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FINAL SUMMARY REPORT
ASTP COMMUNICATIONS SYSTEMS ANALYSES AND
PERFORMANCE PREDICTIONS

NAS 9-13697

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Final Summary Report (TRW Systems Group)
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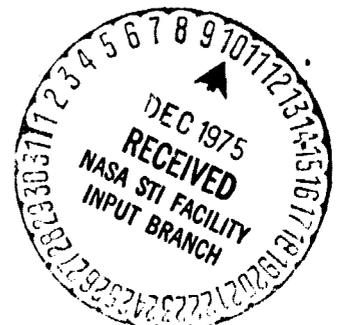
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I. WORK PERFORMED DURING THE CONTRACT PERIOD

A. Summary

Progress on the three study tasks during the contract period has been good. All contract deliverables have been delivered and all internal milestones have been met. There are no unresolved problems remaining to be considered by the tasks. The principal work of the contract has been to provide ASTP mission communication coverage and performance analyses and, secondarily, to analyze anomalies and special compatibility problems as they arise. The end product of the contract has been spacecraft-to-ground communications performance predictions for the ASTP mission, both for direct communication links to ground and for those links via the ATS-6 relay satellite to ground. In addition, solutions have been given for the special mission anomalies and compatibility problems encountered.

A brief summary describing the work activities expended under this contract is given below. Each activity is grouped under the study task in which it was performed. In Section II a list of the contract deliverables is furnished. This is the final progress report for TRW Contract NAS 9-13697 and concludes the effort on this contract.

B. Technical Accomplishments by Study Task

1. VHF and S-Band Math Models

- a. Developed a math model to map the "cone of coverage" of a high-gain antenna into a phi-theta spacecraft look angle diagram.
- b. Compiled parameter tables for circuit margin performance parameters for the CSM/GAPSAT forward and reverse communication links.
- c. Updated the VHF and S-band mathematical models for ASTP mission application.
- d. Assisted EJ5 in analyzing ASTP/ATS-6 Design Verification Test results.

- e. Generated an ASTP magnetic tape library of preliminary and then final communication system parameters.
- f. Compiled an updated ASTP parameter list using final communication system parameters.
- g. Modified the PM uplink and downlink modulation loss equations to model the use of a new Goddard multi-tone ranging system instead of the currently used PRN ranging system.
- h. Prepared an appendix listing the parameters required to define the expected performance and capabilities of the CSM/ATS-6/STDN communication links.

2. Performance Predictions and RF Coverage Analysis

- a. Performed an analysis of the communications coverage provided by two GAPSAT satellites in support of the ASTP mission, in case the ATS-F satellite should become inoperative.
- b. Computed postdetection signal-to-noise ratios (SNR's) in the FM subcarrier bandwidths for reverse link mode R5 as a function of predetection SNR and for various IF bandwidths.
- c. Generated FM improvement curves in support of a study of launch phase TV for the ASTP mission.
- d. Generated a CSM/ASTP antenna pattern tape in preparation for RF coverage analysis.
- e. Generated contour plots for the CSM S-band omni, VHF/AM, and DM VHF/FM antennas.
- f. Obtained S-band terrain profile data for the new ASTP ground stations and inserted the data into the appropriate communications analysis computer programs.
- g. Generated tables giving the CSM and STDN expected and required received signal levels for the ATS-6 relay links - one table refers to the forward link modes while the other table refers to the reverse link modes.

- h. Computed performance predictions for a new Goddard STDN ranging system in support of the ASTP mission.
 - i. Generated a series of plots of predicted downlink signal strength versus elapsed mission time from Soyuz lift-off for the Apollo direct link S-band PM communication system for selected ASTP mission phases.
 - j. Prepared a series of HGA coverage limitation diagrams which give a profile of the antenna look angles to the ATS-6 relay satellite for the period which includes rendezvous and docking through the final Apollo-Soyuz separation.
3. Incompatibility Problems and Anomalies
- a. Investigated the accuracy of two different parabolic dish antenna gain-beamwidth calculators which give conflicting results.
 - b. Performed spectral analysis and subcarrier frequency selection for an FM link, with 4 MHz video baseband information and split-phase code PSK modulation on a subcarrier.
 - c. Investigated the IF and loop filter bandwidth characteristics for the Lenkurt-Marelli demodulator.
 - d. Participated in the Communication System Compatibility Test Coordination Meetings held at JSC.
 - e. Monitored the high-gain antenna acquisition and tracking tests so as to determine the effect of test results on ASTP/ATS-6 communication performance predictions.

II. DELIVERABLES TRANSMITTED DURING THE CONTRACT PERIOD

"Spherical/Rectangular Transformation Algorithm for a Conical Antenna Field-of-View," TRW IOC 74:2552.6-81, 19 June 1974.

ASTP Operations Data Book (ODB) Contour Plots for the CSM S-band Omni, VHF/AM, and DM VHF/FM Antennas, MSC-07765 (Volume I).

"Table of Expected Performance of ASTP (CSM-111) Forward Link Modes at the CSM, ATS-6 Relay," TRW Report 25990-H057-R0-00, 23 May 1975.

"Table of Expected Performance of ASTP (CSM-111) Reverse Link Modes at STDN Ground Stations, ATS-6 Relay," TRW Report 25990-H057-R0-00, 23 May 1975.

"Performance Predictions for STDN Tone Ranging (3 Modulation Indices Cases)," TRW IOC 75:2512.6-27, 5 May 1975.

"ASTP Direct Link S-Band Signal Strength Plots for Selected Mission Phases," TRW IOC 75:2512.6-43, 14 July 1975.

"ASTP Direct Link S-Band Signal Strength Plots for the Mission Period: End of MA-059 Data Take to Apollo Entry Interface, TRW IOC 75:2512.6-48, 17 July 1975.

"ASTP HGA Coverage for Apollo Revolutions 28 through 59," TRW IOC 75:2512.6-47, 17 July 1975.

"Bimonthly Progress Report No. 1," TRW Report 25180-H001-R0-00, 28 February 1974.

"Bimonthly Progress Report No. 2," TRW Report 25180-H002-R0-00, 30 April 1974.

"Bimonthly Progress Report No. 3," TRW Report 25180-H003-R0-00, 28 June 1974.

"Bimonthly Progress Report No. 4," TRW Report 25180-H004-R0-00, 30 August 1974.

"Bimonthly Progress Report No. 5," TRW Report 25180-H005-R0-00, 30 October 1974.

"Bimonthly Progress Report No. 6," TRW Report 25180-H006-R0-00, 31 December 1974.

"Bimonthly Progress Report No. 7," TRW Report 25180-H007-R0-00, 3 March 1975.

"Bimonthly Progress Report No. 8," TRW Report 25180-H008-R0-00, 30 April 1975.

"Bimonthly Progress Report No. 9," TRW Report 25180-H009-R0-00, 23 July 1975.

"Bimonthly Progress Report No. 10," TRW Report 25180-H010-R0-00, 29 August 1975.