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BENDIX SYSTEMS DIVISION ANN ARBOR, MICH.

ALSEP Internal Wiring

NO.

ATM-296

REV. NO.

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This report covers an investigation of cable and connector requirements for components of ALSEP subsystems. The cabling and connection techniques for connecting between the experiments and the central station are described in ATM-64A.

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1.0 INTRODUCTION

Cabling and connectors within ALSEP subsystems are needed to interconnect functional components and to provide for external deployed cable and test cables. Because of stringent reliability goals, together with limits on volume and weight, the use of connectors is to be minimized. Light-weight "thinwall" hookup wire is recommended to further reduce weight.

2.0 APPLICABLE DOCUMENTS (from Contract Exhibits)

Grumman Spec. LSP-390-8A

"Connectors, Miniature Circular (see Figure 1)

NASA Criteria and Standards (see Appendix A)

3.0 MULTIPIN CONNECTORS

A connector reported in use in the Apollo system, featuring contacts on a 110-per-square-inch density, is the Hughes Connecting Device (Electronic Products Division, 500 Superior Avenue, Newport Beach, California) series WS rectangular screw-lock varieties. These connectors meet requirements of polarization (by a hex-shaped collar on the center screw) and moisture sealing.

The recommendation is made to employ the potting version (WSP) with pin contacts on the components of the subsystem and the environmental seal (WSW) series for the harnessing system. This connector series accommodates No. 22 and No. 24 guage wire in a crimp-type removable contact. The use of crimp contacts is recommended with thin-wall hookup wire because of the hazard to wire insulation from soldering.

4.0 COAXIAL CONNECTORS

RG-141 cable (or RG-142, double-shielded) was selected as a best compromise between size, weight, and RF loss characteristics. A threaded-shell connector such as the "N" type or the smaller TNC were considered for use on the antenna. The TNC is recommended, pending a determination on whether the astronaut can manipulate it. For use inside the central station a smaller coaxial connector is desired. Candidates reviewed were Amphenol series 27 (not noisture proof) Sealectro "Conhex" (special adaptation for RG-141 cable) and Omni-Spectra OSM series. The latter was

ABSTRACT GRUMMAN SPEC LSP-390-8A (A5) 12-3-65
CONNECTORS, Miniature Circular, Electrical Power
Subsystem, Design Control Specification for

SHELL STYLES Gold Irridite Shell

- (D) 1 Flanged Wall Mounting Receptacle with Potting Shell
- 2 Cable Connecting Receptacle (non-mounted)
- 3 Flanged Box Mounting Receptacle
- (D) 4 Straight Plug (Mates with 1, 2, 3) with Potting Shell
- 5 Jam Nut Receptacle
- 6 Thru-Bulkhead Receptacle
- 7 Hermetically-Sealed Receptacle, Solder Mounting
- 8 " " " Flanged "
- 9 " " " Jam Nut "
- (D) 0 " " " Thru-Bulkhead

(D) indicates drawing is shown, others marked "Future"

CONTACTS Crimp type, Copper Alloy, Alumel, and/or Chromel

#20	7.5 Amp	Finish 150 uin Gold MIL-G-45204 type II over 200 uin Silver per QQ-S-365 Socket sleeve unplated Monel
#16	20 "	
#12	40 "	

CONTACTS COAX

PIN LSC-390-8-401	for RG-188/U	0106-024-000
-402	" "	0107-023-000
-403	RG-195/U	0106-027-000
-404	" "	0107-032-000

INSERT ARRANGEMENTS: (1ST NO. IN STD ARRANGEMENT IS SHELL SIZE)

FIG NO	CONT. ACTS	STD ARRANG.	SPEC	FIG NO	CONTACTS	STD ARR'G	SPEC
1	2 #20	8-?		14	11 #16	18-11	MS33713 ①
2	4 #20	8-4	MS33708 ①	15	32 #20	18-32	" ①
3	6 #20	10-6	MS33709 ①	16	16 #16	20-16	MS33714 ①
4	3 #16	12-3	MS33710 ①	17	37 #20, 2 #16	20-39	" ①
5	8 #20	12-8	BENDIX PT	18	41 #20	20-41	" ①
6	10 #20	12-10	MS33710 ①	19	21 #16	22-21	MS33715 ①
7	5 #16	14-5	MS33711 ①	20	55 #20	22-55	" ①
8	6 #20, 4 #16	14-12	MS33711 ①	21	61 #20	24-61	MS33716 ①
9	14 #20, 1 #16	14-15	MS33711 ①	22	10-COAX	24-?	
10	18 #20	14-18	BENDIX PT	23	55 #22	18-?	
11	19 #20	14-19	MS33711 ①	24	4 #12	14-4	MS24260 ②
12	8 #16	16-8	MS33712 ①	25	7 #12	14-?	
13	26 #20	16-26	" ①	26	12 #12	20-?	

- ① PER MIL-C-26482C
- ② PER MIL-C-26482X OR-26500B
- ③ PER MIL-C-26500B

RECEPTACLE COVER WITH CHAIN, CAPTIVE SEAL TYPE

LSC-390-8-1 THRU-9 FOR MS SHELL SIZES 8-10-12-14-16-18-20-22-24

CONNECTOR PART NO.

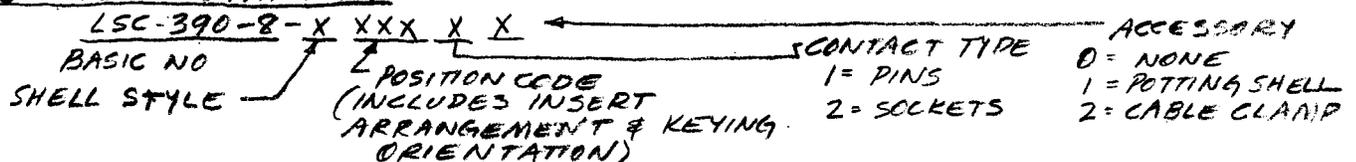


FIG. 1 CONNECTORS



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preferred over the Bendix BRM series because (1) the coupling nut is hex-shaped rather than knurled, and (2) more durable stainless steel is used rather than brass.

The connector for mounting on the component (such as diplexer) would be OSM No. 215 or OSM No. 214CC (CC indicates captured contact); while a suitable mating connector for the cable harness is OSM No. 511-1 straight plug with crimp connector (T and B tool No. WT-408 is required for crimping).

5.0 HARNESS CONSTRUCTION

One method of minimizing the use of connectors is to pigtail a cable from each component and use connectors at a central interconnect matrix board. This method has a disadvantage that the design and acceptance of each component (such as transmitters, receiver, A/D converter, etc.) is conditioned on the final harness configuration. A more flexible system is to mount the connector on the component and perform the harnessing by having cables, with mating component connector at one end and providing for harness interconnection by such means as a printed (multi-layer?) pin board. While the use of wire-wrap would be specified for GSE, the use of stranded wire in the payload package precludes this. Thus another method such as AMP's "Termi-Point" would apply (see Figure 2).

6.0 HOOKUP WIRE

In order to conserve space and weight the use of thin-wall wire is recommended. Two common types are MIL-W-16878 type ET and KT which employ Teflon TFE and FEP primary insulation with a nominal .006" wall thickness (see Table I). This type wire with an overcoat of .0005 to .001" ML Polyimide was recommended by Hughes (No. 24 AWG) for spacecraft wiring.¹ A type of wire referred to as "LEM Standard" has an HF film wrap (double wrap, reverse direction, first layer 0-1-1/2, 50% lap, second layer 1/2-1-1/2, 50% lap) with a 1/2 mil FEP dispersion overcoat. The LEM wire was found quite satisfactory in tests by GE R&D Center.²

¹"Solving Spacecraft Wire Problems," J. G. Read, Electronic Design, July 19, 1965.

²"Evaluation of Thin Wall Spacecraft Electrical Wiring," K. N. Mathes and L. J. Frisco, Final Report on NAS 9-4549.

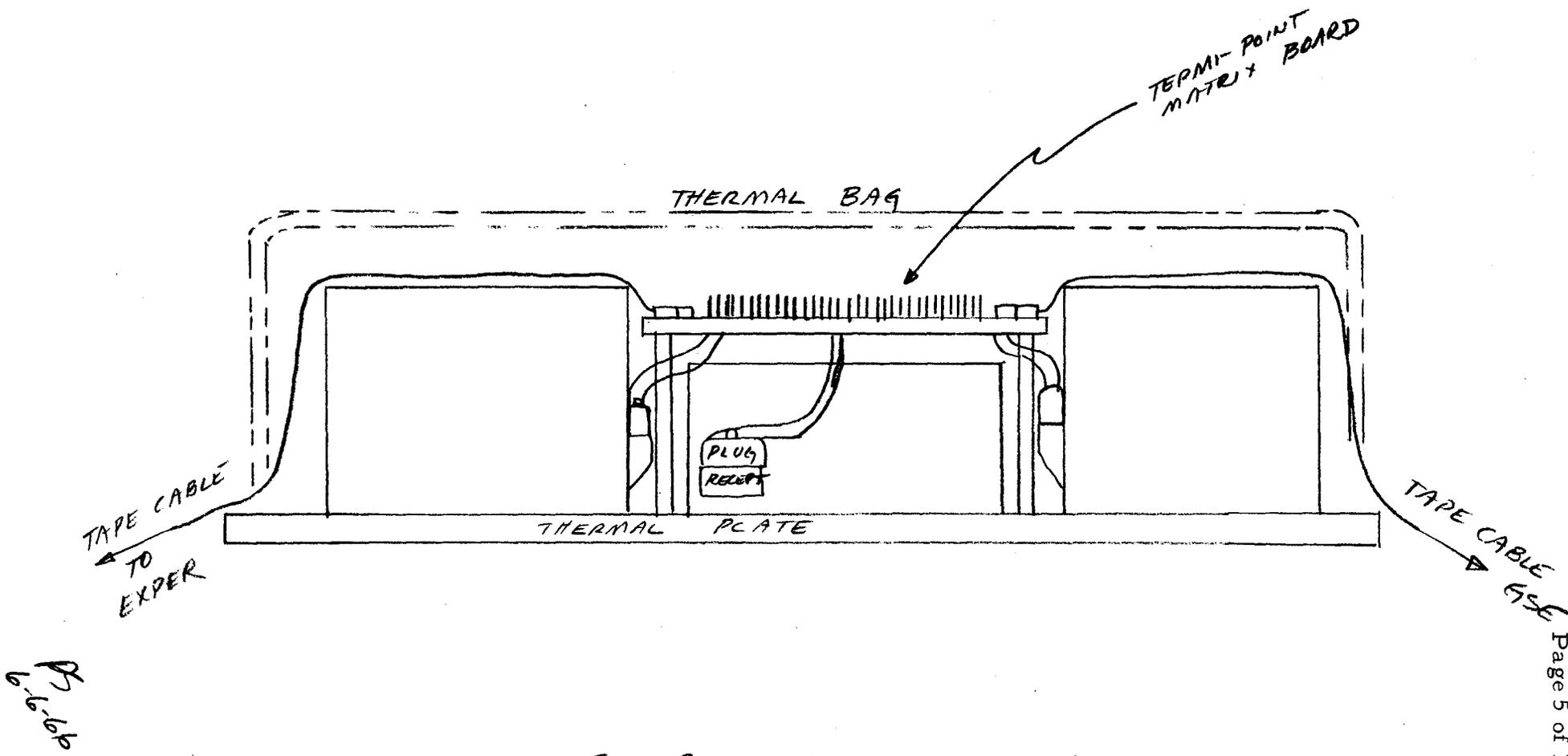


FIG 2 INTERNAL CONNECTIONS



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Table I Type ET and KT Wire Data

Type (AWG Size)	Conductor (1)	Diam. over Cond.	Diam. over Insul.	Resist. K ft.	Wt. K ft. (2)
ET-32	7 No. 40 (.0031)	.009	.019/.023	179	.48
30	7 No. 38 (.0040)	.012	.022/.026	111	.66
28	7 No. 36 (.0050)	.015	.025/.029	69.0	.92
26	7 No. 34 (.0063)	.019	.029/.033	42.9	1.31
24	7 No. 42 (.0080)	.024	.034/.038	26.8	1.92
22	7 No. 30 (.0100)	.030	.040/.044	16.7	2.82
20	7 No. 28 (.0126)	.038	.048/.052	10.5	4.25

(1) Minimum number of strands, recommend 10 or 19

(2) From ITT Surprenant.

APPENDIX A

NASA/MSC MANNED SPACECRAFT CRITERIA AND STANDARDS
(Applicable to Connectors and Wiring)

- DS-1 System Accessibility for Maintenance: All spacecraft systems, equipment and components shall be designed with features that contribute to the ease and rapidity of maintenance. Equipment expected to require servicing or maintenance shall be designed to be accessible without the removal of other equipment, wire bundles, and fluid lines unless specific approval from the program office is obtained.
- All electrical connectors and cable installations shall be designed with sufficient flexibility, length, and protection to permit disconnection and reconnection without damage to wiring or connectors.
- DS-3 Electrical Connectors - Keying: All electrical connectors, plugs and receptacles shall be positively keyed to prevent incorrect connection with other accessible connectors, plugs or receptacles.
- DS-6 Protection of Exposed Electrical Circuits: Electrical circuits which are to be disconnected or cut in the normal course of mission events (e.g., vehicle separation) shall be protected against short circuiting or compromising of other circuits during the remaining phases of the mission.
- DS-18 Spacecraft Material - Restriction on Use of Polyvinyl Chloride (PVC): Polyvinyl Chloride (PVC) shall not be used on manned spacecraft except under either of the following conditions:
- a. PVC's surface temperatures will not exceed 120°F and/or pressures will not be less than 3 psia under normal or emergency conditions.
 - b. Adequate data is presented on outgassing, toxicity, physical changes, etc., for approval by the cognizant program office.
- DS-20 Redundant Electrical Circuits: Redundant electrical circuits shall not be routed through the same connector except where only a single umbilical exists between major spacecraft modules. In this case, the redundant circuits shall be routed through pins that provide the maximum practical separation.

- DS-25 Wire Bundles - Protective Coating: Where protective coating or sheathing is added to wire bundles, ability to withstand anticipated handling and operating deformations without wire damage shall be demonstrated by appropriate qualification test programs.
- DS-31 Electrical Connectors - Moisture Protection: Electrical connectors and wiring junctions to connectors shall be sealed from moisture to prevent open and short circuits.
- DS-32 Electrical Connectors - Pin Assignment: Electrical circuits shall not be routed through adjacent pins of an electrical connector if a short circuit between them would constitute a single failure that would cause loss of the crew.
- PS-10 Protective Covers or Caps for Receptacles and Plugs - Electrical: Electrical plugs and receptacles shall be protected at all times.

Protective covers or caps shall be placed over electrical plugs and receptacles whenever they are not connected to the mating part. The protective covers or caps shall:

- a. Be moisture proof.
 - b. Protect against damage to sealing surfaces, threads, or pins.
 - c. Be resistance to abrasion, chipping, or flaking.
 - d. Be brightly colored so as to be easily discernible and command attention.
 - e. Have cleanliness requirements equivalent to plugs or receptacles on which they are used.
 - f. Be made of material which is compatible with the connector material.
- PS-13 Wire Splicing: Splicing of wire is undesirable in manned spacecraft.

If splicing is absolutely necessary, the splice must be witnessed and inspected by a qualified NASA representative. Records shall be kept of the splice showing operator, contractor's inspector, date, location of wire and splice, and other data deemed appropriate for complete record of the splice.

Splices not incorporated on drawings or covered in Engineering Orders (EO's) shall require Material Review Board (MRB) approval.

This standard applies to all types of splices, except the so called "bob-tail" splice, in which shield leads are connected for common grounding. This splicing application is approved, if adequate records are kept according to instructions in paragraph 2.

PS-20 Electrical Wire Acceptance Tests: Government Source Inspection at the wire manufacturer's facility shall be performed on each lot of electrical wire prior to delivery. A manufacturer's test report certified by the Government Inspector shall accompany each shipment to the user, including prime contractors, subcontractors, and Government installations. As a minimum, the following tests shall be performed by the manufacturer on 100% of the delivered wire:

1. Unshielded Wire and Shielded Wire Primaries (before Shielding)
 - a. Dielectric strength - Wet Tank Dielectric Test per MIL-W-22759A (WEP), para. 4.7.4.2.
 - b. Insulation resistance - per MIL-W-22759A (WEP), para. 4.7.4.3.
2. Shielded Wire
 - a. Dielectric strength - per MIL-C-27500 (USAF), para. 4.5.3, - potential to be a minimum of 2500 volts ac.

At the using installation each reel shall be considered as an individual inspection lot, and a sample or samples from each reel shall be subjected to the following tests as a minimum:

1. Examination of Product - Each sample shall be carefully examined per MIL-W-22759A (WEP), para. 4.7.1 to verify that construction, physical dimensions, marking, and workmanship are in accordance with the detail specification, and that damage has not occurred as a result of handling, following the tests by the manufacturer.
2. Finished Wire Weight - per MIL-W-22759A (WEP), para. 4.7.4.4.
3. Conductor Resistance - per Federal Specification J-C-98, Method 6021
4. Insulation Elongation - per Federal Specification J-C-98, Method 3031.

5. Insulation Minimum Wall -
Thickness and Concentricity - per MIL-W-22759A (WEP),
para. 4.7.4.7.

Any failure during testing by the manufacturer or user shall be cause for immediate rejection of the test reel and shall require failure analysis and corrective action on the part of the manufacturer.

- PS-23 Wire Insulation Potting Preparation - Etching: When etching of wire insulation is required to provide satisfactory bonding to potting materials, the open end of the wire shall not be exposed to the etchant. The preferred process is to form the wire into a "U" shape, immersing only the bent portion in the etchant with the open ends above the etchant level. The un-etched end of the wire shall not be cut off prior to neutralization of the etchant.