NASA
National Aeronautics and
Space Administration

STS-2 Second Space Shuttle Mission

Press Kit

September 1981

RELEASE NO: 81-138

CONTENTS

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202 755-8370

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RELEASE NO: 81-138

SHUTTLE TO CARRY SCIENTIFIC PAYLOAD ON SECOND FLIGHT

In a major space first, the Space Shuttle Orbiter Columbia will become the first spacecraft ever to make more than one trip into space when it is launched from NASA's Kennedy Space Center, Fla., now scheduled for no earlier than 8 a.m. EDT on Oct. 9, 1981.

This is the second in a series of four test flights to qualify the nation's new Space Transportation System for routine space operations. First flight of the Columbia was April 12 - 15, 1981.

Joe H. Engle and Richard H. Truly are the crew for the flight, STS-2, which is scheduled for a duration of five days, four hours and 10 minutes.

September 22, 1981

-more-

Neither of the astronauts has previously flown in orbit, although three of Engle's 16 flights in the rocket-powered X-15 were above 80 kilometers (50 miles). Engle and Truly flew the Orbiter Enterprise in two of the five approach and landing glide flights in 1977 in which the Orbiter was released from a 747 aircraft.

On this second flight, the Orbiter will carry the first scientific and applications payload to fly on the Shuttle and a Canadian-built remote manipulator arm which someday will be used to deploy and retrieve space payloads.

One major objective for STS-2 is the evaluation of Columbia's ability to serve as a steady platform for Earth-viewing instruments. The OSTA-1 (Office of Space and Terrestrial Applications) package in the payload bay calls for Columbia to be flown in an upside down position (-Z local vertical) for most of the flight. Except for activation, deactivation and occasional data takes, OSTA-1 experiments are largely automated and require little crew attention.

Another major operation will be unloaded testing of the Canadian-built 15-meter (50-foot) long remote manipulator arm.

Orbiter systems testing will continue for measuring space radiator, attitude control, electrical power generation and other systems performance.

STS-2 will be launched into a 38-degree inclination orbit, circularized first at 222 km (120 nm) and later boosted to 253.7 km (137 nm) for the remainder of the flight. The first day will be taken up with OSTA-1 and Orbiter systems activation and tests of the payload bay door opening/closing mechanisms.

The second flight day will include checkout of the remote manipulator system in direct, manual, automatic and backup modes, and in activating and stowing the robot arm.

Day 3 will include an airlock extravehicular activity demonstration in which Engle will don a Shuttle spacesuit and walk through the EVA procedures, stopping just short of airlock depressurization. Data from remote manipulator arm operations will also be evaluated.

Day 4 activities will be deactivation of OSTA-1 experiments and general clean-up, catch-up prior to entry day.

Before buttoning up the payload bay doors on entry day, Engle and Truly will don the escape pressure suits, align Columbia's inertial measurement unit and prepare for the orbital maneuvering system deorbit maneuver which will bring Columbia back into the atmosphere to a landing on Rogers Dry Lake at Dryden Flight Research Center, Edwards, Calif. During final approach to Edwards, Columbia will be guided automatically by the microwave scanning beam landing system on the lakebed down to flare, where the crew will land manually.

Engle and Truly will not be tethered by microphone/headset cables in Columbia's cabin, but for the first time, will use wireless microphones tied into Orbiter's communications system.

Entry groundtrack to landing will be almost identical to that of Columbia's maiden flight -- deorbit burn over the Indian Ocean, entry into the atmosphere over the western Pacific, crossing the California coast near Monterey, letting down over the San Joaquin Valley to a landing on Runway 23 at Edwards in the Mojave Desert. Landing teams from Kennedy Space Center will remove the crew and "safe" Columbia after landing.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

Note: Technical descriptions of Orbiter and booster structures and systems are in the Space Shuttle News Reference book. Press kits for each of the Shuttle missions will contain information on payloads, timelines, flight crew and other details peculiar to each flight.

SCHEDULED PRESS BRIEFINGS

Date & Time (EDT)		Briefing	Location
T-4	9:00 a.m.	Countdown Status	KSC
T-3	9:00 a.m.	Countdown Status	KSC
	10:30 a.m.	STS-2 Vehicle	KSC
	1:30 p.m.	Terminal Countdown and Mission Rules	KSC
T-2	9:00 a.m.	Countdown Status	KSC
	10:30 a.m.	STS-2 Flight Plan	KSC
	1:00 p.m.	OSTA-1 Payload	KSC
	3:00 p.m.	Remote Manipulator System	KSC
T-1	9:00 a.m.	Countdown Status	KSC
	1:30 p.m.	Prelaunch Press Conference	KSC
T (approx. 1 hour after launch)		Postlaunch Press Conference	KSC
T thru T+5		Flight Director Change of Shift Briefings	JSC
T+3		Spacesuit Briefing	JSC
T+4	a.m.	Chase Pilot Briefing	DFRC
	p.m.	Landing Operations Briefing	DFRC
T+5 (approx. 2 hours after landing)		Post Landing Briefing	DFRC
T+6	2:00 p.m.	Orbiter Status Briefing	DFRC

NOTE: Times are subject to adjustment.

STS-2 OBJECTIVES: CONTINUING THE SHAKEDOWN

Second in the series of four engineering test flights readying the Shuttle system for operational flight, STS-2 will stress Columbia's load-carrying capabilities and structure somewhat greater than the benign first flight. Columbia's payload bay will house developmental flight instrumentation and Orbiter experiments as well as the first scientific payload to be carried by the Space Transportation System.

The Canadian-built remote manipulator arm, or payload deployment and retrieval system, is scheduled to be flown and operated during STS-2, STS-3 and STS-4. While the 15-m (50-ft.) long robot arm will not move a payload during this flight, an induced environment contamination monitor and a plasma data package will be aboard Columbia for its next flight, STS-3, now tentatively scheduled for late January 1982. Each of the packages will be grabbed and "waved" around the Orbiter to measure spacecraft-made "contaminations" from thruster exhausts to water dumps.

Qualifying the Space Shuttle for routine operational flight will be done by the building-block approach -- progressively adding new tasks and operations in each successive flight of the four orbital flight tests.

STS-2 primary flight objectives are to fly the vehicle with a heavier payload than the first flight, test Columbia's ability to hold steady attitude for Earth-viewing payloads, measure the range of payload bay environment during launch and entry, run further tests on the payload bay doors and space radiators and operate the remote manipulator arm.

An array of seven Earth-viewing experiments are in the OSTA-1 payload described in detail in another part of this press kit. Farther aft in the payload bay, a cruciform truss carries the developmental flight instrumentation package and the induced environment contamination monitor.

Also mounted in the payload bay is the aerodynamic coefficient identification package -- a box packed with accelerometers and gyros for measuring and recording Orbiter aerodynamic performance in hypersonic, supersonic and transonic flight. Passive experiments in the Orbiter experiments series carried on STS-2, and not requiring crew attention or spacecraft maneuvers, are tile gap heating effects, catalytic surface effects, and dynamic, acoustic and thermal environment.

Program engineers have defined 82 functional test objectives and 40 functional supplementary objectives for the orbital flight test program in mandatory and highly-desirable categories. The STS-2 crew activity plan schedules 58 test and 27 supplementary objectives in the timeline.

During entry, a series of aerodynamic response tests will be run in all speed regimes from hypersonic down through subsonic to evaluate Orbiter stability and control system effectiveness. Aerodynamic stick outputs and programmed test inputs will cycle reaction control system and the aerosurface control system in combination and singly to induce attitude oscillations. Similar tests were run at subsonic speeds during the 1977 approach and landing test flights with Orbiter Enterprise. No such tests were performed on STS-1.

Shuttle spacesuits, or extravehicular mobility units, are stowed in the airlock for a contingency spacewalk to close balky payload bay doors. Should such a spacewalk become necessary, Columbia's cabin pressure would be lowered from 14.5 pounds per square inch (21/79 percent oxygen/nitrogen mix) to 9 psi (28/72 percent oxygen/nitrogen). Lowering cabin pressure to 9 psi eliminates the need for Engle to pre-breathe oxygen on an umbilical or on a portable oxygen system to "wash" suspended nitrogen from his blood before going out to haul the doors shut.

ORBITER COLUMBIA'S SECOND FLIGHT

(Configuration)

Columbia's payload bay is somewhat more crowded on STS-2 than it was on the first flight. The orbital flight test development flight instrumentation and Orbiter experiments have been joined by the OSTA-1 payload.

OSTA-1, mounted on a Spacelab pallet, is an array of Earth-viewing instruments to demonstrate the Orbiter's research capabilities.

Also carried in the payload bay are the induced environment contamination monitor mounted on the instrumentation truss and the aerodynamic coefficient identification package.

Down between the mid-fuselage frames and below the payload bay floor, an additional set of cryogenic oxygen and hydrogen tanks has been installed to supply reactants to the Columbia's fuel cells for extending electrical power capacity.

Elsewhere aboard Columbia, auxiliary power unit No. 2 has been replaced. This unit experienced failure of both heaters in the gas generator during STS-1. All three fuel cell power plants have been replaced with improved versions. Again, additional water has been loaded in potable and waste water tanks to feed the flash evaporators for a minimum six orbits after launch to cover the contingency of failure of the payload bay doors to open and expose the space radiators for spacecraft cooling.

Creature comforts provided Engle and Truly are not as sophisticated as they will be for operational flights.

-more-

Meals stowed in the middeck food lockers will be heated in a carry-on food warmer until airliner-type galleys are installed on Columbia and subsequent Orbiters.

One sleeping bag is stowed in the middeck for evaluation during STS-2. The bag is attached by pip-pins to modular storage locker fronts, and is similar to the sleep restraints used in Apollo. The crewman not using the sleeping bag will sleep strapped into his ejection seat on the flight deck. Sleep kits, with ear plugs and eye covers, are provided.

After STS-4, the ejection seats will be removed from Columbia. Until then, crews will wear modified Air Force high-altitude pressure suits during launch and entry.

Columbia and its tank and boosters will weigh seven tons more at liftoff than on STS-2. Total vehicle weight for STS-1 was 2,023,750 kilograms (4,461,620 pounds); for STS-2 the vehicle will weigh 2,030,250 kg (4,475,943 lb.) at launch -- 6,500 kg (14,323 lb.) more.

Payload bay cargo weights are: OSTA-1, pallet, wiring harness, attach fittings, etc. 2,425 kg (5,347 lb.); DFI, IECM, ACIP, Orbiter experiments, mounting hardware, etc. 6,370 kg (14,041 lb.) for a total payload weight of 8,795 kg (19,388 lb.).

LAUNCH PREPARATIONS, COUNTDOWN AND LIFTOFF

Assembly of the Space Shuttle "stack" for the STS-2 mission began soon after the completion of STS-1. Erection of the twin solid rocket boosters for the second mission began in the Vehicle Assembly Building at Kennedy Space Center on May 20 on the same mobile launcher platform used for the first mission.

The Orbiter Columbia arrived at Kennedy from the Dryden Flight Research Center in California aboard the 747 Shuttle carrier aircraft on April 28, and was moved into the Orbiter Processing Facility for extensive post-mission examination the next day. Refurbishment of the Orbiter, its thermal protection system and the preparations for the installation of the Remote Manipulator System, OSTA-1 payload and flight instrumentation began immediately.

The external tank for STS-2 arrived at Kennedy via an ocean-going barge on April 22, and was taken into the Vehicle Assembly Building for systems checkout in High Bay 4.

The tank was mated to the twin solid rocket boosters in High Bay 3 of the Vehicle Assembly Building on June 30.

The Canadian-built remote manipulator arm to be used to deploy and retrieve Shuttle payloads arrived at Kennedy on April 22 and was taken to the Operations and Checkout Building in the Industrial Area for assembly and checkout. It was moved to the Processing Facility on June 20 for installation in the Orbiter's payload bay.

The OSTA-1 scientific package underwent assembly, checkout and flight validation in the Operations and Checkout Building and was transported to the Orbiter Processing Facility on July 1 and inserted in the Columbia's payload bay. The OSTA-1 Interface Verification Test was conducted July 18-20 to make certain the Orbiter and payload were properly integrated.

The Columbia was moved from the Processing Facility to the Assembly Building on Aug. 10, and was hoisted into place on the back of the external tank/solid rocket booster combination. This mating completed the Space Shuttle vehicle for the STS-2 mission.

The Shuttle Interface Test was conducted in late August to verify the mechanical and electrical connections between the various elements and to verify the functioning of the onboard systems.

The assembled Space Shuttle and its mobile launcher platform were moved to Pad A of Launch Complex 39 on Aug. 31 to undergo final processing prior to launch. Pad to vehicle connections were verified, the hypergolic systems were serviced and a dry countdown demonstration test was performed, clearing the way for the actual countdown and launch. Additionally, the communications loop between the Payload Operations Control Center and the OSTA-1 payload was exercised.

The launch countdown for STS-2 will be conducted in Firing Room 1 of the Complex 39 Launch Control Center by a government/ industry team of about 200.

The STS-2 pre-count will begin at the T-73 hour mark with a call-to-stations for the launch team. The final countdown begins at about the T-5 hour point, and includes opportunities for several hold periods.

Pre-count and final countdown activities will include powering up of the vehicle, servicing the Orbiter's fuel cell reactant tanks, pressurizing the Orbital Maneuvering System and Reaction Control System propellant tanks, software loading of the Orbiter's computer mass memory units and warmup of the inertial navigation units.

Among the major milestones in the countdown are:

Count Time	Event
T-20 hours	Retract Rotating Service Structure.
T-10 hours	Sound suppression water tank fill.
T-7 hours	Begin clearing pad for countdown. Clearing complete by T-5 hours.
T-5 hours	Begin final countdown. Begin chilldown and fill of external tank.
T-3 hours, 30 min.	Wake up flight crew for breakfast and suiting.
T-2 hours, 15 min.	External tank filled, in top off mode.
T-2 hours, 5 min.	Enter one hour built-in hold. Crew starts move to pad during hold.
T-1 hour, 50 min.	Crew entry and hatch closeout begins. Complete by T-1 hour, 5 min.
T-30 min.	White room crew clears pad.
T-20 min.	Enter 10 minute built-in hold.
T-9 min.	Enter 10 minute built-in hold.
T-9 min.	Launch Director "go-for-launch" received. Start ground launch sequencer (auto sequence).
T-7 min.	Retract crew access arm.
T-5 min.	Start Orbiter auxiliary power units. Arm external tank/solid rocket boosters ignition and range safety systems.
T-3 min., 30 sec.	Orbiter transfers to internal power.
T-2 min., 55 sec.	Begin pressurization of liquid oxygen tank; retract vent hood (beanie cap) and arm.
T-1 min., 57 sec.	Begin pressurization of liquid hydrogen tank.
T-28 sec.	Solid rocket booster hydraulic power units activated. Orbiter computers assume control of terminal countdown.

T-7 sec.	Main engine start sequence.
T-3 seconds	Main engines at 90 percent thrust.
T-0**	Solid rocket booster ignition and hold-down post release. Liftoff.

** STS-1 had two T-0s, one at the estimated main engine 90 percent thrust time and the second at planned SRB ignition. The STS-2 countdown has been adjusted so that there is only one T-0.

LAUNCH WINDOW

STS-2 will be launched from Pad A of Complex 39 no earlier than Oct. 9, 1981. The launch window on that date opens at 8 a.m. EDT and closes at 1:40 p.m. for a launch opportunity of four hours, 52 minutes in duration. The period from 11:38 a.m. to 12:26 p.m. is not available in order to avoid an unfavorable Sun angle on landing at the end of the mission. The window assumes a nominal landing on Runway 23 on Rogers Dry Lake at the Dryden Flight Research Center but offers the option of landing on Runway 15 if conditions are favorable for gaining landing experience under crosswind conditions.

Among the key considerations in establishing the launch window are lighting conditions which will permit photographic documentation of the launch and sufficient lighting for a safe landing at any of the designated landing sites.

STS-2 will be flown in an orbit with an inclination of 38 degrees at a planned altitude of 254 km (137 nm) above the Earth's surface.

SPACE SHUTTLE MISSION EVENTS

EVENT	TIME		ALTITUDE		RELATIVE VELOCITY		RANGE	
	Min.	Sec.	km	N. Miles	km/h	mph	km	N. Miles
SSME Ignition	-0	7	0	0	0	0	0	0
SSMEs at 90% Thrust	-0	3	0	0	0	0	0	0
SRB Ignition/Holddown Bolts Triggered	0	0	0	0	0	0	0	0
Liftoff	+0	.3	0	0	0	0	0	0
Clear Tower	+	6.8	106a	347b	119	74.3	0	0
Begin Pitchover	+	7.3	137a	400b	129	80.5	0	0
Maximum Dynamic Pressure (Max Q)	+	51.6	7.9	4.3	1222	764	3.5	1.9
SRB Separation	+2	7	50.6	27.3	4592	2870	46.7	25.2
Main Engine Cutoff	+8	39.4	118	63.7	26,669	16,668	1399	755
External Tank Jettisoned	+8	51.4	120.8	64.2	26,664	16,666	1501	810
OMS-1 Ignition	+10	33.4	126.2	68.1		16,646	80.2x13.5	1275
OMS-1 Cutoff	+11	56.4	131.6	71	ΔV-146fps	16,730	120.2x53.5	1619
OMS-2 Ignition	+41	51.4	223.7	120.7		16,473		8954
OMS-2 Cutoff	+43	4.4	222.4	121.0	ΔV-122fps	16,554	120.2x120.2	9047

SPACE SHUTTLE MISSION EVENTS

EVENT	TIME		ALTITUDE		RELATIVE VELOCITY		RANGE	
	Min.	Sec.	km	N. Miles	km/h	mph	km	N. Miles
OMS-3A Ignition	+6h 20m	435				17,391(I)		
OMS-3A Cutoff	+6h 20m	55			ΔV-10fps	17,397(I)	119x120	
OMS-3B Ignition	+6h 24m	55				17,398(I)		
OMS-3B Cutoff	+6h 25m	19			ΔV-21fps	17,413(I)	120x137	
OMS-4 Ignition	+7 09m	27				17,328(I)		
OMS-4 Cutoff	+7 10m	04			ΔV-30fps	17,348(I)	137x137	
Deorbit Ignition	123h 12m	04		850,073 ft.		17,345	137.3x133	
Deorbit Cutoff	123h 14m	04				17,532	136.8x94	
Entry Interface	123h 38m	18		400,000 ft.		Mach 25**		
Enter TAEM* Interface	124h 03m	58		81,748 ft.		1,700 **		59.6
TAEM Autoland Interface	124h 09m	03		9,925		400**	35,000 ft. from runway threshhold	
Weight on Wheels (Main Gear)	124h 10m	24				227**		
Wheel Stop	124h 11m	02						

Note: a - meters; b - feet.
Trajectory parameters may be subject to minor modification prior to launch
I - Inertial Velocity

*Terminal Area Energy Management
**Relative Velocity

GUIDE TO USING THE FLIGHT PLAN

1. Summary Level Timeline (12-hour timespan)

The following letters (a-j) reference those in Figure 2-1.

a. Timescales: Two time references are presented in this section. The two time references used are Central Daylight Time (CDT) (or TIG minus) and Mission Elapsed Time (MET). MET is referenced to liftoff beginning at 00/00:00:00 (days, hours, minutes and seconds).

b. Crewmen (CDR & PLT): This is the column where titles of scheduled activities are shown for the commander (CDR) and pilot (PLT) at the appropriate times.

c. Day/Night and Orbit:

1) Day/Night - The orbital day/night intervals are shown by black bars when the Orbiter is in darkness.

2) Orbit - Indicates which orbit the spacecraft is in by numerical sequence. The beginning of an orbit occurs when the Orbiter crosses the Earth's equator going from the southern to the northern hemisphere (ascending node). The succession of orbits is numbered in this column starting with Orbit 1 for launch.

d. Earth Trace W/SAA: This is a display of the groundtrack of the Orbiter and when it passes over the South Atlantic Anomaly (SAA) (indicated by a ' ├──┤ ').

e. GSTDN Coverage: The GSTDN communication coverage periods are indicated in this area with a horizontal line indicating when communication is available; the GSTDN site is identified to the right of the line.

f. SIR-A, SMIRR, OCE: Times are identified in these areas for referenced experiment data-takes. TIMES enclosed by a box represent alternate data opportunities.

g. OPS: The GPC software configuration in use during the flight is indicated in this area.

h. Deorbit OPT: Times are identified in this area when deorbit burn opportunities exist for Edwards AFB (EDW).

i. Attitudes and Maneuvers:

1) Attitude - The current attitude of the vehicle is identified in this area, i.e., IMU, -ZLV.

2) Maneuvers - An '↑' is placed at the time an attitude maneuver occurs.

j. TV: TV is indicated in this area with a ' ├──┤ '.

FORMAT

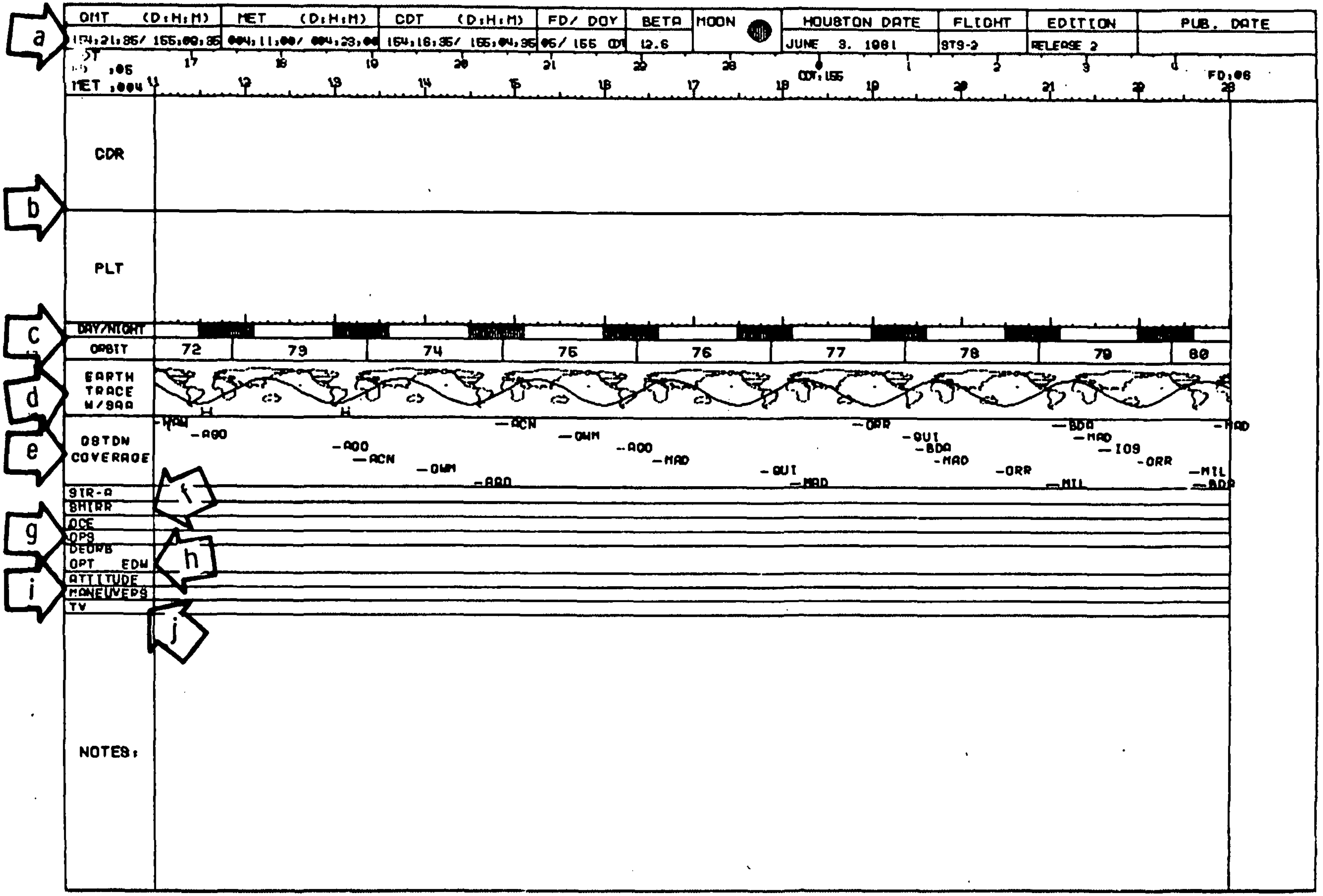
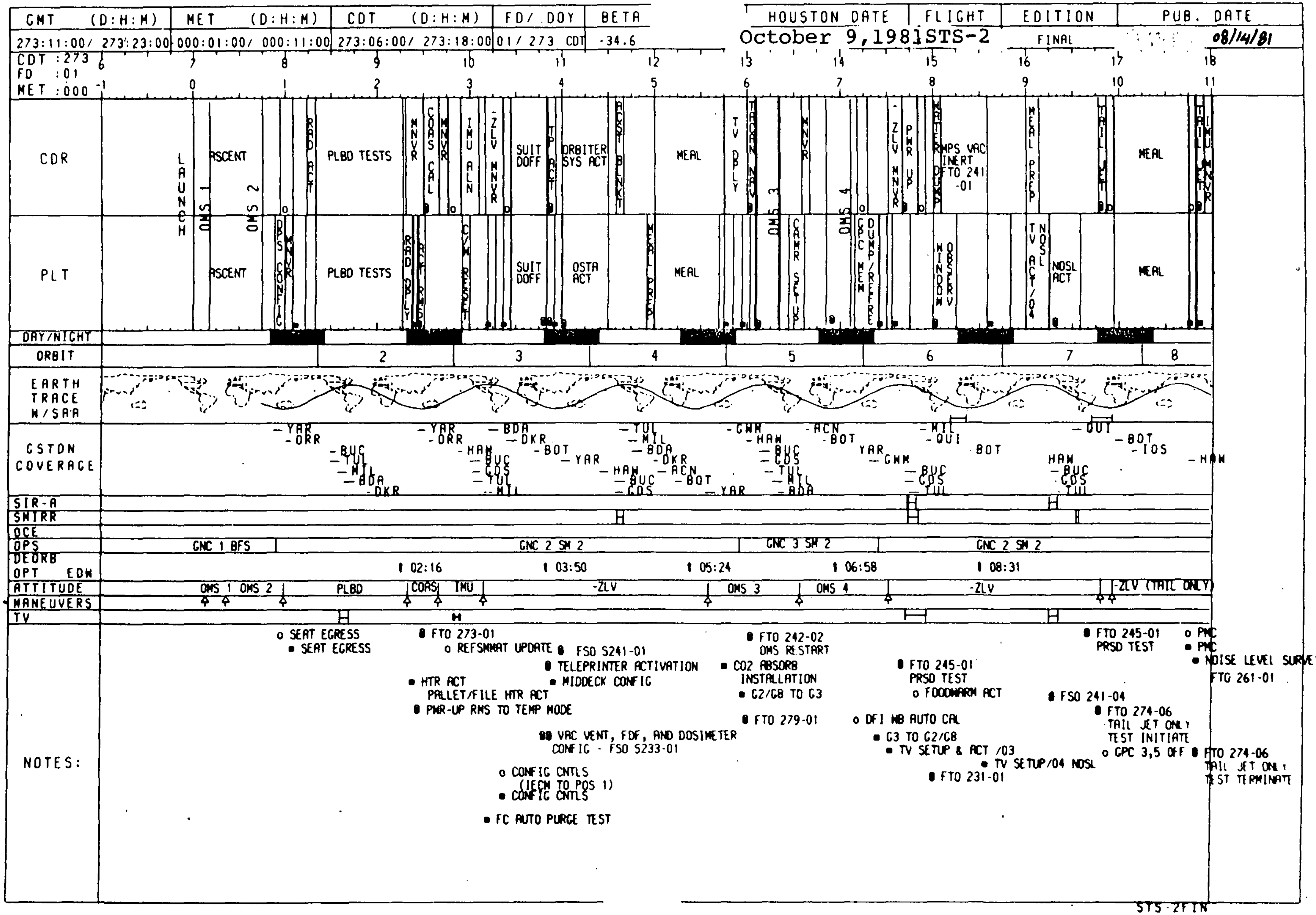


Figure 2-1

SUMMARY TIMELINE



GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
273:23:00/ 274:11:00	000:11:00/ 000:23:00	273:18:00/ 274:06:00	01/ 273 CDT	-33.3	October 9,1981	STS-2	FINAL	08/14/81

CDT :273 — 18, 19, 20, 21, 22, 23, 0 (CDT:274), 1, 2, 3, 4 (FD:02), 5, 6
FD :01
MET :000 — 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

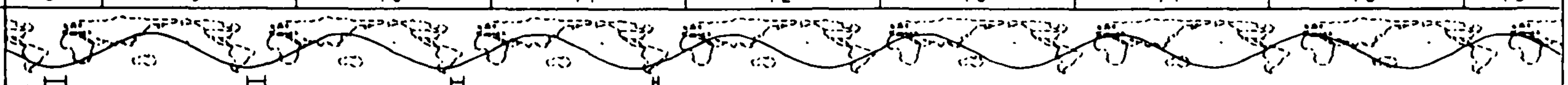
CDR: I MU MNVR | I MU ALN | AUT NAV | - ZLV MNVR | PRE SLEEP ACT | SLEEP | POST SLEEP ACT | I MU MNVR | I MU ALN | - ZLV MNVR | RMS PRE-DEPLOY C/O | MEAL

PLT: PRE SLEEP ACT | SLEEP | POST SLEEP ACT | HYD PUMP | MEAL PREP | CAMR SYS SETUP | RMS PRE-DEPLOY C/O | MEAL

DAY/NIGHT

ORBIT: 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16

EARTH TRACE W/SAA



GSTDN COVERAGE: AGO, BOT, IOS, HAW, AGO, AGO, ACN, GWM, AGO, ACN, DKR, GWM, AGO, DKR, MAD, QUI, DKR, MAD, ORR, QUI, BDA, MAD, YAR, ORR, MIL, BDA, MAD, IOS

SIR-A

SMIRR

OCE

OPS: GNC 2 SM 2

DEORB OPT EOM

ATTITUDE: IMU/NAV | -ZLV | IMU | -ZLV

MANEUVERS

TV

NOTES:

- NOISE LEVEL SURVEY FTO 261-01
- CO2 ABS CHG
- FC PURGE
- FTO 278-01 AUTONOMOUS NAVIGATION
- ST SELF TEST
- S TRK THRESHOLD FTO 273-07
- FC PURGE
- FTO 243-02 THREE SYS INTERACT START

STS-2FIN

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
274:11:00/ 274:23:00	000:23:00/ 001:11:00	274:06:00/ 274:18:00	02/ 274 CDT	-31.9	October 10,1981	STS-2	FINAL	08/14/81

CDT :274 — 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
FD :02
MET :000 — 23, 0 (MET 001), 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

CDR: MEAL; RMS GROUP 1; SPEC SMIRR; RMS GROUP 1; HYD PUMP; SIR-A MAN; OPS; RMS GROUP 1; SIR-A MAN; OPS; RMS GROUP 1; MEAL PREP; SIR-A MAN; OPS; ACT SIR-A; MEAL; RMS THERMAL; VRCS HLD; SUIT DONNING; SEAT INGRESS; SEAT EGRESS; SUIT DOFFING; PMC; MEAL PREP; MEAL; IMU MNVR; IMU ALIGN; MNVR

PLT: WATER DUMP; MEAL; TV SETUP; ACT/OS; RMS GROUP 1; RMS GROUP 1; TV SETUP; ACT/OS; RMS GROUP 1; MEAL; SUIT DONNING; SEAT INGRESS; SEAT EGRESS; SUIT DOFFING; HYD PUMP; RMS THERMAL; PMC; ACIP; MEAL

DAY/NIGHT

ORBIT: 16, 17, 18, 19, 20, 21, 22, 23, 24

EARTH TRACE W/SAA

GSTDN COVERAGE: YAR, ORR, TUL, MIL, BDA, MAD, IOS, YAR, ORR, BUC, TUL, GDS, MIL, BDA, DKR, BOT, YAR, ORR, HAW, BUC, GDS, TUL, MIL, BDA, DKR, ACN, BOT, YAR, HAW, BUC, GDS, TUL, MIL, BDA, ACN, BOT, YAR, GWM, HAW, BUC, GDS, TUL, MIL, BDA, ACN, BOT, GWM, BUC, GDS, TUL, QUI, BOT, HAW, BUC, QUI, ACO, BOT, IOS, HAW

SIR-A / SMIRR / OCE

OPS: GNC 2 SM 2

DEORB OPT EDM: 00:35; 02:09; 03:44; 05:18; 06:52

ATTITUDE: -ZLV; -ZLV; GRAVITY GRADIENT; IMU; TR

MANEUVERS

TV

NOTES:

- o HYD PUMP FTO 243-02 THREE SYS INTERACT TERMINATE
- ● FTO 243-03 SINGLE SYS THERMOSTAT START
- o RMS GROUP 1
- ● RMS PWR DOWN
- ● SEAT/POS CONFIG
- o O2 TK HTR RECONFIG
- ● FTO 243-03 SINGLE SYS THERMOSTAT TERMINATE
- o SEAT/POS CONFIG
- ● GRAVITY GRADIENT FTO 274-10 GRAVITY GRADIENT ATTITUDE CONTROL
- ● FSO S233-03 ACIP ON-ORBIT TEST
- o GRAVITY GRADIENT TERMINATE FTO 274-10
- ● ORB MAINT IA ATT

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
274:23:00/ 275:11:00	001:11:00/ 001:23:00	274:18:00/ 275:06:00	02/ 274 CDT	-30.2	October 10,1981	STS-2	FINAL	08/14/81

CDT :274 — 18, 19, 20, 21, 22, 23, 0 (CDT:275), 1, 2, 3, 4 (FD:03), 5, 6

FD :02

MET :001 — 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

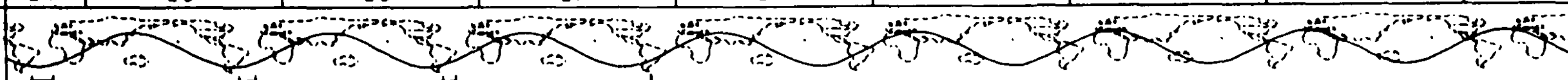
CDR: ORB MAINT | MNVR | ORB MAINT | -ZLV MNVR | PRE SLEEP ACT | SLEEP | POST SLEEP ACT | IMU MNVR | IMU ALIGN | -ZLV MNVR | MEAL

PLT: FD PURGE | PRE SLEEP ACT | SLEEP | POST SLEEP ACT | TV SETUP | TV ACT/OPS | MEAL

DAY/NIGHT

ORBIT: 24, 25, 26, 27, 28, 29, 30, 31, 32

EARTH TRACE W/SAA



GSTDN COVERAGE: AGO, BOT, IOS, HAW, AGO, AGO, ACN, GWM, AGO, ACN, DKR, GWM, AGO, DKR, MAD, QUI, DKR, MAD, ORR, QUI, BDA, MAD, YAR, ORR, MIL, BDA, MAD, LOS, YAR

SIR-A

SMIRR

OCE

OPS: GNC 2 SM 2

DEORB OPT EDW

ATTITUDE: 1A, 1B, -ZLV, IMU, -ZLV

MANEUVERS

TV

NOTES:

o MNVR

o INTERCNCT RET

● CO2 ABS CHG
o WATER DUMP

o ST SELF TEST
o S TRK THRESHOLD
FTO 273-07

o WATER DUMP
● FC PURGE

STS-2FIN

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
275:11:00/ 275:23:00	001:23:00/ 002:11:00	275:06:00/ 275:18:00	03/ 275 CDT	-28.5	October 11,1981	STS-2	FINAL	08/14/81

CDT :275 6 7 8 9 10 11 12 13 14 15 16 17 18
FD :03 MET:002
MET :001 23 0 1 2 3 4 5 6 7 8 9 10 11

CDR: MEAL, RMS PWR UP, RMS GROUP 2, VTR PLAY, SET/ACT, SIR-A MAN, OPS, RMS GROUP 2, MEAL PREP, EXERCISE, ACT SIR-A, MEAL, IECM MNVR, IECM, S BAND ANTENNA, ZLV MNVR, MANUAL LVLH TFST, EXERCISE, MEAL, IMU MNVR, IMU ALN, MNVR, ORB MAINT, MNVR, ORB MAINT

PLT: MEAL, SET SIR-A, RMS PWR UP, RMS GROUP 2, VTR PLAY, SET/ACT, SIR-A MAN OPS, RMS GROUP 2, RMS PWR DOWN, EXERCISE, MEAL, HYD PUMP, EXERCISE, MEAL PREP, WCS CLEAN, MEAL, HYD PUMP, WATER DUMP

DAY/NIGHT

ORBIT: 32, 33, 34, 35, 36, 37, 38, 39, 40

EARTH TRACE W/SAA

GSTDN COVERAGE: YAR, ORR, TUL, MIL, BDA, NAD, IOS, YAR, ORR, BUC, GDS, TUL, MIL, BDA, DKR, BOT, YAR, ORR, HAW, BUC, GDS, TUL, MIL, BDA, DKR, ACN, BOT, YAR, HAW, BUC, GDS, TUL, MIL, BDA, ACN, BOT, YAR, GWM, HAW, BUC, GDS, TUL, MIL, BOT, GWM, BUC, GDS, TUL, QUI, BOT, HAW, QUI, AGO, BOT, IOS, HAW, AGO

SIR-A

SWIRR

OCE

OPS: GNC 2 SM 2

DEORB OPT EDW: 02:02, 03:36, 05:10, 06:44

ATTITUDE: -ZLV, RMS/PCRS, -ZLV, IECM, S-BAND, LVLH, -ZLV, GRAVITY GRADIENT, IMU, 2A, 2B

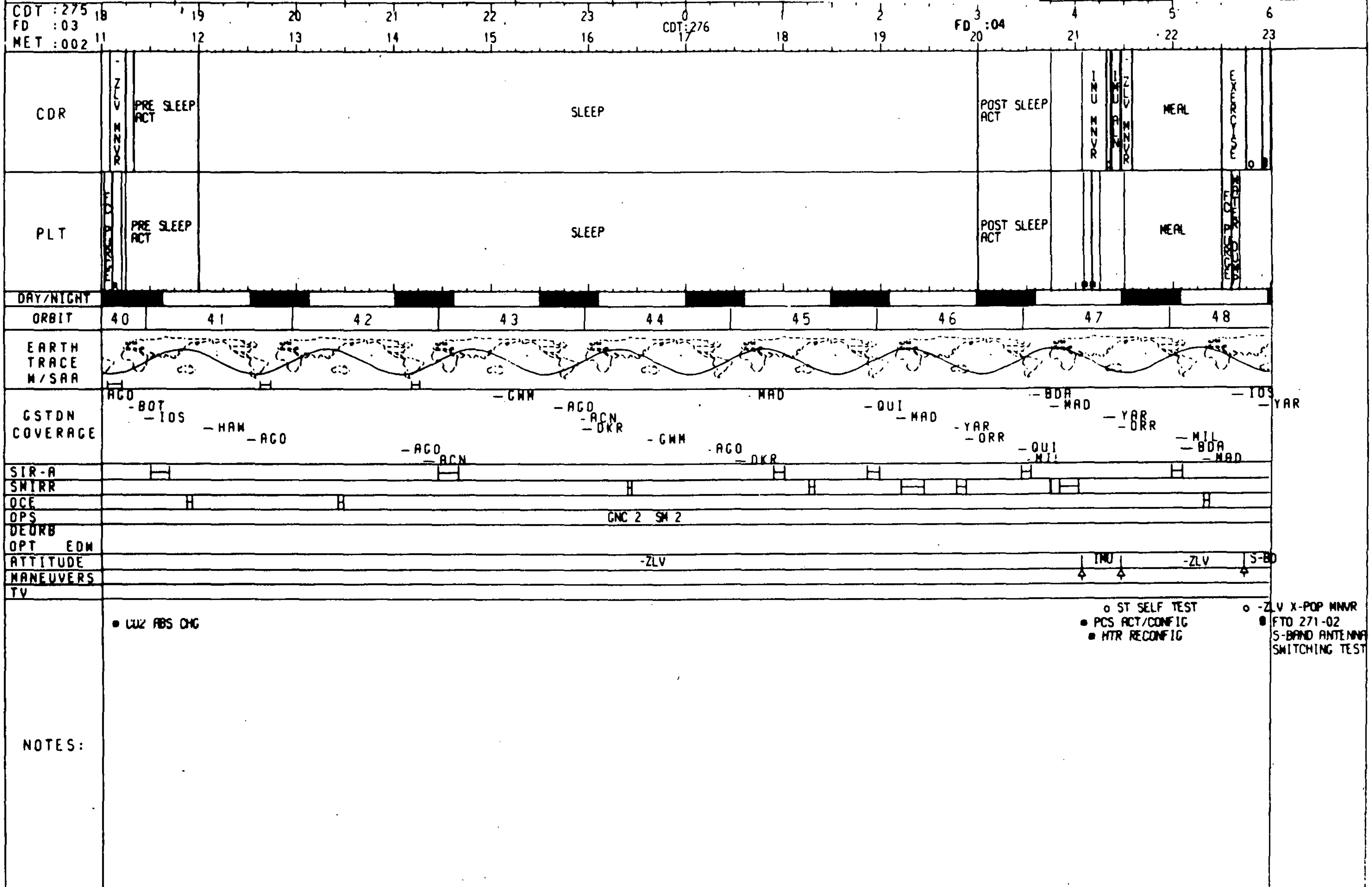
MANEUVERS

TV

NOTES:

- o WATER DUMP
- ● FC PURGE
- o TV/10 ACT RMSMNVR
- ● FTO 252-09
- ● FTO 271-01
- o -ZLV X-POP MNVR
- ● FTO 243-01 SINGLE SYS NO INTERACTION START
- o GRAVITY GRADIENT FTO 274-10 GRAVITY GRADIENT ATTITUDE CONTROL
- o GG TERMINATE
- ● FTO 243-01 SINGLE SYSTEM NO INTERACTION TERMINATE
- ● FTO 273-1

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
275:23:00/ 276:11:00	002:11:00/ 002:23:00	275:18:00/ 276:06:00	03/ 275 CDT	-26.7	October 11,1981	STS-2	FINAL	08/14/81



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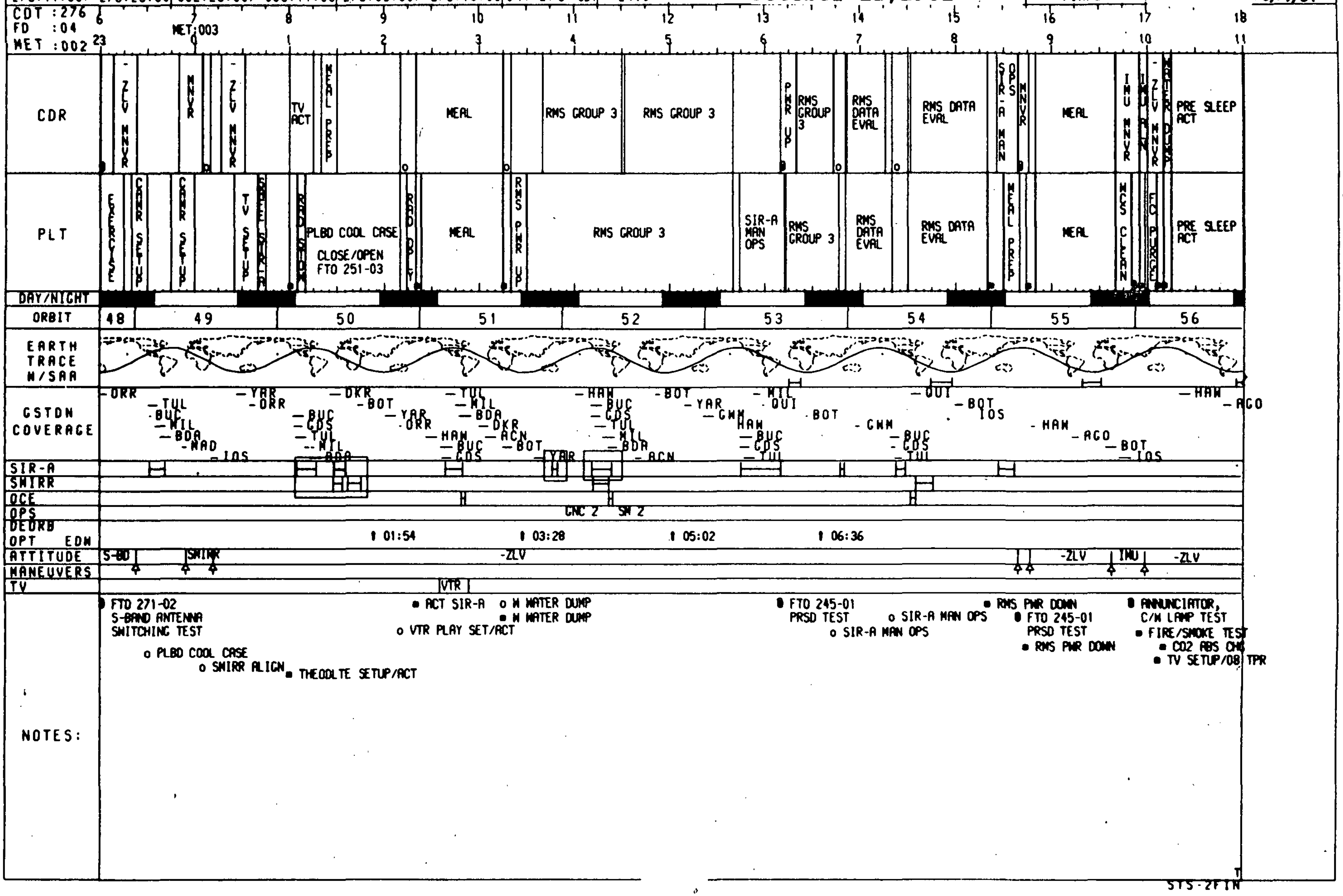

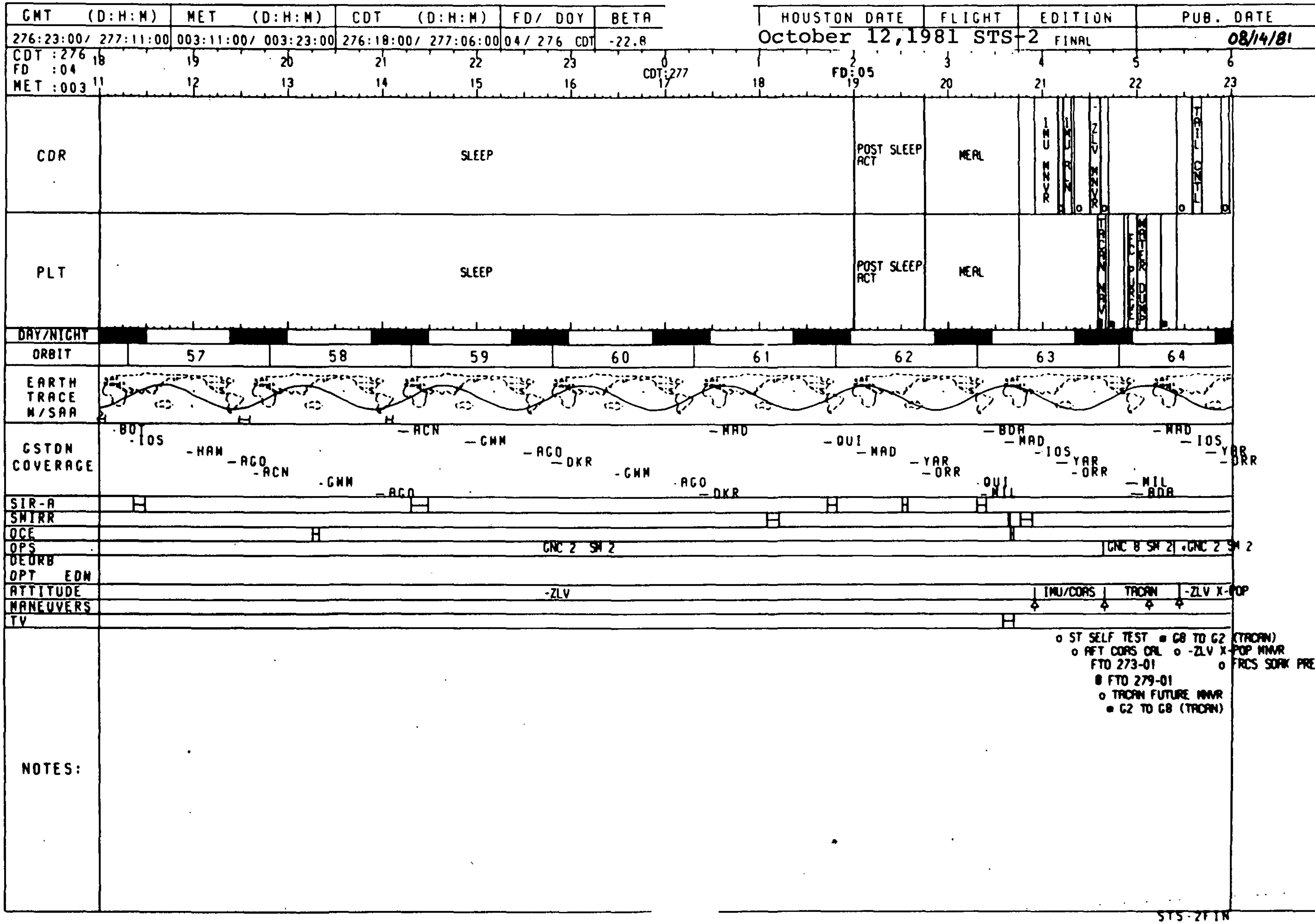
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CDT (D:H:M) 276:18:00/ 277:06:00
FD/ DOY 04/ 276 CDT
BETA -22.8
HOUSTON DATE October 12,1981
FLIGHT STS-2
EDITION FINAL
PUB. DATE 08/14/81
CDT :276
FD :04
MET :003
CDT:277
FD:05
CDR
PLT
SLEEP
POST SLEEP ACT
MEAL
IMU MNVR
IMU ALN
ZLV MNVR
TAIL CNTL
TACAN NAV
FC PURGE
WATER DUMP
DAY/NIGHT
ORBIT
57
58
59
60
61
62
63
64
EARTH TRACE W/SAA
GSTDN COVERAGE
BOT
IOS
HAW
AGO
ACN
GWM
AGO
ACN
GWM
AGO
DKR
GWM
MAD
AGO
DKR
QUI
MAD
YAR
ORR
BDA
MAD
IOS
YAR
ORR
QUI
MIL
MAD
IOS
YAR
ORR
MIL
BDA
SIR-A
SMIRR
OCE
OPS
GNC 2 SM 2
GNC 8 SM 2
GNC 2 SM 2
DEORB OPT EDW
ATTITUDE
-ZLV
IMU/CORS
TACAN
-ZLV X-POP
MANEUVERS
TV
NOTES:
o ST SELF TEST
o AFT CORS CAL FTO 273-01
■ FTO 279-01
o TACAN FUTURE MNVR
■ G2 TO G8 (TACAN)
■ G8 TO G2 (TACAN)
o -ZLV X-POP MNVR
o FRCS SOAK PREP
STS-2FIN

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
277:11:00/ 277:23:00	003:23:00/ 004:11:00	277:06:00/ 277:18:00	05/ 277 CDT	-20.7	October 13, 1981	STS-2	FINAL	08/14/81

CDT :277 — 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18
FD :05
MET :003 — 23, MET:004 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

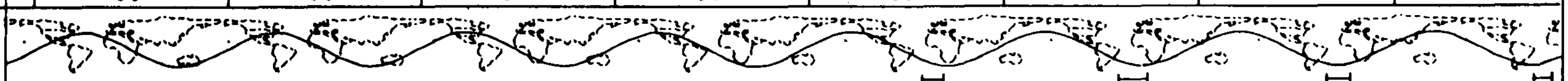
CDR: FIRE F3 / FIRE F3 / FIRE F3 / FIRE F3 / FIRE F3 / ZLV MNVR / EXERCISE / MEAL / AIRLOCK-EVA DEMO FTO 263-01 / MEAL / NOSE JET / RCS JET TEST / RCS TRANS TESTS / IMU MNVR / IMU ALN / AFT COAS ALIGN-CAL / PTC / INITIATE / PRE SLEEP ACT

PLT: CAMR SETUP / EXERCISE / TV ACT/07 FOOD / MEAL PREP / CAMR SETUP / MEAL / AIRLCK-EVA SUPPORT / WINDOW OBSERV / EXERCISE / AIRLCK-EVA SUPPORT / AIRLCK-EVA SUPPORT / MEAL PREP / NOSE JET / MEAL / NOSL DEACT / CAMR SETUP / WATER DUMP / FC PURGE / PRE SLEEP ACT

DAY/NIGHT

ORBIT: 65, 66, 67, 68, 69, 70, 71, 72

EARTH TRACE W/SAA



GSTDN COVERAGE: BUC, TUL, MIL, BDA, MAD, DKR, IOS, YAR, ORR, HAW, BUC, GDS, TUL, MIL, BDA, DKR, BOT, YAR, TUL, MIL, BDA, DKR, HAW, BUC, GDS, ACN, BOT, YAR, GWM, HAW, BUC, GDS, TUL, MIL, BDA, ACN, BOT, YAR, GWM, MIL, QUI, BUC, GDS, TUL, BOT, GWM, HAW, BUC, GDS, TUL, QUI, BOT, IOS, HAW, AGO, BOT, IOS, HAW, AGO

SIR-A
SMIRR
OCE
OPS: GNC 2 SM 2
DEORB OPT EDW: 01:46, 03:20, 04:54, 06:28
ATTITUDE: -ZLV X-POP (TAIL JET) / -ZLV (TAIL JET CNTL) / -ZLV NOSE JET CNTL / RCS / RCS FTO / IMU/COAS VERIF / ALIGN / PTC
MANEUVERS
TV

NOTES:

- TV SETUP/07 FOOD
- o TV SETUP
- PRIME FTO 263-01
- FTO 231-01
- NOISE LVL CK
- FTO 274-01 NOSE JET ONLY TEST INITIATE
- NOISE LVL CK
- AIRLCK-EVA SUPPORT
- FTO 274-01 NOSE JET ONLY TEST TERMINATE
- FSO S241-04
- o PRCS ATT HOLD FTO 274-07 PRCS NARROW DEADBAND ATTITUDE HOLD PERFORMANCE
- FTO 274-03-04-05-08 FTO 242-03
- FTO 247-01
- FTO 273 -02-06
- CO2 ABS CHG
- CABIN TV STOW

STS-2FIN

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA	HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
277:23:00/ 278:11:00	004:11:00/ 004:23:00	277:18:00/ 278:06:00	05/ 277 CDT	-18.6	October 13,1981	STS-2	FINAL	08/14/81

TIG -6 -5

FD :05 CDT:278 FD:06

MET :004 11 12 13 14 15 16 17 18 19 20 21 22 23

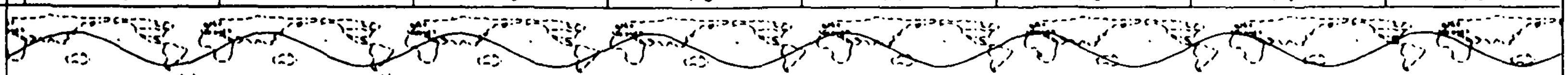
CDR: SLEEP | POST SLEEP ACT | IMU MNVR | IMU ALN | -ZLV MNVR | MEAL | CAMR SETUP | ENT STOWAGE | MNVR | FCS C/O | CREW SYS | DEACT

PLT: SLEEP | POST SLEEP ACT | FC PURGE | WATER DUMP | MEAL | ENT STOWAGE | DPS CONFIG | FCS C/O | DPS CONFIG | CREW SYS | DEACT

DAY/NIGHT

ORBIT: 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80

EARTH TRACE W/SAA



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SIR-A

SMIRR

OCE

OPS: GNC 2 SM 2 | GNC 8 SM 2 | GNC 2 SM 2

DEORB OPT ECN

ATTITUDE: PTC | IMU | -ZLV | TAIL TO SUN

MANEUVERS

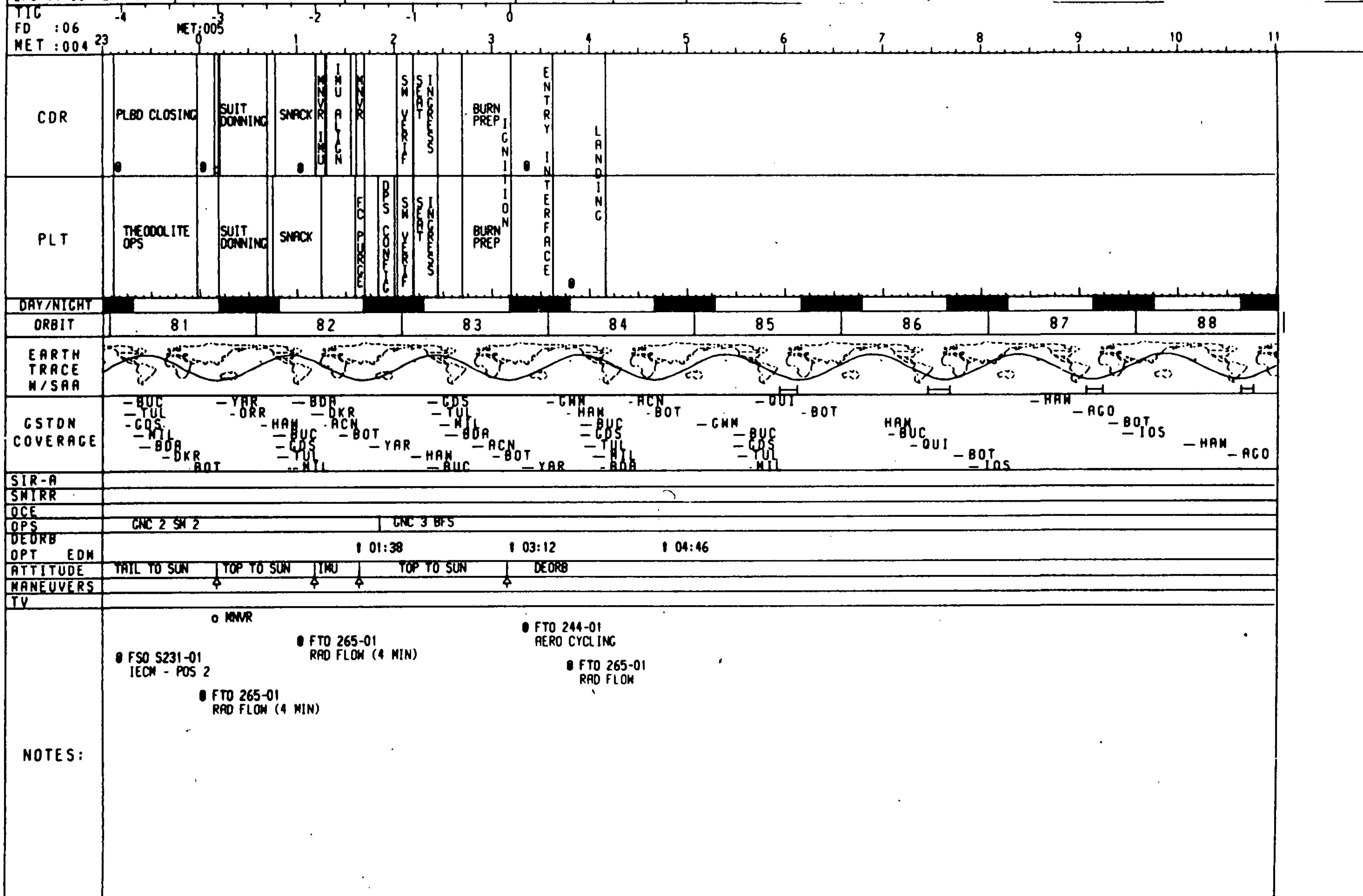
TV

NOTES:

- o ST SELF TEST
- ACST BLNKT STOW
- O2 TK HTR RECONFIG
- PALLET OSTA DEACT FSO S241-05
- FCS & DED DISPLAY ENTRY CONFIG
- o SEAT/POS CONFIG
- SEAT/POS CONFIG
- o RAD BYP/STOW RAD FTO 265-01

GMT (D:H:M)	MET (D:H:M)	CDT (D:H:M)	FD/ DOY	BETA
278:11:00/ 278:23:00	004:23:00/ 005:11:00	278:06:00/ 278:18:00	06/ 278 CDT	-16.4

HOUSTON DATE	FLIGHT	EDITION	PUB. DATE
October 14,1981	STS-2	FINAL	08/14/81



LANDING AND POSTLANDING OPERATIONS

The Kennedy Space Center is responsible for ground operations of the Space Shuttle, including preparations for return of Columbia to Kennedy Space Center for STS-3.

A recovery convoy will move to begin preliminary securing and safing operations as soon as the Columbia has come to a stop. Some of those operations include establishment of communications with the flight crew, connection of ground cooling and purge air units, conduct a post-landing inspection and connection of the ground tow vehicle. The operation should allow the flight crew to leave the vehicle approximately 45 minutes after landing.

The 18-unit ground convoy consists of the elements needed to detect and disperse hazardous vapors, service the Columbia's systems, transport ground support personnel wearing protective garments, provide access to the crew compartment and transport the flight crew and their replacement ground crew, and also provide fire-fighting protection.

The ground operations are conducted basically as follows:

After the vehicle comes to a stop on the dry lake bed at Dryden Flight Research Center, the flight crew will safe the Columbia's orbital maneuvering and reaction control systems.

Next, ground personnel wearing protective garments will approach the Columbia and use sensitive "sniffer" equipment to verify that no hazardous gases are present around the Orbiter. A mobile wind machine will be used to reduce the possibility that explosive or toxic gases exist in dangerous concentrations.

Vehicles with maneuverable access platforms will then be positioned at the rear of the Orbiter near its umbilical connection panels. Large transporters carrying purge air and cooling units will then be moved into place behind the Orbiter and their lines connected to the Orbiter umbilical panels.

Once the connections are made, Freon from one transporter will begin flowing through the Orbiter's cooling systems, and purge air from the other transporter will supply air conditioning for temperature and humidity control of the Orbiter payload bay.

Following a safety assessment, the flight crew will be permitted to leave the Orbiter and will be replaced by a ground operations crew. The Orbiter will then be towed to the Dryden Center.

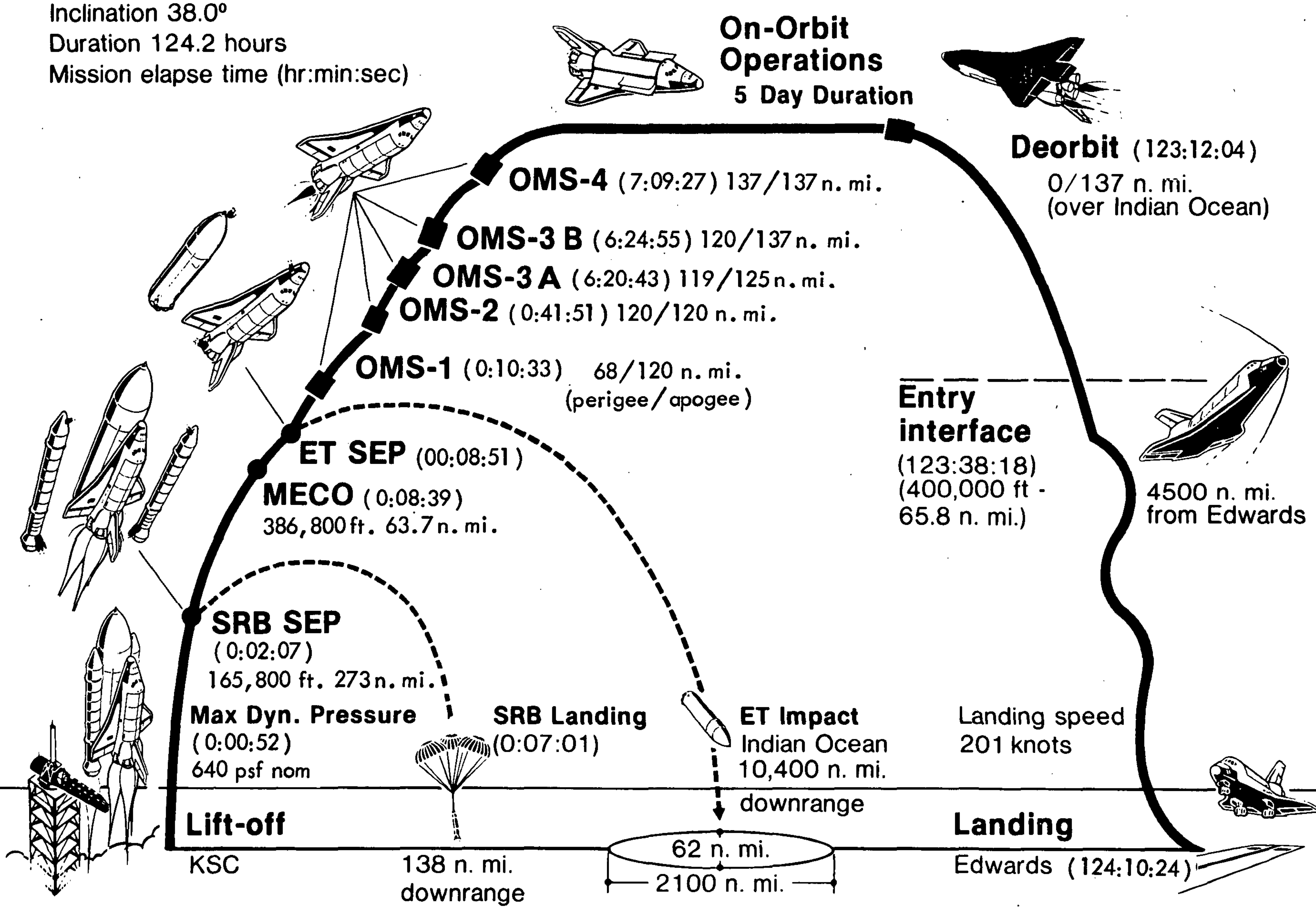
The elapsed time from Orbiter stop to beginning of towing should be appoximately one hour. An additional week to 10 days will be spent in ferry preparations and mating of the Orbiter to the 747 Shuttle Carrier Aircraft. Nominal flight time to return the Orbiter to Kennedy Space Center will be two days, including one overnight stop for refueling and crew rest.

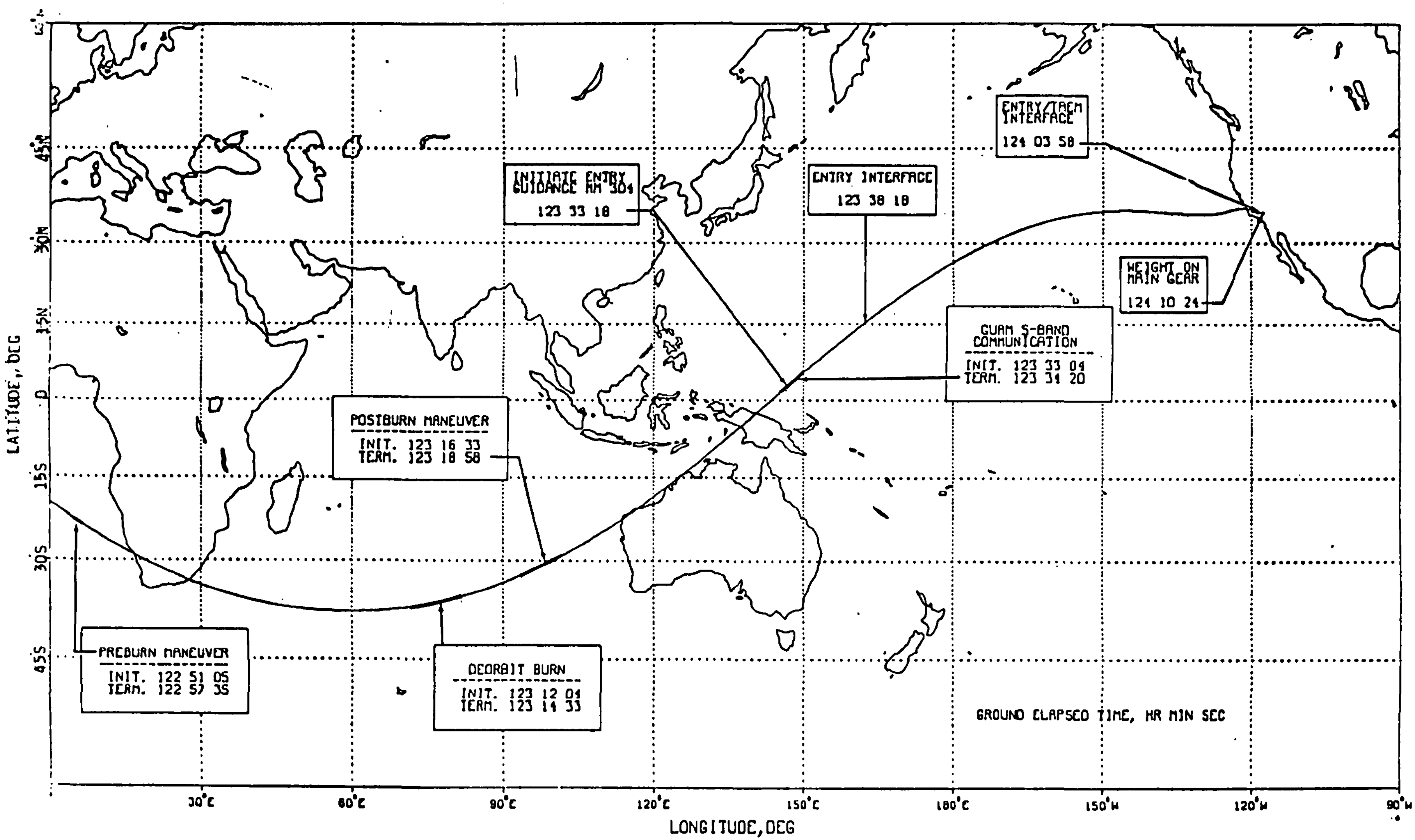
NASA

S-81-11652

Space Shuttle Nominal Mission Profile for STS-2

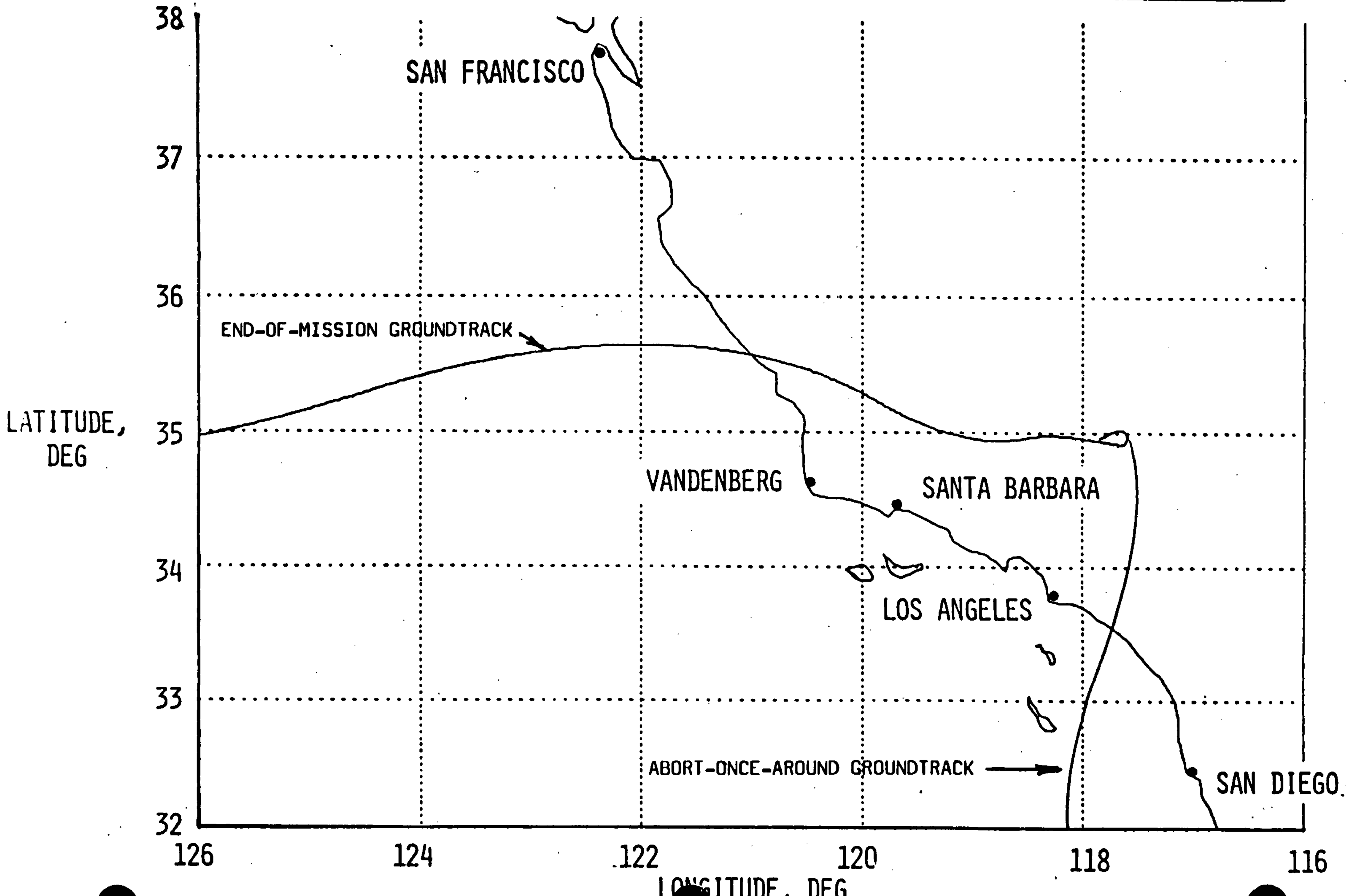
Nominal orbit 137/137 n. mi.
Inclination 38.0°
Duration 124.2 hours
Mission elapse time (hr:min:sec)





STS-2 DEORBIT-THROUGH-LANDING GROUNDTRACK

JSC/DSAD MISSION PLANNING AND ANALYSIS DIVISION	STS-2 POSTBLACKOUT ENTRY GROUNDTRACK	NO: DATE: NAME: ORG:



IF THINGS GO WRONG

(Contingencies)

While there has never been a launch abort in any U.S. manned space flight program, flight crews and flight controllers must still train and plan for emergency early landing. The safe return of the flight crew, the Orbiter and its payloads to an intact landing is emphasized in abort planning philosophy.

The preferred type of Shuttle launch abort is the abort-to-orbit in which combined thrust from main engines and orbital maneuvering system engines is enough to reach a minimal 194 km (105 nm) orbit. An abort-to-orbit would be called for if one main engine should shut down before enough velocity is reached to yield a 235 km (127 nm) orbit.

Earlier shutdown of one main engine would force an abort-once-around situation in which Columbia would land near the end of one orbit at Dryden Flight Research Center. Also, any critical systems failure aboard Columbia after orbital insertion calls for an abort-once-around landing.

Loss of a second main engine during launch forces a trans-Atlantic abort landing, or "Press to Rota" in which the flight crew would steer the vehicle toward a main engine cutoff velocity and position that would allow gliding Columbia to the runway at the U.S. Naval Air Station, Rota, Spain.

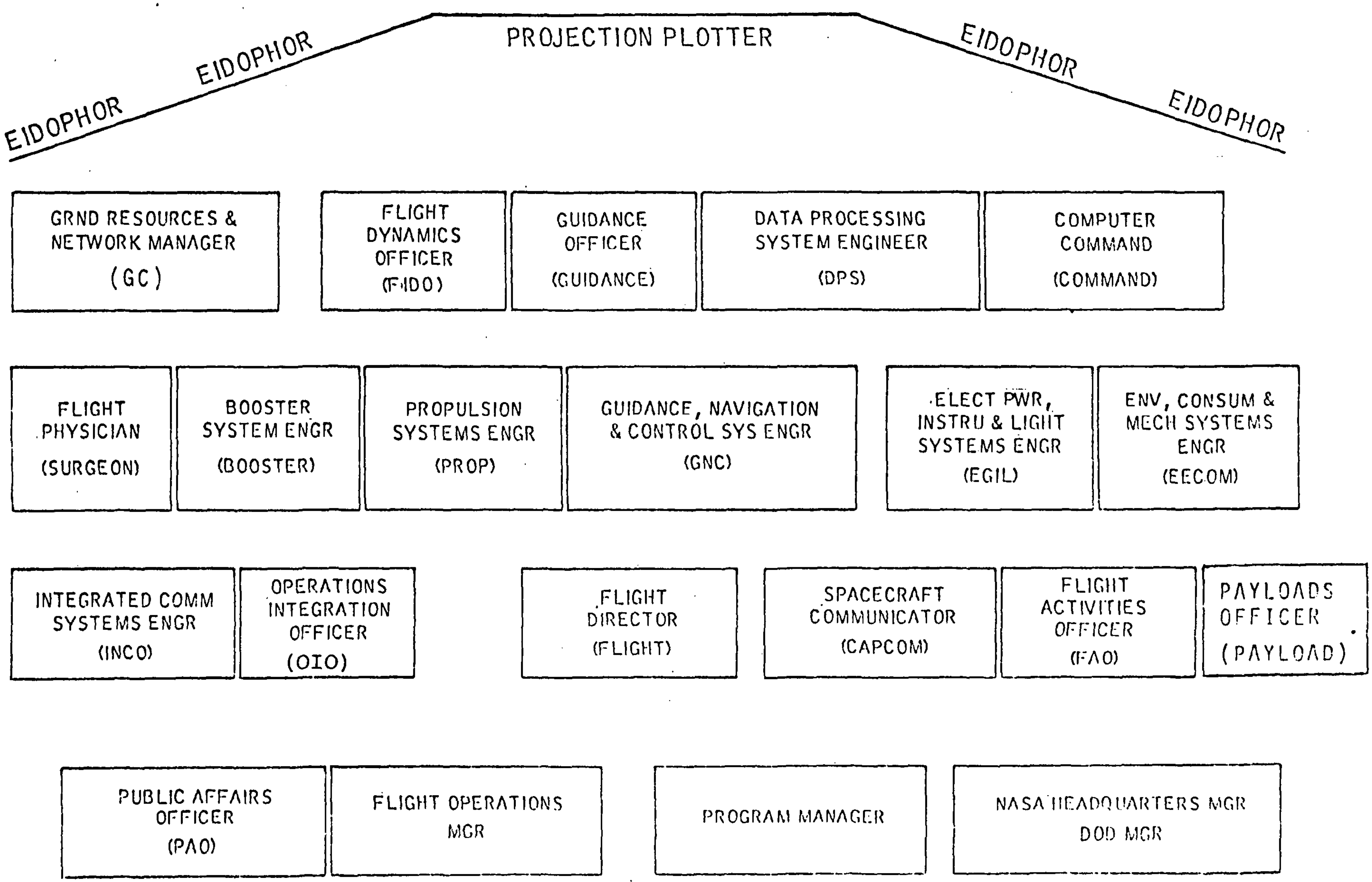
Shutdown of one or more main engines early in the launch phase calls for a return-to-launch-site abort. Once an abort decision is made, Columbia and the external tank would be flown in a pitch-around maneuver to heads-up and pointed back along the ground track to Cape Canaveral. Whatever main engine thrust still available would then be used to kill off eastward velocity, and reverse direction until the Kennedy Space Center runway could be reached by gliding along a normal entry trajectory. Major Orbiter systems failure during ascent could also force a return-to-launch-site abort.

Loss of control or impending catastrophic failure during ascent, from tower clear to 30,480 m (100,000 ft.) calls for crew ejection. Loss of two main engines prior to seven minutes of flight also calls for crew ejection.

The STS-2 alternate landing site is Northrup Strip on the U.S. Army White Sands Missile Range, N.M., if autumn rains muddy up Rogers Dry Lake at the Dryden Center at Edwards. Contingency landing sites, in addition to Edwards and Northrup, are Hickam Air Force Base/Honolulu International Airport, Hawaii; Kadena Air Base, Okinawa; and Rota Naval Station, Spain.

MCC MISSIONS OPERATIONS CONTROL ROOM (MOCR) POSITIONS

ROOM 231



HUNTSVILLE OPERATIONS SUPPORT CENTER

A team of Space Shuttle systems experts participates in launches of the Shuttle from the Huntsville Operations Support Center, a special facility situated at Marshall Space Flight Center, Huntsville, Ala.

During pre-mission, countdown, launch and powered flight toward orbit, Marshall engineers, development project managers and their contractors man consoles in the support center to monitor real time data being transmitted from the Shuttle. Their purpose is to evaluate and help solve any problems that might crop up with Marshall-developed Shuttle elements, including the Space Shuttle main engines, external tank and solid rocket boosters. They also are concerned with problems in the overall Main Propulsion System and Range Safety System.

The data, which provide information on the "health" of these systems, are gathered by sensors aboard the Shuttle and are instantaneously transmitted from the launch site to the support center. There the information is processed by computers and displayed on screens and other instruments at 12 stations in the Engineering Console Room. More than 3,000 temperature, pressure, electrical voltage and other measurements are made every second. During the 10 hours of peak activity before and during launch, more than 11 million measurements are assessed by teams of experts.

In addition to monitoring this data, support center personnel view the Shuttle on the launch pad via two closed circuit television lines. They also have access to more than 50 direct communications lines that link them with the launch site at Kennedy Space Center, Mission Control Center at Johnson Space Center, and with responsible contractor plants.

OSTA-1 PAYLOAD

The OSTA-1 payload developed by NASA's Office of Space and Terrestrial Applications is the first science and applications payload scheduled by the Space Transportation System and will provide an early demonstration of the Space Shuttle's research capabilities.

During the second Shuttle flight, STS-2, the Orbiter Columbia will assume an Earth-viewing attitude called Z-axis local vertical in which the instruments carried in the payload bay will be aimed at the Earth's surface. The OSTA-1 experiments concern remote sensing of land resources, environmental quality, ocean conditions, meteorological phenomena and life sciences. Five of the experiments will be located on a Spacelab pallet in the payload bay. Two will be carried in the crew compartment.

The experiments mounted in the payload bay include the Shuttle Imaging Radar-A (SIR-A), a side-looking synthetic aperture radar which maps terrestrial features; the Shuttle Multispectral Infrared Radiometer (SMIRR) which will test a technique to determine rock types; Feature Identification and Location Experiment (FILE) which will help develop techniques to make data gathering by Earth resources satellites more efficient; Measurement of Air Pollution from Satellites (MAPS), an experiment to measure the amount of carbon monoxide in the middle and upper troposphere (12-18 km or 7.5-11 mi.) and the Ocean Color Experiment (OCE), an instrument to detect differences in ocean color which may indicate concentrations of plankton and schools of fish.

The two experiments carried in the crew compartment include the Heflex Bioengineering Test (HBT), designed to prepare the way for a later Spacelab experiment in micro-gravity plant growth, and the Night/Day Optical Survey of Lightning (NOSL), an instrument for observing and recording lightning discharges from the vantage point of space.

The payload is located on mountings close to the center of the Columbia's payload bay and weighs 2,542 kg (5,347 lb.).

Orbital Flight Test Pallet

The five OSTA-1 experiments being flown in the Orbiter's payload bay are being carried on a special "U"-shaped structure called an orbital flight test pallet. The 3 by 4 m (10 by 13 ft.) aluminum frame and panel structure weighing 1,218 kg (2,685 lb.), is an element of Spacelab, a reusable, modular research facility being developed for the Space Transportation System by the European Space Agency (ESA) in cooperation with NASA. Spacelab will be carried inside the Orbiter's cargo bay on missions set to begin in 1983.

The pallet was originally designed to hold a group of experiments requiring direct exposure to space during a Spacelab mission. It allows many experiment payloads to be prepackaged and checked out as a unit prior to installation in the Orbiter. The experiment equipment is connected to a series of hardpoints on the main (frame) structure of the pallet. Attachment of a pallet to the Orbiter is accomplished through the use of trunnions and keel fittings.

The pallet being carried on STS-2, is an engineering model of the flight version pallet. This engineering unit has been certified for flight and has been adapted for use with special subsystems which provide interfaces between the payload and Orbiter systems. These subsystems were developed by NASA using, for the most part, off-the-shelf hardware.

The pallet's active thermal control subsystem employs coldplates and a pallet-mounted Freon pump to reject heat, generated by the experiments, by sending it through the Orbiter's payload heat exchanger. A power subsystem includes a control box mounted to the pallet to distribute Orbiter electrical power to the payload and provide fused wire protection. The experiment control and data handling subsystem includes a pallet mounted multiplexer/demultiplexer which provides for control of the payload from the Orbiter and for the return of data from the experiments.

The Spacelab Program Office at Marshall Space Flight Center, Huntsville, Ala., is responsible for design, development and integration of the overall orbital flight test pallet system.

The pallet is built by the British Aerospace Corp. under contract to ERNO (Zentral Gesellschaft VFW-Fokker mbh) and ESA.

Shuttle Imaging Radar-A (SIR-A)

The Shuttle Imaging Radar-A antenna is the most prominent portion of the OSTA-1 payload. It will send and receive microwave radiation to create maplike images of the Earth's surface. Similar radar systems have uncovered ancient Mayan canals and have flown on an ocean-surveying satellite (Seasat) to study ice flows and ocean wave patterns. This application to Earth land resource study in delineating faults and other geological formations may aid in locating oil and other mineral deposits.

Because radar uses its own energy source rather than relying on reflected energy from another point such as the Sun, it is independent of day/night cycles in recording images. It also can penetrate cloud cover and vegetation, giving an accurate picture of the Earth's surface, even under a tropical rain forest.

The imaging radar will be operated over selected targets primarily in the United States. The instrument will be turned on by an automatic sequencer, but may be overridden by commands from the ground.

A radar image 50 km (31 mi.) wide will be recorded along the Shuttle's ground track. During its planned operating time of eight hours, the instrument will take data covering a total 10 million square km, or about the size of the United States. The system has a resolution of 40 m (131 ft.).

The imaging radar antenna is 9.35 m (31 ft.) long, 2.16 m (7 ft.) wide, and 15 cm (5.9 in.) thick and weighs 181 kg (399 lb.). It is formed by seven epoxy fiberglass panels supported by an aluminum truss structure mounted to the pallet so that the viewing angle is 47 degrees from nadir.

Electronics for the radar are coupled to coldplates and mounted on the pallet. The electronics module measures 1.5 m (4.9 ft.) long by 1 m (3.2 ft.) wide by 25 cm (9.8 in.) deep. It weighs 136 kg (300 lb.). Included in the module are a transmitter, receiver, calibrator and control computer.

The transmitter generates a frequency modulated rf pulse. The pulse repetition frequency can be changed to accommodate a varying range, preventing the instrument from transmitting while signals are being received. The receiver contains a variable gain amplifier to control sensitivity to the return signal and a video amplifier to maintain a relatively constant amplitude in the signal output to the optical recorder.

The calibrator generates a controlled amplitude signal which is fed to the receiver and used to measure the intensity of the echo.

The computer controls all operating modes for the radar.

The radar's optical recorder is a spare from the Apollo program modified to increase its film capacity from two to eight hours. The optical recorder is mounted on the experiment shelf and measures 60 by 60 by 50 cm (24 by 24 by 20 in.) and weighs 68 kg (150 lb.). After the data film is returned it is processed to produce a two-dimensional image.

Radar images collected by the instrument will be compared with other data, particularly Landsat images, to develop geologic information for locating hydrocarbon and mineral deposits.

Principal investigator is Charles Elachi, Jet Propulsion Laboratory, Pasadena, Calif.

Co-investigators are Walter E. Brown, Jet Propulsion Laboratory; Louis Dellwig, University of Kansas; Anthony W. England, Johnson Space Center; Max Guy, Centre National Etudes Spatiales, France; Harold MacDonald, University of Arkansas; R. Stephen Saunders, Jet Propulsion Laboratory; and Gerald Schaber, U.S. Geological Survey at Flagstaff, Ariz.

Shuttle Multispectral Infrared Radiometer (SMIRR)

The Shuttle Multispectral Infrared Radiometer complements the imaging radar instrument by working to determine the best spectral bands to use in remote sensing of rock types. That information, taken together with the delineation of geographical features provided by the radar, could help develop a global map of mineral indicators. The spectral bands investigated by the infrared radiometer could be incorporated into such remote sensing spacecraft.

The instrument will evaluate 10 bands in the 0.5 to 2.5 u m range. Data will be correlated with field spectrometer data to determine whether the data gathered on the ground is sufficient for determining the best spectral bands to use in geological mapping from spacecraft.

The instrument will operate during daytime passes over land areas when cloud coverage is less than 30 percent. It will not be operated within 10 minutes of a Shuttle water dump or fuel cell purge because the optics are sensitive to moisture and contamination. A data taking cycle may last from two to 20 minutes with a data recording capacity of six hours.

The infrared radiometer equipment consists of a telescope, a filter wheel, two detectors, two film cameras and related electronics. The entire unit weighs 99 kg (218 lb.) and measures 56 by 94 by 117 cm (22 by 37 by 46 in.). The telescope is a modified version of the Mariner instrument that gathered images of Venus and Mercury in 1973. Calibration lamps are mounted inside the telescope barrel. An opaque cover rotates over the top of the telescope to protect the instrument when the experiment is not in operation.

A filter wheel with 15 evenly spaced positions rotates at 100 revolutions per second. Every third opening is opaque to provide a zero based for the detector electronics. The other 10 positions contain filters to sample the spectral bands of interest.

Two mercury-cadmium-telluride detectors convert photons to electrons which comprise the transmission signal. The detector assembly is mounted to a thermoelectric cooler to maintain a temperature of minus 81 degrees Celsius.

The 16mm cameras correlate the data with the ground view over which it will be taken. One camera is black and white, the other color. Both will be triggered each 1.28 second cycle, half a cycle or 0.64 second apart.

The electronics assembly amplifies the detector signal, integrates the signal over the time an individual filter is in the optical path, and converts the signal from analog to digital form for recording on the payload recorder.

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The timing and control electronics coordinate the filter wheel, the detector readout and the cameras.

Principal investigator is Alexander F. H. Goetz, Jet Propulsion Laboratory, Pasadena, Calif.

Co-investigator is Lawrence C. Rowan, U.S. Geological Survey at Reston, Va.

Feature Identification and Location Experiment (FILE)

The Feature Identification and Location Experiment is designed to help develop equipment which will make remote sensing instruments such as Shuttle Imaging Radar-A and Shuttle Multispectral Infrared Radiometer more efficient by activating them only when conditions are right for taking data.

Using the ratio between visual red reflectance and near infrared reflectance, this experiment will attempt to characterize scenes as either vegetation, water, snow or clouds, or bare ground. It will suppress further data collection in a certain category after it has acquired a given number of scenes.

The long-term goal, extending over several Shuttle flights, is to develop landmark tracking technology that will meet the needs of future Earth resources and global monitoring missions. These needs include the automatic acquisition of specific landmarks or generic surface features such as coniferous or deciduous forests, the location of those surface features without precise knowledge of spacecraft position, and the suppression of data acquisition when the scientific objectives are not in view or when cloud cover is excessive.

Once the Shuttle assumes its Earth-viewing attitude, the feature identification instrument will be turned on and operate thereafter at the direction of its Sun sensor.

The experiment's system consists of a sunrise sensor, two television cameras, a decision-making electronics unit, a buffer memory, a tape recorder and a 70mm camera.

The sunrise sensor will activate the experiment when the Sun is 60 degrees from the Space Shuttle's zenith (30 degrees above the horizon).

One of the two television cameras is equiped with an optical filter for visual red; the other with a filter for the near infrared. The output of these cameras is sent to the decision-making electronics unit, where the ratio of the television camera measurements for each picture element (pixel) is determined. The experiment will contain scene class counters to determine when the instrument has recorded an adequate number of scenes of a certain type and suppress further data acquisition from such scenes.

The buffer memory accepts the high-speed output of the decision-making electronics unit and sends it to the tape recorder at the lower speed it can accept.

The digitized video signal and the classification data will be recorded on a Lockheed Mark V tape recorder.

The Hasselblad 70mm camera will take a color photograph for each frame of the television data.

Principal investigator is Roger T. Schappell, Martin Marietta, Denver, Colo.

Co-investigators are John C. Tietz, Martin Marietta; and W. Eugene Sivertson and R. Gale Wilson, both of NASA Langley Research Center, Hampton, Va.

Measurement of Air Pollution From Satellites (MAPS)

The Measurement of Air Pollution from Satellites experiment will measure the distribution of carbon monoxide in the middle and upper troposphere (that part of the atmosphere from the Earth's surface to an altitude of between 12 and 18 km -- 7.5 to 11 mi.). The experiment will evaluate the performance under varying conditions of techniques which may be used in later spacecraft to monitor air pollution.

The experiment consists of an electro-optical head, an electronics module, a digital tape recorder and an aerial camera. The package measures 90 by 76 by 58 cm (35 by 30 by 23 in.) and weighs 80 kg (176 lb.). The equipment is attached to a coldplate and mounted to the pallet.

The electro-optical head contains two gas cells, one with carbon monoxide at a pressure of 266 torr, the other with carbon monoxide at 76 torr; their corresponding detectors; a direct radiation detector; an external balance and gain check system; and an internal balance system.

The electronics module consists of the signal processors, the balance system controls and the circuits needed to operate the system.

The Lockheed Mark V digital tape recorder operates at 50 bits per second.

The aerial camera is equipped with a light sensor and will photograph the ground track during sunlight.

The core of the experiment's instrument is a gas filter correlation radiometer. Thermal radiation passes through the atmosphere into the viewport of the downlooking instrument. The carbon monoxide in the air produces unique absorption lines in the transmitted energy.

A beam of the incident radiation passes through the high pressure carbon monoxide gas cell and onto a detector. The cell acts as a filter for the effects of carbon monoxide present at low altitudes.

A second beam falls directly onto a detector without passing through any gas filter. The voltage difference between the signals from these two detectors can be used to determine the amount of carbon monoxide present in the atmosphere at an altitude of 7 to 8 km (4.3 to 4.9 mi.).

A third beam passes through the low pressure carbon monoxide gas cell and onto a detector. The low pressure cell filters out the effects of carbon monoxide present at high atmospheric levels. The difference from this signal's voltage and that from the direct detector provides a measurement of carbon monoxide concentration at an altitude of 10 to 12 km (6 to 7.5 mi.).

The instrument is powered on after the Shuttle assumes the -Z local vertical attitude and, after a 30-minute warm-up, takes data throughout the Earth-viewing orientation.

Principal investigator is Henry Reichle Jr., NASA Langley Research Center.

Co-investigators are William L. Chameides, Georgia Institute of Technology; W. Donald Hesketh, Langley Research Center; Claus B. Ludwig, Photon Research, Inc.; Reginald E. Newell, Massachusetts Institute of Technology; Leonard K. Peters, University of Kentucky; Wolfgang Seiler, Max Planck Institute for Chemistry at Mainz; John W. Swinnerton, U.S. Naval Research Laboratory; and H. Andrew Wallio, Langley Research Center.

Ocean Color Experiment (OCE)

The Ocean Color Experiment is designed to test equipment which will distinguish high concentrations of algae in the ocean from the other obscuring reflections, such as high sediment concentration and the sea floor. By detecting the green color of chlorophyll, the dominant pigment in this basis of the ocean food chain, satellites can help locate schools of fish or point out pollution areas.

To avoid the reflective interference encountered in coastal waters, the instrument will gather its data in the eastern areas of both the Atlantic and Pacific Oceans. Still, only 10 to 20 percent of the radiation detected will be usable by the instrument in detecting chlorophyll. Most of the light reflected from the ocean surface will be scattered by air molecules and atmospheric aerosols.

About 25 two- to 13-minute ocean flyovers will be recorded on the instruments data tapes, these taken during sunlit passes over two main areas -- the friction area between the Canary Island current and equatorial countercurrent and the upwelling area off the coast of Peru. The experiment also will take data along the eastern coast of the United States in the areas of Cape Cod and Georgia. Surface data will be gathered by ships and low-flying aircraft in these four areas.

The experiment's instrument is a modified version of the U-2 Ocean Color Scanner. It consists of two main modules -- the scanner and the electronics.

The 34-kg (74-lb.) scanner module is a cylinder 75 cm (30 in.) long flattened on one side 27 by 23 cm (11 by 9 in.) mounted on the pallet. The instrument components are mounted on an aluminum plate which is divided into four sections by bulkheads. The first section houses the motors for the scanner mirror and doors and the devices for timing pickup. The second section contains the scanner mirror and is equipped with bomb bay type doors which protect the instrument during ascent and entry. The third section contains the telescope. The fourth section houses the optics and an electronics box.

The electronics module weighs 60 kg (132 lb.) and measures 29 by 71 by 91 cm (11 by 28 by 36 in.). It consists of the signal amplifiers, a digitizer and the data handling system.

The rotating mirror on the experiment instrument scans plus or minus 45 degrees from nadir across the direction of flight and reflects radiations into a telescope. The telescope images the scene through a 1 by 2mm field stop and onto a diffraction grating. The diffraction light (that is, light separated into its component colors) is directed onto a bundle of 24 glass fibers, and a different spectral band is channeled through each glass fiber. The fibers are coupled to eight silicon photodiode detectors.

The signal from the 700 to 800 nanometer channel contains almost none of the information sought by this experiment (subsurface scattering) because the water itself absorbs radiance in this spectral range. The signal is caused mostly by light reflected from the surface and scattered off air molecules. Thus, this signal can be used to calculate the contribution of these noise factors to the radiance received by the other spectral channels. The useful information is contained in the difference between the total radiation registered in each of the other channels and the radiation registered in the 700 to 800 nanometer channel.

The signal from each of the other channels will be examined to determine what color bands were scattered by the ocean contents.

Principal investigator is Hongsuk H. Kim, NASA Goddard Space Flight Center, Greenbelt, Md.

Co-investigators are Lamdin R. Blaine and Robert S. Fraser, both of Goddard Space Flight Center; Norden E. Huang, NASA Wallops Flight Center, Wallops Island, Va.; Heinz van der Piepen, DFVLR (West German Research and Development Institute for Air and Spacecraft).

Night/Day Optical Survey of Lightning (NOSL)

The Night/Day Optical Survey of Lightning is one of two OSTA-1 investigations carried in the crew compartment and it will involve the use of astronauts in observing and recording lightning and thunderstorms.

Many observers of thunderstorms, including astronauts in space, have commented on the unusual nature of some lightning phenomena. The experiment instrument will be used in an attempt to gather quantitative data on these events from the unique vantage point of space.

The crew will use a motion picture camera to film lightning flashes in nighttime thunderstorms. A diffraction grating will be attached to the lens during these observations to provide lightning spectrographs which can be used to determine the temperature, pressure, molecular species, electron density and percent ionization in the lightning's path.

A photo-optical system will be used to record lightning flashes during the daytime passes. The system will generate audio impulses which will be recorded on magnetic tape.

The experiment equipment consists of the camera, the attached photocell sensor and the connected tape recorder. The equipment is stowed in lockers until ready for use on orbit.

The motion picture camera is a 16mm data acquisition camera, a model which has been flight tested on Apollo and Skylab missions. The camera will run on 28 Vdc power supplied by the Shuttle Orbiter.

The photocell sensor is mounted on top of the camera and its field of view is aligned with the camera. The camera/sensor package is 40 by 24 by 20 cm (16 by 9 by 8 in.) high.

The stereo cassette tape recorder is a Sony TC124.

Twenty 43-m (140-ft.) film magazines, three 60-minute tape cassettes and spare batteries will be kept in a stowage apron mounted on the crew cabin wall.

Principal investigator is Bernard Vonnegut of the State University of New York at Albany.

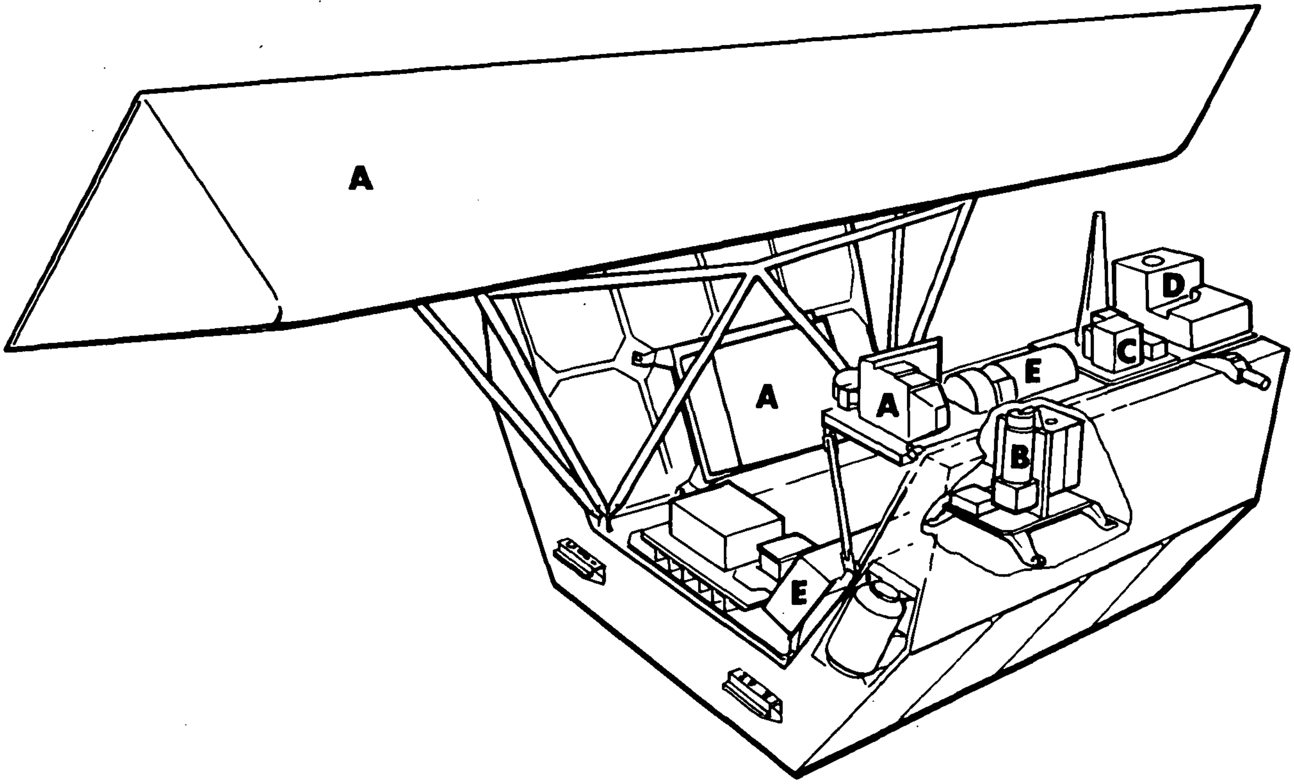
Co-investigators are Otha H. Vaughan Jr., NASA Marshall Space Flight Center, Huntsville, Ala., and Marx Brook, New Mexico Institute of Mining and Technology.

Heflex Bioengineering Test (HBT)

The Heflex Bioengineering Test is not a full-blown experiment, but a preliminary test in support of a later Spacelab experiment in micro-gravity plant growth. The Spacelab Heflex (for Helianthus annus Flight Experiment) depends on dwarf sunflower plants grown to a particular height range. The test flown on STS-2 will investigate the relationship between plant height and initial soil moisture content in a near weightless environment.

Shortly before launch, a suitcase-like container will be loaded aboard Columbia containing 72 sealed plant modules varying in soil moisture content from 58 to 80 percent by weight. The container will be stowed in a locker in the crew compartment and removed unopened as soon as possible after flight for evaluation.

Principal investigator is Allan H. Brown of the University of Pennsylvania.



OSTA-1 Payload

Diagram shows location of experiment components for the OSTA-1 payload. Attached to the U-shaped Spacelab pallet are:

A. Shuttle Imaging Radar-A

B. Shuttle Multispectral Infrared Radiometer

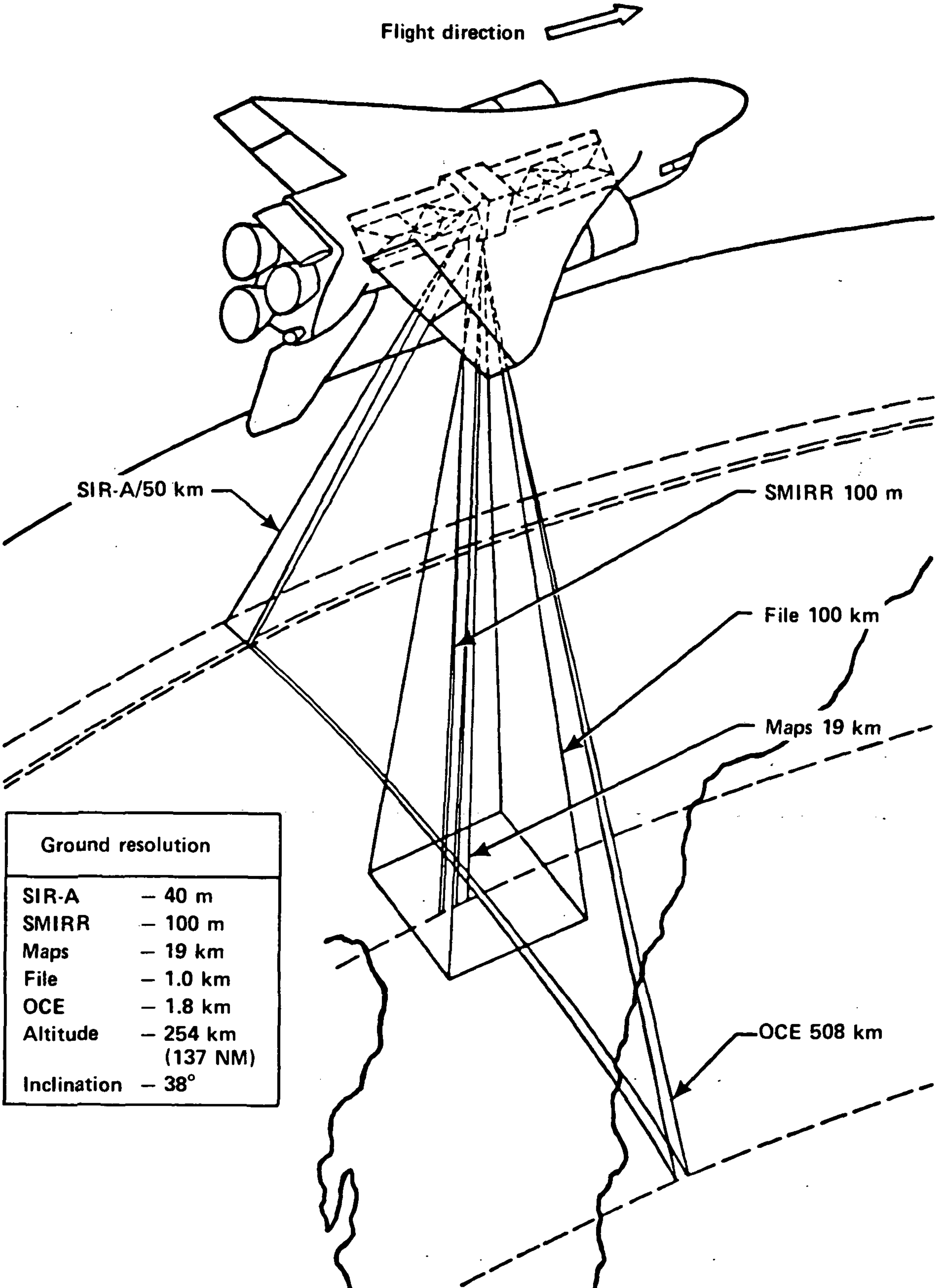
C. Feature Indentification and Location Experiment

D. Measurement of Air Pollution from Satellites

E. Ocean Color Experiment

Two other experiments in the payload -- the Night/Day Optical Survey of Lightning and the Heflex Bioenginering Test -- will be located in the crew compartment.

OSTA-1 PAYLOAD GROUND COVERAGE



Ground resolution	
SIR-A	– 40 m
SMIRR	– 100 m
Maps	– 19 km
File	– 1.0 km
OCE	– 1.8 km
Altitude	– 254 km (137 NM)
Inclination	– 38°

STS-2 ORBITER EXPERIMENTS PROGRAM

A complete and accurate assessment of Shuttle performance during the launch, boost, orbit, atmospheric entry and landing phases of a mission requires precise data collection to document the Shuttle's response to these conditions.

The Office of Aeronautics and Space Technology through its Orbiter Experiments Program, is providing research experiments onboard the Shuttle Orbiter to record specific, research-quality data. The data will verify the accuracy of wind tunnel and other ground-based simulations made prior to flight; verify ground-to-flight extrapolation methods, and verify theoretical computational methods. The data also will be useful to the Office of Space Transportation Systems to further certify Shuttle and expand its operational envelope.

The primary objective of the Orbiter Experiments Program is to increase the technology reservoir for development of future (21st Century) space transportation systems. The following experiments are currently included in the program and are slated to fly on early Shuttle flights.

Aerodynamic Coefficient Identification Package (ACIP)

The primary objectives of the Aerodynamic Coefficient Identification Package are:

- To collect aerodynamic data during the launch, entry and landing phases of the Shuttle;
- To establish an extensive aerodynamic data base for verification of and correlation with ground-based data, including assessments of the uncertainties of such data;
- To provide flight dynamics data in support of other technology areas, such as aerothermal and structural dynamics.

Instruments in this package include dual-range linear accelerometers and rate gyros. Also included are the power conditioner for the gyros, the power control system and the housekeeping components. The package is installed colinearly with the geometric axes of the Orbiter and post-installation measurements made to establish the position within 10 arc minutes. The instruments continuously sense the dynamic X, Y and Z attitudes and performance characteristics of the Orbiter through these critical flight phases. The Aerodynamic Coefficient Identification Package also provides high rate sampling of the positions of Orbiter control surfaces for recording with the package's attitude data.

Principal technologist is D.B. Howes of Johnson Space Center, Houston.

Materials and Structures Research

During the launch and entry phases of Orbiter flight and in certain types of on-orbit operation, the outer skin of the vehicle will be subjected to conditions that increase the surface temperatures to very high values. The thermal protection system has the function of attentuating these temperatures to an acceptable level to protect the primary structure and skin of the Orbiter. This is achieved through the use of three different materials in three different manners.

One material, rigidized silica fibers, is coated with one of two different coating materials to become either high-temperature reusable surface insulation or low-temperature reusable surface insulation.

The second material, Nomex felt, is called flexible reusable surface insulation and is applied as a blanket to the Orbiter skin surfaces that receive lower heating effects. The third material, reinforced carbon-carbon, is used in place of metal structures on the leading edges of the wings and stabilizer and on the nose cone, the surfaces which become hottest during launch and entry.

These three materials and applications are supplemented by additional thermal protection at other locations. For example, gap-filling material is fitted between the tiles; thermal barriers are installed at the perimeters of hatches, doors and other penetrations; and aerothermal seals are installed at the hinge joints of the elevons and body flaps.

The requirements for the thermal protection system specify reusability with a minimum of unscheduled maintenance and the accomplishment of scheduled maintenance within the time allotted for turnaround of the Orbiter.

Meeting these specifications requires extensive knowledge of performance of thermal protection system materials and components. The Tile Gap Heating Effects and the Catalytic Surface Effects experiments will provide this information.

Tile Gap Heating Effects (TGH) Experiment

Analyses and ground tests have shown that the gaps between the tiles of the thermal protection system generate turbulent airflow, which will cause increased heating during the reentry phase of flight. Tests have also shown that the heating effect may be reduced by optimum design of the gaps and by altering the radii at the edges of the tiles. The tile gap experiment was devised to further the investigations of heating phenomena. The results will enable improvements in reusable element thermal protection systems to reduce the convective heating caused by gaps and other discontinuities.

The Orbiter will be instrumented with a removable panel 45.7 cm (18 in.) square, which will carry 11 tiles of baseline material and size. The panel will be fitted to the underside of the Orbiter fuselage. The gaps between tiles will be carefully calculated and controlled during fitting to ensure that the heating rates generated during entry will be no higher than those of the baseline tile array. The aim will be to produce a design that will result in heating rates lower than those of the baseline system.

In addition to gap spacing, the gap depth will also be controlled through the use of fillers fitted at the bottom of certain gaps; i.e., at the junction of the tiles and the Orbiter fuselage skin. The radii at the outer edges of the tiles will be controlled during fabrication to conform to calculations that show the reduced effects in combination with the spacing.

Thermocouples wil be fitted to the tile surfaces and at various depths in the gaps to measure temperatures during reentry. The output of the thermocouples will be recorded on the Orbiter's development flight instrumentation system. To assist in evaluation, Tile Gap Heating Effects data will be compared to development flight instrumentation data obtained from earlier missions.

Principal technologist is F. Centolanzi, Ames Research Center.

Catalytic Surface Effects (CSE) Experiment

A strong shockwave will encompass the Shuttle Orbiter during the atmospheric reentry maneuver. The shock wave severely compresses and heats the air flowing through it, causing the molecules to dissociate and react chemically with each other.

Computations show that as the dissociated atomic oxygen approaches the cooler regions of flow adjacent to the Orbiter, the atomic oxygen fails to recombine into molecular oxygen.

This experiment will investigate the chemical reaction caused by impingement of atomic oxygen on the Shuttle thermal protection system which was designed under the assumption that the atomic oxygen would recombine at the thermal protection system wall. This chemical reaction releases additional heat which results in higher thermal protection system temperatures. In this case, the surface is referred to as being a catalytic surface, that is, it allows the chemical reaction to take place.

If the thermal protection system surface is non-catalytic, then atomic oxygen will not recombine into molecular oxygen and the heating rates will be lowered. Thus, the temperature of the Orbiter during reentry will be lower. With lower temperatures, Orbiter thermal protection system weight could be reduced, its flight envelope could be expanded, or greater reusability could result.

The technology objective is to verify analytical predictions which could not be adequately simulated in ground-based facilities. The results will provide data and improved computational techniques for future thermal protection system designs.

The Catalytic Surface Effects will use two baseline tiles, selected from those having development flight instrumentation thermocouples, located on or near the Orbiter lower fuselage centerline. These tiles will be sprayed with an overcoating mixture of chrome-iron-spinel, a highly efficient catalytic material and a vinyl acetate binder which will protect the overcoat during ground operations. The mixture is compatible with the existing tile and coating and will not alter the thermal or mechanical properties of the uncoated portions of the thermal protection system. During Orbiter ascent, the vinyl acetate will burn off the tile surface, leaving the chrome-iron-spinel exposed.

Thermocouple measurements recorded during reentry will be used to determine Catalytic Surface Effects performance. Comparison of this experiment data with data taken on previous flights from uncoated tiles will aid in the performance evaluation.

At the end of each mission, the overcoat will be removed from the tiles, leaving the thermal protection system in its original condition.

Principal technologist is D. Stewart, Ames Research Center.

Structural Dynamics

Dynamic, Acoustic and Thermal Environment (DATE) Experiment

To fully and economically exploit the benefits of the Orbiter's large cargo-carrying capability, it is necessary to predict payload environments with accuracy and dispatch.

Such predictions will facilitate payload development and reduce the need for ultraconservative design and test. The Dynamic, Acoustic and Thermal Environment experiment will collect information for use in making credible predictions of cargo-bay environments. These environments are neither constant nor consistent throughout the bay and are influenced by interactions between cargo elements. The experiment instrumentation which includes accelerometers, microphones, thermocouples and strain gages have been installed on both the DFI pallet and the OSTA-1 pallet on STS-2. Sensor outputs will be recorded for post-flight interpretation. The Goddard Space Flight Center, Greenbelt, Md., will be responsible for the data reduction.

Principal technologist is W. Bangs, Goddard Space Flight Center.

Induced Environment Contamination Monitor (IECM)

The Induced Environment Contamination Monitor is a desk-sized detector containing 10 instruments for contaminants in and around the Space Shuttle Orbiter cargo bay which might adversely affect delicate experiments being carried aboard.

The monitor, developed by the Marshall Space Flight Center, Huntsville, Ala., is in the Shuttle cargo bay on the second, third and fourth missions. It also will be a part of Spacelab missions one and two. It will operate during pre-launch, ascent, on-orbit, descent and post-landing.

With the monitor instrumentaton, contaminant sources may be identified and eliminated. It will also provide data on the interaction of the induced and natural environments, and will provide critical data for planning of future Shuttle payloads.

Contaminants to be monitored during Shuttle flights include any outgassing from materials within the Shuttle, as well as gases from the reaction jets which control the vehicle in orbit.

The on-orbit measurements include molecular return flux, background spectral intensity, molecular deposition and optical surface effects. During the other mission phases, dew point, humidity, aerosol content and trace gas will be measured, as well as optical surface effects and molecular deposition.

After each Shuttle flight, the monitor will be returned to Marshall for refurbishment. The flight data will be combined with Orbiter data furnished by the Johnson Space Center, Houston, for a comprehensive analysis.

The detector will operate attached to a release mechanism (also developed by Marshall) on the Development Flight Instrumentation pallet during the second Shuttle mission, but on the third and fourth flights it will be moved around and outside the cargo bay by the Orbiter's Remote Manipulator System and then reattached. On Spacelab missions one and two, it will be attached to the Spacelab pallet.

Measurements will be made with 10 separate instruments: a humidity monitor, dew point hygrometer, air sampler, cascade impactor, passive sample array, optical effects module, temperature-controlled quartz crystal microbalance, cryogenic quartz crystal microbalance, camera/photometer and mass spectrometer.

A brief description of the objectives of each of the IECM instruments follows:

Mass Spectrometer -- The Mass Spectrometer has been incorporated into the detector to measure molecular return flux, from which molecular column density may be calculated.

The purpose of the Mass Spectrometer measurement is twofold: to define the offgassing and outgassing molecules transported to surfaces in the Shuttle bay for correlation to actual deposition measurements on optical and temperature-controlled surfaces, and to define the gas cloud (induced atmosphere) through which optical experiments must look.

Camera/Photometer -- Of particular concern to the astronomical community is the effect on astronomical experiments of induced contamination in the form of individual particles and general background. Even a moderate particulate generation rate by the Shuttle would severely limit the performance of an infrared telescope.

To make optical measurements of both the induced particulate environment and the background brightness, two automated camera/photometers have been placed aboard the detector unit.

Cryogenic Quartz Crystal Microbalance -- The objective of the Cryogenic Quartz Crystal Microbalance is to provide a record of the adsorption and desorption of molecular contamination in the Shuttle cargo bay. On specific Shuttle missions when the cargo bay is oriented so that it does not receive direct solar heating for long periods of time, the instrument will have the special objective of measuring molecular water vapor.

Temperature-Controlled Quartz Crystal Microbalance -- The Temperature-Controlled Quartz Crystal Microbalance is designed to detect the adsorption or desorption of molecular contamination in the Shuttle cargo bay as a function of temperature. The contamination sources will be characterized as a function of direction and events. Contamination will also be grouped into categories according to desorption activation energies.

Optical Effects Module -- The Optical Effects Module is designed to provide the Shuttle cargo bay user community information applicable to assessing the contamination hazards likely to be encountered by optical components of space-borne instrumentation.

The optical degradation of some typical window materials will be measured and monitored during pre-launch, orbital and post-landing phases. Optical property changes due to deposition of particulates and molecular films will be discriminantly measured utilizing an integrated scattered light measurement in conjunction with direct, self-calibrating transmission measurements.

Passive Sample Array -- An array of optical samples will be exposed to the natural and induced environments of the Shuttle cargo bay for later return and analysis on the ground to evaluate the optical effects of contamination. Inclusion of the Passive Sample Array permits the greater scope and range of analysis required to more fully assess the physical mechanisms of degradation due to deposited contaminants.

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The samples are measured in the laboratory prior to experiment integration. Control samples are included in these measurements and are then stored in a controlled, "clean" environment. Following retrieval of samples, whether during pre-flight activities or after the flight, the measurements are repeated and the analysis is based on any encountered changes.

Cascade Impactor -- The Cascade Impactor provides a determination of concentration and particle size distribution, as a function of time, of air-suspended contaminants in the spacecraft environment during ground-based, ascent, descent and post-landing phases.

In addition to the cascade stages, the impactor measures the amount of airborne nonvolatile residue for molecules with sufficiently high sticking coefficient at the temperature encountered.

Air Sampler -- The objective of the Air Sampler is to determine the gaseous contaminants in the cargo bay area of the Shuttle during orbital missions. Basically, the requirements can be categorized into three groups: ground-based; ascent; and descent sampling phases.

During the ground-based sampling, the presence of organic and silicone polymers (such as hydraulic fluids and lubricants) is of most concern. During ascent, the primary interest is in hydrochloric acid from the solid rocket booster plume as well as hydrocarbons and silicones. During descent, the gaseous sources of greatest concern are expected to be nitrogen compounds resulting from reentry effects on the adhesives for the thermal protective system; hydrocarbons and silicones can also be sampled during descent.

Dew Point Hygrometer -- The Dew Point Hygrometer will measure the dew point of the air surrounding the monitor. The measurements will be made prior to launch and as long as the vehicle is within the Earth's atmosphere, including ascent, reentry and landing.

Humidity Monitor -- Humidity measurements will be made while the vehicle is the Earth's atmosphere to produce a humidity/temperature profile of the environment within the cargo bay. The Humidity Monitor will measure the relative humidity from 0 to 70 degrees Celsius (32 to 158 degrees Fahrenheit). The temperature measurement (0 to 100 C or. 32 to 212 F) will be made by a thermistor located within the humidity sensor mounting.

ORBITER'S ROBOT "ARM"

(Remote Manipulator System)

Columbia has been fitted with a Canadian-built remote manipulator system for initial testing during STS-2. Part of the payload deployment and retrieval system, the mechanical arm will be used in operational flights to deploy satellites and other payloads or to grapple payloads for stowing in the payload bay and subsequent return to Earth.

Designed as an analog to the human arm, the manipulator system has shoulder, elbow and wrist joints driven by DC electric motors controlled by the flight crew using a combination of direct visual observation and television cameras on the elbow and wrist joints. The arm may be operated in five different modes ranging from full manual to computer-controlled through hand controls and keyboard at the payload station on the flight deck.

The manipulator system is installed on the left payload bay longeron for STS-2. A second one can be installed on the right longeron for specific payload tasks, although both arms could not be operated simultaneously.

The arm, built of a light-weight carbon composite tubing 38 cm (15 in.) in diameter, is 15.3 m (50.25 ft.) long, and weighs 408 kg (900 lb.). A thermal blanket provides temperature control for protecting joint-drive mechanisms and electronics. Brushless electric motors and gear trains drive the joints for pitch up/down, yaw left/right and wrist roll motions. The "hand," called an end effector, has snare wires that engage a grapple fixture on the payload.

Television cameras at the wrist and elbow provide the operator visual cues for maneuvering the end effector toward a grapple fixture or other target. Operator hand controllers are similar to those used for spacecraft maneuvers -- a rotational hand controller for roll, pitch and yaw motions, and translational hand controller for up/down, left/right and fore/aft motions. When deactivated, the arm is latched into three cradle pedestals along the left longeron. If the drive mechanisms jam and the arm cannot be moved to its stowed position, and if contingency spacewalks are unsuccessful in restowing, the arm can be amputated with a pyrotechnic device.

The five arm operating modes are as follows:

- Automatic -- Operators select autosequence loaded into general purpose computer software which then moves arm through sequence; or, operator enters desired position coordinates into computer with keyboard at operator's station.

- Manual Augmented -- Operator drives arm end effector with hand controllers without controlling individual joint motions.

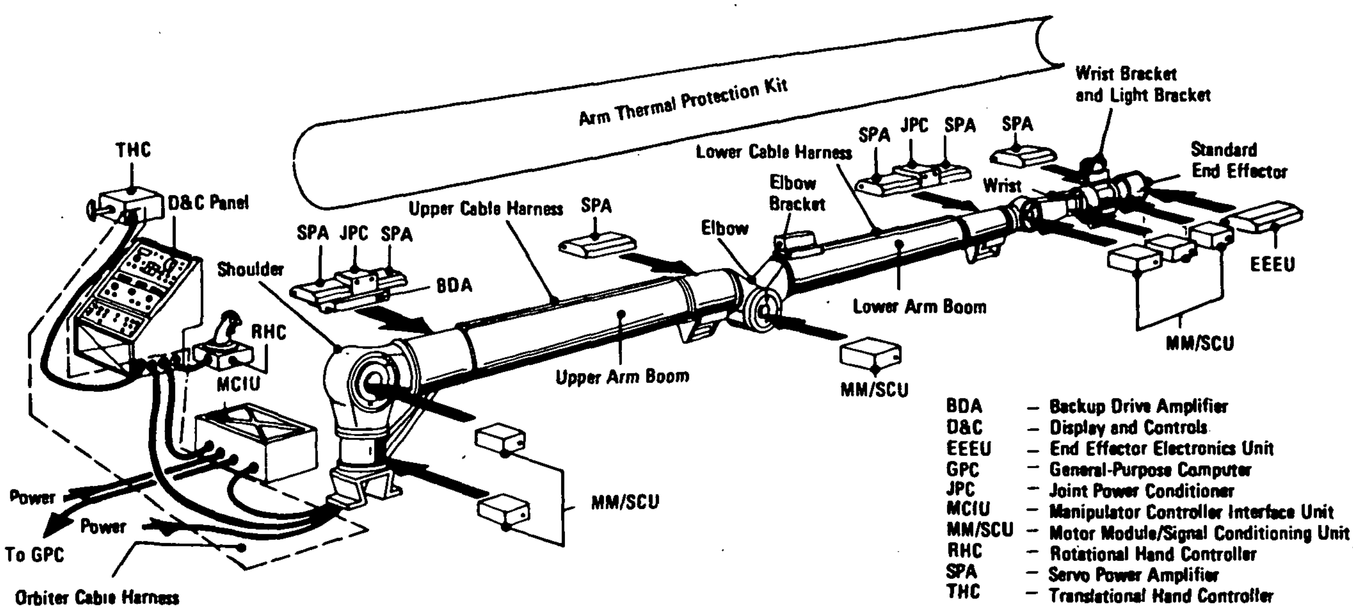
- Manual Single Joint Drive -- Operator drives arm through control panel switches o a joint-by-joint basis.

- Direct Drive -- Operator controls motion through hardwired command from control panel that bypass the general purpose computer.

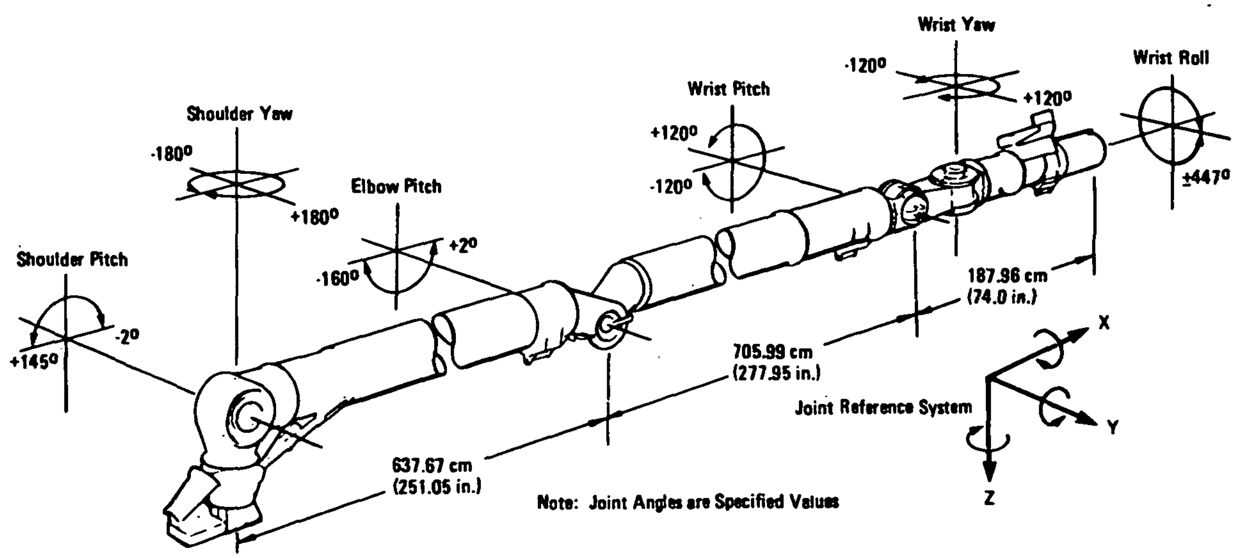
- Backup Drive Control -- Essentially same as direct drive, only commands pass through backup electronics and wiring.

The arm was developed and built under a cooperative agreement between NASA and the National Research Council of Canada. Spar Aerospace Limited is system prime contractor. Canada has absorbed the costs of research and development of the first arm installed aboard Columbia.

REMOTE MANIPULATOR SYSTEM



RMS Components



Mechanical Arm-Stowed Position and Movement Configuration

TRACKING AND DATA NETWORK

One of the key elements in the Shuttle mission is the capability to track the spacecraft, communicate with the astronauts and to obtain the telemetry data that informs ground controllers on the condition of the spacecraft and its astronauts. The heart of this complex network is located at Goddard Space Flight Center in Greenbelt, Md., just outside Washington, D.C., where the Spaceflight Tracking and Data Network and the NASA Communications Network is located.

With the exception of very brief periods during the launch and recovery of STS-2, Goddard serves as the heartbeat of the mission, receiving all telemetry, radar and air-to-ground communications and relaying that information to the Johnson Space Center in Houston and to other NASA and Department of Defense facilities participating in the mission. Most video (TV) transmission facilities used during the mission are provided by and monitored for quality by Goddard personnel.

Spaceflight Tracking and Data Network

The Spaceflight Tracking and Data Network is a highly complex NASA worldwide system that provides reliable, realtime communications with the Space Shuttle Orbiter and crew. The network is maintained and operated by the Goddard Space Flight Center.

The network for the Orbital Flight Test Program consists of 18 ground stations equipped with 4.3, 9, 12 and 26 m (14, 30, 40 and 85 ft.) S-band antenna systems and C-band radar systems, augmented by 15 Department of Defense geographical locations providing C-band support and one Department of Defense 18.3-m (60-ft.) S-band antenna system. In addition, there are six major computing interfaces located at the Goddard Center; Network Operations Control Center; Western Space and Missile Center, Calif.; Air Force Satellite Control Facility, Colo.; White Sands Missile Range, N.M.; and Eastern Space and Missile Center, Fla., providing realtime network computational support.

The network has support agreements with the governments of Australia, Spain, Senegal, Botswana, Ecuador, Chile, United Kingdom and Bermuda to provide NASA tracking stations support to the Space Transportation System program.

In the Spaceflight Tracking and Data Network Operations Control Center at Goddard, the network director and a team of operations managers and network systems specialists, keep the entire network tuned for the mission support. Should the Johnson Space Center Mission Control Center be seriously impaired for an extended time, facilities serving the Network Operations Control Center become an emergency mission control center manned by Johnson personnel, with the responsibility of safely returning the Space Shuttle Orbiter to a landing field.

The Merritt Island, Fla., S-band station provides the appropriate data to the Launch Control Center at the Kennedy Space Center and the Mission Control Center at Johnson during prelaunch testing and the terminal countdown. During the first minutes of launch and during the ascent phase, the Merritt Island and Ponce de Leon, Fla., S-band and Bermuda S-band stations, as well as the C-band stations located at Bermuda; Wallops Island, Va.; Grand Bahama; Grand Turk; Antigua; Cape Canaveral; and Patrick Air Force Base, Fla., will provide appropriate tracking data, both high speed and low speed, to the Kennedy and Johnson Control Centers.

The Madrid, Spain; Indian Ocean Station Seychelles; Orroral and Yarragdee, Australia; and Guam stations provide critical support to the Orbital Maneuvering System 1 and 2 burns on the first revolution. During the orbital phase all the S-band and C-band stations that see the Space Shuttle Orbiter at 30 degrees above the horizon will support and provide appropriate tracking, telemetry, air-ground and command support to the Johnson Mission Control Center through Goddard.

During the nominal reentry and landing phase planned for Edwards Air Force Base, Calif.; the Goldstone and Buckhorn, Calif.; S-band stations and C-band stations at the Pacific Missile Test Center, Vandenberg Air Force Base, Edwards Air Force Base and Dryden Flight Research Center will provide highly critical tracking, telemetry, command and air-ground support to the Orbiter and send appropriate data to the Johnson and Kennedy Control Centers.

NASA Communications Network

The tracking network is linked together by the NASA Communications Network. All information flows to and from the Johnson Mission Control Center and the Orbiter Columbia over this communications system.

The communications network consists of more than two million circuit miles of diversely routed communications channels. It uses domestic and international communications satellites, submarine cable and terrestrial landlines and microwave radio systems to interconnect the myriad of tracking stations, launch and orbital control centers, and other supporting locations.

The hub of the communications network is the main switching center at Goddard Space Flight Center. From Goddard, NASCOM personnel direct overall network operation including those at supporting communications network switching centers in Madrid, Spain; Canberra, Australia; and Jet Propulsion Laboratory, Pasadena, Calif. Additionally, communications network support activities are provided by Air Force communications centers at Cape Canaveral, Fla., and Vandenberg Air Force Base.

Since its support of the Apollo Soyuz Test Project in July 1975, the communications network has been significantly enhanced and changed to ready it for Space Shuttle support. A key change has been implementation of two simultaneous air/ground S-band voice circuits in addition to UHF radio capability. In all previous Apollo missions only one S-band circuit was provided. Telemetry data circuitry from tracking stations was increased in size to handle 128,000 bits per second (128 Kbps) in realtime versus the 14-21 Kbps in previous programs. Correspondingly, the command data circuit to a station was increased from 7.2 Kbps to a 56 Kbps capability.

To accommodate the increase in data quantity, the communications network realtime data switching system at Goddard was enhanced to deal with the higher data rates.

During previous manned program support, use of communications satellites was limited to those connecting the United States with foreign locations (Intelsat system). Since then, domestic communications satellites have become available and have been fully exploited so they now play a key role in extending voice, data and television signals from key locations and stations in the United States. Additionally, they provide for extending data between Goddard and foreign locations as well as between Goddard and Johnson. Their availability, in fact, has allowed for the implementation and operation of the complex voice, data and television network assembled for Space Shuttle support.

Much of the communications network developed for Space Shuttle support has been exercised during normal support of the worldwide Spaceflight Tracking and Data Network as well as during extensive testing in preparation for the Space Shuttle missions.

Network Systems Support

At fraction-of-a-second intervals, the network's data processing systems, with Johnson's Mission Control Center as the focal point, "talk" to each other or to the spacecraft. High-speed computers at the remote site relay commands at a 56 kilobit data rate on such matters as control of cabin pressure, orbital guidance commands or "go-no-go" indications to perform certain functions. In addition, they provide digital voice uplink and downlink from the stations to the Orbiter Columbia.

The command and air-ground voice is mixed together at the remote station and uplinked to the Orbiter at a 72 or 32 kilobit rate.

Such "uplink" information is communicated at a rate of about 4,800 bits per second. Communication between remote ground sites, via high-speed communications links, occurs at the same rate on a 56 kilobit line. Houston reads information, two channels at a time, from these ground sites at 1,544,000 bits per second.

The computer systems perform many other functions, including:

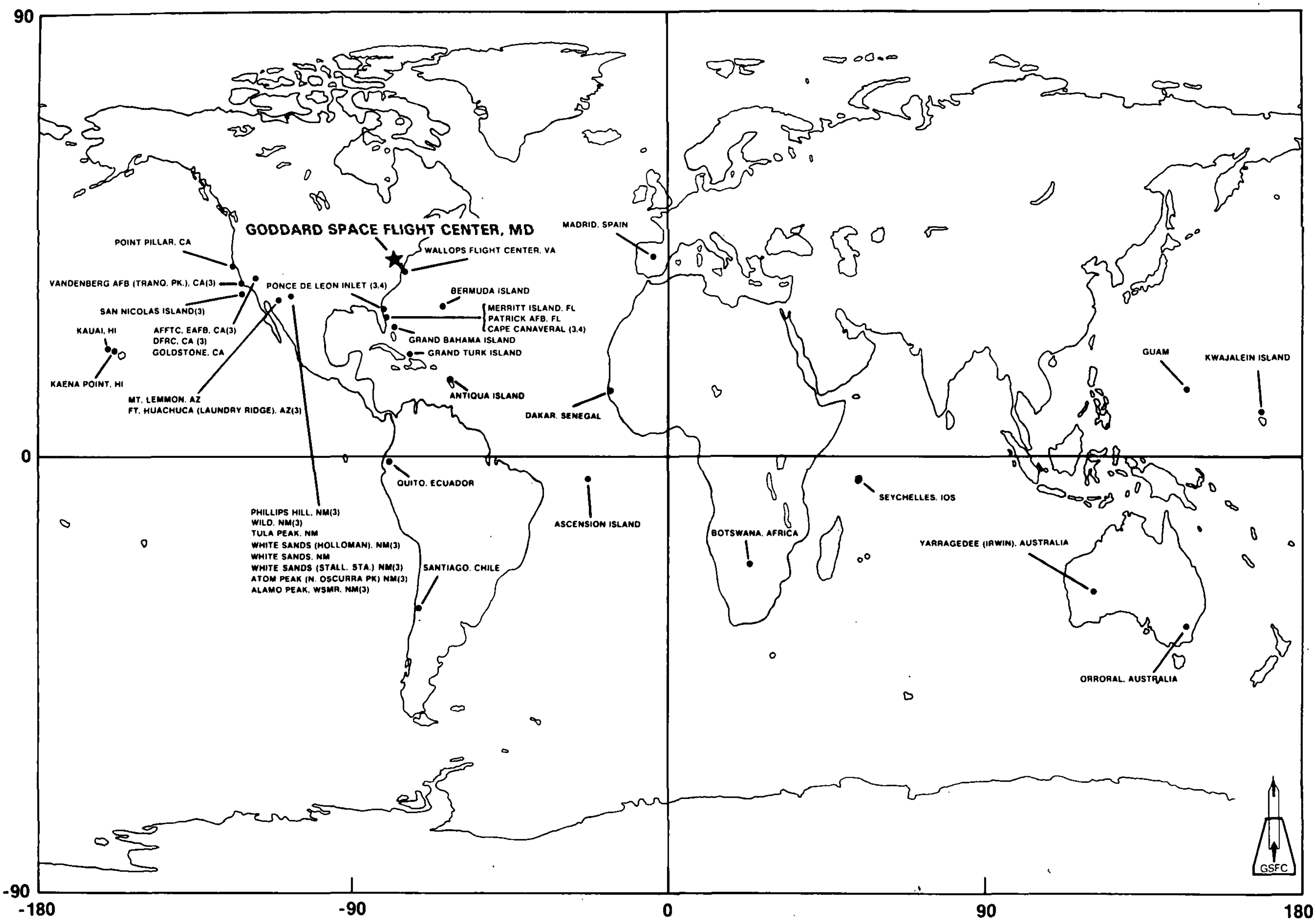
- Assuring the quality of the transmission lines by continually exercising data paths;
- Verifying accuracy of the messages; and
- Constantly updating the flight status.

For downlink data, sensors built into the spacecraft continually sample cabin temperature, pressure and physical information on the astronauts such as heartbeat and respiration. These data are transmitted to the ground stations at 96, 128 or 192 kilobits.

At Mission Control Center, the computers:

- Detect and select changes or deviations, compare with their stored programs, and indicate the problem areas or pertinent data to the flight controllers;
- Provide displays to mission personnel;
- Assemble output data in proper formats; and
- Log data on magnetic tape for reply for the flight controllers.

Realtime orbital television will be received by the Merritt Island, Fla.; Madrid, Spain; Kauai, Hawaii; and Goldstone, Calif.; S-band stations and transmitted to the Johnson Mission Control Center, via Goddard.



SPACEFLIGHT TRACKING AND DATA NETWORK (STDN)

STS-2 TELEVISION SCHEDULE

Elapsed Time Day/Hours:Minutes	Subject
00/01:35 - 01:42	Payload bay camera view of payload bay door tests and checkout.
00/07:42 - 07:56	Cabin and payload bay cameras show activation of OSTA-1 payload.
00/09:18 - 09:21	Night/Day Optical Survey of Lightning. (NOSL) setup and demonstration from cabin camera.
00/23:50 - 23:58 01/00:07 - 00:13	Deployment of the remote manipulator arm.
01/02:52 - 03:07	Operation of remote manipulator arm.
03/19:01 - 19:08	Teleprinter message removal.
04/02:28 - 02:44	Meal preparation on middeck.
04/05:37 - 05:51	EVA/airlock operation demonstration.
04/21:44 - 21:53	Cycling of aerosurfaces shown by payload bay camera.

SHUTTLE STANDARD OFT MENU

Day 1*, 5	Day 2, 6	Day 3, 7	Day 4
Meal A			
Peaches (T)	Applesauce (T)	Dried Peaches (IM)	Dried Apricots (IM)
Beef Pattie (R)	Dried Beef (NF)	Sausage (R)	Breakfast Roll (I)(NF)
Scrambled Eggs (R)	Granola (R)	Scrambled Eggs (R)	Granola w/Blueberries (R)
Bran Flakes (R)	Breakfast Roll (I)(NF)	Cornflakes (R)	Vanilla Inst. Breakfast (B)
Cocoa (B)	Choc. Inst. Brkfst. (B)	Cocoa (B)	Grapefruit Drk. (B)
Orange Drink (B)	Orange-Grapefruit Drink (B)	Orange-Pineapple Drink (B)	
Meal B			
Frankfurters (T)	Corned Beef (T)(I)	Ham (T)	Ground Beef w/ Pickle Sauce (T)
Turkey Tetrazzini (R)	Asparagus (R)	Cheese Spread (T)	Noodles & Chicken (R)
Bread (2X) (I)(NF)	Bread (2X) (I)(NF)	Bread (2X) (I)(NF)	Stewed Tomatoes (T)
Bananas (FD)	Pears (T)	Gr.Beans & Broccoli (R)	Pears (FD)
Almond Crunch Bar (NF)	Peanuts (NF)	Crushed Pineapple (T)	Almonds (NF)
Apple Drink (2X) (B)	Lemonade (2X) (B)	Shortbread Cookies (NF)	
	Cashews (NF)	Strawberry Drink (B)	
	Tea w/Lemon & Sugar (2X) (B)		
Meal C			
Shrimp Cocktail (R)	Beef w/BBQ Sauce (T)	Cr. Mushroom Soup (R)	Tuna (T)
Beef Steak (T)(I)	Cauliflower w/Cheese (R)	Smoked Turkey (T)(IM)	Macaroni & Cheese (R)
Rice Pilaf (R)	Gr.Beans w/Mushrooms (R)	Mixed Italian Veg. (R)	Peas w/Butter Sauce (R)
Broccoli au Gratin (R)	Lemon Pudding (T)	Vanilla Pudding (T)	Peach Ambrosia (R)
Fruit Cocktail (T)	Pecan Cookies (NF)	Strawberries (R)	Chocolate Pudding (T)
Butterscotch Pud. (T)	Cocoa (B)	Tropical Punch (B)	Lemonade (B)
Grape Drink (B)			

NOTE: *Day 1 (launch day) consists of Meal B and C only.

Abbreviations

T - Thermostabilized
IM - Intermediate Moisture
R - Rehydratable
B - Beverage (Rehydratable)
I - Irradiated
FD - Freeze Dried
NF - Natural Form
X - Serving

CREW BIOGRAPHIES

NAME: Joe Henry Engle (Colonel, USAF) - STS-2 Commander

BIRTHPLACE AND DATE: Born Aug. 26, 1932, Abilene, Kans.; Home - Chapman, Kans.

PHYSICAL DESCRIPTION: Blond hair; hazel eyes; height: 6 feet; weight: 160 pounds.

EDUCATION: Attended primary and secondary schools in Chapman and is a graduate of Dickinson County High School; received a bachelor of science degree in aeronautical engineering from the University of Kansas in 1955.

MARITAL STATUS: Married to the former Mary Catherine Lawrence of Mission Hills, Kans.

CHILDREN: Laurie J., April 25, 1959; Jon L., May 9, 1962.

RECREATIONAL INTERESTS: His hobbies include flying (including World War II fighter aircraft), big game hunting, back-packing and athletics.

ORGANIZATIONS: Member of the Society of Experimental Test Pilots.

SPECIAL HONORS: For flight testing of the NASA-USAF X-15 research rocket airplane, he received the:

- USAF Astronaut Wings (1964)
- USAF Distinguished Flying Cross (1964)
- AFA* Outstanding Young USAF Officer of 1964
- U.S. Junior Chamber of Commerce -- one of the Ten Outstanding Young Men in America (1964)
- AIAA* Lawrence Sperry Award for Flight Research (1966)
- AIAA* Pioneer of Flight Award (1965)

For flight testing of the Space Shuttle Enterprise during the Approach and Landing Test (ALT) program in 1977, he received:

- USAF Distinguished Flying Cross (1978)
- SETP* Iven C. Kincheloe Award for Flight Test (1977)
- NASA Exceptional Service Medal
- NASA Special Achievement Award
- AFA* David C. Schilling Award for Flight
- AIAA* Haley Space Flight Award for 1980
- AAS* Flight Achievement Award
- Soaring Society of America - Certificate of Achievement

* AFA - Air Force Association
AIAA - American Institute of Aeronautics and Astronautics
SETP - Society of Experimental Test Pilots
AAS - American Astronautical Society

EXPERIENCE: Engle was a test pilot in the X-15 research program at Edwards Air Force Base, Calif., from June 1963 until his assignment to the Lyndon B. Johnson Space Center. Three of his 16 flights in the X-15 exceeded an altitude of 50 miles (the altitude that qualifies a pilot for astronaut rating). Prior to that time, he was a test pilot in the Fighter Test Group at Edwards.

He received his commission in the Air Force through the AFROTC program at the University of Kansas and entered flying school in 1957. He served with the 47th Fighter Day Squadron and the 309th Tactical Fighter Squadron at George Air Force Base, Calif. He is a graduate of the USAF Experimental Test Pilot School and the Air Force Aerospace Research Pilot School.

He has flown over 135 different types of aircraft during his career (25 different fighters), logging more than 10,000 hours flight time -- 6,800 in jet aircraft.

NASA EXPERIENCE: Col. Engle is one of the 19 astronauts selected by NASA in April 1966. He was backup lunar module pilot for the Apollo 14 mission.

He was commander of one of the two crews who flew the Space Shuttle Approach and Landing Test flights from June through October 1977. In this series of flight tests, he and crewmate Richard H. Truly evaluated the Orbiter handling qualities and landing characteristics. They also obtained the stability and control and performance data in the subsonic flight envelope for the Space Shuttle. Engle and Truly flew the first flight of the Space Shuttle in the orbital configuration (i.e., with the tail cone removed).

Engle was the backup commander for STS-1, the first Shuttle orbital test flight.

NAME: Richard H. Truly (Captain, USN) - STS-2 Pilot

BIRTHPLACE AND DATE: Born in Fayette, Miss., on Nov. 12, 1937. He is the son of James B. Truly of Forest, Miss.

PHYSICAL DESCRIPTION: Brown hair; brown eyes; height: 5 ft., 8 in.; weight: 150 lb.

EDUCATION: Attended schools in Fayette and Meridian, Miss.; received a bachelor of aeronautical engineering degree from Georgia Institute of Technology in 1959.

MARITAL STATUS: Married to the former Colleen Hanner of Milledgeville, Ga. Her mother, Mrs. Daniel M. Hanner, resides in Rutledge, Ga.

CHILDREN: Richard Michael, May 10, 1961; Daniel Bennett, Aug. 9, 1963; Lee Margaret, Sept. 8, 1969.

RECREATIONAL INTERESTS: He enjoys general outdoor sports and is a stamp collector.

SPECIAL HONORS: Presented two NASA Exceptional Service Medals (1973 and 1978); the Johnson Space Center Superior Achievement Award (1972) and Special Achievement Award (1978; the Soaring Society of America's Certificate of Achievement Award (1978); the SETP's Iven C. Kincheloe Award (1978); the Air Force Association's David C. Schilling Award (1978); the American Astronautical Society's Flight Achievement Award for 1977; the Navy Distinguished Flying Cross (1979); the American Institute of Aeronautics and Astronautics Haley Space Award for 1980.

EXPERIENCE: Truly received his commission through the Naval Reserve Officer Training Corps (NROTC) program at Georgia Tech.

He completed naval flight training in 1960 at Beeville, Texas, and was assigned to Fighter Squadron 33 from 1960 to 1963. During this period, he served aboard the USS INTREPID (CVS 11) and the USS ENTERPRISE (CVA(N)65) and has made more than 300 carrier landings. He was a member of Class 64A at the USAF Aerospace Research Pilot School, Edwards Air Force Base, Calif., and was subsequently assigned there as an instructor upon graduation.

From November 1965 to September 1969, he was assigned to the USAF Manned Orbiting Laboratory Program on astronaut status.

With over 6,000 hours in jet aircraft, he has acquired proficiency in the F-8, F-9, F-11, F-101, F-104 and F-106.

NASA EXPERIENCE: Capt. Truly became a NASA astronaut in September 1969. He was a member of the astronaut support crew and a capsule communicator for all three of the Skylab missions and the Apollo Soyuz Test Project.

Truly and Joe H. Engle were one of the two two-man crews who flew Space Shuttle Approach and Landing Test flights during the period June through October 1977. This series of critical Orbiter flight tests involved initially Boeing 747/ Orbiter captive-active flights, followed by air-launched, unpowered glide, approach and landing tests (free flights). There were three captive tests with the Orbiter Enterprise carried atop the Boeing 747 carrier aircraft allowing inflight test and checkout of Orbiter systems, and five free flights which permitted extensive evaluations of the Orbiter's subsonic flying qualities and performance characteristics during separation, up and away flight, flare, landing and rollout -- providing valuable real time data duplicating the last few minutes of an operational Shuttle mission. Truly and Engle flew the second and fourth free flights, with Free Flight 4 being the first flight in the orbital configuration (with the tailcone removed).

He was backup pilot for STS-1, the first orbital flight test of the Shuttle.

SPACE SHUTTLE PROGRAM MANAGEMENT

NASA Headquarters

James M. Beggs	Administrator
Dr. Hans Mark	Deputy Administrator
L. Michael Weeks	Acting Associate Administrator for Space Transportation Systems
David R. Braunstein	Deputy Associate Administrator for Space Transportation Systems (Management)
Daniel M. Germany	Director, Orbiter Programs
Walter F. Dankoff	Director, Engine Programs
Edward P. Andrews	Director, Ground Systems and Flight Test
LeRoy E. Day	Director, Systems Engineering and Integration
Frank Van Rensselear	Director, Upper Stage
Jerry J. Fitts	Director, Solid Rocket Booster and External Tank

Johnson Space Center

Christopher C. Kraft Jr.	Director
Clifford E. Charlesworth	Deputy Director
Glynn S. Lunney	Manager, Space Shuttle Program
Donald K. "Deke" Slayton	Manager, Orbital Flight Test
Aaron Cohen	Manager, Space Shuttle Orbiter Project Office
George W. S. Abbey	Director of Flight Operations
Maxime A. Faget	Director of Engineering and Development
Lynwood C. Dunseith	Director of Data Systems and Analysis

Kennedy Space Center

Richard G. Smith	Director
Dr. Robert H. Gray	Manager, Shuttle Projects Office
John J. Neilon	Manager, Cargo Projects
George F. Page	Director, Shuttle Operations
Thomas S. Walton	Manager, Cargo Operations

Marshall Space Flight Center

Dr. William R. Lucas	Director
Thomas J. Lee	Deputy Director
Robert E. Lindstrom	Manager, MSFC Shuttle Projects Office
James E. Kingsbury	Director, Science and Engineering Directorate
James B. Odom	Manager, External Tank Project
George B. Hardy	Manager, Solid Rocket Booster Project
James R. Thompson Jr.	Manager, Space Shuttle Main Engine Project
James M. Sisson	Manager, Engineering and Major Test Management Office

Dryden Flight Research Center

Isaac T. Gillam IV	Director
Robert F. Johannes	Deputy Director
John A. Manke	Chief of Flight Operations
Mel Burke	Shuttle Project Manager

Goddard Space Flight Center

A. Thomas Young	Director
Dr. John H. McElroy	Deputy Director
Richard S. Sade	Director of Networks Directorate Space Tracking and Data Network
Walter LaFleur	Deputy Director of Networks Directorate (STDN)
William B. Dickinson	Division Chief, NASA Communications Network
Donald D. Wilson	Assistant Chief, NASA Communications Network
Daniel Spintman	Chief, Network Operations Division
James M. Stevens	Shuttle Network Support Manager

ABBREVIATIONS/ACRONYMS

AA	Accelerometer Assembly, Angular Accelerometer
A/A	Air-to-Air
ACCEL	Accelerometer
ACCU	Audio Center Control Unit
ACIP	Aerodynamic Coefficients Identification Package
ACN	Ascension Island (STDN site)
ADI	Attitude Directional Indicator
AGO	Santiago, Chile (STDN site)
ANG	Angle
ANT	Antenna
AOA	Abort Once Around
AOS	Acquisition of Signal
APU	Auxiliary Power Unit
ATO	Abort to Orbit
AUD	Audio
AUTO	Automatic
BDA	Bermuda Island (STDN site)
BOT	Botswana (STDN site)
BRT	Bright
BUC	Buckhorn, Calif. (STDN site)
CAL	Calibration
CAMR	Camera
CCTV	Close Circuit Television
CCU	Crewman Communications Umbilical
CDR	Commander
CNSL	Console

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CNTLR	Controller
C/O	Checkout
COAS	Crewman Optical Alignment Sight
CONT	Continuous
CRT	Cathode Ray Tube
CTR	Center
C/W	Caution and Warning
DAP	Digital Auto Pilot
DB	Deadband
DFI	Development Flight Instrumentation
DISC	Discrete
DKR	Dakar, Senegal (STDN site)
DTO	Detailed Test Objective
ECLS	Environmental Control Life Support
EDW	Edwards AFB, Calif. (Deorb OPT site)
EES	Emergency Ejection Suits
EET	Entry Elapsed Time
EI	Entry/Interface
ET	External Tank
FCS	Flight Control System
FDF	Flight Data File
FM	Frequency Modulation
FRD	Flight Requirements Document
FSO	Functional Supplementary Objective
FTO	Functional Test Objective
GDS	Goldstone, Calif. (STDN site, 1st antenna)
GDX	Goldstone, Calif. (STDN site, 2nd antenna)

GLRSHLD	Glareshield
GMT	Greenwich Mean Time
GNC	Guidance Navigation and Control
GPC	General Purpose Computer
GWM	Guam Island, U.S. (STDN site)
H2	Hawaii (Kauai, STDN site)
HIC	Hickam AFB, Hawaii (Deorb OPT site)
HTR	Heater
IECM	Induced Environmental Contamination Monitor
IMU	Inertial Measurement Unit
INRTL	Inertial
IOS	Indian Ocean (STDN site)
ITS	Interim Teleprinter System
KAD	Kadena AB, Ryuku Islands (Deorb OPT site)
KSC	Kennedy Space Center, Fla. (Deorb OPT site)
L	Left
LH2	Liquid Hydrogen
LON	Longitude
LOS	Loss of Signal
LOX	Liquid Oxygen
LTG	Lighting
LVLH	Local Vertical Local Horizontal
MAD	Madrid, Spain (STDN site, 1st antenna)
MAN	Manual
MAX	Madrid, Spain (STDN site, 2nd antenna)
MECO	Main Engine Cutoff
MET	Mission Elapsed Time

MIL	Merritt Island, Fla. (STDN site, 1st antenna)
MLX	Merritt Island, Fla. (STDN site, 2nd antenna)
MNVR	Maneuver
NOR	Northrup FLT Strip, N.M. (Deorb OPT site)
NOZ	Nozzle
O2	Oxygen
OFI	Operational Flight Instrumentation
OI	Operational Instrumentation
OMS	Orbital Maneuvering System
OPR	Operator
OPS	Operations, Operational Sequence
ORB	Orbiter
ORR	Orroral Valley, Australia (STDN site)
OVHD	Overhead
PA	Power Amplifier
PCM	Pulse-Code Modulation
PL	Payload
PLBD	Payload Bay Doors
PLT	Pilot
PM	Phase Modulation
PMC	Private Medical Communication
PNL	Panel
POS	Position
PRO	Proceed
PTC	Passive Thermal Control
PWR	Power
QTY	Quantity

QUI	Quito, Ecuador (STDN site)
R	Right
RCDR	Recorder
RCS	Reaction Control System
REF	Reference
REFSMMAT	Reference Stable Member Matrix
RELMAT	Relative Matrix
RGA	Rate Gyro Assembly
ROS	Regulated Oxygen System
ROT	Rota, Spain (Deorb OPT site), Rotation
RT	Rotation Discrete Rate
SAA	South Atlantic Anomaly
SEL	Select
SEP	Separation
SGLS	Space Ground Link System
SPKR	Speaker
SPLY	Supply
STBY	Standby
SV	State Vector
SYS	Systems
TB	Talkback
TDRS	Tracking and Data Relay Satellite
TK	Tank
T/L	Timeline
TRKR	Tracker
TUL	Tula Peak, N.M. (STDN site)
TV	Television

UHF	Ultra High Frequency
VAC	Vacuum
VLV	Valve
VTR	Video Tape Recorder
WCS	Waste Collection System
WIN	Irwin, Australia (STDN site)
WMC	Waste Management Compartment
XFER	Transfer
X-POP	X Body Axis Perpendicular to Orbit Plane
Y-POP	Y Body Axis Perpendicular to Orbit Plane
-ZLV	-Z Local Vertical (-Z Body Axis Towards Earth)

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