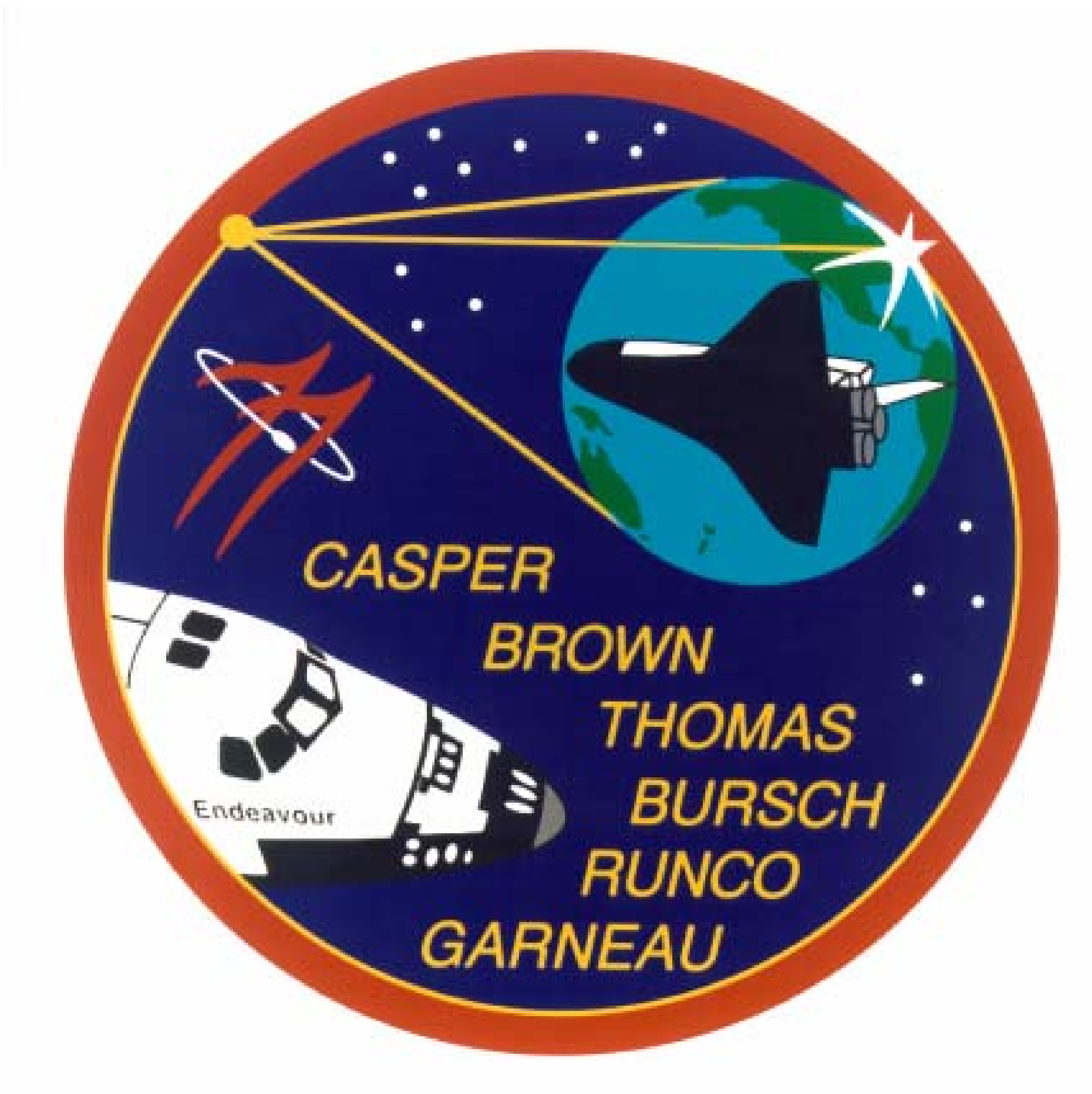
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-77

PRESS KIT
MAY 1996



SPARTAN-207, SPACEHAB-4

STS-77 INSIGNIA

STS077-S-001 -- The STS-77 insignia, designed by the crewmembers, displays the space shuttle Endeavour the lower left and its reflection within the tripod and concave parabolic mirror of the Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN) Inflatable Antenna Experiment (IAE). The center leg of the tripod also delineates the top of the Spacehab's shape, the rest of which is outlined in gold just inside the red perimeter. The Spacehab is carried in the payload bay and houses the Commercial Float Zone Furnace (CFZF) and Space Experiment Facility (SEF) experiments. Also depicted within the confines the IAE mirror are the mission's rendezvous operations with the Passive Aerodynamically Stabilized Magnetically Damped Satellite/Satellite Test Unit (PAM/STU) satellite and a reflection of Earth. The PAM/STU satellite appears as a bright six-pointed star-like reflection of the Sun on the edge of the mirror with the space shuttle Endeavour in position to track it. The sunglint on the mirror's edge, which also appears as an orbital sunset, is located over Goddard Space Flight Center (GSFC), the development facility for the SPARTAN/IAE and Technology Experiments Advancing Missions in Space (TEAMS) experiments. The reflection of Earth is oriented to show the individual countries of the crew as well as the ocean which Captain Cook explored in the original Endeavour. The mission number "77" is featured as twin stylized chevrons and an orbiting satellite as adapted from NASA's insignia. The stars at the top are arranged as seen in the northern sky in the vicinity of the constellation Ursa Minor. The field of 11 stars represents both the TEAMS cluster of experiments (the four antennae of Global Positioning System Attitude and Navigation Experiment (GANE), the single canister of Liquid Metal Thermal Experiment (LMTE), the three canisters of Vented Tank Resupply Experiment (VTRE), and the canisters of PAM/STU, and the 11th flight of the Endeavour. The constellation at the right shows the four stars of the Southern Cross for the fourth flight of Spacehab.

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.

NEWS MEDIA CONTACTS

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RELEASE: 96-83

SPACE COMMERCIALIZATION AND TECHNOLOGY DEMONSTRATIONS HIGHLIGHT SHUTTLE MISSION STS-77

NASA's fourth Shuttle mission of 1996 is devoted to the continuing effort to help open the commercial space frontier.

During the flight, designated STS-77, Endeavour and a six-person crew will perform microgravity research aboard the commercially owned and operated SPACEHAB Module. Endeavor's crew also will deploy and retrieve a research satellite and perform rendezvous operations with a test satellite.

Launch of Endeavour is currently targeted for May 16, 1996 at approximately 6:32 a.m. EDT from Kennedy Space Center's Launch Complex 39-B. The STS-77 mission is forecast to last 10 days, 0 hours, 37 minutes. The actual STS-77 flight duration will be determined by power consumption and the amount of cryogenic fuel available to support Endeavour's electrical power system depending on how close to the target launch date Endeavour actually begins its mission. Mission Control in Houston will closely monitor power consumption along with cryo reserves. Shuttle managers will have the option of shortening the mission one day if necessary. An on-time launch and full 10-day mission duration will result in a landing on May 26 at 7:09 a.m. EDT at Kennedy Space Center's Shuttle Landing Facility, FL.

The STS-77 crew is commanded by John Casper, making his fourth Shuttle flight. The pilot for the mission, Curt Brown, is making his third flight. There are four mission specialists assigned to the flight. Andrew Thomas, serving as Mission Specialist-1, is making his first flight. Mission Specialist-2 is Dan Bursch is making his third flight. Mario Runco, serving as Mission Specialist-3, also is making his third flight. Mission Specialist-4 is Canadian astronaut Marc Garneau, who is flying in space for the second time.

Over 90 percent of the payloads aboard Endeavour are being sponsored by NASA's Office of Space Access and Technology, Washington, DC, through its Commercial Space Centers and their industrial affiliates. Primary payloads include experiments flying aboard the pressurized, commercially-developed SPACEHAB Module, the Inflatable Antenna Experiment to be deployed aboard the free-flying Spartan-207 carrier spacecraft, and a suite of four technology experiments known as "TEAMS," in the Shuttle's payload bay.

Additionally, secondary experiments on the flight will include a 'Brilliant Eyes' cryo-cooling experiment, a facility for examining the effect of microgravity on small aquatic creatures, and a small facility for examining the microgravity effects on simple living systems.

In 1990 NASA contracted SPACEHAB, Inc. for the lease of their SPACEHAB Space Research Laboratories for a series of flights. STS-77 marks the fourth flight of the SPACEHAB under this contract.

The SPACEHAB single module will be carrying nearly 3,000 pounds of experiments and support equipment for 12 commercial space product development payloads in the areas of biotechnology, electronic materials, polymers and agriculture as well as several experiments for other NASA payload organizations. One of these, the Commercial Float Zone Facility (CFZF) has been developed through international collaboration between the U.S., Canada and Germany. It will heat various samples of electronic and semi-conductor material through the float zone technique.

Another facility on SPACEHAB will be the Space Experiment Facility (SEF), which will grow crystals by vapor diffusion. This experiment is expected to yield large, defect-free crystals that are important for electronic applications and remote sensing.

In addition to the SPACEHAB module, the Goddard Space Flight Center's deployable Spartan 207 is another one of the primary payloads on this flight and the most ambitious Spartan mission to date. It will deploy and test the Inflatable Antenna Experiment (IAE). The IAE experiment is meant to lay the groundwork for future technology development in inflatable space structures and will be launched and inflated like a balloon on orbit. The experiment will validate the deployment (inflation) and performance of a large inflatable antenna during a ninety-minute mission. The antenna structure then will be jettisoned and the Spartan spacecraft recovered at mission end.

Inside Endeavour's cargo bay will be four experiments called Technology Experiments for Advancing Missions in Space (TEAMS): The Global Positioning System (GPS) Attitude and Navigation Experiment (GANE) will determine to what accuracy the GPS system can supply attitude information to a space vehicle; the Vented Tank Resupply Experiment (VTRE) will test improved methods for in-space refueling; the Liquid Metal Thermal Experiment (LMTE), which will evaluate the performance of liquid metal heat pipes in microgravity conditions, and the Passive Aerodynamically Stabilized Magnetically Damped Satellite (PAMS) payload will be a technology demonstration of the principle of aerodynamic stabilization in the upper atmosphere of low-Earth orbit. Cameras on the Shuttle will record the PAMS satellite as it is deployed. Later during the mission the Shuttle will rendezvous with the satellite on two separate days and will point the PAMS measuring system, while cameras aboard the Shuttle record the satellite's movements.

The Brilliant Eyes Ten Kelvin Sorption Cryocooler Experiment (BETSCE) carries an instrument that can quickly cool infrared and other sensors to near absolute zero using the evaporation of hydrogen. BETSCE is a technology demonstration experiment to show that cryocoolers of this type, called "sorption coolers," can operate in the absence of gravity. Sorption coolers have essentially no vibration, are very efficient at these cold temperatures, and can operate reliably for over 10 years.

NASA's Office of Life and Microgravity Sciences and Applications, Washington, DC, is responsible for two experiments. The two experiments are the Aquatic Research Facility (ARF), and the Biological Research In a Canister (BRIC). The ARF is a joint Canadian Space Agency/NASA project and will be making its first flight into space on Endeavour. The ARF allows sophisticated investigations with a wide range of small aquatic species. The facility will permit scientists to investigate the process of fertilization, embryo formation and development of calcified tissue and feeding behaviors of small aquatic organisms while in microgravity.

The BRIC payload has flown several times. The focus on this flight will be on the tobacco hornworm during its metamorphosis period. This study will examine the synthesis of protein necessary to form muscle. Analysis will be made using the hemolymph (blood), flight muscle, intersegmental muscles and cuticle of the insect. This study will clarify the mechanism(s) behind one endocrine system in insects which may aid in research on endocrine systems in general, including those of humans when subject to microgravity effects.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

NASA Television Transmission

NASA Television is available through the Spacenet-2 satellite system. Spacenet-2 is located on Transponder 5, at 69 degrees West longitude, frequency 3880.0 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, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; 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 at 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 provided 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 payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

The NASA Headquarters Public Affairs Internet Home Page provides access to the STS-77 mission press kit and status reports. The address for the Headquarters Public Affairs Home Page is:
http://www.nasa.gov/hqpao/hqpao_home.html

Informational materials, such as status reports and TV schedules, also are available from an anonymous FTP (File Transfer Protocol) server at **ftp.hq.nasa.gov/pub/pao**. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

Pre-launch status reports from KSC are found under ftp.hq.nasa.gov/pub/pao/statrpt/ksc, and mission status reports can be found under ftp.hq.nasa.gov/pub/pao/statrpt/jsc. Daily TV schedules can be found under ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked.

Access by CompuServe

Users with CompuServe accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

STS-77 QUICK LOOK

Launch Date/Site:	May 16, 1996/KSC Launch Pad 39-B
Launch Time:	6:32 AM EDT
Launch Window:	2 hours, 30 minutes
Orbiter:	Endeavour (OV-105), 11th flight
Orbit Altitude/Inclination:	153 nautical miles, 39 degrees
Mission Duration:	10 days, 37 minutes (if power margins permit)
Landing Date:	May 26, 1996
Landing Time:	7:09 AM EDT
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Sites Ben Guerir, Morocco Moron, Spain Zaragoza, Spain Abort-Once Around: Edwards Air Force Base, CA
Crew:	John Casper, Commander (CDR) Curt Brown, Pilot (PLT) Andrew Thomas, Mission Specialist 1 (MS 1) Dan Bursch, Mission Specialist 2 (MS 2) Mario Runco, Mission Specialist 3 (MS 3) Marc Garneau, Mission Specialist 4
EVA Crew (if required):	Mario Runco (EV 1), Dan Bursch (EV 2)
Cargo Bay Payloads:	SPACEHAB-04 BETSCE Spartan-207/IAE TEAMS-01
In-Cabin Payloads:	ARF-1 BRIC-07

SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes for STS-76 include:

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

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit of the Earth before landing at the Kennedy Space Center, FL.

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

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

MISSION SUMMARY TIMELINE

Flight Day 1
Launch/Ascent
OMS-2 Burn
SPACEHAB Activation
RMS Checkout

Flight Day 2
SPACEHAB Operations
Rendezvous Tool Checkout
Spartan Deploy
IAE Inflation and Jettison
Separation Maneuvers

Flight Day 3
Spartan Rendezvous and Retrieval
SPACEHAB Operations

Flight Day 4
SPACEHAB Operations
PAMS-STU Ejection and Initial Separation

Flight Day 5
SPACEHAB Operations
TEAMS Operations
PAMS-STU Rendezvous Maneuvers

Flight Day 6
TEAMS Operations
SPACEHAB Operations
Off Duty Time

Flight Day 7
PAMS-STU Rendezvous and Stationkeeping
Separation Maneuver
SPACEHAB Operations

Flight Day 8
PAMS-STU Rendezvous
Stationkeeping and Final Separation
SPACEHAB Operations

Flight Day 9
TEAMS Operations
SPACEHAB Operations
Educational Activities
Crew News Conference

Flight Day 10
TEAMS Operations
SPACEHAB Operations
Flight Control System Checkout
Reaction Control System Hot-Fire
Cabin Stow

Flight Day 11
SPACEHAB Deactivation
Deorbit Prep
Deorbit Burn
KSC Landing

STS-77 ORBITAL EVENTS SUMMARY

(Based on a May 16, 1996 Launch)

Event	MET	Time of Day (EDT)
Launch	0/00:00	6:32 AM, May 16
OMS-2	0/00:43	7:15 AM, May 16
Spartan-207/IAE Release	1/01:02	7:34 AM, May 17
IAE Inflation	1/03:04	9:36 AM, May 17
IAE Jettison	1/04:34	11:06 AM, May 17
Spartan Grapple	2/04:05	10:37 AM, May 18
PAMS-STU Ejection	2/22:43	5:15 AM, May 19
Crew News Conference	8/01:10	7:42 AM, May 24
Deorbit Burn	9/23:37	6:09 AM, May 26
KSC Landing	10/00:37	7:09 AM, May 26

PAYLOAD AND VEHICLE WEIGHTS

	Pounds
Orbiter (Endeavour) empty and 3 SSMEs	152,696
Shuttle System at SRB Ignition	4,519,288
Orbiter Weight at Landing with Cargo	254,879
SPACEHAB Module	8,948
Spartan-207	1,866
Inflatable Antenna Experiment	992
PAMS-STU	115
BETSCE	887
Aquatic Research Facility	117
BRIC	68

CREW RESPONSIBILITIES

Payloads	Prime	Backup
SPACEHAB	Thomas	Garneau
Remote Manipulator System	Garneau	Runco, Thomas
Rendezvous	Casper	Brown, Bursch
Spartan/IAE	Thomas	Runco
TEAMS	Runco	Thomas
PAMS-STU	Runco	Bursch
EVA	Runco (EV 1), Bursch (EV 2)	--------
Intravehicular Crewmember	Brown	--------
GBA	Garneau	Brown
GANE	Runco	Thomas
Secondaries	Thomas	Garneau
DSOs	Brown	Casper
Earth Observations	Runco	Thomas

DEVELOPMENTAL TEST OBJECTIVES/ DETAILED SUPPLEMENTARY OBJECTIVES

DTO 301D	Ascent Structural Capability Evaluation
DTO 305D	Ascent Compartment Venting Evaluation
DTO 306D	Descent Compartment Venting Evaluation
DTO 307D	Entry Structural Capability
DTO 312	External Tank Thermal Protection System Performance
DTO 415	Water Spray Boiler Electrical Heater Capability
DTO 700-8	Global Positioning System Development Flight Test
DTO 805	Crosswind Landing Performance
DSO 331	LES and Sustained Weightlessness on Egress Locomotion
DSO 487	Immunological Assessment of Crewmembers
DSO 491	Characterization of Microbial Transfer Among Crewmembers
DSO 493	Monitoring Latent Virus Reaction and Shedding in Astronauts
DSO 802	Educational Activities
DSO 901	Documentary Television
DSO 902	Documentary Motion Picture Photography
DSO 903	Documentary Still Photography

SPARTAN 207/IAE

Spartan 207 (SP207/IAE) is one of the primary payloads on mission STS-77 and the most ambitious Spartan mission to date. The STS-77 crew will deploy and test --as the Spartan spacecraft's sole payload -- the Inflatable Antenna Experiment (IAE).

Managed by Goddard, Spartan is designed to provide short-duration, free-flight opportunities for a variety of scientific studies. The Spartan carrier provides an attitude control system, a data handling and power system, and a thermal control system. A typical Spartan configuration consists of two main pieces of hardware, a Spartan Flight Support Structure (SFSS) and a Spartan free-flyer with the experiment. Part of the SFSS is the Release Engage Mechanism (REM) which allows the free-flyer to be removed from and returned to its berthing position in the Orbiter cargo bay. The free-flyer is deployed and retrieved by the Remote Manipulator System which is operated by an astronaut.

This mission's Spartan configuration is unique in that the IAE is in an additional separate unit that will be ejected once the experiment has completed. Only the Spartan carrier with the experiment recorders will be returned to the cargo bay.

This is the second flight for this Spartan carrier, which flew successfully on STS-63 in February 1995. It is the fifth flight for the cross-bay support structure, and the third for the REM. Overall, STS-77 will be the eighth Spartan mission to fly on the Space Shuttle.

The IAE experiment will lay the groundwork for future technology development in inflatable space structures, which will be launched and then inflated like a balloon on-orbit. This payload will validate the deployment (inflation) and performance of a large inflatable antenna during a ninety- minute sequence before jettisoning the antenna structure and recovering the Spartan spacecraft at sequence end. The inflation process will be captured by the crew, using a variety of still cameras, a motion picture camera, and video cameras. The on-orbit performance of the antenna (surface accuracy) will be determined by illuminating the antenna surface with arrays of lights mounted on the Spartan and capturing the resulting patterns on video recorders aboard the Spartan. These will be analyzed after the Spartan is returned to Earth by the Shuttle.

The IAE is a large inflatable antenna 50 feet (14 meters) in diameter which is mounted on three 92-foot (28 meter) struts. Once in low-Earth orbit, the Spartan will become a platform for the antenna which, when inflated in space, will be roughly the size of a tennis court. The antenna was developed by L'Garde Inc., of Tustin, CA, a small aerospace business, and JPL under NASA's In-Space Technology Experiments Program.

Because the mass and stowed (uninflated) volume of inflatable components is many times less than an equivalent solid structure, inflatable structures have the potential to significantly reduce by 10 to 100 times the cost of future missions using these components. This inflatable antenna weighs only about 132 pounds (60 kilograms) and the operational version may be developed for less than $10 million -- a substantial savings over current mechanically deployable hard structures that may cost as much as $200 million to develop and deliver to space.

Inflatable structures also have the potential to deploy much more reliably than conventional mechanical systems used for deploying rigid structures. In addition, the small packaged size of the inflatable components allows very large structures to be deployed in space with a single small launch vehicle. For example, large space antennas many times the size of today's mechanical orbiting antennas could be used for a variety of applications in space, including satellite antennas for space and mobile communications, Earth observations, astronomical observations, and space-based radar.

The IAE is a prime example of a low-cost technology validation experiment. These experiments are designed to inexpensively test the fundamental performance of a technology in the weightless vacuum of space when it is impossible to do so on the ground. Inflatable systems cannot be evaluated on Earth due to the effects of gravity and atmospheric pressure on the balloon structure. They must be tested on-orbit and the results compared with analytical predictions to achieve the confidence necessary to allow their use in operational systems.

Additionally, the Spartan carrier itself will be implementing new technologies. It will be testing a Solid-State Recorder using flash EEPROM memory, developed under a Small Business Innovative Research contract between Goddard and SEAKR Engineering, Inc. of Englewood, CO. Some of the electronics boxes on the Spartan carrier implemented a Parylene coating process that allows the use of commercial plastic integrated circuits on-orbit.

Experiment and Mission Management

The Spartan project is managed by NASA's Goddard Space Flight Center, Greenbelt, MD, for the Office of Space Science, Washington, DC. IAE is sponsored by NASA's Office of Space Access and Technology, Washington, D.C.

Online Information

Additional information about the Spartan Project is available on the Internet on:

http://sspp.gsfc.nasa.gov/sptnhome.html

or

http://sspp.gsfc.nasa.gov/sp207.html.

SPARTAN-207 RELEASE AND DEPLOYMENT

The Spartan-207 satellite will be deployed on Day two of the mission. Mission Specialist Mario Runco will release the Spartan using the shuttle's mechanical arm, and Commander John Casper will back Endeavour away from the satellite.

Once Endeavour reaches a distance of 400 feet directly in front of the Spartan, Casper will hold Endeavour's position while experiment operations with the Spartan begin. Slightly less than an hour later, Casper will begin a partial flyaround of the satellite, maintaining a distance of about 400 feet, moving to a point directly above Spartan. This partial flyaround will align Endeavour within the transmission direction of the experiment work with the Inflatable Antenna Experiment.

Once Endeavour is directly above Spartan at a distance of 400 feet, the IAE will be inflated. Endeavour will stationkeep 400 feet above Spartan for about an hour and twenty minutes while the IAE is inflated and experiment operations are conducted.

Following those operations, Casper will fire Endeavour's jets to begin separating from the vicinity of the Spartan. The jet firing will initially move Endeavour farther above the satellite, and the shuttle will be about 900 feet away at the time the IAE is jettisoned from Spartan. The jettisoned IAE will move in front of and below than Spartan, while the separation burn performed by Endeavour will move the shuttle above and behind the satellite at a rate of almost two and a half nautical miles per orbit. During the next day, Endeavour will range as much as 40-60 nautical miles behind the satellite before again closing in.

Spartan 207 Rendezvous and Retrieval

Endeavour will return to the vicinity of Spartan-207 on Day three of the mission to retrieve the satellite. The final phase of the rendezvous will begin when Endeavour reaches a point eight nautical miles behind the satellite and the Terminal Phase Initiation burn is performed by the shuttle, putting Endeavour on a course to intercept the Spartan.

As Endeavour closes the final eight nautical miles, there will be an opportunity for four small midcourse correction firings of the shuttle steering jets to fine-tune its course toward Spartan. Also during this time, Garneau will extend the shuttle's mechanical arm into the position for retrieval of the satellite.

Shortly after the fourth and final mid-course correction, Casper will take over manual control of Endeavour's flight. At the time Casper begins manually flying Endeavour, the shuttle will be about 2,500 feet directly below the satellite. Casper will fly the shuttle to a point about 400 feet directly in front of Spartan before closing to within 35 feet. As Casper aligns Endeavour with Spartan, Garneau will move the mechanical arm into place to lock onto the Spartan grapple fixture. Once captured, Garneau will lower Spartan back into the cargo bay and latch it in place for its return to Earth.

PAMS/STU Deploy and Rendezvous Operations

The Satellite Test Unit (STU), part of the Passive Aerodynamically Stabilized Magnetically Damped Satellite (PAMS) test, will be deployed from Endeavour on Day four of the mission. Although the satellite will not be retrieved, Endeavour will subsequently rendezvous three times with the satellite to acquire satellite attitude information during the rest of the mission.

After STU is ejected from the payload bay, Endeavour will fire its engines to separate from the satellite, aiming to reach a point about eight nautical miles behind STU over the next two orbits. From that point, Endeavour will immediately begin a rendezvous with the satellite, firing its engines in a Terminal Phase

Initiation (TI) burn which will put the shuttle on a course to intercept a point about 2,000 feet behind the STU.

As Endeavour closes the eight nautical miles, the shuttle will have the opportunity to perform as many as four small midcourse correction firings, if needed, to fine tune the course toward the satellite. When the shuttle crosses directly behind the STU, Commander John Casper will fire the shuttle steering jets to stationkeep at that position as PAMS experiment operations are performed. Casper will maintain Endeavour at a distance of 2,000-2,300 feet behind the STU for about an hour and forty-five minutes while the experiment work is under way. The experiments will consist of video recordings of the on-orbit attitude of the satellite as it passes through the upper atmosphere of low-Earth orbit. Once the experiment runs are completed, Casper will fire Endeavour's engines to separate from the vicinity of the satellite, putting the shuttle on a course that will have it range as far as 100 nautical miles behind the STU.

Endeavour will revisit the satellite for further attitude measurements on both Day seven and Day eight of the mission, performing the same basic rendezvous, stationkeeping, and separation sequence starting from a point eight nautical miles behind the satellite. During the Day seven and eight operations, Endeavour will stationkeep at a distance of 2,000-2,300 feet behind the STU for about six hours on each day.

SPACE ACCESS AND TECHNOLOGY PAYLOADS

Over 90 percent of the payloads aboard STS-77 are being sponsored by the Office of Space Access and Technology, Washington, DC, through its Commercial Space Centers and their industrial affiliates, and by NASA's Goddard Space Flight Center, Greenbelt, MD, Jet Propulsion Laboratory, Pasadena, CA, Langley Research Center, Hampton, VA, and Lewis Research Center, Cleveland, OH.

Primary payloads include experiments flying aboard the pressurized, commercially-developed SPACEHAB Module; an Inflatable Antenna Experiment to be deployed aboard the free- flying Spartan-207 carrier spacecraft; and a host of four technology experiments known as "TEAMS," housed aboard a "Hitchhiker" carrier mounted in the Shuttle's payload bay.

Additionally, secondary experiments will include a "Brilliant Eyes" cryo-cooling experiment and the joint U.S./Canada aquatic research facility.

SPACEHAB-4

One of the objectives of NASA's Space Technology enterprise is to 'use the unique attributes of the space environment to enable industry creation of new and improved products and services.' To carry out this objective, NASA's Office of Space Access and Technology sponsors Commercial Space Centers, which are non-profit consortia of industry, academia, and government partners, that foster the use of space for commercial products and services. These payloads primarily reflect the interests and initiatives of industry partners.

In 1990 NASA contracted SPACEHAB, Inc., for the lease of their SPACEHAB Space Research Laboratories for a series of flights. STS-77 marks the fourth flight of the SPACEHAB under this contract and it will carry 10 commercial space product development payloads in the areas of biotechnology, electronic materials, polymers and agriculture as well as several experiments for other NASA payload organizations.

SPACEHAB Module

A SPACEHAB single module will be carrying nearly 3,000 pounds of experiments and support equipment on the STS-77 mission. Twenty-eight lockers, four SPACEHAB soft stowage bags and two single racks will house the experiments and equipment in the module. The SPACEHAB module will be located in the forward portion of Endeavour's payload bay, connected to the middeck by a short tunnel to allow the crew access to the commercial space laboratory.

The module was delivered to NASA on April 3 for installation into Endeavour's payload bay while on Launch Pad 39B. Vertical installation of a SPACEHAB module first occurred on the most recent Shuttle mission, STS-76, and has become the standard method of installation for SPACEHAB modules.

SPACEHAB-4 Experiments

The Advanced Separation Process for Organic Materials (ADSEP) enhances separation technologies for medical products. Separation, purification and classification of cells are limiting factors in biomedical research and pharmaceutical drug development. Advanced separation technology, sponsored by the Consortium for Materials Development in Space at the University of Alabama-Huntsville and developed by Space Hardware Optimization Technology Inc., Floyd Knobs, IN, is designed to foster separation capabilities for terrestrial commercial application and microgravity research. This particular mission, in collaboration with biomedical researchers, will focus on understanding gravitational effects on the manufacture of recombinant hemoglobin products. This area may have significant impact on blood transfusion products where transfusion of hemoglobin rather than whole blood can reduce complications such as blood rejection, infectious disease transmission, and blood contamination in areas without suitable storage capability.

The Commercial Generic Bioprocessing Apparatus (CBGA) will house a number of small test tube-sized fluid mixing syringes controlled at several different temperatures. The versatility of this apparatus allows investigations on a variety of molecular, cellular, tissue and small animal and plant systems. For this flight the apparatus will be configured into four temperature controlled lockers holding 272 individual experiments. Sponsored by BioServe Space Technologies (NASA's Commercial Center at the University of Colorado, Boulder) a number of specific commercial objectives will be pursued in partnership with several of the Center's industrial affiliates. These will include evaluation of pharmaceutical production of bacterial and fungal systems with Bristol-Myers Squibb, crystallization of oligonucleotides-RNA to gain 3-D structural information for drug design in AIDS research with NeXstar and Amgen, administration of a proprietary chemical to enhance bone marrow macrophage differentiation with Chiron Corp., and tests of a proprietary cell growth inhibitors (cancer research) with Synchrocell, Lockheed Martin and the Kansas State University Research Foundation.

The Plant Generic Bioprocessing Apparatus (PGBA) will be flown for the first time. This two-locker plant growth chamber has been developed by BioServe Space Technologies in collaboration with the Wisconsin Center for Automation and Robotics at the University of Wisconsin - Madison. The plant growth area of the chamber is 12^2 by 10^2 with a 10^2 plant height and 2.5^2 root depth. In collaboration with Bristol- Myers Squibb, the commercial goal is to investigate the change in the production of secondary metabolites in microgravity.

Investigations will include the study of Artimisia annua, which produces an antimalarial compound, and Cataranthus roseus, which produces chemotherapeutic compounds. Working with Dean Food, a study will be made of the effects of space flight on starch, sugar and fatty acid content of special strains of spinach plants. A forestry products company is interested in the lignin production and reaction wood formation in Loblolly pine, and clover plants will be included to study the nitrogen fixation mechanism in microgravity at the behest of Research Seeds, Inc. While a nine-day mission is not very long for plant growth, the sponsoring affiliates hope to establish the potential for long duration missions to benefit development of new products derived from plants.

The Fluids Generic Bioprocessing Apparatus-2 (FGBA-2) payload represents an evolutionary step in carbonated fluids management technology. For the Coca-Cola Company, the primary corporate sponsor, FGBA-2 will provide a test bed to determine if carbonated beverages can be produced from separately stored carbon dioxide, water and flavored syrups and determine if the resulting fluids can be made available for consumption without bubble nucleation and resulting foam formation. Coca-Cola also will be verifying and obtaining additional data on the effects of space flight on changes in taste perception. Such data might aid in understanding altered tastes in specific target populations on Earth, such as the elderly, and eventually lead to altered beverage formulations that could increase hydration for such individuals and for astronauts. The sponsor--BioServe Space Technologies--is using the technology and lessons learned from this mission to apply to other commercial space life sciences activities including the development of plant growth and cell culture biotechnology facilities, closed environment research facilities and other projects that require management of two-phase fluids. Payload health and engineering data will be collected along with video images documenting behavior of the carbonated beverages during transfer operations.

The IMMUNE-3 experiment is a commercial middeck payload sponsored by BioServe Space Technologies and Kansas State University, Manhattan. The corporate affiliate leading the IMMUNE-3 investigation is Chiron Corp., Emeryville, CA. NASA's Ames Research Center, Mountain View, CA, provides payload and mission integration support.

The goal is to test the ability of Insulin-like Growth Factor to prevent or reduce the detrimental effects of space flight on the immune and skeletal systems of rats. Space flight has been shown to induce alterations in immune responses and reductions in skeletal development in rats; this may model immune disorders and impaired skeletal development on Earth. A demonstrated ability to counter reduced bone formation and immune system impairment accompanying spaceflight may provide new product markets for Chiron on Earth and a future therapeutic for long-term space missions.

Along with extensive ground-based research, acquired knowledge could be used to develop protocols designed to protect the immune systems of patients undergoing chemotherapy or radiotherapy, to treat patients with AIDS, primary immune-deficiency and a broad range of infectious diseases. The applications toward a variety of bone disorders are currently under investigation, and should be aided by the findings of this flight investigation.

Three Commercial Protein Crystal Growth investigations on this flight will use three techniques. One is a process driven by temperature change that will produce crystals of a new form of recombinant human insulin provided by Eli Lilly; the other uses vapor diffusion to crystallize different proteins with objectives that address a range of diseases. The insulin crystals will support a better understanding of the protein's structure to help Eli Lilly, an affiliate of the Center for Macromolecular Crystallography --a NASA Commercial Space Center at the University of Alabama, Birmingham--understand the mode of action of this new form of insulin. The microgravity environment helps to produce large, well-ordered protein crystals that can be used for x- ray diffraction studies to determine the three-dimensional structures of the individual proteins. Knowledge of these structures can facilitate the development of new or more effective pharmaceuticals to combat diseases.

The vapor diffusion experiments will use flight hardware that is an improved adaptation of the most common laboratory method for growing protein crystals. It will provide for 128 individual experiments. The temperature driven hardware will use sample holders of different volumes, with different temperature gradients, to test systems that provide industry with more operational flexibility, and allow smaller amounts of expensive sample materials.

Gas Permeable Polymer Membrane (GPPM) is flying the third in the series of flights to use microgravity for development of enhanced polymers for manufacture of improved rigid gas permeable contact lenses. Polymer development of lens material in microgravity has shown polymers can be formed that will have greater uniformity of structure, increased gas permeability allowing greater oxygen flow for improved comfort to wearers, greater durability of material, and greater machinability in the manufacture process. NASA's Langley Research Center, Hampton, VA, and Paragon Vision Sciences of Phoenix, AZ, are the partners in this commercial research effort.

Four Handheld Diffusion Test Cell (HHDTC) experiment units each containing eight test cells will grow protein crystals by diffusing one liquid into another. In liquid- liquid diffusion, different fluids are brought into contact but not mixed. Over time, the fluids will diffuse into each other through random motion of molecules. The gradual increase in concentration of the precipitant within the protein solution causes the proteins to crystallize. Liquid- liquid diffusion is difficult on Earth because differences in solution densities allow mixing by gravity-driven thermal convection. In addition, the greater density of the crystals allows them to settle into inappropriate parts of the cell.

The proteins that will be grown in microgravity include: lysozyme, catalase, concanavalin b, cnavalin, myoglobin, thaumatin, ferritin, apoferritin, satellite tobacco mosaic virus and turnip yellow mosaic virus

Commercial Float Zone Furnace (CFZF) experiments have the goal of producing large, ultra-pure compound semiconductor and mixed oxide crystals for electronic devices and infrared detectors. Three international agencies are cooperating on the project: NASA Marshall Space Flight Center, Huntsville, AL, the Canadian Space Agency (CSA) and the German Space Agency (DARA). The U.S. samples of gallium arsenide (GaAs) and gallium antinomide (GaSb) have been prepared by the University of Florida in cooperation with industrial participant Atramet, Inc. A liquid encapsulate around the float zone to promote the growth of a larger crystal in the microgravity environment will be used. This technique was investigated on the first SPACEHAB mission in 1993. The parabolic-ellipsoid mirror type furnace is provided by the CSA and DARA. The furnace flew on the D-2 Spacelab mission in 1993. Telescience will be used during the mission to enable researchers on the ground to view and/or control the melts and work with the astronauts to control the melts.

The Space Experiment Facility (SEF), developed and managed by The University of Alabama in Huntsville's Consortium for Materials Development in Space will house a crystal growth experiment and a metals experiment.

The crystal growth experiment, which will use the SEF's transparent furnace, will focus on mercurous chloride a valuable electro-optic material of commercial interest. Larger and higher quality mercurous chloride crystals could improve devices used in spectral imaging.

The metals experiment, conducted in SEF's opaque furnace, will use liquid phase sintering (LPS) to bond powdered metals. LPS may provide greater understanding of alloy behavior and porosity on these metal composites. One area that could potentially benefit from improved metal composites is the machine tool industry.

The NIH-C7 experiment continues the collaboration between NASA and the National Institutes of Health (NIH). It is a middeck-locker experiment that will repeat and augment previously flown experiments investigating the effect of space flight on musculoskeletal development at the cellular level.

The experiment payload consists of two biomedical studies sponsored by NASA and NIH. These experiments will use a computerized tissue culture incubator known as the Space Tissue Loss Culture Module. The module was developed at the Walter Reed Army Institute of Research, Washington, DC, to study cells in microgravity.

The experiments will study the effects of space flight on muscle and bone cells from chicken embryos. The experiments on STS-77 will augment data from a previous flight in November 1994. Results of this research may lead to development of measures to maintain the strength of muscles and bones during long-duration space voyages and may provide insights and health benefits for people on Earth as well.

The scientific objective of the NIH/NASA collaboration is to investigate fundamental biological processes governing cell action under different levels of gravity. The effects of space flight on bone cells, specifically the calcification and developmental activity in maturing cartilage cells will be examined.

The effects of space flight on muscles to determine if microgravity causes damage or loss of muscle fibers, using special markers of cell damage, growth assays, measurements of muscle size and multiple biochemical assessments also will be studied.

TECHNOLOGY EXPERIMENTS FOR ADVANCING MISSIONS IN SPACE (TEAMS)

Inside the Space Shuttle Endeavour's payload Hitchhiker (HH) experiment carrier managed by the Goddard Space Flight Center will be four experiments called Technology Experiments for Advancing Missions in Space (TEAMS).

These experiments will include: The Global Positioning System (GPS) Attitude and Navigation Experiment (GANE); the Vented Tank Resupply Experiment (VTRE); the Liquid Metal Thermal Experiment (LMTE); and the Passive Aerodynamically Stabilized Magnetically Damped Satellite (PAMS). The experiments are flown together at reduced cost and with the Hitchhiker carrier providing the needed resources (power, data, etc.) to each experiment

The Hitchhiker carrier can carry equipment mounted in canisters and also has mounting plates of various sizes for user equipment. The carrier provides electrical power, command signals, and "downlink" data interfaces. Hitchhiker customers operate their payloads from a Goddard control center using their own ground support equipment (usually a personal computer) to send commands and display data.

Global Positioning System (GPS) Attitude and Navigation Experiment (GANE)
Johnson Space Flight Center (JSC), Houston, Texas

The Global Positioning System is a Department of Defense navigation system that allows world-wide navigation capabilities. GPS is becoming the world standard navigation system that allows anyone anywhere to know their position within 100 meters or less. Pilots, boaters hikers, and just about anyone can use this system for accurate real-time position and velocity determination.

One unique aspect of GPS is its capability for determining the attitude of a vehicle using three or four antennas, and measuring the GPS carrier phase through each antenna. This technique has been successfully tested on surface vehicles and aircraft, but it has not been tested in space before.

The International Space Station will use GPS not only for position, velocity, and time information but attitude determination as well. To assure GPS attitude can be measured to 0.1 degrees or less per axis of rotation, a flight experiment aboard the shuttle was proposed in 1994. This flight experiment will fly commercial off-the-shelf equipment and Station supplied equipment to determine the accuracy with which GPS derived attitude can be measured in an orbital environment.

Vented Tank Resupply Experiment (VTRE)
NASA Lewis Research Center, Cleveland, Ohio

The Vented Tank Resupply Experiment (VTRE) is to test improved methods for in-space refueling. The results of the experiment will be used in future designs of spacecraft liquid storage tanks. This experiment is the responsibility of the Lewis Research Center in Cleveland, Ohio, with Lockheed Martin as contractor.

When a spacecraft stays in space for long periods, such as the planned International Space Station, they need to be resupplied. This includes resupplying everything from rocket propellant to drinking water. The VTRE will primarily test technologies for using a vented fill method in space. In a vented fill, vapor is allowed to vent from the tank to make room for the incoming liquid. This is a common method as familiar as pouring coffee into a cup or gasoline into a gas tank. In space, however, the near total absence of gravity complicates the process.

The key VTRE component undergoing test is the Capillary Acquisition Vane, a set of flat panels inside the tank that keep the liquid away from the tank vent tap. These simple devices take advantage of a liquid surface tension or capillary action, a property that makes liquids adhere to solid surfaces and wick into small crevasses. The vanes are designed to accumulate the liquid where the liquid tap is located and provide a vapor pocket where the venting tap is located. Capillary Acquisition Vanes have been successfully used for years as liquid acquisition devices for rocket propellant, but their ability to vent vapor without venting any liquid remains to be demonstrated.

Passive Aerodynamically Stabilized Magnetically Damped Satellite (PAMS)
Goddard Space Flight Center, Greenbelt, MD

The Goddard Space Flight Center's Passive Aerodynamically Stabilized Magnetically Damped Satellite(PAMS) experiment is a technology demonstration of the principle of aerodynamic stabilization. PAMS consists of a small deployed satellite and a measuring system to observe the satellite during a shuttle mission.

Aerodynamic stabilization is a method that can be used to position a satellite in a specific orientation while in low Earth orbit. Aerodynamic stabilization works the same way as a dart. The front of the dart is weighted and once the dart is thrown, it will always right itself with the head facing forward. In the same manner, the PAMS satellite will eventually be oriented with the heavy end facing forward in orbit. This principle can be used to partially control the attitude of small satellites.

Cameras on the shuttle will record the satellite as it is deployed. Later during the flight, the shuttle will rendezvous with the satellite on two separate days. The Shuttle will trail 2,000 feet behind the satellite and point the PAMS measuring system. The cameras aboard the Shuttle will record the satellite movements over eight orbits.

Liquid Metal Thermal Experiment (LMTE)
Air Force Phillips Laboratory

The purpose of the Liquid Metal Thermal Experiment (LMTE) is to evaluate the performance of liquid metal heat pipes in microgravity conditions.

Heat pipes are thermal management devices used on many existing and planned space systems for the purpose of waste heat removal. In their simplest form, they consist of a tube containing a porous wicking material saturated with a working fluid. During operation, the fluid alternately vaporizes and condenses at different ends of the pipe as it absorbs and releases the waste heat.

Many different kinds of fluids are used including ammonia, oxygen, and potassium depending on the desired operation temperatures. The three LMTE heat pipes contain potassium and are designed to operate at 300 to 1000 degrees Celsius. Heat pipes in this high temperature range have never been operated in microgravity conditions. The operational characteristics of liquid metals in space are, therefore, not well understood. The data obtained from LMTE will be invaluable to space system designers requiring high temperature heat rejection.

LMTE is sponsored by the Air Force Phillips Laboratory, Albuquerque, NM, with support from the Air Force Space Test Program.

SECONDARY PAYLOADS

Brilliant Eyes Ten Kelvin Sorption Cryocooler Experiment (BETSCE). The Brilliant Eyes Ten Kelvin Sorption Cryocooler Experiment (BETSCE) is a microgravity experiment carrying an instrument that can quickly cool infrared and other sensors to near absolute zero.

Developed at NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA, it will be used to cool infrared sensors aboard spacecraft to 10 degrees Kelvin, or -441.6 degrees Fahrenheit. (Absolute zero is -459.6 F).

BETSCE is a space shuttle technology demonstration experiment to show that cryocoolers of this type, called "sorption coolers", can operate in the absence of gravity. Sorption coolers have essentially no vibration, are very efficient at these cold temperatures, and can operate reliably for over 10 years.

Sorption coolers work by using specialized metal alloy powders, called metal hydrides, that absorb the hydrogen refrigerant through means of a reversible chemical reaction. In the sorption compressor, the metal powder is first heated to release and pressurize the hydrogen, and then cooled to room temperature to absorb hydrogen and reduce its pressure. By sequentially heating and cooling the powder, the hydrogen is circulated through the refrigeration cycle. Ten degrees Kelvin is achieved by expanding the pressurized hydrogen at the cold tip of the refrigerator. This expansion actually freezes the hydrogen to produce a solid ice cube at 10 degrees Kelvin. The heat load generated by the device being cooled then sublimates the ice. This closed cycle operation is repeated over and over.

Nothing moves in the compressor so it doesn't vibrate and tend to wear out like conventional refrigerator compressors that contain moving pistons that rub. The absence of vibration is an important quality needed for spacecraft and instruments such as infrared astronomical telescopes that need a precision pointing capability or a mechanically quiet platform on which to operate.

Before this new technology, the only way to achieve temperatures in space as low as 10 degrees Kelvin has been to launch extremely large, heavy, and expensive dewars containing liquid helium or solid hydrogen. Unfortunately, these dewars have very limited lifetimes because the cryogens eventually get boiled off and become depleted. The ability to achieve a lifetime of ten or more years, with no vibration, opens the door to a wide variety of future missions that could benefit from this novel technology. Sorption coolers are currently baselined on several missions, including the recently proposed Primordial Structure Investigation (PSI) mission, and have been proposed for a variety of future infrared astrophysics missions such as the Next Generation Space Telescope and spaceborne interferometers.

BETSCE experiment development was funded by the Air Force Space and Missiles System Center and the Department of Defense's Ballistic Missile Defense Organization (BMDO). NASA's Office of Space Access and Technology (OSAT) is sponsoring the Shuttle flight for BETSCE.

The **Aquatic Research Facility (ARF)** is a joint Canadian Space Agency (CSA)/NASA project with CSA providing flight hardware, NASA providing flight opportunities, and both agencies sharing in the scientific investigations. This is the first flight of ARF, a Canadian designed and built middeck payload which allows sophisticated investigations of a wide range of small aquatic species. The facility will permit scientists to investigate the process of fertilization, embryo formation and differentiation, development of calcified tissue and feeding behaviors of small aquatic organisms.

The facilities three experiments will provide an integrated international investigation of early development and ocean ecology: Dr. Bruce Crawford of the University of British Columbia will study developing starfish embryos until they are able to orient and feed themselves. Dr. Ron odor of Dalhousie University will study advanced stages of bi-valves (mussels), focusing on the development of adult tissue structure, calcium deposition/loss and feeding behavior. Dr. Heidi Schatten of the University of Wisconsin - Madison will investigate the effects of gravity on sea urchin fertilization and early embryo differentiation and development.

This research will potentially improve the way scientists model human development, as well as the factors which may disrupt it.

The Biological Research In a Canister (BRIC) 07 is the subject of research for NASA at the University of Arizona, Tucson, AZ.

Spaceflight has been shown to effect the endocrine system of crewmembers. This study will aid in the discovery of the mechanism(s) behind one endocrine system in insects which may aid in research on endocrine systems in general, including human systems.

In addition to the principal investigator and NASA staff, college undergraduates, high school students and an elementary school teacher are involved in the project. Specific activities include an outreach program in Tucson, AZ that has elementary school kids excited about science the space program, and this project in particular.

The experimental procedures begin with the pupa, at 5 to 65 hours after development commences. The pupa will be placed in the BRIC canisters and loaded onto the Orbiter. No inflight manipulation or procedures are required. Postflight, all pupae will be examined morphologically. Half to two-thirds of the pupa will be sacrificed for hemolymph collection for amino acid and analysis of the hormone ecdysone. The remaining pupa will be transported back to the PI's lab and monitored for development to adulthood. During the last 24 hours before adult emergence, the dorsolongitudinal flight muscle will be excised and analyzed for protein content and concentration.

BRIC experiments are sponsored by NASA's Office of Life and Microgravity Sciences and Applications.

GET AWAY SPECIAL (GAS)

The GAS project is managed by NASA's Goddard Space Flight Center, Greenbelt, MD. NASA began flying these small self-contained payloads in 1982. The project gives individuals or organizations an opportunity to perform experiments in space on the Space Shuttle.

Customer: California Institute of Technology, Pasadena
CA G-056

Caltech's Gamma-ray Astrophysics Mission (GAMCIT) payload is the first space payload built by Caltech's chapter of the Students for the Exploration and Development of Space (SEDS), GAMCIT, originally designed by Astronaut John Grunsfeld, will study an enigmatic source of cosmic radiation known as gamma ray bursts. While these intense bursts of high-energy radiation were first discovered in the late 1960s by satellites watching for clandestine nuclear tests, their precise nature and origin still remains an intriguing astrophysical mystery.

Customer: German Space Agency
G-142 and G-144

The German Space Agency (DARA) is flying two payloads. The experiments are called MAUS, a German acronym for autonomous material science experiments under microgravity. It is one of the programs for flight opportunities the Federal Republic of Germany offers scientists from disciplines of material research and processing to perform material science investigations under microgravity conditions. These experiments were developed by scientists from the Technical University of Munich and the Technical University of Clausthal. Diffusion Coefficient Measurement Facility (DCMF) G-163

The Diffusion Coefficient Measurement Facility (DCMF) will measure the speed at which Mercuric Iodide (solid) is evaporated and then transported as a vapor under microgravity conditions.

Customer: Utah State University
G-200

Three experiments are being flown in canister G-200. In addition, the payload will contain popcorn kernels in zip lock bags as an experiment by an elementary school. After being flown, students will pop the popcorn and compare it with a similar sample maintained in one gravity.

Customer: British Sugar plc.
G-490

This experiment was designed and constructed by the School of Electronics and Electrical Engineering in the Robert Gordon University, Aberdeen, Scotland. The launch services were sponsored by British Sugar plc. The payload carries two main experiments. The first investigation is to verify a proposal that low-level gravitational field can be measured by observing their effect on the convection currents present in a heated liquid. The second project has been devised by a group of children from Elrick Primary School near Aberdeen. A series of controlled experiments are being carried out on selected samples of seeds, oats, wheat, barley and nape-oil to quantify the effects of space flight on growth patterns.

Customer: Canadian Space Agency
G-564 and G-565

The Canadian Space Agency (CSA) will fly experiments in two GAS canisters, Nanocrystal Get Away Special (NANO-GAS) and Atlantic Canada Thin Organic Semiconductors (ACTORS). The results of these experiments may lead to the development of new materials with applications in high performance lasers and in electronic equipment and components. Canadian astronaut Marc Garneau will be on board this mission to assist in monitoring the operation of these experiments in his role as mission specialist.

Customer: NASA Lewis Research Center
G-703

The Microgravity Smoldering Combustion (MSC) experiment studies the smolder characteristics of porous combustible materials in a microgravity environment. Smoldering is a non-flaming form of combustion that takes place in the interior of porous combustible materials. The propagation of the smolder reaction is controlled by complex thermos- chemical mechanisms, which are not well understood. The experiment objective is to provide a better understanding of these controlling mechanisms, both in microgravity and Earth gravity. Customer: NASA Lewis Research Center G-741

The G-741 experiment is an extension of the study of the fundamentals of nucleate pool boiling heat transfer under the microgravity conditions of space. An improved understanding of the basic processes that constitute boiling is sought by removing the buoyancy effects which mask other phenomena. The canister consists of two reflight experiments which propose to broaden the range of experimental parameters beyond those covered previously in order to study an element involved in the boiling process which, as a result of the experimental work in microgravity conducted to date, appears to play a significant role in pool boiling - that of dryout and its reverse - wetting. Tank Pressure Control Experiment/Reduced Fill Level (TPCE/RFL)

An important issue in microgravity fluid management is controlling pressure in on-orbit storage tanks for cryogenic propellants and life support fluids, particularly liquid hydrogen, oxygen and nitrogen. The purpose of the Tank Pressure Control Experiment/Reduced Fill Level (TPCE/RFL) is to provide some of the data required to develop the technology for pressure control of cryogenic tankage.

This STS-77 experiment will investigate pressure rise rates and pressure control (using a mixer) for tanks that are approximately 40 percent full of oxygen (Freon 113). These conditions simulate those encountered by multiple-burn cryogenic stages used for lunar or planetary exploration. Although the pressure rise rates are expected to be lower for the reduced fill level tanks, the ability of the jet mixer to effectively cool all regions of the tank is of great interest.

TPCE/RFL uses flight hardware previously developed by the Boeing Defense and Space Group under NASA's In-Space Technology Experiments activity. The flight hardware is on loan from the NASA Lewis Research Center.

STS-77 CREWMEMBERS

STS077-S-002 -- These six astronauts have been named to fly aboard the space shuttle Atlantis in support of the Spacehab-04 mission, scheduled for launch in May of this year. In the front row are astronauts John H. Casper (right), mission commander; and Curtis L. Brown, Jr., pilot. In the rear, from left, are astronauts Daniel W. Bursch, Mario Runco, Jr., Marc Garneau and Andrew S. W. Thomas, all mission specialists. Garneau represents the Canadian Space Agency (CSA).

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

John H. Casper

John H. Casper (Colonel, USAF) will serve as Commander for STS-77. Casper was born July 9, 1943, in Greenville, SC, but considers Gainesville, GA, to be his hometown. He graduated from Chamblee High School, Chamblee, Georgia, in 1961; received a bachelor's of science degree in engineering science from the U.S. Air Force Academy in 1966, and a master's of science degree in astronautics from Purdue University in 1967. He also is a 1986 graduate of the Air Force Air War College.

Casper was selected by NASA in May 1984 and became an astronaut in June 1985. A veteran of three space flights, STS-36 in 1990, STS-54 in 1993, and STS-62 in 1994, Casper has logged over 585 hours in space.

Curtis L. Brown Jr.

Curtis L. Brown Jr. (Lieutenant Colonel, USAF) will serve as the Pilot for Mission STS-77. Brown was born March 11, 1956, in Elizabethtown, NC. He graduated from East Bladen High School, Elizabethtown, NC, in 1974 and received a bachelor's of science degree in electrical engineering from the Air Force Academy in 1978.

Brown was selected as an astronaut candidate by NASA in June 1987 and completed a one-year training and evaluation program in August 1988 which qualified him for assignment as a pilot on future Space Shuttle flight crews. A veteran of two space flights, Brown has logged over 453 hours in space. He was the pilot on STS-47 in 1992, and STS-66 in 1994.

Andrew S. W. Thomas

Andrew S. W. Thomas (Ph.D.) will serve as Mission Specialist-1 on the STS-77 mission. Thomas was born December 18, 1951, in Adelaide, South Australia. He received a bachelor's of engineering degree in mechanical engineering, with First Class Honors, from the University of Adelaide, South Australia, in 1973, and a doctorate in mechanical engineering from the University of Adelaide, South Australia, in 1978.

Thomas was selected by NASA in March 1992 and reported to the Johnson Space Center in August 1992. In August 1993, following one year of training, he was appointed a member of the astronaut corps and qualified for assignment as a mission specialist on Space Shuttle flight crews. STS-77 will be Thomas' first space flight.

Daniel W. Bursch

Daniel W. Bursch (Commander, USN) will serve as Mission Specialist-2 during the STS-77 mission. Bursch was born July 25, 1957, in Bristol, PA, but considers Vestal, NY, to be his hometown. He graduated from Vestal Senior High School, Vestal, NY, in 1975; received a bachelor's of science degree in physics from the United States Naval Academy in 1979, and a master's of science degree in engineering science from the Naval Postgraduate School in 1991.

Bursch was selected by NASA in January 1990 and became an astronaut in July 1991. A veteran of two space flights, Bursch has logged over 505 hours in space. He served as a mission specialist on STS-51 in 1993, and STS-68 in 1994.

Mario Runco Jr.

Mario Runco Jr. will serve as Mission Specialist-3 on the STS-77 mission. Runco was born January 26, 1952, in the Bronx, NY, but considers Yonkers, NY, to be his hometown. He graduated from Cardinal Hayes High School, Bronx, NY, in 1970; received a bachelor's of science degree in meteorology and physical oceanography from the City College of New York in 1974, and a master's of science degree in meteorology from Rutgers University, New Brunswick, NJ, in 1976.

Runco was selected by NASA as an astronaut candidate in June 1987 and qualified for assignment as an astronaut mission specialist in August of 1988. A veteran of two space flights, STS-44 in 1991 and STS-54 in 1993, Runco has logged over 310 hours in space.

Marc Garneau

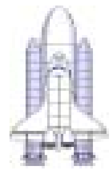
Marc Garneau (Ph.D.) is a member of the Canadian Space Agency (CSA) and will serve as Mission Specialist-4 on the STS-77 mission. Garneau was born February 23, 1949, in Quebec City, Canada. He attended primary and secondary schools in Quebec City & Saint-Jean, Quebec, and in London, England. He received a bachelor's of science degree in engineering physics from the Royal Military College of Kingston in 1970, and a doctorate in electrical engineering from the Imperial College of Science and Technology, London, England, in 1973. Garneau attended the Canadian Forces Command and Staff College of Toronto in 1982-83.

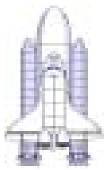
Garneau was one of six Canadian astronauts selected in December 1983 and flew as a payload specialist on Shuttle Mission 41-G in October 1984. In July 1992 Garneau was selected for astronaut candidate training and following one year of training, he was appointed a member of the astronaut corps and qualified for assignment as a mission specialist on Space Shuttle flight crews. Garneau has logged over 197 hours in space.

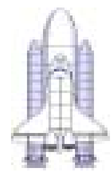
For complete biographical information on NASA astronauts, see the NASA Internet astronaut biography home page at address: http://www.jsc.nasa.gov/Bios/.

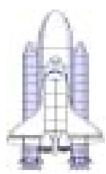
SHUTTLE FLIGHTS AS OF MAY 1996

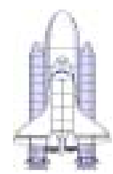
76 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 51 SINCE RETURN TO FLIGHT











OV-102 Columbia (19 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery (21 flights)**	**OV-104 Atlantis (16 flights)**	**OV-105 Endeavour (10 flights)**
		STS-70 07/13/95 - 07/22/95		
		STS-63 02/03/95 - 02/11/95		
STS-75 02/22/96 - 03/09/96		STS-64 09/09/94 - 09/20/94		
STS-73 10/20/95 - 11/05/95		STS-60 02/03/94 - -2/11/94		
STS-65 07/08/94 0 07/23/94		STS-51 09/12/93 - 09/22/93		
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93	STS-76 03/22/96 - 03/31/96	
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92	STS-74 11/12/95 - 11/20/95	
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92	STS-71 06/27/95 - 07/07/95	
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91	STS-66 11/03/94 - 11/14/94	
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-72 01/11/96 - 11/20/96
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-69 09/07/95 - 09/18/95
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-67 03/02/95 - 03/18/95
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-68 09/30/94 - 10/11/94
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-59 04/09/94 – 04/20/94
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-61 12/02/93 - 12/13/93
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-57 06/21/93 - 07/01/93
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