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1.0 INTRODUCTION

This EMI Protection Design Guidelines report has been prepared as a guide for use by ALSEP experiment fabrication and subsystem designers.

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2.0 EMI DESIGN CONSIDERATION

Proper operation of the ALSEP system and each of its subsystems relies upon the elimination of any harmful EMI. As a guide for achieving this interference free design, the ALSEP program has a contractually imposed EMI requirement at the system level to meet MIL-I-26600 and MSC-ASPO-EMI-10A. In order to achieve an interference free design, ALSEP Systems Engineering has imposed these requirements at the subsystem level. This will minimize system functional integration problems.

EMI shall be a consideration in the design, layout, and packaging of all electronic and electrical circuitry. All of the practices and procedures required for reduction of EMI shall be employed fully up to the point of over complicating construction or lunar handling or derating the functional and/or reliability aspects of the equipment. The design shall be such that, before interference control components are applied, the amount of interference internally generated and propagated is the minimum achievable. The application of interference control components (e.g., filtering, shielding, bonding components) shall conform to good engineering practice and, shall be an integral part of the system or component.

The most important aspects of design for interference free design are discussed in the following sections.

2.1 Grounding

An important consideration in EMI free design is the grounding concept used and the proper application of this concept. Exhibit B states that a single point ground system will be used and carried back to a ground point within the data subsystem in the central station. It further states that there will be a minimum of 1 Meg dc resistance between all ground leads (power, signal, chassis) leaving each of the subsystems. In the cases where a primary power of 29 VDC is supplied to the subsystem and converted to the required voltages within that subsystem there will be three ground conductors isolated from each other in the subsystem, and connected together at the system single point ground. The primary experiment power (29 VDC) conductor will carry the primary power current only. The signal ground, although tied in the power ground in the subsystem, will only carry small signal currents through the interconnect cable. The chassis ground, which effectively carries no current, prevents the development of static voltages between subsystems, and between the subsystem case and electronics within. Within the central station the single point ground concept will be employed to the fullest extent possible. In the data subsystem, where all of the needed voltages are supplied by the PCU, separation of power grounds and signal grounds is not possible so a common signal and ground return wire will be used and returned to the system single point ground. If the chassis of these units are isolated electrically from the system ground the chassis will be tied to the system ground by a single wire. If the chassis cannot be electrically isolated from the system ground, the point of contact will be jumpered by a good bonding technique to the thermal plate and the chassis wire ground will not be used.

2.2 Equipment Enclosures

All RF circuitry will be contained in RF enclosures. For the purpose of this application the term RF enclosures will mean all units containing frequencies above 50K Hz. An RF enclosure is a case capable of containing the electromagnetic energy. The number of mechanical discontinuities in the case (e. g., covers, inspection plates, joints) shall be kept to a minimum. All necessary mechanical discontinuities shall be electrically continuous across the interface of the discontinuity so as to provide a low impedance path. Multiple-point spring-located contacts or metallic woven mesh are suggested as desirable methods of obtaining low impedance continuity between contacting surfaces. Where feasible, continuous seam welding or soldering should be considered. Ventilation openings shall be designed to permit conformance to the radiated interference limits. Electrical bonding shall be provided where access doors or cover plates form a part of the shielding. Hinges, in themselves, are not considered satisfactory conductive paths.

At frequencies below 50K Hz normal electrically conducting cases constructed for structural adequacy and protection from physical damage are sufficient for EMI protection. Care should be taken to insure that no non-conducting coatings are used on mating surfaces and that surfaces are kept clean.

In those cases where RF power transmitters are part of the operating systems, harmonic or other spurious interference suppression devices shall be designed and installed as a part of the transmitter coaxial output circuit.

2.3 Shielding

All wires, parts, and components which could be a source of EMI, or susceptible to EMI should be evaluated to determine shielding requirements.

2.3.1 Wire Shields

It is preferred that interference reduction be accomplished inside the equipment when such means gives results equal to or better than the use of shielded lines. If however, this is not possible the offending wires or wire bundles will be surrounded by braided wire or metal tubing over their length. The interconnecting flat conductor cable will achieve proper shielding of susceptible and radiating lines by grounding alternate conductors betweeen lines.

If the purpose of the shield is to protect the wire from external EMI sources, the shield will be insulated and grounded at one point only at the end closest to the central station. Shields used to contain EMI will be tied to chassis ground at both ends. In this case shield insulation is not required. In the ALSEP experiment to central station interconnections the major problem will be to protect the lines from external EMI. Thus, all shields will be floating at the experiment end. The interconnecting cable shields will all be tied to the system reference ground in the data processor. Except for coax cables, shields will not be used as current carrying return lines.

2.3.2 Shield Continuity

Shield continuity will be maintained through connectors by tying the shield through pins on the connectors.

2.4 EMI Fixes

If, after careful design in accordance with the foregoing paragraphs, additional interference control components are required, components shall be used that conform to the environmental requirements of the equipment. No special or exodic filters or other EMI fixes will be used until testing and EMI considerations dictate their use. Separately installed and external components shall not be used unless specifically authorized by ALSEP Systems Engineering. Drawings of all installations of interference control devices shall be approved by Bendix.

3.0 RECOMMENDED PROCEDURES FOR EMI FIXES

Failure of any subsystem to meet the EMI requirements will be evaluated from a system standpoint. A decision as to whether a fix is required will be made based on its effect on other subsystems, and/or its influence on system EMI requirements.

Should a fix be required, Bendix Systems Engineering Group and NASA will determine the type of fix and where the fix will be applied.

3.1 Fix in Offending Subsystem

If the fix is to be made in the offending subsystem or experiment, that subsystem group will incorporate the fix and shall be charged with any weight penalties.

3.2 Fix in Interconnecting Cable

If the fix is to be made in the interconnecting cable, the BxS System Engineering Group will incorporate the fix and the source of the EMI will be charged with any weight penalties.

3.3 Fix of Susceptible Subsystem

If the fix is to be made in the susceptible subsystem that subsystem group will incorporate the fix. If that subsystem is GFE, NASA and BxS Systems Engineering will recommend the technique for making the fix. If the susceptible subsystem passed the EMI susceptibility tests, the subsystem responsible for EMI shall be charged with any weight penalties involved in fix.

3.4 Fix at System Level

If all subsystems pass EMI requirements and an EMI problem exists in the integrated system, the fix will be made by BxS Systems Integration and weight charged to BxS.

3.5 EMI Buy Off

Failure of an experiment, subsystem, or the ALSEP system to meet MIL-I-26600 and MSC-ASPO-10A will be evaluated by BxS Systems Engineering. If it is judged that this out of spec condition will not present an interference problem, it will be requested that units be bought off with the approval of NASA.

4.0 REFERENCE DOCUMENTS

Military

MIL-I-26600	Interference Control Requirements, Aeronautical Equipment, 2 June 1958

NASA

MSC-ASPO-EMI-10A	Addendum to MIL-I-26600, 17 October 1963

Other

Sprague Technical Paper No. 62-1	Interference Control Techniques, 1962
Handbook on Radio Frequency Interference, Volumes I, II, III and IV, particularly Vol III	Methods of Electromagnetic Interference-Free Design and Interference Suppression, 1962, Frederick Research Corporation