NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-70

PRESS KIT
MAY 1995

TDRS-G DEPLOYMENT

STS-70 INSIGNIA

STS070-S-001 -- *Designed by the crewmembers, the STS-70 insignia depicts the space shuttle Discovery orbiting Earth in the vast blackness of space. The primary mission of deploying a NASA Tracking and Data Relay Satellite (TDRS) is depicted by three gold stars. They represent the triad composed of spacecraft transmitting data to Earth through the Tracking and Data Relay Satellite System (TDRSS). The stylized red, white and blue ribbon represents the American goal of linking space exploration to the advancement of all humankind. Surnames of the five astronaut crew members are spaced around the periphery of the insignia.*

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.

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RELEASE: 95-71

DISCOVERY LAUNCH TO MARK 100TH HUMAN SPACEFLIGHT

Thirty-four years after Alan B. Shepard's historic 15- minute sub-orbital flight into space, America will launch its 100th human space mission on June 8 with the flight of the Space Shuttle Discovery.

Designated STS-70, the mission is scheduled to be launched into a 160-mile circular orbit during a two hour 30 minute window that opens at 9:01 a.m. EDT on June 8. The mission is scheduled for seven days, 22 hours and 10 minutes, but Shuttle officials may shorten the flight to five days depending on when the mission actually begins so that the next Shuttle mission - a historic linkup with the Russian space station Mir - can be launched about June 23. An eight-day mission would result in a June 16 landing at the Kennedy Space Center, FL. A shortened flight would see Discovery touch down on June 13.

Aboard Discovery will be a five-person crew commanded by two-time Shuttle pilot Terence "Tom" Henricks, pilot Kevin Kregel and mission specialists Donald Thomas (second flight), Nancy Currie (second flight) and Mary Ellen Weber. This will be Kregel and Weber's maiden space voyage.

Discovery's primary objective is the deployment of the Tracking and Data Relay Satellite-G, the last in a series of a space-based satellite network that provides communications, tracking, telemetry, data acquisition and command services essential to Shuttle and low-Earth orbital spacecraft missions.

Approximately six hours after launch, TDRS-G will be released out of Discovery's payload bay. It will be boosted to geostationary orbit 22,300 miles above the Earth by a powerful 2-stage, 16-ton solid-fueled Inertial Upper Stage, positioned at 171 degrees West longitude.

STS-70 will mark another significant milestone with the first flight of the new Block I Space Shuttle main engine. Main Engine #1 - engine 2036 - features improvements that increase the reliability and safety margins of the main engines. SSMEs No. 2 and No. 3 are the current design.

The Block I engine features improvements such as a new liquid oxidizer turbopump produced through a casting process that eliminates all but six of the 300 welds that exist in the current pump. A new two-duct powerhead improves fluid flows within the engine to decrease pressure and loads. A new single-coil heat exchanger in the powerhead eliminates all seven weld joints inside the engine, reducing wear, maintenance and post-flight inspections. On STS-73, scheduled for launch in late September 1995, all three of the SSMEs will be of the Block I design.

With TDRS successfully deployed, Discovery's crew will turn their attention to middeck experiments.

Among the payloads stowed in Discovery's middeck is the Commercial Protein Crystal Growth facility in which researchers will grow crystals of human alpha interferon protein, a protein pharmaceutical that is currently used against human viral hepatitis B and C. The objective is to use these crystals to determine the three-dimensional structure of molecules using crystallography to assist in the development of the next generation of alpha interferon drugs.

A University of Arizona researcher will examine the tobacco hornworm to determine how its hormone system and muscle formation are affected by zero-gravity in an experiment called Biological Research in Canisters-4. Basic information in hormone and muscle development will have a direct impact on basic research and development for long duration human space missions, as well as potentially affecting such areas as insect development and pest control on Earth.

BRIC-5, a State University of New York at Stony Brook experiment, will study the effects of spaceflight on the cell division of the daylily. This research will contribute to a better understanding of plant development and reproduction, which in turn will directly affect the ability to grow plants in space.

National Institutes of Health-sponsored experiments in the middeck will examine the effects of space flight on the behavior, muscle, nerve and bone development and circadian timing of rats. Much of this research is directed at developing a greater understanding of basic physiological processes which could provide insight into a range of medical challenges on Earth.

NASA and the Walter Reed Army Institute are collaborating on the space tissue loss-B experiment which will investigate the effects of microgravity on embryogenesis, using the Medaka fish egg as its biology model.

Also on board are a bevy of DOD-sponsored experiments including:

- Hand-Held, Earth-Oriented, Cooperative, Real-Time, User- Friendly, Location Targeting and Environmental System (HERCULES-B), a multispectral video camera-based geolocating system;

- Military Applications of Ship Tracks (MAST), which will take high resolution photographs of ship tracks to assist in an understanding of the effect of man-made aerosols on clouds and the resulting impact on the climate system;

- Microencapsulation in Space (MIS), which will look at a novel approach of encapsulating a drug in a biodegradable polymer so that as the polymer degrades the drug is released at a controlled rate;

- Midcourse Space Experiment (MSX), which will support the DOD’s development of surveillance capabilities of ballistic missiles during the midcourse of their flight;

- Visual Function Tester (VFT), an instrument which could help explain why astronauts lose their ability to see clearly at close range when in space;

- Window Experiment (WINDEX), which will study the dynamics of thruster plumes, Shuttle glow, water dumps and flash evaporator system releases, atmospheric night glow and aurora to better understand the environment around low- Earth orbit satellites; and

- Radiation Monitoring Equipment (RME), prototype dosimeter instruments which measure exposure to ionizing radiation on the Shuttle.

Students in the U.S. and Argentina will speak to the astronauts via the Shuttle Amateur Radio Experiment. Among the schools scheduled to have an opportunity to talk to the astronauts are those in Troy and Euclid, OH; Farmingdale and Schenectady, NY; Concord, NH; Highland and Grand Rapids, MI; New Port Richey, FL, and Fallbrook, CA.

STS-70 will be the 21st flight of the Orbiter Discovery, and the 69th in the Space Shuttle program.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

NASA Television Transmission
NASA Television is available through Spacenet-2 satellite system, transponder 5, channel 9, at 69 degrees West longitude, frequency 3880.0 MHz, audio 6.8 Megahertz.

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; NASA Headquarters, Washington, DC. The schedule will be updated to reflect changes dictated by mission operations.
Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern time.

Status Reports

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

Briefings

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

Access by Internet
NASA press releases can be obtained automatically by sending an Internet electronic mail message to domo@hq.nasa.gov. In the body of the message (not the subject line) users should type the words "subscribe press- release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service.
Informational materials also will be available from a data repository known as an anonymous FTP (File Transfer Protocol) server at ftp.pao.hq.nasa.gov under the directory /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.

The NASA public affairs homepage also is available via the Internet. The page contains images, sound and text (press releases, press kits, fact sheets) to explain NASA activities. It also has links to many other NASA pages. The URL is: **http://www.nasa.gov/hqpao/hqpao_home.html**

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 fax

An additional service known as fax-on-demand will enable users to access NASA informational materials from their fax machines. Users calling (202) 358-3976 may follow a series of prompts and will automatically be faxed the most recent Headquarters news releases they request.

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-70 QUICK LOOK

Launch Date/Site:	June 8, 1995/KSC Pad 39B
Launch Time:	09:01 a.m. EDT
Launch Window:	2 hours, 30 minutes
Orbiter:	Discovery (OV-103) - 21st flight
Orbit/Inclination:	160 nautical miles/28.45 degrees
Mission Duration:	7 days, 22 hours, 10 minutes
Landing Date:	June 16, 1995
Landing Time:	8:30 a.m. EDT
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Landing - Banjul, The Gambia Ben Guerir, Morocco Moron, Spain Abort Once Around - Edwards Air Force Base, CA
Crew:	Tom Henricks, Commander (CDR) Kevin Kregel, Pilot (PLT) Don Thomas, Mission Specialist 1(MS 1) Nancy Currie, Mission Specialist 2 (MS 2) Mary Ellen Weber, Mission Specialist 3 (MS 3)
Cargo Bay Payloads:	Tracking and Data Relay Satellite/Inertial Upper Stage
Middeck Payloads:	Biological Research in Canisters (BRIC) Bioreactor Development Systems (BDS) Commercial Protein Crystal Growth (CPCG) National Institutes of Health-R-2 (NIH R-2) Space Tissue Loss-B (STL-B) Midcourse Space Experiment (MSX)
In-Cabin Payloads:	Hand-Held, Earth-Oriented, Cooperative, Real-Time, User-Friendly, Location Targeting and Environmental System (HERCULES) Microencapsulation in Space-B (MIS-B) Military Application of Ship Tracks (MAST) Radiation Monitoring Equipment-III (RME-III) Shuttle Amateur Radio Experiment (SAREX) Window Experiment (WINDEX) Visual Function Tester-4 (VFT-4)

UPDATED STS-70 QUICK LOOK

Launch Date/Site:	July 13, 1995/KSC Pad 39B
Launch Time:	9:41 a.m. EDT
Launch Window:	2 hours, 30 minutes
Orbiter:	Discovery (OV-103) - 21st flight
Orbit/Inclination:	160 nautical miles/28.45 degrees
Mission Duration:	7 days, 22 hours, 10 minutes
Landing Date:	July 21, 1995
Landing Time:	7:51 a.m. EDT
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Landing - Banjul, The Gambia Ben Guerir, Morocco Moron, Spain: Abort Once Around: - Edwards Air Force Base, CA
Crew:	Tom Henricks, Commander (CDR) Kevin Kregel, Pilot (PLT) Don Thomas, Mission Specialist 1 (MS 1) Nancy Currie, Mission Specialist 2 (MS 2) Mary Ellen Weber, Mission Specialist 3 (MS 3)
Cargo Bay Payloads:	Tracking and Data Relay Satellite/Inertial Upper Stage
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DEVELOPMENT 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 Evaluation
DTO 312	External Tank Thermal Protection System Performance
DTO 319D	Shuttle/Payload Low Frequency Environment
DTO 414	APU Shutdown Test
DTO 524	Landing Gear Loads and Brake Stability Evaluation
DTO 656	PGSC Single Event Upset Monitoring
DTO 677	Evaluation of Microbial Capture Device, Microgravity
DTO 779	STS Orbiter Attitude Control Translational Thrusting
DTO 805	Crosswind Landing Performance

DSO 491	Characterization of Microbial Transfer Among Crewmembers
DSO 603	Orthostatic Function During Entry, Landing and Egress
DSO 621	In Flight Use of Florinef to Improve Orthostatic Intolerance
DSO 624	Pre and Postflight Measurement of Cardiorespiratory Responses to Submaximal Exercise
DSO 626	Cardiovascular and Cerebrovascular Responses to Standing Before and After Space Flight
DSO 802	Educational Video
DSO 901	Documentary Television
DSO 902	Documentary Motion Picture Television
DSO 903	Documentary Still Photography
DSO 904	Assessment of Human Factors

SPACE SHUTTLE ABORT MODES

The Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes for STS-70 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 Edwards Air Force Base, CA.

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

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

STS-70 SUMMARY TIMELINE

Flight Day 1
Launch
Orbital Maneuvering System-2 & 3 Burn
Secondary Payload Activation
TDRS-G/IUS Deploy
IUS Ignition

Flight Day 2
OMS 4 Burn
Visual Function Tester Setup
CPCG Activation
SAREX Setup
HERCULES Setup
WINDEX Setup
Bioreactor Demonstration System Operations

Flight Day 3
HERCULES Operations
Visual Function Tester Operations
Bioreactor Demonstration System Operations
WINDEX Operations
SAREX Operations

Flight Day 4
Bioreactor Demonstration System Operations
WINDEX Operations
SAREX Operations
HERCULES Operations

Flight Day 5
Visual Function Tester Operations
WINDEX Operations
Bioreactor Demonstration System Operations
AMOS Reaction Control System Tests
SAREX Operations

Flight Day 6
WINDEX Operations
HERCULES Operations
Bioreactor Demonstration System Operations

Flight Day 7
Visual Function Tester Operations
HERCULES Operations
Bioreactor Demonstration System Operations
WINDEX Operations

Flight Day 8
Visual Function Tester Operations
Flight Control System Checkout
Reaction Control System Hot-Fire
Crew News Conference
Cabin Stow

Flight Day 9
Deorbit Prep
Deorbit Burn
Landing

PAYLOAD AND VEHICLE WEIGHTS

	Pounds
Orbiter (Discovery) empty and 3 SSMEs	173,885
Tracking and Data Relay Satellite-G Deployable	4,905
Inertial Upper Stage - Deployable	32,868
TDRS-G - Airborne Support Equipment	5,586
BDS	155
BRIC	30
CPCG	116
HERCULES	161
MIS	120
NIH-R-2	133
SAREX	27
STL	68
DTOs/DSOs	5
Shuttle System at SRB Ignition	4,522,790
Orbiter Weight at Landing	195,195

STS-70 ORBITAL EVENTS SUMMARY

Event	MET
Launch	0/00:00
OMS-2	0/00:42
TDRS-G/IUS Deploy	0/06:12
Sep-1 Burn	0/06:13
Sep-2 Burn	0/06:27
IUS Injection Burn	0/07:12
OMS-4 Circ Burn	1/03:45
Deorbit Burn	7:21:08
KSC Landing	7:22:10

STS-70 CREW RESPONSIBILITIES

Primary Payload	Responsibility
TDRS-G/IUS	Thomas, Weber

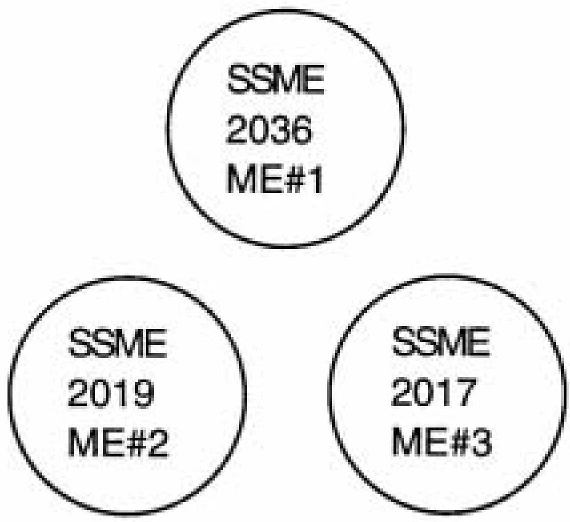
Secondary Payloads	Responsibility
WINDEX	Henricks, Kregel, Currie
STL	Currie, Weber
RME	Kregel, Currie
NIH-R (PARE)	Thomas, Currie
MIS-B	Thomas, Weber
HERCULES	Henricks, Kregel, Currie
CPCG	Currie, Weber
BRIC	Kregel, Currie
BDS	Weber, Thomas
SAREX	Thomas, Currie
VFT	Weber, Henricks
DTO 656(PGSC)	Thomas, Weber
DTO 779 (Orbiter Control)	Henricks, Kregel
DSO 677(Microgravity)	Currie
DSO 904 (Human Factors)	All
DSO 621 (Orthostatic)	Thomas
DSO 603C (Landing Ortho)	Thomas
DSO 624 (Cardiovascular)	All

BLOCK 1 SPACE SHUTTLE MAIN ENGINE

STS-70 will be the first flight for an upgraded version of a Space Shuttle Main Engine (SSME). On this flight, one engine will be of a new configuration known as Block 1, while the remaining two engines will be of the current SSME design.

The first flight planned to use three Block 1 engines is STS-73, currently targeted for late September 1995.

The Block 1 configuration will greatly increase engine performance, reliability and safety. Together the three SSMEs produce the almost 1.5 million pounds of thrust which assist in carrying the Shuttle system into orbit.



Engine configuration for STS-70
SSME 2036 is the first Block 1 engine to fly on the Shuttle.

One enhancement to the Block 1 engine is the new high pressure liquid oxidizer turbopump built by Pratt & Whitney. The pump housing in the new design is produced through a unique casting process, eliminating all but six of the 300 welds that exist in the current pump. This increases the safety margins and reliability of the main engines. The new turbopumps will not require a detailed inspection until they have flown 10 times. The high pressure liquid oxygen pumps used in the current SSME must be removed after every flight for inspection.

Flight certification for the turbopumps, which provide the oxidizer to the engine, was completed in March 1995. The new pumps underwent a test program equivalent to 40 Space Shuttle flights, a milestone in the final certification of the pumps for flight.

The improved pump design also incorporates new ball bearings of silicon nitride. The ceramic bearings are 30 percent harder and 40 percent lighter than steel and have an ultra-smooth finish, thus producing less friction during pump operation.

Another enhancement to the Block 1 engine is the new two-duct powerhead. The powerhead contains the preburners that generate the gas to drive the turbopump turbines. It collects the hot gases of the turbines downstream and ducts them into the main injector. By replacing the three smaller fuel ducts in the current design with two enlarged ducts, the new design significantly improves fluid flows within the engine. Pressure and loads are decreased, turbulence is reduced, maintenance is eliminated and inspections are minimized. The two-duct powerhead is constructed with fewer welds, thus eliminating potential weak spots.

The powerhead also has a single-coil heat exchanger, replacing the current two-coil design. The heat exchanger provides pressure to the Shuttle’s external tank, enabling it to provide propellants to the engines. The new configuration eliminates all seven weld joints inside the engine. Constructed of a continuous piece of stainless steel alloy, this reduces wear on the tube and lessens the chance of damage. Maintenance and post-flight inspections also are reduced.

The SSME project is managed by Marshall Space Flight Center. Pratt and Whitney, West Palm Beach, FL, developed and manufactured the new pump. Rocketdyne, Canoga Park, CA, will integrate the pump into the main engine.

TRACKING AND DATA RELAY SATELLITE SYSTEM

History

The Tracking and Data Relay Satellite System (TDRSS) is a space-based network that provides communications, tracking, telemetry, data acquisition and command services essential to Shuttle and low-Earth orbital spacecraft missions.

The TDRSS was initiated following studies in the early 1970s which showed that a system of telecommunications satellites, operated from a single ground station, could meet the needs of NASA's mission better and more cost- effectively than the then existing network of tracking and communications ground stations located around the world.

The TDRSS has delivered on the promise, enabling NASA to cut telecommunications costs while increasing data acquisition and communications contact time with spacecraft six-fold. TDRSS can provide communications services to orbital spacecraft over 85 percent of each orbit for most satellites, and continuous service for some orbital positions.

In addition to the Shuttle, TDRSS customers include the Compton Gamma Ray Observatory (GRO), Upper Atmosphere Research Satellite, Hubble Space Telescope, Earth Radiation Budget Satellite, Extreme Ultraviolet Explorer, TOPEX- POSEIDON, and other non-NASA missions. Among future TDRSS-dependent missions are the international Space Station and the Earth Observation System. NASA estimates the value of the space missions which will have relied on the TDRSS through the end of this decade is in the tens of billions.

The TDRSS consists of two major elements: A constellation of geosynchronous satellites and a ground terminal complex located at White Sands, New Mexico. The original ground terminal, Cacique, is currently undergoing rehabilitation. When Cacique is returned to service in 1996, it will be a virtual twin of the new Danzante terminal, which became fully operational in March and is providing all operational services. Together, these two terminals will eliminate a critical single point of failure and provide the capacity to use partially failed Tracking and Data Relay Satellite (TDRS) spacecraft to meet NASA's communications needs in the future.

Current Status

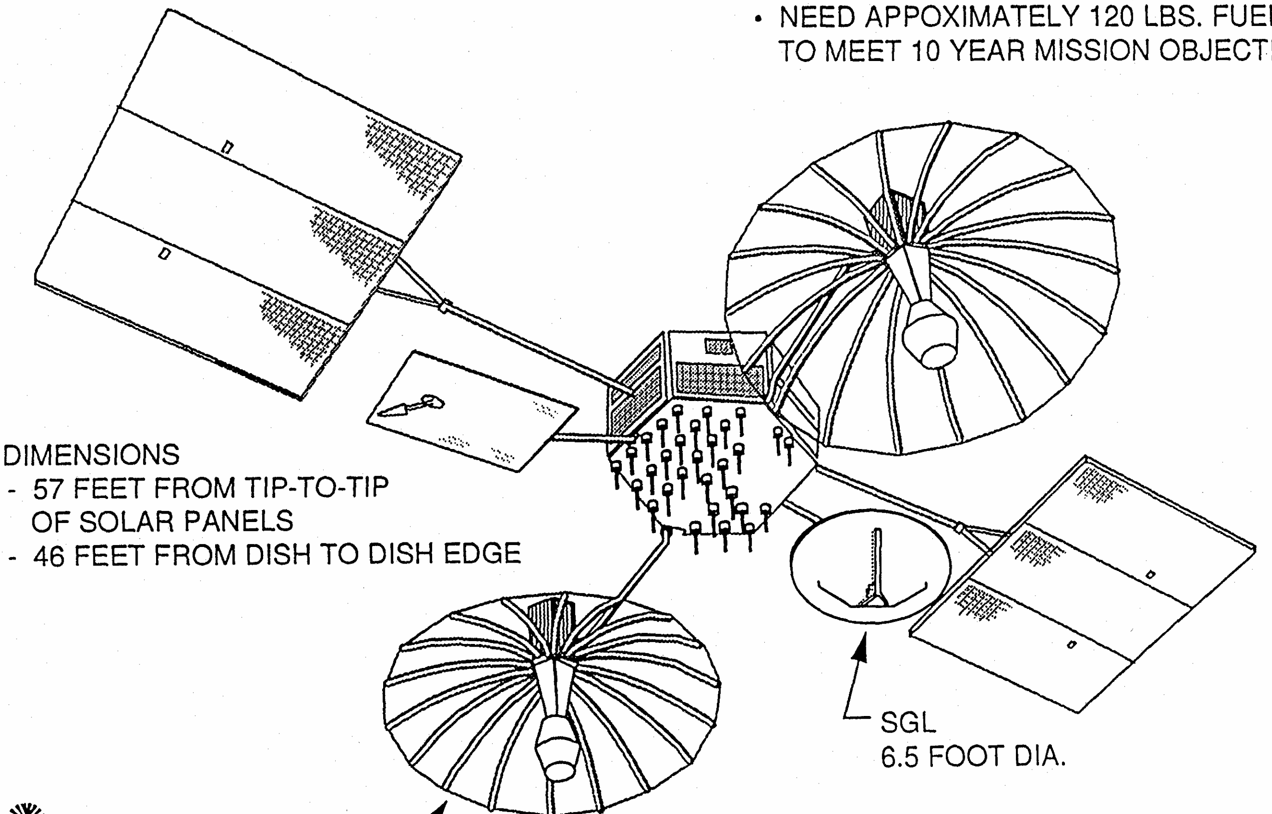
NASA's latest Tracking and Data Relay Satellite, TDRS-G, is scheduled for launch on board Discovery. TDRS-G is the seventh and final in the first series of communications spacecraft that make up the TDRSS. Although TDRS-G will be stored on orbit and not used immediately, it is being launched now to take advantage of the experienced crew for the critical launch and deployment sequence. In addition, on-orbit storage is less costly than ground storage and extended crew retention.

After Discovery achieves orbit, the TDRS-G spacecraft and its attached Inertial Upper Stage (IUS) will be deployed from the Shuttle cargo bay. The IUS consists of two Solid Rocket Motors (SRMs) which will inject the TDRS/IUS into geostationary orbit. The IUS SRM-1 will first place the TDRS/IUS into a transfer orbit with an apogee near geosynchronous altitude. At the first apogee the IUS SRM-2 will fire to place the TDRS/IUS in geostationary orbit. The TDRS/IUS will be maneuvered to the appropriate orientation and TDRS-G will separate from the IUS.

Once it is on orbit, the TDRS-G designation will be changed to TDRS-7. Following the spacecraft bus checkout and the On-Orbit Test Phase, TDRS-7 will be ready to provide service.

TDRS - 7

- IUS TARGET WEIGHT 4,905 LBS.
  - FUEL ADJUSTED AS NEEDED
  - DRY WEIGHT 3,802 LBS. (INCLUDING 269 LBS ADAPTER)
- NEED APPOXIMATELY 120 LBS. FUEL TO MEET 10 YEAR MISSION OBJECTIVE



- DIMENSIONS
  - 57 FEET FROM TIP-TO-TIP OF SOLAR PANELS
  - 46 FEET FROM DISH TO DISH EDGE

TDRS-1 was launched in April 1983, on board Space Shuttle Challenger, and the second TDRS was lost in the Challenger accident in January 1986. TDRS-3 was launched on board Space Shuttle Discovery in September 1988, and TDRS-4 was launched on board Discovery in March 1989. TDRS-5 was launched on board Space Shuttle Atlantis in August 1991. TDRS-6 was launched on board Space Shuttle Endeavour in January 1993. The five orbiting TDRS spacecraft are all functioning, but only three (TDRS-4, TDRS-5, and TDRS-6) are fully operational. Because of the flexible capability of the TDRSS, following the successful launch and checkout of TDRS- G, the TDRSS constellation will be reconfigured.

TDRS-1 is presently positioned at 275 degrees West longitude and is operated from New Mexico via the remote TDRSS ground terminal located in the Deep Space Network Complex in Canberra, Australia. TDRS-1 is used primarily to provide service to the Compton GRO, which has a failed tape recorder. Although TDRS-1 sustained significant damage during its launch in 1983, resulting from a failure of the launch vehicle upper stage, this spacecraft has provided excellent service for many years and continues to serve in a limited capacity well beyond its planned seven year lifetime.

Present plans call for TDRS-3 to replace TDRS-1 at 275 degrees West longitude, southeast of Sri Lanka, to continue support to GRO as well as provide added support for the STS/MIR rendezvous activities, and potential support to Space Station. TDRS-1 will be repositioned to 139 degrees West longitude and may be used to support science investigations in the South Pole region. TDRS-5 at 174 degrees West longitude, southwest of Hawaii, and TDRS-4 at 41 degrees West longitude, East of Brazil, are designated as the prime operational spacecraft and provide the bulk of the support to NASA TDRS customers. TDRS-6, now located at 46 degrees West longitude, has its user support payload turned off to preserve lifetime and serves as an on-orbit reserve spacecraft. After TDRS-G is deployed in geostationary orbit and successfully checked out, it will be positioned at 171 degrees West longitude. The successful launch and checkout of TDRS-G will give NASA the essential requirement of having two fully operational satellites and two fully operational “ready reserve” satellites. Because of NASA’s critical dependence on TDRSS, at least one fully-functional spacecraft must be available in reserve to replace a failed operational spacecraft. This will assure that NASA communications, telemetry and data acquisition capabilities required by space missions will not be jeopardized.

TDRS-G is the last of a generation of seven spacecraft, built by TRW of Redondo Beach, CA, that make up the initial series of communication satellites for NASA. Future system needs will be supported by the TDRS-H, I, J spacecraft, the next series of satellites, whose initial launch is planned for 1999.

TDRS Spacecraft Launch and Operational Status

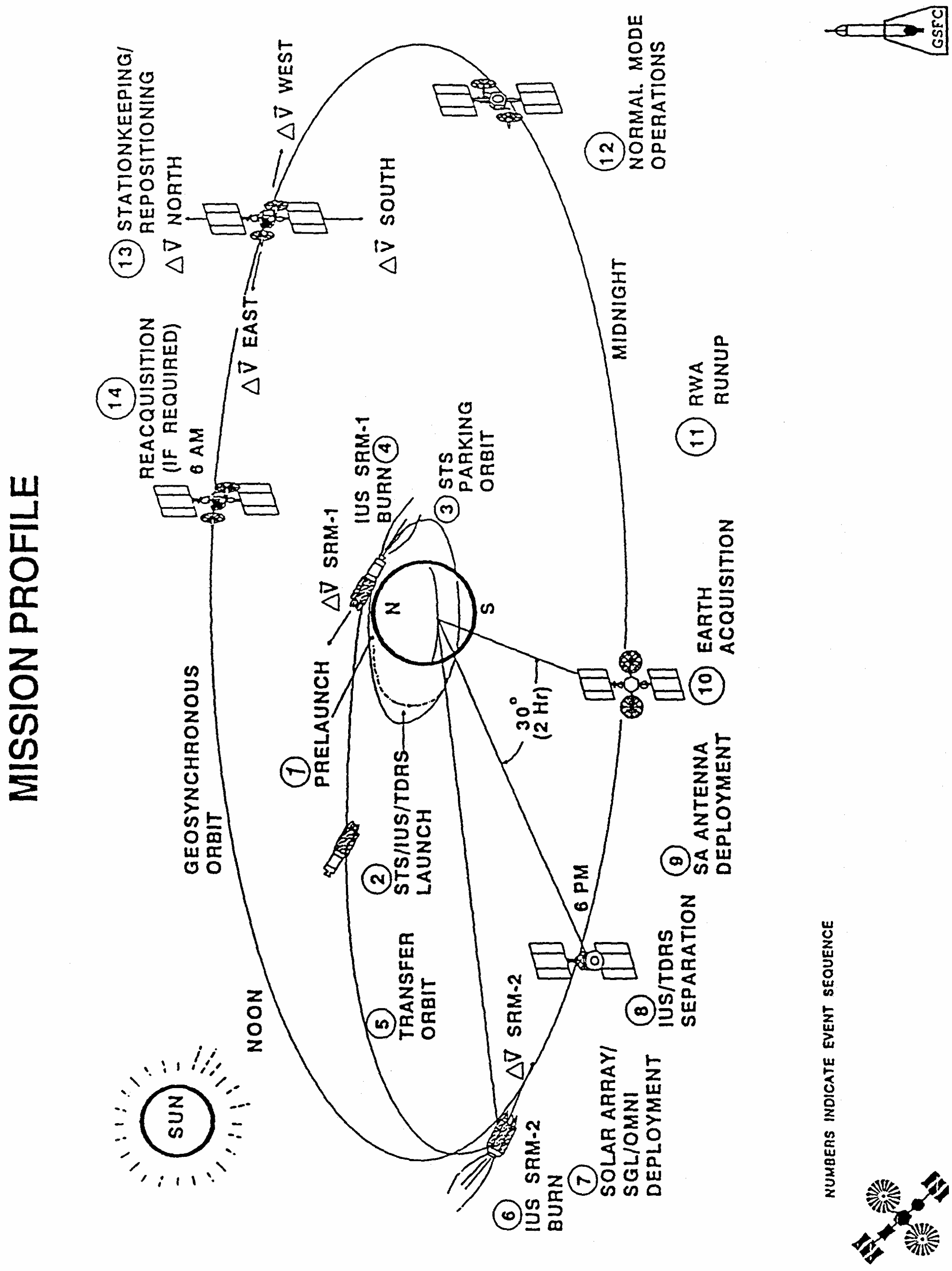
Spacecraft	Mission		Status
TDRS-1	STS-6	April 5, 1983	Partially operational
TDRS-2	51-L	January 28, 1986	Lost in the Challenger Accident
TDRS-3	STS-26	September 29, 1988	Partially operational
TDRS-4	STS-29	March 13, 1989	Fully operational
TDRS-5	STS-43	August 2, 1991	Fully operational
TDRS-6	STS-54	January 13, 1993	Fully operational

Current Position

TDRS-1	275 degrees West
TDRS-3	62 degrees West
TDRS-4	41 degrees West (over the Atlantic Ocean off Brazil)
TDRS-5	174 degrees West (East of Gilbert Islands and South of Hawaii)
TDRS-6	46 degrees West

Reconfigured Position after TDRS-G (7) Checkout

TDRS-1	139 degrees East
TDRS-3	275 degrees West
TDRS-4	44 degrees West
TDRS-5	174 degrees West
TDRS-6	46 degrees West
TDRS-7	171 degrees West


MISSION PROFILE
SUN
NOON
GEOSYNCHRONOUS ORBIT
1 PRELAUNCH
2 STS/IUS/TDRS LAUNCH
3 STS PARKING ORBIT
IUS SRM-1 BURN 4
ΔV SRM-1
N
S
5 TRANSFER ORBIT
6 IUS SRM-2 BURN
ΔV SRM-2
7 SOLAR ARRAY/ SGL/OMNI DEPLOYMENT
8 IUS/TDRS SEPARATION
6 PM
9 SA ANTENNA DEPLOYMENT
30° (2 Hr)
10 EARTH ACQUISITION
11 RWA RUNUP
MIDNIGHT
12 NORMAL MODE OPERATIONS
13 STATIONKEEPING/ REPOSITIONING
ΔV NORTH
ΔV SOUTH
ΔV WEST
ΔV EAST
14 REACQUISITION (IF REQUIRED)
6 AM
NUMBERS INDICATE EVENT SEQUENCE
GSFC

TDRS CONSTELLATION STATUS

	LAUNCHED	GEOSYNCHRONOUS ORBIT	IN-ORBIT CHECKOUT COMPLETE	UTILIZATION
TDRS-1	APRIL 4, 1983 STS-6 (CHALLENGER)	JUNE 29, 1983	• DECEMBER 28, 1983 • ONE SATELLITE SYSTEM • ACCEPTANCE APRIL 1985	• CURRENTLY ON ROUTE TO 138(D) W. (WILL SUPPORT NSF SCIENCE MISSIONS
TDRS-3	SEPTEMBER 29, 1988 STS-26 (DISCOVERY)	SEPTEMBER 30, 1988	• JANUARY 15, 1989 • TWO SATELLITE SYSTEM • ACCEPTANCE JULY 1989	• CURRENTLY AT 85(D) E. & BEING USED FOR STS AND GRO SUPPORT
TDRS-4	MARCH 13, 1989 STS-29 (DISCOVERY)	MARCH 14, 1989	JUNE 9, 1989	• CURRENTLY DESIGNATED AS TDRS EAST AT 41(D) W. & PROVIDING USER SUPPORT
TDRS-5	AUGUST 2, 1991 STS-43 (ATLANTIS)	AUGUST 3, 1991	OCTOBER 7, 1991	• CURRENTLY DESIGNED AS TDRS WEST AT 174(D) W. & PROVIDING USER SUPPORT
TDRS-6	JANUARY 13, 1993 STS-54 (ENDEAVOUR)	JANUARY 14, 1993	MARCH 4, 1993	• CURRENTLY AT 46(D) W. • AVAILABLE AS ON-LOCATION BACKUP FOR TDRS-E
TDRS-7	JUNE 8, 1995 STS-70 DISCOVERY	JUNE 9, 1995	AUGUST 1995	TO BE LOCATED AT 171(D) W., DESIGNED TDRS-SPARE, WILL BE A SCHEDULEABLE SPARE, ACTIVELY USED FOR STS-SUPPORT

TDRS-2 LOST JANUARY 28, 1996 ABOARD STS-51L (CHALLENGER)

Deployment Sequence

TDRS-G will be deployed from Discovery approximately six hours after launch on orbit five (over the Pacific north of Hawaii). Injection burn to geostationary orbit will be initiated at 77 degrees East longitude (Indian Ocean, south of India), placing the satellite in orbit at 178 degrees West longitude (over the Pacific near the Gilbert Islands).

The STS-70 crew elevates the IUS/TDRS to 29 degrees in the payload bay for preliminary tests and then raises it to 58 degrees for deployment. A spring-loaded ejection system is used for deploying the IUS/TDRS.

The first burn of the IUS booster will take place one hour after deployment, or about seven hours after launch. The second and final burn (to circularize the orbit) will take place five and one half hours after the first burn, approximately 12 1/2 hours into the mission. Separation of the booster and satellite will occur at 13 hours after launch.

Upon reaching geostationary orbit, the deployment of appendages and antennas is started. The deployment sequence is:

1. Deploy solar arrays.
2. Deploy Space-to-Ground Link (STGL) boom.
3. Deploy Solar Sail boom.
4. Separation of IUS and TDRS.
5. Release Single Access (SA) booms.
6. Position SA antennas.
7. Open SA antennas.

During steps five, six and seven, Earth acquisition is taking place concurrently.

The TDRS is three-axis stabilized with the Multiple Access (MA) fixed antennas pointing constantly at the Earth while the solar arrays track the Sun.

Communication System

The TDRS' do not process customer traffic. Rather, they operate as "bent pipe" repeaters, relaying signals and data between the user spacecraft and the ground terminal and vice versa without processing.

Nominally, the TDRSS is intended to meet the requirements of up to 24-customer spacecraft, including the Space Shuttle, simultaneously. It provides two types of service: (1) MA which can relay data from as many as 20 low data rate (100 bits per second to 50 kilobits per second) customer satellites simultaneously and (2) single access antennas which provide two high data rate channels (300 megabits per second) from both the East and West locations.

The White Sands Complex (WSC), provides a location with a clear line-of-sight to the TDRS' and a place where rain conditions have limited interference with the availability of the Ku-band uplink and downlink channels. The WSC is operated for NASA by Allied Signal Technical Services Corporation; Columbia, MD, and GTE Government Systems Corp., Needham Heights, MA.

Other associated facilities located at the Goddard Space Flight Center (GSFC) include: the Network Control Center, which provides the primary interface with customer satellites to schedule service and act as the focal point for NASA user communications with the WSC; the Flight Dynamics Facility, which provides antenna pointing information for user spacecraft and the TDRS; and, the NASA Communications (NASCOM) Network, a global system which provides operational communications support to all NASA projects.

NASCOM offers voice and data links with the Space Network, the Ground Networks, and the user spacecraft control centers and data processing facilities. For TDRSS, NASCOM provides a common carrier interface through Earth terminals to link GSFC, White Sands, and the Johnson Space Center in Houston. NASA's Office of Space Communications, Washington, DC, has overall management responsibility of these tracking, data acquisition and communications facilities.

TDRS Components

The TDRS' are composed of three distinct modules: An equipment module, a communications payload module and an antenna module. The modular design reduces the cost of individual design and construction efforts that, in turn, lower the cost of each satellite.

The equipment module housing the subsystems that operate the satellite is located in the lower hexagon portion of the main body of the spacecraft. The attitude control subsystem stabilizes the satellite to provide accurate antenna pointing and proper orientation of the solar panels to the Sun. The electrical power subsystems consist of two solar panels that provide a ten-year power supply of approximately 1,700 watts. The thermal control subsystem consists of surface coatings and controlled electric heaters.

The payload module, located on the upper hexagon portion of the main body of the spacecraft, is composed of the electronic equipment required to provide communications between the user spacecraft and the ground. The receivers and transmitters for single access services are mounted in compartments on the back of the SA antennas.

The antenna module is composed of five antenna systems: two SA, the MA arrays, STGL, and the S-band omni for satellite health and housekeeping.

For SA service, each TDRS has two dual-feed S-band, Ku- band parabolic (umbrella-like) antennas. These antennas are free to be positioned in two axes, directing the radio beam to orbiting user spacecraft below. These antennas are used primarily to relay communications to and from user spacecraft. The high data rate provided by these antennas is available to users on a time-shared basis. Each antenna is capable of supporting two-user spacecraft services simultaneously--one at S-band and one at Ku-band--provided both users are within the beam width of the antenna.

The MA antenna array, consisting of 30 elements, is hard-mounted on the spacecraft body on the surface of the antenna module facing the Earth.

Another antenna, a 6.5-foot (2-meter) parabolic reflector, provides the prime link for relaying transmissions to and from the ground terminal at Ku-band.

THE INERTIAL UPPER STAGE (IUS)

The Inertial Upper Stage (IUS) will be used on Space Shuttle mission STS-70 to boost NASA’s TDRS-G Tracking and Data Relay Satellite from low-Earth orbit to geosynchronous orbit, some 22,300 statute miles (35,000 kilometers) from Earth.

Background

The IUS was originally designed as a temporary stand-in for a reusable space tug. The IUS was then named the Interim Upper Stage. The word “Inertial” (signifying the guidance technique) later replaced “Interim” when it was observed that the IUS would be needed through the 1990s.

The IUS was developed and built by the Boeing Aerospace Co., Seattle, WA, under contract to the Air Force Material Command’s Space and Missile Systems Center. The Space and Missile Systems Center is executive agent for all Department of Defense activities pertaining to the Space Shuttle system and provides the IUS to NASA for Space Shuttle use. For NASA missions, the IUS program is managed by the Marshall Space Flight Center, Huntsville, AL.

NASA’s most recent use of an IUS was on the STS-54 mission of the Space Shuttle (launched Jan. 13, 1993), which successfully transported the TDRS-F satellite to geosynchronous orbit. It also has boosted the Galileo probe on a journey to explore Jupiter, the Magellan spacecraft to Venus, and the Ulysses toward a polar orbit of the Sun.

Specifications

The IUS is a two-stage, solid rocket propelled, three- axis stabilized vehicle for placing spacecraft in a high- Earth orbit or on an escape trajectory for an interplanetary mission.

The IUS is 17 feet (5.18 meters) long and 9.25 feet (2.8 meters) in diameter, with an overall weight of approximately 32,500 pounds (14,742 kilograms). The IUS consists of a first stage comprised of a large solid rocket motor containing 21,400 pounds (9,707 kilograms) of propellant and generating approximately 42,000 pounds (188,496 Newtons) of thrust and an interstage. The second stage consists of a solid rocket motor with 6,000 pounds (2,722 kilograms) of propellant generating approximately 18,000 pounds (80,784 Newtons) of thrust, and an equipment support section.

The large solid rocket motor is the longest thrusting duration solid rocket motor ever developed for space application, with the capability to fire for as long as 150 seconds. Mission requirements determine the thrust level and burn duration of the solid rocket motors. These factors are controlled by tailoring the solid propellant load.

The equipment support section houses the avionics systems of the IUS. These systems provide guidance, navigation, control, telemetry, command and data management, reaction control and electrical power. All mission-critical components of the avionics system, along with thrust vector actuators, reaction control thrusters, motor igniter and pyrotechnic stage separation equipment are redundant to assure reliability of better than 98 percent.

The IUS employs Airborne Support Equipment for installation in the Space Shuttle as well as operation and deployment from the orbiter. The Airborne Support Equipment consists of mechanical, avionics, and structural equipment located in the orbiter. The Airborne Support Equipment structurally attaches the IUS and the payload to the orbiter payload bay, provides interface for the IUS and payload checkout and elevates the IUS/payload for deployment from the Orbiter.

The TDRS spacecraft is attached to the IUS at eight attachment points provided on the forward surface of the forward ring of the Equipment Support Section. The eight- point attachment provides substantial load-carrying capability while minimizing the transfer of heat across the connecting points. Power, command and data transmission between the two are provided by several IUS interface connectors.

In addition, the IUS provides an insulation blanket of multiple layered, double-aluminized Kapton and polyester net spacers across the IUS/TDRS interface. The outer layer of the blanket, facing the TDRS spacecraft, is a special Teflon-coated fabric called Beta cloth. The blankets are vented toward and into the IUS cavity, which in turn is vented to the orbiter payload bay. There is no gas flow between the spacecraft and the IUS. The thermal blankets are grounded to the IUS structure to prevent electrostatic charge buildup.

Flight Sequence

After the orbiter payload bay doors are opened in orbit, the orbiter will maintain a preselected attitude to keep the payload within thermal requirements and constraints.

On-orbit predeployment checkout begins, followed by an IUS command link check and spacecraft communications command check. Orbiter trim maneuvers normally are performed at this time.

Forward payload restraints will be released and the aft frame of the airborne support equipment will tilt the IUS/TDRS to an angle of 29 degrees from the payload bay. This will extend the TDRS into space just outside the orbiter payload bay, allowing direct communication with Earth during systems checkout. The orbiter will then be maneuvered to the deployment attitude. If a problem has developed at this point within the orbiter, the TDRS spacecraft or the IUS, the IUS and spacecraft can be restowed and potentially recycled for additional deployment attempts.

Prior to deployment, the spacecraft electrical power source will be switched from orbiter power to IUS internal power by the orbiter flight crew. After verifying that the spacecraft is on IUS internal power and that all IUS/TDRS predeployment operations have been successfully completed, a “go/no-go” decision for IUS/TDRS deployment will be sent to the crew.

When the orbiter flight crew is given a “go” decision, they will activate the pyrotechnic devices that disconnect the IUS/TDRS umbilical cables. The crew will then command the electromechanical tilt actuator to raise the tilt table to a 58-degree deployment position.

During deployment, the orbiter’s thrusters will be inhibited and a pyrotechnic separation device initiated to physically separate the IUS/TDRS spacecraft combination from the tilt table and orbiter. Compressed springs provide the force to push the IUS/TDRS from the orbiter payload bay at approximately 4.2 inches (0.10 meters) per second. The deployment is normally performed in the shadow of the orbiter or in Earth eclipse.

The tilt table will be lowered to minus six degrees after IUS and its spacecraft are deployed. Approximately 19 minutes after IUS/TDRS deployment, the orbiter’s engines will be ignited to move the orbiter away from the IUS/TDRS.

At this point, the IUS/TDRS is controlled by the IUS onboard computers. Approximately 10 minutes after the IUS/TDRS is deployed from the orbiter, the IUS onboard computer will send out signals used by the IUS and/or TDRS to begin mission sequence events.

The IUS will maneuver to the required thermal attitude and perform any required spacecraft thermal control maneuvers.

At approximately 45 minutes after deployment from the orbiter, the pyrotechnic inhibits for the solid rocket motor will be removed. The belly of the orbiter has been oriented towards the IUS/TDRS combination to protect the orbiter windows from the IUS's plume.

When the proper transfer orbit opportunity is reached, the IUS computer will send the signal to ignite the first- stage motor. This is expected at approximately 60 minutes after deployment (L+7 hours, 13 minutes). After firing approximately 146 seconds and prior to reaching the apogee point of its trajectory, the IUS first stage will expend its fuel. While coasting, the IUS will perform any maneuvers needed by TDRS for thermal protection or communications. When this is completed, the IUS first stage and interstage will be separated from the IUS second stage.

Approximately six hours, 12 minutes after deployment (L+12:30), the second-stage motor will be ignited, thrusting for about 108 seconds. After second-stage burn is completed, the IUS stabilizes the TDRS while the solar arrays and two antennas are deployed. Once the TDRS has completed its deployment activities, the IUS second stage will be separated and then perform a final collision/contamination avoidance maneuver before deactivating.

BIOLOGICAL RESEARCH IN CANISTERS (BRIC-4 / BRIC-5)

Research on plant growth and development, as well as research on the hormone system of insects, is an important part of the scientific mission of STS-70. Biological Research in Canisters (BRIC) experiments, designed to examine the effects of microgravity on a wide range of physiological processes in plants, insects, and small invertebrate animals, are part of the Small Payloads Program. Research in the “quick turn around” (on average one year or less) BRIC program has provided basic scientific information on a range of important topics, from plant metabolism affecting food crops to information on the processes of insect development and pest control.

Previous BRIC experiments have focused on starch metabolism in plant seedlings (BRIC-1 & 3), on development in plant tissue culture (BRIC-2), and on ways that hormones affect the development of gypsy moths from worm-like juveniles to winged adults (BRIC-1). BRIC payloads are flown in canisters located in lockers on the Shuttle’s middeck. These canisters are simple carriers for small biological payloads and afford the investigator the opportunity to expose their samples to a microgravity environment for extended periods of time.

BRIC-4

Dr. Marc E. Tischler of the University of Arizona College of Medicine will examine the tobacco hornworm to determine how its hormone system and muscle formation processes are affected by an altered gravitational field. In his study entitled “Effects of Microgravity on Tobacco Hornworm During Metamorphosis”, Dr. Tischler will examine the hormone system of the tobacco hornworm (Manduca sexta).

Previous studies on the juvenile tobacco hornworm showed alterations in chemical building blocks (amino acids), rate of adult development and flight muscle size as a result of exposure to microgravity. All of these parameters are dependent on the levels of the hormone Ecdysone. In normally-developing tobacco hornworms, Ecdysone release occurs near the outset of adult development. Ground studies indicate that altered orientation of the developing insect within the first 96 hours produces significant changes. Dr. Tischler’s study also will examine the synthesis of protein necessary to form muscle in the developing tobacco hornworm during flight.

Spaceflight has been shown to affect the hormone systems of humans, animals and insects, as well as increasing muscle degeneration of crew members. This study will examine a biological specimen whose hormone system and muscle formation appear to be sensitive to an altered gravitational field. This will add to the knowledge base of gravitational biology and the space life sciences by shedding light on the interactive role of gravity on a variety of biological mechanisms. Basic information in hormone and muscle development will have a direct impact on basic research and development for long duration human space flight, as well as potentially affecting such areas as insect development and pest control on Earth.

In addition, there has been a science-educational outreach effort associated with the study of insect development. College undergraduates, high school students and elementary schools throughout the Tucson, AZ, area are involved in a Manduca outreach project. This outreach program began three years ago with a single elementary school which was provided with young caterpillars, and artificial diet and instructions on maintaining the insects. To date, hundreds of students in the Tucson area have studied the tobacco hornworm in the classroom. This outreach project has proven to be a strong bridge between the University and its local public schools and has served to get elementary students excited about science and the space program.

BRIC-5

In the experiment, “Plant Embryos and Fidelity of Cell Division in Space”, Dr. Abraham D. Krikorian of the State University of New York at Stony Brook, will test whether the cell division changes observed in the daylily (Hemerocallis cultivar. Autumn Blaze) are the result of the direct effects of microgravity or indirect effects such as water availability.

This research is important because human exploration of space depends on our ability to grow plants in microgravity. Long duration space missions require a large supply of food and water. It will not be possible to store the necessary volume or mass of food required for extended space missions. As a result, it is critical that food production systems be developed for use in flight. Current efforts in a range of biotechnologies are dependent on the ability to use and manipulate these systems in space.

To develop these food production systems, which are dependent on individual plants, plant cells must be able to grow normally. Dividing and developing plant cells need to process and pass on accurate genetic information to new plants. The extent to which such growth and development will occur in microgravity is a key concern for modern plant biotechnologies in space.

Preliminary results from the Plant Cell Research experiment aboard STS-47 and Proembryogenesis in Space experiment aboard STS-65 have shown genetic abnormalities occur to plants during space flight. Mechanisms of information transfer or signaling through various parts of the cell do not occur normally in space. Because ground based studies indicate that water related activity can impact the integrity of chromosomes, it is possible that the results observed in STS-47 and STS-65 are not due to the direct effect upon the plants but on the indirect effects mediated by water availability to the plant cells.

This experiment will use daylily cells as a model system to test the impact of the changes in water availability and activity on plant reproduction. Plant development entails an orderly progression of cellular events both in terms of time and space. Previous studies have demonstrated that microgravity has adverse effects on plant cell function. Work from Cosmos 782 and 1129 indicated that while the broad events of plant development proceeded in space, the progression was slowed and there were fewer later stages generated in the plant population.

One of the major indirect effects of microgravity on plant development may be on water. In microgravity water does not go to the bottom of a container; it floats, is affected by air currents and stays on the sides of containers. This affects the availability of water for plant growth and development. Changes in water relations in microgravity affect moisture availability, surface tension, buoyancy driven convection, gas diffusion and stratification.

This research will contribute to our understanding of plant development and reproduction, which in turn, will directly affect our ability to grow plants in space. The research also will support a better understanding of the basic processes of plant genetics in general, which may provide benefits here on Earth, particularly in arid environments.

BIOREACTOR DEVELOPMENT SYSTEM (BDS)

Just as gravity affects the manner in which crystals grow and materials are processed, Earth's pull also can alter the development of cells and tissues. Microgravity, however, can provide life science researchers with the opportunity to grow cells into three-dimensional tissue pieces that are not achievable using conventional tissue culture methods on Earth.

The Bioreactor Demonstration System is designed to use ground-based and space-bioreactor systems to grow individual cells into organized tissue that is morphologically and functionally similar to the original tissue or organ.
The BDS is composed of a device developed at the Johnson Space Center that uses a rotating cylinder to suspend cells and tissues in a growth medium, simulating some aspects of microgravity. The system, which is already being used extensively in ground-based research, also provides for gas and nutrient exchange.

The purpose of the flight experiment is to demonstrate the performance of the bioreactor in actual microgravity. As such, the primary goal is to assess the fluid dynamic characteristics of the bioreactor in microgravity.

This includes not only the motion of various sizes of small particles in the bioreactor under different conditions, but also the ability of the bioreactor to provide the environment and metabolic support required to grow and maintain mammalian cell cultures in microgravity.

The experiment protocol uses colon cancer cells as a test of the bioreactor performance. At specified times during the flight, the STS-70 crew members will inject color producing substances to document fluid movement in the reactor, and various-sized beads to estimate the tissue size that could be supported in the bioreactor. Crew members also will perform off-line measurements of pH, glucose and carbon dioxide content within the bioreactor and will record the results of the system's performance.

Investigators anticipate the fluid dynamics analysis will show sufficient mixing to support tissue growth with minimal cell damage. They also hope the system will allow the colon cancer cells to metabolize glucose, producing acid, thereby demonstrating the function of the pH sensor. BDS also will demonstrate the bioreactor's ability to provide oxygen and glucose and remove waste products.

The BDS Team consists of Stanley J. Kleis, Ph.D., engineering principal investigator; J. Milburn Jessup, M.D., cell science principal investigator; Richard Saur, mission manager; and Neal R. Pellis, Ph.D., program director.

NATIONAL INSTITUTES OF HEALTH-R-2

Space Flight Effects on Mammalian Development
Principal Investigator: Jeffrey Alberts, Ph.D.
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This project emphasizes features of the rat's behavior and physiology that are known to contribute to successful pregnancy, labor, delivery and the onset of postnatal care - especially lactation. Lacking the challenge of working against gravity and disruption of specific behaviors, such as self-grooming, may compromise the female's ability to give birth and provide sufficient milk. Development of vestibular (balance) function in all species begins well before birth. The use of pregnant animals exposed to microgravity will eliminate the effects of gravity from direct input during the development of this system. Examination of the behavior of the offspring after birth is expected to provide information about the earliest development of the vestibular system under gravity as compared to microgravity circumstances.

Neuromuscular Development and Regulation of Myosin Expression
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The purpose of this experiment is to determine whether gravity is required prior to birth for the normal development of muscles. Prior to birth, muscle cells migrate to the limbs and form specific muscles which become innervated by axons whose cell bodies are in the spinal cord. The muscle fibers within the muscle go through a series of changes until they reach their adult state. This process of muscle specialization is initiated prior to birth and continues through the first month after birth. This study will determine whether exposure to microgravity during embryonic development affects the normal development of muscles and nerves by examining the innervation of muscles by nerves, the morphological development of muscles and the differentiation of muscle fibers into adult types. These experiments will provide valuable information regarding how muscles develop.

Effect of Space flight on the Development of the Circadian Timing System
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Development of the neurologic system, particularly the retina and its connections in the brain, and the circadian timing system, the internal "clock" which regulates sleep-wake cycles and other daily physiologic functions, begins well before birth. The circadian timing system is an important temporal organizer controlling both the physiology and behavior of organisms. For example, conditions such as jet-lag, shift-work and some sleep and mental disorders are frequently associated with dysfunction of the circadian timing system. The exposure of developing rat offspring to microgravity may lead to alterations in these systems, which may increase our fundamental understanding of the development and operation of these systems.

Effect of Microgravity on Bone Development
Nicola C. Partridge, Ph.D.
Saint Louis University Medical Center
Department of Pharmacological and Physiological Science
St. Louis, MO

Under conditions of weightlessness, humans and experimental animals show loss of bone mass accompanied by excretion of calcium in urine. The development of skeletal bone also may be affected by exposure to microgravity in utero (before birth). If so, different enzymes and proteins (tissue plasminogen activator, plasmin, collagenase, etc.) important for bone development may appear at altered times and at altered levels. The present study will investigate the expression of these enzymes in fetal and postnatal rats exposed to microgravity in utero. Such findings would shed light on the importance and role of gravity in developing skeletal bone. The information gained may help in the therapeutic intervention of bone diseases on Earth, such as osteoporosis.

Histological Effects of Microgravity on Rat Body Wall Musculature

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Department of Anatomy and Neurobiology
Dalhousie University Halifax, Nova Scotia, Canada

Postural muscles in the hind limbs of rodents deteriorate dramatically (i.e., decondition) under extended periods of weightlessness. The muscles of the body wall of rodents and other quadrupeds are themselves postural muscles that help elevate the abdomen and flex the spine during locomotion. Additionally, these muscles are extremely important in a variety of visceral functions that require large increases in abdominal pressure (e.g., coughing, defecation, parturition, etc.). If these muscles deteriorate, as do hind limb postural muscles, then this may severely compromise the ability of animals to give normal vaginal birth as a result of being exposed to microgravity. Greater understanding of the basic physiological processes involved in this research could provide insight into a range of medical challenges from diseases involving severe muscle degeneration, to helping accident victims who are immobilized with bedrest for extended periods of time, to developing countermeasures for severe muscle degeneration.

COMMERCIAL PROTEIN CRYSTAL GROWTH

The Commercial Protein Crystal Growth (CPCG) experiment aboard STS-70 is sponsored by the Center for Macromolecular Crystallography (CMC) based at the University of Alabama at Birmingham. The CMC is one of 11 NASA Centers for the Commercial Development of Space and forms a bridge between NASA and private industry by developing methods for the crystallization of macromolecules in microgravity. These crystals are used to determine the three-dimensional structure of the molecules by X-Ray crystallography. The structural information not only provides a greater understanding of the functions of macromolecules in living organisms, but it also provides scientific insight into the development of new drugs.

By the technique of protein crystallography, crystals of purified proteins are grown in the laboratory and X-Ray diffraction data are collected on these crystals. The three-dimensional structure is then determined by analysis of these data. Unfortunately, crystals grown in the gravity environment of Earth frequently have internal defects that make such analysis difficult or impossible. Space-grown crystals often have fewer defects and are much better than their Earth-grown counterparts.

The protein crystal growth experiment on STS-70 will consist of the Protein Crystallization Facility (PCF). The objective of the PCF experiment, contained in a thermal control enclosure located in Discovery's middeck, will be to crystallize human alpha interferon protein. Alpha interferon is a protein pharmaceutical that currently is used against human viral hepatitis B and C. The objective is to discover the next generation alpha interferon pharmaceuticals and formulations.

For the eight PCF flights to date, seven yielded larger space-grown crystals and five yielded crystals of superior X-Ray quality. Two yielded crystals, though larger than their Earth-grown counterparts, that were too small for x- ray analysis; thus, their X-Ray diffraction quality could not be assessed. On the SPACEHAB 1 and 2 missions with the PCF, the CMC grew crystals of human insulin of exceptional quality. These crystals provided the pharmaceutical industry with the most detailed picture ever seen for this important protein, the key medication for diabetes. Industry will now use this structural information to develop a novel and improved time-release insulin formulation.

With continued research, the commercial applications developed using protein crystal growth have phenomenal potential, and the number of proteins that need study exceeds tens of thousands. Current research, with the aid of pharmaceutical companies, may lead to a whole new generation of drugs which could help treat diseases such as cancer, rheumatoid arthritis, periodontal disease, influenza, septic shock, emphysema, aging and AIDS.

A number of pharmaceutical companies partner with the CMC, including:

- BioCryst Pharmaceuticals, Inc.
- Eli Lilly and Co.
- Schering-Plough
- DuPont Merck Pharmaceuticals
- Eastman Kodak
- Upjohn Co.
- Smith Kline Beecham Pharmaceuticals
- Vertex Pharmaceuticals, Inc.

Principal Investigator for the STS-70 Commercial Protein Crystal Growth experiment is Dr. Larry DeLucas, Director of the CMC.

SPACE TISSUE LOSS - B (STL-B)

The STL-B experiment is a collaborative research project between Walter Reed Army Institute of Research, Washington, DC, and the NASA Life & Microgravity Sciences and Applications Div., Washington DC. The researchers: Dr. Debra Wolgemuth, Columbia Univ.; Dr. Carey Phillips, Bowdoin College; and Dr. William Wiesmann, WRAIR, are investigating the effects of microgravity on embryogenesis. Their analysis is centered on the evaluation of a very well described and understood biology model, the Medaka fish egg. The study focuses on evaluating the micro-gravity effect at the molecular level. Of particular interest is the digital image capture of the (gastrolation) development phase via the STL-B on board video microscope and telemetry to the investigators on the ground. This follow-up experiment will help validate previous STS-59 findings as well as provide additional definition to the model for future space biology experimentation.

STL-B is a DOD payload and is being flown under the direction of the DOD Space Test Program.

HAND-HELD, EARTH-ORIENTED, COOPERATIVE, REAL-TIME, USER- FRIENDLY, LOCATION TARGETING, AND ENVIRONMENTAL SYSTEM (HERCULES)

HERCULES-B is the third generation of a space-based geolocating system. For this configuration, a XYBION multispectral video camera has been integrated with the HERCULES geolocation hardware. The second generation, HERCULES-A, used NASA's Electronic Still Camera (ESC) and was flown twice (STS-53 and 56). HERCULES-B will allow the system to respond to requirements that exploit multispectral techniques.

The geolocation part of the system, built by the Naval Research Laboratory, calculates and tags every frame of video with latitude and longitude with an accuracy of three nautical miles. The multispectral video camera is a high resolution (38 line pairs/mm) XYBION IMC-301 image intensifying camera. The XYBION was integrated by the Night Vision and Electronic Sensors Directorate. This camera will allow multispectral imagery @ 15 meter Ground Sampling Distance (GSD) from the Shuttle in the 500-900 nanometer spectral region. The camera uses filter wheels that rotate in the optical path at 300 rpm. Several filter wheels (each with six filters), suggested by the Environmental Research Institute of Michigan and the Office of Naval Research, will be provided to the crew to be changed during the mission. The camera also has a 'panchromatic mode' that allows high shutter speed imagery to be obtained. In this mode, the high shutter speeds (<100 microseconds) will allow the effects of Orbiter and operator motion to be decreased. With the longest focal length lens (1800 mm), GSDs of three meters are anticipated based on laboratory and field measurements. Various focal length lenses (320-1830 mm) will be used in panchromatic mode which will allow a wide variety of fields of view and GSDs.

This system will be used to locate a wide variety of features on the ground.

HERCULES is a DOD payload and is being flown under the direction of the DOD Space Test Program.

MICROENCAPSULATION IN SPACE - B (MIS-B)

Microencapsulation in Space (MIS) makes its second space flight aboard the Space Shuttle Discovery. The purpose of this project, developed at Southern Research Institute and sponsored by the U.S. Army Dental Research Detachment, Walter Reed Army Institute of Research, is to produce a novel pharmaceutical (microencapsulated antibiotic) in weightless conditions using equipment that has been improved since the first MIS flight in 1992 (STS- 53).

The same experiment will be conducted using newly designed equipment which should improve the yield of the microspheres. In the experiment, the drug (ampicillin) is entrapped within a biodegradable polymer, so that as the polymer degrades in the body, the drug is released at a controlled rate. In the 1992 Space Shuttle experiment, the microcapsules were perfectly shaped, more homogeneous, and free of residual solvents, thus purer than those made in gravity, but the yield was small.

Microencapsulated antibiotics, which are capable of providing precise and predictable sustained drug release rates, control wound infections more effectively than systemically administered antibiotics and do so in vivo after a single application to infected wounds. The microencapsulated formulations provide high antibiotic concentrations in the wound site over a prolonged period of time, during which the polymeric carrier biodegrades into carbon dioxide in water. The end result is that all microorganisms in the wound are killed by the antibiotic, and the drug carrier (polymer) dissolves in the body leaving no residue.

According to Dr. Thomas Tice of Southern Research Institute, who is principal investigator, “The space environment should result in a greater versatility for microencapsulation methodologies, thereby allowing a more successful use of procedures presently used on Earth. Some pharmaceuticals that have failed to encapsulate on Earth should successfully encapsulate in space.”

Dr. Jean Setterstrom, an Army scientist who has worked closely with Southern Research on microencapsulated antibiotics for over 15 years, stated that the Army has supported this project because they recognize the potential of microencapsulation technology in targeting drugs in newer, more powerful ways to get enhanced pharmaceutical efficacy with fewer adverse effects in vivo. This offers dramatically improved treatment modalities for deployed soldiers ranging from better therapeutic drugs to prophylactic vaccines.

MIDCOURSE SPACE EXPERIMENT (MSX)

MSX is a Department of Defense program sponsored by the Ballistic Missile Defense Office, designed to support the development of surveillance capabilities of ballistic missiles during the midcourse of their flight. The principal instrument of the program is a satellite in a 99 degree inclination, 898 kilometer altitude polar orbit. The imaging and spectrographic sensors carried by the MSX satellite cover a broad range of spectral regions from the far ultraviolet to the long wave infrared. The MSX Shuttle experiments are flown under the direction of the Defense Department's Space Test Program and involve using the MSX satellite to observe the plumes from Shuttle engine burns and the Shuttle body, representative of a resident space object (RSO), against Earth and space backgrounds.

STS-70 will be the first Shuttle mission involving the MSX program. This mission occurs during the MSX satellite's on-orbit checkout phase following its launch. The MSX experiment for this mission involves a checkout of the satellite's ability to acquire, track, and accurately point at the Shuttle against Earth and space backgrounds. This capability is critical to the success of follow-on experiments related to plume and resident space object (RSO) characterization.

The MSX Shuttle Plume Observations involve observing the Shuttle while various Reaction Control System or Orbital Maneuvering System engines are fired in specified combinations, at various angles to the path of the Shuttle, and for specified durations. Images and spectra of the resulting plumes are observed in ultraviolet, visible, and infrared wavelength regions. The data will be used to understand the fundamental processes producing plume. The resulting understanding will be incorporated into models to predict what can be observed by space-based sensors from a wide variety of missile systems.

The MSX Shuttle RSO experiments involve acquiring and tracking the Shuttle body against a space, Earth limb, or hard Earth background. The data will be used to develop the capability for operational surveillance systems to acquire and track objects against a variety of backgrounds.

MILITARY APPLICATIONS OF SHIP TRACKS (MAST)

The Office of Naval Research (ONR) is sponsoring the Military Applications of Ship Tracks (MAST) experiment on STS-70. MAST, which flew for the first time on STS-65 in July 1994, is part of a five-year research program developed by ONR to examine the effects of ships on the marine environment. The Naval Postgraduate School, Monterey, CA, will conduct the experiment at the Johnson Space Center during the mission.

The objective of MAST is to determine how pollutants generated by ships modify the reflective properties of clouds. Ship tracks are observed in satellite imagery as long, narrow, curvilinear cloud features that have greater brightness than the surrounding clouds. The STS-70 crew will photograph ship tracks using large format, handheld cameras. These high-resolution photographs will provide insight into the processes of ship track production on a global scale. MAST will help in understanding the effects of man-made aerosols on clouds and the resulting impact on the climate system.

MAST is a DOD payload and is being flown under the direction of the DOD Space Test Program.

RADIATION MONITORING EQUIPMENT -III (RME-III)

RME stands for Radiation Monitoring Equipment, the name given to prototype dosimeter instruments flown on the Space Shuttle. RME-III has been successfully flown on various Space Shuttle missions since STS-31. RME is being integrated and flown on the STS-70 mission under the direction of the Defense Department's Space Test Program. It has been flown in conjunction with other radiation experiments, such as the CREAM (Cosmic Radiation Effects and Activation Monitor) and SAM (Shuttle Activation Monitor).

RME-III is an instrument which measures the exposure to ionizing radiation on the Space Shuttle. It displays the dose rate and total accumulated radiation dose to the operator, while simultaneously registering the number of radiation interactions and dose accumulated at ten second intervals. This data is stored in RME-III's memory module(s), for follow-up analysis upon return to Earth. The radiation detector used in the instrument is a spatial ionization chamber called a tissue equivalent proportional counter (TEPC) which effectively simulates a target size of a few microns of tissue, the dimensions of a typical human cell. For this reason, TEPC-based instruments such as the RME-III are called micro-dosimeter instruments.

The data obtained from the RME-III are archived and are being used to update and refine models of the space radiation environment in low-Earth orbit. This will assist space mission planners to more accurately assess risk and safety factors in future long-term space missions, such as the international Space Station. RME-III also has been used to measure radiation exposure in high altitude aircraft, such as the Concorde.

WINDOW EXPERIMENT (WINDEX)

The objective of WINDEX is to gain an understanding of the chemistry and dynamics near a Low-Earth-Orbit (LEO) satellite. This information will prevent misinterpretation of the measurements of the Earth, solar system, and stars from LEO platforms. This knowledge also will prevent damage to sensitive systems and solar arrays during rendezvous and docking operations.

WINDEX will record the dynamics of thruster plumes, Shuttle glow, water dumps, atmospheric nightglow, aurora, and flash evaporator system (FES) releases. Thruster plumes provide the largest perturbations on the LEO environment. Thruster firings can enhance the local densities of gases by several orders of magnitude and introduce numerous non- natural elements. These non-natural elements react with the atmosphere or with the spacecraft systems in the plume cloud. WINDEX would like to record the high speed (< ¼ sec) phenomena associated with the start-up and shut-down transients of the thruster as well as observe how these transients affect the Shuttle glow. Shuttle glow can be an indicator of the flow field around the Shuttle. Measurements of the Shuttle glow will help us understand the chemistry around the Shuttle and obtain a measure of the optical contamination of LEO based sensors. Low-light level spectrally resolved images will provide this information. Water dumps, FES releases, and fuel cell purges also are a major contributor to the non-natural environment around a LEO satellite. WINDEX will look at water dumps to identify particle size and freezing dynamics of liquid water releases in the LEO environment. In order to separate the optical emissions of the near-field glow or plume data from the natural background, WINDEX must obtain atmospheric nightglow information. WINDEX will accomplish this by obtaining spectrally resolved images of limb and nadir night glow. This data will identify the dynamics of the middle and upper atmosphere (50 - 300 Km altitude). Information on the aurora will also help define the natural background environment of LEO platforms.

WINDEX is integrated and flown under the direction of the DOD Space Test Program.

VISUAL FUNCTION TESTER - 4 (VFT-4)

Since the Gemini space flights three decades ago, some of NASA's Shuttle astronauts have described a loss in their ability to see clearly at close range when in space. Interestingly enough, most of the astronauts experiencing this change were in their early forties and could see clearly without reading glasses when they were on the ground. Vision scientists at Human Systems Center's Armstrong Laboratory at Wright-Patterson AFB want to know why.

The next step in seeking the answers begins when the Discovery begins its eight-day mission, carrying with it an instrument that measures the range of how close and far away the human eye can see clearly while in near zero gravity conditions, often referred to as microgravity. The instrument, called the Vision Function Tester - 4 (VFT-4), was invented and patented by two Armstrong Laboratory scientists, Dr. H. Lee Task and Colonel Louis Genco.

Based on astronauts' accounts, the reasons why eyesight may change in space have been narrowed to two possible explanations. VFT-4 gives researchers a chance to get first-hand information and test those ideas. One theory put forth by the Principal Investigator, Lt. Col. Gerald Gleason, a vision scientist with the Visual Displays Systems Branch, Human Engineering Division, Crew Systems Directorate, is that the eye is like a water balloon. Rest it on a table and it gets longer as it flattens out (which is the normal condition on Earth). Put that balloon in space and it shortens, becoming more round. The eye could do the same thing and when it shortens it becomes far- sighted, causing more difficulty seeing objects up close. In addition to taking pre-and post-flight measurements of two astronauts' eyes using the Vision Function Tester, the participating astronauts will use the instrument daily throughout the Shuttle flight. The information gathered during these 30-minute sessions will also help Armstrong scientists evaluate how quickly the eye adjusts in space and how it is affected over time.

The results of the Shuttle experiments are relevant to the Department of Defense as the information will be used to better simulate a microgravity environment on the ground. In turn, contact lenses or reading glasses may be prescribed to compensate for the changes astronauts and military pilots experience in microgravity.

VFT-4 is integrated and flown aboard the Space Shuttle under the direction of the Department of Defense Space Test Program. This program is open to all experiments within the DOD desiring space flight. The vision experiments aboard Discovery are the second in a series of a projected five to be conducted aboard Space Shuttle missions over the next two years.

SHUTTLE AMATEUR RADIO EXPERIMENT (SAREX)

Students in the U.S. and Argentina will have a chance to speak via amateur radio with astronauts aboard the Discovery. Ground-based amateur radio operators ("hams") will be able to contact the Shuttle through automated computer-to-computer amateur (packet) radio links. There also will be voice contacts with the general ham community as time permits.

The radio contacts are part of the SAREX (Shuttle Amateur Radio EXperiment) project, a joint effort by NASA, the American Radio Relay League (ARRL), and the Radio Amateur Satellite Corporation (AMSAT).

The project, which has flown on 17 previous Shuttle missions, is designed to encourage public participation in the space program and support the conduct of educational initiatives through a program to demonstrate the effectiveness of communications between the Shuttle and low- cost ground stations using amateur radio voice and digital techniques.

Space Shuttle Mission Specialist Donald Thomas (call sign KC5FVF) will talk with students in 10 schools in the U.S. and Argentina using "ham radio."

Students in the following schools will have the opportunity to talk directly to orbiting astronauts for approximately 4 to 8 minutes:

- Hook Elementary School, Troy, OH (KA8CBE)
- East Memorial Elementary School, Farmingdale, NY (N2PSG)
- Concord High School, Concord, NH (N1JHJ)
- Schenectady Museum Amateur Radio Station, Schenectady, NY (WB2CRZ)
- Euclid High School, Euclid, OH (WA8WKQ)
- Milford High School, Highland, MI (N8IHO)
- ITT Technical Institute, Grand Rapids, MI (WJ8F)
- Gulf Middle School, New Port Richey, FL (KD4SSU)
- Fallbrook Union High School, Fallbrook, CA (KM6WF)
- Colegio San Nicolas, Santa Fe, Argentina (LU2FCY)

Several audio and digital communication services have been developed to disseminate Shuttle and SAREX-specific information during the flight.

The ARRL ham radio station (W1AW) will include SAREX information in its regular voice and teletype bulletins.

The amateur radio station at the Goddard Space Flight Center, (WA3NAN), will operate around the clock during the mission, providing SAREX information, retransmitting live Shuttle air-to-ground audio, and retransmitting many SAREX school group contacts.

Information about orbital elements, contact times, and crew operating schedules will be available during the mission from NASA ARRL (Steve Mansfield, 203/666-1541) and AMSAT (Frank Bauer, 301/286-8496). AMSAT will provide information bulletins for interested parties on Internet and amateur packet radio.

Current Keplerian elements to track the Shuttle are available from the NASA Spacelink computer information system (BBS), (205) 895-0028 or via Internet spacelink.msfc.nasa.gov., and the ARRL BBS (203) 666-0578. The latest element sets and mission information also are available via the Johnson Space Center (JSC) ARC BBS or the Goddard Space Flight Center (GSFC) BBS. The JSC number is (713) 244-5625, 9600 Baud or less. The GSFC BBS is available via Internet. The address is wa3nan.gsfc.nasa.gov.

STS-70 SAREX Frequencies

Routine SAREX transmissions from the Space Shuttle may be monitored on a worldwide downlink frequency of 145.55 MHz.

The voice uplink frequencies are (except Europe):

144.91 MHz
144.93
144.95
144.97
144.99

The voice uplink frequencies for Europe are:
144.70
144.75
144.80

Note: The astronauts will not favor any one of the above frequencies. Therefore, the ability to talk to an astronaut depends on selecting one of the above frequencies chosen by the astronaut.

The worldwide amateur packet frequencies are:

Packet downlink 145.55 MHz
Packet uplink 144.49 MHz

The GSFC amateur radio club planned HF operating frequencies:

3.860 MHz	7.185	14.295	21.395	28.650

STS-70 CREWMEMBERS

STS070-S-002 **--** *These five NASA astronauts are in training for the STS-70 mission aboard the space shuttle Discovery. Left to right are astronauts Kevin R. Kregel, Nancy J. Currie, Terence T. (Tom) Henricks, Mary Ellen Weber and Donald A. Thomas. Henricks and Kregel are commander and pilot, respectively. The other three are mission specialists. Among the tasks they are expected to perform is the deployment of another satellite in the network of the Tracking and Data Relay Satellite System (TDRSS).*

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

TERENCE (TOM) HENRICKS, COMMANDER

Air Force Colonel Terence "Tom" Henricks, 42, will serve as commander of Discovery.

Born in Bryan, OH, Henricks considers Woodville, OH, to be his hometown. Henricks received a bachelor's degree in civil engineering from the United States Air Force Academy in 1974, and a master's in public administration from Golden Gate University in 1982. He has logged 747 parachute jumps and more than 4,700 hours flying time.

Henricks completed his pilot training at Craig Air Force Base in Selma, AL, and F-4 conversion training at Homestead Air Force Base in Miami, FL. He then flew in F-4 fighter squadrons in England and Iceland. He attended the USAF Test Pilot School in 1983 and remained at Edwards AFB, CA, as an F-16C test pilot and chief of the 57th Fighter Weapons Wing Operating Location until he was selected as an astronaut in 1985.

Since joining NASA, Henricks has re-evaluated Shuttle landing sites around the world; served as assistant manager for Engineering Integration in the Shuttle Program Office; worked as lead astronaut of the Shuttle Avionics Integration Laboratory at the Johnson Space Center and of the Vehicle Test and Checkout Office at the Kennedy Space Center.

Henricks has served as pilot of two space flights. His first mission was STS-44 in November 1991. The primary mission was to deploy the Defense Support Program satellite with an Inertial Upper Stage rocket booster. His second mission, STS-55 in April 1993, was a cooperative Spacelab mission with the German Space Agency which included 89 different experiments in materials processing, life sciences, robotics, technology, astronomy and Earth mapping.

Henricks has logged over 405 hours in space.

KEVIN KREGEL, PILOT

Pilot Kevin Kregel, 38, will be making his first space flight. Kregel, who was born in New York City, considers Amityville, NY, to be his hometown.

Kregel earned a bachelor's degree in astronautical engineering from the U.S. Air Force Academy in 1978 and a master's degree in public administration from Troy State University in 1988.

Kregel earned his pilot's wings in 1979 at Williams Air Force Base, AZ. From 1980 to 1983, he was assigned to F-111 aircraft at RAF Lakenheath. While serving as an exchange officer flying A-6E aircraft with the U.S. Navy at NAS Whidbey Island in Seattle, WA, and aboard the USS Kitty Hawk, Kregel made 66 carrier landings during a cruise of the Western Pacific. His next assignment was another exchange tour at the U.S. Naval Test Pilot School at Patuxent River, MD. Upon graduation he was assigned to Eglin AFB, FL, conducting weapons and electronic systems testing on the F- 111, F15 and the initial weapons certification test of the F15E aircraft.

Kregel resigned from active duty in 1990 to take a position as an aerospace engineer and instructor pilot at JSC's Ellington Field offices. His primary responsibilities included flying as an instructor pilot in the Shuttle Training Aircraft and conducting the initial flight test of the T-38 avionics upgrade.

Selected as an astronaut in March 1992, Kregel has served as the Astronaut Support Personnel Team at the Kennedy Space Center.

DONALD THOMAS, MISSION SPECIALIST 1

Cleveland native Donald Thomas, Ph.D., 40, will be making his second flight as Mission Specialist 1.

Thomas holds a bachelor's degree in physics from Case Western Reserve University in 1977, and master's and doctorate degrees in materials science from Cornell University in 1980 and 1982, respectively.

Following his graduation, Thomas joined AT&T Bell Laboratories in Princeton, N.J., working as a senior member of the technical staff. He also served as an adjunct professor in the Physics Department of Trenton State College. He holds two patents and has authored several technical papers.

Thomas left AT&T in 1987 to work for Lockheed Engineering and Sciences Company in Houston, where his responsibilities involved reviewing materials used in the Shuttle payloads. In 1988, he joined the Johnson Space Center as a materials engineer, working on analysis of advanced composite materials for use on the Space Station. He also was principal investigator for the Microgravity Disturbances Experiment on STS-32.

Thomas was selected as an astronaut in January 1990. His first mission, STS-65 in July 1994, was a 15-day Spacelab flight which included 80 experiments focusing on materials and life sciences research in space. With the completion of that mission, Thomas has logged almost 354 hours in space.

NANCY CURRIE, MISSION, SPECIALIST 2

Army Major Nancy Currie, 36, will make her second space flight as Mission Specialist 2 during STS-70.

Born in Wilmington, DE, Currie considers Troy, OH, to be her hometown. She received a bachelor's degree in biological science from Ohio State University in 1980 and a master's in safety engineering from the University of Southern California in 1985.

Following her graduation from Ohio State University, Currie served as a neuropathology research assistant at the OSU College of Medicine. She was commissioned as a lieutenant in the U.S. Army in July 1981 and has served in a variety of leadership positions including helicopter instructor pilot, section leader, platoon leader and Brigade flight standardization Officer. As a senior army aviator, Currie has logged over 3,300 flying hours in a variety of rotary-wing and fixed-wing aircraft. She has instructed in all phases of rotary-wing flight, including combat skills and night vision goggle operations. She was assigned to the Johnson Space Center in September 1987 as a flight simulation engineer on the Shuttle Training Aircraft and was subsequently selected as an astronaut in 1990. Since joining the astronaut corps, she has served as the lead for flight crew equipment, the Remote Manipulator System and as a spacecraft communicator.

Her first space flight occurred in June 1993 on STS-57. The primary objective of the mission was to retrieve the European Retrievable Carrier satellite. The mission also featured the first flight of the Spacehab module, carrying 22 microgravity experiments and featured a space walk by two crew members..

After the one flight, Currie has accumulated 239 hours in space.

MARY ELLEN WEBER, MISSION SPECIALIST 3

Rounding out the STS-70 crew will be Mary Ellen Weber, Ph.D., 32, who will serve as Mission Specialist 3.

Born in Cleveland, OH, Weber considers Bedford Heights, OH, to be her hometown. She holds a bachelor's degree in chemical engineering from Purdue in 1984 and a doctorate in physical chemistry from the University of California at Berkeley in 1988.

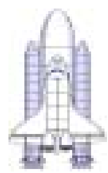
During her undergraduate studies at Purdue, Weber held engineering internships at Ohio Edison, Delco Electronics and 3M. After her graduation, she joined Texas Instruments to research new techniques in microelectronics manufacturing. In 1990, she was assigned to SEMATECH, a U.S. semiconductor manufacturing consortium in Austin, TX, to develop novel high-density plasma reactors for silicon etching. This work led to a further assignment at Applied Materials and Technology in Santa Clara, CA, to develop a world-class plasma etcher. She holds one patent and has published eight technical papers. She also is a national competitive sky diver with over 1,900 jumps.

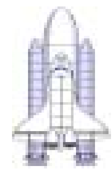
Weber was selected as an astronaut in March 1992. Since then she has assisted in Shuttle processing and launches for the Astronaut Office and has worked in the Shuttle Avionics Integration Laboratory.

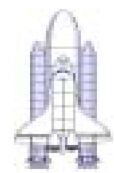
STS-70 is her first space mission.

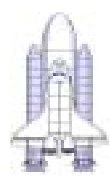
SHUTTLE FLIGHTS AS OF MAY 1995

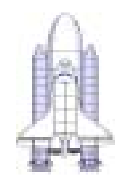
70 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 45 SINCE RETURN TO FLIGHT











		STS-63 02/03/95 - 02/11/95		
		STS-64 09/09/94 - 09/20/94		
		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-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92		
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92	STS-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-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
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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
OV-102 Columbia (17 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery (20 flights)**	**OV-104 Atlantis (14 flights)**	**OV-105 Endeavour (9 flights)**