MISSION STATUS BULLETIN

VOYAGER

December 6, 1978

No. 27

Mission Highlights

A flurry of activity in early December will conclude the flight team's test and training period, and will be followed by a 2-week period of low activity on-board the spacecraft to give flight team members a break before Encounter Operations begin in earnest with the Observatory phase on January 4, 1979.

Most of the activity will center around the encountering spacecraft, Voyager 1, while the cruising spacecraft, Voyager 2, will continue its routine calibrations and housekeeping chores.

Near Encounter Test

Highlight of the spacecraft activities in Voyager 1's final month of the Earth-to-Jupiter cruise phase will be the Near Encounter Test on December 12 through 14. This will be a thorough preview of the 39-hour period on March 3 through 5, 1979, when Voyager 1 will make its closest approach to the giant planet Jupiter.

The Near Encounter Test will put the spacecraft, tracking stations, and flight team through their paces in a scenario as near the real thing as possible. Instrument pointing will be restricted during the test, however, as many of the instruments must not point within 20 degrees of the Sun. During closest approach in March, the Sun will be blocked from the instruments' views by the planet and satellites, but during the December test precautions will be taken to protect the instruments.

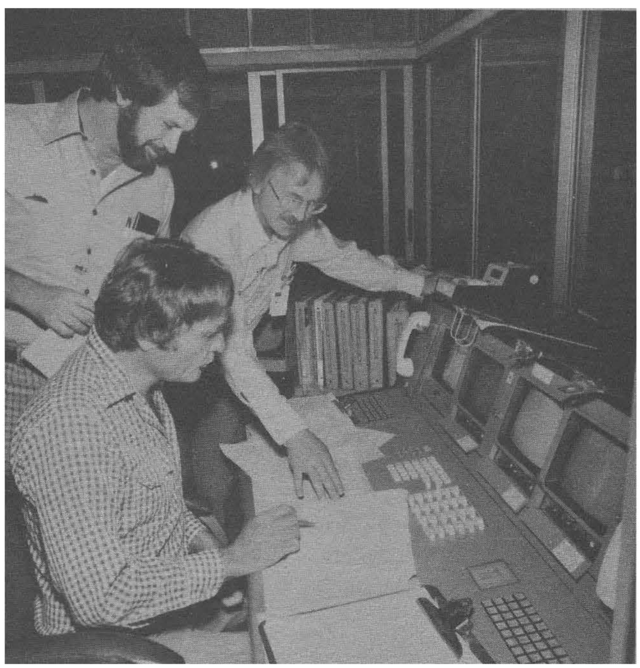
Assessment of the Near Encounter Test performance should be completed by January 5.

Test and Training

The Voyager Project acquired a new spacecraft in November, but this one is a phantom and all of its activities are simulated, since it is used for test and training. No data from this spacecraft ever appears on a controller's display, but detailed timelines of its activity are always within reach, and its data conditions are passed by voice or slips of paper.

Why the elaborate "game"? The problems of the phantom spacecraft stimulate utilization of recovery procedures and the tactics of applying resources to problem solving. Anomalies of all sorts are simulated: antennas begin to drift off point, high winds suddenly force the stowing of simulated stations imperiling critical data playback, key personnel become mysteriously incapacitated. All of this could happen for real, at any time of day or night, and so the flight team is geared to cope with any contingency. Nothing must go wrong during the critical encounter period in March.

The three key encounter sequences to be transmitted to and executed by Voyager 1 in early March have been tested under real pressures and real schedules, while the two cruising spacecraft have provided practice in real data analysis. And although a fine line is followed between impacting on-going operations and the requirement to train for Encounter, one never knows when the emergency could be real. . .



AFTER A PHANTOM – Keeping track of simulated spacecraft events during test and training are (seated) Wayne Henry, lead mission controller, and (standing, from left) Gerry Stillwell, deputy mission control team chief, and Rod Zieger, mission control team chief.

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Readiness Reviews

Prior to the Near Encounter Test, a series of readiness reviews will be conducted to assess preparations for Jupiter Encounter.

On December 5, the ground data system (GDS) will be reviewed, with reports on the tracking stations, computing facilities, data lines, and procedures. Also on December 5, the imaging review will assess the status of the imaging system and the plans for imaging during the Encounter phases.

The Encounter Operations Readiness Review will be held on December 7, with reports on the readiness of the flight team, the Deep Space Network, the mission control and computing center, and the public affairs office.

Finally, on December 11, the final cruise-phase meeting of the Science Steering Group will brief the scientists on Voyager 1's Jupiter Encounter preparations status and the science investigators will report on the status of their respective instruments aboard the craft.

Imaging

Voyager 1 is expected to return Jupiter images this month which will exceed the resolution of all previous Earth-based photographs of the giant planet. Beginning December 10, a 20-hour "movie" of the planet will be taken, with shuttering of the cameras every hour. This period will cover two rotations of the planet, and will provide 3-color coverage of the planet every 36 degrees of Jovian rotation. The movie to be taken in late January will involve shuttering the cameras every 96 seconds and will provide 3-color coverage of the planet every 3 degrees of the planet's rotation.

	Distance from Earth	Distance to Jupiter	One-Way Light Time	Heliocentric Velocity
VOYAGER 1:	618 million km (384 million mi)	90 million km (56 million mi)	34 min 24 sec	50,706 kph (31,500 mph)
VOYAGER 2:	574 million km (357 million mi)	154 million km (96 million mi)	31 min 49 sec	46,090 kph (28,639 mph)

The Voyager Spacecraft

(This is the ninth in a planned series of brief explanatory notes on the spacecraft and its subsystems.)

Part 9 — Radio Science

The same radio system that provides tracking and communications with Voyager will be used to explore the planetary systems and interplanetary space.

Measurements of Voyager's radio communication waves will provide information on the gravitational fields and atmospheres of the planets and their satellites, the rings of Saturn, the solar corona, and general relativity.

Science Objectives

Changes in the frequency, phase, delay, intensity, and polarization of the radio signals between Earth and the spacecraft provide a wealth of information about the space between the two and about the forces that affect the craft and alter its path.

For example, the gravity fields of the planets and satellites will pull on the spacecraft, altering its velocity and thus changing the radio frequency. The mass density of the satellites and the internal structures of the planets can then be calculated from the observed effects on the spacecraft.

When the spacecraft moves behind a celestial body, as viewed from Earth (called occultation), the radio waves coming from the spacecraft will pass through the atmosphere and ionosphere of that body on their way toward Earth. Changes in the signal characteristics during these periods will give information about the vertical structure of the atmosphere, ionosphere, clouds, turbulence, and possibly, weather.

As Voyager 1's microwave signals pass through the rings of Saturn in 1980, the nature of the rings will be investigated. Rock particles would affect the signal differently than would water or ammonia ices. Various sizes of particles will also be evident and scattering of the radio waves will provide a measure of the total amount of material (and of what sizes) in the rings.

Occultation measurements will be made at Jupiter, Saturn and its rings, the Saturnian satellite Titan, and possibly Uranus (by Voyager 2 in 1986).

Voyager 1's radio waves will pass by Jupiter's equatorial region, while Voyager 2's rays will pass near the south polar region. As the radio signals pass through the planet's atmosphere, profiles of the relative temperature and pressure of the gases at various distances from the surface will be compiled. This and other data can be used to determine the amounts of the various elements in the atmosphere as compared to each other (the abundance ratios).

Except for the first months of their journeys, the two spacecraft appear close together in the sky as seen from Earth by the Deep Space Network's antennas. When the Earth moves to the opposite side of the Sun from the spacecraft (superior conjunction), as will happen several times during the mission, it will be possible to see changes in the radio signals as they pass near the solar corona regions on their way to Earth. In the fall of 1979, a unique alignment of Earth, the Sun, and the Voyager, Pioneer, and Helios spacecraft will allow an intensive study of the Sun's properties because the ray paths from each spacecraft will probe a different region of the solar corona, making possible nearly simultaneous measurements.

Instrumentation

Voyager's radio equipment includes several improvements over previous planetary missions, both for engineering and scientific purposes. These include coherent, high-power 3.5- and 13-centimeter wavelength amplifiers, increased antenna size [the 3.66-meter (12-foot) diameter antenna dish is the largest of its type ever flown], an ultra-stable oscillator, improved phase and group delay stabilities in the spacecraft transponder, and an attitude control thruster design which reduces spacecraft accelerations along the Earth-spacecraft line-of-sight.

The radio science instrumentation uses a new on-board stabilized frequency reference, known as the ultra-stable oscillator (USO). Compared to previous spacecraft radio systems, the USO makes Voyager less sensitive to thermal and electrical changes, as well as to radiation effects. The USO is designed to give maximum frequency stability for periods from 1 second to 10 minutes.

Investigators

V.R. Eshleman of Stanford University (California) is the radio science team leader. Team members include G.L. Tyler (Stanford), T.A. Croft (Stanford Research Institute, Menlo Park, California), and J.D. Anderson, G.F. Lindal, G.S. Levy, and G.E. Wood (JPL).