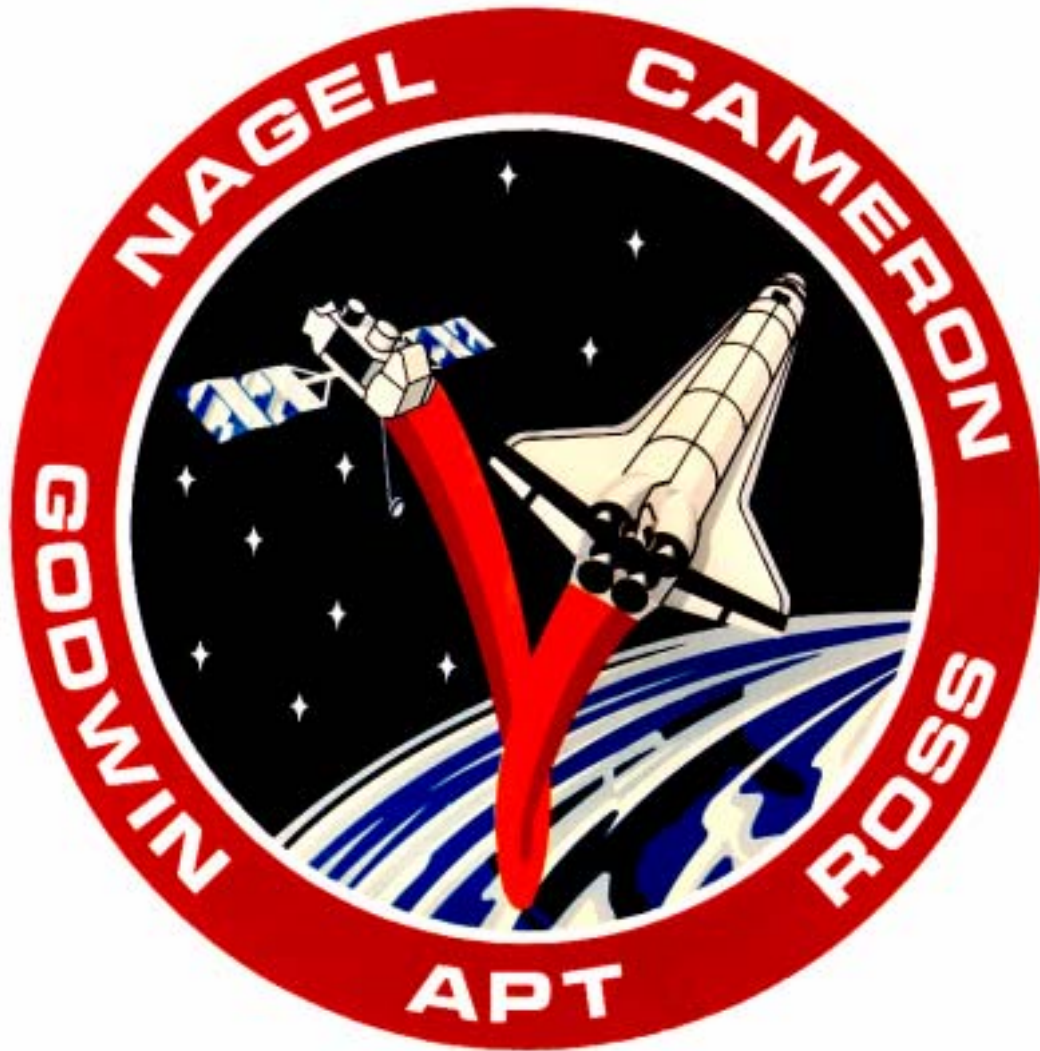


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

**SPACE SHUTTLE
MISSION
STS-37**

**PRESS KIT
APRIL 1991**



GAMMA RAY OBSERVATORY (GRO)

STS-37 INSIGNIA

STS037-S-001 -- The principal theme of the STS-37 insignia, designed by astronaut crewmembers, is the primary payload -- Gamma Ray Observatory (GRO) -- and its relationship to the space shuttle. The Shuttle and the GRO are both depicted on the insignia and are connected by a large gamma. The gamma symbolizes both the quest for gamma rays by GRO as well as the importance of the relationship between the manned and unmanned elements of the United States space program. The Earth background shows the southern portion of the United States under a partial cloud cover while the two fields of three and seven stars, respectively, refer to the STS-37 mission designation.

The NASA insignia design for 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 illustration by the various news media. When and if there is any change in this policy, which is not anticipated, it will be publicly announced.

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GAMMA RAY OBSERVATORY, SPACEWALK HIGHLIGHT STS-37

Shuttle mission STS-37, the 39th flight of the Space Shuttle and the eighth flight of Atlantis, will be highlighted by deployment of the Gamma Ray Observatory (GRO), the second of NASA's four great space observatories, and the first American spacewalk in more than 5 years.

The launch of Atlantis is currently scheduled for no earlier than 9:18 a.m. EST on April 5. GRO, to be placed into a 243-nautical-mile high orbit on the 3rd day of the flight, will complement the Hubble Space Telescope (HST) and attempt to unravel the mysteries of the universe through observations of gamma rays, among the highest frequency wavelengths of the spectrum. GRO is the second in four planned great observatories, including HST, the Advanced X-Ray Astrophysics Facility and the Space Infrared Telescope Facility.

On the 4th day of the flight, the Extravehicular Activity Development Flight Experiments (EDFE) will require the first spacewalk by American astronauts since Shuttle mission STS-61B in November 1985. The spacewalk will test the Crew and Equipment Translation Aids, three prototype cart designs that are part of an effort to develop a transportation device for use on the exterior of Space Station Freedom. Other spacewalk experiments include tests of the Shuttle's robot arm as a work platform for astronauts and instrumented evaluations of astronauts' ability to work with tools in weightlessness.

On the middeck, Atlantis will carry several secondary experiments including the Bioserve ITA Materials Dispersion Apparatus (BIMDA), a study in biomedical materials processing; Protein Crystal Growth-III (PCG-III), another in a sequence of Shuttle experiments that grow crystals in weightlessness; the Shuttle Amateur Radio Experiment-II (SAREX-II), an experiment that will allow the crew to contact amateur radio operators around the world who are within range of the Shuttle's flight path; the Space Station Heat Pipe Advanced Radiator Element-II (SHARE-II), a study of an evolving design of cooling radiators for Space Station Freedom; and the Radiation Monitoring Equipment-III (RME-III), a monitor of the amount of radiation penetrating the Shuttle's crew compartment during the flight.

In addition Atlantis will have the Ascent Particle Monitoring Experiment in the payload bay, a package of instruments that measure contamination in the cargo bay during launch. The orbiter also will participate in the Air Force Maui Optical System (AMOS), a continuing series of observations of Shuttle orbital engine firings by ground Air Force instruments.

The mission is planned to last 5 days and 12 minutes, concluding with a landing at Edwards Air Force Base, Calif., at 9:30 a.m. EDT, April 10th. Commanding Atlantis will be Air Force Col. Steven R. Nagel. Marine Corps Lt. Col. Kenneth D. Cameron will serve as pilot. Mission specialists will be Air Force Lt. Col. Jerry L. Ross; Dr. Linda M. Godwin; and Dr. Jay Apt. Mission specialists Ross and Apt will perform the spacewalk on the 4th day of the flight.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

GENERAL 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 the change-of-shift briefings from Johnson Space Center, Houston, will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Johnson Space Center; and NASA Headquarters, Washington, D.C. The TV schedule will be updated daily 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 TV schedule may be obtained by dialing 202/755-1788. This service is updated daily at noon EST.

Status Reports

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

Briefings

An STS-39 mission press briefing schedule will be issued prior to launch. During the mission, flight control personnel will be on 8-hour shifts. Change-of-shift briefings by the off-going flight director will occur at approximately 8-hour intervals.

STS-37 QUICK LOOK

Launch Date:	No earlier than April 5, 1991
Launch Site:	Kennedy Space Center, Fla., Pad 39B
Launch Window:	9:18 a.m. to 1:56 p.m. EST (4 hours, 38 minutes)
Orbiter:	Atlantis (OV-104)
Orbit:	243 x 243 nautical miles
Inclination:	28.45 degrees
Landing Date/Time:	April 10, 1991, 9:30 a.m. EDT
Primary Landing Site:	Edwards Air Force Base, Calif.
Abort Landing Sites:	Return to Launch Site - KSC, Fla. Transoceanic Abort Landing - Banjul, The Gambia Abort Once Around - Edwards Air Force Base, Calif.
Crew:	Steven R. Nagel, Commander Kenneth D. Cameron, Pilot Linda Godwin, Mission Specialist 1 Jerry L. Ross, Mission Specialist 2 Jay Apt, Mission Specialist 3
Cargo Bay Payloads:	Gamma Ray Observatory (GRO) EVA Development Flight Experiments (EDFE) Ascent Particle Monitor (APM)
Middeck Payloads:	Bioserve ITA Materials Dispersion Apparatus (BIMDA) Protein Crystal Growth-III (PCG-III) Shuttle Amateur Radio Experiment-I (SAREX-II) Radiation Monitoring Equipment-III (RME-III) Air Force Maui Optical System (AMOS) Space Station Heat Pipe Advanced Radiator Element-II (SHARE-II)

SUMMARY OF MAJOR ACTIVITIES

Flight Day 1

Ascent
OMS 2
PCG activation
RMS checkout
SAREX activation
BIMDA
DSOs

Flight Day 2

GRO in-bay checkout
Depressurize cabin to 10.2 psi
EMU checkout
SHARE-II
AMOS

Flight Day 3

GRO deploy

Flight Day 4

EDFE EVA

Flight Day 5

FCS checkout
Mid-Range Targeted Station Keeping (DTO 822)
Middeck payloads deactivation
Cabin stow

Flight Day 6

Deorbit
Landing

VEHICLE AND PAYLOAD WEIGHTS

	<u>Pounds</u>
Orbiter (Atlantis) empty and 3 SSMEs	71,785
Remote Manipulator System (robot arm)	1,258
Gamma Ray Observatory	34,643
GRO Middeck Equipment	99
Airborne Electrical Support Equipment	523
Ascent Particle Monitor (APM)	22
BioServe ITA Materials Dispersion Apparatus (BIMDA)	72
Crew and Equipment Translation Aids Cart Assembly	215
CETA Hardware	588
Detailed Test Objectives (DTO)	106
Detailed Supplementary Objectives (DSO)	47
Portable Data Acquisition Package	200
Protein Crystal Growth (PCG)	63
Radiation Monitoring Experiment (RME)	7
SHARE II Middeck Priming Experiment	40
Shuttle Amateur Radio Experiment (SAREX)	66
Total Vehicle at SRB Ignition	4,523,759
Orbiter Landing Weight	191,029

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 either Edwards Air Force Base, Calif.; the Shuttle Landing Facility (SLF) at Kennedy Space Center, Fla.; or White Sands Space Harbor (Northrup Strip), NM.
- **Trans-Atlantic Abort Landing (TAL):** Loss of two 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 (RTL):** Early shutdown of one or more engines, without enough energy to reach Banjul, would result in a pitch around and thrust back toward KSC until within gliding distance of the SLF.

STS-37 contingency landing sites are Edwards AFB, Kennedy Space Center, White Sands, Banjul, Ben Guerir or Moron.

TRAJECTORY SEQUENCE OF EVENTS

Event	MET (d/h:m:s)	Relative Velocity (fps)	Mach	Altitude (ft)
Launch	00/00:00:00			
Begin Roll Maneuver	00/00:00:09	160	600	
End Roll Maneuver	00/00:00:16	340	2500	
Throttle to 89%	00/00:00:18	390	3180	
Throttle to 67%	00/00:00:28	650	7790	
Max. Dyn. Pressure	00/00:00:52	1,170	1.09	26,580
Throttle to 104%	00/00:00:59	1,320	1.25	33,380
SRB Staging	00/00:02:05	4,090	3.73	156,440
Main Engine Cutoff	00/00:08:33	24,600	23.13	363,660
Zero Thrust	00/00:08:39	24,646	22.85	370,550
ET Separation	00/00:08:51			
OMS 2 Burn	00/00:41:44			
GRO Release	02/03:35:00			
Deorbit Burn (orb 77)	04/23:12:00			
Landing (orb 78)	05/00:12:00			
Apogee, Perigee at MECO:		238 x 32 nautical miles		
Apogee, Perigee post-OMS 2:		243 x 243 nautical miles		

STS-37 PRELAUNCH PROCESSING

Kennedy Space Center workers began preparing Atlantis for its eighth flight into space when the vehicle was towed into the Orbiter Processing Facility on Nov. 21 following its previous mission, STS-38.

About 31 modifications were made to the orbiter Atlantis during its 15-week stay in the Orbiter Processing Facility. A significant modification was the installation of the five new general purpose computers. The new carbon brake system also was installed and many upgrades were made to the thermal protection system. All of Atlantis' systems were fully tested while in the OPF. Both orbital maneuvering system pods and the forward reaction control system were removed and transferred to the Hypergolic Maintenance Facility for required testing.

GAMMA RAY OBSERVATORY

GRO, which weighs just over 35,000 pounds (15,876 kilograms), will be the heaviest NASA science satellite ever deployed by the Space Shuttle into low-Earth orbit.

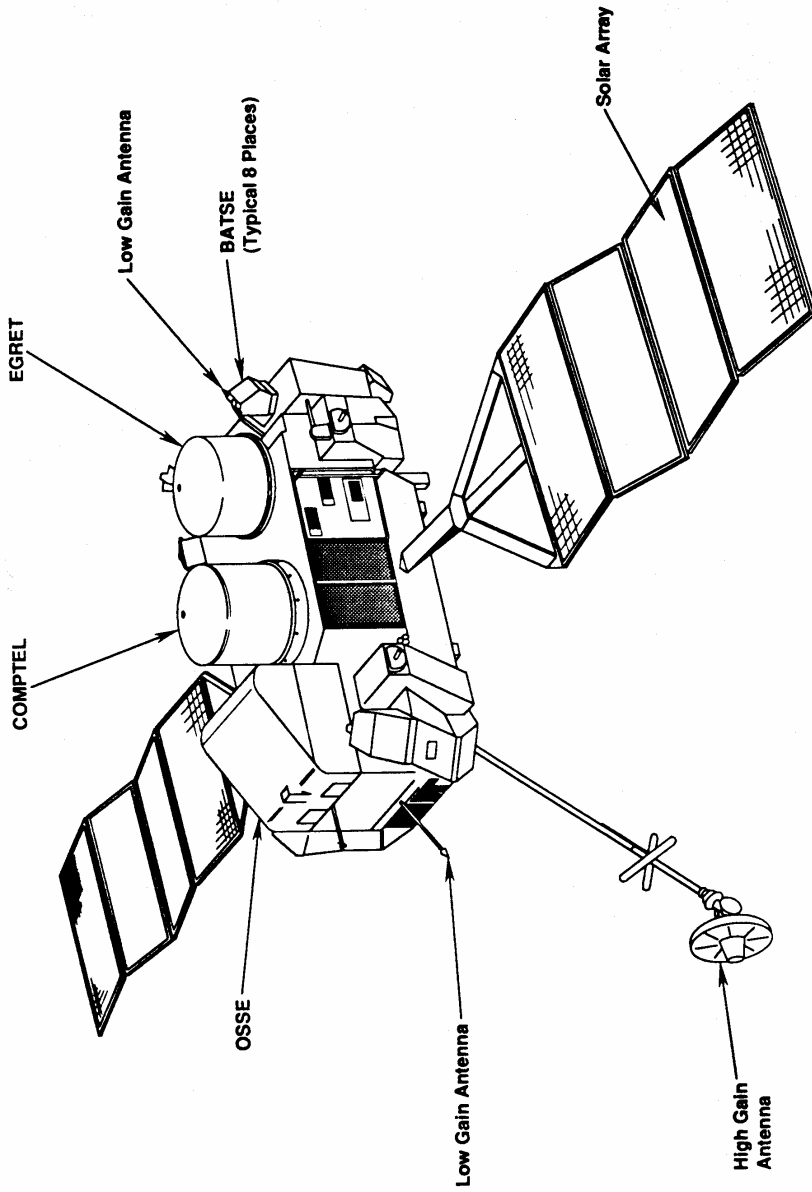
GRO is a space-based observatory designed to study the universe in an invisible, high-energy form of light known as gamma rays. Although a variety of smaller satellites and high-altitude balloons have carried instruments to study the universe in gamma-ray light during the past 30 years, GRO represents a dramatic improvement in sensitivity, spectral range and resolution.

Gamma-rays, which cannot penetrate the Earth's atmosphere, are of interest to scientists because these rays provide a reliable record of cosmic change and evolution. Their study will yield unprecedented answers about the structure and dynamics of the Milky Way Galaxy, the nature of pulsars, quasars, black holes and neutron stars, as well as clues about the origin and history of the universe itself.

The four instruments on GRO were selected by NASA to provide the first comprehensive, coordinated observations of a broad gamma-ray energy range with much better sensitivity than any previous mission. The instruments include: the Burst and Transient Source Experiment (BATSE), the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMPTEL) and the Energetic Gamma Ray Experiment Telescope (EGRET). During the first 15 months of the mission, an all-sky survey is planned. The observing program that follows will be guided by the results of this survey.

The instruments onboard GRO, with sensitivities 10 times greater than that of earlier instruments, will scan active galaxies for new information on celestial objects. GRO also can detect the very high temperature emissions from the vicinity of stellar black holes, thereby providing evidence for the existence of these exotic objects. GRO observations of diffuse radiation will not only help resolve questions relating to the large scale distribution of matter in the universe, but also about the processes that may have taken place shortly after the universe began in the theoretical energetic explosion or "Big Bang."

GRO is a NASA cooperative program. The Federal Republic of Germany, with co-investigator support from The Netherlands, the European Space Agency, the United Kingdom and the United States, has principal investigator responsibility for COMPTEL. The Federal Republic of Germany also is furnishing hardware elements and co-principal investigator support for EGRET.



Gamma-Ray Observatory (GRO)

GAMMA RAY OBSERVATORY SUBSYSTEMS

The Gamma Ray Observatory is the first scientific payload with a refuelable onboard propulsion system. In addition, GRO provides the support and protection necessary for the observatory to complete its mission. The spacecraft's subsystems include propulsion, power, controls, electronics, communications and thermal.

Propulsion

The Gamma Ray Observatory has a self-contained propulsion system that will allow controllers on the ground to keep the GRO spacecraft at the proper altitude. The propulsion system provides thrust for orbit altitude change, orbit maintenance, attitude control and if necessary, controlled reentry. GRO's four propellant tanks hold 4,200 pounds (1900-kilograms) of hydrazine fuel. The spacecraft has four 100-pound (45-kilogram) thrusters and isolation valves. GRO also has four dual thruster modules, each consisting of two 5-pound (2.2-kilogram) thrusters for attitude control. The fuel tanks are designed to be refueled by a future Space Shuttle mission, although no mission is currently planned for this purpose.

Attitude Control and Determination System

The primary purpose of the Attitude Control and Determination (ACAD) subsystem is to point the GRO instruments to selected celestial gamma-ray sources and to supply attitude information for data processing. The ACAD subsystem is a three-axis system made up of many NASA standard components and other flight-proven hardware. The system contains sensors that tell GRO where it's pointed and actuators for vehicle orientation. The primary sensors are the Fixed-Head Star Trackers and the Inertial Reference Unit. The star trackers relay information to GRO's onboard computers about the location of the spacecraft based on the known positions of pre-programmed guide stars. The Inertial Reference Unit relays attitude and position information based on the forces of inertia working in much the same manner as a gyroscope. The primary actuators are the four Reaction Wheel Assemblies. They rely on the principle of the spinning flywheel to maintain spacecraft attitude.

Communications and Data Handling

The Communications and Data Handling (CADH) system is based on the standard NASA modular design used with great success on the Solar Maximum Mission and Landsats 4 and 5. By using modules, repair of damaged or defective components is vastly simplified. The CADH subsystem consists of the CADH module, a 60-inch (152 centimeter) high-gain antenna, two omnidirectional low-gain antennas and a radio frequency combiner to interface the module with the antennas.

The CADH includes two second generation Tracking and Data Relay Satellite System (TDRSS) transponders for both incoming and outgoing transmissions to TDRSS and for command and telemetry transmissions to the Shuttle during in-bay and deployment sequences. Two NASA standard tape recorders are included for data storage. They will be used to record data for later playback to scientists on the ground. These playbacks, or data dumps, take place every other orbit at a rate of 512 kilobytes per second via the high-gain antenna system and the TDRSS S-band.

GRO also has a sophisticated clock that converts spacecraft time into universal time and distributes it to each instrument. Remote Interface Units are distributed throughout the spacecraft to interface the instruments with other onboard subsystems.

Electrical Power

The Observatory's solar arrays are accordion style, multi-panel, rigid arrays, deployed by motor-driven rigid booms. The total power available for the observatory from the solar arrays is approximately 2000 watts. Two Modular Power System (MPS) modules condition, regulate and control solar-array power during sunlight portions of the orbit to satisfy load demands and battery charging. During eclipse periods, NiCad batteries supply the spacecraft power. The batteries also supplement solar-array power during periods of peak power. Each MPS can receive power from external sources during ground operations and while in the Shuttle payload bay.

Thermal Subsystems

The thermal control of the observatory's subsystems and instruments is accomplished by coatings, blankets, louvers, radiators and heaters. The instruments are thermally isolated from each other and the spacecraft structure to reduce temperature.

The COMPTEL instrument uses a heat pipe system that transfers heat to a remote radiator providing active cooling for the instrument. The other instruments have passive thermal designs.

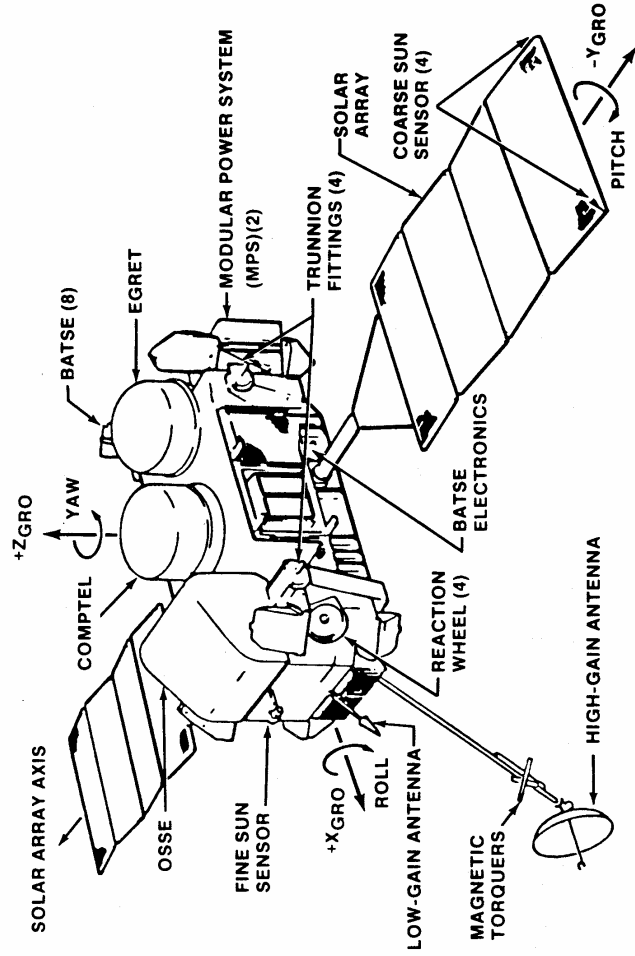
GRO uses three types of heaters, each having redundant thermostats and heater elements. Operational heater circuits are adequate for normal orbital operations. Make-up heaters replace the power of an instrument or component when it is turned off in orbit. Space Shuttle auxiliary heaters are used to maintain temperatures while GRO is in the payload bay.



SSP INTEGRATION
AND OPERATIONS

STS-37 PAYLOAD INFORMATION DOCUMENT

TOP VIEW OF GAMMA RAY OBSERVATORY CONFIGURATION

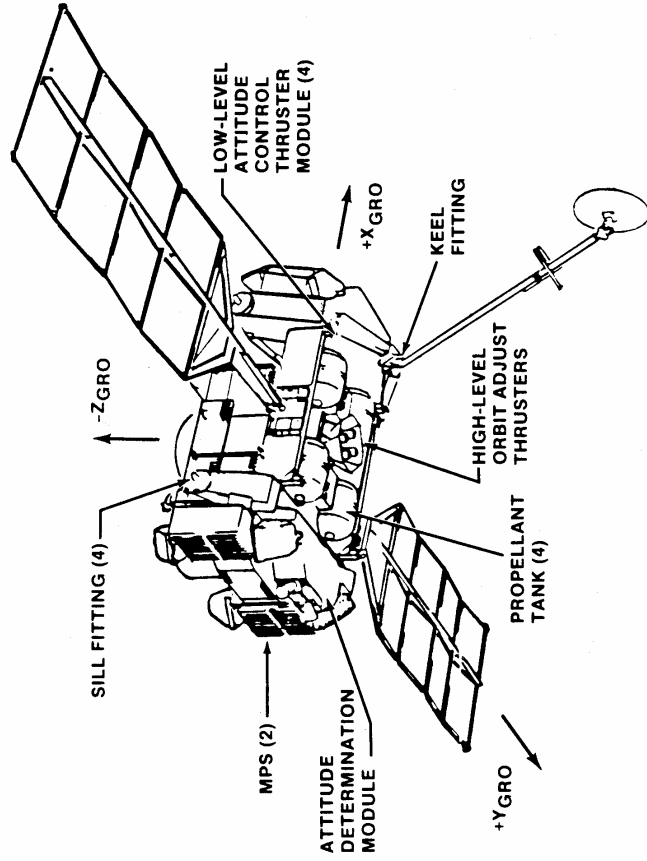




SSP INTEGRATION
AND OPERATIONS

STS-37 PAYLOAD INFORMATION DOCUMENT

BOTTOM VIEW OF GAMMA RAY OBSERVATORY CONFIGURATION



GAMMA RAY OBSERVATORY SCIENCE INSTRUMENTS

Gamma rays are a form of light that cannot penetrate the Earth's atmosphere or be seen by the human eye. Gamma rays have the highest energies of any type of light radiation. Since high-energy processes tend to produce high-energy radiation, gamma rays are emitted by some of the most exotic structures in our universe -- supernovae, neutron stars, black holes and quasars. The study of gamma rays offers a window into the inner workings of these and other fascinating objects, providing insights unattainable from the study of any other form of radiation.

Although the four instruments on GRO are essentially telescopes for seeing gamma-ray light, they do not look like ordinary telescopes. Instead, the GRO instruments observe gamma rays indirectly, by monitoring flashes of visible light, called scintillations, that occur when gamma rays strike the detectors (made of liquid or crystal materials) built into the instruments.

GRO's instruments are much larger and much more sensitive than any gamma-ray instrument ever flown in space. Size is crucial for gamma-ray astronomy. Because gamma rays are detected when they interact with matter, the number of gamma-ray events recorded is directly related to the mass of the detector. With the small number of gamma rays emanating from celestial sources, large instruments are needed to detect a significant number of photons in a reasonable amount of time.

The gamma rays emitted from celestial objects span a wide range of energies. The most energetic gamma rays to be studied by GRO have energies some 1 million times greater than the weakest. This is a far greater range in energy than that spanned by visible light, and no single instrument yet devised can detect gamma rays throughout this range. GRO's four instruments together span the gamma-ray range from about 20,000 to 30 billion electron volts (eV). Each of the four instruments has a unique design and is specialized for particular types of observations.

Burst and Transient Source Experiment (BATSE)

The Burst and Transient Source Experiment (BATSE) was developed by scientists and engineers at Marshall Space Flight Center, Huntsville, Ala., to continuously monitor a large segment of the sky for detection and measurement of short, intense bursts and other transient sources of gamma rays. BATSE consists of 8 identical detectors, with one detector located at each corner of the spacecraft to give it a very wide field of view. BATSE works in the low-energy part of the gamma-ray range (20,000 to 2 million eV) in which bursts are expected. Once BATSE discovers a burst of gamma rays, it can signal the other three instruments to study the source in more detail. Dr. Gerald Fishman of Marshall is the principal investigator.

Oriented Scintillation Spectrometer Experiment (OSSE)

The Naval Research Laboratory (NRL), Washington, D.C., designed the Oriented Scintillation Spectrometer Experiment (OSSE) to detect nuclear-line radiation and emissions associated with low energy gamma-ray sources (100,000 to 10 million eV). OSSE is sensitive to the spectral signature of radioactive elements. This enables OSSE to study supernovae and novae which are believed to be the sites where the heavy elements are created. These elements are the basis for life as we know it. OSSE also will provide insight into various types of science targets, such as neutron stars, black holes, pulsars and quasars. Dr. James Kurfess of the NRL is the principal investigator.

Imaging Compton Telescope (COMPTEL)

The Imaging Compton Telescope (COMPTEL), developed as a cooperative effort by the Federal Republic of Germany, The Netherlands, the European Space Agency and the United States, is designed for observations at moderate gamma-ray energies (1 to 30 million eV). Because COMPTEL has a wide field of

view (though not as wide as BATSE) and can locate gamma ray sources, one of its primary functions will be to produce a detailed map of the sky as seen in moderate gamma rays. Dr. Volker Schoenfelder of the Max Planck Institute, Germany, is the principal investigator.

Energetic Gamma Ray Experiment Telescope (EGRET)

The Energetic Gamma Ray Experiment Telescope (EGRET) is between 10 and 20 times larger and more sensitive than any high energy, gamma-ray telescope previously flown in space. The mission of EGRET, a joint effort by scientists and engineers at NASA's Goddard Space Flight Center (GSFC), Greenbelt, Md.; Stanford University, Stanford, Calif.; Max Planck Institute, Germany; and Grumman Aerospace Corp., Bethpage, NY, is to search the cosmos for high energy gamma-rays. One of its primary missions will be to generate a map of the sky as seen in high-energy gamma rays, complementing the map produced by COMPTEL. Another will be to discover and monitor gamma-ray emissions from pulsars. Goddard's Dr. Carl Fichtel is the principal investigator.

PAYLOAD OPERATION AND CONTROL CENTER (POCC)

Instructions sent to GRO during its science mission begin with the controllers located in the GRO Payload Operations Control Center (POCC) at GSFC. The focal point for all pre-mission preparations and on-orbit operations, the POCC is part of the Multisatellite Operations Control Center (MSOCC) at Goddard that provides mission scheduling, tracking, telemetry data acquisition, command and processing required for down-linked data.

Data Processing Systems

GRO engineering and experiment data will be processed in the POCC and the Packet Processor (PACOR) Data Capture Facility. The POCC will receive real time and playback telemetry data via TDRSS. The PACOR will receive real time and playback data in parallel with the POCC. The PACOR will record, time order, quality check and transmit sets of science data packets to the four instrument sites via a computer electronic mail system or by magnetic computer tape. The instrument sites are: Burst and Transient Source Experiment, Marshall Space Flight Center, Huntsville, Ala; Oriented Scintillation Spectrometer Experiment, Naval Research Laboratory, Washington, D.C.; Imaging Compton Telescope, U. S. interface, University of New Hampshire, Durham, N.H.; and the Energetic Gamma Ray Experiment Telescope, GSFC.

The Mission Operations Room, an integral part of the POCC, is responsible for all aspects of mission control, including spacecraft health and safety, and is operated on a 24-hour basis. This arrangement will provide command management, flight dynamics and communications support through the use of an extensive array of interactive terminals, color graphic microprocessors, recorders and close circuit television. Science Support Center

GSFC is the site of the Science Support Center (SSC) for the Gamma Ray Observatory. The SSC supports guest investigators through proposal preparation assistance, support of the proposal selection process and data archive search activities. In addition, the SSC will assist NASA's Office of Space Science and Applications, Astrophysics Division, in managing the review and evaluation of proposals for specific observations and theoretical investigations in the gamma-ray portion of the spectrum.

The SSC is developing software that will provide a common link for data from each of the instruments for investigators whose studies involve more than one of GRO's diverse capabilities.

The SSC also is developing and instituting the software systems that will allow data from the observatory to be archived by the National Space Science Data Center (NSSDC) also located at Goddard. Cataloging methods will be developed to allow future guest investigators the opportunity to easily access data for scientific study either at Goddard's facilities or at their home laboratories.

Data archived by the SSC and the NSSDC generally will become available one year after it has been processed into usable form. The SSC provides a uniform interface with all of the principal investigator teams and publishes a newsletter with items of interest to the scientific community.

GREAT OBSERVATORIES

The GRO is the second of four "Great Observatories" being built by NASA to study the universe across the electromagnetic spectrum. The first, the Hubble Space Telescope, was launched in April 1990. HST primarily conducts studies using visible and ultraviolet light. The other Great Observatories are the Advanced X-ray Astrophysics Facility, expected to be launched in 1998, and the Space Infrared Telescope Facility, scheduled for launch at the end of the decade.

The GRO program is managed by GSFC for NASA's Office of Space Science and Applications. The spacecraft was built by TRW, Redondo Beach, Calif.

MID-RANGE TARGETED STATIONKEEPING

Mid-Range Targeted Stationkeeping, designated as a Detailed Test Objective (DTO 822) for STS-37, will be a rendezvous experiment to help determine the precision with which the Shuttle can intercept a point behind an orbiting target and maintain the position without onboard radar. The orbiting target for the test will be the previously deployed Gamma Ray Observatory.

Following completion of EVA activities on flight day 4, a phase adjustment burn will be performed to begin closing the distance between Atlantis and GRO. While the crew sleeps, Atlantis will close from about 100 miles to within 50 miles behind the target.

An additional phasing maneuver will be made, early on flight day 5, to move Atlantis to within 20 miles. The crew then will conduct a final interception maneuver, using star trackers and optical alignment sights to identify and close in on the test point 8 miles behind GRO.

Stationkeeping 8 miles behind GRO, the crew will maneuver Atlantis around the test point, using RCS jets to conduct out-of-plane translations and attitude changes. Following those, the crew will use the star trackers and optical alignment sights to locate and maneuver back to the stationkeeping point.

Acquired data will be used to assess manual stationkeeping tools and techniques for potential rendezvous cases in which orbiter radar systems are not available.

EXTRAVEHICULAR ACTIVITY DEVELOPMENTAL FLIGHT EXPERIMENT

On STS-37, astronauts will venture into the payload bay for the 14th time in the 10-year history of the Shuttle program, when mission specialists Jerry Ross and Jay Apt perform a 6-hour extravehicular activity (EVA) during flight day 4. When Ross opens the airlock hatch, he will be the first astronaut to do so since he closed it Dec. 1, 1985, during STS-61B.

During the spacewalk, Apt and Ross will test several different translation devices which could be the predecessors of devices to be used on Space Station Freedom. The flight tests will answer questions including the speed of translation, complexity of equipment required, ease of translation and crew loads applied to tools and equipment for future EVA experiences.

Ross is designated as extravehicular crew member 1 (EV1) and will have red stripes on his spacesuit, while Apt is EV2. Pilot Ken Cameron will perform the functions of the intravehicular crewmember (IV1), monitoring the progress of the spacewalk from inside Atlantis.

The EVA Developmental Flight Experiment (EDFE) is composed of three sets of evaluations: the Crew and Equipment Translation Aid (CETA); the Crew Loads Instruments Pallet Experiment (CLIP), also known as Detailed Test Objective (DTO) 1203; and the EVA Translation Evaluation, DTOs 1202 and 1205.

Portable Data Acquisition Package

EDFE experiments require the use of a data recording system, called the Portable Data Acquisition Package (PDAP), that will collect information on stresses imparted to the track and cart by the astronauts. The system also will measure forces and torque imparted to the tools the astronauts use during the CLIP experiment.

The PDAP will record 32 channels of analog data with each channel being sampled 150 times per second. The analog signals will be digitized to 12-bit resolution, time tagged and recorded on a hard disk for retrieval after landing.

The three PDAPs flown on Atlantis will be stored inside the crew compartment and mounted on the EDFE experiments by Ross and Apt after the spacewalk begins. They will be brought back into the crew compartment at the completion of the EVA.

Crew and Equipment Translation Aid (CETA)

CETA consists of three carts and a tether Shuttle that move down a 46.8 foot track mounted on the port side of the payload bay. While the Gamma Ray Observatory is in the payload bay, the track is stored in two 23.4-foot sections in the forward part of the bay. Crew members will extend the track to the test position at the onset of the EVA and stow it after the evaluations are complete.

The tether Shuttle is a small translation aid to which astronauts clip their safety tethers. It also is equipped with a small handhold for translations and rides on the CETA track.

For each evaluation, the three CETA carts are mounted to a common truck attached to the translation track. The truck is an approximately 20-inch square assembly with four roller clusters that ride on the track. The individual carts are fixed to the truck for each evaluation and each has its own brake.

The first cart to be tested will be the manual configuration. Once positioned in the foot restraints, the astronaut will propel himself, hand over hand, down the rail. Both the tether Shuttle and the manual cart configuration are baselined for Space Station Freedom.

The mechanical version resembles a railroad car mechanism with which the astronaut pumps a T-handle to move. This motion is converted by a gear train into the continuous motion of two wheel drives. A leg restraint connects to the CETA truck and the tether Shuttle to keep the astronaut in a nearly prone position while pumping the cart.

The final CETA cart uses electrical currents, generated by the astronaut, to move the truck down the rail. The astronaut places himself in foot restraints and pumps two handles in a bicycle-like motion to create a maximum of 24 volts to drive two small motors. The motors then propel the truck down the track.

Maximum speed for all three carts is 6 feet per second. Apt and Ross both will evaluate all three vehicles, at times carrying each other to simulate transporting cargo to a work station. Following the CETA evaluation, Ross and Apt will begin working with the scheduled DTOs.

Detailed Test Objectives

CLIP consists of three force torque sensor plates, a soft stowage assembly and a foot restraint system. The CLIP assembly is stowed on the forward port side of the payload bay. Crew members will perform specific tasks that represent those used during normal EVAs, such as tightening a bolt or turning a knob. The foot restraint and work site are instrumented with sensors that measure the crew induced loads to force and moment signals recorded on the PDAP. Most of the tasks required for the CLIP evaluations will be repeated twice by both EVA astronauts, for a total of about 80 tasks each.

ETE will obtain crew translation data for EVA systems requirements definition, technique development and equipment design. The ETE uses Shuttle hardware such as a manipulator foot restraint and an EVA force measurement tool with various standard orbiter hardware such as the remote manipulator system and the RMS rope reel to evaluate translation rates and techniques.

Astronauts inside Atlantis' crew compartment will maneuver EVA crew members positioned in the MFR on the end of the RMS. The arm will move the astronaut at speeds up to 1.3 feet per second at a distance no closer than 10 feet from the orbiter to gauge maximum comfortable velocity rates and acceleration. Ross also will manually maneuver the RMS while it is configured in "limp mode" to evaluate its ease of positioning by an EVA astronaut. Going from the very complex systems of the RMS to the very simple, the final evaluation if time permits, will consist of astronauts crossing a rope strung across the payload bay.

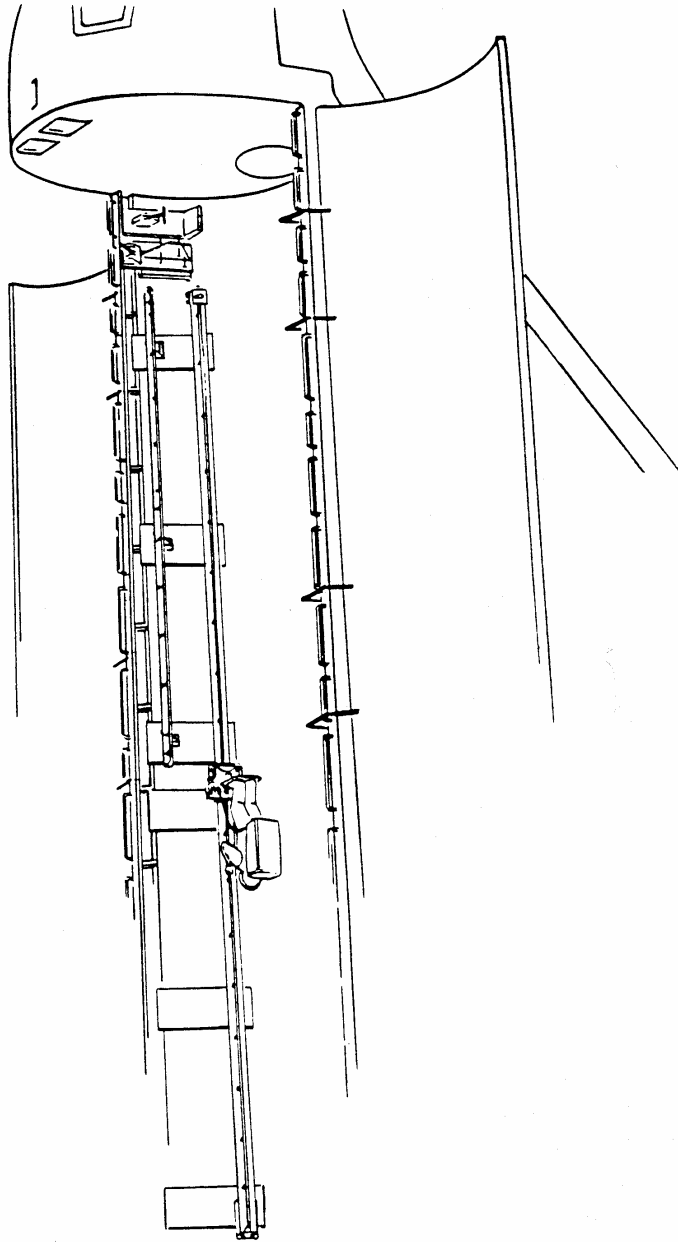
EDFE is sponsored by the Space Station Freedom and managed by the Crew and Thermal Systems Division in the Engineering Directorate at the Johnson Space Center.



SSP INTEGRATION
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STS-37 PAYLOAD INFORMATION DOCUMENT

CETA MONORAIL OPERATIONS

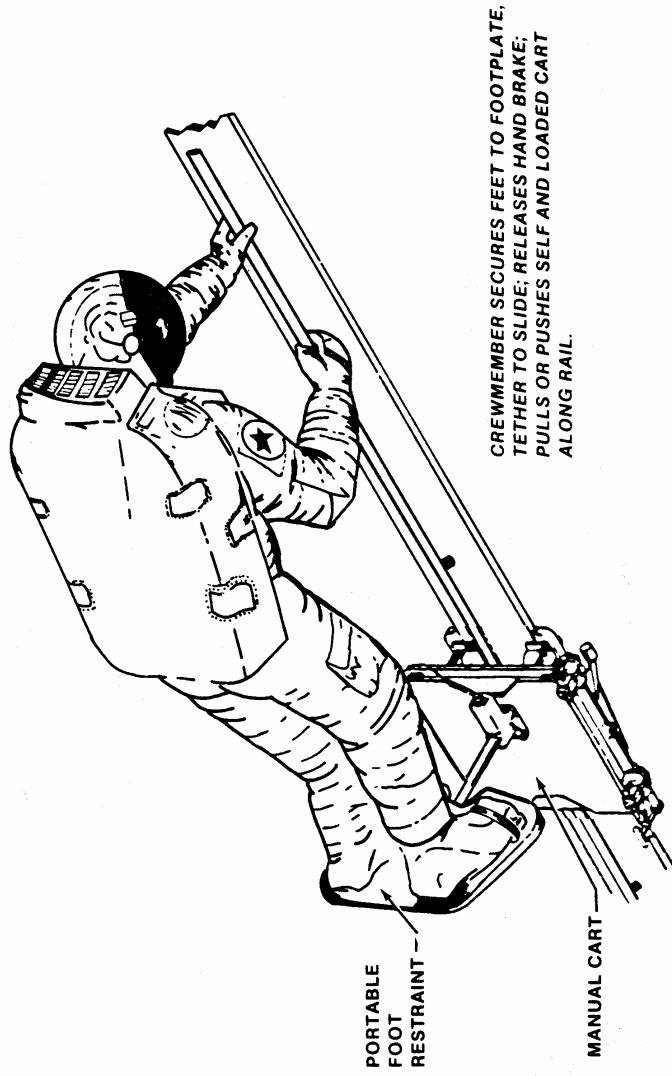




SSP INTEGRATION
AND OPERATIONS

STS-37 PAYLOAD INFORMATION DOCUMENT

MANUAL CART CONCEPT



PORTABLE
FOOT
RESTRAINT

MANUAL CART

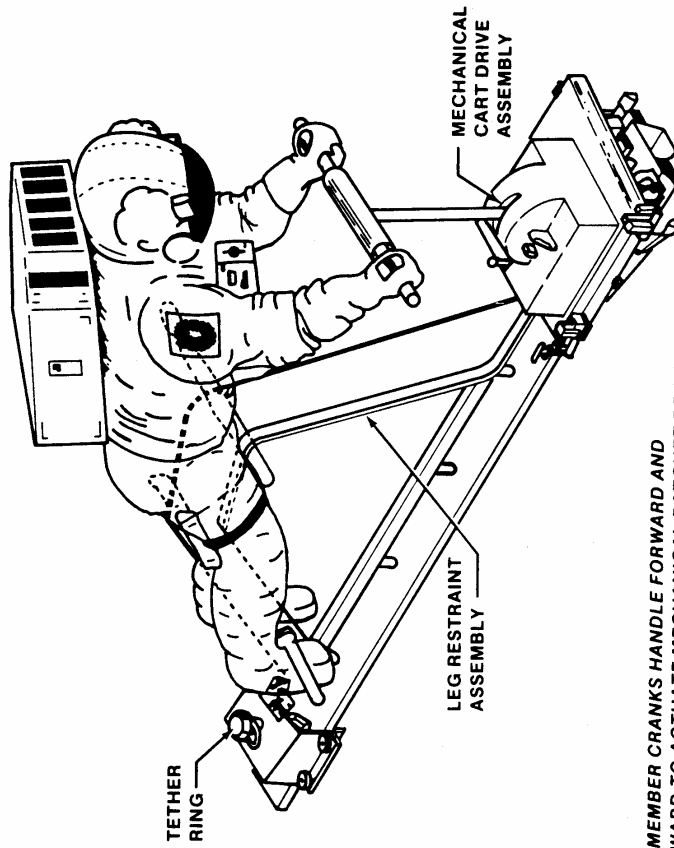
CREWMEMBER SECURES FEET TO FOOTPLATE,
TETHER TO SLIDE; RELEASES HAND BRAKE;
PULLS OR PUSHES SELF AND LOADED CART
ALONG RAIL.



SSP INTEGRATION
AND OPERATIONS

STS-37 PAYLOAD INFORMATION DOCUMENT

MECHANICAL CART



CREWMEMBER CRANKS HANDLE FORWARD AND BACKWARD TO ACTUATE MECHANICAL RATCHET DRIVE

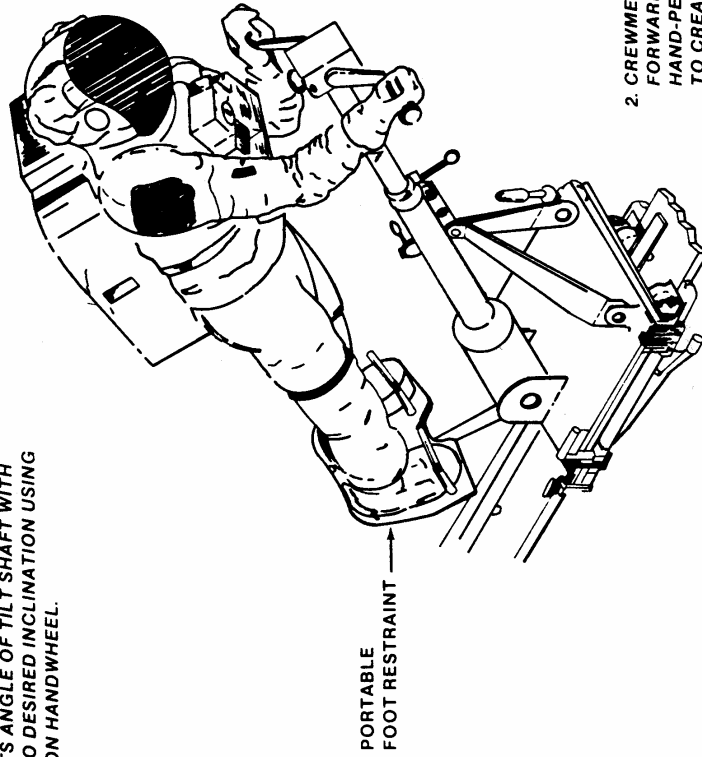


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ELECTRIC CART WITH CRANK HANDLE

1. CREWMEMBER MOUNTS TILT SHAFT;
ADJUSTS ANGLE OF TILT SHAFT WITH
CART TO DESIRED INCLINATION USING
POSITION HANDWHEEL.



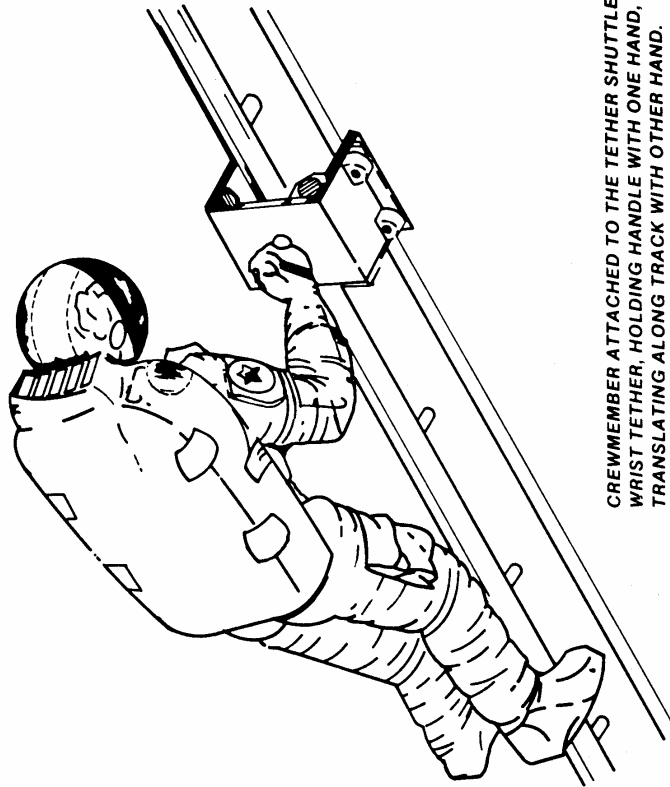
2. CREWMEMBER MOVES CART
FORWARD OR BACKWARD BY
HAND-PEDALING POWER CRANK
TO CREATE DC POWER FOR
CART'S ELECTRIC DRIVE
MOTOR.



SSP INTEGRATION
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STS-37 PAYLOAD INFORMATION DOCUMENT

TETHER SHUTTLE



CREWMEMBER ATTACHED TO THE TETHER SHUTTLE WITH
WRIST TETHER, HOLDING HANDLE WITH ONE HAND, AND
TRANSLATING ALONG TRACK WITH OTHER HAND.

BIOSERVE ITA MATERIALS DISPERSION APPARATUS (BIMDA)

The BioServe ITA Materials Dispersion Apparatus (BIMDA) payload has been jointly developed by BioServe Space Technologies, a NASA Center for Commercial Development of Space (CCDS) located at the University of Colorado, Boulder, and its industrial affiliate, Instrumentation Technology Associates, Inc. (ITA), Exton, Penn. Also collaborating in the BIMDA activity are researchers from NASA's Johnson Space Center, Houston, and Ames Research Center, Mountain View, Calif.

Sponsored by NASA's Office of Commercial Programs, the objective of the BIMDA experiment is to obtain data on scientific methods and potential commercial applications of biomedical and fluid science processing and activities in the microgravity environment of space.

The BIMDA primary elements, developed by ITA, are the Materials Dispersion Apparatus (MDA) minilabs and their controller with a self-contained power supply. The MDA minilab is a compact device capable of mixing as many as 150 samples, using liquid-to-liquid processes using two or three fluids, and can grow crystals, cast thin-film membranes and conduct biomedical and fluid science experiments. The MDA experiments include the study of protein crystal growth in space, collagen polymerization, fibrin clot formation, liquid-solid diffusion and the formation of thin film membranes.

Another primary element of the BIMDA payload is the bioprocessing testbed, designed and developed by BioServe. The test bed contains the hardware for six bioprocessing modules and six cell syringes. The bioprocessing testbed elements will be used to mix cells with various activation fluids followed by extended periods of metabolic activity and subsequent sampling into a fixative solution. The bioprocessing module and cell experiments are to determine the response of live cells to various hormones and stimulating agents under microgravity conditions.

On this first of three planned flights of BIMDA aboard the Space Shuttle, 17 principal investigators will use the MDA to explore the commercial potential of 61 different experiments in the biomedical, manufacturing processes and fluid sciences fields.

BIMDA Hardware

The BIMDA payload includes three elements of hardware: cell syringes, bioprocessing modules (contained in a bioprocessing testbed) and the Materials Dispersion Apparatus (MDA) minilab units. All are contained within a temperature-controlled environment provided by a NASA Refrigerator/Incubator Module (R/IM) in a Shuttle middeck locker position.

At the beginning of BIMDA activation, the testbed housing the cell syringes and bioprocessing modules, will be removed from the R/IM and attached with Velcro to an available surface within the middeck. The testbed will remain outside the R/IM until BIMDA reconfiguration prior to reentry. The MDA minilabs will remain within R/IM.

The cell syringe apparatus consists of six two-chambered syringes containing biological cells, needle/valve adapters and sample vials. When the plunger is depressed, the payload is activated, thus the fluids in the two chambers are mixed and permitted to react. Periodic samples are taken during the flight, using the needle/valve adapters and sample vials.

The six bioprocessing module units each consist of three syringes connected via tubing and a three-position valve. The valve controls the flow of biological cells/fluids between various syringes, allowing different types of mixing and sampling from one syringe to another. The valve apparatus provides options for variations in the mixing of fluids.

The MDA minilabs will remain in the thermally controlled environment of the R/IM during the entire flight. Each MDA minilab unit consists of a number of sample blocks having self-aligning reservoirs or reaction chambers in both top and bottom portions of the device. By sliding one block in relation to the other, the reservoirs align to allow the dispersion to occur between substances contained within each reservoir. The process of sliding the blocks can be repeated to achieve time-dependent dispersion (or mixing) of different substances. A prism window in each MDA unit allows the crew member to determine the alignment of the blocks on each unit.

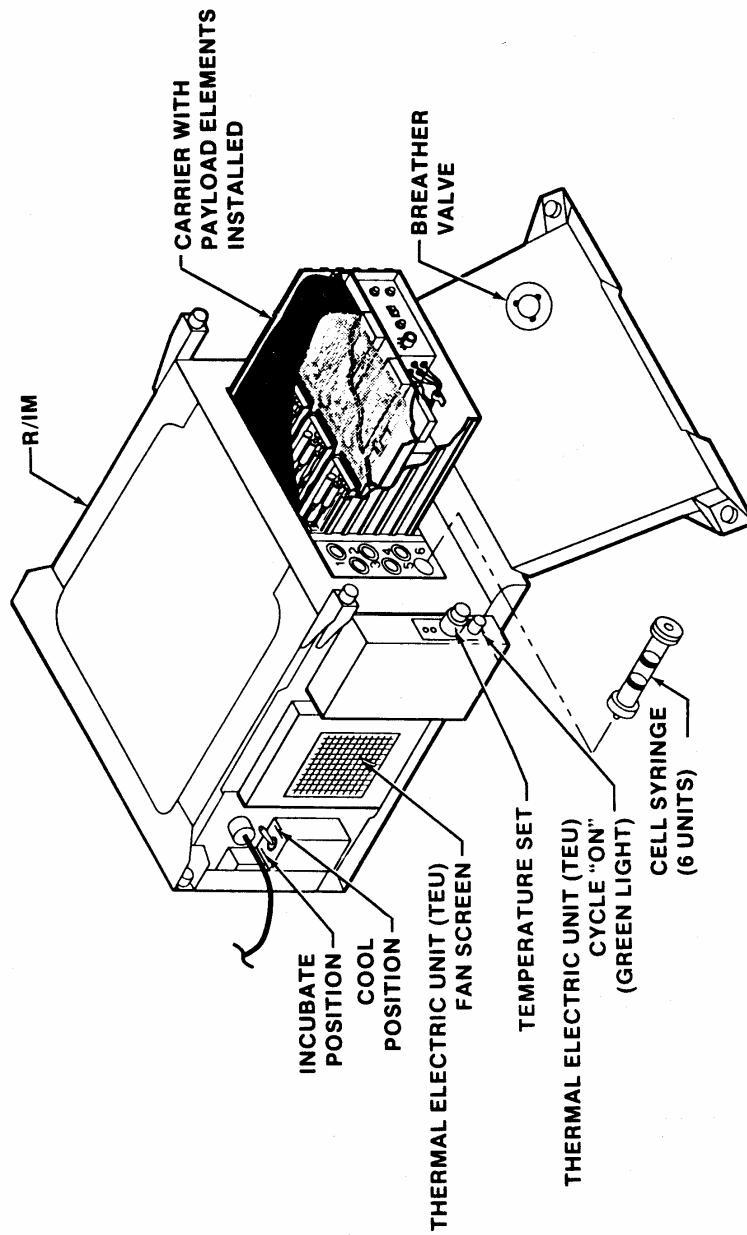
Lead investigator for the BIMDA payload is Dr. Marvin Luttges, Director of BioServe Space Technologies.



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STS-37 PAYLOAD INFORMATION DOCUMENT

BIMDA CONFIGURATION

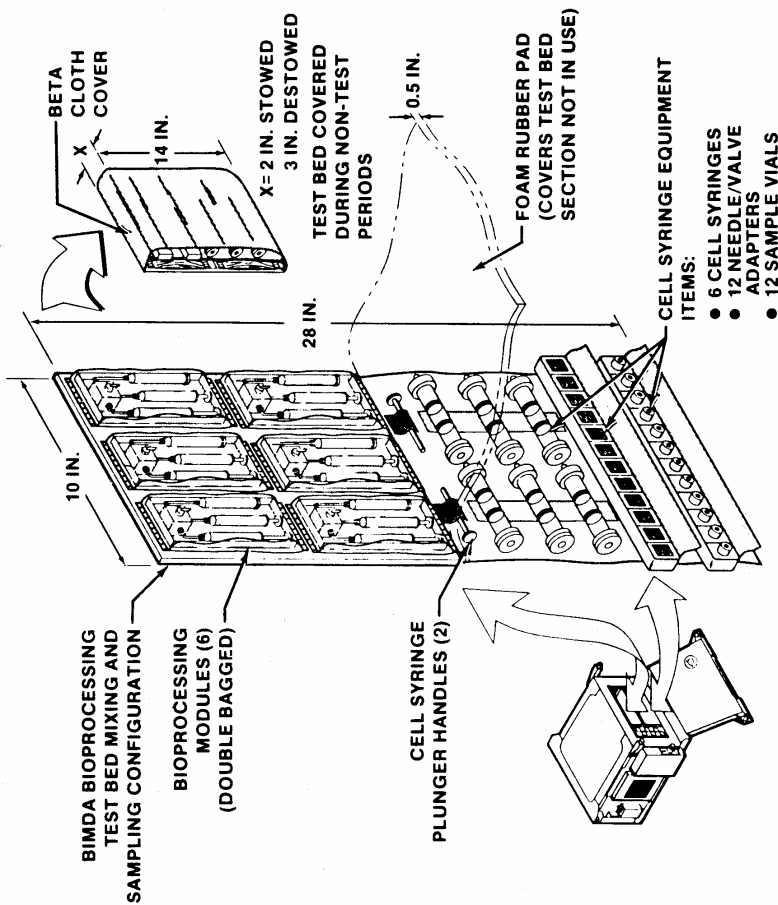




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STS-37 PAYLOAD INFORMATION DOCUMENT

BIMDA BIOPROCESSING TEST BED



PROTEIN CRYSTAL GROWTH EXPERIMENT

The Protein Crystal Growth (PCG) payload aboard STS-37 is a continuing series of experiments leading toward major benefits in biomedical technology. The experiments on this Space Shuttle mission could improve pharmaceutical agents such as insulin for treatment of diabetes.

Protein crystals like inorganic crystals such as quartz, are structured in a regular pattern. With a good crystal, roughly the size of a grain of table salt, scientists are able to study the protein's molecular architecture.

Determining a protein crystal's molecular shape is an essential step in several phases of medical research. Once the three-dimensional structure of a protein is known, it may be possible to design drugs that will either block or enhance the protein's normal function within the body or other organisms. Though crystallographic techniques can be used to determine a protein's structure, this powerful technique has been limited by problems encountered in obtaining high-quality crystals, well ordered and large enough to yield precise structural information.

Protein crystals grown on Earth often are small and flawed. The problem associated with growing these crystals is analogous to filling a sports stadium with fans who all have reserved seats. Once the gate opens, people flock to their seats and in the confusion, often sit in someone else's place. On Earth, gravity-driven convection keeps the molecules crowded around the "seats" as they attempt to order themselves. Unfortunately, protein molecules are not as particular as many of the smaller molecules and often are content to take the wrong places in the structure.

As would happen if you let the fans in slowly, microgravity allows the scientists to slow the rate at which molecules arrive at their seats. Since the molecules have more time to find their spot, fewer mistakes are made, creating better and larger crystals.

During the STS-37 flight, experiments will be conducted using bovine insulin. Though there are four processes used to grow crystals on Earth -- vapor diffusion, liquid diffusion, dialysis and batch process -- only batch process will be used in this set of experiments. Shortly after achieving orbit, a crewmember will activate the experiment to grow insulin crystals.

Protein crystal growth experiments were first carried out by the investigating team during Spacelab 3 in April 1985. The experiments have flown a total of 8 times, with the first 4 primarily designed to develop space crystal growth techniques and hardware.

The STS-26, -29, -32 and -31 experiments were the first opportunities for scientific attempts to grow useful crystals at controlled temperatures by vapor diffusion in microgravity. The STS-37 set of PCG experiments will use the batch process and fly in a new hardware configuration, the Protein Crystallization Facility, developed by the PCG investigators.

The PCG program is sponsored by NASA's Office of Commercial Programs and the Office of Space Science and Applications, with management provided through Marshall Space Flight Center, Huntsville, Ala. Richard E. Valentine is Mission Manager, Blair Herron is PCG experiment manager and Dr. Daniel Carter is project scientist for Marshall.

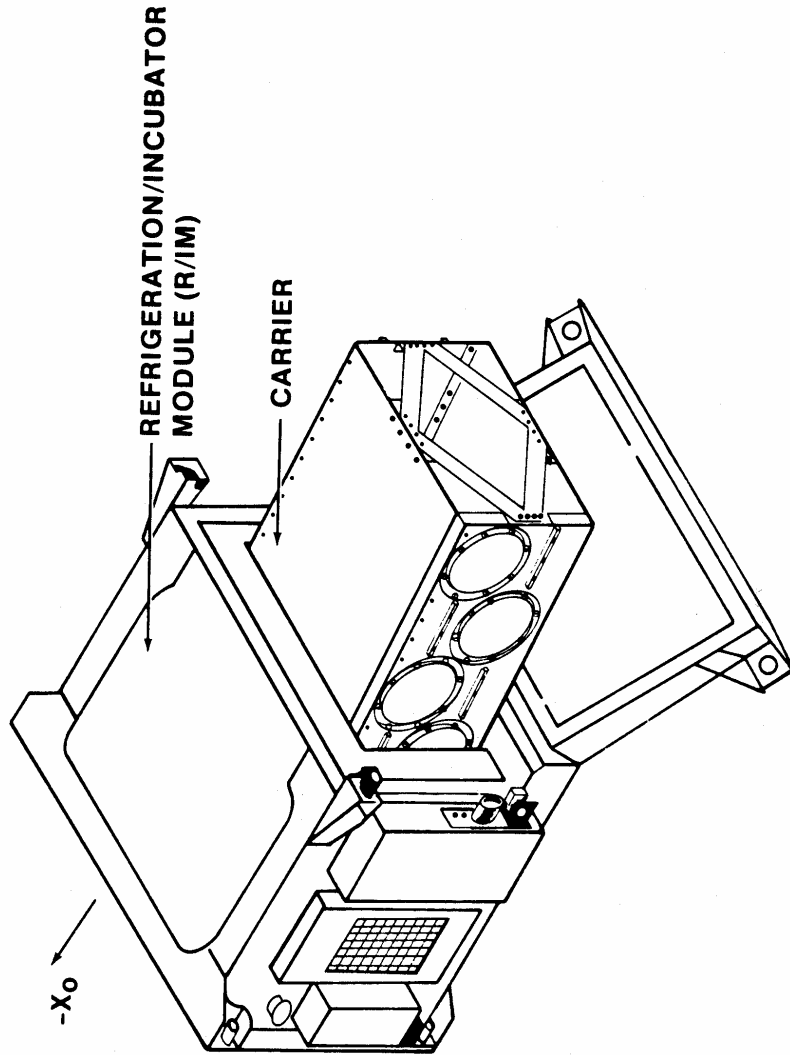
Dr. Charles E. Bugg, director, Center for Macromolecular Crystallography (CMC), a NASA Center for the Commercial Development of Space located at the University of Alabama-Birmingham, is lead investigator for the PCG experiment. Dr. Lawrence J. DeLucas, associate director and chief scientist, and Dr. Marianna Long, associate director for commercial development, also are PCG investigators for CMC.



SSP INTEGRATION
AND OPERATIONS

STS-37 PAYLOAD INFORMATION DOCUMENT

PCG BLOCK II CONFIGURATION



SPACE STATION HEAT PIPE ADVANCED RADIATOR ELEMENT

The Space Station Heat Pipe Advanced Radiator Element-II (SHARE-II) is a small middeck experiment that follows up the evolving design of a full-scale heat pipe experiment carried in the payload bay on STS-29.

On STS-29, a flight test of a 43-foot long heat pipe, a proposed heat-dissipating radiator, found design flaws in the manifold. The manifold is a portion of the radiator that takes ammonia vaporized in an evaporator and moves it through several pitchfork-oriented pipes that converge into one, long single pipe that runs the length of the radiator. The manifold on the original SHARE was designed in a T-shape, with sharp angles that were discovered to block the vapor, thus preventing the radiator from functioning.

On STS-37, two small, transparent test articles will be flown in a single middeck locker. One test article, representing about a 1.5-foot long section of heat pipe, will simulate the actual size of the manifold section. The redesigned manifold features more of a Y-shape convergence of pipes, in theory allowing for easier transportation of the fluid.

A second test article, about 1-foot long, will simulate a screen inserted into a portion of the heat pipe to trap and reduce bubbles in the fluid, thus preventing blockages in the heat pipe.

SHARE-II has no power requirements. For the test of the new manifold design, a crew member will open two valves that will allow an ethanol and water mixture to flow through the pipes. Information on the test will be recorded by videotaping the flow with an onboard camcorder. The walls and structure of both test articles are Plexiglas, allowing complete visibility into the pipes. Recordings of the flow in the manifold test article will be repeated three times, expected to take about 1 hour in total.

On the second article, testing a bubble-screening portion of pipe, the crew will inject bubbles into one end of the test article with a syringe. Then, using another syringe, the crew will pull fluid from the opposite end of the article to force the fluid and bubbles through the screened section of pipe.

A third SHARE experiment is scheduled to fly on STS-43 featuring a redesigned 22-foot long radiator now planned for use with Space Station Freedom.

SHUTTLE AMATEUR RADIO EXPERIMENT

Conducting short-wave radio transmissions between ground-based amateur radio operators and a Shuttle-based amateur radio operator is the basis for the Shuttle Amateur Radio Experiment (SAREX) to fly aboard STS-37.

SAREX will communicate with amateur stations in line-of-sight of the orbiter in one of four transmission modes: voice, slow scan television (SSTV), data or (uplink only) fast scan television (FSTV). The voice mode is operated in the crew-attended mode while SSTV, data or FSTV can be operated in either an attended or automatic mode.

During STS-37, Pilot Ken Cameron, a licensed operator (KB5AWP), will operate SAREX when he is not scheduled for orbiter or other payload activities. Cameron will make at least four transmissions to test each transmission mode. The remaining members of the STS-37 crew -- Commander Steve Nagel (N5RAW) and mission specialists Linda Godwin (N5RAX), Jay Apt (N5QWL) and Jerry Ross (KB5OHL) -- also are licensed ham operators.

SAREX crew tended operating times will be dictated by the time of launch. Cameron will operate SAREX, a secondary payload, during his pre- and post-sleep activities each day. Cameron and his crewmates also may operate SAREX throughout their work day as their schedules permit. This means that amateur stations below the Shuttle during SAREX operating times can communicate with the Atlantis crew. Crew members also will attempt to contact the Soviet space station Mir, but any such contact will depend on each of the spacecraft's orbital paths.

The robotic mode of SAREX will provide automated operation with little human intervention. The robot is used when the crew is not directly involved in the system's operations and is expected to cover most of the U.S. passes.

SAREX previously has flown on missions STS-9, STS-51F and STS-35 in different configurations, including the following hardware: a low-power hand-held FM transceiver; a spare battery set; an interface module; a headset assembly and an equipment assembly cabinet that has been redesigned since its last flight on STS-51F. The cabinet now includes the packet system and can hold the camera and monitors. Additional hardware includes: a television camera and monitor; a payload general support computer (PGSC); and an antenna which will be mounted in a forward flight window with a fast scan television (FSTV) module added to the assembly.

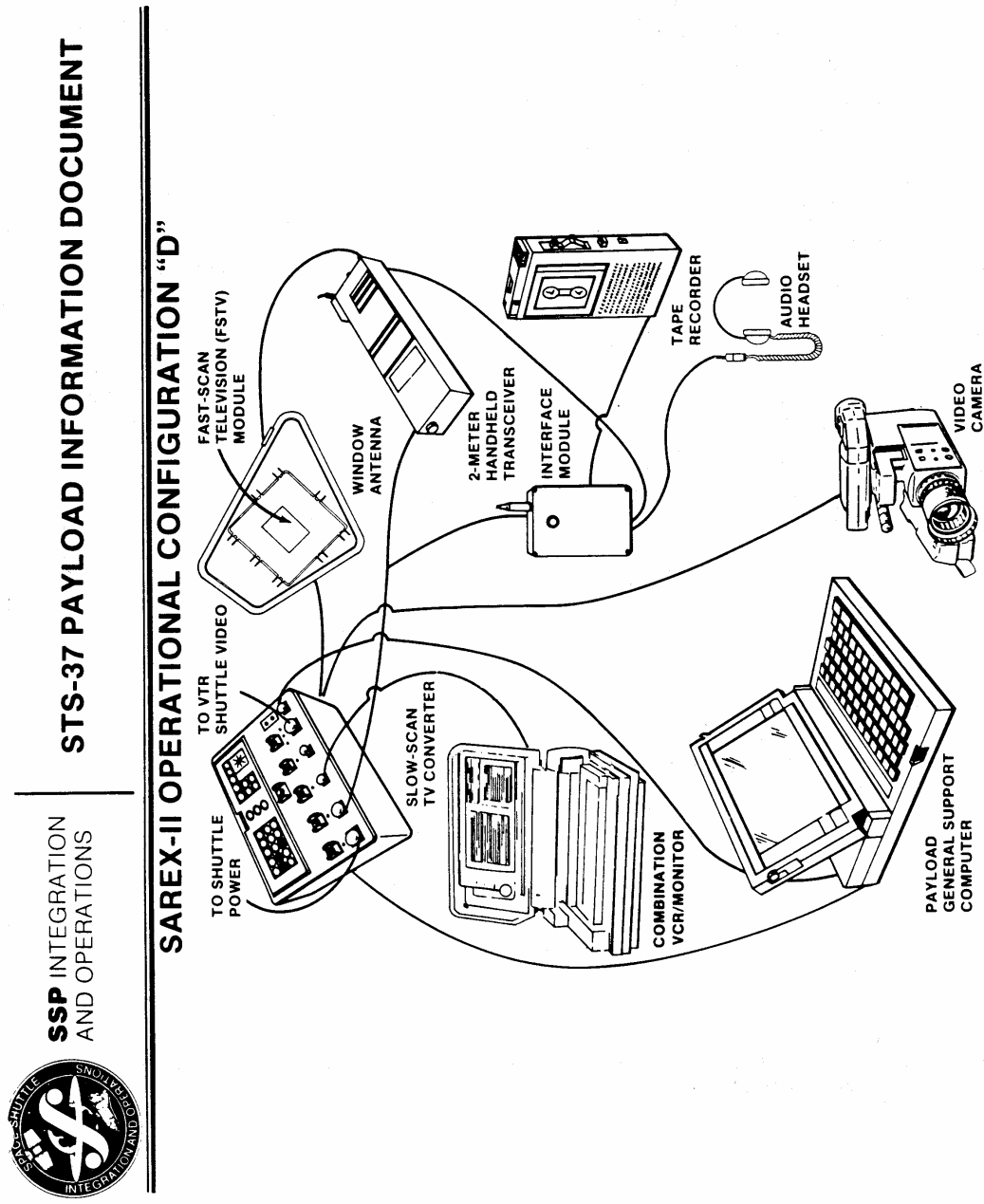
SAREX is a joint effort of NASA, the American Radio Relay League (ARRL)/Amateur Radio Satellite Corporation (AMSAT) and the JSC Amateur Radio Club.

STS-37 SAREX Frequencies

	Shuttle Transmitting Frequency	Accompanying Shuttle Receiving Frequencies
Group 1	145.55 MHz	144.95 MHz
	145.55	144.91
	145.55	144.97
Group 2	145.51	144.91
	145.51	144.93
	145.51	144.99

Group 1 includes voice and slow scan operations. Group 2 includes digital and packet operations.

The 10 U.S. educational groups scheduled to contact Atlantis are: Clear Creek Independent School District of Houston; The University School in Shaker Heights, Ohio; Discovery Center Museum in Rockford, Ill.; Potter Junior High School in Fallbrook, Calif.; Hanover Elementary School in Bethlehem, Pa.; several schools in Southwest Oklahoma with operations based in Lawton; Lyman High School in Longwood, Fla.; Monroe Central School in Parker City, Ind.; Beaver Creek Elementary School in Downington, Pa.; and Reizenstein Middle School in Pittsburgh, Pa.



SSP INTEGRATION AND OPERATIONS



ADVANCED SHUTTLE GENERAL PURPOSE COMPUTERS

On STS-37, Atlantis' avionics system will feature the first set of five upgraded general purpose computers (GPCs), plus a spare, to fly aboard the Shuttle.

The updated computers have more than twice the memory and three times the processing speed of their predecessors. Officially designated the IBM AP-101S, built by IBM, Inc., they are half the size, about half the weight and require less electricity than the first-generation GPCs. The central processor unit and input/output processor, previously installed as two separate boxes, are now a single unit.

The new GPCs use the existing Shuttle software with only subtle changes. However, the increases in memory and processing speed allow for future innovations in the Shuttle's data processing system.

Although there is no real difference in the way the crew will operate with the new computers, the upgrade increases the reliability and efficiency in commanding the Shuttle systems. The predicted "mean time between failures" (MTBF) for the advanced GPCs is 6,000 hours, and it is hoped to reach 10,000 hours. The MTBF for the original GPCs is 5,200 hours.

Specifications

Dimensions:	19.55" x 7.62" x 10.2"
Weight:	64 lbs
Memory capacity:	262,000 words (32-bits each)
Processing rate:	1 million instructions per second
Power requirements:	550 watts

RADIATION MONITORING EXPERIMENT-III

Radiation Monitoring Equipment-III (RME-III) measures the rate and dosage of ionizing radiation to the crew at different locations throughout the orbiter cabin. The hand-held instrument measures gamma ray, electron, neutron and proton radiation and calculates the amount of exposure. The information is stored in memory modules for post-flight analysis.

RME-III will be stored in a middeck locker during flight except for when it is turned on and when memory modules are replaced every 2 days. It will be activated as soon as possible after achieving orbit and will operate throughout the flight. To activate the instrument, a crew member will enter the correct mission elapsed time.

The instrument contains a liquid crystal display for real-time data readings and a keyboard for function control. It has four zinc-air batteries and five AA batteries in each replaceable memory module and two zinc-air batteries in the main module.

RME-III, which has flown on STS-31 and STS-41, is the current configuration, replacing the earlier RME-I and RME-II units. The Department of Defense, in cooperation with NASA, sponsors the data gathering instrument.

The instrument contains a liquid crystal display for real-time data readings and a keyboard for function control. It has four zinc-air batteries and five AA batteries in each replaceable memory module and two zinc-air batteries in the main module.

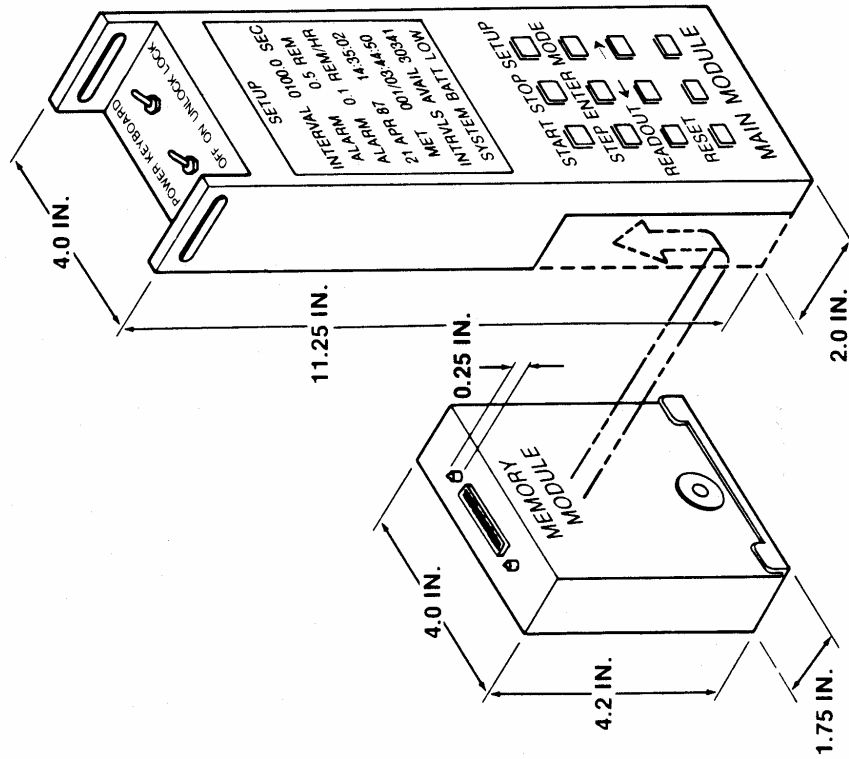
RME-III, which has flown on STS-31 and STS-41, is the current configuration, replacing the earlier RME-I and RME-II units. The Department of Defense, in cooperation with NASA, sponsors the data gathering instrument.



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RADIATION MONITORING EQUIPMENT CONFIGURATION



ASCENT PARTICLE MONITOR

The Ascent Particle Monitor (APM) instruments will be mounted in Atlantis' payload bay during STS-37 to measure contaminants in the bay during launch and ascent.

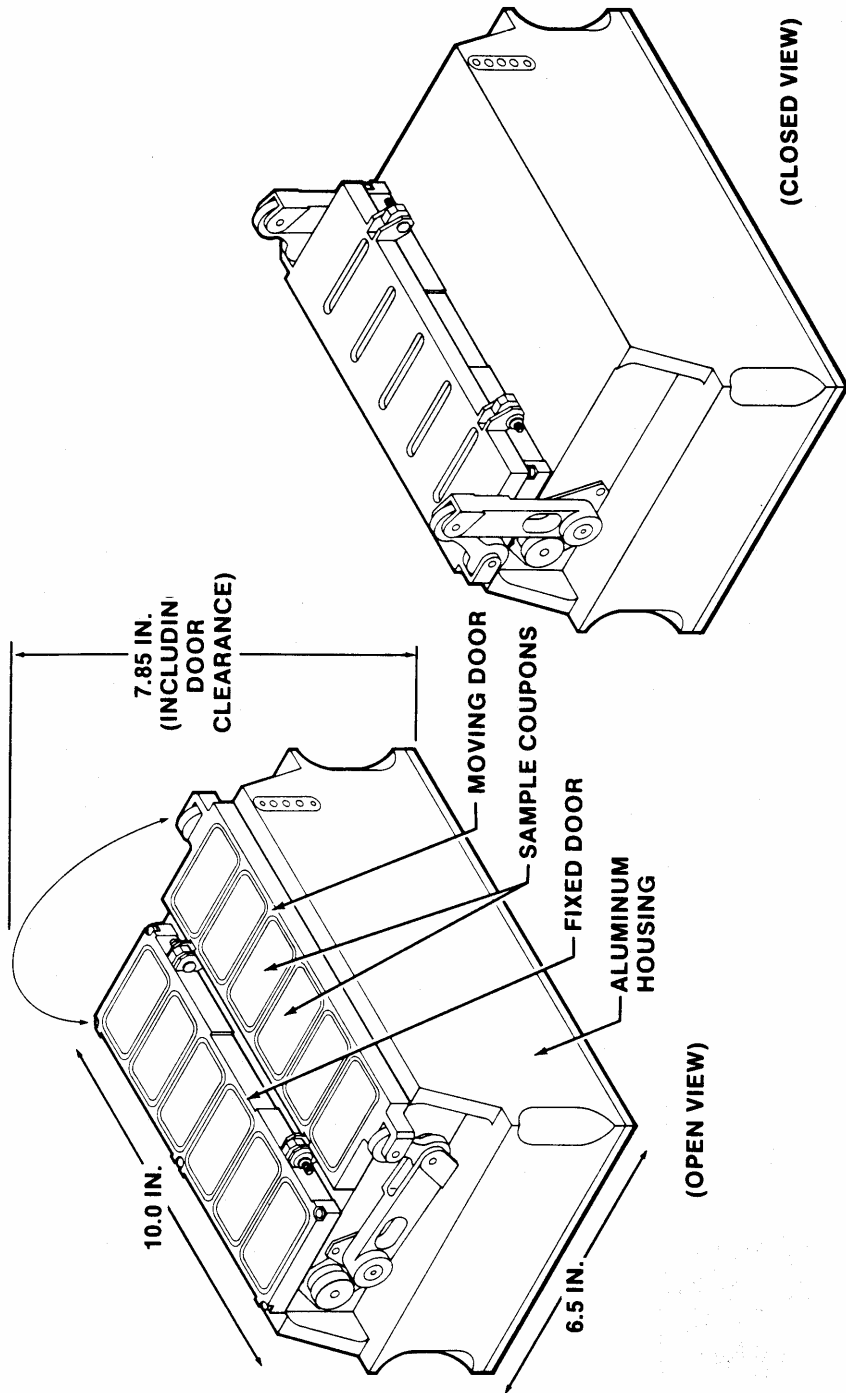
The APM is a completely automatic system consisting of a small aluminum sample box with doors that will open immediately prior to liftoff. When the doors are opened, 12 sample collection coupons are exposed to gather particles in the environment. The doors close following ascent to protect the samples for analysis after Atlantis has landed. The APM has flown previously on several Shuttle missions and is part of an ongoing effort to better characterize the cargo bay environment during launch.



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ASCENT PARTICLE MONITOR (APM)

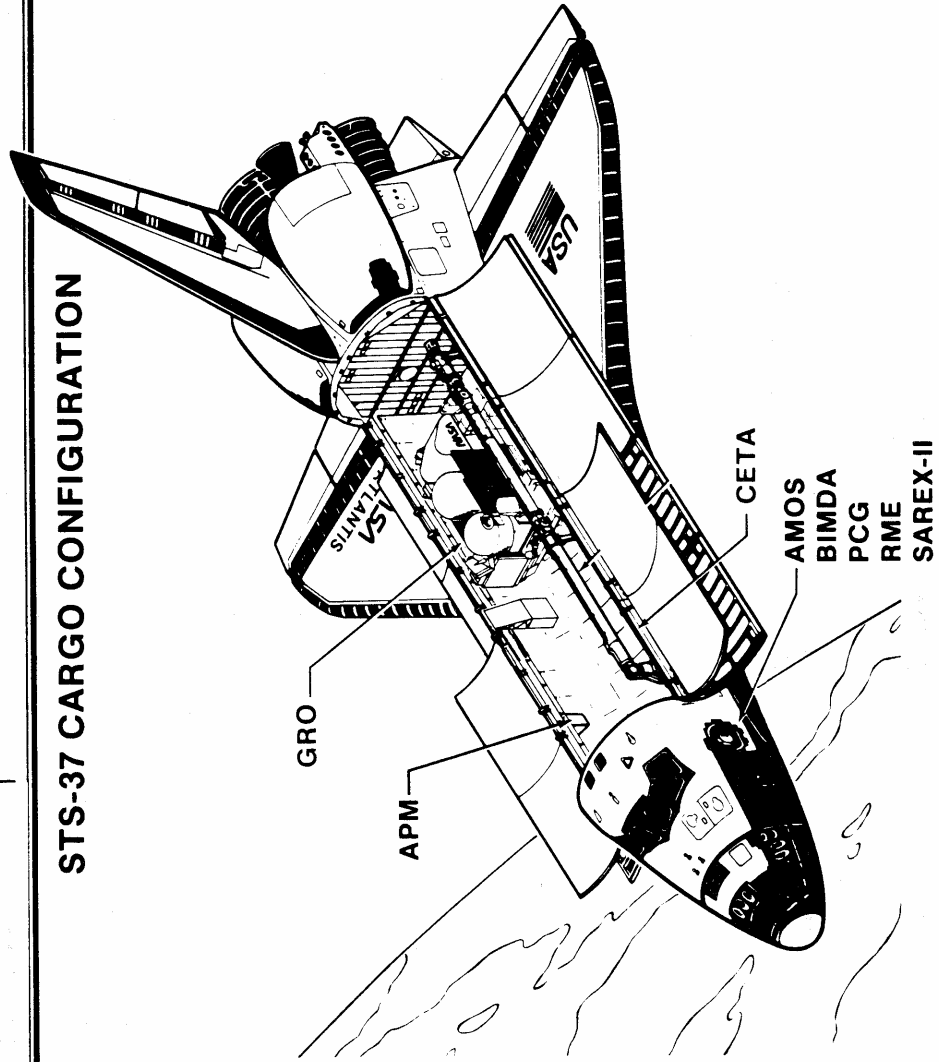




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STS-37 CARGO CONFIGURATION



STS-37 CREWMEMBERS



STS037-S-002 -- STS-37 Atlantis, Orbiter Vehicle (OV) 104, official crew portrait includes pilot Kenneth D. Cameron (left), commander Steven R. Nagel (center), and mission specialist Linda M. Godwin (right) seated in front and wearing crew t-shirts and Jerome Apt (left) and Jerry L. Ross (right) standing and wearing extravehicular mobility units (EMUs). Apt and Ross will participate in extravehicular activity (EVA) during the mission. The United States flag and the mission insignia are displayed in the background.

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PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

STEVEN R. NAGEL, 44, Col., USAF, will serve as Commander of STS-37. Selected as an astronaut in August 1979, Nagel considers Canton, Ill., his hometown. Nagel first flew as a mission specialist on STS-51G, launched in June 1985 to deploy three communications satellites. Nagel next served as Pilot for STS-61A, the West German D-1 Spacelab mission, launched in October 1985.

Nagel graduated from Canton Senior High School in 1964; received a bachelor of science in aeronautical and astronautical engineering from the University of Illinois in 1969; and received a master of science in mechanical engineering from California State University, Fresno, in 1978.

Nagel received his commission in 1969 through the Air Force Reserve Officer Training Corps program at the University of Illinois. He completed undergraduate pilot training at Laredo Air Force Base, Texas, in February 1970, and subsequently reported to Luke Air Force Base, Arizona, for F-100 checkout training.

He served as an F-100 pilot with the 68th Tactical Fighter Squadron from October 1970 to July 1971, and then served a 1-year tour of duty as a T-28 instructor for the Laotian Air Force at Udorn RTAFB, Udorn, Thailand. In 1975, he attended the USAF Test Pilot School and was assigned to the 6512th Test Squadron located at Edwards Air Force Base, Calif., upon graduation. He worked as a test pilot on various projects, including flying the F-4 and A-7D. Nagel has logged more than 6,300 hours flying time, 4,000 hours in jet aircraft.

KENNETH D. CAMERON, 41, Lt. Col., USMC, will serve as Pilot. Cameron was selected as an astronaut in June 1985, considers Cleveland his hometown and will be making his first space flight.

Cameron graduated from Rocky River High School, Ohio, in 1967. He received bachelor and master of science degrees in aeronautics and astronautics from the Massachusetts Institute of Technology.

He enlisted in the Marine Corps in 1969 at Paris Island, N. C., and was assigned in Vietnam for 1 year as a platoon commander with the 1st Battalion, 5th Marine Regiment and later, with the Marine Security Guards at the U.S. Embassy, Saigon. Cameron received his wings in 1973 at Pensacola, Fla., and was assigned to Marine Attack Squadron 223, flying A-4M Skyhawks.

He graduated from the Navy Test Pilot School in 1983 and was assigned as project officer and test pilot in the F/A-18, A-4 and OV-10 airplanes with the Systems Engineering Test Directorate at the Naval Air Test Center. Cameron has logged more than 3,000 hours flying time in 46 different aircraft.

LINDA M. GODWIN, 38, will serve as Mission Specialist 1 (MS1). Selected as an astronaut in 1985, Godwin was born in Cape Girardeau, Mo. Godwin graduated from Jackson High School, Mo., in 1970; received a bachelor of science in mathematics and physics from Southeast Missouri State in 1974; and received a master of science and doctorate in physics from the University of Missouri in 1976 and 1980, respectively.

Godwin joined NASA in 1980, working in the Payload Operations Division at the Johnson Space Center as a flight controller and payloads officer. Godwin is an instrument rated private pilot.

BIOGRAPHICAL DATA

JERRY L. ROSS, 43, Lt. Col., USAF, will serve as Mission Specialist 2 (MS2). Selected as an astronaut in May 1980, Ross considers Crown Point, Ind., his hometown and will be making his third space flight.

Ross first flew as a mission specialist on STS 61-B, launched in November 1985 to deploy three communications satellites. During the flight, Ross performed two 6-hour spacewalks to demonstrate space construction techniques. Ross next flew on STS-27, launched in December 1988, a Department of Defense-dedicated flight.

Ross graduated from Crown Point High School in 1966. He received a bachelor of science and master of science in mechanical engineering from Purdue University in 1970 and 1972, respectively. Ross has logged 207 hours in space, including 12 hours of spacewalk time.

JAY APT, 41, will serve as mission specialist 3 (MS3). Selected as an astronaut in June 1985, Apt considers Pittsburgh, Pa., his hometown and will be making his first space flight.

He graduated from Shady Side Academy in Pittsburgh in 1967; received a bachelor of arts in physics from Harvard College in 1971; and received a doctorate in physics from the Massachusetts Institute of Technology in 1976.

Apt joined NASA in 1980 and worked in the Earth and Space Sciences Division of the Jet Propulsion Laboratory, doing planetary research as part of the Pioneer Venus Orbiter Infrared Team. In 1981, he became the Manager of JPL's Table Mountain Observatory.

From the fifth Shuttle mission in 1982 through the 16th in 1985, he served as a flight controller and payloads officer. Apt has logged more than 2,200 hours flying time in 25 different types of airplanes, sailplanes and human-powered aircraft.

STS-37 MISSION MANAGEMENT

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J.R. Thompson	Deputy Administrator
Dr. William B. Lenoir	Associate Administrator, Office of Space Flight
Robert L. Crippen	Director, Space Shuttle
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Alphonso V. Diaz	Deputy Associate Administrator, Space Science and Applications
Dr. Charles J. Pellerin Jr.	Director, Astrophysics Division
Douglas R. Broome	GRO Program Manager
Dr. Alan N. Bunner	GRO Program Scientist

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Dr. Dale W. Harris	Acting Director, Flight Projects Directorate
Dale L. Fahnestock	Director, Mission Operations and Data Systems Directorate
John Hrastar	GRO Project Manager
Thomas LaVigna	GRO Deputy Project Manager
Karl Schauer	GRO Mission Operations Manager
Robert Ross	GRO Systems Manager
Martin Davis	GRO Observatory Manager
Jimmy Cooley	GRO Instrument Manager
Dr. Donald Kniffen	GRO Project Scientist
Dr. Carl Fichtel	Co-Principal Investigator, EGRET
Dr. Eric Chipman	Director, GRO Science Support Center

KENNEDY SPACE CENTER, FL

Forrest S. McCartney	Director
Jay Honeycutt	Director, Shuttle Management and Operations
Robert B. Sieck	Launch Director
John T. Conway	Director, Payload Management and Operations
Joanne H. Morgan	Director, Payload Project Management
Robert Webster	STS-37 Payload Manager

MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, AL

Thomas J. Lee	Director
Dr. J. Wayne Littles	Deputy Director
G. Porter Bridwell	Manager, Shuttle Projects Office
Dr. George F. McDonough	Director, Science and Engineering
Alexander A. McCool	Director, Safety and Mission Assurance
Victor Keith Henson	Manager, Solid Rocket Motor Project
Cary H. Rutland	Manager, Solid Rocket Booster Project
Jerry W. Smelser	Manager, Space Shuttle Main Engine Project
Gerald C. Ladner	Manager, External Tank Project

JOHNSON SPACE CENTER, HOUSTON, TX

Aaron Cohen	Director
Paul J. Weitz	Deputy Director
Daniel Germany	Manager, Orbiter and GFE Projects
P.J. Weitz	Acting 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

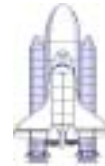
Roy S. Estess	Director
Gerald W. Smith	Deputy Director
J. Harry Guin	Director, Propulsion Test Operations

DRYDEN FLIGHT RESEARCH FACILITY, EDWARDS, CA

Kenneth J. Szalai	Director
T. G. Ayers	Deputy Director

SHUTTLE FLIGHTS AS OF APRIL 1991

38 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 13 SINCE RETURN TO FLIGHT



STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-41 10/06/90 - 10/10/90	
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-31 04/24/90 - 04/29/90	
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-33 11/22/89 - 11/27/89	
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-29 03/13/89 - 03/18/89	
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85
		STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85

OV-102
Columbia
(10 flights)

OV-099
Challenger
(10 flights)

OV-103
Discovery
(11 flights)

OV-104
Atlantis
(7 flights)