# Helios Mission Support

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*The previous article, in The Deep Space Network Progress Report 42-22, discussed the Helios Prototype Model Spacecraft/DSN compatibility test effort conducted at the Jet Propulsion Laboratory, Pasadena. Since that time, the prototype has been transported to Cape Canaveral where it will serve both as a forerunner to the first flight spacecraft and as back-up. This article treats the compatibility verification tests that were performed after the prototype's arrival at Cape Canaveral, with particular emphasis upon the first use of the former Spacecraft Compatibility Station equipment in the consolidated Spacecraft Tracking and Data Network facility at Merritt Island, Florida.*

## I. Introduction

After completing environmental and DSN compatibility testing at JPL (Ref. 1), the Helios prototype model (PM) spacecraft and its associated support equipment were transported to Cape Canaveral, Florida, where they will serve as a back-up to the flight model spacecraft during the latter's launch preparations.

After unpacking and set-up in Building AO at Cape Canaveral, the condition of the PM spacecraft was checked by running a DSN compatibility verification test with the newly relocated Spacecraft Compatibility Station (formerly DSS 71) equipment within the STDN facility at Merritt Island, Florida now designated STDN (MIL-71). The tests between the PM spacecraft and STDN (MIL-71) were conducted between July 31, and Aug. 2, 1974, and totaled 39 hours in length.

These tests, while successful, did reveal a few corrective actions that will be necessary prior to the start of the flight (F-1) model/DSN compatibility tests scheduled for the latter part of September 1974. The three most significant corrective actions are discussed.

## II. Corrective Actions

### A. Communications Distance

Because of the increased distance between Building AO and the STDN (MIL-71) facility over that between Building AO and the former DSS 71 facility, there was insufficient signal level to perform a two-way link range

calibration using the ranging zero delay device. This was temporarily circumvented by employing the STDN's 9-m-diam tracking antenna operating at 500 W of power for the up-link to the spacecraft, while maintaining the downlink from the spacecraft into the small, fixed-orientation roof-mounted antennas normally used with the DSN equipment housed at the STDN facility—denoted STDN (MIL-71). Since such an arrangement is non-standard for both the DSN and for STDN (when acting as a Near-Earth Phase Network (NEPN) support facility), it is desirable to add 32 dB to the STDN (MIL-71) link capability by either, or a combination of, higher transmitter power and larger fixed antennas on the roof. Both of these options are under current study with consideration being given to both the short-term (F-1 Compatibility Tests) and long-term (future flight project) needs.

### B. Signal Level Fluctuations

The PM/DSN compatibility verification tests were the first involving a spacecraft and the newly relocated equipment STDN (MIL-71) using a microwave path over a body of water (Banana River). Signal level variations as much as $\pm$ 4 dB interfered with testing—most notably the command threshold tests and telemetry bit-error-rate tests at 32 and 8 bps. While a major contributor to these fluctuations was eventually traced to a faulty RF coupler (test adapter) at the spacecraft end of the link, there remained a $\pm$1 dB link fluctuation. Serious consideration is being given to techniques for at least partially compensating these fluctuations in the microwave path.

### C. Threshold Measurements

The unattenuated RF signal level from the PM spacecraft (Building AO) as received via the existing small roof-top antennas at STDN (MIL-71) was $-70$ dBm. PIN modulators are used within the STDN (MIL-71) equipment to reduce the effective received signal level to the value specified for each particular portion of the compatibility test sequence. These PIN modulators have a dynamic range of only 70 dB—thereby necessitating the use of additional (usually variable) attenuators in series with the receiver input for threshold tests. Some of the testing was impaired by RF leakage around these external attenuators and into the receiver. Effort is now underway to supply STDN (MIL-71) with a special, shielded attenuator box which will permit independent attenuator adjustment of both the up- and down-links. Again, both the short-term and long-term aspects are being considered.

## III. Tests

Despite the foregoing initial difficulties, sufficient tests were successfully completed at Cape Canaveral to verify that both the PM spacecraft and the relocated DSN equipment at STDN (MIL-71) were compatible. This verification test was a prelude to further ground data system (GDS) tests the Helios Project wished to perform in addition to the somewhat limited 2-day GDS testing that occurred at the conclusion of the PM/CTA 21 compatibility tests during May 1974. The GDS tests with the PM at Cape Canaveral included an end-to-end test wherein PM telemetry was decoded at STDN (MIL-71), formatted onto high-speed data lines (HSDLs) and sent to the Mission Control and Computing Center (MCCC) at JPL, where it was processed and re-routed via other HSDLs to the German Control Center in Oberpfaffenhofen (Southwest of Munich) where it was successfully displayed. A test of the reverse process, wherein commands originating at Oberpfaffenhofen were to be sent through the MCCC to the PM spacecraft at Cape Canaveral was not successful due to procedural problems in Germany. However, commands originating at the MCCC were successfully executed via STDN (MIL-71) to the PM spacecraft, thereby verifying the proper operation of the DSN/MCCC portion of the command system interface. Since the MCCC interface with Germany had been previously verified, the command procedural problem that occurred during the Cape tests was not considered serious; however, the test will be repeated at a later date.

In addition to the preceding, the GDS tests involved the relocated DSN equipment at STDN (MIL-71) in an NEPN compatibility/data flow test. In this latter configuration, PM telemetry data were received by the STDN (MIL-71) 9-m antenna and fed into the STDN (MIL-71) receivers where it was detected and symbol-synchronized, then placed onto an HSDL. This HSDL, routed via the Goddard Space Flight Center, was one of two fed into the Automatic Switching Unit (ASU) computer in the (MIL-71) portion of that STDN facility. The other HSDL carried Helios telemetry received by the AFETR TEL-4 station. After data stream selection by the ASU, the data were passed into the standard DSN telemetry system for decoding and formatting for transmission to the MCCC. This test successfully demonstrated the PM spacecraft's compatibility with the NEPN, thereby achieving another important milestone in the preparation for Helios-A launch.

## Reference

1. Goodwin, P. S., "Helios Mission Support," in *The Deep Space Network Progress Report 42-22*, pp. 16–21, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1974.