Pioneer Venus Mission Support

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This article reports on activities within the Deep Space Network (DSN) to prepare for the Pioneer Venus Multiprobe Venusian Encounter.

I. Mission Description

The Pioneer Venus Multiprobe Mission is designed to investigate the Venusian atmosphere down to the lowest scale height above the surface (probe survival after impact is not a mission requirement). The mission consists of a Large Probe, three Small Probes and the Bus. The Bus is the mother spacecraft that carried and supported the probes from launch until probe separation.

The four probes are individual spacecraft and transmit their data directly to Earth. The Large Probe carries seven scientific instruments, a radio receiver for two-way doppler tracking only, and transmits data at 256 or 128 bits per second. The Small Probes are identical. Each carries three scientific instruments and transmits data at 64 or 16 bits per second. Their reference frequency for one-way doppler tracking is provided by stable oscillators. Each probe will begin transmission about 22 minutes prior to entering the atmosphere.

II. DSN Entry Support

The DSN will meet one of its greatest challenges on December 9, 1978. In a brief 2 hours, the 64-meter Deep Space Stations (DSS) at Goldstone, California (DSS 14) and Canberra, Australia (DSS 43) must acquire and collect data in real time from four probes that have never been acquired in flight. After the probes reach the surface, DSSs 14 and 43 must support the Bus entry along with any surviving probes. The Bus will be supported by two 26-meter DSSs during the probe descent phase.

III. DSN Implementation at DSSs 14 and 43 for Multiprobe Entry

The following special implementation was required for the Pioneer Venus Multiprobe entry:

(1) Spectral Signal Indicators (SSI):

Three special spectrum indicators (SSI) with microprocessor controls were designed and installed to rapidly identify the probe signals and provide accurate frequencies to acquire lock on the DSN closed loop receivers. The SSI is the key to performing the mission.

(2) Multiprobe Simulator:

The simulator was required for mission test and training. It generates the four Probe's S-band signals, and

simulates the entry doppler profile and telemetry bit rate changes in accordance with the mission timeline.

(3) Open Loop Receivers (OLR)

Two OLRs were added making a total of four 300-kHz bandwidth OLRs. They are the signal input to the SSI and provide predetected signals to the analog recorders for telemetry data recovery.

(4) Venus Wind Experiment Receiver/Recorder:

A special 2-mHz open loop receiver and a 12-megabit-per-second digital recording assembly that simultaneously records the signals from the four Probes and Bus plus two calibration tones were installed to support measurement of the Venus winds using long baseline interferometry techniques.

(5) A fifth closed loop receiver (RCVR 7) and subcarrier demodulator assembly (SDA 7), and three Programmable Oscillator Control Assemblies (POCA) were also installed.

(6) The telemetry processor software was modified to accommodate dual-channel convolutional decoding in a single computer. This added the capability of processing the four Probe data streams simultaneously.

IV. Entry Procedure Development

Entry procedures were developed by the Pioneer Network Operations Project Engineer (NOPE) and three DSS shift supervisors who will support the actual entry event. With a preliminary version of the procedure complete, the authors went to DSS 14 and performed the sequence using the procedure with regular station personnel. After three days of testing and rewriting, the procedures were ready for use in training tests. One major discovery was that station operations during the entry event required a crew complement of 16 to 17 operators as compared to a normal crew complement of 5 to 7 operators. It was decided that entry would be supported by combining two crews plus additional personnel from other crews.

V. Unique Entry Support Features

A. Mission Control

The probe entry phase, by its very nature, precludes any project direction. The DSS must therefore support this phase on their own.

B. Dual Uplinks to the Large Probe

To maximize the probability of acquiring postentry two-way lock with the Large Probe in a minimum amount of time, both DSS 14 and 43 will simultaneously transmit to the probe. The real-time doppler data will be utilized to determine which DSS has captured the probe receiver.

VI. Entry Sequence of Events

In Table 1, the uncertainties in probe event times are (1) ±22 seconds for preentry events, and (2) ±60 seconds for entry and postentry events.

Table 1. Time order of the major entry events

	Time (GMT)	DSS	Event
1.	1530		Large Probe receiver on.
2.	1600	14	Antenna on point-Bus in view.
3.	1618	14	Perform Large Probe uplink acquisition.
4.	1730	43	Venus rise.
5.	1748	14/43	Perform minus 60-min checklist.
6.	1825	14/43	Start prime analog (PPR) and digital (DRA) recorders. Put doppler data to line.
7.	182613		Large Probe carrier on.
		14	Acquire on SSI, lock receiver 3 (2-way doppler).
		43	Acquire on SSI, lock receiver 3 (3-way doppler).
8.	1830	14/43	Start backup PPR and DRA recorders.
9.	183113		Small Probe 2 carrier on.
		14/43	Acquire on SSI, lock receiver 2.
10.	183113	14/43	Large Probe subcarrier on; lock telemetry.
11.	183401		Small Probe 3 carrier on.
		14/43	Acquire on SSI, lock receiver 7
12.	183613	14/43	Small Probe 2 subcarrier on; lock telemetry.
13.	183708		Small Probe 1 carrier on.
		14/43	Acquire on SSI, lock receiver 1
14.	183901	14/43	Small Probe 3 subcarrier on; lock telemetry
15.	184013	43	Reconfigure for Large Probe bit rate change.
16.	184313	43	Large Probe bit rate change; lock telemetry.
17.	1845	43	Transmitter on-start Large Probe postentry uplink sweep.
18.	1846	14	Start Large Probe postentry uplink sweep.
19.	184813	14/43	Large Probe entry; receiver 3 out of lock.
20.	184825	14/43	Acquire on SSI, lock receiver 3 (1-way doppler).
21.	184830	14/43	Large Probe bit rate change; lock telemetry.
22.	1851	14/43	Receiver 3 out of lock; acquire on SSI, lock receiver 3 (2-way doppler).
23.	185130	TRK	Inform DSS of correct doppler mode; 3-way DSS turns off transmitter.
24.	185313	14/43	Small Probe 2 entry; receiver 2 out of lock.
25.	185326	14/43	Acquire on SSI, lock receiver 2.
26.	185601	14/43	Small Probe 3 entry; receiver 7 out of lock.
27.	185614	14/43	Acquire on SSI, lock receiver 7.
28.	185918	14/43	Small Probe 1 entry; receiver 1 out of lock.
29.	185931	14/43	Acquire on SSI, lock receiver 1.
30.	190413	14/43	Large Probe parachute jettison. Possible receiver 3 out of lock due to doppler shift.
31.	1906	43	Reconfigure for Small Probe 2 bit rate change.
32.	1909	43	Reconfigure for Small Probe 3 bit rate change.
33.	190913	14/43	Small Probe 2 bit rate change; lock telemetry.
34.	1912	43	Reconfigure for Small Probe 1 bit rate change.
35.	191201	14/43	Small Probe 3 bit rate change; lock telemetry.
36.	191518	14/43	Small Probe 1 bit rate change; lock telemetry.
37.	1925	14/43	Prime PPR tape change.
38.	1930	14/43	Backup PPR tape change.
39.	1943	14/43	Large Probe impact.
40.	1945	14/43	Prime DRA tape change.
41.	1948	14	Reconfigure receiver 3 for Bus; lock telemetry.
42.	1949	14/43	Small Probe 2 impact.
43.	1950	14/43	Backup DRA tape change.
44.	1953	14	Bus bit rate change; lock telemetry.
45.	1953	14/43	Small Probe 3 impact.
46.	1954	43	Reconfigure receiver 2 for Bus – lock telemetry.
47.	1955	14/43	Small Probe 1 impact.
48.	2024	14/43	Bus entry.
49.	2025	14/43	Prime PPR tape change.
50.	2028	14/43	Bus burns up; loss of signal.