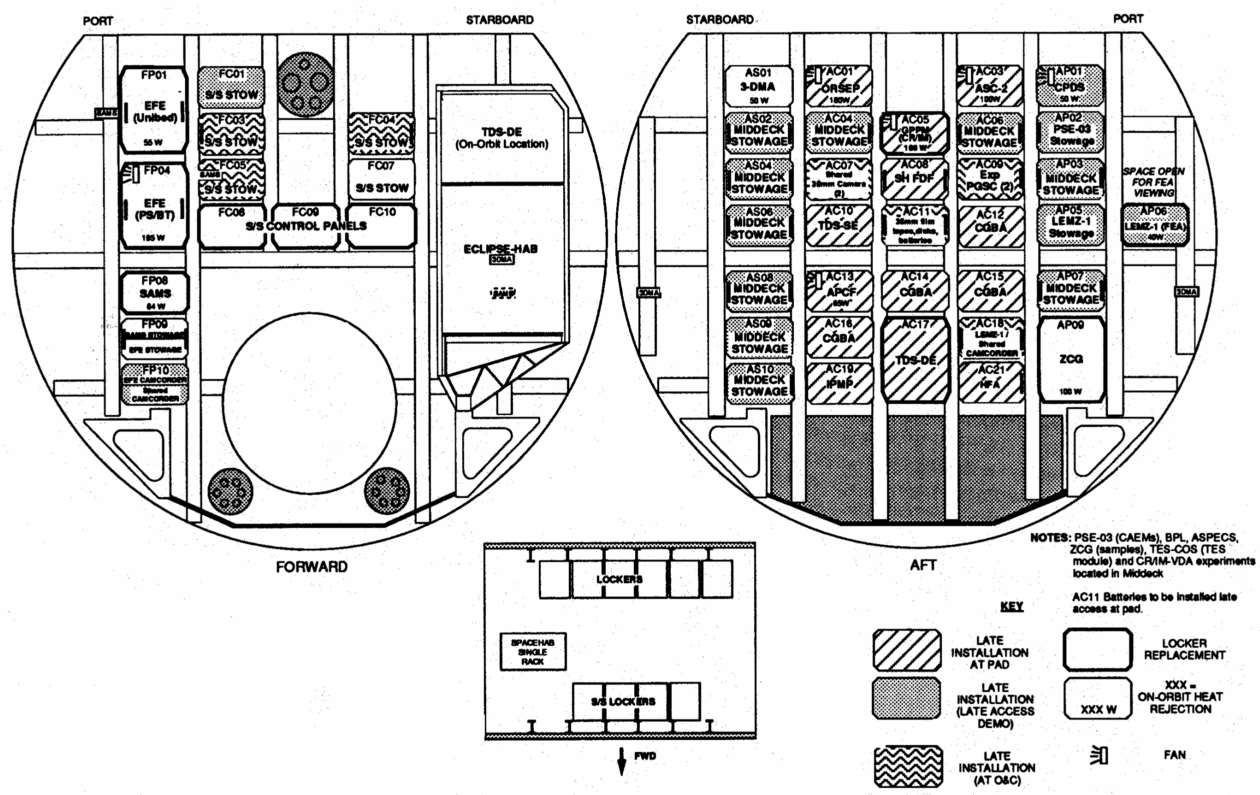


Single Rack



Double Rack

SPACEHAB's Space Research Laboratory Mission One Layout Configuration



SPACEHAB-01 COMMERCIAL MATERIAL SCIENCE EXPERIMENTS

Equipment for Controlled Liquid Phase Sintering Experiments

The CMDS, based at the University of Alabama in Huntsville (UAH), has developed the Equipment for Controlled Liquid Phase Sintering Experiments (ECLiPSE), making its first long-duration space flight on STS-57 in the SPACEHAB. The UAH CMDS is a NASA Center for the Commercial Development of Space (CCDS).

The ECLiPSE experiment investigates the liquid phase sintering (LPS) of metallic systems. Sintering is a process by which metallic powders are consolidated into a metal at temperatures only 50-75 percent of that required to melt all of the constituent phases. In LPS, a liquid coexists with the solid, which can produce sedimentation, thus producing a material that lacks homogeneity and dimensional stability. To control sedimentation effects, manufacturers limit the volume of the liquid. The ECLiPSE experiment examines metallic composites at or above the liquid volume limit to more fully understand the processes taking place and to produce materials that are dimensionally stable and homogeneous in the absence of gravity.

The ECLiPSE project is focused on composites of hard metals in a tough metal matrix. This composite will have the excellent wearing properties of the hard material and the strength of the tough material. Applications of such a composite include stronger, lighter, more durable metals for bearings, cutting tools, electrical brushes, contact points and irregularly shaped mechanical parts for high stress environments.

Kennametal, Inc., is an industry partner of the UAH CMDS participating in the ECLiPSE experiment and has immediate applications for materials improvements in the ceramic composites tested. Kennametal is developing stronger, more durable tool bits. Wyle Laboratories also is an industrial partner with the UAH CMDS on the ECLiPSE experiment.

This Shuttle flight of the ECLiPSE payload is building on the experience of other ECLiPSE flights on suborbital sounding rockets. Suborbital flights have provided only 1-3 minutes of sample processing time, and now the longer flight durations possible on the Shuttle are required. Because the hardware was originally designed to fly in suborbital rockets, it is very automated, requiring little crew interaction. The UAH CMDS is planning more suborbital rocket flight testing and future SPACEHAB missions of the ECLiPSE experiment as part of its sintered and alloyed materials project.

Principal Investigator for ECLiPSE is Dr. James E. Smith Jr., Associate Professor and Head, Department of Chemical and Materials Engineering, University of Alabama in Huntsville.

Gas Permeable Polymeric Materials

The Gas Permeable Polymeric Materials (GPPM) payload is sponsored by the Instrument Research Division, NASA Langley Research Center (LaRC), through a joint NASA/industry program initiated in 1987 with OACT. STS-57 and at least one future space flight of this polymer study program will determine if certain types of polymers made in microgravity are very different from the same polymers made simultaneously on the ground.

Plastic materials, which are made of very large molecules called "polymers," are used in everyday life in many ways. Some polymers prevent gases, such as oxygen, from passing through. These polymers are used in keeping foods fresh for long periods of time in a refrigerator or freezer. Other polymers allow one or more gases to pass through. These polymers, called gas permeable polymeric materials, also have many uses.

The Gas Permeable Polymeric Materials (GPPM) flight experiment will determine if certain types of polymers made in low gravity while the Space Shuttle is in orbit are very different from the same polymers made at the same time on the ground.

Gas permeable polymeric materials are being developed for many uses. These include special contact lenses for long-term wear and for use by pilots and astronauts; medical applications such as dialysis and blood gas monitoring; control of fermentation and other industrial processes and commercial production of pure gases.

Another promising use is the development of sensors that will measure any gas in the air in very small amounts. In this device, a very thin layer of the polymer is coated on a sensor. The polymer allows only the gas which is to be measured to pass through it. The sensor then measures the amount of gas that is present. These devices will be used in monitoring indoor air quality and in detecting dangerous gases, such as carbon monoxide.

Gravity may affect many properties of the polymer while it is being made. As early as 1984, it was suggested that these effects may be eliminated or at least reduced if the polymer was made in the low gravity of space flight. A better understanding of how these polymers are formed also can be learned under these conditions. These experiments must be carried out on the Space Shuttle with the assistance of the astronaut crew because the rates at which the polymers are formed are very slow. If these polymers are very different as expected, many new and improved products will result from them.

The gas permeable polymeric materials being studied by NASA are useful to the contact lens and industrial gas industries. In addition, the polymers being developed by these industries are of special interest to NASA.

A joint NASA and industry program to study polymers made in low gravity was approved in January 1987 by the NASA Office of Commercial Programs, now the OACT. The Instrument Research Division at the NASA LaRC is the NASA organization performing the study. A leading manufacturer of polymers for contact lenses, the Paragon Optical Co., of Phoenix, Ariz., is the Industrial Guest Investigator.

The GPPM flight experiment will be carried out in a sealed aluminum container called the Polymerization Module, developed by the Systems Engineering Division at LaRC. The flight Polymerization Module will be installed in a Commercial Refrigerator/Incubator Module (CRIM) developed by Space Industries Inc., Webster, Texas. The CRIM, which is a small refrigerator and oven in a single unit, can maintain temperatures over a range of 4 degrees C to 40 degrees C for indefinite periods.

Twenty-eight polymer materials will be placed into the flight Polymerization Module and CRIM in an experiment preparation room at the SPACEHAB Payload Processing Facility near the NASA Kennedy Space Center. Identical materials will be placed in another Polymerization Module and laboratory CRIM. The materials will be kept at 4 degrees C until the start of the experiment.

The Polymerization Module and CRIM will be used on future missions in the SPACEHAB Space Research Laboratory or in a middeck locker on the Shuttle. At least one more mission is being planned by NASA and Paragon researchers. This mission also may provide an opportunity for additional industrial guest investigators to perform an experiment.

Investigations into Polymer Membrane Processing

The Investigations into Polymer Membrane Processing (IPMP) payload will make its eighth Space Shuttle flight for the Ohio-based Battelle Advanced Materials Center, a NASA CCDS.

The objective of IPMP is to investigate the physical and chemical processes that occur during the formation of polymer membranes in microgravity, such that the improved knowledge base can be applied to commercial membrane processing techniques. The STS-57 mission will provide additional data on the polymer precipitation process to the knowledge base being developed by Battelle and its industrial partners.

Polymer membranes are porous films which have numerous industrial applications in separation and filtration devices for pollution control, food, chemical and drug purification, and kidney dialysis. The largest potential market may be the environmental sector. Space-based polymer membrane experiments and resulting product improvements could play an important role in pollution control and may serve to significantly reduce the growing problem of dangerous gas emissions in the environment. Amoco Chemical Co., DuPont and Bend Industries, Inc., have contributed to this project due to the impact it may have on gas separation technology.

A two-step process is used frequently to make polymer membranes. A sample mixture of polymer and solvents is applied to a casting surface. The first step is the evaporation of solvents from the mixture. In the second step, the remaining sample is immersed in a fluid bath (typically water) to precipitate the membrane, form the solution and complete the process.

Results from IPMP's previous seven Shuttle and two sounding rocket flights indicate that polymers grown in space do show consistently different material properties than those produced on Earth. The latest flights have produced polymers that demonstrate the gravitational influence on both the size and distribution of the pores, which is a determining factor in the ability of the commercial sector to use polymers for filtration and separation processes.

The results and knowledge gained from all of the IPMP commercially- applied research flights are being analyzed for potential process-enhancing applications in existing industrial processing plants. Through the dissemination of this information, it is expected there will be increased interest on the part of U.S. materials, chemical and environmental companies to grow polymers and other materials in space on a commercial basis.

IPMP Principal Investigator is Dr. Vince McGinniss, Battelle Advanced Materials Center, Columbus, Ohio. IPMP Program Manager is Lisa McCauley, also of Battelle.

Liquid Encapsulated Melt Zone

The Liquid Encapsulated Melt Zone (LEMZ) experiment is sponsored by the Consortium for Commercial Crystal Growth based at Clarkson University, Potsdam, N. Y., a NASA CCDS. The LEMZ payload is developed by the University of Florida, Gainesville, an academic affiliate of the consortium.

LEMZ is the first experiment in a series of activities to determine the feasibility of commercial, space-based production of materials for applications in the computer, optics and sensor/detector industries. These materials are needed for the next generation of high speed optoelectronic digital circuits, optoelectronic devices and transportation systems. Researchers at the University of Florida have produced small gallium arsenide single crystals encapsulated in molten boron oxide using LEMZ in ground-based experiments.

One of the major thrust areas in materials science is the growth of single crystals with improved homogeneity (uniform parts), purity and structural perfection. However, single crystals grown on Earth have many flaws and impurities because they are in contact with a container. The naturally occurring low gravity conditions of space flight allow large crystals to be grown without touching a container -- a process called floating zone crystal growth.

Floating zone crystal growth is expected to result in large single crystals with purity, compositional homogeneity and structural perfection unattainable on the ground.

The hardware used in the LEMZ experiment is the Fluid Experiment Apparatus (FEA) constructed by an industrial partner of the Consortium for Commercial Crystal Growth, Rockwell International. In orbit, several indium bismuth rods will be melted in the FEA. Indium bismuth is a low-melting- temperature compound being used on STS-57 to test the value of liquid encapsulation. Other materials of greater commercial interest will be used on future flights of LEMZ.

The Consortium for Commercial Crystal Growth is teaming with Rockwell International, the University of Florida, McDonnell Douglas and the State of Florida Technology Research and Development Authority (TRDA) on the LEMZ payload. The LEMZ program is part of the consortium's goal to produce high quality single crystals of semiconductors, complex oxides, non-linear optical materials and sensor/detector crystals.

Principal Investigator for LEMZ is Professor Reza Abbaschian, Chairman and Professor, Materials Science and Engineering Department, University of Florida at Gainesville.

Support of Crystal Growth Experiment

The Battelle Advanced Materials Center, a NASA CCDS based in Columbus, Ohio, is sponsoring the Support of Crystal Growth (SCG) Experiment on STS-57.

This experiment is a successor to one conducted in the Spacelab glovebox flown on the first United States Microgravity Laboratory (USML-1) mission in July 1992. SCG supports the Zeolite Crystal Growth (ZCG) experiment also flying in the SPACEHAB Space Research Laboratory in that it provides the invaluable information required to establish the ZCG autoclave mixing protocol so that the resulting crystal growth is optimized. To do this, SCG will assist the crew member and principal investigator in determining how the solutions should be mixed for each of several solution combinations and mixer configurations.

Ground-based and flight research has shown that mixing of the zeolite precursor solutions is critical to producing high quality crystals. Nuclear magnetic resonance imaging studies, KC-135 flights and analysis of the USML-1 results demonstrate the need to optimize the mixing process (uniform mixing while minimizing shear). Determining the proper amount of mixing remains an empirical science and therefore, must utilize crew observation and judgment which requires extensive training and experience.

SCG consists of 12 transparent "autoclaves," comparable to the solution containment portion of the ZCG autoclaves, and a battery-powered screwdriver to activate the mixing process. The "autoclaves" are transparent to facilitate on- board observation by a crew member. Throughout the activation process, a crew member will observe the progression and condition of the mixing of the two solutions. The crew member will downlink video of each activation/mixing and consult with the principal investigator regarding application to the ZCG autoclave activation. This experiment is critical to the success of the ZCG experiment and thus, to the success of the Battelle CCDS zeolite program as a whole.

The Principal Investigator is Dr. Al Sacco Jr., Worcester Polytechnic Institute, Worcester, Mass. Lisa A. McCauley, Battelle Advanced Materials Center, is the flight program manager.

Zeolite Crystal Growth

STS-57 will be the second Shuttle flight of the Zeolite Crystal Growth (ZCG) payload, developed by the Battelle Advanced Materials Center, Columbus, Ohio, a NASA CCDS. The ZCG experiment flew on the first United States Microgravity Laboratory (USML-1) Shuttle mission (July 1992) and the results appear very positive, and all mission objectives were accomplished.

Zeolite crystals are complex arrangements of silica and alumina which occur both naturally and synthetically. An open, three-dimensional, crystalline structure enables the crystals to selectively absorb elements or compounds. As a result, the crystals are highly useful as catalysts, molecular sieves, absorbents and ion exchange materials.

Zeolites are used for purification and catalytic purposes. As a purifier, zeolites work as molecular-scale sieves to remove contaminants from solutions. If improved zeolites were used in kidney dialysis as a purifier, the time needed to complete dialysis could be significantly reduced. Zeolites also could help in removing impurities in blood molecules, which would be helpful in blood transfusions. As catalysts, zeolites aid in making industrial processes more efficient. The catalytic procedure used to process crude oil into gasoline could benefit from improved zeolites, potentially increasing the yield of gasoline, thus reducing U.S. dependence on foreign oil sources. Amoco Chemical Co. and DuPont are Battelle's industrial affiliates on this flight of ZCG.

Ultimately, space-produced zeolite crystals are expected to be larger and of higher quality than their ground-produced counterparts, providing tremendous industrial potential for such crystals. The zeolites produced in microgravity are considered high value-added products and will be scaled up to production quantities using the space station and recoverable orbital systems launched by expendable launch vehicles.

The nucleus of the experiment will consist of 38 autoclaves, each containing two solutions in separate chambers and a screw-activated mixing assembly. To activate the experiment, a crew member will operate the screw assembly with a battery-powered screwdriver, which mixes the two zeolite precursor solutions. By repeating this process several times, proper mixing of the two solutions can be obtained (several different mixing devices are to be used on this mission). Results from the Support to Crystal Growth experiment, also flying in the

SPACEHAB Space Research Laboratory, will be used to determine the appropriate mixing protocol for each autoclave.

Principal Investigator for ZCG is Dr. Albert Sacco Jr., Worcester Polytechnic Institute, Worcester, Mass. ZCG Program Manager is Lisa McCauley, Battelle Advanced Materials Center.

SPACEHAB-01 COMMERCIAL LIFE SCIENCE EXPERIMENTS

ASTROCULTURE[tm]

The ASTROCULTURE[tm] payload is sponsored by the Wisconsin Center for Space Automation and Robotics (WCSAR), a NASA CCDS located at the University of Wisconsin, Madison.

Currently, no satisfactory plant growth unit is available to support long-term plant growth in space. Increases in the duration of space missions, including stays on the space station, have made it necessary to develop plant growth technology that could minimize the cost of life support while in space. Plants can reduce costs of providing food, oxygen and pure water and also lower costs of removing carbon dioxide in human space habitats.

Before plants can be grown in the ASTROCULTURE[tm] unit, however, a series of experiments are being conducted on the Space Shuttle to evaluate the critical subsystems essential for the space-based applications which also will have tremendous uses on Earth, such as improved dehumidification/humidification units, water-efficient irrigation systems and energy-efficient lighting systems for plant growth.

Results from the flight of the first ASTROCULTURE[tm] experiment on STS- 50, the flight of the first United States Microgravity Laboratory (USML-1) in July 1992, indicate that the experiment successfully achieved all of its goals, and experiment results are expected to provide new information dealing with the performance of water and nutrient delivery in space. ASTROCULTURE[tm] has been approved for four more Shuttle flights.

The ASTROCULTURE[tm] unit consists of a covered cavity with two growth chambers containing inert material that serves as the root matrix; a water supply system consisting of a porous stainless steel tube embedded into the matrix, a water reservoir, a pump and appropriate valves for controlling the pressure flow of water through the stainless steel tube; a water recovery system consisting of the same components as the water supply system; and a microprocessor system for control and data acquisition functions. The flight hardware for this mission is self-contained in a SPACEHAB locker and weighs approximately 50 pounds.

This flight of ASTROCULTURE[tm] will evaluate the performance of other important aspects of the water and nutrient delivery system not studied during the first space experiment. In addition, the STS-57 experiment will provide information on the performance of a light emitting diode (LED) lighting system during an extended period of microgravity. A preliminary evaluation of the LED system was made on the Consort-5 sounding rocket flight in November 1992.

In orbit, the water supply and recovery systems will be activated to initiate circulation of a nutrient solution through the porous tubes. Subsequently, the solution will move through the wall of each porous tube into the matrix by capillary forces. In the matrix, the small pores will be filled with the solution and the large pores with air, thereby providing a non-saturated state. The recovery system will operate at several pressure levels to determine the rate at which the solution will move through the matrix and the capacity of the supply system to provide the solution to the matrix.

The amount of solution transferred from the supply reservoir to the recovery reservoir will be monitored, and data collected by the computer will indicate the supply system's overall capacity for replacing water and nutrients removed by plants growing in microgravity.

The current industry affiliates on ASTROCULTURE[tm] include Automated Agriculture Assoc., Inc., Dodgeville, Wisc.; Biotronics Technologies, Inc., Waukesha, Wisc.; Quantum Devices, Inc., Barveveld, Wisc.; and Orbital Technologies Corp., Madison, Wisc. Principal Investigator is Dr. Raymond J. Bula, WCSAR.

BioServe Pilot Laboratory

The BioServe Pilot Laboratory (BPL) is sponsored by BioServe Space Technologies, a NASA CCDS based at the University of Colorado in Boulder.

The BPL will play an important role in providing the commercial and scientific communities affordable access to space for material and life sciences research. The main focus of the project is to provide a "first step" opportunity to companies interested in exploring materials processing and life science experiments in space. The notion behind the project is to allow industry a mechanism for entry level "proof of concept" flights. Thus, the BPL is a crucial screening device for more complex, targeted space research and development activities.

The BPL payload will support investigations in a wide variety of life sciences areas with primary emphasis on cellular studies. For STS-57, two series of investigations will be carried out on bacterial products and processes.

One investigation series examines Rhizobium trifolii behavior in microgravity. Rhizobia are special bacteria that form an intimate and advantageous, or symbiotic, relationship with plants. The bacteria infect the plants early in seedling development to form nodules on the plant roots. The bacteria in these nodules derive nutritional support from the plant while in turn providing the plant with nitrogen fixed from the air. Plants that form such relationships with rhizobia are called legumes and include alfalfa, clover and soybean. Such plants do not require synthetic fertilizers to grow. In contrast, many important crop plants such as wheat and corn are dependent on synthetic fertilizers since they do not form symbiotic relationships with rhizobia.

The experimental system employing Rhizobium trifolii is a model that can be used to better understand the multi-step process associated with rhizobia infection of legumes. Once understood, it may become possible to manipulate the process to cause infection of other crop plants. The potential savings in fertilizer production would be tremendous.

One of the commercial goals of the BioServe center is to determine whether microgravity might be exploited as a tool for rhizobial infection of significant crop plants. This BPL investigation, along with complimentary investigations in BioServe's Commercial Generic Bioprocessing Apparatus (CGBA) also flying in the SPACEHAB Space Research Laboratory, should provide the data needed to address this goal.

Another series of investigations being flown in the BPL concerns the bacteria E. Coli. These bacteria are normally found in the gastrointestinal tracts of mammals, including humans. E. Coli have been well studied as a model system for bacterial infection and population dynamics and in genetics research. With regard to commercial application, the genetic material in E. Coli has been manipulated to produce bacteria capable of secreting important pharmaceutical products. These bacteria also serve as a model for bacteria used in waste treatment and water reclamation.

For STS-57, these bacteria are being studied to determine changes in growth and behavior that occur as a consequence of exposure to microgravity. The commercial objectives for this investigation include understanding and controlling bacterial infection in closed environments, exploiting bacteria and other micro-organisms in the development of ecological life support systems and waste management, and determining the opportunity for enhanced genetic engineering and enhanced pharmaceutical production using bacterial systems.

Yet another BPL investigation examines a biomedical test model based on cells derived from a frog kidney. This investigation is intended to provide insight into effects of microgravity on cell behavior - especially cell division. Gravitational effects on such cell systems may be used as models of diseases or disorders that occur on Earth. For STS-57, the kidney cell system is being examined to determine feasibility for use as such a test model.

On STS-57, the BPL will consist of 40 Bioprocessing Modules (BPMs) stowed in a standard locker in the SPACEHAB Space Research Laboratory. The BPMs will contain the biological sample materials. The stowage locker also will contain an Ambient Temperature Recorder (ATR) which will provide a temperature history of the payload throughout the mission.

Each BPM consists of three syringes held together on an aluminum tray. Generally, the center syringe in each BPM will be loaded with the cell culture system. Adjacent syringes will contain process initiation and termination fluids, respectively. A three-way valve is mounted on the trays which permits fluid transfer from one syringe to the next. The syringes, valve tubing and fittings provide for containment of the sample materials. The hardware is further enclosed in heat-sealed plastic bags to provide additional levels of containment.

For most of the investigations, simultaneous ground controls will be run. Using similar hardware and identical sample fluids, ground personnel will activate and terminate BPMs in parallel with the flight crew. Synchronization will be accomplished based on voice downlink from the crew. Ground controls will be conducted at the SPACEHAB Payload Processing Facility at Cape Canaveral, Fla.

Dr. Marvin Luttges, Director of the BioServe CCDS, is Program Manager. Drs. Louis Stodieck and Michael Robinson, also of BioServe, are responsible for mission management.

Commercial Generic Bioprocessing Apparatus

The Commercial Generic Bioprocessing Apparatus (CGBA) payload is sponsored by BioServe Space Technologies, a NASA CCDS located at the University of Colorado, Boulder. The purpose of the CGBA is to allow a wide variety of sophisticated biomaterials, life sciences and biotechnology

investigations to be performed in one device in the low gravity environment of space.

During the STS-57 mission, the CGBA will support 27 separate commercial investigations, which can be loosely classified in three application areas: biomedical testing and drug development, controlled ecological life support system (CELSS) development and agricultural development and manufacture of biological-based materials.

Biomedical Testing and Drug Development -- To collect information on how microgravity affects biological organisms, the CGBA will include eight biomedical test models. Of the eight test models, four are related to immune disorders: one will investigate the process in which certain cells engulf and destroy foreign materials (phagocytosis); another will study bone marrow cell cultures; two others will study the ability of the immune system to respond to infectious-type materials (lymphocyte and T-cell induction); and one will investigate the ability of immune cells to kill infectious cells (TNF-Mediated Cytotoxicity).

The other four test models -- which are related to bone and developmental disorders, wound healing, cancer and cellular disorders -- will investigate bone tissue, brine shrimp development, inhibition of cell division processes, stimulation of cell division processes and the ability of protein channels to pass materials through cell membranes.

Test model results will provide information to better understand diseases and disorders that affect human health, including cancer, osteoporosis and AIDS. In the future, these models may be used for the development and testing of new drugs to treat these diseases.

Controlled Ecological Life Support System (CELSS) Development -- To gain knowledge on how microgravity affects micro-organisms, small animal systems, algae and higher plant life, the CGBA will include 13 ecological test systems. Two of the test systems will examine miniature wasp development. Seven separate studies will concern seed germination and seedling processes related to CELSS development.

Another three test systems will investigate bacterial products and processes and bacterial colonies for waste management applications.

Finally, one other system will study new materials to control build- up of unwanted bacteria and other micro-organisms.

Test system results will provide research information with many commercial applications. For example, evaluating higher plant growth in microgravity could lead to new commercial opportunities in controlled agriculture applications. Test systems that alter micro-organisms or animal cells to produce important pharmaceuticals could later be returned to Earth for large-scale production. Similarly, it may be possible to manipulate agricultural materials to produce valuable seed stocks.

Biomaterials Products and Processes -- The CGBA also will be used to investigate six different biomaterials products and processes. Two investigations will attempt to grow large protein and RNA crystals to yield information for use in commercial drug development. A third investigation will evaluate the assembly of virus shells for use in a commercially-developed drug delivery system.

Another experiment will use bacteria to form magnetosomes (tiny magnets) for potential use in advanced electronics. Two other investigations will use fibrin clot materials as a model of potentially implantable materials that could be developed commercially as replacements for skin, tendons, blood vessels and even cornea.

Results from the 27 investigations will be carefully considered in determining subsequent steps toward commercialization. STS-57 marks the third of six CGBA flights. Future flights will continue to focus on selecting and developing investigations that show the greatest commercial potential.

For most of the investigations, simultaneous ground controls will be run. Using identical hardware, samples fluids and materials, ground personnel will activate and terminate FPAs in parallel with the flight crew. Synchronization will be accomplished based on indications from the crew as to when specific GAPs are operated. A temperature controlled environment at the SPACEHAB Payload Processing Facility (SPPF), Cape Canaveral, Fla., will be used to duplicate flight conditions.

Dr. Marvin Luttges, Director of the BioServe CCDS, is program manager for CGBA. Drs. Louis Stodieck and Michael Robinson, also of BioServe, are responsible for mission management.

Organic Separation

The Consortium for Materials Development in Space (CMDS) based at the University of Alabama in Huntsville (UAH), has developed the Organic Separation (ORSEP) payload for flight on STS-57. The UAH CMDS is a NASA CCDS.

ORSEP offers the commercial and scientific communities the opportunity to separate cells and particles by a mechanistic technique unavailable on Earth. The potential commercial value of separations includes the opportunity to culture cell subpopulations on return to Earth, the revelation that subpopulations exist and as is the case for protein crystal growth in space, in scientific study of the purified samples.

he ORSEP hardware was built by Space Hardware Optimization Technology (SHOT), Inc., Floyd Knobs, Ind. It is of considerably lower cost than existing phase partitioning devices, and SHOT may be able to capture a good portion of the commercial market on Earth. The hardware is a modular design which can be configured for use with the Shuttle middeck, Spacelab, Get Away Special canisters, the SPACEHAB Space Research Laboratory, sounding rockets and parabolic flight aircraft.

It is a multi-sample, multi-step, fully automated device that separates non- biological particles, as well as biological cells, particles, macromolecular assemblies and organelles in low gravity via partitioning in liquid polymer two- phase systems. The hardware has been designed to perform partitioning in microgravity for a long duration because 2-3 hours are required for each separation step. Commercial interests were factored into the hardware design in its multi-sample capability that offers temperature control and sterility.

On STS-57, the SPACEHAB Space Research Laboratory makes available continuous power, which allows for constant heating/cooling for the experiment while the vacuum of space provides thermal insulation. As a result of these design features, four samples can be processed through 12 purification steps while being held at 4 degrees C in a sterile environment.

Four particle samples will be processed on STS-57 in the ORSEP apparatus. Delicate biological materials have been avoided in order to verify that the separations are due to the operation of the ORSEP rather than an unexpected response of a sensitive sample, such as to a launch delay or a delay in the recovery of the payload.

The CCR CCDS is using ORSEP to study the separation of organic materials from unwanted impurities. When making any type of drug or any material to be used for medical purposes, purity is an extremely important characteristic to the ultimate usefulness of the product. Enhanced purity will enable smaller quantities of drugs to be used, with reduced chances of unwanted side effects. When certain fluids containing pharmaceuticals are mixed in space, the two fluids will separate, much like oil and water. During this process, impurities will often separate out and be located in the boundary between the two fluids. They then may be removed, leaving the ultra-pure desired products.

The Principal Investigator for ORSEP in Dr. James M. Van Alstine, University of Alabama in Huntsville.

Protein Crystal Growth

The Center for Macromolecular Crystallography (CMC), based at the University of Alabama in Birmingham (UAB), is sponsoring Protein Crystal Growth (PCG) experiments on STS-57. The CMC is a NASA CCDS, which forms a bridge between NASA and private industry to stimulate biotechnology research for growing protein crystals in space and offers other protein crystallography services to a wide range of pharmaceutical, chemical and biotechnology companies.

The objective of space-based protein crystal growth experiments is to produce large, well-ordered crystals of various proteins. These crystals will be used in ground-based studies to determine the three-dimensional structures of the proteins. These experiments also continue to investigate how to control and optimize protein crystal growth in order to reduce uncertainties or risks associated with using this space-based process as a vital and enabling technology for many critical areas.

Since proteins play an important role in everyday life -- from providing nourishment to fighting diseases - research in this area is quickly becoming a viable commercial industry. Scientists need large, well-ordered crystals to study the structure of a protein and to learn how its structure determines a protein's functions.

The technique most-widely used to determine a protein's three- dimensional structure is X-Ray crystallography, which requires large, well-ordered crystals for analysis. Crystals produced on Earth often are large enough to study, but they usually have numerous gravity-induced flaws. However, space-produced crystals tend to have more highly-ordered structures that significantly facilitate x- ray diffraction studies.

Studies of such crystals not only can provide information on basic biological processes, but they may lead to the development of food with higher protein content, highly resistant crops and - of great importance - more effective drugs. By studying the growth rates of crystals under different conditions, scientists can find ways to improve crystal growth in microgravity, thus providing higher- quality crystals for study and the ability to produce satisfactory protein crystals that are hard or impossible to grow on Earth. For these reasons, the CMC has conducted protein crystal growth experiments on 17 Shuttle missions including STS-57.

Vapor Diffusion Apparatus and Crystallization Facility Experiments

There are three PCG experiments on STS-57, two of which are contained in thermal control enclosures called Commercial Refrigerator/Incubator Modules (CRIM). One of the CRIM will hold three Vapor Diffusion Apparatus (VDA) trays at a temperature of 22 degrees C. One side of each VDA tray holds 20 double-barreled syringes, while the other side holds plugs that cap the tips of the syringes. Protein solution will be stored in one barrel of each syringe, and the other barrel will house precipitant solution. A reservoir of concentrated precipitant solution surrounds each syringe inside the crystal growth chamber.

A second CRIM contains the Protein Crystallization Facility (PFC). This equipment will utilize changing temperature as a means of producing protein crystals in microgravity. The PFC apparatus consists of four containers which can individually hold as much as 500 ml of protein solution. The buffered protein solution is initially maintained at a temperature which will not induce crystallization. Once in orbit, the CRIM is programmed by the crew to begin slowly changing temperature on a temperature profile which will optimize the crystallization process.

Due to each protein's short lifetime and the crystals' resulting instability, the protein crystal growth experiments will be retrieved within 3 hours of landing and returned to the CMC for post-flight analyses.

Direct-Control Protein Crystal Growth

A third crystallization system on STS-57 will test new protein crystal growth space hardware. The crystallization system will consist of six syringes in a VDA tray and will be contained in a Thermal Enclosure System (TES) which occupies two SPACEHAB lockers and provides a hermetically-sealed and thermally-controlled environment. Within the TES, the Crystal Observation System (COS) will allow real-time crew monitoring during the crystal growth period.

The COS video system will provide individual experiment observation via video cameras mounted to allow viewing of each growth chamber. The system will allow crew members to focus from the front of the droplet to the back, thereby providing the ability to detect individual crystals, study their growth rate and morphology, and continually observe the crystals on board or send video downlink images of the crystals to scientists in the Payload Operations and Control Center (POCC). This new hardware will provide critical information regarding differences in crystal growth rates and vapor equilibration times in the microgravity environment.

The COS in its hermetically sealed thermally controlled environment represents a significant step towards the dynamic control of the several variables that affect protein crystal growth. By developing the ability to create tailor made, monitored and programmed environments for each sample, such systems are expected to be able to significantly reduce the risks involved in growing valuable crystals of the most troublesome proteins. Industrial samples will be flown in each of the protein crystal growth hardware - the VDA, PFC and COS - including malic enzyme from Upjohn Pharmaceuticals, recombinant human insulin from Eli Lilly and Company and alpha-thrombin from DuPont Merck Pharmaceuticals.

The CMC has flown over 50 different types of proteins in space, seeking protein structure data and techniques for predictable enhancement by growth in microgravity. Crystallographic analysis has revealed that on average 20 percent of proteins grown in space are superior to their Earth-grown counterparts. As a result of advances made by the CMC in its microgravity crystallographic technologies, 40 percent of the proteins flown on the first United States

Microgravity Laboratory (USML-1) mission in July 1992, yielded diffraction size crystals, several of which were superior to any previously grown on Earth.

With continued research, the commercial applications developed using protein crystal growth have phenomenal potential, and the number of proteins that need study exceeds tens of thousands. Current research with the aid of pharmaceutical companies may lead to a whole new generation of drugs, which could be able to help treat diseases such as cancer, rheumatoid arthritis, periodontal disease, influenza, septic shock, emphysema, aging and AIDS. These possibilities plus drugs and other products for agriculture, proteins for bioprocessing in manufacturing processes and waste management and other biotechnical applications, represent critical capabilities for dealing with the future of the world.

A number of companies are participating in the CMC's protein crystal growth project including BioCryst Pharmaceuticals, Inc., Eli Lilly & Co., Schering-Plough Research, DuPont Merck Pharmaceuticals, Sterling Winthrop Inc., Eastman Kodak Co., The Upjohn Co., Smith Kline Beecham Pharmaceuticals and Vertex Pharmaceuticals, Inc. Principal Investigator for the protein crystal growth experiments is Dr. Charles E. Bugg, Director of the UAB CMC.

Physiological Systems Experiment

The Center for Cell Research (CCR), a NASA CCDS based at Pennsylvania State University, is sponsoring the third Physiological Systems Experiment (PSE) payload on STS-57.

The PSE-03 payload is the result of a collaboration by the CCR and the Space Dermatology Foundation (SDF), a group of dermatologists and scientists concerned with the future implications and effects of space travel and habitation on the human skin. It will investigate the role of two growth factors involved in accelerating or enhancing tissue repair. Microgravity appears to slow down the normal tissue repair process. The slow down mimics changes associated with conditions on Earth.

The objective of PSE-03 on STS-57 is to increase the dermatologic database and to demonstrate the value of microgravity in dermatologic studies. The results of the experiment will be shared with the medical community and the pharmaceutical and biotechnical industries through the SDF. The SDF plans to develop and maintain a database of space-related dermatology and dermatologic conditions, which will be the only one of its kind.

PSE-03 is a first step in exploring how microgravity can improve the understanding of the ways growth factors regulate tissue repair and regeneration. The knowledge gained in these studies may be useful in the development of new medicines for burn victims, diabetics, elderly surgical patients, bed sore sufferers or other skin injury patients for whom healing is slow and difficult.

The results also may provide additional information about how the basic gene processes underlying blood vessel and soft tissue formation are turned on and off. In addition, the experiment may have direct application in space by helping dermatologists devise therapies to treat astronauts who receive skin and/or soft tissue injuries during prolonged space flight.
Prior to space flight, the growth factors will be implanted in six different areas in each of the 12 male adult rats. The rats will be housed in groups of six in two completely self-contained units equipped with food and water. Fans will circulate cabin air through the units. The units, known as Animal Enclosure Modules (AEM), were developed by NASA's Ames Research Center, Mountain View, Calif. The AEM hardware provides the rats with appropriate life support throughout the mission and returns them in good health at the end of the mission. No interaction with the crew is required in orbit, however, clear plastic covers on the AEM hardware will permit the crew to visually inspect the condition of the rats.

When returned, the tissues surrounding the implantation sites will be examined to determine the effect of the growth factors. Those tissues and others will be studied by researchers affiliated with the CCR, SDF and with pharmaceutical and biotechnical companies. The experiment designers expect the 7 day mission to provide sufficient exposure to microgravity to study the initial phases of tissue repair and the manner in which the two growth factors affect the process.

PSE-01, conducted in 1990 with Genentech Inc., San Francisco, increased basic scientific knowledge regarding human bone and muscle disease and immune cell deficiency. PSE-02, conducted in 1992 with Merck & Co., Inc., West Point, Penn., tested a developmental drug designed to counteract the effects of osteoporosis.

Dr. W. C. Hymer is Director of the Center for Cell Research at Pennsylvania State University and co-investigator for PSE-03. Dr. William W. Wilfinger is the CCR Director of Physiological Testing. Dr. Steven R. Kohn, President, Space Dermatology Foundation, is the SDF representative.

SPACEHAB-01 JOHNSON SPACE CENTER INVESTIGATIONS

Application Specific Pre-programmed Experiment Culture System

The Application Specific Pre-programmed Experiment Culture (ASPEC) System is sponsored by the Medical Sciences Division, Space and Life Sciences Directorate, NASA Johnson Space Center (JSC), Houston. The ASPEC system is a part of the bioreactor project which is aimed at developing a series of hardware concepts for facilitating the development of human cells and tissue cultures in the weightless or microgravity environment of space flight where cells can grow in all directions for extended periods of time.

Medical science is unable to grow large high-fidelity human tissue models in Earth's gravity. Microgravity or its emulation will allow cells to be suspended for long-term growth and development. Tissues grown in this way are useful in testing chemotherapeutic protocols, understanding growth requirements and treating specific medical maladies. Potential medical science spin-offs include investigations of viral growth, cancer models and therapeutics, and transplantation tissue.

"A near-term goal is to test the equipment and its impact on a growing colon cancer," said Glenn Spaulding, Manager of the biotechnology program at the Johnson Space Center. "From this study, we will be able to refine culture techniques here and in space."

The ASPEC system is a set of self-contained cell growing and cell maintenance units for use in space flight experiments. Cell cultures may be initiated in the device or mature cell cultures may be transferred into the ASPEC, which can maintain a cell culture experiment for as long as 14 days.

The ASPEC system will carry several culture vessels on STS-57, its first space flight. Each culture vessel has the potential of carrying one complete experiment. On STS-57 the experiment is being flown with colon cancer cells to be grown in the chamber and brought back for study. On Endeavour's last mission in January, the culture chamber was flown as a testbed to demonstrate movement of fluid through the unit to provide constant nutrients to growing cells.

The hardware of the ASPEC system includes three ASPEC units, an ASPEC power cable, a locker with a modified door and packing foam. Each ASPEC unit has an independent plumbing and sensor system to regulate temperature and pH and to provide a fresh growth medium and serum to the cells as needed.

The STS-57 crew will routinely check power indicators and airflow through the ASPEC units and clean the vent screens as necessary. The crew also will take still photographs of the system configuration. The shutdown procedure will be initiated by the crew. This will begin an automated process for removing experiment materials from the reactor chamber, chilling the removed samples to 10 degrees C to prevent protein breakdown and other degradation and injecting formalin into the vessels to "fix" the remaining cells.

A near term goal of the experiment is to provide toxicology testing that will identify the potential long-duration hazards on shorter Shuttle missions. This forms a bridge between identifying specific toxicants and their biological impacts.

On the Shuttle, ASPEC will serve as the "foundation experiment" for the space station. Growing cells to full maturity may take several months, which can only be done on long-duration flights aboard the station.

Principal Investigator for ASPEC is Dr. Glenn Spaulding, Medical Sciences Division, Space and Life Sciences Directorate, JSC.

Charged Particle Directional Spectrometer

The Charged Particle Directional Spectrometer (CPDS) experiment on STS- 57 is sponsored by the Solar System Exploration Division, Space and Life Sciences Directorate, Johnson Space Center (JSC). The CPDS performs the functions of both a research instrument and an operational monitor. It detects and records the many different types of nuclear radiation that bombard an orbiting space vehicle. In so doing, information is gathered about the characteristics of these particles at the orbital altitude, and a record is made of the amount and type of exposure the crew members receive.

The particles come from two groups. First are particles trapped in orbit around the Earth by the Earth's magnetic field. These particles mainly consist of protons, although other varieties of the nuclear population also are present. The second are intergalactic particles, or cosmic rays, that happen to be passing by the Earth. All of these particles can be considered orbital debris on a nuclear scale.

Knowledge of the particle's type, energy and direction is of interest to basic research in physics. Medical researchers can use much of the same information, but in addition, they are concerned with the linear energy transfer of the particle, particularly in living tissue such as human beings. The measurement indicates how much potential damage the particles do as they transverse through living beings. Such information is necessary to help determine guidelines that will ensure the long-term health and safety of astronauts. Several CPDS instruments are intended to be included as standard equipment on the space station.

The CPDS experiment consists of three different instruments: a pair of Area Passive Dosimeters (APDs), the Tissue Equivalent Proportional Counter (TEPC) and the actual CPDS apparatus. The APDs are routinely flown on Space Shuttle missions. They are similar to film strips. Particles which strike the strips leave a distinctive signature. The strips are analyzed after the flight and give a good indication of total dosage received during the flight.

The TEPC utilizes a detection element that absorbs particle energy in a manner similar to living tissue. The data received from this instrument are particularly useful in assessing possible hazards to the crew. And since the TEPC is an active electronic instrument, a time record of when each particle strikes is maintained. TEPCs have flown on several Shuttle missions and have been instrumental in, among other things, determining the configuration of the South Atlantic Anomaly.

The CPDS apparatus is the most sophisticated instrument of the experiment hardware. It consists of several layers of different types of detectors. The various detectors have different characteristics to enable the instrument to gather as much data as possible from each particle strike. One important new feature of the CPDS is its ability to determine the direction of individual particles. Particle flux is believed to be more intense in some directions than in others. If this is confirmed, future spacecraft designs may position crews to receive maximum shielding from the spacecraft structure.

The CPDS experiment is completely housed in a SPACEHAB locker mounted high on the aft bulkhead. It requires only electrical power to be operational. The instruments are activated by the crew as soon after reaching orbit as practical and are turned off just before the descent back to Earth. Data are retained in internal memories and are read out and analyzed post-flight.

Principal Investigator for CPDS is Dr. Gautam D. Badwar, Solar System Exploration Division, Space and Life Sciences Directorate, JSC.

Human Factors Assessment

The Human Factors Assessment (HFA) experiment is being conducted on STS-57 by the Crew Interface Analysis Section of the Flight Crew Support Division, Space and Life Sciences Directorate, Johnson Space Center (JSC). The primary concerns of human factors engineers at JSC are the investigation and evaluation of human-machine and human-environment interfaces unique to spaceflight which affect crew productivity and ultimately mission success.

During the mission, data will be collected on three different aspects of crew activity in space: the acoustic and lighting environments of the orbiter, ease of movement -- or translation -- through the middeck-to-SPACEHAB transfer tunnel and the use of electronic procedures to perform tasks. The hardware to facilitate data collection includes a MacIntosh Powerbook computer with a voice recognition system using Supercard displays and for environmental measurements, a B&K Type 2231 Modular Precision Sound Level Meter and a Minolta Photographic Spotmeter.

Evaluation of the acoustic and lighting environments (HFA-SOUND and HFA- LIGHT, respectively) seeks to gain objective and subjective measures of the noise and lighting environments during the STS-57 mission and also will assess any effects on crew performance attributable to these environments. HFA- SOUND additionally seeks to determine if noise is more bothersome to the crew as the mission progresses and to compare noise levels and crew-perceived annoyance across missions.

The HFA-SOUND and -LIGHT investigations will determine whether current spacecraft acoustic and lighting design criteria are being met, and what levels are indeed acceptable to the crew during the mission to minimize negative effects of these environments on crew performance. Ten 1/3 octave sound level and several lighting measures will be taken in the SPACEHAB Space Research Laboratory, the middeck and the flight deck. This investigation will help identify noise-producing hardware and problematic lighting configurations that are particularly detrimental to crew member performance.

The investigation assessing translation through the transfer tunnel (HFA- TRANS) seeks to assess the SPACEHAB tunnel adapter and hatch designs for ease of crew translation and equipment transfer between the middeck and the SPACEHAB Space Research Laboratory.

HFA-TRANS data will provide basic information on translation speeds in the weightless environment of space and techniques which will contribute to training and timelining of tasks for subsequent SPACEHAB and Spacelab missions and on the space station. The data also will be compared to data collected on crew translation through the Spacelab tunnel during STS-40 (June 1991) and STS-47 (September 1992).

Comments on the various features of the SPACEHAB adapter and tunnel designs will contribute to recommendations for the design of more efficient translation areas in the future. Translation video will be collected early and late in the mission.

The electronic procedures portion of this experiment (HFA-EPROC) seeks to facilitate future use of electronic flight procedures. Crew performance with electronic procedures must be at least equal to that achieved with paper procedures.

Current EPROC research will help define baseline paper procedures performance and identify specific strong and weak points of both paper and computer procedures. The current research also will help define specific ways to achieve improved performance with computer procedures.

EPROC will be of particular significance for future, longer-duration missions which will increasingly rely on electronic procedures since they are more easily launched, updated in flight and offer automatic or on-request capabilities not available with paper. The development of human factors design guidelines for such electronic procedures will be increasingly important for future space missions.

The HFA-EPROC experiment consists of two tasks: a computer task which will simulate a space station propulsion system task and a non-computer task performed in conjunction with the Tools and Diagnostic Systems Soldering Experiment. Each task will be performed with paper and computer-based procedures.

The Principal Investigator for HFA is Sue Adam, Flight Crew Support Division, Space and Life Sciences Directorate, JSC.

Neutral Body Posture

The Space and Life Sciences Directorate, JSC, is sponsoring the Neutral Body Posture (NBP) experiment on STS-57. NBP will investigate the changes in posture of the human body over the course of a space mission. Previous space missions have shown that in addition to lengthening of the spine, posture takes on a configuration unique to spaceflight. The data from NBP will be useful in the design of future space facilities, workstations and hardware, especially since the last in-depth study of this nature was conducted during the Skylab program in the early 1970s.

A minimum of two STS-57 crew members will be evaluated. As time allows, data may be collected on additional crew members. The crew members to be evaluated will wear a special sleeveless T-shirt and be photographed with orbiter camcorders and 35 mm cameras mounted roughly along orthogonal axes with respect to the vehicle. The crew members under evaluation will assume a relaxed position while photos are collected. This process will be performed both early and late in the mission.

Principal Investigator for NBP is Frances E. Mount, Flight Crew Support Division, Space and Life Sciences Directorate, JSC.

Tools and Diagnostic Systems

The Tools and Diagnostic Systems (TDS) experiment is sponsored by the Space and Life Sciences Directorate, JSC. The objective of TDS is to demonstrate the maintenance of experiment hardware on-orbit and evaluate the adequacy of its design and the crew interface. The TDS experiment on STS-57 will mark the first demonstration of soldering on an American space mission.

The TDS experiment is a group of equipment selected from the tools and diagnostic equipment to be supplied to the space station program. These tools and diagnostic equipment will provide the space station program with on- orbit diagnostic and repair capability. The hardware consists of off-the-shelf equipment modified to perform acceptably in the space environment.

There are two parts to TDS: the Soldering Experiment (SE) to demonstrate practical soldering in the microgravity environment and to evaluate the use of a new restraint configuration for crew members performing precise tasks and the Diagnostic Equipment (DE) experiment to demonstrate microgravity maintenance capabilities using state-of-the-art diagnostic equipment.

In the SE, a crew member will solder a printed circuit board containing 45 connection points, then de-solder 35 points on a similar printed circuit board. The soldering work station consists of a glovebox to contain debris, mounted on a SPACEHAB-supplied work bench, where the circuit boards will be held in a clamp, which is in turn mounted on an experiment rack. Of interest to investigators are the techniques used by the crew member and the quality of the work of the crew member, which is dependent on the ability of the crew member to properly place the solder on the heated connection point.

The crew member also will be asked to evaluate two types of foot restraints used while performing the SE. One restraint consists of adjustable foot loops similar to the current Space Shuttle design. The other is an arrangement of foot restraint bars designed for use on the space station. Two crew members will perform the experiment twice, but it may be repeated if time allows.

The DE experiment will operate the development unit for the space station diagnostic equipment caddy. This diagnostic caddy contains a function sweep generator, a logic analyzer/oscilloscope and a multimeter. This combination of equipment is able to produce an analog or digital test signal, which is input to the test equipment, and captures and displays the resultant output.

The work station consists of the SPACEHAB-supplied work bench mounted on a rack, which provides a recess into which the diagnostic equipment caddy will be mounted. A frequency counter also is supplied for analysis.

As part of the DE experiment, a failure in flight will be simulated, after which the Payload General Support Computer (PGSC) will uplink a troubleshooting procedure, a test equipment configuration file and a test setup diagram. The file to configure the test equipment will allow the complex diagnostic equipment setup to be performed by the support crew on the ground. Then the flight crew will perform the procedures and record and downlink the results.

The ground crew will analyze the data obtained and uplink files for a "fix" to the problem for the crew. Upon completion of the repair, the test will culminate with successful performance of the frequency counter's function.

The Principal Investigator for TDS is Jackie Bohannon, Flight Crew Support Division, Space and Life Sciences Directorate, JSC.

SPACEHAB-01 PAYLOADS SPACE STATION EXPERIMENT

Environmental Control and Life Support System Flight Experiment

NASA's space station office in Reston, Va., is sponsoring the Environmental Control and Life Support System (ECLSS) Flight Experiment (EFE) to test components of the water recycling system being developed for the space station.

With a projected rate of four crew members at a time aboard the space station, they will use about 50 pounds of water a day. Without an efficient system for reusing this water over and over again, about 10 tons of water would have to be sent to the space station every 90 days, requiring special Space Shuttle flights just for the replenishment of the water supply.

Engineers at the Marshall Space Flight Center (MSFC), Huntsville, Ala., have succeeded in developing a prototype system that can recycle shower and wash water, urine and even respiration and perspiration captured from the air back into potable drinking water. Taste tests and other end-use tests run at MSFC during 1992 demonstrated that the systems work well and that the recycled water is clean and acceptable for crew use. However, now the systems must be tested onboard the Space Shuttle in low Earth orbit to make sure they perform just as well in the microgravity environment of space flight.

The EFE consists of three pieces of recycling hardware -- a bellows tank, a gas/water phase separator and two unibeds (filters). These components will be housed in two containers occupying the equivalent of four lockers in the forward bulkhead of the SPACEHAB Space Research Laboratory. The bellows tank features a Pyrex see-through window that will allow crew members to observe how gas and water behave inside the tank in microgravity -- examining, for instance, whether the air bubbles colonize or cling to the tank walls. The phase separator will separate the gas from the mixture.

The experiment also will carry about a half gallon of pure water, into which will be mixed potassium iodide (simulating a wastewater contaminant). The iodide mixture will be run through the unibed filters to purify the water. The purification experiment will test both the efficiency of the unibeds in purifying the water and the rate at which the unibeds are depleted.

Two types of unibeds will be flown on STS-57 as part of the ECLSS Flight Experiment, one which is spring-loaded and the other which is not. The two types will be tested to determine if the spring is required for the unibeds to work properly in the microgravity environment. If it is not required, the spring can be eliminated to reduce the weight of the hardware.

The current industry affiliates on the ECLSS Flight Experiment are Boeing Aerospace, Life Systems, Inc., and Hamilton Standard. The Principal Investigators for the ECLSS Flight Experiment are NASA Marshall Space Flight Center, Huntsville, Ala., and Boeing Aerospace.

SPACEHAB-01 PAYLOADS SUPPORTING HARDWARE

Three-Dimensional Microgravity Accelerometer

The Consortium for Materials Development in Space (CMDS), is sponsoring the Three-Dimensional Microgravity Accelerometer (3-DMA) on the STS- 57 mission. The CMDS is a NASA CCDS based at the University of Alabama, Huntsville (UAH).

The acceleration measurement system will help chart the effects of deviations of microgravity on the experiments being conducted in space. The microgravity environment inside the SPACEHAB Space Research Laboratory will be measured in three dimensions by the 3-DMA, allowing researchers to review experiment results against deviations from microgravity. This information will be used to determine the degree of microgravity achieved inside the SPACEHAB Space Research Laboratory. Disturbances caused by operating various experiments in SPACEHAB and the residual microgravity resulting from orbiter rotational motions and by drag will be measured.

The 3-DMA hardware consists of four accelerometer assemblies to be located in different parts of the SPACEHAB Space Research Laboratory. The accelerometers provide the acceleration data to a central control box located in a single locker. The data are recorded in flight on two gigabyte magnetic hard drive devices.

The accelerometer package comprises three remotely located standard three-dimensional systems and new invertible accelerometers in the central unit. The new, unique invertible feature permits measurements of absolute microgravity and low-level, quasi-steady, residual accelerations (i.e., atmospheric drag) that have proven difficult to measure in the past.

A potential application of 3-DMA would be to characterize the microgravity environment of space platforms in support of experiments, research and commercialization activities.

Principal Investigator for 3-DMA is Jan Bijvoet of the UAH CMDS.

Space Acceleration Measurement System

NASA's Lewis Research Center (LeRC), Cleveland, is sponsoring the Space Acceleration Measurement System (SAMS) on the STS-57 mission. SAMS is designed to measure and record low-level acceleration during experiment operations. The signals from these sensors are amplified, filtered and converted to digital data before being stored on optical disks and sent via downlink to the ground control center.

SAMS has flown on six previous Shuttle flights and acquired nearly 15 gigabytes of data which represents 50 days of operation. Approximately two gigabytes of data will be acquired on the SPACEHAB mission.

The high density floppy disks have approximately one megabyte of capacity. The capacity of a double-sided optical disk used on Shuttle missions is 400 megabytes. This compares to approximately 400 high density floppy disks or 40 standard boxes of ten disks. All the data will fit on one optical disk measuring about 5 inches square and one-half inch thick.

Three sensors will be flown. One will measure the disturbances near an Environmental Control Support System, another sensor will be located on the support structure of the SPACEHAB Space Research Laboratory and the third will be attached to a locker door to determine the level of disturbances experienced by experiments in the locker and nearby. The second and third sensors are primarily to measure the acceleration characteristics of the SPACEHAB Space Research Laboratory for future experiments. Scientists will use the SAMS data in different ways, depending on the nature of the science experiment and the principal investigators' experience and ground-based testing results. The principal investigators will typically look for acceleration events or conditions that exceed a threshold where the experiment results could be affected. This may be, for example, a frequency versus amplitude condition, an energy content condition or simply an acceleration magnitude threshold.

Data from previous missions have shown the levels of disturbance evident in the Spacelab module by the use of the crew exercise treadmill located in the middeck. This data, along with other missions' data, are important in order to reduce and isolate disturbances on future missions, including on the space station.

SAMS flight hardware was designed and developed in-house at LeRC. The Principal Investigator for SAMS is Charles Baugher of NASA's Marshall Space Flight Center, Huntsville, Ala., and the Project Manager is Richard DeLombard of NASA Lewis.

SPACEHAB-01 COMMERCIAL MATERIAL SCIENCE EXPERIMENTS OVERVIEW

Experiment	Sponsor	Affiliates	Experiment Description	Potential Commercial Applications
Equipment for Controlled Liquid Phase Sintering Experiment-SPACEHAB (ECLiPSE)	Consortium for Materials Development in Space, Huntsville, AL (CCDS*)	Wyle Laboratories; Kennametal, Inc.	Uses a rack-mounted, enclosed furnace assembly to investigate controlled liquid phase sintering of metallic systems in microgravity	Development of stronger, lighter and more durable bearings, cutting tools, electrical contact points, and irregularly shaped parts for high stress environments
Gas Permeable Polymer Materials (GPPM)	NASA Langley Research Center, Hampton, VA	Paragon Optical Co.	Processes gas permeable polymer materials in microgravity.	Development of rigid extended-wear contact lenses with improved comfort and durability.
Investigations into Polymer Membrane Processing (IPMP)	Battelle Advanced Materials Center, Columbus, OH (CCDS*)	Amoco Chemical Co.; DuPont; Bend Industries	Evaporates mixed solvent systems in microgravity using induced convection to control the porosity of polymer membranes.	Improvement of kidney dialysis, water purification and water desalination.
Liquid Encapsulated Melt Zone (LEMZ)	Consortium for Commercial Crystal Growth, Potsdam, NY (CCDS*)	Rockwell International; McDonnell Douglas; State of Florida Technology, Research and Development Authority; University of Florida (Gainesville)	Explores the feasibility of liquid encapsulated melt zone processing in microgravity, and studies the interaction of the encapsulate with the melt and the effects of gravity perturbation on the system.	Development of next-generation electronic and radiation-hardened devices to support data, sensor and control system.
Support of Crystal Growth (SCG)	Battelle Advanced Materials Center, Columbus, OH (CCDS*)	Amoco Chemical Co.; DuPont; Worcester Polytechnic Institute	Provides information required to establish the Zeolite Crystal Growth experiment mixing protocol.	Support of zeolite crystal applications.
Zeolite Crystal Growth (ZCG)	Battelle Advanced Materials Center, Columbus, OH (CCDS*)	Amoco Chemical Co.; DuPont; Worcester Polytechnic Institute	Evaluates the growth of zeolite crystals in microgravity.	Improvement of gasoline refining, water purification, blood impurity removal and radioactive waste clean-up.

* NASA Center for the Commercial Development of Space

SPACEHAB-01 COMMERCIAL LIFE SCIENCE EXPERIMENTS OVERVIEW

Experiment	**Sponsor**	**Affiliates**	**Experiment Description**	**Potential Commercial Applications**
ASTROCULTURE[tm]	Wisconsin Center for Space Automation and Robotics, Madison, WI (CCDS*)	Automated Agriculture Assoc., Inc.; Biotronics Technologies, Inc.; Quantum Devices, Inc.; Orbital Technologies Corp.	Validates a concept for supplying water and nutrients to plants growing in microgravity.	Development of an enclosed environmental system with earth-based and space-based uses, including improved dehumidification, humidification and energy efficient lighting.
BioServe Pilot Laboratory (BPL)	BioServe Space Technologies, Boulder, CO (CCDS*)	Abbot Labs; Alza; Aquatic Products; Chiron; Martin Marietta; Spaceport Florida Authority; Synchrocell	Determines the responses of cells to various hormones and stimulating agents in microgravity.	Development of next-generation drugs and space-grown polymers.
Commercial Generic Bioprocessing Apparatus (CGBA)	BioServe Space Technologies, Boulder, CO (CCDS*)	Abbot Labs; Aquatic Products, Chiron, Martin Marietta, OmniDelta; Spaceport Florida Authority; Synchrocell; Water Technologies	Processes biological fluids by mixing components in a microgravity environment.	Improvement of bio-implantable products, immune disease research and waste management systems.
Organic Separation (ORSEP)	Consortium for Materials Development in Space, Huntsville, AL (CCDS*)	Interfacial Dynamics Corp.; Space Hardware Optimization Technology, Inc.	Explores the use of phase separation techniques in microgravity conditions to separate cells, cell fragments and heavy molecules.	Improvement of techniques for processing pharmaceutical and biotechnology products.
Protein Crystal Growth (PCG) Thermal Enclosure System with Crystal Observations System (TES-COS)	Center for Macromolecular Crystallography, Birmingham, AL (CCDS*)	BioCryst Pharmaceuticals, Inc.; Eli Lilly & Co.; Schering-Plough Research; DuPont Merck Pharmaceuticals; Sterling Winthrop, Inc.; Eastman Kodak Co.; The Upjohn Co.; Smith Kline Beecham Pharmaceuticals; Vertex Pharmaceuticals	Grows high-quality protein crystals by vapor diffusion. TES includes the Crystal Observation System (COS) to monitor crystal growth in realtime.	Acceleration of drug research and development.
Physiological Systems Experiment (PSE)	Center for Cell Research, University Park, PA (CCDS*)	Space Dermatology Foundation	Determines the effects of biomaterials on animal physiological systems.	Design and development of medicines to treat terrestrial diseases, such as osteoporosis, which are mimicked during space exposure.

* NASA Center for the Commercial Development of Space

SPACEHAB-01 JOHNSON SPACE CENTER (JSC) EXPERIMENTS OVERVIEW

Experiment	**Sponsor**	**Experiment Description**	**Potential Commercial Applications**
Application Specific Pre-programmed Experiment Culture (ASPEC)	Medical Sciences Division, Space and Life Sciences Directorate, JSC	Controls cell culture variables to optimize the assembly of tissues from basic cells and substrates.	Development of human cells and tissue cultures in microgravity useful in setting chemotherapeutic protocols, understanding growth requirements and treating specific medical maladies.
Charged Particle Directional Spectrometer (CPDS)	Solar System Exploration Division, Space and Life Sciences Directorate, JSC	Measures charge and direction of atomic particles in the Space Shuttle/SPACEHAB environment.	Improvement of crew health during long-duration space missions.
Human Factors Assessment (HFA)	Crew Interface Analysis Section, Flight Crew Support Division Space and Life Sciences Directorate, JSC	Measures and evaluates the Space Shuttle/SPACEHAB environment including acoustics and lighting, computerized polling of crew opinion, crew movement and interaction with equipment.	Evaluation of human-machine and human-environment interactions during routine operations of the SPACEHAB Space Research Laboratory.
Neutral Body Posture (NBP)	Flight Crew Support Division, Space and Life Sciences Directorate, JSC	Analyzes the effects of microgravity on human posture.	Design of future space facilities, workstations and hardware.
Tools and Diagnostics System (TDS)	Flight Crew Support Division, Space and Life Sciences Directorate, JSC	Evaluates microgravity effects on the physics and human factors of electronic circuit board soldering, the operation of a portable battery charger, and the operation of a portable electronic diagnostic equipment package.	Demonstration of experiment hardware maintenance in orbit, including the first demonstration of soldering on an American space missions.

SPACEHAB-01 SPACE STATION

Experiment	Sponsor	Affiliates	Experiment Description	Potential Commercial Applications
Environmental Control Life Support System (ECLSS) Flight Experiment	Space Station *Freedom* Office, Reston, VA	Boeing Aerospace Life Systems, Inc.; Hamilton Standard	Investigates the performance of key components for a water reclamation and management system.	Development of key components for Space Station *Freedom*, such as an enhanced water reclamation system.

SPACEHAB-01 SUPPORTING HARDWARE OVERVIEW

Hardware	Sponsor	Hardware Operation	Potential Applications
Three Dimensional Microgravity Accelerometer (3DMA) -------------------- Space Acceleration Measurement System (SAMS)	Consortium for Materials Development in Space, Huntsville, AL (CCDS*) -------------------- NASA Lewis Research Center, Cleveland, OH	Measures Accelerations in three axes within the SPACEHAB environment.	Characterization of low-gravity environment for the development of space hardware and for experiment data analysis.

COMMERCIAL GENERIC BIOPROCESSING APPARATUS INVESTIGATIONS ON STS-57

Biomedical Testing and Drug Development

These investigations will provide information to develop a better understanding of diseases and disorders that affect human health including cancer, osteoporosis and AIDS. These models may be used for the development and testing of new drugs to treat these diseases.

Experiment	**Investigator**	**Experiment Description**	**Specific Application**
T-Cell Induction Test Model	Kansas State University	Examines immune system's ability to respond to infectious-type materials.	Immune Disorders
TNF-Mediated Cytotoxicity Test Model	Kansas State University	Examines immune cells' ability to kill infectious cells.	Immune Disorders
Bone Marrow Cell Culture Test System	Kansas State University	Studies bone marrow cultures in microgravity.	Immune Disorders
Phagocytosis Process Testing	University of Rochester	Investigates process in which certain cells engulf and destroy foreign materials.	Immune Disorders
Brine Shrimp Test System	Kansas State University	Examines brine shrimp development in microgravity.	Development Disorders
Inhibitor Protein Test Model	Kansas State University	Studies inhibition of cell division process.	Cancer
Gap Junction Processes	Kansas State University	Investigates ability of protein channels to pass materials through cell membranes.	Cellular Disorders
Cell Division Processes	University of Colorado	Studies stimulation of cell division processes.	Cellular Disorders.

COMMERCIAL GENERIC BIOPROCESSING APPARATUS INVESTIGATIONS ON STS-57

Controlled Ecological Life Support System (CELSS) Studies

These investigations could lead to new commercial opportunities in controlled agriculture applications, large scale production on Earth of important pharmaceuticals, and production of valuable see stocks by manipulation of agricultural materials.

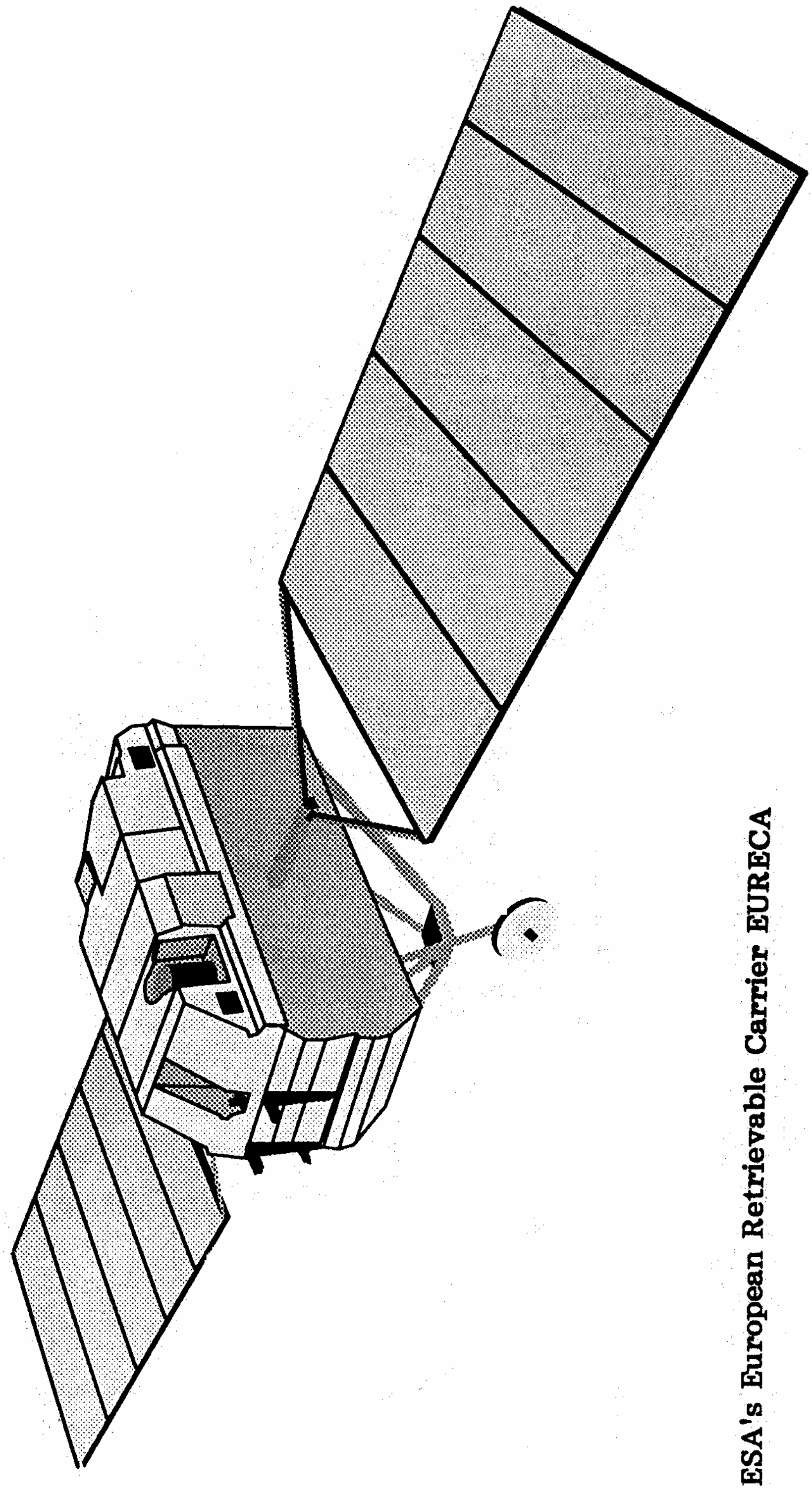
Experiment	**Investigator**	**Experiment Description**	**Specific Application**
Seed Germination Products (4 studies)	University of Colorado	Studies seed germination in microgravity.	Controlled Ecological Life Support System (CELSS) Studies
Seeding Processes (2 studies)	Kansas State University	Examines seeding processes in microgravity.	CELSS Studies
Plant Tissue Culture Products	University of Colorado	Studies secondary metabolic production during spaceflight	CELSS Studies
Miniature Wasp Test System	University of Colorado	Investigates miniature wasp development in microgravity.	CELSS Studies
Fruit Fly Test System	Kansas State University	Examines fruit fly development in microgravity.	CELSS Studies
Bacterial Products and Processes	University of Colorado	Studies bacterial products and processes in microgravity.	Waste Management
Bacterial Products and Processes	Kansas State University	Studies bacterial products and processes in microgravity.	Waste Management
Bacterial Colony Test System	University of Colorado	Studies bacterial products, processes and colonies in microgravity.	Waste Management
Pentaiodide Product Testing	University of Colorado	Investigates new materials to control build-up of unwanted bacteria and other micro-organisms.	Microbial Control

COMMERCIAL GENERIC BIOPROCESSING APPARATUS INVESTIGATIONS ON STS-57

Biomaterials Products and Processes

Potential applications of these investigations include commercial drug development and a drug delivery system, and the development of potentially implantable materials used commercially as replacements for skin, tendons, blood vessels and cornea.

Experiment	**Investigator**	**Experiment Description**	**Specific Application**
Virus Capsid Product	Kansas State University	Evaluates assembly of virus shells.	Drug Delivery System
Protein Crystal Morphology Products	University of Colorado	Growth of large protein crystals.	Drug Development
RNA Crystal Growth Products	University of Colorado	Growth of large RNA crystals.	Drug Development
Magnetosome Assembly Processes	University of Colorado	Formation of magnetosomes (tiny magnets) using bacteria	Advanced Electronics
Fibrin Clot Materials (2 studies)	University of Colorado	Use of fibrin clot materials as a model of potentially implantable materials.	Synthetic Implants



ESA's European Retrievable Carrier EURECA

EUROPEAN RETRIEVABLE CARRIER (EURECA)

F. Schwan - Industrial Project Manager Deutsche Aerospace, ERNO Raumfahrttechnik Bremen, Germany

W. Nellessen - ESA Project Manager ESTEC Noordwijk, The Netherlands

The European Space Agency's (ESA) EURECA spacecraft was launched on July 31, 1992, by the Space Shuttle Atlantis (STS-46) and deployed at an altitude of 230 nautical miles (425 km). It ascended using its own propulsion to the operational orbit of 270 nautical miles (500 km). Several weeks prior to the STS 57 launch, ground controllers will lower EURECA's altitude where it will be retrieved by Endeavour and brought back to Earth.

The EURECA-1 mission primarily has been devoted to research in the fields of material and life sciences and radiobiology, all of which require a controlled microgravity environment. The selected microgravity experiments have been carried out in seven facilities. The remaining payload comprises space science and technology.

During the mission, EURECA's residual carrier accelerations have not exceeded 10-5g. The platform's altitude and orbit control system made use of magnetic torquers augmented by cold gas thrusters to keep disturbance levels below 0.3 Nm during the operational phase.

Physical characteristics

• Launch mass	9,900 lbs. (4491 kg)
• Electrical power solar array	5000 W
• Continuous power to EURECA experiments	1000 W
• Launch configuration	dia: 14.76 ft (4.5 m.) length: 8.33 ft (2.54 m)
• Volume	132 cubic ft (40.3 m)
• Solar array extended	66 ft x 11.5 ft (20 m x 3.5 m)

User friendliness

Considerable efforts have been made during the design and development phases to ensure that EURECA is a "user friendly" system. As is the case for Spacelab, EURECA has standardized structural attachments, power and data interfaces. Unlike Spacelab, however, EURECA has a decentralized payload control concept. Most of the onboard facilities have their own data handling device so that investigators can control the internal operations of their equipment directly. This approach provides more flexibility as well as economical advantages.

Operations

All EURECA operations are controlled by ESA's Space Operations Centre (ESOC) in Darmstadt, Germany. During the deployment and retrieval operations, ESOC functions as a Remote Payload Operations Control Centre to NASA's Mission Control Center, Houston, and the orbiter is used as a relay station for all the commands.

Throughout the operational phase, ESOC has controlled EURECA through two ground stations at Maspalomas, Canary Islands (Spain), and Kourou, French Guiana. EURECA has been in contact with its ground stations for a relatively short period each day. When it was out of contact, its systems operated with a high degree of autonomy, performing failure detection, isolation and recovery activities to safeguard ongoing experimental processes.

An experimental advanced data relay system, the Inter-orbit Communication Package, was included in the payload. This package communicated with the European Olympus Communication Satellite to demonstrate the possible improvements for future communications with data relay satellites. Such a system will significantly enhance real time data coverage.

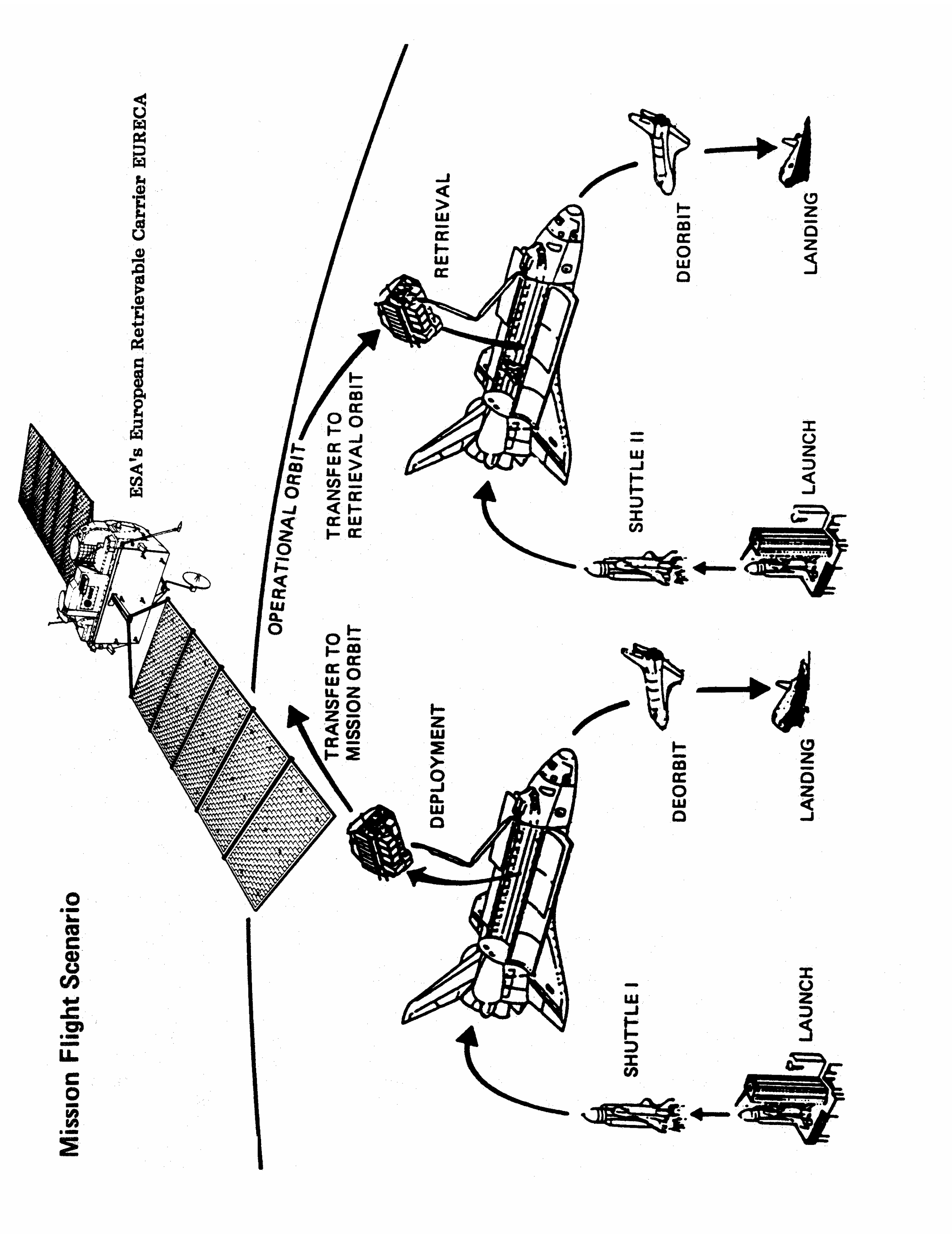
EURECA Retrieval Operations

The EURECA free-flying experiment platform will be retrieved on the fourth day of STS-57. EURECA was deployed from Atlantis on STS-46 on Aug. 1, 1992. During its approximately 10-month stay in orbit, EURECA has supported investigations in processing metallurgical samples, growing crystals and conducting biological and biochemical studies. Several weeks before the STS-57 launch, EURECA controllers will lower the spacecraft's orbit from 270 nautical miles (500 km) high to 257 nautical miles (300 km) in preparation for the retrieval.

David Low will grasp the 5-ton EURECA with the Shuttle's robot arm and lower the platform into latches in the aft cargo bay.

Beginning on flight day one, a series of engine firings will adjust Endeavour's catch-up rate so that on the morning of flight day four, a final altitude adjustment burn will move Endeavour up to the 257-nautical-mile EURECA orbit. During the catch-up maneuvers, Endeavour's onboard navigational star trackers will sight on EURECA during the best lighting period, from noon to sunset of each orbit, to provide the most accurate course correction information for each maneuver.

For the final mid-course corrections, the crew will use Endeavour's rendezvous radar to refine their information about the position of EURECA in relation to Endeavour. For about the final one and a half miles of Endeavour's approach to EURECA, Commander Ron Grabe will fly the Shuttle's maneuvers manually.


Mission Flight Scenario
ESA's European Retrievable Carrier EURECA
OPERATIONAL ORBIT
TRANSFER TO MISSION ORBIT
TRANSFER TO RETRIEVAL ORBIT
DEPLOYMENT
RETRIEVAL
SHUTTLE I
SHUTTLE II
DEORBIT
DEORBIT
LAUNCH
LAUNCH
LANDING
LANDING

EURECA RETRIEVABLE CARRIER

Structure

The EURECA structure is made of high strength carbon-fiber struts and titanium nodal points joined together to form a framework of cubic elements. This provides relatively low thermal distortions, allows high alignment accuracy and simple analytical verification, and is easy to assemble and maintain.

Larger assemblies are attached to the nodal points. Instruments weighing less than 220 lbs. (100 kg) are assembled on standard equipment support panels similar to those on a Spacelab pallet.

Thermal Control

Thermal control for EURECA combines active and passive heat transfer and radiation systems. Active transfer, required for payload facilities which generates more heat, is achieved by means of a Freon cooling loop which dissipates the thermal load through two radiators into space. The passive system makes use of multi-layer insulation blankets combined with electrical heaters. During nominal operations, the thermal control subsystem rejects a maximum heat load of about 2300 W.

Electrical Power

The electrical power subsystem generates, stores, conditions and distributes power to all the spacecraft subsystems and to the payload. The deployable and retractable solar arrays, with a combined raw power output of some 5000 W together with four 40 Ah nickel-cadmium batteries, provide the payload with a continuous power of 1000 W, nominally at 28 V, with peak power capabilities of up to 1500 W for several minutes.

Attitude and Orbit Control

A modular attitude and orbit control subsystem (AOCS) was used for attitude determination and spacecraft orientation and stabilization during all flight operations and orbit control maneuvers.

An orbit transfer assembly, consisting of two redundant sets of four thrusters was used to boost EURECA to its operation attitude at 500 km and to return it to its retrieval orbit at about 300 km.

EURECA has been developed under ESA contract by DASA (Deutsche Aerospace/ERNO Raumfahrttechnik) (Germany), and their subcontractors Sener (Spain), AIT (Italy), SABCA (Belgium), AEG (Germany), Fokker (The Netherlands), Matra (France), Snia BPD (Italy), BTM (Belgium) and Laben (Italy).

EURECA SCIENCE

Solution Growth Facility - a multi-user facility dedicated to the growth of monocrystals from solution, consisting of a set of four reactors and their associated control system.

Protein Crystallization Facility - a multi-user solution growth facility for protein crystallization in space. The object of the experiments is the growth of single, defect-free protein crystals of high purity and of a size sufficient to determine their molecular structure by X-Ray diffraction.

Exobiology and Radiation Assembly - a multi-user life science facility for experiments on the biological effects of space radiation.

Multi-Furnace Assembly - a multi-user facility dedicated to material science experiments. It is a modular facility with a set of common system interfaces which incorporates 12 furnaces of three different types, giving temperatures of up to 1400 degrees C.

Automatic Mirror Furnace - an optical radiation furnace designed for the growth of single, uniform crystals from the liquid or vapor phases, using the traveling heater or Bridgman methods.

Surface Forces Adhesion Instrument - studies the dependence of surface forces and interface energies on physical and chemical-physical parameters such as surface topography, surface cleanliness, temperature and the deformation properties of the contacting bodies.

High Precision Thermostat Instrument - an instrument designed for long term experiments requiring microgravity conditions and high precision temperature measurement and control.

Solar Constant And Variability Instrument - designed to investigate the solar constant, its variability and its spectral distribution, and measure:

- fluctuations of the total and spectral solar irradiance
- short term variations of the total and spectral solar irradiance within time scales ranging from hours to few months, and
- long term variations of the solar luminosity in the time scale of years (solar cycles) by measuring the absolute solar irradiance.

Solar Spectrum Instrument - designed to study solar physics and the solar- terrestrial relationship in aeronomy and climatology. It measures the absolute solar irradiance and its variations in the spectral range from 170 to 3200 n.m., with an expected accuracy of 1 percent in the visible and infrared ranges and 5 percent in the ultraviolet range.

Occultation Radiometer Instrument - designed to measure aerosols and trace gas densities in the Earth's mesosphere and stratosphere.

Wide Angle Telescope - designed to detect celestial gamma and X-Ray sources with photon energies in the range 5 to 200 keV and determine the position of the source.

Timeband Capture Cell Experiment - an instrument to study the microparticle population in near-Earth space -- typically Earth debris, meteoroids and cometary dust.

Radio Frequency Ionization Thruster Assembly - designed to evaluate the use of electric propulsion in space and to gain operational experience before endorsing its use for advanced spacecraft technologies.

Advanced Solar Gallium Arsenide Array - to provide valuable information on the performance of gallium arsenide (GaAs) solar arrays and on the effects of the low Earth orbit environment on their components.

GET AWAY SPECIAL EXPERIMENTS

NASA's Get Away Special (GAS) program, managed by the Goddard Space Flight Center (GSFC), Greenbelt, Md., is a vehicle that allows the world to get involved in the U.S. space program. Individuals and organizations of all countries have gained access to space by sending scientific research and development experiments onboard the Space Shuttle via the GAS program. Since its inception, 87 payloads have flown on 18 Space Shuttle missions.

NASA's GAS bridge assembly, a structure which fits across the payload bay of the Space Shuttle orbiter, is capable of holding up to 12 GAS canisters (or cans), and offers an efficient and convenient way to fly multiple payloads simultaneously.

On STS-57, the GAS bridge is flying with a total of 10 GAS payloads from the U.S., Canada, Japan and Europe. Also on the bridge is one secondary payload, a commercialization experiment sponsored by the Consortium for Materials Development in Space at the University of Alabama, Huntsville and one GAS ballast can. Clarke Prouty is GAS Mission Manager and Lawrence R. Thomas is Customer Support Manager for the Shuttle Small Payloads Project at Goddard. The 10 GAS payloads are:

G-022 Liquid Gauging Technology Experiment

Customer: European Space Agency, European Space Research and Technology Centre, Noordwijk, The Netherlands
Customer Manager: Manfred Trischberger
NASA Technical Manager: Richard Hoffman, GSFC

This experiment demonstrates two in-orbit methods of gauging liquids in tanks - the Periodic Volume Stimulus (PVSM) and the Foreign Mass Injection Method (FMIM).

Both approaches work well in the presence of gravity, but the peculiar properties of liquid under microgravity conditions could lead to a lower measurement accuracy. This experiment will study, in particular, errors caused by the following effects:

- liquid distribution in the tank
- unconnected liquid quantities
- uneven heating
- unintentional intrusion of fluid in pipes, sensor apertures, etc.

G-324 CAN DO

Customer: Charleston County School District, Charleston, S. C.
Customer Manager: Carol A. Tempel
NASA Technical Manager: Neal Barthelme, GSFC

A detailed description of G-324 CAN DO is available in the educational activities part of the STS-57 press kit.

G-399 Insulin Tagging and Artemia Growth Experiments

Customer: Dr. Ronald S. Nelson, Inc., Fresno, Calif.
Customer Manager: Dr. Ronald S. Nelson
NASA Technical Manager: Gary Sneiderman, GSFC

This payload is composed of two experiments. Its primary objective is to successfully operate an insulin tag experiment and a brine shrimp Artemia physiology experiment. The experiments also will focus on educating students about all aspects of carrying out scientific experiments.

G-450 Multiple Experiments

Customer: Vandenberg Section, American Institute of Aeronautics and

Astronautics, Vandenberg AFB, Calif.
Customer Manager: Martin Waldman
NASA Technical Manager: Mark Anderson, GSFC

This is a multi-disciplinary package composed of six self-contained modules, each containing multiple experiments. The experiments are designed and developed by California Central Coast elementary, middle and high schools.

- Module one contains solidification/crystallization of saccharin and cryogen transfer.

- Module two addresses the effects of radiation on bacteria and effects of microgravity on sprouting seeds.

- Module three is bacteria survival in radiation and zero point energy.

- Module four consists of electrode occlusion and bubble formation and microgravity bonding.

- Module five contains osmosis, reverse osmosis and effects of radiation on seeds.

- Module six is crystal growth, fluids in microgravity and silver crystal growth.

G-452 Crystal Growth of Gallium-Arsenide

Customer: Society of Japanese Aerospace Companies, Tokyo, Japan
Customer Manager: Dr. Naotake Tateyama
NASA Technical Manager: Herb Foster, GSFC

This GAS can consists of 12 small electric furnaces. The four kinds of experiments to be carried out in low gravity are:

- Growth of a single crystal gallium-arsenide from liquid phase
- Growth of a crystal gallium-arsenide based mixed crystal
- Addition of a heavy element to gallium-arsenide
- Addition of a heavy element to indium-antimony crystal

G-453 Semi-Conductors/Superconductor Experiment

Customer: Society of Japanese Aerospace Companies, Tokyo, Japan
Customer Manager: Dr. Naotake Tateyama
NASA Technical Manager: Herb Foster, GSFC

This GAS can contains four different kinds of experiments. Three of the four are materials experiments on semi-conductors and a superconductor, and the other is on boiling an organic solvent under weightlessness.

G-454 Crystal Growth

Customer: Society of Japanese Aerospace Companies, Tokyo, Japan
Customer Manager: Dr. Naotake Tateyama
NASA Technical Manager: Herb Foster, GSFC

This experiment studies the crystal growth of indium gallium arsenic from vapor phase under weightlessness, the crystal growth of three selenic-niobium from vapor phase, the crystal growth of an optoelectric crystal by the diffusion method and formation of superferromagnetic alloy.

G-535 The Pool Boiling Experiment

Customer: NASA Headquarters, Office of Space Science and Applications, Microgravity Sciences Division, Washington, D.C.
Customer Manager: Warren Hodges
NASA Technical Manager: Tom Dixon, GSFC

The objective of this experiment is to improve the understanding of the boiling process. This involves putting a pool of liquid in contact with a surface that can supply heat to the liquid. The experiment will observe heating and vapor bubble dynamics associated with bubble growth/collapse and subsequent bubble motion. The lack of gravity driven motion makes the boiling process easier to study in microgravity.

G-601 High Frequency Variations of the Sun

Customer: San Diego Section, American Institute of Aeronautics and Astronautics, San Diego, Calif.
Customer Manager: Brian Dubow
NASA Technical Manager: Neal Barthelme, GSFC

This experiment will measure and analyze high-frequency variations of the Sun analyzing light that the Sun releases to the Earth. It also will determine better the physics of the Sun and other stars. The primary purpose of the experiment involves measuring rapid variations in the solar flux.

G-647 Configurable Hardware for Multi-Disciplinary Projects in Space (CHAMPS)

Customer: Canadian Space Agency, Ottawa, Ontario, Canada
Customer Manager: Duncan Burnside
NASA Technical Manager: Russ Griffin, GSFC

This is a versatile payload that will provide an inexpensive means for Canadian scientists to conduct their materials science experiments in space. CHAMPS, built by MPB Technologies in Montreal, is designed to be adaptable, combining the advantages of generic and dedicated research facilities for materials processing in space. This experiment will examine a recently-developed technique for crystal growth called Liquid Phase Electro-Epitaxy (LPEE) in a microgravity environment. LPEE regulates crystal growth by passing an electrical current through a subject material.

GAS Ballast Payload

Customer: Goddard Space Flight Center, Greenbelt, Md.

GAS ballast payloads are flown for stability when a GAS payload drops out and no GAS payload is available to replace it. This ballast payload contains a small accelerometer package furnished by Goddard to record accelerations during the mission.

Sample Return Experiment

Jet Propulsion Laboratory, Pasadena, Calif.
Principal Investigator: Dr. Peter Tsou

The Sample Return Experiment (SRE) sits on top the ballast GAS can. The primary science objective of the GAS SRE is the quantification of extraterrestrial particles and other orbital debris present in the orbiter bay. A secondary objective of this experiment will be a realistic test for comet sample collection concepts. The sample particles that are to be encountered and collected have speeds of 10-14 km/second (16-22 m.p.h.) and diameters of 10-200 micrometers.

CONSORTIUM FOR MATERIALS DEVELOPMENT IN SPACE COMPLEX AUTONOMOUS PAYLOAD (CONCAP)

The Consortium for Materials Development in Space Complex Autonomous Payload-IV (CONCAP-IV) is a small, Shuttle cargo bay payload sponsored by the University of Alabama in Huntsville (UAH) Consortium for Materials Development in Space (CMDS). The CMDS is one of the NASA Centers for the Commercial Development of Space (CCDS) managed by NASA's new Office of Advanced Concepts and Technology (OACT).

CONCAP-IV is the fourth area of investigation in a series of payloads deriving their name from the consortium in CMDS and the Complex Autonomous Payload (CAP) program managed by the NASA Goddard Space Flight Center. On STS-57, CONCAP-IV will investigate the growth of nonlinear organic (NLO) crystals by a novel method of physical vapor transport in the weightlessness of the space environment.

Nonlinear optical materials are the key to many optical applications now and in the future -- optical computing is a prime example. Many studies have suggested that the photonics industry ultimately will grow to the scale of the current electronics industry. Just as materials improvements in silicon were essential to electronics, so too are improved optical materials required for advanced in photonics. The investigations in the CONCAP series seek to determine whether crystals grown in space can speed the evolution of photonics.

During the experiment, it is anticipated that the microgravity in space will facilitate two goals of improved NLO crystal growth -- it will avoid convection, leading to crystals grown with more uniform composition, and it will avoid the deformation of the crystals under their own weight at the relatively high growth temperatures where they are extremely soft.

The experiment operation involves heating up a chamber containing the material needed to produce the crystal, but keeping one spot on the chamber walls cooler than the rest of the chamber walls. This method causes the vapor of the material to condense onto the cold spot where the crystal grows, much like water vapor condenses into dew on grass.

Within CONCAP-IV there are six NLO "ovens," each containing two NLO growth cells. Each of the twelve cells is comprised of a glass chamber, about 1 inch in diameter and 2 inches long and contains the sample material to be processed. Each cell is wrapped in a heater. Within each cell is a small copper plug that is kept slightly cooler than the rest of the cell, providing a place for sample material vaporized by the heater to recondense and grow the desired crystal or thin film material.

The "ovens" are constructed from two aluminum cylinders, one inside the other, with the area between them vented to space to form an insulating vacuum -- like a thermos bottle. The resulting reduction in heat loss is a very important consideration since CONCAP-IV is battery-operated, providing a limited power supply. The high and low temperatures in each chamber are controlled by a miniaturized computer designed and built specially for this purpose.

The crystals being grown have two important properties. First, when a laser beam passes through the crystal it comes out with twice the frequency (half the wavelength) of the original beam. This is important because it doubles the range of frequencies available for laser applications. Currently, lasers only operate efficiently at a limited number of frequencies, with some very important frequencies missing for scientific and commercial applications.

Second, when an electric field is applied to some NLO materials, the refractive index of the material changes. When the refractive index changes, so does the path of light traveling through the crystal. This is like having a prism which will bend a light beam different degrees when voltages are applied to the crystal. The changing of the path of a light beam results in the crystals or thin film acting as a high speed, nearly instantaneous switch.

Such properties are extremely important to the optoelectronics and photonics industry, especially for optical computing. Without NLO materials, optical computers would be impossible. Nonlinear optical materials could play the same role in photonics and optoelectronics that semiconductors do in the electronics industry.

Displaytech, Inc., Boulder, Colo., is participating with the UAH CMDS in CONCAP-IV. Displaytech is a commercializer of high-performance electro-optical devices. The Principal Investigator is Dr. Thomas Leslie, Associate Professor, Chemistry Department, UAH. The Payload Manager is William Carswell, Research Associate, UAH.

SUPERFLUID HELIUM ON-ORBIT TRANSFER (SHOOT) FLIGHT DEMONSTRATION

The Superfluid Helium On-Orbit Transfer (SHOOT) Flight Demonstration, managed by NASA's Goddard Space Flight Center, is an experiment designed to develop and demonstrate the technology required to resupply liquid helium containers in space. In addition, components developed for SHOOT may find use in future space cryogenic (low temperature) systems.

Many detectors for astrophysics and observation of Earth require cooling to extremely low temperatures to achieve high sensitivity. To achieve these low temperatures, liquid helium is used for cooling. By allowing the liquid to slowly vaporize, an instrument may be cooled to temperatures below 2 Kelvin (K) (-519o F, -271o C).

Examples of facilities that already have flown using liquid helium are the Infrared Astronomy Satellite (IRAS), launched in 1983, which discovered more than a quarter million new infrared objects and the Cosmic Background Explorer (COBE), launched in 1989, which has studied the Big Bang, the primeval explosion that started the expansion of the universe.

The liquid helium gradually vents to space as it cools the instruments, therefore the instrument has a finite lifetime. It takes only a small amount of heat to evaporate liquid helium. For example, a 100 watt light bulb left on in a 53 gallon (200 liter) dewar would evaporate all the liquid in less than 1.5 hours. Both IRAS and COBE ran out of liquid in 10 to 11 months of operation.

To achieve lower temperatures in the liquid, the vapor pressure is lowered. On the ground, this is accomplished by powerful vacuum pumps. In orbit, this is achieved by venting to the vacuum of space. By doing this, IRAS achieved a temperature of 1.64 K and COBE a temperature of 1.37 K. By contrast, cold, deep space is a relatively warm 2.74 K, twice as warm as COBE's liquid helium. Thus, COBE was the coldest known object in the universe outside of the Earth's atmosphere. SHOOT is expected to set a new low temperature record at 1.1 K.

The SHOOT experiment consists of two vacuum insulated Thermos-like containers, called dewars, each holding 55 gallons (207 liters) of liquid helium. The two dewars are connected by a vacuum insulated transfer line. Liquid helium is pumped from one dewar to another at rates from 1.3 to 4.4 gallons per minute (300 to 1000 liters per hour). Each of dewar's plumbing, including pumps, valves and instrumentation, is nearly identical so that each dewar in turn may act as the supply or receiver dewar.

The SHOOT dewars are attached to a Hitchhiker bridge which spans the width of the orbiter bay. The SHOOT electronics interface to the Shuttle through the Hitchhiker avionics.

Having no viscosity, superfluid helium will leak through the smallest hole. Because the space around the cryogen tank must be a very good vacuum to insulate the liquid, no leak of any size can be tolerated. A leak at room temperature would be approximately 10,000 times greater with superfluid helium. Even an air leak which is so small that it would take 20 million years to fill the dewar is unacceptable. SHOOT has approximately 160 welds and 60 removable metal seals between the superfluid and the vacuum space. All of these have been checked and shown to be absolutely leak tight.

SHOOT will consist of experiments in liquid management in low gravity, filling a large gap in the knowledge of the behavior of cryogens in space. The problem of controlling the position of cryogenic liquids in orbit is a difficult one. The evaporating gas must be allowed to leave the dewar, but the liquid must be contained. On the ground this is easy since the liquid is denser than the gas and gravity holds it in the bottom of the tank. In a low gravity environment, the liquid location is not well defined. Surface tension, heat inputs and the small residual accelerations of a spacecraft all play a role in positioning the liquid.

SHOOT will accomplish the first active management of liquid cryogens in space. A device called a phase separator allows helium vapor to leave the tank while the liquid is retained. The liquid will be gathered from the walls of the tank and fed to a superfluid pump. This pump converts heat directly to pressure by an effect unique to superfluid helium called the fountain effect.

SHOOT is part experiment and part demonstration. Because so little experience with cryogen management in low gravity exists, the first part of SHOOT's on-orbit operations will be to gather as much data as possible about how the liquid is delivered to the pumps by liquid acquisition devices, the behavior of the liquid/vapor discriminators and the slosh and cooldown of the liquid. Control of the experiment will be from the ground through the Payload Operations Control Center at Goddard with the astronauts monitoring from the Shuttle's aft flight deck at key times.

At one point the astronauts will accelerate the orbiter to settle the liquid in one end of the dewar to calibrate sensors. During two transfers, the Shuttle will be accelerated to move the liquid away from the pump to see if such disturbances interrupt the flow. Once the transfer of liquid stops, the acceleration will be stopped and the return of the liquid to the pump will be monitored.

Near the end of the operations, the astronauts will control a transfer completely from the aft flight deck. They will use a program which has some expert system capabilities to control the transfer and diagnose any problems which may occur. This will be the first use of an expert system for a payload on the orbiter.

SHOOT was developed and managed by Goddard for NASA's Office of Space Systems Development, Advanced Program Division, Washington, DC.

SHOOT will:

- achieve the lowest temperature ever in orbit -- 1.1 K (-457o F, 1.1 degrees above absolute zero).
- demonstrate the first active management of liquid cryogen in space.
- demonstrate the first use of an expert system in space.
- demonstrate two types of liquid acquisition systems for delivering liquid to the pump.
- make the first observations of thermal layering and mixing of a cryogen in orbit.
- demonstrate superfluid mass gauging to 1 percent accuracy.
- demonstrate controlled cooldown of a warm dewar.

SHOOT spin-off technologies include:

- Cryogenic motor driven valves are leak tight after hundreds of cycles.
- A liquid/gas phase separator for use with normal liquid helium as well as superfluid, enabling easier ground servicing of future small dewars.
- Liquid/vapor discriminators which can be used for other cryogens as well as liquid helium.
- A relatively simple thermometry system to obtain resolution of 0.00001 K or better.

STS-57 EXTRAVEHICULAR ACTIVITY:
DETAILED TEST OBJECTIVE 1210

STS-57 crew members David Low and Jeff Wisoff will perform a 4-hour extravehicular activity (EVA) on the fifth day of the flight as a continuation of a series of spacewalks NASA plans to conduct to prepare for the construction of the space station.

STS-57 will be launched as a 6-day, 22-hour, 40-minute flight. After launch, if calculations of the amount of fuel and energy required to retrieve EURECA and operate Spacehab match preflight projections, the flight will be extended by 24 hours. The EVA is the lowest priority of any objective or experiment on the flight, and the spacewalk will be performed only if the flight is extended by one day to become about a 7-day, 23-hour flight.

The space station demonstration EVAs, the first of which was performed on STS-54 in January 1993, are designed to refine training methods for spacewalks, expand the EVA experience levels of astronauts, flight controllers and instructors, and aid in better understanding the differences between true microgravity and the ground simulations used in training.

In addition, since the Shuttle's remote manipulator system (RMS) mechanical arm will be aboard Endeavour to retrieve EURECA, the STS-57 spacewalk will assist in refining several procedures being developed to service the Hubble Space Telescope on mission STS-61 in December 1993.

Low will be designated extravehicular crew member 1 (EV1) and Wisoff will be designated extravehicular crew member 2 (EV2). Pilot Brian Duffy will serve as intravehicular crew member 1 (IV1), assisting the spacewalkers from inside the crew cabin of Endeavour.

During the spacewalk, Low and Wisoff first will take turns in a foot restraint mounted on the end of the robot arm, holding their fellow crew member in various ways to imitate moving a large, inanimate piece of equipment. Next, they will investigate different methods of managing their safety tethers while mounted in the robot arm restraint.

Another objective is planned to have each crew member, mounted in the robot arm restraint, practice aligning their fellow crew member into a foot restraint mounted on the side of the cargo bay, simulating the task of aligning a large object into a tightly fitting restraint. The crew members also will practice working with various tools while in the robot arm restraint and gauge the ability of the restraint to hold them steady as they tighten or loosen a bolt.

The information gathered by these tests is expected to apply to both the HST servicing spacewalks and space station construction planning, since moving, aligning and installing objects with large masses from the end of the robot arm will be integral to both jobs.

Among the items hoped to be better determined are the speed at which the arm can be moved while an astronaut holds an object on the end, how large an object it is feasible to handle while in the arm foot restraint, the amount of time required for such tasks using an EVA crew member and the arm and how much stability is supplied by the arm during hands-on work such as tightening bolts and other attachment equipment.

FLUID ACQUISITION AND RESUPPLY EXPERIMENT II

Principal Investigator: Susan L. Driscoll Marshall Space Flight Center, Huntsville, Ala.

The Fluid Acquisition and Resupply Experiment (FARE II) will investigate the dynamics of fluid transfer in microgravity. The experiment previously flew as FARE I on STS-53 in 1992 and also as the Storable Fluid Management Demonstration (SFMD) on STS 51-C in 1985.

In space, liquid in a container does not readily settle on the bottom or leave a pocket of gas on top as it does on Earth. The position of liquids in weightlessness is highly unpredictable because the liquid and gas may locate or mix in any area within the container. To replenish on-board fluids and prolong the life of space vehicles such as the space station, satellites and extended duration orbiters, methods for transferring gas-free propellants and other liquids must be developed.

FARE I was conducted primarily to assess the ability of a screen channel capillary system to drain liquids while working in a microgravity environment. Additionally, some experimentation was conducted regarding the control of liquid motion during tank refill sequences.

Housed in four middeck lockers of the orbiter Endeavour, FARE II is designed to demonstrate the effectiveness of a device to alleviate the problems associated with vapor-free liquid transfer. The device exploits the surface tension of the liquid to control its position within the tank.

The basic flight hardware consists of a 12.5 inches (30.48 cm) spherical supply tank and a 12.5 inches (30.48 cm) spherical receiver tank made of transparent acrylic. Additional items include liquid transfer lines, two pressurized air bottles, a calibrated cylinder and associated valves, lines, fittings, pressure gauges and a flowmeter display unit.

The experiment is essentially self-contained, with the exception of a water- fill port, air-fill port and an overboard vent connected to the orbiter waste management system.

Mission specialists will conduct this experiment eight times during the flight, using a sequence of manual valve operations. Air from the pressurized bottles will be used to force fluid from the supply tank to the receiver tank and back to the supply tank. This process should take about 1 hour each time it is performed. An overboard vent will remove the vapor from the receiver tank as the fluid level rises.

The FARE II control panel, containing four pressure gauges and one temperature control gauge, will be used by the crew to monitor and control the experiment. Camcorder video tapes and 35-mm photographs will be made during the transfer process. The crew also will have the option of using air-to- ground communication to consult with the principal investigator, if necessary.

The test fluid used for this experiment is water with iodine, used as a disinfectant; blue food coloring, which will allow better visibility of the liquid movement; a wetting solution, known as Triton X-100, to give the fluid the consistency of a propellant; and an anti-foaming emulsion agent to prevent bubbles from forming in the receiver tank.

Post-mission analysis of FARE II will include evaluation of the experiment equipment, as well as review of camcorder video tapes and 35-mm photographs. Because there will be no real-time data downlink during this experiment, detailed study and analysis of test data will not be conducted until after the mission.

Historically, problems dealing with fluid orbital transfer have been dealt with by using bellows to move liquid without any pressurant gas or vapor surface. These systems are heavier, more complex, more expensive and more prone to leakage during the transfer process than conventional methods of liquid containment, such as the FARE II equipment.

The mission managed by NASA's Marshall Space Flight Center, Huntsville, Ala., will utilize equipment developed by Martin Marietta. At Marshall, Susan L. Driscoll is the Principal Investigator for FARE II.

AIR FORCE MAUI OPTICAL SYSTEM

The Air Force Maui Optical System (AMOS) is an electrical-optical facility on the Hawaiian island of Maui. No hardware is required aboard Endeavour to support the experimental observations. The AMOS facility tracks the orbiter as it flies over the area and records signatures from thruster firings, water dumps or the phenomena of "Shuttle glow," a well-documented fluorescent effect created as the Shuttle interacts with atomic oxygen in Earth orbit. The information obtained by AMOS is used to calibrate the infrared and optical sensors at the facility.

STS-57 SPECIAL EVENTS & EDUCATIONAL ACTIVITIES

Get-Away-Special #324 -- CAN DO

The Charleston County School District's CAN DO experiment (GAS #324) is designed to take 1,000 photos of the Earth allowing students to make observations and document global change by comparing the CAN DO photos with matched Skylab photos. The canister also contains 350 small passive student experiments. CAN DO is sponsored by NASA's Langley Research Center, Hampton, Va., and supported by the South Carolina Space Grant Consortium.

The CAN DO payload uses GAS hardware and is housed in a 5 cubic foot canister. The canister is sealed with a 0.92 inch fused silica window, which is optically flat and ground to a quarter wave tolerance, permitting photography in visible light, infrared and ultraviolet wavelengths.

The primary payload of CAN DO, known as GEOCAM, contains four Nikon 35-mm cameras equipped with 250 exposure film backs. The GEOCAM system will match closely the larger Skylab film format in both coverage and quality allowing direct examination and comparison of the changes that have occurred to the planet in the last 20 years.

One thousand photographs will be taken by the four cameras over the course of the Shuttle mission. Photographic targets will be chosen by teachers and students based on weather, Sun angle, orbiter orientation and crew activities. Targets selected will be sent to the Shuttle once a day as crew notes.

These efforts will be managed through a student-run mission control room at the Medical University of South Carolina. Student-teacher teams of 12 to 20 will operate four desks monitoring crew activities and mission timeline, monitoring weather data, targeting geological or environmental interests and communicating the target objectives with NASA's Johnson Space Center's Earth Observations Lab and the Shuttle Small Payload Customer Support Room.

Activities and reports from the control room will be televised to students throughout the state by the South Carolina Educational Television Network. The Medical University of South Carolina will provide technical assistance.

The CAN-DO teachers have designed classroom activities for grades K- 12 using the 1,000 photos to make observations. The photos comprise the first educational payload to photograph the Earth from space. Students will search for natural and human-induced environmental changes that may have taken place during the past 20 years. Comparison between the photos, past and present, enables students to discover for themselves the major effects caused by deforestation, urbanization, river sediment loads, desertification, coastal erosion, lake levels wetlands and pollution.

With assistance from atmospheric scientists, the photos should provide clues to the degradation of the air quality often mentioned by astronauts. Faculty members of the College of Charleston will aid in the interpretation of the results.

The second experiment carried on CAN DO is 350 student-designed experiments. No other GAS payload in the history of the space program has ever undertaken this many different experiments. These experiments have been submitted from more than 60 Charleston County classrooms and from invited school districts from Maryland, Virginia, Texas, Arizona and Massachusetts.

These experiments allow students to participate directly in research by testing the effect of space on various materials. Students from K-12 have chosen materials ranging from brine shrimp eggs to bubble solution to lipstick to cotton seeds to fly in space. A major goal of the student experiments is to teach the skills of proper experimental design as well as execution of valid scientific experiments.

Each student team has five samples of their materials in small 5 ml cryovials: one to fly in space, one to serve as a passive control and one each to be exposed to high doses of radiation, extreme cold and centrifuge. The control procedures will be carried out at the Medical University of South Carolina as part of its Business/Education Partnership Program with the Charleston County School District Office of Math, Sciences and Technology.

In addition to the students' vial experiments, the WESTVACO Forestry Division has donated Sycamore and Loblolly Pine seeds to be placed into the canister. Classes participating in CAN DO will receive seedlings grown from space-exposed seeds and encouraged to raise "space trees."

Students and teachers from the Poquoson School District in Poquoson, Va., are participating in the payload's student-designed experiments. Also, a team of Poquoson secondary students will travel to Charleston and operate the weather desk at the student mission control. NASA Langley atmospheric research scientists will provide appropriate training to the Poquoson students for their weather desk assignment.

SHUTTLE AMATEUR RADIO EXPERIMENT-II

The Shuttle Amateur Radio Experiment-II (SAREX-II) provides for public participation in the space program, supports educational initiatives and demonstrates the effectiveness of making contact between the Space Shuttle and low-cost amateur "ham" radio stations on the ground.

On STS-57, Pilot Brian Duffy, call sign N5WQW, and Janice Voss, call sign to be determined, will operate SAREX. Duffy has operated SAREX in flight before during Shuttle mission STS-45. Operating times for school contacts are planned into the crew's activities. The school contacts generate interest in science as students talk directly with Voss or Duffy. There will be voice contacts with the general ham operator community as time permits. and short wave listeners (SWLs) worldwide also may listen. When Voss or Duffy are not available, SAREX- II will be in an automated digital response mode.

On STS-57, SAREX-II will include VHF FM voice and VHF packet. The primary voice frequency that SAREX-II uses is 145.55 MHz downlink. There are a variety of uplink frequencies. Contacts with Endeavour will be possible between 42 degrees north latitude to 42 degrees south latitude, covering the lower half of the continental United States and Hawaii, all of Africa, most of South America, Australia, the East and the Far East.

SAREX has flown previously on STS-9, STS-51F, STS-35, STS-37, STS-45, STS-50, STS-47, STS-55 and STS-56. SAREX is a joint effort of NASA, the American Radio Relay League (ARRL), the Amateur Radio Satellite Corp. (AMSAT), and the Johnson Space Center's Amateur Radio Club. Information about orbital elements, contact times, frequencies and crew operating schedules will be made available during the mission by these agencies and by amateur radio clubs at some other NASA centers.

Hams from the JSC club, W5RRR, will be operating on amateur short wave frequencies, and the ARRL station, W1AW, will include SAREX information in its regular voice and teletype bulletins. The amateur radio station at the Goddard Space Flight Center, WA3NAN, in Greenbelt, Md., will operate around-the-clock during the mission, providing information and re-transmitting live Shuttle air-to- ground audio. The JSC Public Affairs Office will operate a SAREX information desk during the mission, and mission information also will be available on the dial-up computer bulletin board (BBS) at JSC.SAREX Frequencies.

	Shuttle Transmitting Frequency	**Shuttle Receiving Frequency**
U.S.	145.55 MHz	144.99 MHz
South America	145.55	144.97
& Asia	145.55	144.95
	145.55	144.93
	145.55	144.91
Europe	145.55	144.70
	145.55	144.75
	145.55	144.80
South Africa	145.55	144.95
Packet	145.55	144.49

GSFC Amateur Radio Club (WA3NAN) planned HF operating frequencies

3.860 MHz   7.185 MHz   14.295 MHz   21.395 MHz   28.395 MHz

To connect to the JSC Compute Bulletin Board, BBS, (8 N 1 1200 baud) dial 713/483-2500 then type 62511.

STS-57 CREWMEMBERS

STS057-S-002 -- These seven astronauts are in training for NASA's STS-57 mission scheduled for spring of this year. In front are astronauts Brian Duffy (left) and Ronald J. Grabe, pilot and mission commander, respectively. In back are (left to right) astronauts Peter J. Wisoff, Nancy J. Sherlock, Janice E. Voss, all mission specialists; and G. David Low, mission specialist and payload commander.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

RONALD J. GRABE, 47, Col., USAF, will be Commander (CDR) of STS-57. Selected as an astronaut in August 1981, Grabe considers New York, N. Y., his hometown and will be making his fourth space flight.

Grabe graduated from Stuyvesant High School, New York, in 1962. He received a bachelors degree in engineering from the United States Air Force Academy in 1966 and studied aeronautics as a Fulbright Scholar at the Technische Hochschule, Darmstadt, West Germany in 1967.

Grabe first flew as Pilot for Shuttle mission STS-51J in October 1985. On his second flight, he was Pilot for Shuttle mission STS-30 in May 1989. On his most recent flight he was Commander of Shuttle mission STS-42 in January 1992. Grabe has logged more than 387 hours in space.

BRIAN DUFFY, 39, Col., USAF, will serve as Pilot (PLT). Selected as an astronaut in June 1985, Duffy was born in Boston, Mass., and will be making his second space flight.

Duffy graduated from Rockland High School, Rockland, Mass., in 1971. He received a bachelors degree in mathematics from the Air Force Academy in 1975 and a masters degree in systems management from the University of Southern California in 1981.

Duffy first flew as Pilot of STS-45 in March 1992 and has logged more than 214 hours in space.

G. DAVID LOW, 37, will serve as Payload Commander and Mission Specialist 1 (MS1). Selected as an astronaut in May 1984, Low was born in Cleveland and will be making his third spaceflight.

Low graduated from Langley High School, McLean, Va., in 1974. He received a bachelors degree in physics-engineering from Washington and Lee University in 1978, a bachelors degree in mechanical engineering from Cornell University in 1980 and a masters degree in aeronautics and astronautics from Stanford University in 1983.

Low first flew as a mission specialist aboard STS-32 in January 1990. His next flight was as a mission specialist on STS-43 in August 1991. He has logged more than 474 hours in space.

NANCY JANE SHERLOCK, 34, Capt., USA, will serve as Mission Specialist 2 (MS2). Selected as an astronaut in January 1990, Sherlock considers Troy, Ohio, her hometown and will be making her first space flight.

Sherlock graduated from Troy High School in 1977. She received a bachelors degree in biological science from Ohio State University in 1980 and a masters degree in safety engineering from the University of Southern California in 1985.

After serving as a Neuropathology Research Assistant for 3 years at the Ohio State University College of Medicine, Sherlock was commissioned in the U. S. Army in 1981. She attended the Army Aviation School and later served as a UH-1H instructor pilot and a standardization instructor pilot for all phases of rotary wing flight. She has logged more than 2,900 hours flying time in rotary wing and fixed wing aircraft.

Sherlock was assigned to NASA as a flight simulation engineer on the Shuttle Training Aircraft at the Johnson Space Center in 1987, developing and directing engineering flight tests, a position she held at the time of her selection.

BIOGRAPHICAL DATA

PETER J. K. (JEFF) WISOFF, 34, will serve as Mission Specialist 3 (MS3). Selected as an astronaut in January 1990, Wisoff was born in Norfolk, Va., and will be making his first space flight.

Wisoff graduated from Norfolk Academy in 1976. He received a bachelors degree in physics from the University of Virginia in 1980, a masters degree in applied physics from Stanford University in 1982 and a doctorate in applied physics from Stanford in 1986.

After completing his doctorate, Wisoff joined the Rice University faculty in the Electrical and Computer Engineering Department, researching the development of new vacuum ultraviolet and high intensity laser sources and the medical application of lasers to the reconstruction of damaged nerves. He is currently collaborating with researchers at Rice University on developing new techniques for growing and evaluating semiconductor materials using lasers.

JANICE VOSS, 36, will serve as Mission Specialist 4 (MS4). Selected as an astronaut in January 1990, Voss considers Rockford, Ill., her hometown and will be making her first space flight.

Voss graduated from Minnechaug Regional High School in Wilbraham, Mass., in 1972. She received a bachelors degree in engineering science from Purdue University in 1975, a masters degree in electrical engineering from the Massachusetts Institute of Technology (MIT) in 1977 and a doctorate in aeronautics and astronautics from MIT in 1987.

Voss was a cooperative education employee at the Johnson Space Center from 1973 to 1975, working with computer simulations in the Engineering and Development Directorate. In 1977, she returned to JSC to work as a crew trainer, teaching entry guidance and navigation. After completing her doctorate, she joined Orbital Sciences Corp., working on mission integration and flight operations support for the Transfer Orbit Stage, a position she held at the time of her selection.

STS-57 MISSION MANAGEMENT

NASA HEADQUARTERS, WASHINGTON, DC

Office of Space Flight

Jeremiah W. Pearson III	Associate Administrator
Bryan O'Connor	Deputy Associate Administrator
Tom Utsman	Space Shuttle Program Director
Leonard Nicholson	Space Shuttle Program Manager (JSC)
Col. Brewster Shaw	Deputy Space Shuttle Program Manager (KSC)

Office of Space Systems Development

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George Levin	Chief, Advanced Space Systems
Michael Card	Program Manager, SHOOT

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Andrew B. Dougherty	Spacehab Utilization Program Manager
Richard H. Ott	Director (Acting), Space Processing Division
Ana M. Villamil	Deputy Director (Acting), Space Processing Division
Dan Bland	Commercial Middeck Augmentation Module Project Manager (JSC)

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Col. Frederick Gregory	Associate Administrator
Charles Mertz	(Acting) Deputy Associate Administrator
Richard Perry	Director, Programs Assurance

Office of Life and Microgravity Sciences and Applications

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John T. Conway	Director, Payload Management and Operations
P. Thomas Breakfield	Director, Shuttle Payload Operations

Marshall Space Flight Center, Huntsville, AL

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Alexander A. McCool	Manager, Shuttle Projects Office
Dr. George McDonough	Director, Science and Engineering
James H. Ehl	Director, Safety and Mission Assurance
Otto Goetz	Manager, Space Shuttle Main Engine Project
Victor Keith Henson	Manager, Redesigned Solid Rocket Motor Project
Cary H. Rutland	Manager, Solid Rocket Booster Project
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Johnson Space Center, Houston, TX

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Paul J. Weitz	Deputy Director
Daniel Germany	Manager, Orbiter and GFE Projects
David Leestma	Director, Flight Crew Operations
Eugene F. Kranz	Director, Mission Operations
Henry O. Pohl	Director, Engineering
Charles S. Harlan	Director, Safety, Reliability and Quality Assurance

Stennis Space Center, Bay St. Louis, MS

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Gerald Smith	Deputy Director
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Ames-Dryden Flight Research Facility, Edwards, CA

Kenneth J. Szalai	Director
Robert R. Meyers Jr.	Assistant Director
James R. Phelps	Chief, Shuttle Support Office.

Ames Research Center, Mountain View, CA

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Victor L. Peterson	Deputy Director
Dr. Joseph C. Sharp	Director, Space Research

Goddard Space Flight Center, Greenbelt, MD

Dr. John Klineberg	Center Director
Thomas E. Huber	Director, Engineering Directorate
Robert Weaver	Chief, Special Payloads Division
David Shrewsberry	Associate Chief, Special Payloads Division

SHUTTLE FLIGHTS AS OF JUNE 1993

55 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 30 SINCE RETURN TO FLIGHT

		STS-56 04/08/83 - 04/17/93		
		STS-53 12/02/92 - 12/09/92		
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92		
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91		
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92
OV-102 Columbia (14 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery (16 flights)**	**OV-104 Atlantis (12 flights)**	**OV-105 Endeavour (3 flights)**