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Superseding
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MILITARY SPECIFICATION
SOFT SOLDERED ELECTRICAL CONNECTIONS
FOR
CONVENTIONAL WEAPONS ITEMS
INCLUDING OTHER RELATED ELECTRONIC DEVICES

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers requirements and inspection criteria for soft soldered electrical connections in intricate and complex electronic or electromechanical items related to conventional weapons and other associated electronic devices.

1.2 These items are high production rate devices in which mission performance is accomplished by a pattern or salvo. The specification aims at the establishment and maintenance of a process level adequate to support functional requirements.

1.3 The requirements herein shall apply to all soldering operations under the contract, including those on subcontracts and purchase orders, except for those cases in which the component specifications cite other Government soldering specifications.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

QQ-S-571 -- Solder, Lead Alloy, Tin-Lead Alloy, and Tin Alloy, Flux Cored Ribbon and Wire, and Solid Form
LLL-R-626 -- Rosin, Gum, Rosin, Wood, and Rosin, Tall Oil

Military

MIL-A-6091 -- Alcohol, Ethyl, Specially Denatured, Aircraft
MIL-E-463 -- Ethyl Alcohol (for Ordnance Use)
MIL-F-14256 -- Flux, Soldering, Liquid (Rosin Base)

(Copies of specifications required by suppliers in connection with specific procurement functions should be obtained from the procurement activity or as directed by the contracting officer.)

3.3.4 Formation of conductors for terminal connections. Conductors shall be formed in such a manner as to avoid excessive strain on terminals or components, and without causing damage to the conductors themselves or to the terminals to which they are attached. The conductor shall be formed so as to achieve intimate contact with the terminal and adjacent members throughout the length of the joint. Excess length may be trimmed after forming and prior to soldering, however, individual loose strands may not be clipped out. In the latter case, the conductor shall be removed and properly prepared before reforming. (See 3.3.5.4 for formation of conductors on printed wiring boards.)

3.3.5 Formation of connections. Except as otherwise specified, all conductors to be soldered to a terminal shall be affixed in place and excess lead length trimmed before any soldering at the terminal is performed. No uninsulated conductor shall cross or intersect another uninsulated conductor or terminal, except within solder joint. A thin protective coating of flux or other acceptable material shall be applied to the formed joint whenever the soldering operation is not expected to be performed immediately, i.e., within one-half hour.

3.3.5.1 Terminal posts. Each conductor attached to a terminal post shall terminate at the post. Looping and continuation of component leads are not permitted. The wrap around the post shall be greater than 180 degrees and less than 360 degrees. Conductors shall be placed on the post, starting at the base and proceeding outward without overlap.

3.3.5.2 Multi-wire or single-wire terminal. When the leads of several components are brought together to serve as a terminal for a common connection, they shall be formed parallel to each other and to stand perpendicular to the path of the connector wire. The connector wire shall encircle all of the lead wires so as to firmly hold them in place mechanically, and shall not be less than 270 degrees in any case. Complete looping of the terminal, and continuation to the next terminal is permitted, but the wrap shall not exceed 540 degrees.

3.3.5.3 Tubular connector terminals. Conductors for attachment to tubular terminal shall be stripped and tinned to the proper length required to obtain proper insulation proximity when the conductor is inserted to the bottom of the conductor pocket. The diameter of the pocket shall be sufficiently large to accept the conductor without reduction of strands. When multi-pin connectors are used, lacing or bundling techniques shall leave each conductor free from strain.

3.3.5.4 Eyelet or plated through holes in circuit boards. Conductors which are to be attached to eyeletted or plated through holes in circuit boards shall terminate at the hole. The conductor shall be formed to enter the eyelet or hole perpendicular (within 15 degrees) to the circuit board. Unless jigs or other suitable holding methods are provided to hold parts rigidly in place, the leads must be formed on the exit side of the board to lie flat against the board forming a hook with the ends of the component leads or wire and not extend beyond the radius or edge of the eyelet or

conductive pad surrounding the hole. When special holding methods are used for supporting parts, the exit leads may protrude during soldering and be clipped after soldering is completed. (See 3.5.1)

3.3.5.5 Tab-type terminals. Tabs with external notches shall be considered as terminal posts and connected as specified in 3.3.5.1. Conductors shall approach perforated or slotted tabs in the plane of the tab, and shall be formed back in the direction of the approaching conductors after insertion through the tab. All conductors to be soldered to a single tab shall be mechanically secured before any of them are soldered. Conductors within the joint may not overlap, but conductors may be attached to both legs.

3.4 Soldering.

3.4.1 Protection from heat. Effective heat sinks and shields or adequate spacing shall be used in all cases in which components are susceptible to heat damage, or where previously soldered work is exposed to remelting.

3.4.2 Fluxing. After the surfaces to be joined have been properly cleaned and mechanically assembled, a thin coating of flux may be placed over the connection just prior to the soldering operation, or fluxing may be accomplished by use of flux cored solder.

3.4.3 Soldering. Solder shall be applied to the heated joint, not to the heating equipment, except for dip or flow soldering. All heating equipment shall be temperature controlled, and procedures shall be established, as applicable, for regular cleaning and retinning of the equipment to insure uniformity of the soldering operation throughout the entire work period of the contract. Active fluxing agents and corrosive materials shall not be used for cleaning soldering tips. Sufficient solder shall be applied to adequately cover all surfaces of the joint without flow to unwanted areas. On tubular joints where leads from cabling or other free or unsupported length of wiring is subject to flexing or movement, solder shall fill the entire cavity with a slight bulge beyond the terminal at the cable end. On tubular joints where leads are confined or enclosed within a unit and not subject to bending or flexing, solder should be applied to fill not less than 50 percent of the cavity, but may fill the cavity up to 100 percent with no overflow or extension of the solder beyond the cavity. The cycle of application of heat, application of solder, and withdrawal of heat shall be controlled in a manner to avoid repeated reheating of the joint in order to retouch deficiencies.

3.4.4 Cooling. The joint shall be allowed to cool upon the removal of the heat source. No liquids or other cooling media shall be used to accelerate cooling. Conductors shall not be disturbed until the joint has completely hardened.

3.4.5 Cleaning. After soldering is completed, all flux shall be removed from the joint and adjacent areas.

3.5 Characteristics of the completed connection.

3.5.1 Visual appearance. An acceptable solder connection shall have a smooth, shiny, clean surface. The contours of the wires and connectors shall be perceptible beneath the solder with prominent filleting between the surfaces of adjacent conductors. All surfaces within the joint shall be covered with solder, and there shall be no evidence of post-solder clipping, except for exit side of printed circuit boards. The extremities of the solder surface shall feather smoothly to the wire and terminal surfaces.

3.5.2 Adherence. All conductors shall be securely held by the solder, and shall show no evidence of motion when subjected to firm probing pressure from an approximately 1/8 inch diameter wooden probe.

3.5.3 Specific defects. In addition to the preceding general characteristics, the joint shall be free from the following specific defects:

a. Rosin joint;
b. Cold solder connection;
c. Fractures in solder;
d. Disturbed solder connection;
e. Nicks or crushing damage;
f. Dirt or other foreign matter imbedded in the solder;
g. Excessive solder (blobs or runoff);
h. Insufficient solder (bare areas or unfilled crevices);
i. Voids or detrimental pin holes;
j. Solder beards or peaks.

3.6 Certification of operators.

3.6.1 Knowledge. Prior to the assignment of any operator to the performance of soldering operations on the contract, the contractor shall insure that the operator is familiar with the particular soldering operations and requirements for the type of items on which the work is being performed under this specification, has had adequate training in effective methods and techniques, and is familiar with appropriate standards of cleanliness needed to produce high quality workmanship.

3.6.2 Proficiency. The contractor shall establish adequate standards for the particular operation or operations which the operator performs and must meet prior to being introduced into the regular production line.

3.6.3 Contractor certification. Operators performing under these items shall have met the requirements of 3.6.1 and contractor will have records of training experience available to the Government.

3.6.4 Requalification. Any operator who has not performed soldering operations in accordance with the applicable parts of this specification for a period of 90 days shall be required to redemonstrate proficiency prior to assignment to the line. Operators whose performance fall below acceptable levels shall be retrained as needed and be subjected to requalification.

3.7 Rework.

3.7.1 Quality. Reworked soldered connections shall meet all of the requirements applicable to the original connection.

3.7.2 Rework in place.

a. Hand soldered connections -- Hand soldered connections in which the mechanical joint is properly made, and which can be corrected by reheating, addition or removal of solder and recooling may be reworked in place, provided the same protection against heat damage is used as was used in the initial soldering operation. When such corrections are made by the original operator before the material is released from the work place, they shall not be considered as defects in evaluating soldering quality. All such defects discovered by subsequent inspection shall be recorded and identified as defects and then repaired as above. While bench rework is permitted under the conditions specified, observation of an unusual frequency of reworking by an operator shall be cause for corrective action.

b. Wave or flow solder connections -- Automatic wave of flow soldering operation may be repeated for not more than one additional run providing there is not a degradation of components and printed wiring boards. Hand resoldering is permitted, if necessary, to remove icicles and bridges of solder or to add solder to the conductive circuit and component joint area.

3.7.3 Replacement of connection (by hand soldering). Except for those defects which can be corrected by rework of the solder alone, repair, when required, shall consist of completely disassembling the joint, cleaning, or replacement of damaged materials as necessary, and repetition of the entire soldering procedure.

3.7.4 Written rework procedures. The contractor shall submit his rework procedures in writing for Government approval prior to performing any rework, except for those specifically defined herein. Particular attention shall be paid to those conditions where additional protection is needed for conductors and components which were not present when the original connection was made, or where a portion of the connection has become obscured by virtue of assembly operations subsequent to the soldering.

3.7.5 Records and identification. Records of results from the inspection of each sample shall be retained and available for review by the Government.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements prior to submission for Government acceptance. Inspection records indicating that required examinations and tests have been made shall be kept complete and available to the Government for the duration of the contract. The Government reserves the right to reinspect any or all work submitted in order to insure that the requirements are being met.

4.2 Examination.

4.2.1 Inspection. Prior to manufacture, the contractor shall submit a plan of inspection suitable to the Government, insuring that inspections will be made at such times that joints are clearly visible and when probing is possible. Also, that all joints in the assembly will be subjected to a uniform level of inspection.

4.2.1.1 Each joint in the inspection sample shall be inspected for the characteristics listed in 4.3.4. Defects of each type shall be recorded.

4.2.2 Magnification. All acceptance examinations shall be performed under adequate illumination, and using a magnification of 2X. A magnification of 7X is recommended for a more detailed analysis of the exact cause of defects which were disclosed by the inspection.

4.3 Acceptance.

4.3.1 Acceptance conditions.

4.3.1.1 Acceptability of the soldering process will be based on certification (4.3.3) and a group assignment based on the number of defects per inspection sample as shown in 4.3.4, Table I. Further assembly operations of material in process from which the sample was drawn shall be subject to the following conditions, depending on the assigned group for each characteristic in table I:

Group I -- No process changes are required.

Group II -- Contractor agrees to introduce prompt corrective action for future production.

Group III-- Contractor agrees to introduce prompt corrective action for future production. The Government reserves the right to introduce tightened end item inspection for functional parameters affected by the soldering deficiencies; or the contractor may elect to screen the material for removal of deficiencies.

4.3.2 Suspension of inspection.

4.3.2.1 The Government reserves the right to suspend acceptance inspection if:

a. The contractor fails to take appropriate corrective action in accordance with 4.3.1.1.

b. The contractor fails to qualify for a reduced inspection level in accordance with 4.3.5.1 within one production month.

4.3.3 Certification. The contractor shall verify that all materials and processes used conform to the requirements of this specification. A certificate of analysis from the contractor or an approved laboratory shall be acceptable evidence of compliance with the chemical requirements of this specification.

4.3.4 Classification of defects.

Inspection sample consists of 120 soldered connections. (See 4.3.5 for sample frequency)

Table I

Defect Number	Defect	Description of Defect	Method of Inspection	Defects per Inspec. Sample Gr. 1 (See 4.3.1.1)	Gr. 2	Gr. 3
Major - Category						
101	Loose joint (Probe)	Joint not soldered, or wire moves under probing	Visual	0-1	2	3 or more
102	Rosin joint	Wire held partially or completely by rosin adhesion	Visual	0-1	2	3 or more
103	Cold solder connection	Chalky, rough, crystalline piled up appearance of the solder at connection	Visual	0-1	2	3 or more
104	Disturbed connection	Stress lines in solder and a grey appearance of the solder at connection	Visual	0-1	2	3 or more
105	Irregular connection (fracture)	Fracture in the solder	Visual	0-1	2	3 or more
Minor - Category						
201	Contaminated connection (within one wire dia.)	Foreign materials, imbedded in the solder outside one wire diameter	Visual	0-6	7-10	11 or more

...or - Category

Defect Number	Defect	Description of Defect	Method of Inspection	Defects per Inspec. Sample (See 4.3.1.1) Gr. 1	Gr. 2	Gr. 3
202	Rosin pockets or voids	Pinholes or pockets within one wire dia. of the connection	Visual	0-6	7-10	11 or more
203	Damaged Connection	Nicks, mars, scratches, broken or clipped strands	Visual	0-6	7-10	11 or more
204	Insufficient solder	No solder fillet between connected parts	Visual	0-6	7-10	11 or more
205	Irregular solder	Peaks in the solder	Visual	0-6	7-10	11 or more
206	Rosin pockets or gas voids (outside one wire dia.)	Pinholes or pockets outside wire diameter	Visual	0-6	7-10	11 or more
207	Excess solder (that could cause shorts)	Contour of soldered parts not visible after soldering.	Visual	0-6	7-10	11 or more

4.3.5 Sampling plan. Sampling frequency is determined on the basis of the number of soldering joints being produced. The number and pre-assigned location of joints to be sampled from a specific number of assemblies or subassemblies, selected at random and making up the total sample size of 120, shall be determined for each inspection level given below. Assignment of inspection locations should be established in a manner which is in proportion to the rate of production. If, during the sampling of the specifically designated soldered joints, the inspector observes an additional non-designated joint or joints on any assembly which is an obvious major defect and would cause failure, the assembly will be removed from the line without scoring the defect. If, however, a minor defect is noted, other than on the designated joints, the assembly will remain in the line and the defect not included in the scoring. The following sampling plan shall be used from initiation of production. Successive samples shall be chosen so as to insure that the output of each operator or station is inspected at approximately equal frequency. Acceptance will be in accordance with 4.3.1.1.

Inspection Level	Produced Number of Soldered Connections/Sample for each Inspection Level	Sample Size
1	5000 max.	120
2	12000 max.	120
3	90000 max.	120
4	over 90000 (weekly production) of soldered connections	120*

4.3.5.1 Qualification for reduced inspection level. Contractor shall start at level 1. Inspection frequency may be reduced when the individual defect rates comply with the following schedule:

Initial Inspection Level (1) — 1 sample/5000 joints

In 10 successive acceptance samples:

a. Majors - All must be in group 1; and
b. Minors - None may be in group 3 and last 5 must be group 1.

Reduced Level (2) — 1 sample/12000 joints

In 5 successive acceptance samples:

a. Majors - All must be in group 1; and
b. Minors - At least 4 samples in group 1 and none in group 3.

Reduced Level (3) — 1 sample/90000 joints

In 2 successive acceptance samples:

a. Both must be in group 1 for major and minor.

Reduced Level (4) — **3 samples/week

4.3.5.2 Tightened inspection. Inspection frequency will be increased to the next tighter level under the following schedule, applicable to the level under which the deficiencies are found:

a. Any defect rate in a sample in group 3.
b. Three defect rates in group 2 in any successive series of 6 samples.
c. Requalification for reduced level will be in accordance with qualification table.

*Three samples of 120 each will be taken from each week's production. The first sample (120) to be taken at the beginning of the week, the second sample (120) the middle of the week and the third sample at the end of the week.

**Continues as long as quality is maintained.

5. PREPARATION FOR DELIVERY

There are no applicable requirements.

6. NOTES

Not applicable.

Preparing Activity:

Army - MU

User Activities

Army - MU

Project No. 1395-A211

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DOCUMENT IDENTIFIER AND TITLE MIL-S-50827A(MU) Soft Soldered Electrical Connections for Conventional Weapons Items Including Other Related Electronic Devices

NAME OF ORGANIZATION AND ADDRESS	CONTRACT NUMBER
	MATERIAL PROCURED UNDER A ☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?
   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*	TELEPHONE NO.
	DATE

DD FORM 1 JAN 72 1426 REPLACES EDITION OF 1 JAN 66 WHICH MAY BE USED

3. REQUIREMENTS

3.1 Materials.

3.1.1 Solder. The composition of the solder alloy shall conform to specification QQ-S-571, type R or type S, SN60 or SN63, tin-lead, unless otherwise specified.

3.1.2 Flux. Flux shall conform to specification MIL-F-14256 or a rosin and alcohol flux may be used. The rosin shall conform to specification LLL-R-626, grade WW. The alcohol shall conform to specification MIL-A-6091 or specification MIL-E-463, grade 2 or grade 3.

3.1.3 Solvents. Solvents shall be non-corrosive to the metallic surfaces on which they are used, and shall not injure nor contaminate insulation materials which they may contact.

3.2 Preparation of parts.

3.2.1 Insulation stripping. To the maximum extent practicable, the amount of conductor exposed shall be sufficient to form the joint, without requiring clipping during assembly (see 3.3.5.4). The conductor shall not show evidence of nicking, clipped or nicked strands, or other mechanical damage. The insulation shall be cleanly stripped without mechanical or thermal damage.

3.2.2 Preparation of surfaces. The surfaces of all parts to be joined shall be thoroughly clean prior to their assembly into the item. Oxides, scale, dirt, and grease shall be removed by mild abrasion or solvents. All abrasion products, solvent, and solvent residue shall be removed prior to assembly. Abrasives shall not be permitted during or after assembly operations.

3.2.3 Tinning. Except for silver plated parts, the surfaces of the parts to be joined shall be tinned with solder immediately after cleaning, and, prior to forming or preparation of the mechanical joint. Tinning of stranded conductors shall cover the entire length to be included in the joint, but shall stop short of the insulation. Tinning shall not be required when materials are supplied pretinned with SN60 or SN63 solder conforming to specification QQ-S-571, or in accordance with a Government specification establishing the tinning requirements for the particular component or material concerned.

3.3 Mechanical joining.

3.3.1 Component and wiring stress. Component leads and other wires connected to or between terminals shall be formed with sufficient slack to minimize component and/or lead stress.

3.3.2 Rigidity. The parts shall be joined in such a manner as to insure that they will not move during the soldering operation. Where this degree of rigidity is not attainable with the joint itself, suitable clamps may be used to hold the conductors in position during soldering. Clamps, braces, or other holding devices shall not cause deformation of the parts which they hold.

3.3.3 Proximity of insulation. Conductors shall be affixed to their terminals so that the end of the insulation lies from one to two times the outside diameter of the wire away from the nearest part of the finished joint, except that the minimum distance shall be 0.030-inch regardless of wire size.