DSN Research and Technology Support

E. B. Jackson and A. L. Price
R. F. Systems Development Section

The activities of the Development Support Group in operating and maintaining the Venus Station (DSS 13) and the Microwave Test Facility are discussed and summarized and progress noted during the period February 16 through April 15, 1975. Major activities include testing of hardware/software for a planned "automated station" demonstration, observation of rotational constancy of various pulsars, antenna gain standardization measurements, Block IV Receiver/Exciter testing at DSS 14, differential very long baseline interferometry (VLBI) observations, and further electromagnetic compatibility testing with the proposed Goldstone Operations Support Radar. Routine clock synchronization transmissions as well as clock synchronization system preparation for Viking and Radio Science Support activities are also discussed.

During the two-month period ending April 15, 1975, the Development Support Group, in operating the Venus Station (DSS 13) and the Microwave Test Facility (MTF), made progress on various programs as discussed below.

I. Station Automation

An automated station will be demonstrated by performing a pulsar track at DSS 13 under remote computer control. In support of this demonstration, the Development Support Group provided 24-1/2 hours of testing. The software and hardware for use at DSS 13 are complete and functioning; the first demonstration awaits the completion of the remote (JPL in Pasadena) computer software. As part of the testing done for this program, pulsar data are being recorded onto magnetic tape for later review.

II. Pulsar Observations

In support of Pulsar Rotation Constancy (OSS-188-41-52-09), we provided 45 hours of pulsar observations, during which we recorded data on the pulsars tabulated in Table 1. These recorded data, from observations made at 2388 MHz, left-circular polarization (LCP), are used to determine precise pulse-to-pulse spacing, pulse shape, and pulse power content.

III. NAR Reliability Testing

Using the 26-m antenna, the station receiver, and the noise-adding radiometer (NAR), data are automatically collected at night and during weekend hours when the station is unmanned. The antenna is fixed in position, and recordings are made of total system temperature. Inasmuch as Earth's rotation causes the antenna to sweep a segment of the sky, data are collected on background temperature as well as radio sources which pass through the beam. During this period, data were collected for a total of 356-1/4 hours, at either 180- or 0-deg azimuth and at elevations of 81.9 through 82.4 deg, in 0.1-deg increments; some data were collected at 80-deg elevation. Data are measured at a frequency of 2295 MHz, right-circular polarization (RCP).

IV. Antenna Gain Standardization

To provide transfer gain standards, observations are made at DSS 13 to determine the received flux density of some calibration radio sources. During this period, measurements at 2278.5 MHz, RCP, of Cygnus A, 3C123, and Cassiopeia A were made using the 26-m antenna, the station receiver, and the NAR. Measurements were made for a total of 21-3/4 hours with the NAR providing a semi-automated data taking cycle inasmuch as it has control of antenna offsets as well as taking and recording the data.

V. Solar Energy Instrumentation

No additional sensors have been added to the Solar Energy Instrumentation Data Acquisition System (SEIDAS) (Ref. 1), but data are being collected and recorded onto magnetic tape, chart recordings, and printed paper tape. However, difficulty has been experienced with the magnetic tape data collection system, and assistance from the system supplier (Instrumentation Technology Company) has been necessary.

VI. Microwave Power Transmission

The collimation tower has been strengthened by replacing the tower side braces with stronger diagonals, and the "rectenna" mounting frame has been installed on the collimation tower. Final electrical work, which includes the installation of the dc load box, monitoring cabling, and the sub-array load lights (36 of them) is underway, pointing toward a final system test and demonstration in May–June of 1975. The rectennas have arrived on site, along with the dc load box, and the operational desk/console for installation into the operating area.

VII. X-Band Radar

The buffer amplifier was delivered by the contractor and testing is underway. Fabrication of final system elements (combiner control printed circuit cards, power supplies, bracketry, etc.) is underway, pointing toward a system test with all "transferable" equipment in late May 1975.

System documentation (test procedures, instruction manuals, etc.) preparation is underway and some deliveries have already been made to the documentation contractor.

VIII. Block IV Receiver/Exciter, DSS 14

In support of the implementation of the Block IV Receiver/Exciter at DSS 14 (as required for the Viking mission), we provided a total of 225 manhours in the following areas:

(1) **Qualification Tests.** Testing is now 75% complete with final testing awaiting the installation of the production voltage-controlled oscillator (VCO)/mixer modules and a new doppler mixer module.

(2) **System Tests.** Provided Block IV support for the following tests: Planetary Ranging System Performance Tests (SPT), Viking Mission Configuration Tests (MCT), Viking Operational Verification Tests (OVT), System Integration Tests, Zero Delay System Tests.

(3) **Training.** Assisted in the familiarization of and informal training of DSS 14 subsystem operations personnel.

(4) **Subsystem Testing.** As the DSS 14 tracking schedule permitted, troubleshooting and testing of the remaining subsystem problems were continued. These problem areas are: hardware replacement, system monitoring interface, doppler quality and QA acceptability.

IX. Goldstone Operations Support Radar

Initial testing had disclosed no interference with telemetry demodulation with a simulated radar signal into the maser at a –10-dBm level. Further testing has been accomplished using a simulated radar maser input signal of +17 dBm at a telemetry demodulation signal-to-noise ratio (at the Symbol Synchronizer Assembly (SSA)) of 1.0 dB. No detectable difference, radar signal on/off, can be found in the telemetry error rate under these conditions. We conclude that, if the interfering signal at 2850 MHz does not exceed +17 dBm at the maser input, no interference will be experienced with normal DSN operations from the Operations Support Radar.

X. Block IIIC Receiver/Exciter, DSS 13

Preparation for the planned Block III Receiver/Exciter Subsystem installation at DSS 13 is underway. This includes the relocation of equipment in the Operations Building and the modification of the present Mod IV R&D receiver. This modification includes reducing the present three-bay receiver into a one-bay unit. The new receiver will provide one wideband open-loop channel and one phase-locked channel. The open-loop operation will still be used in conjunction with a programmed local oscillator mounted in a separate cabinet.

It is planned to incorporate all necessary ECOs to update the Block III subsystem to the present DSN status.

XI. Differential VLBI

In support of the differential VLBI experiment (OTDA 310-10-60-56), DSS 13 in cooperation with the portable ARIES station and the Robledo Deep Space Station (DSS 63) provided 27-1/2 hours of observation, during which data from 132 radio sources were recorded using the special video tape recorder. Observations were made at 2290 MHz using the 26-m antenna adjusted to receive RCP signals and coupled into the station receiver.

XII. Clock Synchronization Transmissions

As arranged by DSN Scheduling, one transmission of one-hour duration was made to DSS 63. During system performance tests, the transmitter water load failed due to a cracked waveguide window. This allowed coolant water to enter and contaminate the waveguide system. The water did not, however, reach the power amplifier output window and the klystron does not appear to be damaged. The waveguide switch and forward/reverse power directional coupler were replaced with spares.

One possible explanation of the water load failure is the possibility of plating or coating of the load cavity or input window by contaminated water, creating a poor impedance match between the waveguide and the load. This would result in heating at the load window, producing a fracture.

To reduce the possibility of this failure recurring, the entire coolant system has been thoroughly examined. Some ferrous piping was found and replaced. One potential trouble source remains, however. This is the antenna-mounted storage surge tank, which is constructed of steel with an internal plastic coating. The cognizant design engineer for the coolant system indicates that the tank has a typical five-year life before the plastic starts to crack, allowing the tank to introduce rust into the system. Although the tank was inspected visually at this time and found to be satisfactory, it is five years old. In view of the Viking Project commitment for this system, replacement with a stainless steel tank is being considered.

Other problems during this period included a control cable failure and a logic section power supply failure in the Programmed Oscillator Assembly. This assembly provides the radio frequency drive and modulation for the transmitter. The faulty components have been replaced with spares.

An additional safety feature has been installed in the transmitter system. An antenna elevation angle actuated cutoff relay now removes the radio frequency drive to the transmitter whenever the antenna elevation angle is less than +10 deg.

XIII. Planetary Radio Astronomy

In support of the Planetary Radio Astronomy experiment (OSS 196-41-73-01), we observe the planet Jupiter and various radio calibration sources. Total receiving system temperature, on and off source, is measured from which received flux density of the radio source can be calculated. These measurements are made at 2295 MHz, LCP/RCP, and utilize the 26-m antenna, the station receiver, and the NAR. Observations, in addition to Jupiter, were made of the sources tabulated in Table 2, and the data were collected semi-automatically under the control of the NAR for a total period of 55 hours.

Reference

1. Jackson, E. B., "DSN Research and Technology Support," in *The Deep Space Network Progress Report 42-26*, p. 120, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1975.

Table 1. Pulsars observed at DSS 13 (Feb. 16 through Apr. 15, 1975)

0031−07	1237+25	1749−28	2021+51
0329+54	1604−00	1818−04	2045−16
0355+54	1642−03	1911−04	2111+46
0525+21	1706−16	1929+10	2218+47

Table 2. Radio calibration sources observed at DSS 13 (Feb. 16 through Apr. 15, 1975)

3C17	3C138	3C348
3C48	3C147	3C353
3C58	3C286	NGC 7252
3C123	3C309.1	NGC 7332