DOCUMENT RESUME

ED 238 677 SE 041 770

TITLE	STS-9 and Spacelab 1. NASA Educational Briefs for the Classroom.
INSTITUTION	National Aeronautics and Space Administration, Washington, D.C.
REPORT NO	EB-83-8
PUB DATE	83
NOTE	4p.
PUB TYPE	Guides - General (050) -- Collected Works - Serials (022)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Aerospace Technology; Elementary Secondary Education; *Environmental Influences; Instructional Materials; International Cooperation; *International Programs; Learning Activities; Objectives; Personnel; *Science Experiments; *Science Laboratories; *Space Exploration; Telecommunications
IDENTIFIERS	European Space Agency; National Aeronautics and Space Administration; PF Project; *Spacelab; Space Shuttle

ABSTRACT

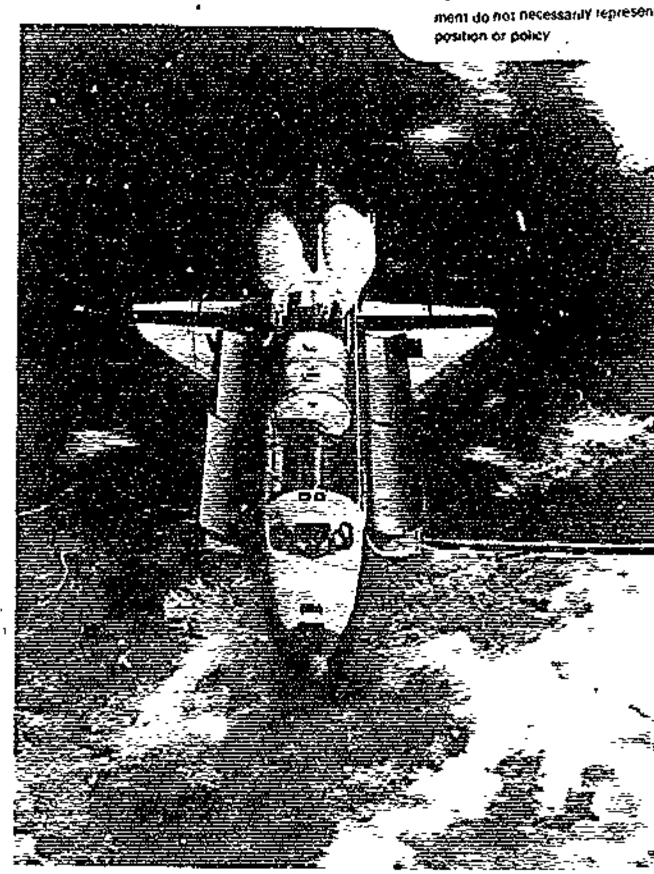
Designed for classroom use, this publication provides an overview of the first Space Shuttle/Spacelab mission, a cooperative venture between the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA). The main purpose of ESA's Spacelab, which will be carried aboard NASA's Space Shuttle (technically called the Space Transportation System or STS), is described as enabling scientists to go into space to conduct experiments which are not possible in Earth's atmosphere and gravity. Topics covered include: (1) the goals of the mission; (2) the types of experiments and investigations which will be performed; (3) the crew; (4) the physical design of the craft; (5) human and data communications between the Johnson Space Center and the Spacelab; and (6) the ability of the Spacelab to be used again. Six questions and activities for classroom instruction are provided. (DC)

NASA Educational Briefs

An Educational Publication of the National Aeronautics and Space Administration

For the classroom

STS-9 and Spacelab 1



Artist's concept of Spacelab 1

A dream is soon to be realized: scientists no longer will be earthbound but, like astronauts, will be able to go into space to perform research that cannot be done on Earth. STS-9 (Space Transportation System-*Columbia*) will carry the European Space Agency's (ESA) Spacelab on its first mission.

Spacelab, a cooperative venture of ESA and NASA, will be launched from the Kennedy Space Center (KSC) in Florida. The flight will last nine days at an orbital altitude of 250 kilometers (155 miles). ESA is responsible for funding, developing, and building Spacelab, a multidisciplinary facility for use in NASA's Space Shuttle orbiter. NASA is responsible for the launch and operational use of Spacelab. Scientists from 11 European nations, Canada, Japan, and the United States are providing instruments and experimental procedures for over 70 different investigations.

Spacelab is a versatile modular laboratory installed in the Space Shuttle orbiter payload bay and exposed to space when the cargo bay doors are opened. It consists of an enclosed pressurized laboratory containing utilities, computers, work benches, and instrument racks for the conduct of experiments, as well as outside platforms (pallets) where such equipment as telescopes, antennas, and sensors are mounted for direct exposure to space. These units may be used in various combinations, returned to Earth, and reused on other flights. Spacelab can be outfitted with several tons of laboratory instruments for studies in astronomy, physics, chemistry, biology, medicine, and engineering.

The Spacelab facility is designed for use by scientists who are not necessarily astronauts; men and women from universities, industries, government agencies, and research institutes in many nations will conduct investigations in Spacelab. They will work in the shirtsleeve environment of the well-equipped laboratory module. They will be able to handle the equipment, react to unexpected experimental conditions and results, change their plans, and gain the greatest scientific yield from the mission. The involvement of users in all phases of the mission from planning through post-flight review, including their presence onboard the flight, is a distinct advantage for space-age scientific research.

Because very low gravity, high vacuum, high-energy radiation, and large volumes of ionized gases are difficult or impossible to achieve in laboratories on ground, some important research problems can be solved only in space, where the conditions occur naturally. Spacelab is able to offer this unique environment to investigators.

Spacelab actually encourages advanced scientific research in space, because by sharing accommodations and instruments, users may conduct a variety of investigations simultaneously and less expensively than on independent missions. With slight modifications, existing laboratory equipment can be flown on Spacelab and returned for reuse. Valuable data can be returned physically as well as transmitted electronically. Experiments and instruments may be modified for reflight on subsequent Spacelab missions.

EB-83-8

National Aeronautics and Space Administration
Washington, D.C. 20546
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Goals

The Investigations selected for the STS-9 mission will test the Spacelab hardware, flight and ground systems, and crew to demonstrate their capabilities for advanced research in space.

Spacelab 1 will demonstrate new instruments and methods for conducting experiments that are difficult or impossible in ground-based laboratories, rockets, or orbiting satellites. It will carry more equipment than a conventional satellite and many of the instruments will be the largest, most powerful, or most sensitive of their kind ever to be placed in orbit.

Furthermore, Spacelab 1 will help demonstrate the practicality of cooperative research projects in space by scientists from different disciplines and nations.

Investigations

The seventy investigations carried aboard Spacelab 1 are in five research disciplines. astronomy and solar physics, space plasma physics, atmospheric physics and Earth observations, life sciences, and materials science. This first mission will demonstrate the broad versatility of the facility and provide an opportunity to sample the capabilities of an orbiting laboratory and should begin to fill the gaps in our knowledge.

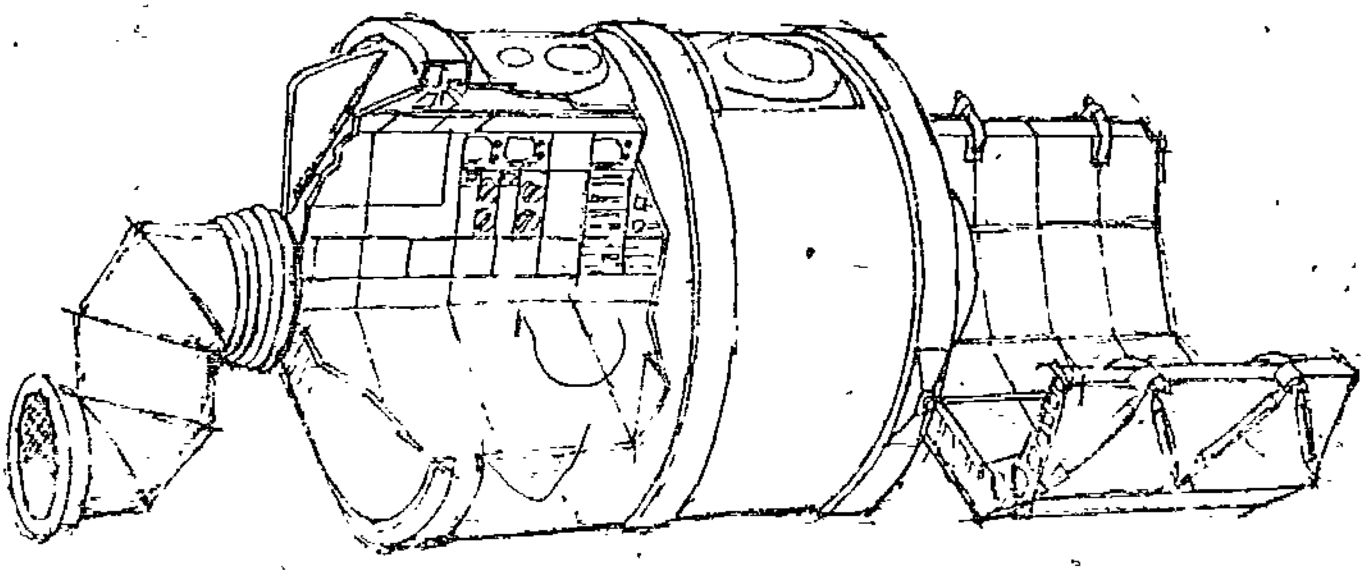
Crew

Spacelab 1 will carry a four-member science crew: two Mission Specialists and two Payload Specialists. Mission Specialists, Dr. Owen Garriott and Dr. Robert Parker, are NASA astronauts who have broad scientific training. They operate various orbiter-Spacelab systems, perform any needed activity outside the spacecraft, and support the investigations as needed. The Payload Specialists are fellow scientists nominated for flight by the organizations sponsoring the payload. They are accepted, trained, and certified for flight by NASA. They conduct the bulk of the scientific activities.

All Specialists collaborate closely with investigators during training and throughout the mission. With the recommendation of the investigators, one American, Dr. Bryon Lichtenberg, and one European, Ulf Merbold, have been chosen as Payload Specialists to accompany the experiments into space. Two other Payload Specialists will support the mission from the payload control center on the ground.

In addition to training for detailed operation of individual experiments in the sponsoring laboratories, the specialists must acquire the necessary skills for living and working aboard the Shuttle-Spacelab. Medical, emergency, and survival skills as well as the normal routines of living in a spacecraft are practiced in training programs at the Johnson, Kennedy, and Marshall Space Centers.

Training for the integrated payload occurs at the Marshall Center. This center is also NASA's lead center for monitoring the development and managing the first Spacelab missions.



The laboratory module and one pallet will be used for the Spacelab 1 mission. Other configurations of Spacelab units can be used for future missions.

Design

Spacelab has been developed on a modular basis and can be varied to meet specific mission requirements. Its two principal components are the pressurized module which provides a comfortable working laboratory and the open pallet that exposes materials and equipment directly to space. Each module is segmented, permitting additional flexibility.

The pressurized module comes in two segments; one, called the core segment, contains supporting subsystems such as data processing equipment and utilities for both the pressurized modules and the pallets. It also has laboratory fixtures such as floor-mounted racks and work benches and supplies and appropriate working space. The second, called the experiment segment, is used to provide more working laboratory space. When only one segment is needed, the core segment is used.

Each pressurized segment is a cylinder 4.1 meters (13½ ft) in diameter and 2.7 m (9 ft) long. When both segments are assembled with end cones, their maximum outside length is 7 m (23 ft).

A tunnel connects the pressurized laboratory with the pressurized cabin of the Shuttle orbiter. The tunnel is also segmented so its length can be varied. An airlock module may be attached to the tunnel to provide additional access to space.

Five pallet segments are available. Each pallet is not only a platform for mounting instrumentation but also can cool equipment, provide electrical power, and furnish connections for commanding and acquiring data from the experiments. The pallets are designed for large instruments, experiments requiring direct exposure to the space environment, or those needing unobstructed or broad fields of view. All experiments on the pallet are controlled from the module by the crew or by computers.

On-Orbit Operations

During a Spacelab flight, the hub of activity for scientists on the ground is the Payload Operations Control Center (POCC), at the Johnson Space Center. For Spacelab 1, the Mission Scientist, ESA Project Scientist, Mission Manager, two Payload Specialists, and all Principal Investigators, with their research teams, gather here to oversee the operation of their experiments.

From the POCC, scientists can communicate with the Spacelab crew by voice and video; command and data links enable them to follow the progress of their experiments. If necessary, they may intervene in the operations by verbally instructing the crew or by sending automated commands to the onboard computer that controls their instruments. Investigators may install their own special equipment for experiment data processing and analysis in the center so they can monitor and modify operations.

Data Return

During the flight, data are also transmitted to the Data Processing Facility at the Goddard Space Flight Center. This facility separates and organizes the mass of incoming data by experiment. Thus, investigators can obtain computer tapes, voice recordings, and video tapes that contain information only about their own experiments. Furthermore, after the Shuttle lands, all experiment equipment and samples will be returned to the Principal Investigators.

Refurbishment and Reuse

Spacelab and many of the experiment instruments are designed to be used on at least 50 missions. After Spacelab 1 is dismantled, all hardware will be inspected and, if necessary, repaired or modified. Some pieces may be required immediately for other Spacelab missions; others will remain available as part of an equipment pool that scientists may draw upon to assemble new experiments quickly and economically.

This research opportunity is so novel that we can hardly predict the full impact of the mission. We will add to our fund of basic scientific knowledge. Some of the investigations will stretch the frontiers of science with major advances in theory and measurements. Others will yield a favorable return-on-investment through major technical advances and practical applications. As we conduct science in space, we expect keener insight into complex processes that govern our universe and life itself.

Questions and Activities for the Classroom

1. What are the advantages of using Spacelab for observing the Sun and stars?
2. Spacelab 1 will measure the range and variability of the solar constant. Research the effects a slight change in the Sun's total radiation would have on Earth's climatic factors.
3. Operating in near-Earth space, Spacelab 1 will offer an extraordinary chance to study the magnetosphere. Describe the changes experienced on Earth due to magnetic storms.
4. What are the advantages of using Spacelab as compared to ground-based and suborbital research techniques?
5. How does the absence of gravity affect human physiology and behavior?
6. Prepare a chart of physical processes that do not occur naturally in microgravity; explain why, and state the advantages of a weightless processing facility.

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