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INTEGRATION PLAN FOR THE RADIO ASTRONOMY EXPLORER (RAE) SPACECRAFT

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BY

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and
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September 1966

Goddard Space Flight Center
Greenbelt, Maryland

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INTEGRATION PLAN FOR THE RADIO ASTRONOMY EXPLORER (RAE) SPACECRAFT

I. INTRODUCTION

The Radio Astronomy Explorer (RAE) spacecraft (Figure 1) is designed to perform measurements of galactic radio noise and bursts of radio energy emanating from the Sun, the Earth, and Jupiter in a frequency band normally attenuated by the Earths ionosphere. The mission consists of two spacecraft with launches scheduled for 1967 and 1968. The spacecraft will be placed in 6000 km circular orbits, will extend antenna arrays to 1500-foot lengths, and will have an expected operating life of one year for each flight.

Goddard Space Flight Center (GSFC), Greenbelt, Maryland is responsible for the mission management*. The Electronics Systems Branch (ESB), Spacecraft Integration and Sounding Rocket Division, GSFC, is responsible for the electronic systems integration of the spacecraft, with that task assigned to the RAE Integration Group.

This document is a general plan for carrying out that task and is a guideline for developing detailed test plans to be used during integration operations.

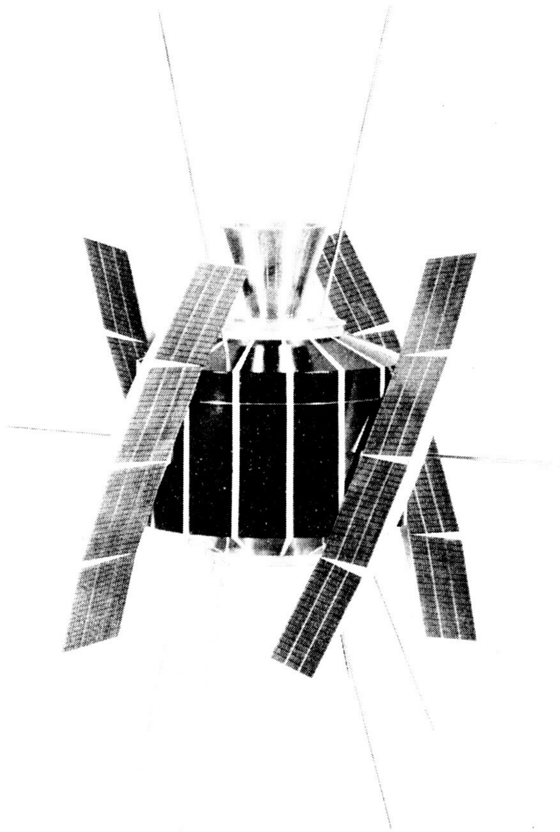

Figure 1–The Radio Astronomy Explorer (RAE) Spacecraft

II. RESPONSIBILITIES

The RAE Integration Group is responsible for the following activities:

a. Participation in spacecraft systems design.

*Franta, A. L., "Integrating Spacecraft Systems," NASA TN D-3049, April 1966.

b. Supervision of electronic interfaces.

c. Participation in coordination of mechanical and operational interfaces.

d. Establishment of cabling and function compatibility.

e. Provision of performance information and coordination of evaluation for flight acceptance of the complete spacecraft, using Automatic Data Processing (ADP) equipment based on a high speed digital computer and special purpose Ground Support Equipment (GSE). Emphasis is placed on real time control and performance monitoring.

f. Establishment of radio frequency (RF) links (command and telemetry) for performance data retrieval. Hardwire links to spacecraft are used solely for initial tests, ground safety, and some calibration.

g. Provision of subsystem excitation and adherence to orbital operation procedures whenever possible during all tests.

h. Provision of advisory and back-up evaluation support to the Project Manager during orbital operations.

i. Provide experiment calibration and subsystem unit acceptance testing services as requested by the Project Office.

j. Maintenance of log books, charts, and magnetic tapes commensurate with good record-keeping practices and special requirements of the Project, including origination of failure reports during spacecraft testing.

k. Provision of RAE software to the Multipurpose Control Center (MPCC).

III. INTEGRATION OUTLINE

a. Electronic interfaces and functions are coordinated. ESB provides a detailed interface document to each subsystem supplier for confirmation. Supplier reviews interfaces and provides Electronic System Branch (ESB) with a complete briefing on the appropriate subsystem.

b. ESB inspects all incoming subsystems for the following:

- General condition

- Connectors within specification

- Appropriate marking.

c. Initial RFI tests are made on all subsystems capable of being bench-checked in the RAE integration lab. DC magnetic fields and AC fields measurements, where appropriate, are made on all subsystems.

   The spacecraft cable harness is checked for wiring accuracy and isolation. Prior to installation of any subsystem, ESB demonstrates to a supplier's representative that the correct functions appear at his connector(s) from the cable harness. The engineering model cable harness is used in this phase.

d. Installation of electrical subassemblies is on a unit-by-unit, or "building-block" basis, following a logical sequence of units whenever schedule permits*. This minimizes the number of functions provided by external support equipment (power supplies, pulse generators, etc.). Each new unit installed is fused for protection until its operation appears normal.

e. RFI radiation and susceptibility measurements are made on the spacecraft after each installation.

f. Required changes are implemented in the Flight model cable harness, which is handled with the same procedure as the Engineering model harness, repeating the building block procedure.

g. Detailed RFI tests are repeated.

h. Spacecraft is subjected to a preliminary thermal test in the 12×12 chamber in building No. 7, GSFC, to iron out system problems, calibrate thermistor channels, collect current profiles, and check out sensor stimulators.

IV. PRE-ENVIRONMENTAL TESTS

a. All unpotted units are potted and subjected to selected environmental tests.

b. The integration procedure is repeated, including all-system current profiles and deviation checks.

*Franta, A. L., "Integrating Spacecraft Systems," NASA TN D-3049, April 1966.

c. RFI and magnetic fields measurements are made on the spacecraft.

d. Detailed calibration of experiments is performed.

V. ELECTRONIC INTEGRATION

a. Block diagram explanation of operation of subsystem.

1. General. This briefing by a subsystem supplier is as detailed as possible to convey a knowledge of logical operation to ESB. The briefing is cross-checked against ESB interface documents.

2. Inputs discussed:

   - Type (analog, supply, digital, etc.)
   - Use (power, switching, data, etc.)
   - Dynamics: Z of line, Z of input, and voltage levels.

3. Outputs discussed:

   - Same as V.a.2, except consideration of Z of output.

4. Pertinent data. Provided in the form of charts, graphs, data sheets covering all environments previously experienced by the subsystem.

5. Cautions discussed:

   - Sequencing restrictions
   - Loading, grounding
   - Handling and orientation for storage and/or operation
   - Failure modes encountered and trouble-shooting guidelines.

b. Bench check demonstration.

1. Where possible, demonstration of bench operation of subsystems is requested by ESB for familiarization with operating procedures, parameters, and calibrations. It is desirable in some cases to operate many modules of a system simultaneously (tape recorder with its electronics and high power transmitter, radiometer with its power supply, etc.).

c. Subsystem package inspection.

1. General. This inspection is in addition to quality assurance inspections and will be performed by ESB whenever a module is delivered or returned to the integration group. (See Figure 2.)

2. Inspection:

- Size and weight (coordinated with Mechanical Systems)
- Connectors: Type, mounting, appearance, pull test on all female pins
- Markings for accuracy and legibility
- General condition of package and circuitry (where exposed)
- Package is stored, with an ESB handling card, in a plastic bag or other cover. Gold-flashed modules are handled with appropriate gloves.

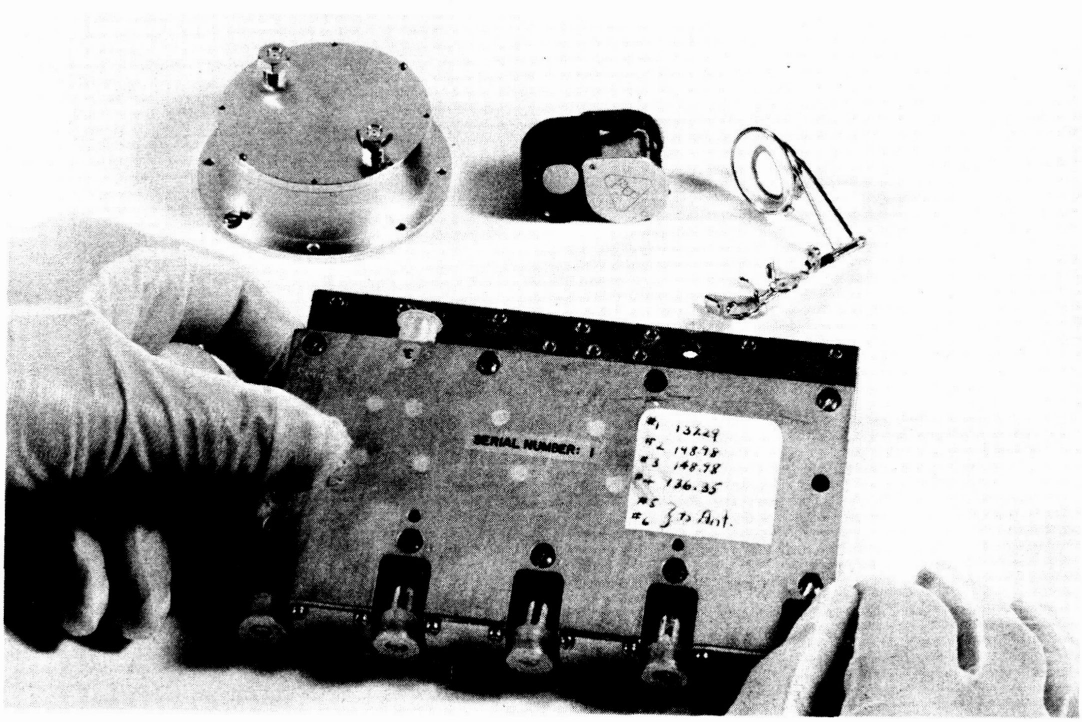

Figure 2–RAE electronics package inspection upon delivery to integration group

d. ESB Handling of Subsystem Modules.

1. Special handling. Observed for all equipment for which a special handling requirement is made known directly to ESB by the subsystem supplier.

2. Storage of modules (packages). In a clean area with locking facility, preferably the RAE shield room cabinet. Modules are enclosed in a plastic container also containing dessicant material.

3. Cleanliness and Handling. Particular attention is paid to connector cleanliness and to package gold flashing and coatings. Clean fabric gloves will be worn for handling of all gold-flashed units.

e. Initial RFI and audio checks for subsystem modules.

1. RFI and audio measurements. Made on a single unit basis for all possible subsystems, following the RAE RFI and Audio specification, utilizing RAE shield room in most cases (Figure 3).

Figure 3–RFI measurements being performed on RAE subsystem package

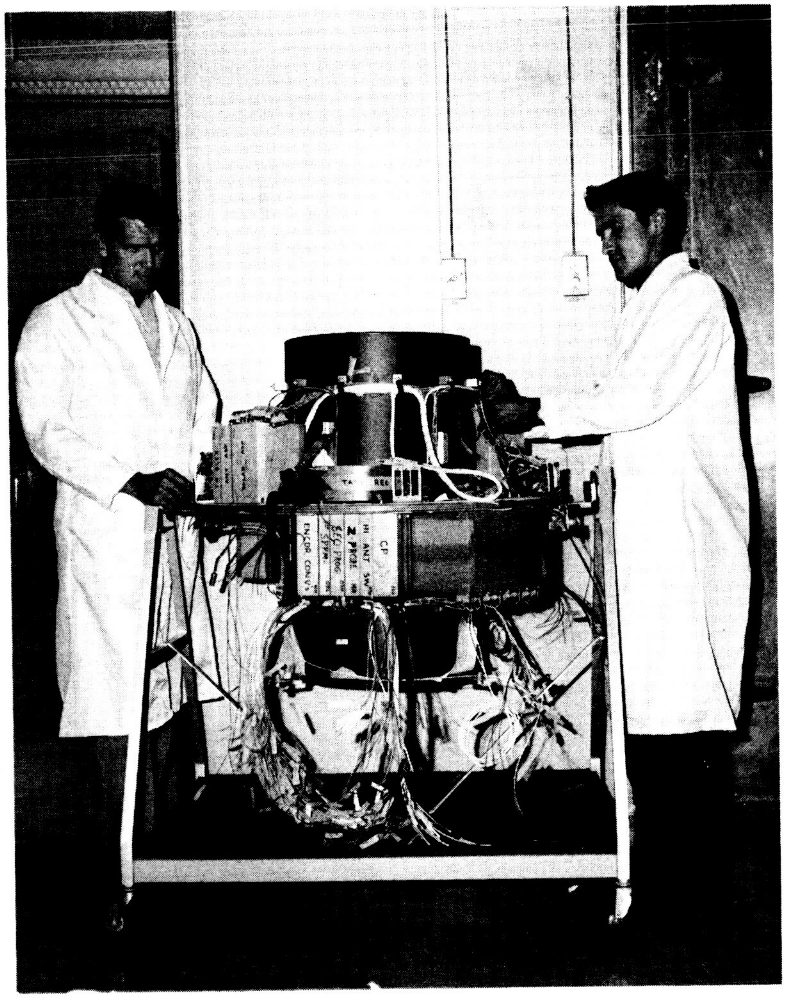

Figure 4–RAE cable harness in fabrication

2. Tests performed:
   - Radiated RFI
   - Conducted RFI
   - Susceptibility to radiated RFI
   - Susceptibility to conducted RFI
   - Audio frequency checks on all lines, using oscilloscope and clip-on current meter.

3. Documentation: Subsystem log and RAE RFI log.

f. Initial magnetic field checks.

1. Magnetic fields tests of all subsystem modules are requested to be made by Magnetic Test Section (MTS), GSFC. Perm, deperm and residual field measurements follow the RAE magnetic field specification.

2. Where possible, AC components of magnetic fields are measured with the subsystem in operation.

3. Documentation is provided by MTS for the use of the Project.

g. Cable Security Checks

1. Initial Cable "ring-out." All cable connections are double-checked for accuracy by the fabricators, using point-to-point measurements for all lines and insuring that no extra connections have been made. Corrections, if any, are implemented as soon as discovered (Figure 4).

2. Major cable "ring-out." All cable connections are checked for appropriate continuity by ESB, using identical procedures as in 1. above. This process is repeated at least once, and once after any major corrections are made. In addition, isolation is checked between all lines using a high voltage device.

3. Inspection. Cable inspection is continuous throughout fabrication of the cable harness. Prior to initial "ring-out," and following final isolation checks, a detailed inspection is performed by ESB, following quality assurance procedures. A connector inspection check list is utilized (Figure 5).

4. Security Check Prior to Package Installation. All cable connections to the unit are checked for appropriate functions, impedances, and terminations prior to installation of the unit. Initially, these checks involve a cable with no other units connected. As installation progresses to include more packages, inactive circuits become active and checkout complexity increases.

5. Documents. Wiring diagram, wiring table, spacecraft log, master log, connector inspection list.

h. Installation of packages.

1. Mechanical installation. ESB personnel deliver packages to Mechanical Systems Branch (MSB) personnel, who install them in the spacecraft in appropriate locations. Prescribed handling procedures are utilized and ESB observes that potential hazards or actual damage to cables, connectors, etc., are avoided.

2. Initial electrical installation. Jumper (test tee) cables are used initially to connect each package to the spacecraft harness. Interrupter-type jacks with fuse adapters are inserted in all power lines to the package. Fuses, rated at not greater than 150 percent of expected power levels, are inserted in the adapters and current meter

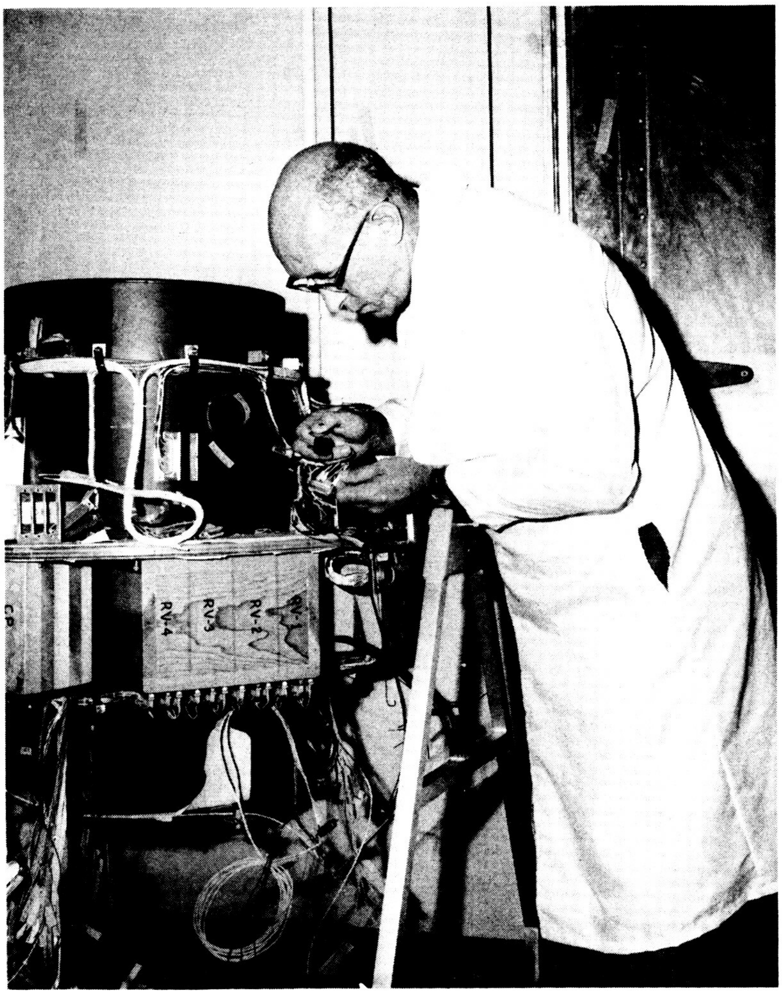

Figure 5–RAE cable harness in inspection

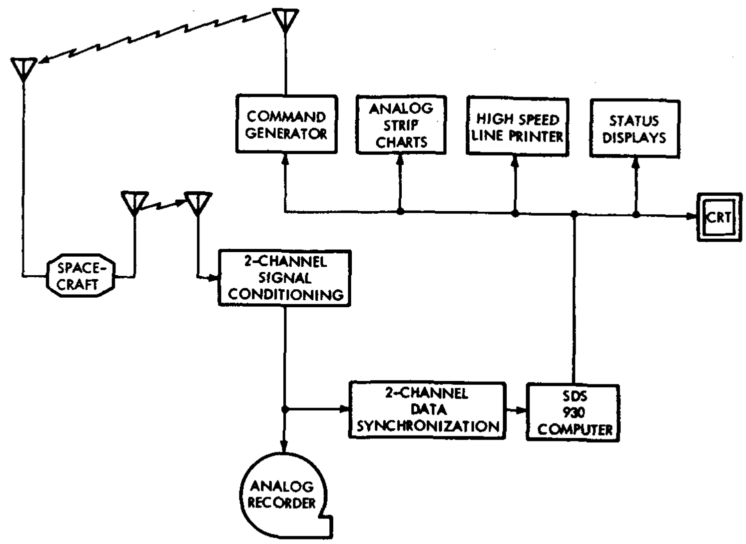

Figure 6–Simplified block diagram of test stand/computer system used for handling RAE PCM test data

probes are installed on all power lines. Outputs from the subject meters are recorded on multi-channel pen recorders. A fuse of higher rating may be inserted if it is determined, by application of power, that turn-on transients momentarily exceed 150 percent of nominal level. Where practical, impedance measurements of package functions are made, using interrupter-type jacks.

3. Test data handling. When spacecraft telemetry is available, package (subsystem) operation is monitored, processed, and displayed by the computer/test stand system shown in Figure 6 and Appendix A. Other data are collected through standard laboratory instruments in close proximity to the spacecraft. Typical of the latter parameters measured are line currents and RF output power.

4. Parameters checked. All inputs and outputs are checked, in all design modes, for proper operation, using acceptance test data and RAE specifications as guidelines. Particular attention is paid to:

   - Signal characteristics
   - Power line ripple
   - Spiking/ringing on all lines
   - Radiated and conducted RFI.

5. Interaction with other subsystems. Upon installation of any package, performance of previously installed subsystems is carefully observed for deviations from standard performance.

6. Subsystem failure procedure. Suspicion of subsystem failure is determined from established failure criteria, including operation out of tolerance and detection of parameter trends toward tolerance limits. In the event of suspected failure, the cognizant subsystem engineer is notified as expeditiously as possible. The following steps are taken:

   (a) ESB endeavors to eliminate as many potential malfunction sources as possible from consideration.

   (b) ESB obtains sufficient data for analysis to minimize trouble shooting time.

   (c) Integration team and cognizant subsystem engineer agree on trouble-shooting procedure(s).

   (d) Trouble-shooting is conducted in the spacecraft environment whenever possible. Subsystem engineers are encouraged to follow this guideline to minimize the number of package removals from the spacecraft. If such removal is necessary, it is coordinated, as in installation, within the electronic and mechanical integration team.

   (e) Failure reports, adhering to "Failure reporting procedure (RAE), are initiated by the cognizant ESB engineer or test conductor. Agreement on terminology, definition, and observation is encouraged between ESB and subsystem engineer.

7. Documents. Wiring diagrams, wiring tables, subsystem block diagrams, and schematics, spacecraft log, master log, component (module) history, and failure reports.

VI. ENVIRONMENTAL TESTS

a. General guidelines

1. Test data. The RAE spacecraft is monitored through the RF telemetry links during all applicable tests, utilizing the RAE test contraol in Building No. 11, CSFC for spacecraft data handling and distribution, as depicted in Figure 7.

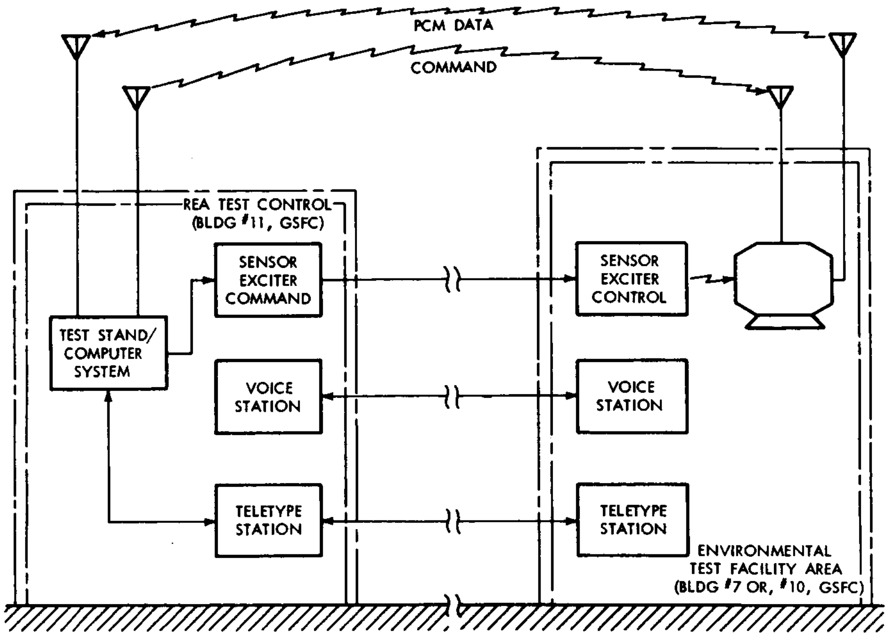

Figure 7–RAE test data, control, and communications links for environmental test

Some internal spacecraft data is returned from RAE test control to the test facility area, utilizing voice and teletype links.

Subsystems are in system configurations appropriate for the test in progress.

Sensor exciters (or other appropriate check devices) are used, whenever practicable, for all like tests.

2. Command. All spacecraft ground commands originate from RAE test control except during those field operations (Agriculture Research Center (ARC) airport, Naval Ordnance Laboratory (NOL) requiring a portable command station. Spacecraft command receiver sensitivity is determined at each test milestone.

3. Pyrotechnic safety. The RAE pyrotechnic safety handling plan is in effect for the duration of Test and Evaluation (T&E). Deviations are specifically determined and requested. Clearance through the cognizant test conductor or integration engineer is mandatory prior to such deviation.

4. Responsibility. Project management defines that the integration team is responsible for the spacecraft in the test facility and indicates whether primary responsibility is mechanical or operational (electronic). When responsibility is operational, RAE test conductor is responsible for the spacecraft. He receives confirmation that environments, spacecraft configuration, and local conditions are appropriate and secure for the test or operation in progress. He initiates requests for changes in environment and configuration as indicated by test procedure or by best judgment when encountering unusual situations. Spacecraft engineer is responsible for ensuring local spacecraft security, primarily from an operational and electronics systems standpoint, during handling, installation, test periods, and idle periods. In the event of emergency, he is authorized to take those steps necessary to protect the spacecraft systems.

b. Procedures for specific environmental tests.

1. Spin Balance. There is no requirement for electrical operation of the RAE spacecraft on the horizontal balance machine. Lumped masses will be used for these tests in place of paddles due to propeller action of the latter in atmosphere.

Live spin and despin tests are performed in the Dynamic Test Chamber (DTC), utilizing a vertical balance machine for that portion. Spacecraft is operated in launch mode during these tests. Yo-Yo despin is accomplished through ground command and the spacecraft pyrotechnic system. Telemetry monitor and ground command are conducted through RF link, with appropriate antennas located in the DTC and flight antennas mounted on the spacecraft.

2. Vibration. Spacecraft is in launch system configuration and is monitored throughout vibration tests. Particular attention is paid to pyrotechnic security.

Following each axis run, an abbreviated checkout is performed in the data/calibration mode: all experiments, tape recorder, magnetic and solar aspect systems, antenna aspect, and boom/pyro programming (selection without action). Following each test phase, a major checkout is performed, equivalent to at least 1/3 (one-third) orbit.

NOTE: In addition to X, Y, and Z runs, in 3rd stage thrust direction, tests must be repeated in the 4th stage thrust direction.

Following completion of all vibration tests, complete boom and pyrotechnic tests are performed, utilizing simulated explosive devices where impractical to use flight-type devices.

3. Thermal vacuum. Conducted in either the 12 × 12 thermal vacuum chamber or the Space Environment Simulation (SES) chamber. Spacecraft is in continuous operation with periodic checkout (as in orbit). Monitor and command are through RF link as in spin tests. Simulated solar power input is provided by hard wire.

   Flight paddles are used when available, with simulated paddles in place of paddles not available. All flight paddle-mounted devices are included in the test assembly. One set of pyrotechnics is ignited after soak at each temperature extreme. All antenna booms (non-silvered) are deployed and retracted, utilizing boom take-up devices, at each temperature extreme. Replacement of pyrotechnic actuators and relocation of boom take-up mechanisms from antenna to damper booms requires that the chamber be brought back to ambient temperature and pressure at least once during thermovacuum testing.

4. Spin-up/deployment. Conducted in the DTC, with no deep thermal control, these tests include all pyrotechnic and mechanical actuations and deployments, except ignition of a live 4th stage motor. Sequences adhere to those planned for flight. RF link and simulated solar power input are provided as in prior tests. A complete checkout of the spacecraft is performed after completion of these tests, although spacecraft may be removed from the DTC for convenience or reasons of facility scheduling.

5. Solar simulation. Conducted in the SES, these tests require that the spacecraft rely on its internal power system. Flight battery and tape recorder are installed for these tests. RF links are used for command and telemetry, and ESB will require no hardwires to the spacecraft. Particular attention is paid to thermal considerations. Thermal condition of the spacecraft is provided solely by spacecraft thermal monitors.

VII. MEASUREMENTS AND CALIBRATION

a. Magnetic fields tests.

1. General. Conducted at the NOL and GSFC magnetic test facilities, these tests are accomplished in at least three phases:

- Initial measurements
- Calibration, compensation, and torque tests
- Final calibration.

ESB will provide command, telemetry readout, and some technical support for all tests. Hardwire monitoring, using a package test connector, is required by the magnetic system supplier. Command, telemetry, and voice communications are as shown in Figure 8. It

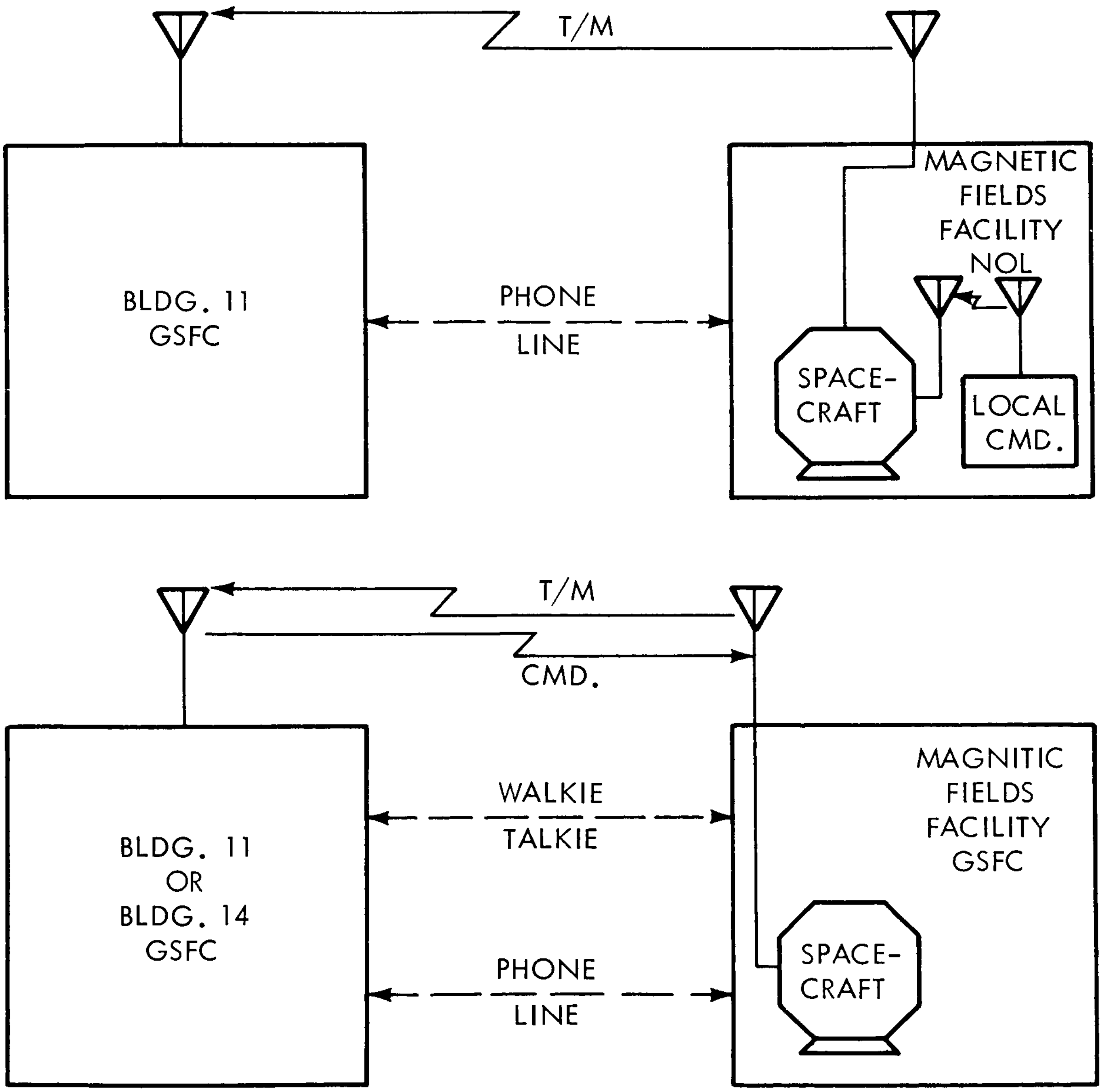

Figure 8–RAE test data, control, and communications links for magnetic fields tests

should be noted that local command capability and hardwire power control is available for these tests.

2. Data distribution. All functions and calibrations are verified through telemetry. A written report and analog test tapes are provided to the project office for distribution to the MPCC and Tracking and Data (T&D) data processing line.

b. Solar aspect tests.

1. General. Calibration is conducted on a spin table located outside Building No. 6, GSFC, or similar location. Tests involve a spinning spacecraft (spin mode) with varying angles between spin axes (Z axis) and the sunline and a stationary spacecraft (solid angle mode) with varying angles between the sunline and all spacecraft axes.

Telemetry readout and command are by direct RF link, utilizing the spacecraft antennas. Voice link to the spacecraft area is by walkie-talkie, as shown in Appendix B.

2. Data distribution. All functions and calibrations are verified through telemetry. A written report and analog test tapes are provided to the project office for distribution as with magnetic system data information.

c. Antenna aspect tests.

1. General. Primary calibration is conducted by the manufacturer. Field calibration is conducted at GSFC, using suitable light sources and bore sight techniques. In addition, a reduced-scale calibration system is utilized during as many tests as is practicable.

2. Data distribution. Similar to solar aspect and magnetic system information and data distribution.

d. Physical measurements.

1. General. Composed of weight, CG, and inertia measurements, there is no requirement for operation of the spacecraft during these measurements.

VIII. RFI PLAN

a. Approach

1. General. A radio frequency interference (RFI) plan is required for the RAE project due to the sensitivity of the radio experiments carried on board the spacecraft.

2. External RFI. RFI originating from outside the spacecraft, including that radiating from the spacecraft telemetry antennas is constrained from entering the spacecraft interior.

3. Internal RFI. RF radiation generated within the spacecraft is maintained at the lowest possible level.

4. Ground plane. The spacecraft structure provides a ground plane for RFI attenuation and power common.

b. Structure.

1. Shelf and center tube. These members form the main load-carrying portion of the spacecraft structure. The 3/4" aluminum honeycomb shelf is maintained in good electrical contact with the center tube (2 sections) as shown in Figure 9. The shelf is gold-flashed to provide good conductivity for package cases and grounding terminals. Measurements indicate that the primary structure exhibits negligible differences of potential under mixed load conditions, with currents up to 10 amps. Upper and lower equipment bays are shielded one from the other.

2. Shell. The ground plane is extended, for RFI shielding, to the spacecraft shell interior and exterior surfaces by appropriate conductive paths which do not compromise thermal isolation requirements. All apertures in the shell are sealed with RFI gaskets or other device to provide a continuous conductive path.

3. Paddles. The paddle structures are not a portion of the spacecraft ground plane. Ground requirements for paddle-mounted devices are provided by cable returns.

4. Apogee kick motor. The ground plane is extended through the motor/spacecraft interface as well as through cabling and shielding.

5. Damper assembly. This assembly is maintained in good electrical contact with the ground plane in both the retracted and extended positions. The damper boom itself is grounded at the mechanism.

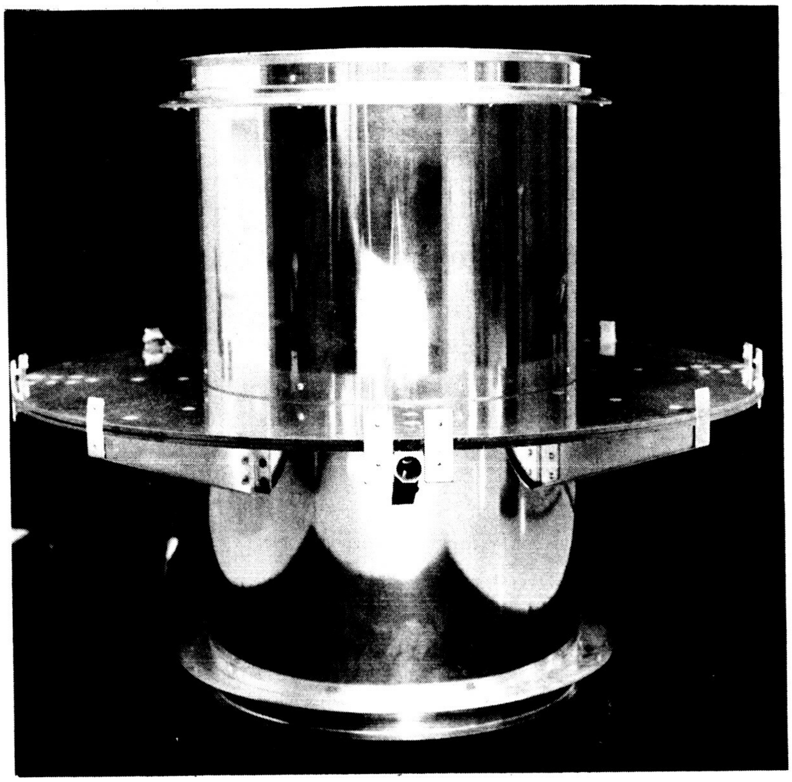

Figure 9—RAE RFI test structure, showing equipment shelf with center tube attached

c. Packages.

1. General. All packages and housings have a continuous conductive outer surface, except for discontinuities due to connector insulation.

2. Radiometers and calibration probes. These, and some other units, are packaged in enclosures in which the metal wall (excepting connector ports) completely encloses the electronics. Gold flash is applied to all surfaces.

3. Frame-mounted packages. All other subsystem units are packaged in aluminum, gold-flashed frames. Following potting, a coat of solder is applied to the exposed potting surfaces, making good electrical contact with the frames.

Shielding sheets are required during the initial integration phase when most cards are unpotted.

4. Package painting. All areas of packages not in contact with another package, the structure, or bookend frames are painted black to meet thermal control requirements.

5. Case ground. The gold-to-gold contact between packages and shelf provides a solid case ground, except for such items as the tape recorder, which is electrically isolated from the shelf due to vibration mount and must provide case ground through the harness.

6. Handling. Package gold surfaces are maintained in a clean condition throughout the test and prelaunch periods. Handling is described in section V. b.2.

7. Test connectors. Small test connectors, included in the package for bench checks, adjustment, and trouble shooting, must be covered by a metal shielding plate when access to such connectors is not required.

d. Cabling.

1. General. Appropriate cabling techniques are used throughout the spacecraft, with consideration for RFI, crosstalk, redundancy, line drop, and saving of weight.

2. Coaxial cable. Coaxial cable is used for all RF signals. Telemetry, command receiver, and Ryle Vonberg (RV) receiver coaxial cables are 50 ohm. All others are 95 ohm. All coaxial cabling incorporates a flat braid shield.

3. Shielded cable. Shielded cable, incorporating flat braid shield and appropriately sized center conductors, is provided for:

   - Pyrotechnic firing lines (twisted shielded pair)
   - All wires exterior to the shell and center tube
   - All audio signals 100 cps or greater
   - Where requested for security against signal pickup
   - Where a requirement is established from tests.

4. Switching signal cable. Power pulses for switching are not transmitted through the spacecraft cable harness, but, instead, signal pulses are transmitted to power dump circuits in close proximity to switches. Switching power loads appear only on short ground lines.

5. Twisted cable. Other than twisted shielded pair used for the pyrotechnic circuits, twisted cables are provided for boom deployment motors, tape recorder motor, and magnetic system magnetometer and electromagnet leads.

6. Ground cables. Excepting motor drive and pyrotechnic cables, all grounds take the shortest possible route to the ground plane. Where practicable, ground returns are separated into the following categories:

   - Power ground
   - Relay switching ground
   - Signal ground
   - Logic ground
   - Performance parameter circuit ground.

7. Cabling changes. If problems are encountered with radiation, coupling, and crosstalk, cabling methods are changed, on a case by case basis, to the method determined by testing to give the best results for each case.

e. Testing.

1. Basic testing. This is, in general, performed in the RAE integration shielded facility, Building No. 11, GSFC, as shown in Figure 10. Tests include separate packages, subsystem groups, and the integrated spacecraft. Procedures follow those outlined in the RAE RFI specification.

2. Proof test. RFI security calibration for the assembled spacecraft is performed in a large, shielded facility that permits extension of wires, simulating experiment antennas, of sufficient length that, when coupled with appropriate matching devices, determine the amount of RF leakage emanating from inside the spacecraft to the experiment antenna system and thence into the experiments themselves.

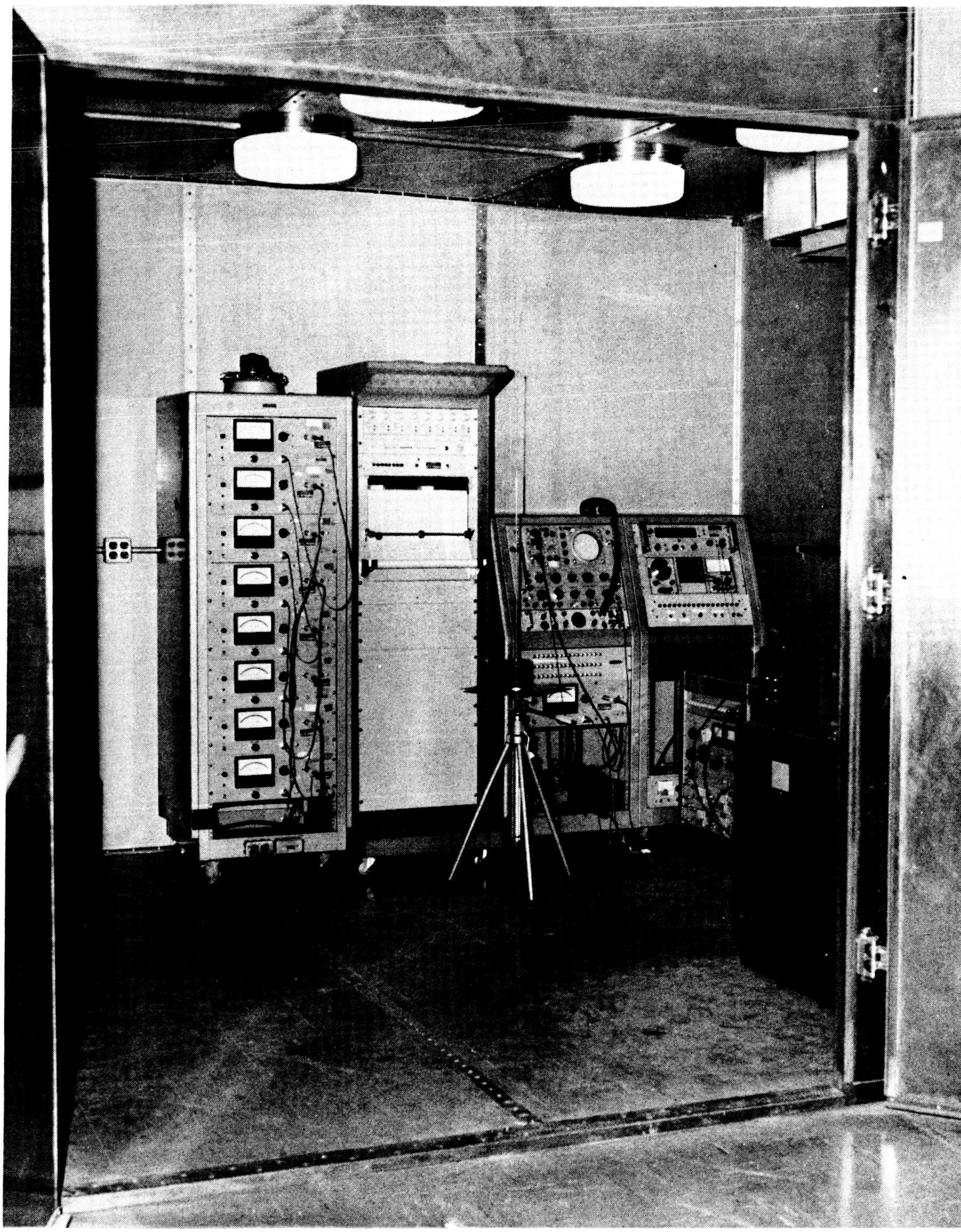

Figure 10–RAE integration shielded facility

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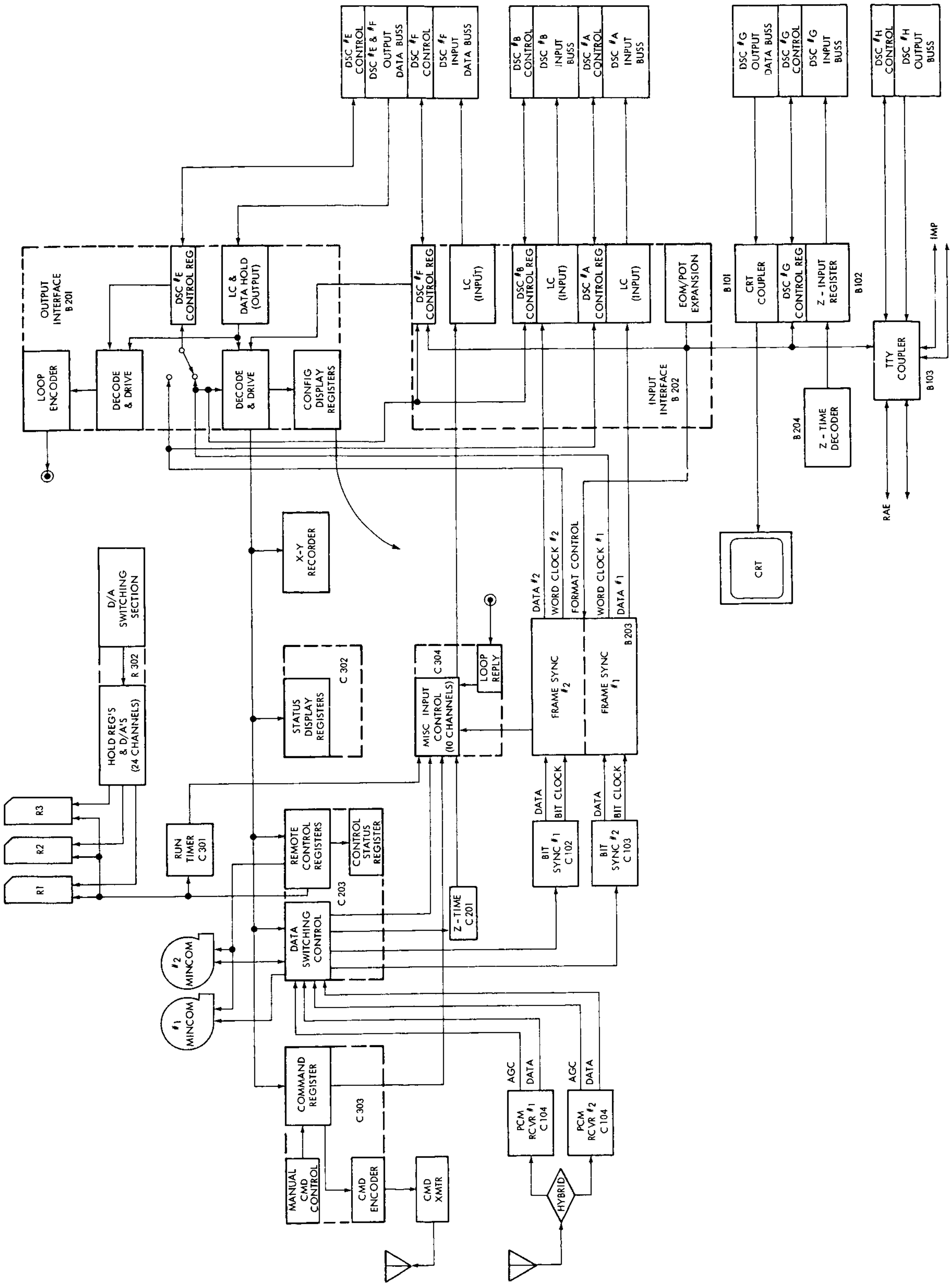
APPENDIX A

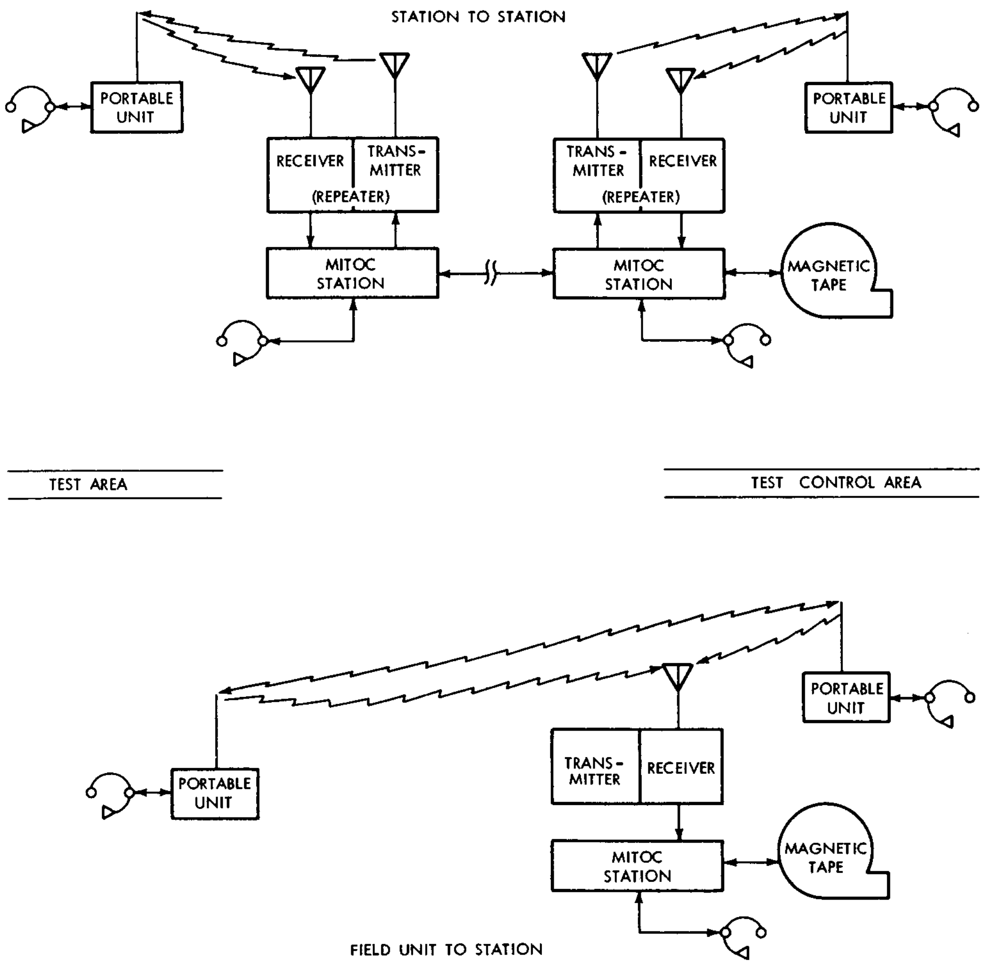
RAE TEST CONTROL CENTER

BLOCK DIAGRAM


DSC #E CONTROL
DSC #E & #F OUTPUT DATA BUSS
DSC #F CONTROL
DSC #F INPUT DATA BUSS
DSC #B CONTROL
DSC #B INPUT BUSS
DSC #A CONTROL
DSC #A INPUT BUSS
DSC #G OUTPUT DATA BUSS
DSC #G CONTROL
DSC #G INPUT BUSS
DSC #H CONTROL
DSC #H OUTPUT BUSS
OUTPUT INTERFACE B 201
DSC #E CONTROL REG
LC & DATA HOLD (OUTPUT)
LOOP ENCODER
DECODE & DRIVE
DECODE & DRIVE
CONFIG DISPLAY REGISTERS
DSC #F CONTROL REG
LC (INPUT)
DSC #B CONTROL REG
LC (INPUT)
DSC #A CONTROL REG
LC (INPUT)
EOM/POT EXPANSION
INPUT INTERFACE B 202
B 101
CRT COUPLER
DSC #G CONTROL REG
Z - INPUT REGISTER
B 102
TTY COUPLER
B 103
IMP
RAE
B 204
Z - TIME DECODER
CRT
X-Y RECORDER
D/A SWITCHING SECTION
R 302
HOLD REG'S & D/A'S (24 CHANNELS)
C 302
STATUS DISPLAY REGISTERS
C 304
MISC INPUT CONTROL (10 CHANNELS)
LOOP REPLY
DATA #2
WORD CLOCK #2
FORMAT CONTROL
WORD CLOCK #1
DATA #1
B 203
FRAME SYNC #2
FRAME SYNC #1
DATA
BIT CLOCK
DATA
BIT CLOCK
BIT SYNC #1 C 102
BIT SYNC #2 C 103
R3
R2
R1
RUN TIMER C 301
REMOTE CONTROL REGISTERS
CONTROL STATUS REGISTER
C 203
Z - TIME C 201
#2 MINCOM
#1 MINCOM
DATA SWITCHING CONTROL
COMMAND REGISTER
C 303
AGC
DATA
AGC
DATA
PCM RCVR #1 C 104
PCM RCVR #2 C 104
MANUAL CMD CONTROL
CMD ENCODER
CMD XMTR
HYBRID

APPENDIX B

RAE INTEGRATION GROUP VOICE LINKS FOR TEST



Locations for fixed and portable RF voice link stations

TEST CONTROL AREA		TEST AREA	
REPEATER UNIT	PORTABLE UNIT	REPEATER UNIT	PORTABLE UNIT
Bldg. #11 GSFC Rm. E-140	Bldg. #11 GSFC Rm. E-140	Bldg. #11 GSFC Rm. E-142 Shield room	Bldg. #11 GSFC Rm E-142 Shield room
Same	Same	Bldg. #7 GSFC Local to vib., therm., thermovac, & spin areas.	Bldg. #7 GSFC Local to and within test chambers.
Same	Same	Bldg. #10 GSFC Local to SES & DTC.	Bldg. #10 GSFC Local to and within SES & DTC.
Same	Same	N/A	Bldg. #6 GSFC Parking lot.
Same	Same	N/A	Magnetic Test Facility GSFC
Same	Same	N/A	Airport, ARC.