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July 6, 1965

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

MANUFACTURING AND QUALITY CONTROL REQUIREMENTS FOR SPACE SYSTEMS ELECTRICAL HARNESSES

QUALITY AND RELIABILITY ASSURANCE LABORATORY

National Aeronautics and Space Administration

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INTRODUCTION

This self-contained document outlines processes, based on new design concepts, which have been developed to assure maximum reliability of space systems electrical harness.

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MANUFACTURING AND QUALITY CONTROL REQUIREMENTS HARNESSES

1. SCOPE

1.1 This document establishes the criteria for assembly and inspection of space vehicle electrical harnesses, comprised in part of:

a. Wire per MSFC Drawing 40M39513/1 and /2 and 40M39526.

b. Solder sleeve terminations.

c. Crimp type contacts.

1.2 General requirements, assembly procedures, and quality requirements are outlined in sections four, five, and six, respectively.

1.3 When conflicts between design drawings and this document exist, the design drawings shall take precedence.

2. REFERENCED DOCUMENTS

2.1 The latest revisions of the following documents form a part of this publication to the extent specified herein.

MIL-F-14256 - Flux, Soldering, Liquid, Rosin Base.

MIL-T-22520 (WEP) - Tool, Crimping, Contact, Electrical Connector.

QQ-S-571 - Solder, Tin Alloy, Lead-Tin Alloy and Lead Alloy.

3. DEFINITIONS

3.1 Solder Sleeve. A solder sleeve is a heat shrinkable plastic sleeve containing a preformed ring of fluxed solder in the middle and thermoplastic sealing rings in the ends.

3.2 Ferrule. A ferrule is a solid one-piece metallic ring for terminating wires or shields.

4. GENERAL REQUIREMENTS

Requirements outlined herein cover aspects of electrical harness manufacture, with particular emphasis being placed upon the more recently developed components and processes.

4.1 Conductors. The type and size of wire shall be as specified by applicable drawings.

4.2 Solder Sleeves. The high temperature solder sleeve shall consist of an irradiated heat shrinkable, nonflammable, polyvinylidene fluoride sleeve (blue tint) containing a preform ring of fluxed (MIL-F-14256) solder (FED-SPEC-QQ-S-571), composition SN60 or 63, at the middle, and a thermoplastic sealing ring in each end (one blue and one white). See figure 1. This termination device shall be used on shielded wire with a diameter over the shield of 0.25 inch and less. Appendix C.

CAUTION: High temperature solder sleeves shall not be used over PVC wire insulation.

4.3 Two-Piece Ferrule Terminations. Two-piece, crimp type, ferrule terminations shall be used to terminate the shields of wires with diameters over the shields in excess of 0.25 inch.

4.4 Heat. A heat source, with the following characteristics, shall be used for solder sleeves:

a. Uniform heat delivery to the circumference of the solder sleeve.

b. Timer control.

Figure 2 shows one type of heat source.

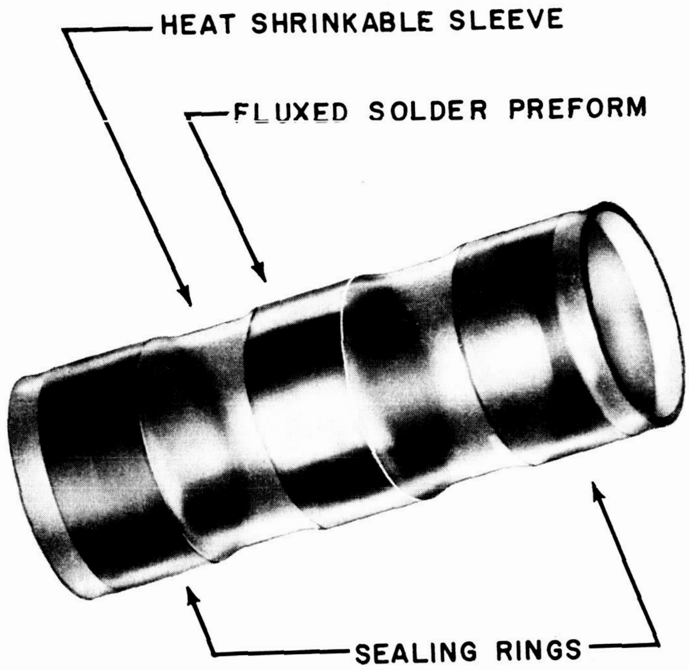


Figure 1. Solder Sleeve

4.5 Tools for Connector Crimp Contacts. Crimp tools shall meet requirements of MIL-T-22520 and shall be selected and verified in accordance with appendix A.

4.6 Contacts. Connector contacts shall be as specified by the design drawing.

4.7 Tubing. Tubing shall be as specified by the design drawing.

5. ASSEMBLY PROCEDURE

5.1 Conductor Preparation. Conductor lengths shall be determined from applicable design drawings and loosely laced into bundles using a running hitch. See figure 3. The stitch shall be 1 to 1.5 inch intervals and the tie or serve shall be 2 inches behind the connectors and shall not exceed 0.75 inch width. Branch breakout ties shall be as shown in figures 4 and 5.

Figure 2. An Experimental Heat Source

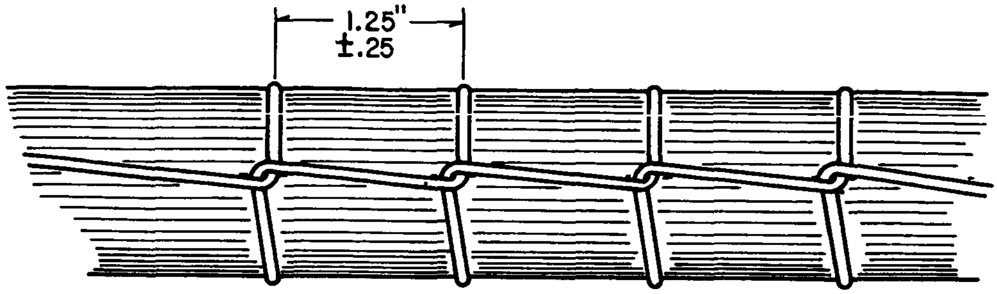


Figure 3. Lacing Stitch Interval

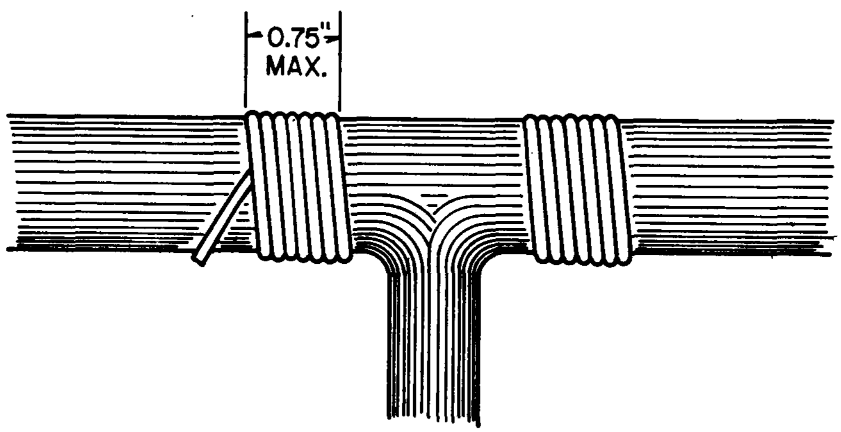


Figure 4. Endless Tie or Serve, Branch Breakout - Both Directions

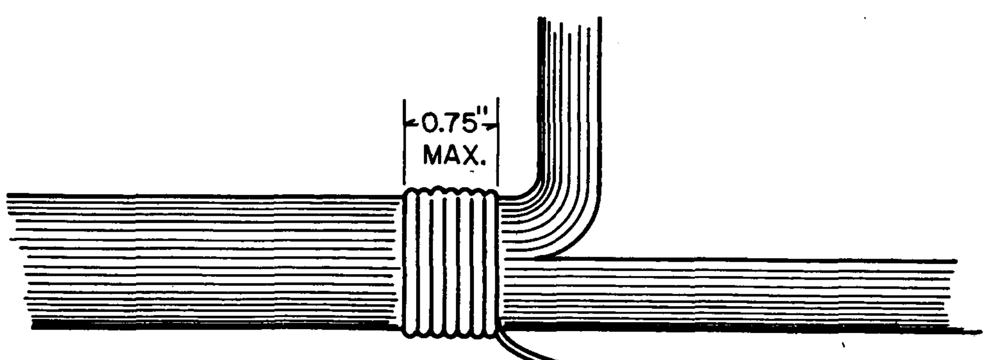


Figure 5. Endless Tie or Serve, Branch Breakout - One Direction

5.1.1 The outer insulation of shielded conductors shall be removed and the insulation ends staggered, starting within 1.5 inches and extending up to 4 inches of the connector end bell. See figure 6.

5.1.2 Remove the shield to within dimension "A" of the outer insulation as shown in figure 6.

5.1.3 Preparatory to using a crimp connection, remove the primary insulation from the conductor to ensure the conductor bottoming in the contact well and the insulation entering the contact insulation cup. The insulation shall be flush with the contact well when an insulation cup is not provided on the contact.

NOTE: The conductor shall not be damaged during the removal of the insulation.

5.1.4 Preparatory to using solder, the conductor strands shall be formed to the original lay and pretinned. (Solder shall not be allowed to flow under the conductor insulation.)

Dip the conductor into a liquid flux conforming to the requirements of MIL-F-14256, and pretin according to one of the following methods.

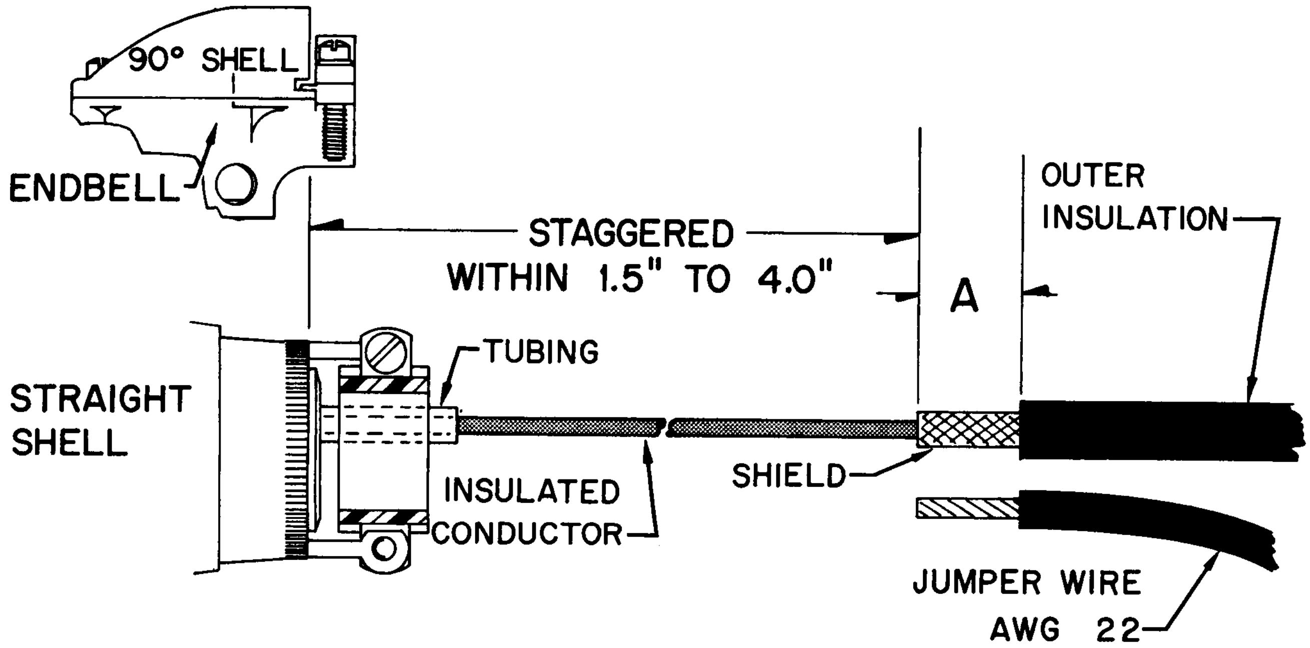
Method 1. Skim the solder pot as necessary. Dip the tip of the conductor into the solder pot (conventional or ultrasonic) whose temperature is maintained at 500 degrees F ± 20 degrees.

Method 2. Apply heat through a hand soldering iron tip to the conductor. When the conductor has reached a sufficient heat, apply solder to the conductor.

NOTE: Nickel plated conductors will require more heat from the soldering iron or longer dip time in pots than tinned-copper conductors. <u>Conductors to be crimped shall not be pretinned with solder.</u>

5.1.5 Jumper wires shall be of the type and size of wire specified in the design drawing.

5.1.5.1 The primary insulation of the jumper wires for solder sleeve terminations shall be removed 0.19 to 0.25 inch and pretinned. See figure 6.



Diameter of Shield	Dimension "A"	Type of Termination
0.25 in. or less	0.19 to 0.25 in.	Solder sleeve
In excess of 0.25	0.38 to 0.50 in.	Two piece ferrule

Figure 6. Solder Sleeve Wire Preparation Dimensions in Inches

Figure 7. Solder Sleeve, Proper Heating

Figure 8. Solder Sleeve, Underheated

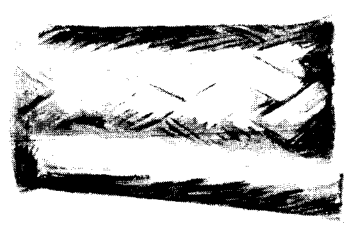


Figure 9. Solder Sleeve, Overheated

5.1.5.2 The primary insulation of the jumper wires for a two-piece crimp ferrule termination shall be removed 0.38 to 0.50 inch. See figure 6.

5.2 Shield Termination. The type of termination determines the method to be followed.

5.2.1 Solder Sleeve Termination.

5.2.1.1 Position the stripped end of the jumper wire toward the connector and parallel to the exposed shield of the conductor.

5.2.1.2 Slip the solder sleeve over the conductor and jumper wire with the solder preform ring positioned around the exposed shield and the pretinned end of the jumper wire.

NOTE: The size of the solder sleeve shall be selected according to the size of the termination.

5.2.1.3 Select the heat source previously calibrated for the particular size of solder sleeve. See appendix B. Position sleeve in fixture. Shrink and seal the sleeve into position, assuring solder flow.

CAUTION: Overheating a connection causes damage to the solder termination and to the conductor insulation. See figures 7, 8, and 9 for the appearance of properly heated, underheated, and overheated sleeves.

5.2.1.4 When design drawings specify maximum coverage of a conductor, the shield may be "floated" by folding back 0.19 to 0.25 inch of the shield over the outer insulation and shrinking a 0.38 to 0.50 inch length of shrink tubing over the foldback. A 0.19 to 0.25 inch, 360-degree opening for installation of the solder sleeve shall be made within 4 inches of the connector end bell or compound. See figure 10.

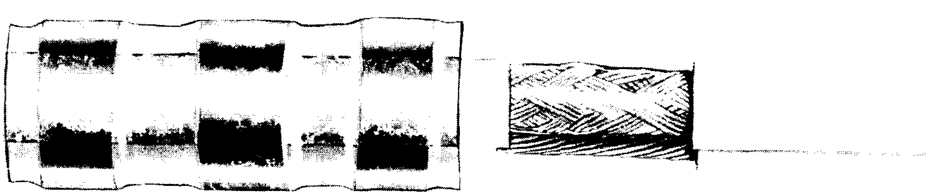


Figure 10. Solder Sleeve, 0.25 Inch, 360 Degree Opening

5.2.2 Two-piece crimp ferrule terminations. See figure 11.

5.2.2.1 Determine the size of ferrules from the cable diameter. The inner ferrule shall be sized to fit over the insulated wire and under the shield.

5.2.2.2 Select the outer ferrule to match the inner ferrule. Position the inner ferrule under the shield.

5.2.2.3 Position the jumper wire so it will enter between the shield and the outer ferrule, from the same direction as the shield.

5.2.2.4 Install the outer ferrule over the shield and inner ferrule. The inner ferrule shall extend a maximum of 0.06 inch beyond the outer ferrule on the shield cutoff side.

5.2.2.5 Using the appropriate tool, crimp the ferrule into position. Trim excess shield from around the ferrule.

5.2.2.6 Install a piece of shrink tubing over the outer ferrule. The shrink tubing shall extend to at least within 0.25 inch of the strain relief clamp or potting compound on the connector side and 0.50 inch on the cable side. The shrink tubing shall not be imbedded in the potting compound.

5.2.2.7 When the design drawing specifies maximum shield coverage, the ferrules may be located within 0.5 inch of the strain relief clamp or potting compound, provided the cable is preformed during fabrication.

5.2.3 When the drawing requires a floating shield, fold 0.19 to 0.25 inch of the shield back over the outer insulation and shrink a 0.38 to 0.50 inch length of shrink tubing over the foldback. The tubing shall be centered over the foldback.

5.3 Preassembly. Following installation of the shield termination the following steps shall be taken.

5.3.1 Place a snug fitting 0.75 to 0.88 inch length of insulating tubing over each conductor so it will be directly under the strain relief clamp when the cable is assembled.

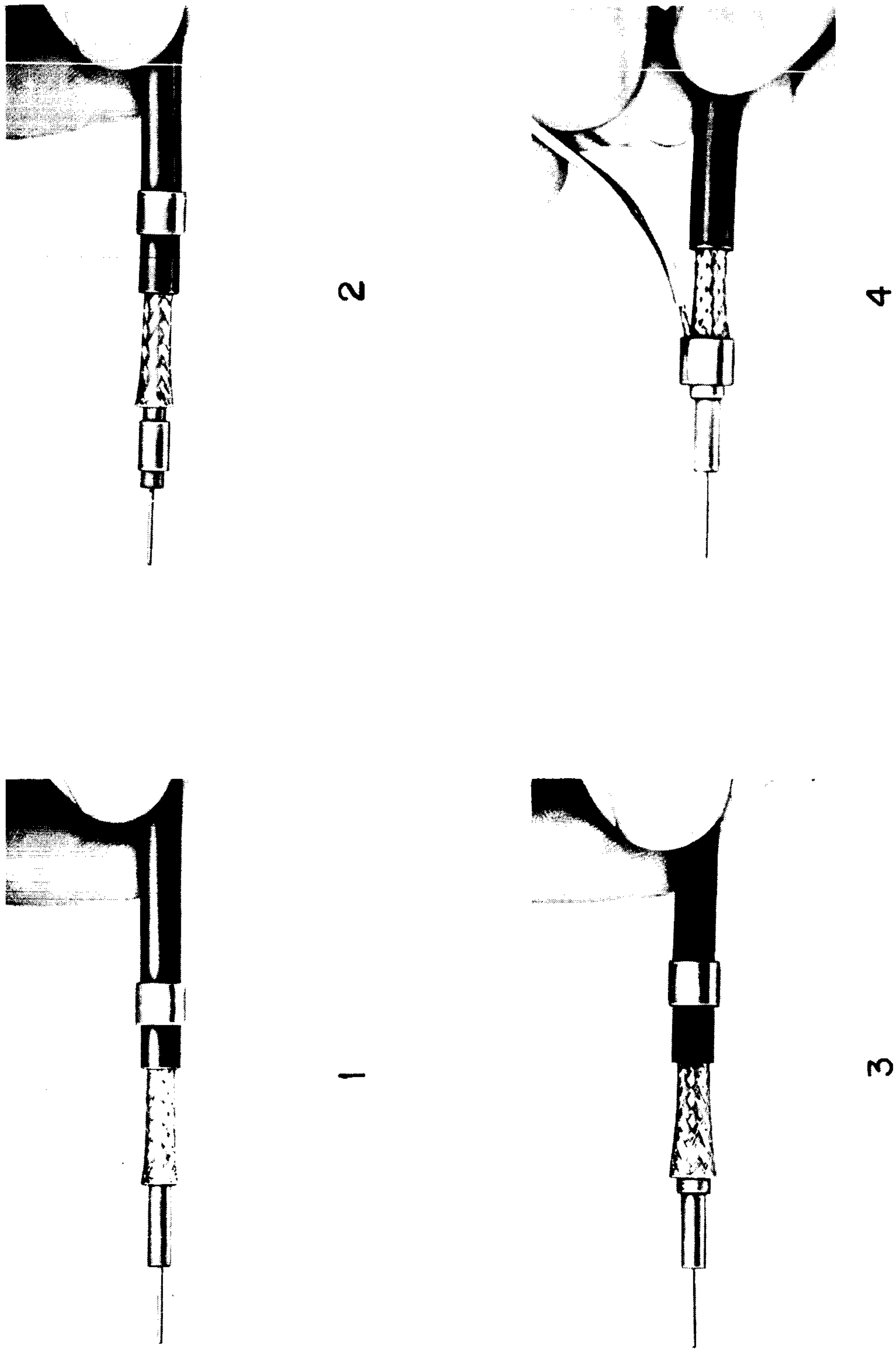


Figure 11. Two Piece Crimp Ferrule Termination

5.3.1.1 Potted or molded connector conductors shall be formed to prevent straight line deflection within 0.50 inch of the connection. Tubing shall not be used.

5.3.2 Prepare a jumper wire to extend from the stub splice to the connector contact.

NOTE: When size of connector contact will not permit use of an AWG22 wire, the connector contact shall determine the size of the jumper wire.

5.3.3 Attach connector contacts to conductors by appropriate means as follows. (Work all conductor crossovers back from the connector for a minimum distance of 8 inches.)

5.3.3.1 Crimp contacts. Crimp contacts shall be affixed to conductors by using tools specified in table I of appendix A. Insert the contacts into the connector with the appropriate insertion tool.

5.3.3.2 Solder contacts. After the conductors have been pretinned, insert them into contact wells. Place the soldering iron tip to the contour side of the contact. When the contact reaches a sufficient temperature, apply solder.

A fillet should be formed between the contact outer wall and the conductor. The solder shall follow the contour of the well entry slot and shall not spill over or adhere to the outside of the well (except for the slight tinned effect where the soldering iron tip contacts the case of the well). Wicking of solder up to the point of insulation termination is permitted. All outside strands shall be clearly discernible adjacent to the insulation. See figure 12.

NOTE: To prevent damage to the conductor by the soldering iron tip, the connector should be clamped with the contact contour toward the operator. Conductors should be inserted and soldered row by row from back to front.

5.3.4 Jumper wires shall terminate into stub splices in groups of 2 to 3 or 4 to 8, including the connector contact terminal jumper wire. See figure 13.

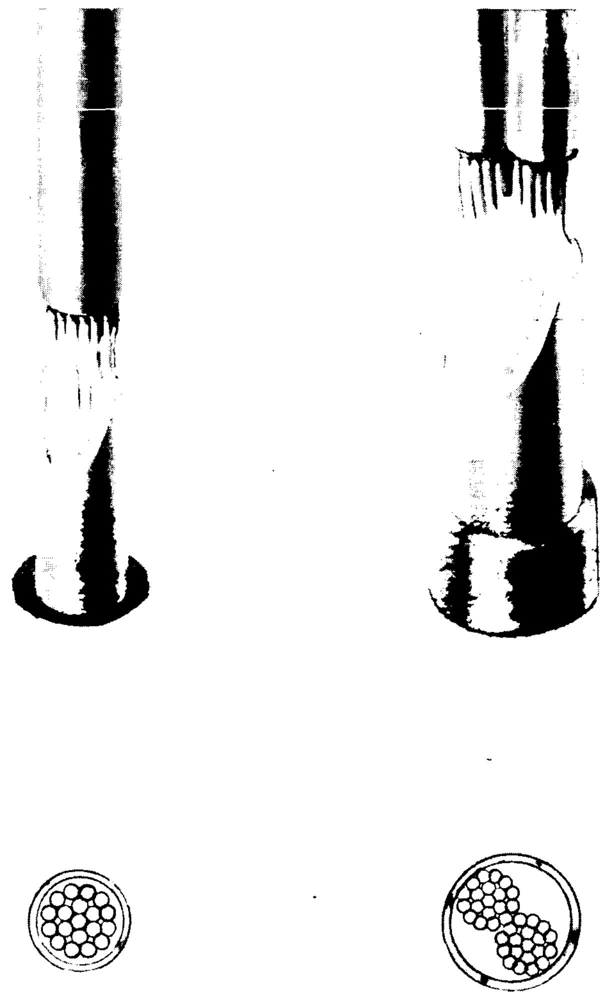


Figure 12. Proper Conductor to Contact Joint

5.3.4.1 The stub splice shall be within 3 inches of the last shielded conductor termination. See figure 14.

5.3.4.2 The connector contact termination jumper wire and the stub splice to stub splice jumper wire shall enter the stub splice from the same direction.

5.3.4.3 The stub splice to stub splice jumper shall have a strain relief loop of 1 to 2 inches.

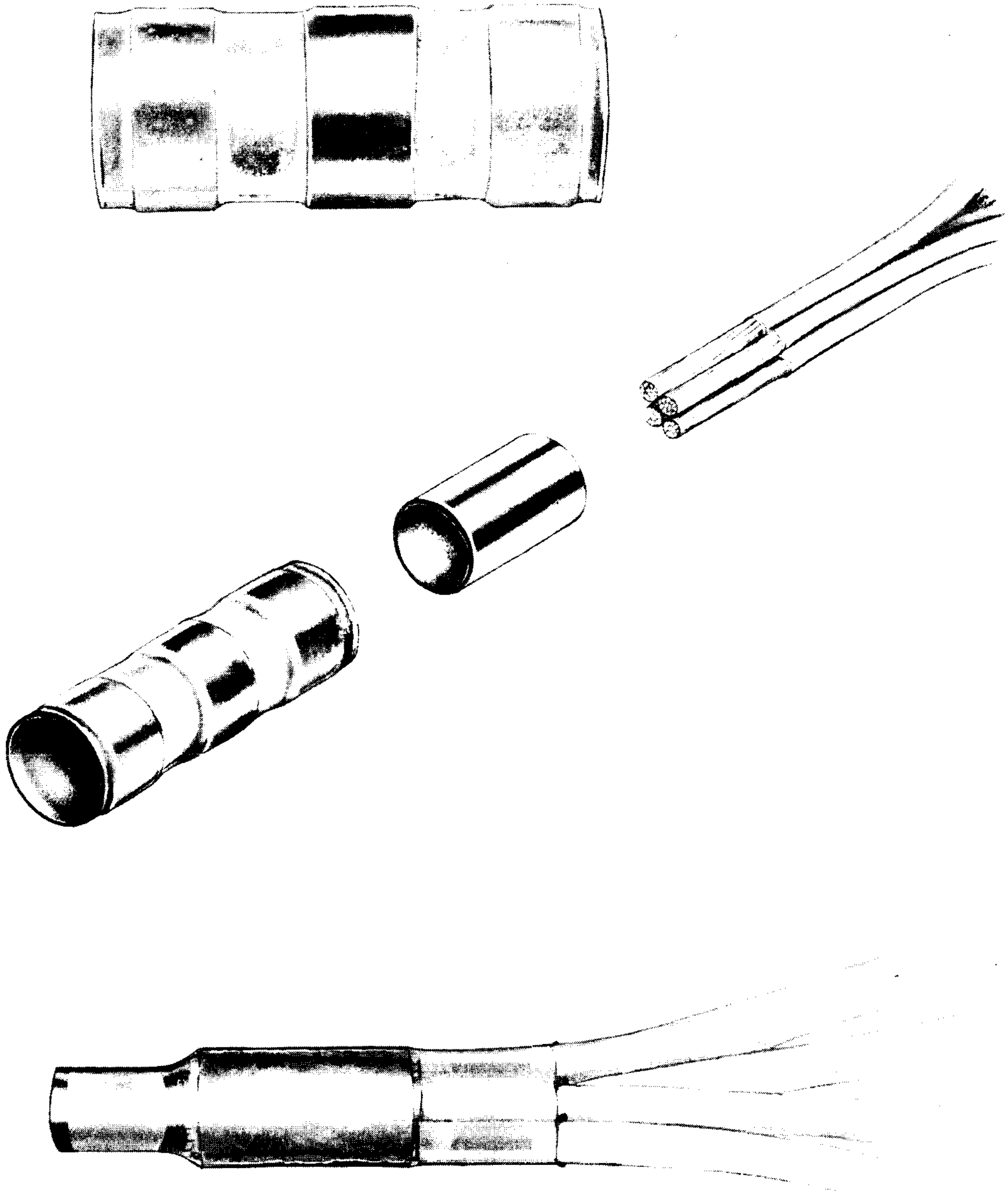


Figure 13. Solder Sleeve Stub Splice

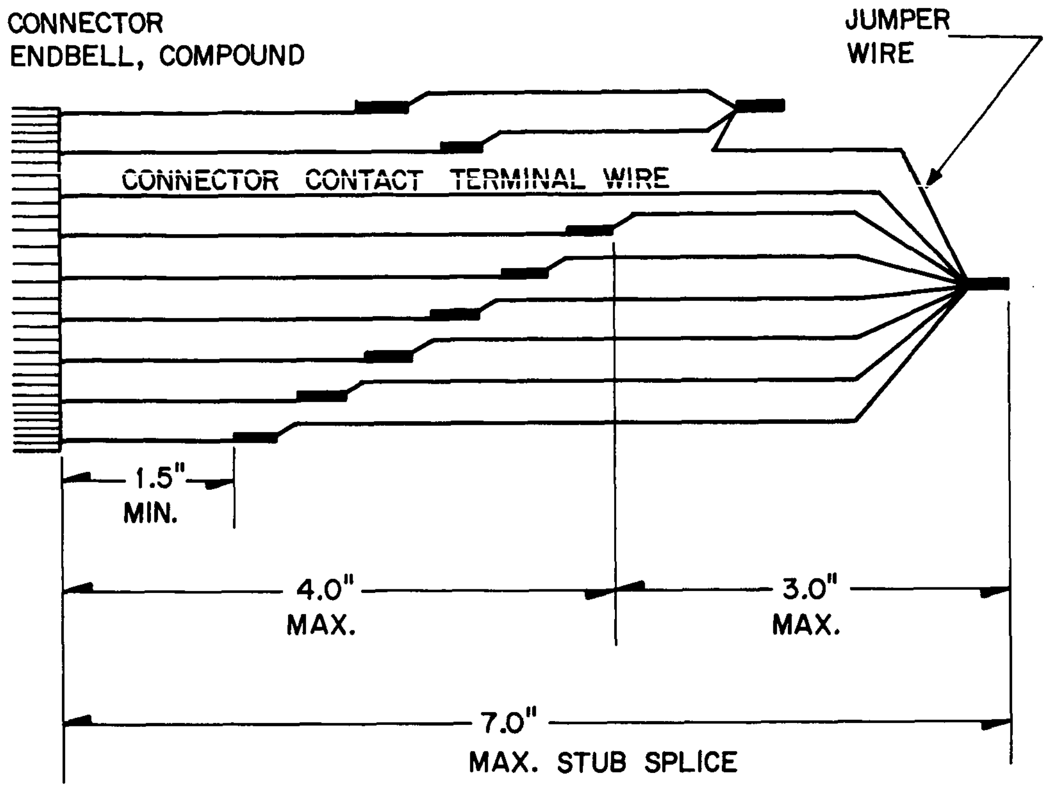


Figure 14. Termination and Stub Splice Dimensions

5.3.4.4 Strip insulation 0.19 to 0.25 inch from the conductor and install a one-piece termination ferrule. A ferrule with an inside diameter of 0.128 shall be used on groups of 4 to 8, and a ferrule with an inside diameter of 0.071 on groups of 2 or 3.

5.3.4.5 Crimp the ferrule as shown in figure 15. (This is a two-crimp operation.)

5.3.4.6 Install a solder sleeve over the jumper stub termination. See figure 13.

5.4 Final Assembly. Assemble the connector and position the strain relief clamp or pot the connector. Tighten the clamp until the tubing becomes slightly compressed.

Figure 15. Two Crimp Configuration

5.4.1 When the wire bundle or wire is not large enough to prevent the clamp from bottoming, filler rod material (silicone rubber) shall be used to position the wire for straight line feed from the connector grommet through the strain relief clamp.

5.4.2 Connector potting shall be performed as specified on the design drawing.

5.5 Coaxial Cables. Cables shall be prepared as specified by the connector manufacturer's assembly instructions.

5.5.1 When the design drawings specify the use of coaxial connector RF adapters to terminate the braid, the following method shall be used:

5.5.1.1 After the outer jacket has been removed as specified by the connector manufacturer, trim the braid to extend 0.344 ± 0.004 inch beyond the jacket. See figure 16.

5.5.1.2 Trim the dielectric back from the end of the conductor as specified by the connector manufacturer.

5.5.1.3 Rotate the dielectric to fan out the braid.

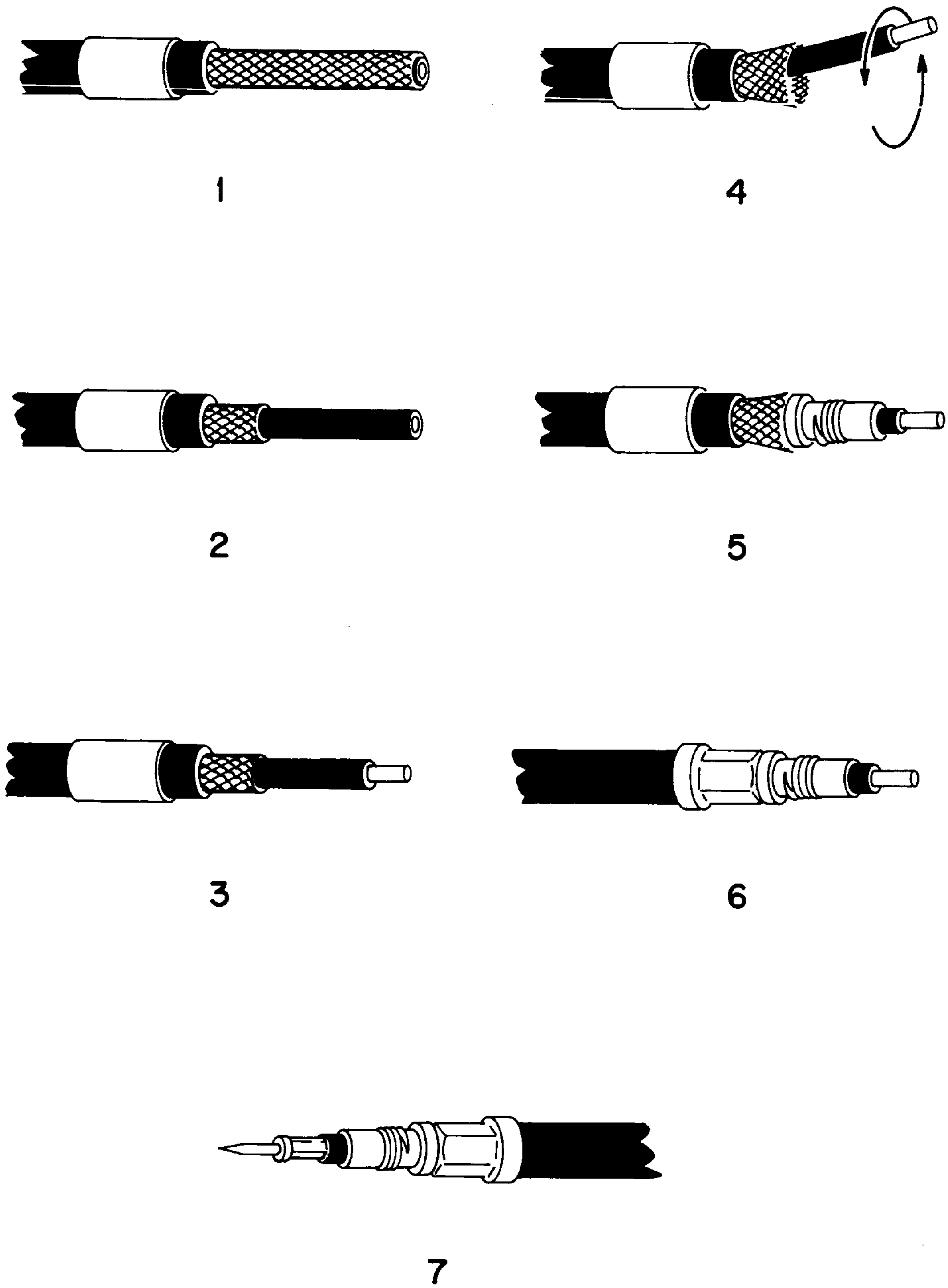


Figure 16. Coaxial Cable Preparation

5.5.1.4 Slide the adapter as far as it will go under the braid and hold firmly in place.

5.5.1.5 Slide the outer sleeve over the braid to the shoulder of the adapter. Crimp the outer sleeve using the adapter manufacturer's recommended tool.

5.5.1.6 Install the coaxial contact on the conductor and assemble by the connector manufacturer's instructions.

6. QUALITY REQUIREMENTS

6.1 Tooling Requirements. Processes discussed on this Special Report are controlled to a large extent by special tooling. The verification of the correct application of currently calibrated tooling will assure satisfactory terminations and preclude large quantities of rejects.

6.1.1 Verification of crimp tools. The tooling used to perform the connector contact crimping should be as specified in table I of appendix A and shall be calibrated to the tolerances of table I. Inspection shall verify that the calibration date is current and that the tool bears the serial number of one that is approved for the particular operation.

6.1.1.1 Inspection may, at their discretion, call for a spot check and require that samples be pulled between regular verification periods.

6.1.2 Verification of Heat Source. The heat source shall be initially qualified and the results recorded as required in appendix B. The heat source shall be subjected to initial qualification prior to the making of any connections for use on deliverable hardware.

6.1.2.1 Routine tests. The heat source shall be subjected to periodic recalibration as required in appendix B. Inspectors may at their discretion call for a recalibration at any time they suspect the heat source to have drifted out of the required heat timing range.

6.1.2.2 Alternate methods of heating sleeves may be utilized for specific application when approved by Quality Control and Manufacturing Engineering Departments.

In all cases, samples of the process shall be submitted at the start of work on each shift.

6.2 Materials. Materials used in processes covered by this document shall be verified against the design drawings. Materials produced by different manufacturers may be used provided they comply with the requirements of the applicable MSFC specification control drawing.

6.2.1 Wires and cable assemblies shall be of the length specified by the design drawings.

6.3 Sampling and Testing. Assurance of continuing product quality is gained by routine verification tests.

6.3.1 Crimp type connector pin or socket terminations shall be subjected to periodic tensile tests as provided in appendix A.

6.3.2 Solder sleeve connectors shall be verified for conformance to the design drawing. At the first use of sleeves from a new lot or shipment sample, wire terminations using these sleeves shall be made and tested as indicated in appendix B. The sample terminations shall be made with the same heat source and by the same personnel as the production units. Sample size shall be four.

6.4 Documentation. Quality documentation shall provide traceability of crimping operations to the specific tool that was used and of solder sleeve operations to the heat source and operator. The serial number of the tool and the initials of the operator shall be entered on the shop traveller.

6.4.1 Calibration record of the tooling shall be maintained as provided in appendices A and B and shall be retained until the tool is scrapped.

7. PACKAGING AND HANDLING

7.1 Damage Prevention. Caution shall be exercised to prevent damage to conductor insulation, connector pins, sockets, and shells of cables in storage, transportation, and assembly.

7.1.1 Conductor insulation. A semirigid container shall be used to store and transport cable. Connector shells shall not be allowed to rest on conductor insulation and shall be secured to prevent movement.

7.1.2 Connector damage. Dust caps shall be installed on the connection side of the solder type connectors when they are removed from storage bags and on crimp type connectors after assembly. A visual check should be made to ascertain pin alignment prior to capping. Rough handling, dropping, or banging against hard surfaces shall be avoided at all times.

7.1.3 Cable damage. The radii of bends shall be no smaller than the minima listed below:

	Diameter Range (In.)	Minimum Radius Bend
Coaxial cables	All	8 times the diameter of cable
Cable	.031 - .050	6 inches
	.051 - up	10 inches

APPENDIX A

CRIMPING TOOL CALIBRATION PROCEDURE

1. SCOPE

This appendix covers the Quality Control requirements for the qualification, calibration, and verification to be used to qualify hand and power crimping tools that produce solderless electrical connections on crimp type contacts.

2. APPLICABLE DOCUMENTS

MIL-T-22520A (WEP) Tool Crimping, Contact, Electrical Connector, (Class I or II).

3. GENERAL REQUIREMENTS

3.1 Serial Number. Each tool shall carry a serial number and be so marked that it can be identified. The serial number shall not appear on any other tool.

3.2 Contacts. The contacts and wire used for qualification test shall be identical to the contacts and wire that are to be used in the fabrication, and they shall be identified by size of contact, conductor, size, plating, and wire insulation used.

3.3 Gages. The "Go and "No-Go" gages used to check the calibration of tools shall correspond in size to the dimensions recommended in table I. These gages shall be certified to an accuracy of 0.0001 inch.

3.4 Tensile Testers. The tensile testers used to perform the pull tests shall have an accuracy of ± 1/2 pound per each 50 pounds.

3.4.1 Head travel control adjustable to 1 inch per minute and capable of maintaining this speed at ± 0.25 inch per minute. The test shall be run at this speed.

3.5 Qualification. A Quality Control representative shall witness the qualification of individual tools.

3.6 Records. Records of each tool calibration and verification test shall be maintained and the tool sealed or identified with accepted Quality Control tabs. Traceability of qualifications shall be recorded for each individual tool.

4. QUALITY CONTROL REQUIREMENTS

4.1 Initial Qualification and Serial Numbering of Tool

4.1.1 The calibration of the tool shall be checked with "Go" and "No-Go" gages using dimensions as indicated in table I. Any necessary adjustments shall be made at this time.

4.1.2 Tensile Tests. The required number of tensile test samples which shall be made after the tool has met the requirements of paragraph 4.1.1 are: three with normal action of the tool, three with deliberate attempts to cause an undercrimp, and three with deliberate attempts to overcrimp.

4.1.2.1 All tensile test samples shall be in accordance with the requirements specified in table I.

4.1.3 In the event a test sample fails to meet the requirements of paragraph 4.1.2.1, the tool shall be identified as rejected and removed from the shop area. Tools may be resubmitted to the calibration activity for verification and placed into operation upon successful readjustment and test.

4.1.4 All test results and identification requirements shall be recorded in the presence of a Quality Control representative and kept on file.

4.1.5 The serial number assigned shall be affixed to the tool by etching or engraving.

TABLE I. WIRE-CONTACT COMBINATION TOOL SELECTION AND TENSILE REQUIREMENTS

WIRE	CE CONTACT SIZE	AWG	BUCHANAN TOOLS 10620 or 10967 Locator	BUCHANAN TOOLS 10620 or 10967 Die	BUCHANAN TOOLS MS3191-1 Positioner	GAGE Go	GAGE No-Go	MIN. (POUNDS) TENSILE
MSFC-SPEC 40M39526	20	2-24	11078	.037	11-7771-5**	.036	.038	10
		22						20* 15
MSFC-SPEC 40M39513								
MIL-W-5086		20	11078	.043	11347-1	.042	.044	20
	16	2-22	11077	.053	11-7771-6**	.052	.054	20* 15
	16	2-20	11077	.053	11-7771-6	.052	.054	20
	16	16	11077	.053	11-7771-6**	.052	.054	50

* MSFC-SPEC 40M39526 and 40M39513 WIRE ONLY
** BENDIX PART NUMBER

Values included in Table 1 are more stringent than those in vendor specifications and have been determined to be reasonable for performing reliable crimps. Tensile testers used to perform the tests shall have an accuracy of ± 1/2 pound per each 50 pounds.

4.1.6 All adjustments of the tool which can affect the crimp shall be sealed and identified for a specific crimp operation.

4.2 Calibration and Verification Procedures

4.2.1 All multicrimp tools shall be verified for the combination of wire to contact and sealed with acceptable identification.

4.2.2 Calibration procedures.

4.2.2.1 Tools shall be inspected for alignment, wear, ratchet release or pneumatic action.

4.2.2.2 Tools are to be calibrated using tool manufacturer's procedures in accordance with table I or specific requirements as indicated on engineering drawings.

4.2.2.3 Hand crimping tools which exhibit total indentor travel in excess of 0.004 inch after release shall not be acceptable. This travel is determined by measuring the indentor spacing at the exact release point and again when the handles or pneumatic actuator are fully closed.

4.2.2.4 Crimping tools that bottom prior to release shall be checked for mechanical malfunctions.

4.2.2.5 Tools with accessible adjustments meeting the calibration procedure, and tools that have positioners for a specific crimp shall be sealed prior to issue.

4.2.3 Testing

4.2.3.1 Sample connections are to be assembled and crimped by workmen using the crimping tool.

4.2.3.2 The crimped contacts shall be inspected for workmanship and axial deformation. Tensile tests values shall be as specified in table I.

4.2.3.3 Quality Control shall identify tools with decals specifying the intended use and acceptability for that use.

4.2.3.4 Tools failing to meet requirements are to be withheld and the reasons indicated under "Remarks" on the record.

4.2.4 Verification period.

4.2.4.1 The routine verification check period and the extent of sampling shall be in writing. Occasionally spot checks may be requested verbally, but such requests shall be limited to three samples and the test results recorded. Any failing crimp shall be reason to remove the tool from the production area.

4.2.4.2 Performance inspection shall be made of samples (a) prior to beginning a series of contacts, by each operator, and (b) every eight hours of operation. Samples shall be identified and have a Quality representative's confirmation of acceptable crimp.

4.3 Recording of Data. All records of qualification, calibration, issue, service verification, reissue, recalibration, and tensile tests shall be recorded for each tool, together with the tool serial number, locator or positioner, wire size and types, and dates of tests and other data pertinent to the maintenance, serviceability, or failure history of the tool.

4.4 Improper Use of Tools. Tools shall be used only for the purpose specified on the decal or inspection seal.

APPENDIX B

HEAT SOURCE QUALIFICATION, CALIBRATION, AND VERIFICATION

1. SCOPE

This appendix covers the Quality Control requirements for the qualification, calibration, and verification of heat sources used to make solder sleeve type shield terminations.

2. APPLICABLE DOCUMENTS

None.

3. GENERAL REQUIREMENTS

3.1 Serial Number. Each heat source shall be marked with an individual serial number.

3.2 Wire and Solder Sleeves. The wire and solder sleeves used for the qualification test shall be identical to those to be used in assembly of electrical harnesses for use on deliverable hardware. They shall be identified by size, color, and wire insulation in the test report.

3.3 Tensile Testers. The tensile tests for the pull tests shall have an accuracy of ± 1/2 pound.

3.3.1 Head travel control adjustable to 1 inch per minute ± 0.25 in./min.

3.4 Qualification. The qualification of individual heat sources shall be witnessed by a representative of the Quality Control Department.

3.5 Records. The time setting required for making satisfactory joints in each of the sleeve sizes shall be recorded, and the record identified by serial number. The recorded values shall be compared with the test values at the recalibration or verification test.

4. QUALITY CONTROL REQUIREMENTS

4.1 Initial Qualification. The heat source shall be set at the manufacturer's recommended settings, and three solder sleeves in each of the sizes shall be attached. The joints shall then be pulled in the tensile tester. Results shall be recorded. If adjustments of time settings are needed, the tests shall be repeated until satisfactory joints are obtained. The settings should then be marked on the heat source.

4.2 Daily Verification Tests. At the start of each shift a sample sleeve shall be made in the size to be worked and submitted to inspection for verification of acceptable quality. Daily tensile tests are not required.

4.3 Periodic Recalibration. At periodic intervals (to be determined by the Quality Control Department) the tests of 4.1 above shall be repeated, and the results compared with those of the initial qualification tests.

4.4 Rejection. Any heat source which fails to make satisfactory joints on the daily sample shall be removed from the work area and sent to recalibration. It shall not be returned to service until, by readjustment or repair, it shall meet the requirements of its initial qualification.

4.5 Tensile Test Samples. For qualification of the heat source, three solder sleeves from those currently supplied to production shall be used in the tensile test.

4.5.1 Shield terminations. Prepare sample lengths of the shielded wire 8 to 12 inches long and jumper wires of the same length. Wire shall be the same as used in production and shall be prepared according to section 5, except that the jumper wire shall be brought out the opposite end of the sleeve for direct pull indication.

4.5.2 For tensile test of the crimped and covered stub splice, jumper wires shall be cut approximately 8 inches in length and prepared and spliced as in section 5, except that one wire must be brought out from the opposite end of the sleeve for direct pull indication.

4.5.3 Set the tensile test machine to pull at the rate of one inch per minute. Clamp the two ends of the specimens in the jaws of the testing machine and pull until a failure occurs. The fracture must occur in the wire rather than in the joint for shield terminations and shall not occur at the joint of stub splices.

APPENDIX C

PRELIMINARY EVALUATION OF THERMOFIT SOLDER SLEEVES

The purpose of this study was to determine the adequacy of Thermofit solder sleeves when used to connect nickel plated, Surok insulated, Alloy 63 wire to nickel plated copper shields.

The Thermofit solder sleeves are a product of Rayclad, Incorporated, of Redwood City, California.

Test samples were prepared by the Electrical Fabrication and Assembly Section (R-ME-DAE) of the Mechanical Engineering Laboratory at the George C. Marshall Space Flight Center as follows:

AWG 20 nickel plated conductors (pretinned and untinned) were terminated to nickel plated copper shields by means of Thermofit solder sleeves. The solder sleeves contained a preformed ring of fluxed solder. A heat source was used to melt the solder and to shrink the sleeves over the connections.

1. TENSILE TEST

Tensile tests, made by R-ME-DAE produced the results found in the table.

AWG Single Conductor
Nickel Plated Alloy 63

Untinned	Tinned
Tensile (lbs)	Tensile (lbs)
* 34.0	* 35.5
* 9.0	* 37.5
* 37.0	* 37.5
24.0	* 35.0
25.0	* 37.0
20.0	38.0
26.0	38.0
8.0	38.0
20.0	38.0
20.0	38.0
31.0	38.0
16.0	38.0

* Denotes TW and SH conductors.

NOTE: The inconsistent results obtained with untinned conductors make mandatory the requirement that all nickel plated wire be tinned prior to soldering.

While additional tests were performed, the results listed in the above test are representative.

The photographs of figures 17 through 20 show longitudinal and transverse cross sections of tinned and untinned solder joints. Note the superior intermetallic composition of the pretinned joints.

2. HUMIDITY TEST

Humidity tests were performed on the Thermofit solder joints by the Environmental Test Section (R-QUAL-QET) of the Quality and Reliability Assurance Laboratory.

The purpose of this test was to determine the resistance of the solder joints to corrosion.

Specimens were exposed to an environment of 90 to 98 percent humidity and 100 degree F temperature for 750 hours. At the completion of the test the specimens were forwarded to the Planning and Engineering Analysis Section for investigation of corrosion. Corrosion was not detected.

3. CONCLUSIONS

The results of the tests made in this investigation prove the adequacy of Thermofit solder sleeves as reliable connections when utilized in an approved manner.

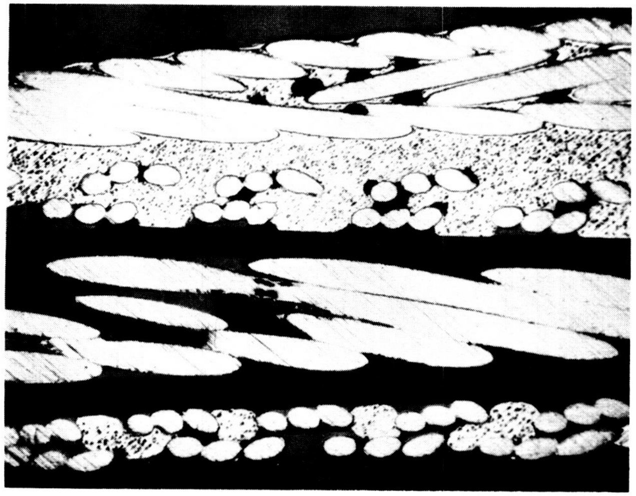


Figure 17. Longitudinal, Pretinned - 40X

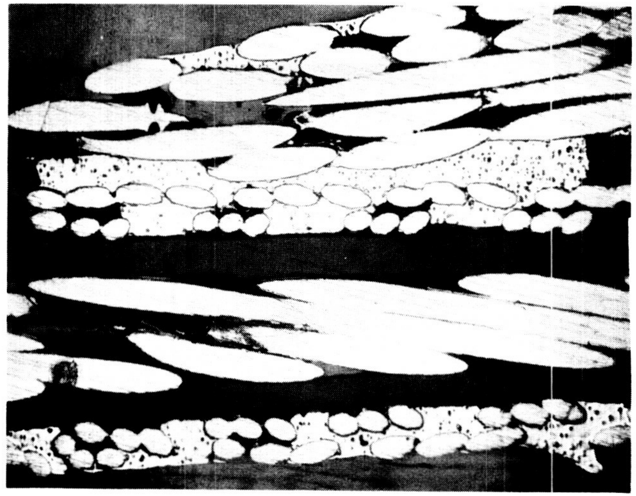


Figure 18. Longitudinal, Untinned - 40X

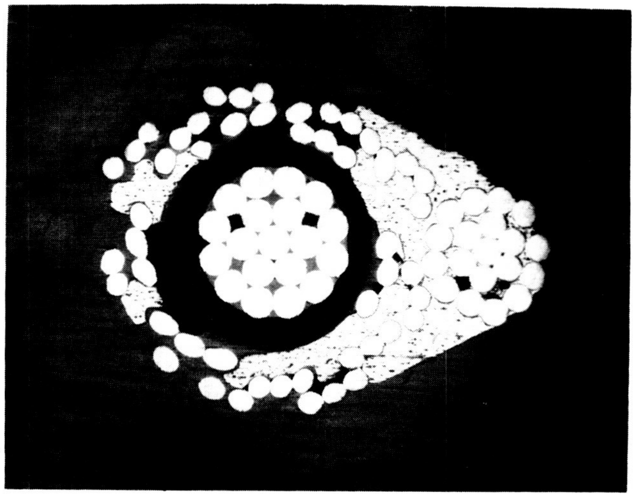


Figure 19. Transverse, Pretinned - 40X

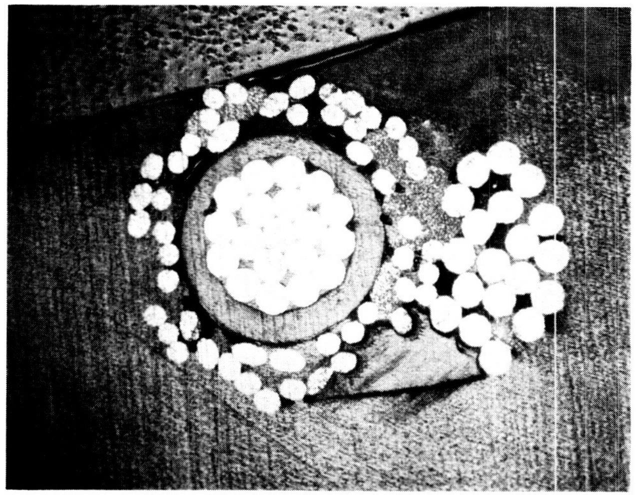


Figure 20. Transverse, Untinned - 40X