MIL-H-62540(AT)
15 June 1987
SUPERSEDING
(see 6.6)

MILITARY SPECIFICATION

HARNESS AND CABLE ASSEMBLIES

This specification is approved for use by US Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for electrical harness and cable assemblies.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

FSC 6145

SPECIFICATIONS
FEDERAL

QQ-B-575	- Braid, Wire, (Copper, Tin Coated, or Silver Coated, Tubular, or Flat).

MILITARY

MIL-C-22520	- Crimping Tools, Terminal Hand, Wire Terminations, General Specification for.
MIL-C-27500	- Cable, Electrical, Shielded and Unshielded, Aerospace.
MIL-C-39029	- Contact, Electrical Connector, General Specification for.
MIL-E-45782	- Electrical Wiring, Procedures for.
MIL-M-81594	- Marking Foil, Hot Stamp Printing of Electrical Insulating Materials.
MIL-T-81914/2	- Tubing, Plastic, Extra Flexible, Convoluted, Polytetrafluoroethylene Close Convolution.

STANDARDS
MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-130	- Identification marking of US Military Property.
MIL-STD-454	- Standard General Requirements for Electronic Equipment.
MIL-STD-810	- Environmental Test Methods.
MIL-STD-45662	- Calibration System Requirements.

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specifed, the issues shall be those in effect on the date of the solicitation.

DRAWINGS
ARMY

11655194	- Process Specification for Soldering Electrical Connections, for Electrical and Electronic Equipment, General Requirements for.
11663357	- Coating Viscous.

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

NATIONAL AEROSPACE STANDARD

NAS 1747 - Splice Conductor and Shield Termination, Solder Style, Heat Shrinkable, Insulated Specification for.

(Application for copies should be addressed to the Aerospace Industries Association of America, Inc., 1725 DeSales Street NW, Washington, D.C. 20036-0000)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. Unless otherwise specified (see 6.2), the contractor shall furnish harness and cable assemblies which shall be subjected to first article inspection (see 4.4). First article inspection samples, properly marked with identifying information shall be representative of the unit to be furnished to the Government. All subsequent harness and cable assemblies delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes.

3.2 Materials. Materials shall be as specified herein and in referenced specifications, standards, and drawings. Material shall be free from defects which adversely affect performance or serviceability of the finished product. Exposed functional parts shall be fabricated from suitable resistant materials or treated to prevent corrosion (see 4.8.1 and 6.4).

3.3 Design and construction. The harness and cable assemblies shall be assembled in accordance with the applicable harness and cable assembly drawings. The installation details of figures 1 through 12 shall guide fabrication where it is not detailed on the drawing (see 4.8.1).

3.3.1 Weight. The weight of the harness and cable assemblies shall not exceed the weight specified on the applicable drawing (see 4.8.2).

3.3.2 Length. The length of the harness and cable assemblies shall be as shown on the applicable drawing. Length measurements shall be as indicated in figure 1 (dimensions W, X, Y and Z) (see 4.8.2).

3.3.3 Tolerances.

3.3.3.1 Connector and adapter angular tolerances. The angular tolerance between the connector keyway and centerline of 45 degree (°) or 90° adapters shall be as specified in table I. Angular tolerance between the connector keyway and the centerline of the 90° boots shall be ± 10° (see 4.8.2).

TABLE I. Angular tolerance.

Shell size	Angular tolerance (°)
08	± 15°
09	± 15°
10	± 15°
11	± 15°
12	± 10°
13	± 10°
14	± 10°
15	± 10°
16	± 7.5°
17	± 7.5°
18	± 7.5°
19	± 7.5°
20	± 7.5°
21	± 5°
22	± 5°
23	± 5°
24	± 5°
25	± 5°
28	± 5°
32	± 5°
36	± 5°
40	± 5°

3.3.3.2 Dimensional tolerance. The dimensional tolerances on length dimensions shall be as follows (see 4.8.2):

Length [inches (in)]	Tolerances (in)
0 to 11.9	-0, +0.5
12 to 71.9	-0, +1.0
72 and up	-0, +2.0

3.3.4 Radio frequency interference (RFI) shielding. The RFI shielding shall be braided wire that meets the requirements of QQ-B-575. The shield shall provide not less than 95 percent (%) coverage when installed and shall be included inside the flexible convoluted jacketing. In special cases where double layer of shielding is specified a layer of jacketing shall be installed between the two layers of shielding and the shielding layers shall not come in contact with each other except at termination points. At each point where a piece of shielding ends, the shield shall be trimmed and sealed to eliminate frayed ends. A layer of jacketing extending one inch on each end of the shield shall be applied between the wire bundle and the shield. Each branch of the assembly shall contain one continuous piece of shield. Shields shall not be spliced. Shielding tape wrap shall be used at the transition points and shall overlap the RFI tubular shielding to the "Y" dimension given in figure 2. Shielding tape wrap shall be held in place using the methods shown in figures 2 and 3 (see 4.8.1 and 4.8.2).

3.3.4.1 Electromagnetic radiation (EMR). The harness and cable assemblies shall have EMR antenna characteristics. Changes made to the identification or the design of connectors, RF, or audio shields from those specified on the applicable harness or cable drawing and associated hardness assurance must be approved by the aquisitioning activity responsible for nuclear hardening and EMR protection (see 4.8.2).

3.3.4.2 Harness terminations. The harness terminations shall be as shown in figures 4, 5 and 6 or as specified on the applicable harness or cable assembly drawing. Terminating adapters and jacketing shall be bonded to mating parts with adhesive unless parts are supplied with adhesive coating. Terminating adapters, boots and jacketing shall be fully covered and watertight with no cracks, splits or abrasions. In cases where a boot is not specified on the drawing, a piece of heat shrinkable tubing shall be substituted. The length of this tubing shall be not less than 6 in. Harness terminations shall be designed to permit exposure of 2 in of wire at connectors and transitions. Harness termination backshells as shown in figure 4B, when associated harness requires RFI shielding, shall be torqued as specified in table II (see 4.8.2).

TABLE II. RFI adapter nut torque.

Shell size	Pound-force inches (lbf • in)	
	Min	Max
08	35	40
09	40	45
10	45	50
11	50	55
12	55	60
13	60	65
14	65	70
15	70	75
16	75	80
17	80	85
18	85	90
19	90	95
20	95	100
21	100	105
22	105	110
23	110	115
24	115	120
25	120	125
28	130	140
32	150	160
36	175	185
40	190	200

3.3.4.2.1 Cable terminating adapters. The cable adapters shall terminate the RFI shielding with a finish that is compatible with the finish of the mating electrical connectors and RFI shield. The adapter nuts shall be torqued to the values specified in table II with standard tools. The adapters shall have anti-rotation features to prevent rotation of the adapter body with respect to the connector (such features shall not preclude component removal to accomplish cable repair. The adapter diameter shall not exceed the diameter of the mating connector (see 4.8.2).

3.3.4.2.2 Shielded wire termination. Heat shrinkable solder sleeves shall be used to connect wire shields to the pigtail wires for termination. The sleeves shall be applied using an infrared heat gun and shall meet the requirements of NAS 1747. Unterminated shield ends shall be covered with the heat shrinkable tubing and shall extend not less than 0.25 inch on each side of the shield end. Sleeves shall be placed not further than three (3) inches from the rear of the connector grommet on connectors with straight backshells,

four (4) inches from the rear of the connector grommet on connectors with 45 or 90° backshells, and 1.5 to 2.5 in.from the rear of the wire positioner when wire positioners are used. The sleeves shall be staggered so that the wire bundle remains at a minimum. Each shield shall be trimmed and sealed to eliminate any frayed ends prior to installing sleeves on tubing (see 4.8.1 and 4.8.2).

3.3.4.3 Harness jacketing. All harness branches shall be covered with the jacketing specified on the harness drawing. When optional jacketing material is specified, each individual harness branch shall be completely covered with one option only. Jacketing shall extend into the boot or transition as specified in figures 2, 4, 5, 7, 8, 9 and 10, depending on the application. The jacketing shall be a flexible convoluted tubing that meets the requirements of MIL-T-81914/2. The convolution may be helical or annular. Bonding of jacket points to their mating parts shall provide a watertight joint. Excessive adhesive on the outside of the harness jacketing shall be removed (see 4.8.1 and 4.8.2).

3.3.4.3.1 Heat shrinkable tubing. The heat shrinkable tubing shall be uniformly shrunk to minimum diameters, determined by the bundle size, with no evidence of cracks, splits, or abrasions. Multiple sections of tubing may be used on long harness branches, provided each individual length is not less than 36 inches long and an overlap of not less than 2 in is maintained. All joints including overlaps, shall be sealed watertight using adhesive specified on the applicable harness or cable assembly drawing (see 4.8.1 and 4.8.2).

3.3.4.3.2 Heat sealable tape. The heat sealable tape shall be tightly wrapped with an overlap of not less than 50% to insure a watertight seal with a minimum harness bundle diameter (see figure 11). The tape shall be cured at temperatures and times specified on the applicable drawing. All joints where heat sealable tape interfaces shall be sealed with adhesive specified on the applicable harness or cable assembly drawing (see 4.8.1 and 4.8.2).

3.3.4.3.3 Adhesive. The adhesive application processes shall conform to adhesive manufacturers specifications. Cure temperatures shall not exceed the temperature rating or cause degradation of any harness or cable material and components (see 4.8.2).

3.3.4.4 Harness transitions. The harness transitions shall be positioned only after the harness jacketing has been installed over the individual branches (see figures 2 and 7). All transitions shall be watertight and free of cracks, splits, or abrasions. The transition shall withstand a horizontal load of not less than 200 pounds (lb) without damage. The transition shall provide for internal accessibility to permit cable repair. Transition reassembly shall be performed without the aid of adhesives. When optional material is specified, only one option shall be used on any individual harness assembly. The existence of a heat shrinkable transition and a heat sealable tape transition on the same assembly is unacceptable (see 4.8.2 and 4.8.3).

3.3.4.4.1 Heat shrinkable transition. The heat shrinkable transition entries shall all be sealed with the adhesive specified on the applicable harness or cable assembly drawing (see 4.8.2).

3.3.4.4.2 Heat sealable tape transition. The heat sealable tape transitions shall be constructed in accordance with figures 8, 9, 10 and 12. Not less than two layers of tape shall be used at all locations. Transitions may be constructed of one continuous piece of tape (see 4.8.2).

3.3.5 Pull strength. The harness and cable assemblies shall meet the requirements of 3.4.1 and 3.4.2 after being subjected to a force of 100 lb applied along the cable axis between the cable terminations for 30 seconds (sec) (see 4.8.2 and 4.8.4).

3.3.6 Bend radius. The natural bend radius of harness and cable assemblies under 3 feet (ft) in length shall not stress the internal wires when a 5 lb load is applied to the free end of the assembly (see 4.8.2 and 4.8.5).

3.3.7 Connector assembly.

3.3.7.1 Crimping.

3.3.7.1.1 Connector contacts. The crimp type connector contacts shall be crimped using procedures defined in MIL-C-22520, and must comply with the requirements specified in MIL-C-39029 except for 1/0 gauge contacts. The crimp barrel of the crimped 1/0 gauge contact shall not exceed 0.595 inch in diameter and the rear or wire end shall measure within the tolerance zone as specified in figure 13. After crimping, the wire axis and contact axis shall be in line with the limits specified in figure 13. The acceptable crimp tensile strength shall be not less than 550 lb axial load when measured in accordance with the performance requirements of MIL-C-39029 (see 4.8.2).

3.3.7.1.2 Terminal lugs. The crimp type terminal lugs shall be crimped to conductors in a manner that conforms with the requirements of MIL-E-45782 (see 4.8.2).

3.3.7.2 Unused contact locations. All unused connector contact locations shall be filled with contacts and all unused grommet feed through holes shall be plugged (see 4.8.2).

3.3.7.3 Connector threads. The connector threads shall be coated with a viscous coating conforming to Drawing 11663357 (see 4.8.2).

3.3.8 Soldering. The soldering of all harness and cable assemblies shall be in accordance with Drawing 11655194 (see 4.8.2).

3.3.9 Fill factor. The fill factor of harness and cable assemblies shall be not more than 70% (see 4.8.2 and 6.3.2).

3.3.10 Spare wires. The harness and cable branches shall contain not less than 10% or at least two spare wires without wire markings (see 4.8.2).

3.3.11 Elastomers. All age sensitive elastomers in harness and cable assemblies shall be installed in the assembly within 8 quarters after the cure date (see 4.8.1 and 4.8.2).

3.4 Performance.

3.4.1 Direct current (dc) resistance. Unless otherwise specified on the harness or cable assembly drawing, the dc resistance measured from the connector contact at one end of a wire conductor to the corresponding contact at the other end (as indicated by the harness and cable assembly wiring diagrams) shall not be greater than the following listed values:

22 AWG 1/ -	0.85 ohm	8 AWG -	0.03 ohm
20 AWG -	0.5 ohm	4 AWG -	0.015 ohm
16 AWG -	0.2 ohm	0 AWG -	0.005 ohm
12 AWG -	0.1 ohm		

1/ American Wire Gauge (AWG) number.

When RFI shields are terminated at the connector shells, the dc resistance between any two connector shells of the assembly shall not exceed 0.5 ohm (see 4.8.6).

3.4.2 Insulation resistance. Unless otherwise specified on the harness or cable assembly drawing, the insulation resistance shall be not less than 100 megohms when measured at 500 ± 50 volts (V) dc applied for at least one second between connector pins and the assembly connector and between isolated circuits (see 4.8.7).

3.4.3 Environmental. Assemblies shall meet the environmental requirements specified in 3.4.3.1 through 3.4.3.4. Assemblies exceeding 3 ft in length, after being exposed to environmental conditions specified in 3.4.3.1 through 3.4.3.4, shall have a bend radius of not less than 3 in (see 4.8.8).

3.4.3.1 Humidity. The harness and cable assemblies shall meet the specified performance requirements of 3.4.1 and 3.4.2, during and after exposure to a relative humidity of 94 ± 4% at 95 ± 2 degrees Fahrenheit (°F) (see 4.8.8.1).

3.4.3.2 Low temperature.

3.4.3.2.1 Storage. The harness and cable assemblies shall meet the specified performance requirements of 3.4.1 and 3.4.2, after exposure to ambient temperature down to -60°F (see 4.8.8.2).

3.4.3.2.2 Operating. The harness and cable assemblies shall meet the specified performance requirements of 3.4.1 and 3.4.2, during and after exposure to temperature down to -60°F (see 4.8.8.2).

3.4.3.3 High temperature.

3.4.3.3.1 Storage. The harness and cable assemblies shall meet the specified performance requirements of 3.4.1 and 3.4.2, after exposure to ambient temperature up to 160°F (see 4.8.8.3).

3.4.3.3.2 Operating. The harness and cable assemblies shall meet the specified performance requirements 3.4.1 and 3.4.2, during and after exposure to temperature up to 140°F (see 4.8.8.3).

3.4.3.3.3 Extreme. When specified on the applicable harness or cable drawing, the assembly shall meet the performance requirements of 3.4.1 and 3.4.2 during and after exposure to the extreme high temperature of 300°F (see 4.8.8.3).

3.4.3.4 Submergence. The harness and cable assemblies shall meet the specified performance requirements of 3.4.1 and 3.4.2, before, during and after submergence. The assembly shall be subjected to a differential pressure of 3 $\pm$ 0.5 pounds per square inch (psi) (see 4.8.8.4).

3.5 Identification marking and color.

3.5.1 Harness and cable marking. Unless otherwise specified on the applicable harness or cable drawing the harness and cable assemblies identification shall be marked on the outer surface of the jacket in accordance with MIL-STD-130 using characters at least 0.12 inch high, placed within 24 in of each connector. In the case of assemblies greater than 0.625 inch in diameter, markings shall be located 180° opposed. Markings shall remain legible after exposure to all environments (see 4.8.2).

3.5.2 Marking indentification. Marking identification information shall be as specified on the application drawing. As a minimum, each assembly shall be identified by the following:

a. Harness or cable assembly part number.
b. Harness or cable reference designation (short sign).
c. Serial number.
d. Month and year of manufacture.
e. Manufacturers code identification (FSCM).
f. Termination reference designations (Placed near the termination but separate from the harness and cable assembly identification).

3.5.2.1 Lettering color. When opaque harness and cable markers are used, dark lettering such as blue or black shall be used; when translucent harness and cable markers are used, light lettering such as white shall be used (see 4.8.2).

3.5.2.2 Wire marking. Marking of wire conductors shall be as specified on the applicable drawing. The applicable numbers shall be marked on the wire within 1.5 to 5 in of the point of termination in ascending order in accordance with MIL-C-27500. The marking shall be visible when the wire is installed in the electrical connector. Marking material and requirements shall be in accordance with MIL-M-81594 (see 4.8.2).

3.5.2.3 Exposed surface colors. Unless otherwise specified on the applicable harness or cable assembly drawing, all exposed metalic fittings shall be olive drab in color and exposed sheating material shall be black (see 4.8.2).

3.5.3 Age control. The harness and cable assemblies that contain any synthetic, age sensitive elastomers shall have the assembly date and the earliest cure date (in quarter and year) indelibly affixed to the assembly (see 4.8.2).

3.6 Workmanship. Workmanship shall be in accordance with 3.6.1, 3.6.2 and MIL-STD-454, requirement 9 (see 4.8.2).

3.6.1 Insulation stripping. The removal of insulation from electrical wire conductors, 12 AWG and smaller, and from outer jackets of shielded cables shall be performed so that there is no evidence of physical damage to the individual wire or braided strands. Minor damage to strands of larger conductors is permitted but shall not exceed the limits specified in Drawing 11655194. For crimp style contacts, the insulation shall be removed from the conductor to a distance within the limits specified for dimension "A" in figure 14. Insulation gap for crimp type terminal lugs shall be as specified in MIL-E-45782 (see 4.8.2).

3.6.2 Contact insertion in connectors. Damage to connector inserts or the contacts due to insertion or extraction is unacceptable. The insertion and extraction tools recommended by the manufacturer of connector and contacts shall be used in all cases. Alcohol or lubricants recommended by the connector manufacturer may be used as an aid to contact insertion. The connector assembly is to be thoroughly dried after lubricant application and there shall be no evidence of residue from lubricant remaining on the connector insert or contacts (see 4.8.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform or witness any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply wih all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Inspection equipment. Unless otherwise specified in the contract (see 6.2), the contractor is responsible for the provision and maintenance of all inspection equipment necessary to assure that supplies and services conform to contract requirements. Inspection equipment must be capable of repetitive measurements to an accuracy of 10% of the measurement tolerance. Calibration of inspection equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspection:

a. First article inspection (see 4.4).
   1. Preproduction inspection (see 4.4.1).
   2. Initial production inspection (see 4.4.2).

b. Quality conformance inspections (see 4.5).
   1. Examination (see 4.5.2).
   2. Tests (see 4.5.3).

c. Control tests (see 4.6).

4.3 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

a. Air temperature 73 $\pm$ 18°F
b. Barometric pressure 28.5 + 2.0 - 3.0 inches mecury (in Hg)
c. Relative humidity 50 $\pm$ 30%

4.4 First article inspection. First article inspections shall be performed on preproduction or initial production samples as specified herein. Approval of the first article sample by the Government shall not relieve the contractor of the obligation to supply harness and cable assemblies that are fully representative of those inspected as a first article sample. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer.

4.4.1 Preproduction inspection. When specified (see 6.2), the preproduction sample shall consist of two assemblies. Preproduction inspection shall consist of inspection as specified in table III.

TABLE III. Classification of inspections.

Title	Requirement	Inspection	First article	Quality conformance		Control
				Examination	Tests	
Materials and construction	3.2 thru 3.3	4.8.1	X			X
Defects (see 4.5.2 and table IV)	3.3.1 thru 3.3.11 and 3.5 thru 3.6.2	4.8.2	X	X		
Harness transitions	3.3.4.4	4.8.3	X		X	X
Pull strength	3.3.5	4.8.4	X		X	X
Bend radius	3.3.6	4.8.5	X		X	X
Direct current resistance	3.4.1	4.8.6	X		X	X
Insulation resistance	3.4.2	4.8.7	X		X	X
Environmental	3.4.3	4.8.8	X		X	X
Humidity	3.4.3.1	4.8.8.1	X		X	X
Low temperature	3.4.3.2	4.8.8.2	X		X	
Storage	3.4.3.2.1	4.8.8.2	X		X	
Operating	3.4.3.2.2	4.8.8.2				
High temperature	3.4.3.3	4.8.8.3	X		X	
Storage	3.4.3.3.1	4.8.8.3	X		X	
Operating	3.4.3.3.2	4.8.8.3	X		X	
Extreme	3.4.3.3.3	4.8.8.3	X		X	
Submergence	3.4.3.4	4.8.8.4	X		X	X

4.4.2 Initial production inspection. Unless otherwise specified (see 6.2), the Government shall select two assemblies, from the first 10 assemblies produced under the production contract for initial production inspection. Initial production units shall be inspected as specified in table III.

4.4.3 First article inspection failure. Test item deficiencies during, or as a result of, the first article test, shall be cause for rejection of the items until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of the first article test, shall be evidence that all items already produced prior to completion of the first article test are

similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government will not accept products until first article testing is completed to the satisfaction of the Government.

4.5 Quality conformance inspection.

4.5.1 Sampling.

4.5.1.1 Lot formation. An inspection lot shall consist of all the harness and cable assemblies of one type and part number, from an identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.5.1.2 Sampling for examination. Samples for quality conformance examination shall be selected in accordance with general inspection level II of MIL-STD-105. Before sampling may be initiated, the contractor shall establish by examination of at least 20 consecutively produced assemblies that the process average percent defective, as defined in MIL-STD-105, is not greater than the specified AQLs.

4.5.2 Examination.

4.5.2.1 Acceptable quality level. Each sample selected in accordance with 4.5.1.2 shall be examined to determine conformance to the following acceptable quality levels (AQL).

Classification	AQL
Major	1.0
Minor	2.5

4.5.2.2 Classification of defects. For examination purposes, defects shall be classified as listed in table IV.

TABLE IV. Classification of defects.

Category	Defect	Method of examination
Critical	None	
Major	AQL 1.0	
101	Incorrect dimensions affecting interchangeability (see 3.3, 3.3.3.1 and 3.3.3.2).	SIE 1/
102	Improper weight (see 3.3.1).	SIE
103	Improper length (see 3.3.2).	SIE
104	Improper RFI shielding (see 3.3.4 and 3.3.4.1).	Visual and SIE

TABLE IV. Classification of defects - Continued.

Category	Defect	Method of examination
105	Improper harness termination (see 3.3.4.2).	Visual
106	Improper cable terminating adapters (see 3.3.4.2.1).	Visual and SIE
107	Improper shielded wire terminations (see 3.3.4.2.2).	Visual and SIE
108	Improper harness jacketing (see 3.3.4.3).	Visual and SIE
109	Improper heat shrinkable tubing application (see 3.3.4.3.1).	Visual and SIE
110	Improper heat sealable tape application (see 3.3.4.3.2).	Visual and SIE
111	Improper adhesive application (see 3.3.4.3.3).	Visual and SIE
Minor	AQL 2.5 Defective	
201	Incorrect dimensions not affecting interchangeability, not within tolerance (see 3.3, 3.3.3.1 and 3.3.3.2).	Visual and SIE
202	Improper workmanship affecting appearance (see 3.6 thru 3.6.2).	Visual

1/ SIE = Standard Inspection Equipment.

4.5.3 Tests. Each harness and cable assembly shall be subjected to the quality conformance tests specified in table III.

4.6 Control tests. Unless otherwise specified (see 6.2), harness and cable assemblies for control tests shall be subjected to the tests specified in table III. The frequency of selected test samples shall be specified by the acquisitioning activity.

4.7 Failure. Failure of any harness or cable assembly to pass any of the specified quality conformance or control tests shall be cause for the Government to refuse acceptance of the production quantity represented, until action taken by the contractor to correct defects and prevent recurrence has been approved by the Government.

4.8 Methods of inspection.

4.8.1 Materials and construction. Conformance to 3.2 and 3.3 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.8.2 Defects. Conformance to 3.3.1 through 3.3.11 and 3.5 through 3.6.2 shall be determined by examination for the defects listed in table IV. Examination shall be visual, tactile, or by measurement with standard inspection equipment.

4.8.3 Harness transitions. To determine conformance to 3.3.4.4, the harness and cable assemblies shall be tested in accordance with MIL-STD-202, method 211A, condition A. Each end of the harness or cable assembly shall be clamped in a suitable holding fixture (harness and cable assemblies terminations shall not be used for clamping in this test setup). Care shall be taken not to damage the harness or cable assembly with excessive clamping force. A force of 200 lb shall be applied along the assemblies horizontal axis for a period of 5 to 10 sec. A calibrated scale with an accuracy of $\pm$ 2% shall be used to measure the pull force. Following the measurement the assembly shall be inspected for damage to the transition and then subjected to the tests of 4.8.6 and 4.8.7.

4.8.4 Pull strength. To determine conformance to 3.3.5, the harness and cable assemblies terminations shall be tested in accordance with MIL-STD-202, method 211A, condition A. Terminations at each end of the assembly shall be clamped in a suitable holding fixture. Care shall be taken not to damage the termination with excessive clamping force. A force of 100 lb shall be applied along the assembly axis for a period of 30 sec. Vertical orientation is preferred, however, horizontal orientation is allowed for long harness and cable assemblies. A calibrated scale with an accuracy of $\pm$ 2% shall be used to measure pull force. Following the force measurement, the assembly shall be inspected for damage to connectors, terminals, wire and insulation and then subjected to the tests of 4.8.6 and 4.8.7.

4.8.5 Bend radius. To determine conformance to 3.3.6, one end of a harness or cable assembly shall be clamped in a suitable holding fixture. Care must be taken not to damage the assembly with excessive clamping force. A 5 lb load shall be applied to the free end of the assembly. A calibrated scale, within an accuracy of $\pm$ 2% shall be used to measure the load force. The natural bend radius of the assembly shall not stress the internal wires. There shall be no evidence of damage to the assembly. Upon completion of this test the assembly shall be subjected to the tests of 4.8.6 and 4.8.7.

4.8.6 Direct current resistance. To determine conformance to 3.4.1, the harness and cable assemblies shall be tested in accordance with MIL-STD-202, method 303.

4.8.7 Insulation resistance. To determine conformance to 3.4.2, the harness and cable assemblies shall be tested in accordance with MIL-STD-202, method 302, test condition B. Measurement may be taken prior to the 2 minute electrification time if the insulation resistance meets the specified limit and is steady or increasing.

4.8.8 Environmental. To determine conformance to 3.4.3, the harness and cable assemblies shall subjected to the environmental tests specified in 4.8.8.1 through 4.8.8.4. The minimum bend radius test for assemblies over 3 ft in length shall be performed in conjunction with the low temperature tests specified in 4.8.8.2.

4.8.8.1 Humidity. To determine conformance to 3.4.3.1, the harness or cable assembly shall be placed in a humidity chamber and subjected to the test specified in MIL-STD-810, method 507.2, procedure II. During and after the humidity exposure the assembly shall be subjected to the tests of 4.8.6 and 4.8.7.

4.8.8.2 Low temperature. To determine conformance to 3.4.3.2, the harness or cable assembly shall be subjected to low temperature tests of MIL-STD-810, method 502.2, procedure I. The temperature of -60°F shall be maintained for a period of 24 hours (hr). At the end of this time, with the temperature stabilized at -20°F, bend the harness or cable assembly (at least 180°) around a 6 inch diameter mandrel. There shall be no evidence of cracks, splits or other damage to the jacketing or conduit. After the inspection and with the temperature stabilized at -20°F, perform the tests of 4.8.6 and 4.8.7. After testing return the assembly to 73 $\pm$ 18°F and perform tests of 4.8.6 and 4.8.7.

4.8.8.3 High temperature. To determine conformance to 3.4.3.3, the harness or cable assembly shall be subjected to the high temperature tests of MIL-STD-810, method 501.2, procedure I. The temperature of +160°F shall be maintained for a period of 48 hr. At the end of this time, return the temperature to +140°F and perform the tests of 4.8.6 and 4.8.7. After testing return the assembly to 73 $\pm$ 18°F and perform the tests of 4.8.6 and 4.8.7. When specified on the applicable harness or cable drawing, the assembly shall be subjected to the extreme high temperature of +300°F for a period of 48 hr and the tests of 4.8.6 and 4.8.7 performed. After testing return the assembly to 73 $\pm$ 18°F and repeat test 4.8.6 and 4.8.7.

4.8.8.4 Submergence. To determine conformance to 3.4.3.4, the harness or cable assembly shall be submerged in a container with the uppermost surface not less than 1 inch below the surface of the liquid and subjected to a differential pressure of 3 $\pm$ 0.5 psi (the internal pressure of the assembly is positive with respect to the external pressure) for a period of 5 minutes $\pm$ 30 sec. Bubbles coming from within the assembly shall be considered leakage. Bubbles resulting from entrapped air on the exterior surface shall not be considered a leak. Connector caps or any suitable device to prevent leakage through the pin opening is permissible. Before, during and after submergence the assembly shall be subjected to the tests of 4.8.6 and 4.8.7. A 5 minute drip dry period is permissible prior to performance of tests conducted after removal from the liquid container.

5. PACKAGING

5.1 Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking for the desired level shall be in accordance with the applicable packaging standard or packaging data sheet specified by the contracting authority (see 6.2).

6. NOTES

6.1 Intended use. The harness and cable assemblies are intended to provide electrical interconnection between operating components and test equipment of the M1 tank system. The harness or cable assembly will also provide environmental, mechanical, and RFI protection for individual electrical wiring. The connectors on each assembly are keyed to minimize the possibility of improper mating to equipment.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Harness or cable assembly drawing number and date.
c. If first article samples are not required (see 3.1).
d. If responsibility for inspection shall be other than as specified (see 4.1).
e. If responsibility for inspection equipment shall be other than as specified (see 4.1.2).
f. If inspection conditions shall be other than as specified (see 4.3).
g. If preproduction inspection is required (see 4.4.1).
h. If initial production inspection is not required (see 4.4.2).
i. Sampling plan for control testing (see 4.6).
j. If control tests are not required (see 4.6).
k. Applicable levels of preservation, packaging, packing and marking (see 5.1).

6.3 Definitions.

6.3.1 Harness and cable jacketing. Harness and cable jacketing is the exterior elastomeric harness cover which accounts for the assembly's water resistance capability. This elastomeric jacketing includes, but is not limited to, heat shrinkable tubing, heat sealable tape, boots and transitions.

6.3.2 Cable fill factor. The cable fill factor is the ratio of the number of conductor pairs in use to the total number of pairs in a cable. The maximum cable fill is the percentage of pairs in a cable which may be used safely and economically without serious interference with the availability and continuity of service.

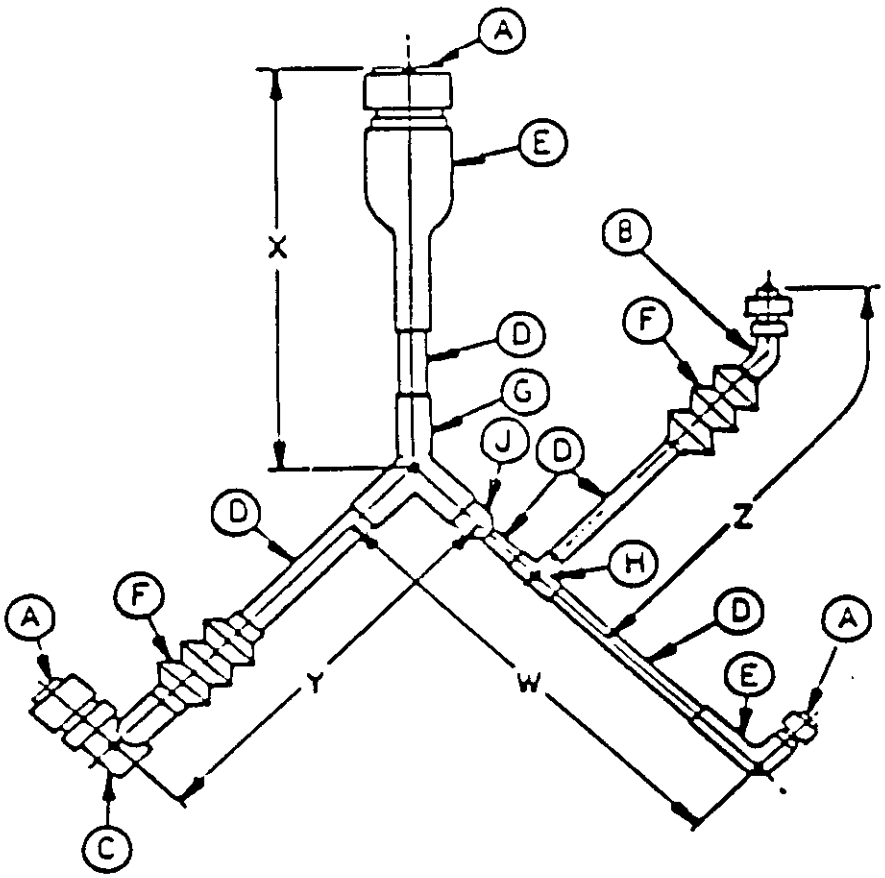
6.4 Disposition of test assemblies. The harness and cable assemblies that have been damaged undergoing tests shall not be used and shall be indelibly marked "DO NOT USE".

6.5 Recycled materials. The use of recycled materials which meet the requirements of the applicable material specifications without jeopardizing the intended use of the item shall be encouraged (see 3.2).

6.6 Subject term (key word) listing.

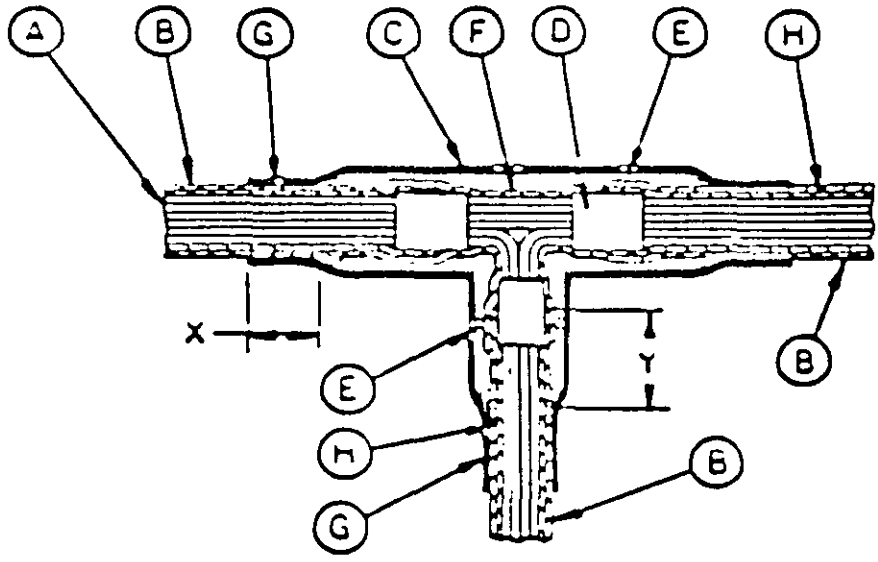
Cable assemblies
Harness assemblies
Harness and cable assemblies

6.7 Supersession data. This military specification supersedes General Dynamics specifications, SC-X15110E, dated 7 October 1986 and SC-X00516, dated 8 March 1984.



A. CONNECTOR ASSEMBLY
B. 45° R.F.I. ADAPTER
C. 90° R.F.I. ADAPTER
D. HEAT SHRINKABLE TUBING
E. BOOT
F. BOOT, CONVOLUTED
G. TRANSITION, "Y"
H. TRANSITION, "T"
I. ADAPTER BOOT

FIGURE 1. Composite harness assembly.



A. WIRE BUNDLE
B. HEAT SHRINKABLE TUBING/HEAT SEALABLE TAPE
C. HEAT SHRINKABLE TUBING TRANSITION/HEAT SEALABLE TAPE TRANSITION
D. HEAT SHRINKABLE TUBING EXTEND FOR .75 INCH EITHER SIDE OF R.F.I. TUBULAR BRAID ENDS.
E. LACING: TIE 2 PLACES EACH BRANCH, EQUALLY SPACED/OR OPTION FIGURE 3.
F. R.F.I. SHIELD TAPE: WRAP TRANSITION BRANCHES WITH MINIMUM 50% OVERLAPPING TURNS.
G. ADHESIVE
H. R.F.I. TUBULAR BRAID

DIMENSION "X" IS MINIMUM OVERLAP DIMENSION OF TRANSITION AND HARNESS JACKETING. "X" DIMENSION MUST BE GREATER THAN 1.00 INCHES.

DIMENSION "Y" IS MINIMUM OVERLAP DIMENSION OF R.F.I. SHIELD TAPE WRAP AND R.F.I. TUBULAR BRAID. "Y" DIMENSION MUST BE GREATER THAN 2.00 INCHES.

HARNESS JACKETING MAY EXTEND OVER R.F.I. TAPE WRAP

FIGURE 2. Harness transition with RFI shielding.

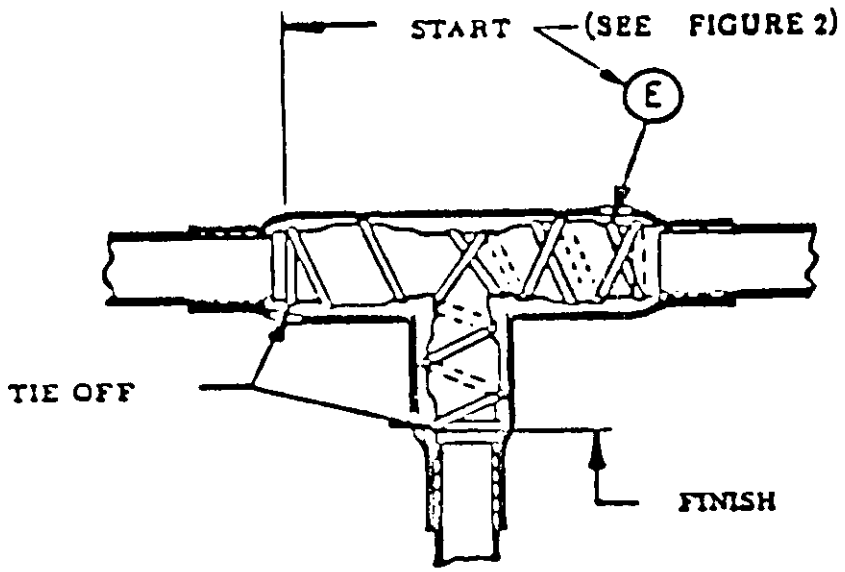
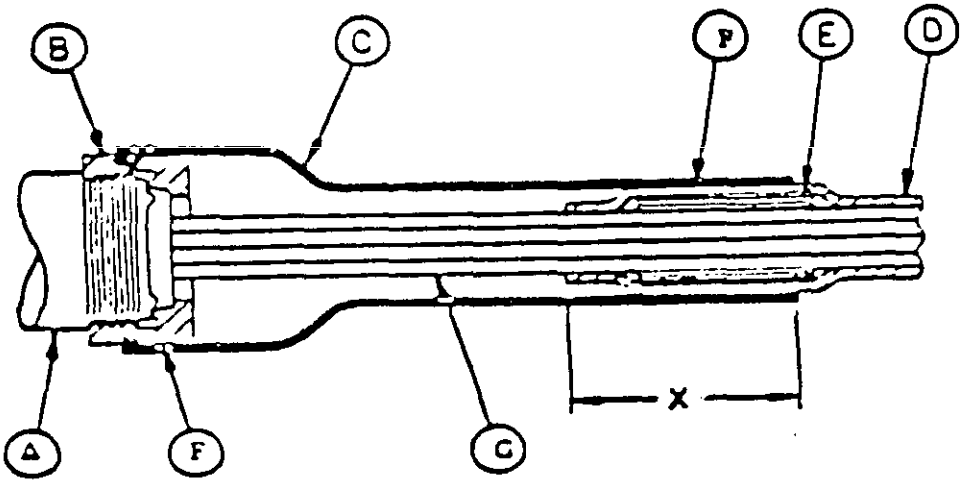


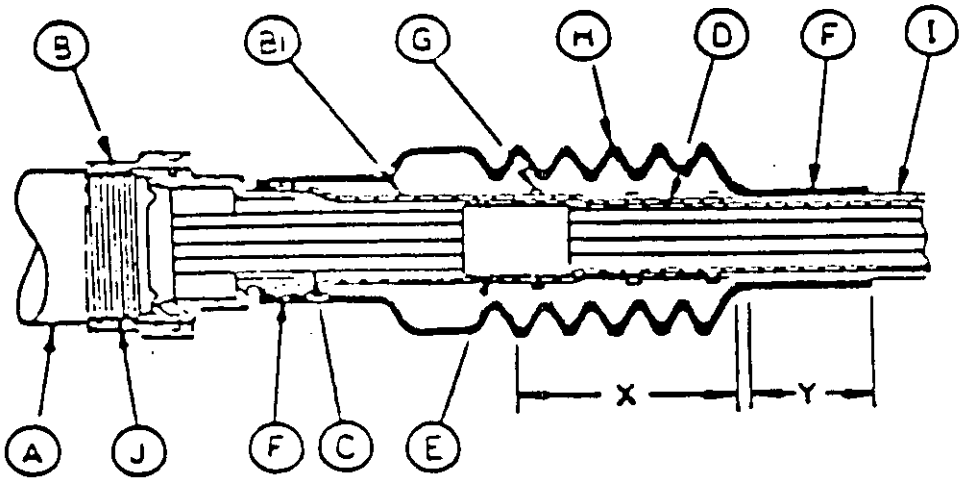
FIGURE 3. Optional lacing of harness transition with RFI shielding.



A. CONNECTOR ASSEMBLY
B. BACKSHELL
C. HEAT SHRINKABLE BOOT
D. HEAT SHRINKABLE TUBING/HEAT SEALABLE TAPE
E. HEAT SHRINKABLE TUBING, IF REQUIRED. TO SHIM UNDER HARNESS JACKETING TO NOMINAL RECOVERED DIAMETER OF BOOT. ALTERNATE METHOD OF ADAPTING SHOWN IN FIGURE 11. USE THE METHOD SPECIFIED ON ASSEMBLY DRAWING. HEAT SEALABLE TAPE MAY ALSO BE USED.
F. ADHESIVE
G. WIRE BUNDLE

DIMENSION "X" IS MINIMUM OVERLAP DIMENSION OF BOOT AND HARNESS JACKETING. "X" DIMENSION MUST BE GREATER THAN 1.50 INCHES.

FIGURE 4. Harness termination (without RFI shielding).



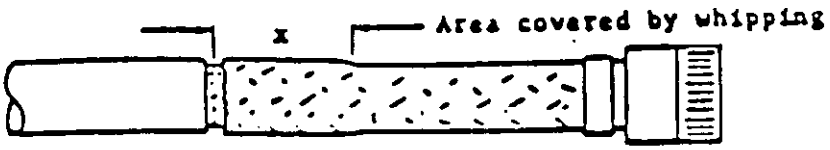
A. CONNECTOR ASSEMBLY
B. R.F.I. ADAPTER
   B1. R.F.I ADAPTER BRAID, ATTACHED
C. WIRE BUNDLE
D. R.F.I. TUBULAR BRAID
E. HEAT SHRINKABLE TUBING/HEAT SEALABLE TAPE:
   EXTEND FOR 0.75 INCH EITHER SIDE
   OF R.F.I. TUBULAR BRAID END.
F. ADHESIVE
G. LACING:
   TIE 3 PLACES EQUALLY SPACED/OR OPTION FIGURE 6
H. HEAT SHRINKABLE CONVOLUTED BOOT
I. HEAT SHRINKABLE TUBING/HEAT SEALABLE TAPE
J. R.F.I. ADAPTER NUT TO BE TORQUED AS SPECIFIED IN TABLE II.

"X" DIMENSION IS MINIMUM R.F.I. TUBULAR BRAID OVERLAP DIMENSION. "X" DIMENSION SHALL BE GREATER THAN 3.00 INCHES.

"Y" DIMENSION IS MINIMUM OVERLAP DIMENSION OF BOOT AND HARNESS JACKETING. "Y" DIMENSION SHALL BE GREATER THAN 1.50 INCHES.

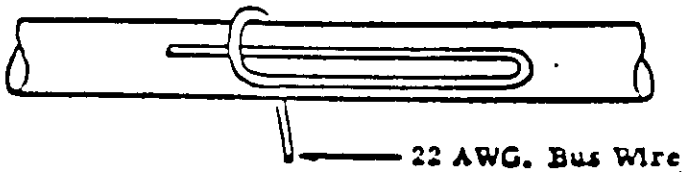
FIGURE 5. Harness termination (with RFI shielding).

Splice overbraid to adapter braid by whipping as shown.

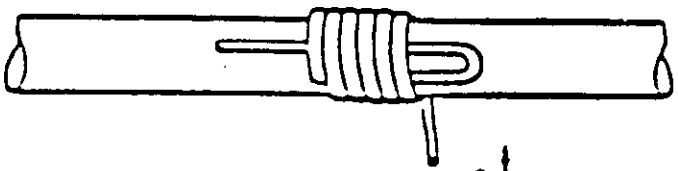


- Whipping to be done as shown.

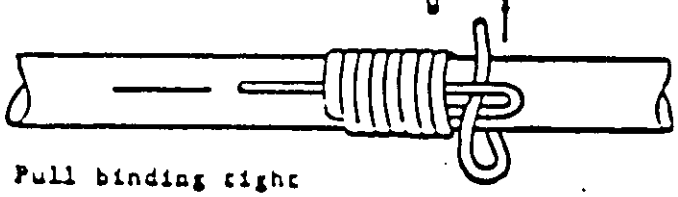
(1)



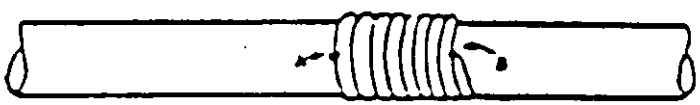
(2)



(3)

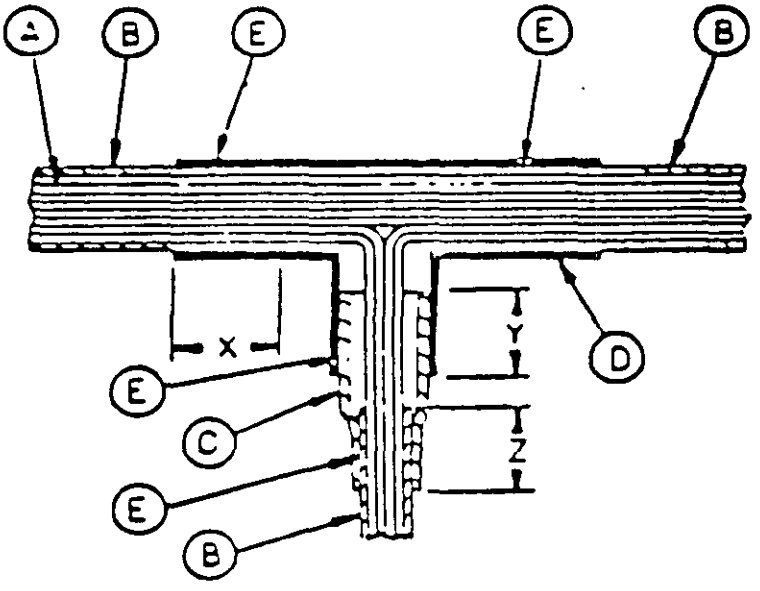


(4)



(5) Spot solder wire to overbraid at A and B.

FIGURE 6. Optional method of RFI shielding termination.



A. WIRE BUNDLE
B. HEAT SHRINKABLE TUBING/HEAT SEALABLE TAPE
C. HEAT SHRINKABLE ADAPTER BOOT
   USE METHOD OF ADAPTING SHOWN IN FIGURE 5.
   IF NO BOOT IS SPECIFIED
D. HEAT SHRINKABLE TUBING TRANSITION/HEAT SEALABLE TAPE TRANSITION
E. ADHESIVE

DIMENSION "X" IS MINIMUM OVERLAP DIMENSION MUST BE GREATER THAN 1.00 INCH.

DIMENSION"Y" IS MINIMUM OVERLAP DIMENSION OF TRANSITION AND BOOT.

DIMENSION "Z" IS MINIMUM OVERLAP DIMENSION OF BOOT AND HARNESS JACKETING.

THESE DIMENSIONS MUST BE MAXIMUM LENGTH ATTAINABLE, LIMITED BY THE BOOT CONFIGURATION.

FIGURE 7. Harness transition without RFI shielding.

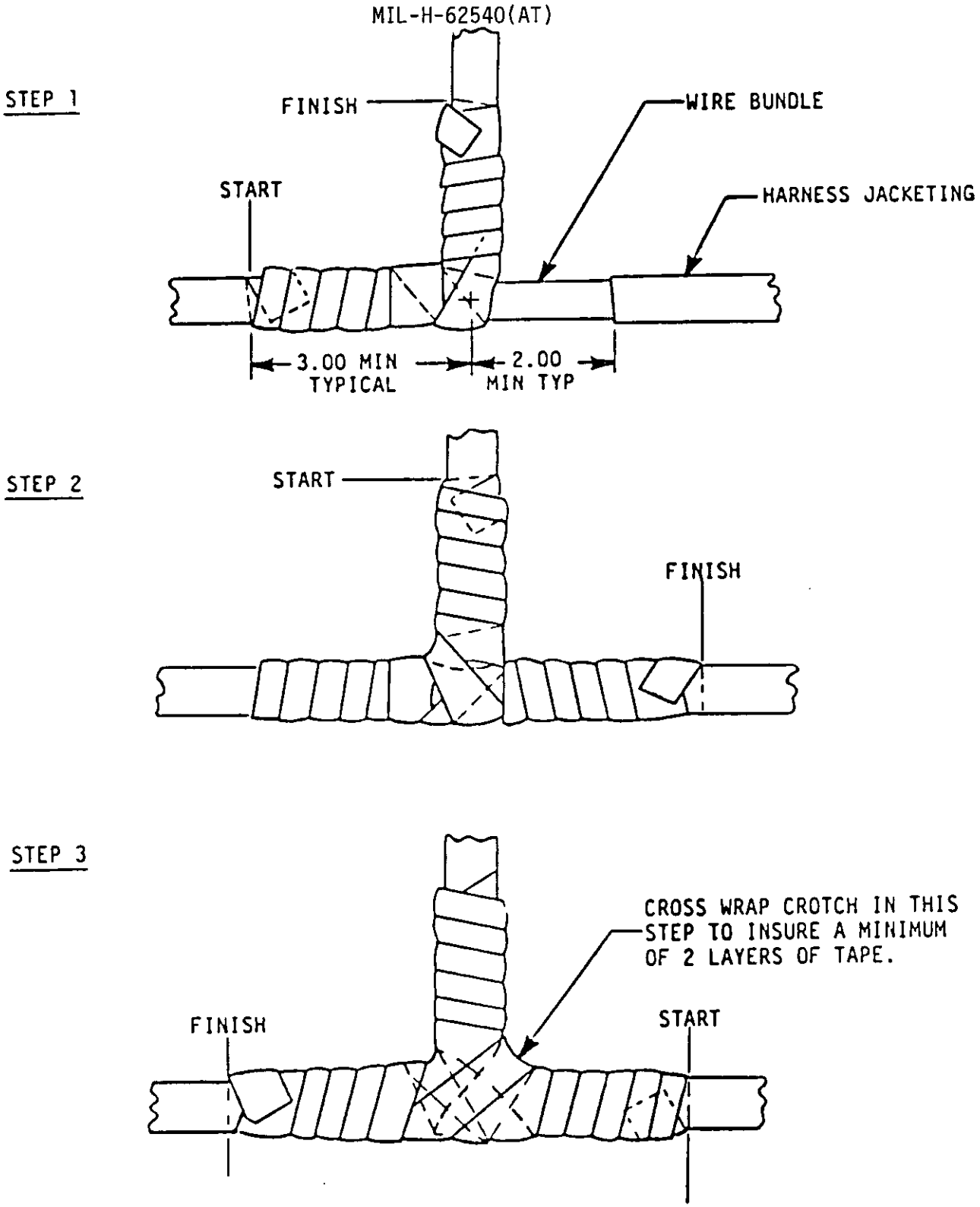


FIGURE 8. Steps in making a transition using heat sealable tape (25 mil).

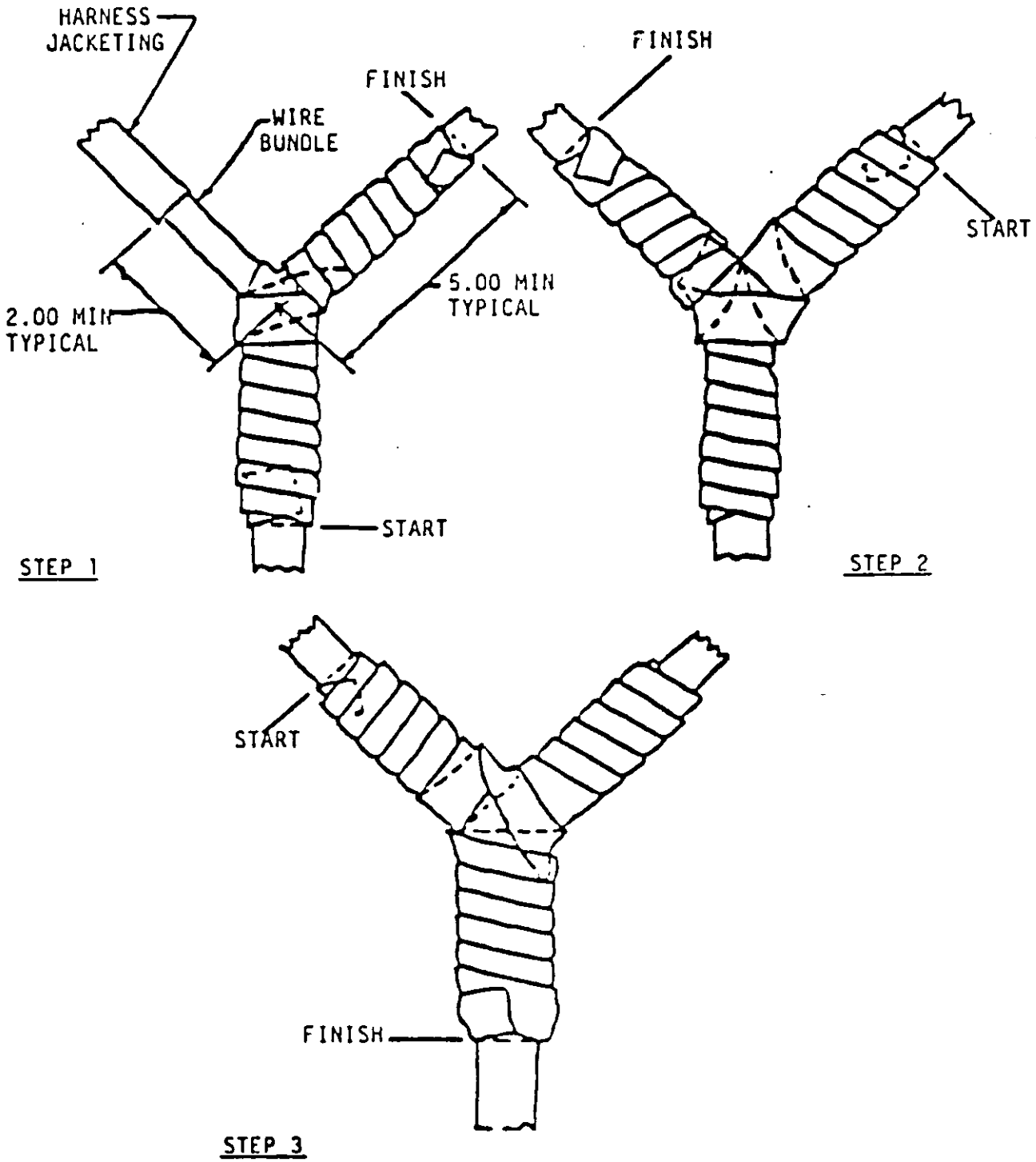


FIGURE 9. Steps in making a "Y" transition using heat sealable tape (25 mil).

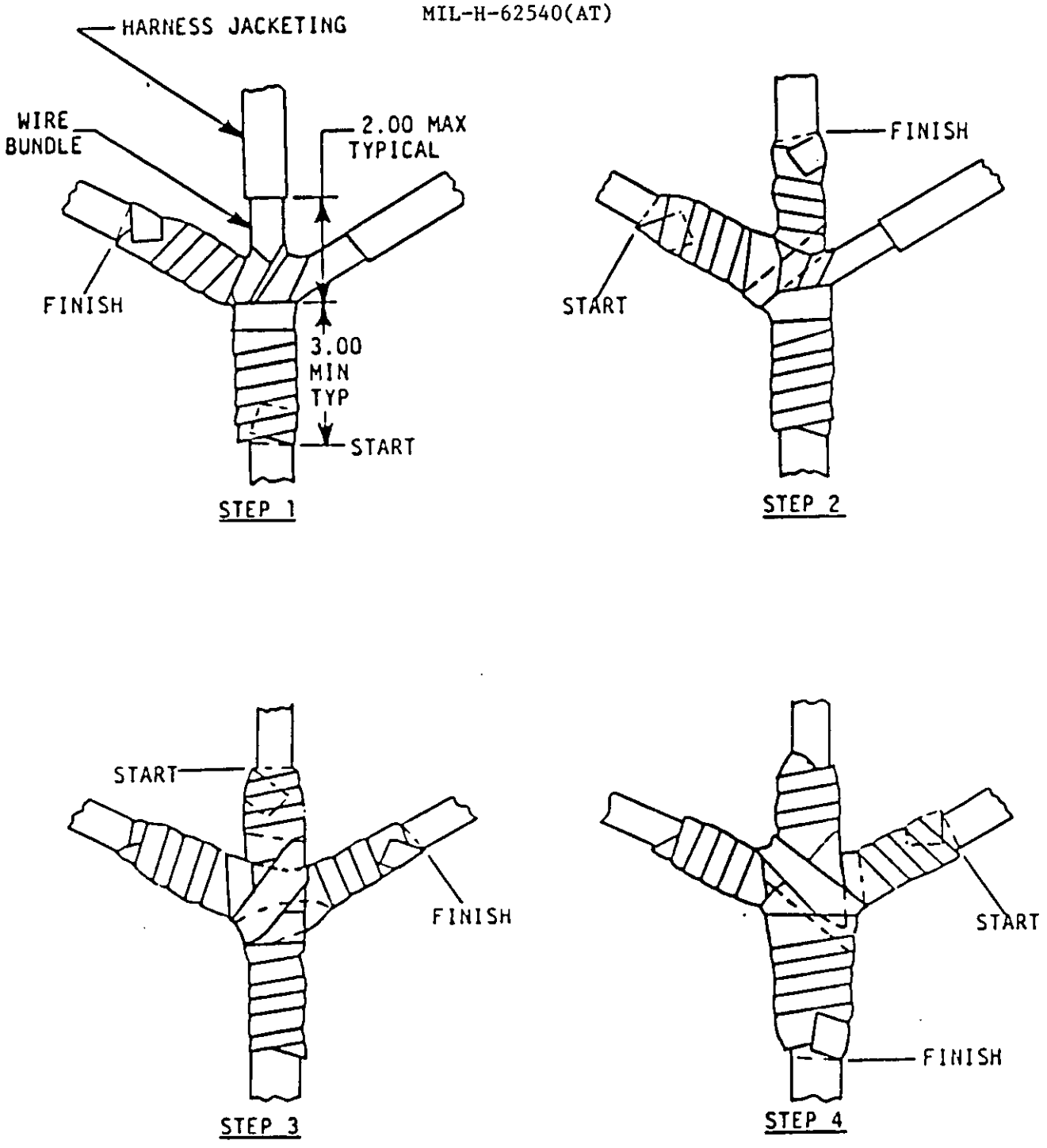
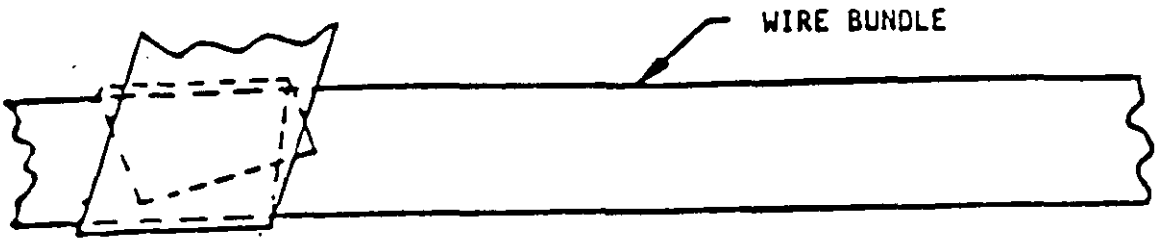
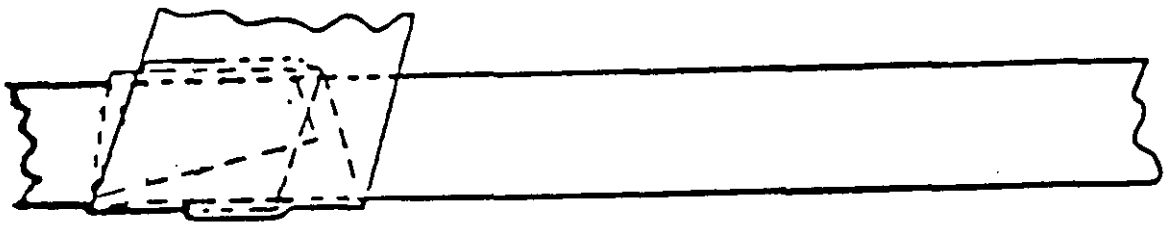


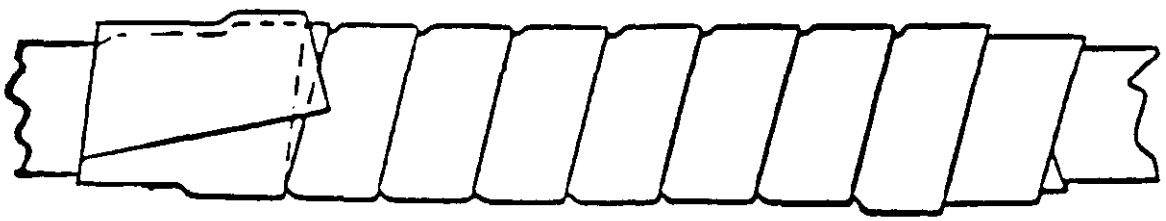
FIGURE 10. Steps in making a "W" transitional using heat sealable tape (25 mil).



START OF TAPE WRAP



WRAPPING USING 50% OVERLAP MIN.



COMPLETION OF TAPE WRAP

FIGURE 11. Method of starting and finishing wrap on harness branches where heat sealable tape is specified.

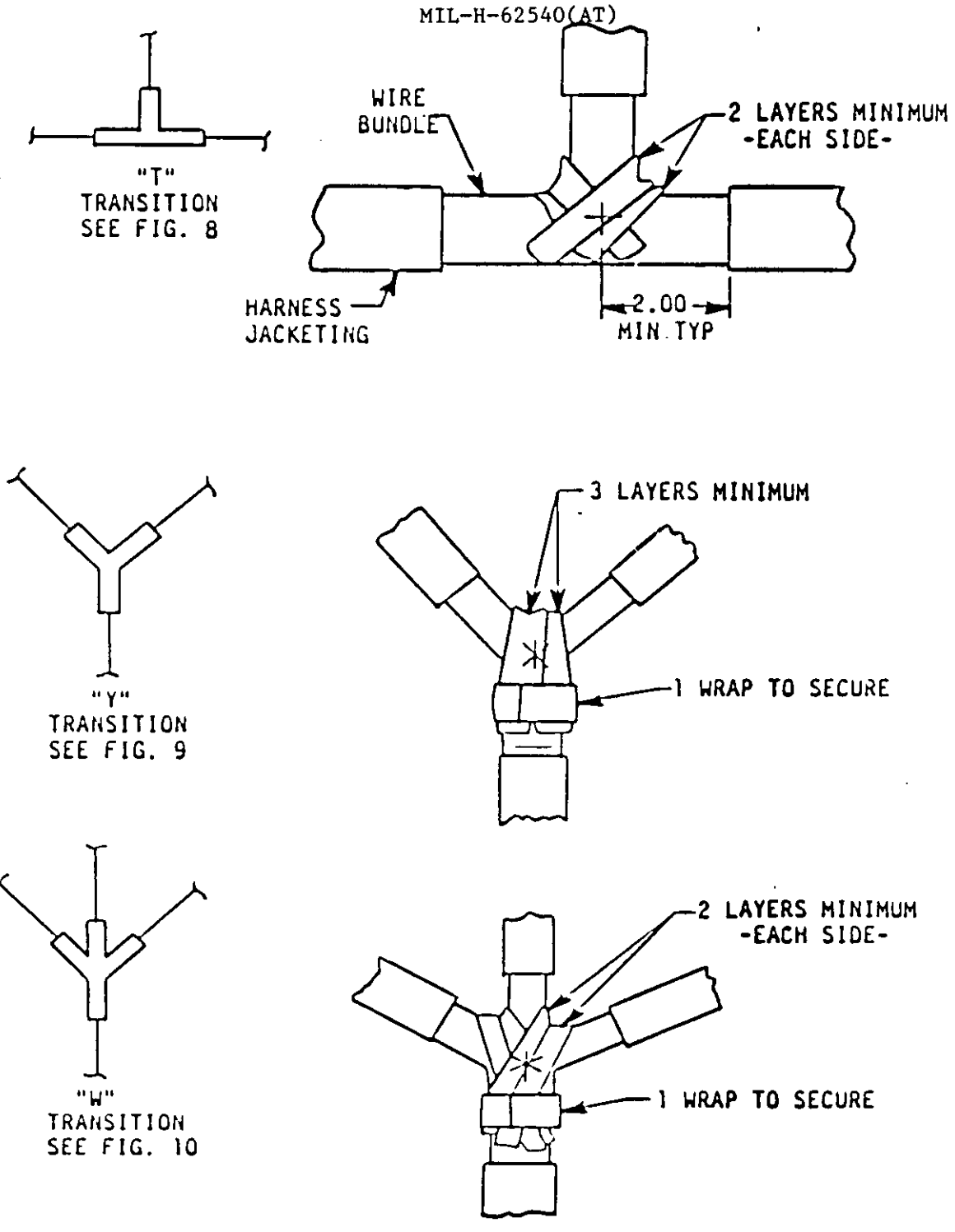


FIGURE 12. Steps for sealing the transition crotch using heat sealable tape (25 mil). (Preliminary step in transition construction)

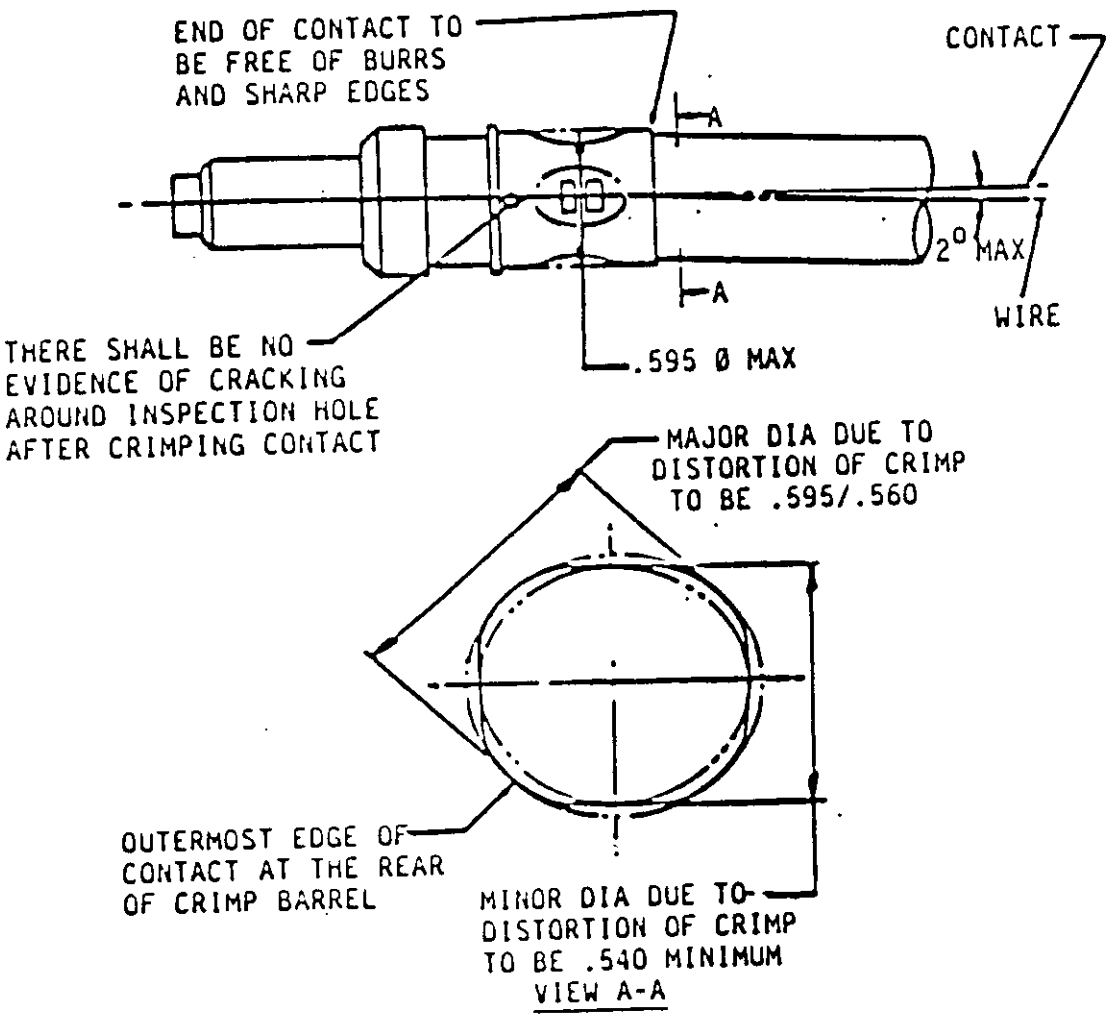
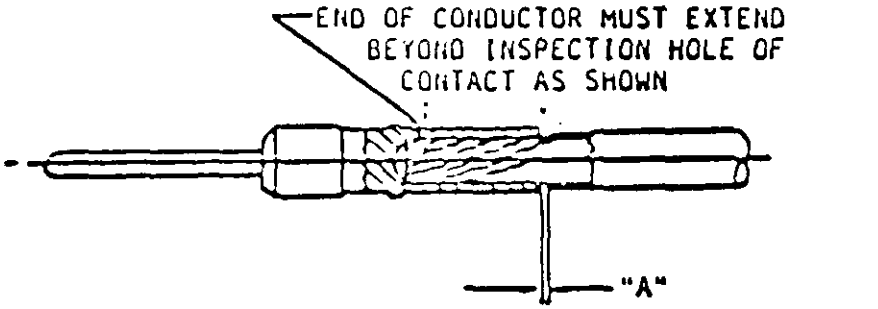


FIGURE 13. Requirements for 1/0 gauge contents.



SIZES 4/0 THROUGH 10-"A" = .000/.030
SIZES 12 THROUGH 28-"A" = .000/.016

FIGURE 14. Insulation gap for crimp type contacts.

Custodian:
Army - AT

Preparing activity:
Army - AT

(Project No. 6145-A051)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

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b. ADDRESS *(Street, City, State, ZIP Code)*	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____

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b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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