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MILITARY SPECIFICATION

SOLDER BATH SOLDERING OF PRINTED WIRING ASSEMBLIES

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

1. Scope. This specification covers machine soldering processes for printed board assemblies used in eletrical and electronic equipment.

2. APPLICABLE DOCUMENTS

2.1 The following government documents of the issue in effect on the 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, Tin Alloy, Tin-Lead Alloy and Lead Alloy

Military

MIL-F-14256	Flux, Soldering, Liquid (Rosin Base)
MIL-P-28809	Printed Wiring Assemblies
MIL-S-45743	Soldering, Manual Type, High Reliability, Electrical and Electronic Equipment
MIL-P-46843	Printed Wiring Assemblies

STANDARDS

Military

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-429	Printed Wiring and Printed Circuits Terms and Definitions

FSC THJM

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Missile Command, ATTN: DRSMI-RCS, Redstone Arsenal, AL 35809 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions may be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein.

IPC-S-801 (Dec 1970) Edge Dip Solderability Test for Printed Wiring Boards

(Application for copies should be addressed to Institute of Printed Circuits, 1716 Howard Street, Evanston, IL 60202).

2.3 Conflict of documents. In case of conflict between any requirement specified herein, and any contained in the engineering documentation (including other specifications or standards referenced therein) the requirements of the engineering documentation shall prevail.

3. REQUIREMENTS

3.1 Applicability. These requirements are applicable to machine soldering operations and application of solder only.

3.2 Materials. Except when otherwise specified on detailed drawings, the materials utilized in soldering operations shall conform to the requirements.

3.2.1 Solder. An Sn 60 or Sn 63 tin lead solder, types conforming to QQ-S-571, shall be used.

3.2.2 Flux. Rosin based fluxes conforming to QQ-S-571 and MIL-F-14256 shall be utilized. Type RA flux shall not be used except on printed board assemblies without stranded wires.

3.2.3 Cleaning solvent. Solvents to be used for the removal of process contaminants and residues from parts and solder joints shall not degrade or damage the materials in the parts being cleaned.

3.3 Facilities, equipment and tools.

3.3.1 The soldering area. The soldering area and machines shall be clean and orderly. Contaminants shall be precluded from the area.

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3.3.1.2 Exhaust for volatile and toxic vapors. Toxic or volatile vapors shall be exhausted in accordance with the OSHA standards.

3.3.1.3 Work station lighting. Working surface lighting of soldering stations shall be 100 foot-candles minimum (1077 lm/m^2). Supplemental lighting may be used as required.

3.3.2 Soldering equipment. The soldering machines used shall heat the printed board assemblies uniformly and have the capacity to maintain the temperature during repetitive solder operations with a maximum temperature variation of ± 10°F (5.6°C) of the nominal soldering temperature.

3.3. Cutting and forming tools for conductor and component leads. Cutting and forming tools shall be as specified in the applicable paragraphs of MIL-S-45743.

3.3.1 Insulation strippers. Insulation strippers shall be as specified in the applicable paragraphs of MIL-S-45743.

3.4 General soldering requirements.

3.4.1 The solder machine and work station maintenance. Work areas and tools shall be maintained in a clean and orderly condition. All dirt, grease, flux, solder spatter, chips, and other contaminating foreign matter shall be promptly removed. Smoking, eating and drinking at the soldering work station shall not be permitted.

3.4.1.1 Dross control. Dross shall be periodically removed from the solder bath to assure that dross does not mix with the liquid solder. Automatic or manual methods are acceptable provided that the dross does not come in contact with the printed wiring assembly during any portion of the soldering process.

3.4.1.2 Dross control materials. Special oils formulated for dross control shall have a flash point higher than the maximum temperature of the solder bath. Such oils shall be compatible with liquid solder and the solder process and shall have an auto ignition point a minimum of 10°F (5.6°C) higher than the maximum temperature of the solder bath. Other materials, a nitrogen blanket or glass balls, may be used providing prior approval is obtained from the procuring agency.

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3.4.2 In-process handling and storage. The printed boards, components, and assemblies shall be protected from contamination and damage during handling, assembly, and storage operations. Soldered subassemblies and assemblies shall, subsequent to cleaning operations and prior to any encapsulation processing, be handled to preclude contamination.

NOTE: Printed board assemblies should be handled only by their edges or with lint-free gloves that are also free of oils, solvent residue, soil, or other contaminants that could be transferred to the assemblies.

3.4.3 Solderability. All surfaces to be soldered that do not conform to the requirements of MIL-STD-202, Test Method 208, and all printed wiring/circuits that do not conform to IPC-S-801 shall be retinned or replated to provide solderability conforming to the MIL-STD-202 or IPC-S-801 requirements, as applicable. To prevent gold embrittlement, those areas of gold plated parts to be soldered shall be subjected to a double tinning operation or the gold removed and a single tinning operation performed. More active fluxes than those specified in 3.2.2 may be used, provided all ionic and non-ionic contaminants are removed within one hour from the time that the item was retinned.

3.4.4 Documentation. The contractor shall have written operating procedures describing the soldering process and the proper operation of the automtic soldering machine and associated equipment. For the soldering machine, these procedures, as a minimum, shall define the preheat temperature, solder temperature, rate of travel, frequency of temperature verification measurements, frequency of solder bath analysis, masking and cleaning requirements. If any of the above mentioned characteristics must be adjusted for different printed board assemblies, the procedure shall identify by printed board assembly drawing number, or other positive identification means, the setting to be utilized for each assembly.

3.5 Operations prior to soldering.

3.5.1 Precleaning. Printed board assemblies shall be clean prior to start of the soldering operations. Cleanliness of the printed wiring assembly shall be sufficient to insure solderability.

NOTE: Printed circuit boards that have been stored may have absorbed moisture and should be baked prior (within 8 hours) to soldering to prevent corrosion or other degradation.

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3.5.2 Masking. Areas of printed board assemblies not to be soldered shall be masked prior to the application of solder flux. The materials used must be compatible with the flux/solder process and shall not cause fire or create fire or health hazards.

3.5.3 The preparation of leads and terminals. The preparation of leads and terminals shall be in accordance with the applicable paragraphs of MIL-S-45743.

3.6 Machine soldering.

3.6.1 Machine soldering shall be performed using an integral system having the following characteristics:

(a) All operations shall be performed semi-automatically or automatically.

(b) Controlled fluxing unit. The fluxing unit can be a separate, non-integral, operation if the solder is applied within two minutes from the application of the flux.

(c) Controlled preheating.

(d) Temperature controlled solder.

(e) Cooling areas.

(f) Controlled conveyor speed.

3.6.2 Flux application. The flux shall be applied by the dip, spray, brush, wave, foam, or other method which will produce an even coated surface. Any thinner used shall be a product from the flux manufacturer recommended for the specific flux being utilized.

3.6.3 Preheating. The boards shall be preheated to a temperature compatible with the flux, conveyor speed, solder temperature, and time of solder contact.

3.6.4 Application of solder. The temperature of the solder bath in the area of contact with the printed wiring board shall be held at 500° ± 25°F (260°C ± 14°C).

3.6.5 The solder contact. The printed board thickness and joint density are critical factors in setting the solder contact. The wave height or other contact method shall be adjusted to assure full solder flow and effective contact with the printed board across the full width of the board. The time of contact between printed board assemblies

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and the solder shall be preselected, dependent upon preheating, thickness of board, number of contacts or conductors, and the type of components. The length of time at temperature shall not cause damage to heat sensitive components or the structure of the board. Components shall be constrained to assure leads do not move during the solder cycle.

3.6.6 Solder bath surface. Adequate means shall be taken to maintain the solder bath cleanliness during the soldering processes.

3.6.7 Conveyor. The conveyor shall transport printed board assemblies through the fluxer (optional), preheater, solder, and cooling are The selected conveyor speed shall be adjusted to assure compliance with 3.6.5. The speed shall not vary more than one inch per minute.

3.6.8 Cooling. The printed board assemblies shall not be lifted from the conveyor, nor shall there be any method of forced cooling, until the solder has solidified after the completion of contact with the solder bath.

3.6.9 Solder bath contamination limits. To maintain the proper purity of the solder bath, the amount of contaminants shall not exceed the percentage specified in Table I.

TABLE I

SOLDER BATH CONTAMINATION LIMITS

Contaminant	Percentage (Maximum)
Antimony	0.75%
Arsenic	0.05%
Copper	0.5%
Iron	0.02%
Gold	0.2%
Cadmium	0.01%
Zinc	0.008%
Aluminum	0.008%
Maximum Accumulative Impurities	1.5%
Maximum Gold-Copper Combination	0.40%

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3.7 Post solder operations.

3.7.1 Cleaning. Cleaning of soldered printed board assemblies shall be initiated as soon as solder has solidified but no more than 1 hour after the board assembly has been soldered. As soon as the board has cooled to the cleaning temperature, solder masks shall be removed . Excess solder shall be removed so that the connection is clean. Mechanical methods such as filing, grinding, or scraping shall not be used. All residual flux and soils shall be removed using solvents or combinations of solvents which will remove contaminants. After final cleaning, finished products shall not be contaminated by handling or environment.

3.7.2 Touch up or rework. Any touch up or rework by manual soldering shall be in accordance with MIL-S-45743.

3.8 Resistivity of solvent extract. When uncoated printed board assemblies are tested as specified in 4.3.2 the resistivity shall be not less than 2,000,000 ohm-centimeter for each unit of 10 square inches (64.5 CM_2) of board surface (counting both sides but not counting the surface areas of the components).

3.9 Solder joint. The solder joint shall have a bright metallic appearance with good adherence. Solder shall cover the wire, conductor, or component lead, and the solder shall form a smooth fillet between the terminal area and each side of the wire or component lead. The contour of the wire or component lead shall be visible after soldering, although individual strands of stranded wire may be obscured. There shall be no defects as noted in the applicable paragraphs of MIL-S-45743.

3.10 Qualification of soldering personnel. The qualification of solder operators and soldering inspectors will be by certificate of training per MIL-S-45743 and the manufacturers (of the soldering machine) operating procedures.

3.11 Workmanship. The workmanship, utilized in accomplishment of the processes specified herein, shall be of a level of quality adequate to assure that the processed products shall meet the performance requirements of the applicable product drawings and specifications, relative to these processes. The solder connections shall have a smooth, bright appearance with metallic luster and shall not have a chalky, gritty, or irregular surface, nor exhibit points (peaks), pits, scars, fractures, trapped flux, foreign materials, or have holes which expose base metal (where the bottom is not visible, exposed base metal will be assumed). The connections shall be completely covered by solder

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to the extent that no base metal is visible, including the copper ends of cut wire or leads. Solder beads shall not project from terminals, nor shall solder spatter exist on adjacent components or surfaces.

NOTE: The visual standards provided as figures in MIL-S-45743 are intended as aids in determining acceptability of processed products. It is expected that strict adherence to the specified requirements should result in a general quality of workmanship equal to the applicable upper illustrations. The applicable center illustrations represent minimum acceptable standards which are undesirable as a general condition but are acceptable. The applicable bottom illustration represents unacceptable conditions. Corrective action should be taken when general quality of workmanship is not in accordance with the applicable upper illustration.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order the supplier 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 any of the inspections set forth in the specification where such inspections are deemed necessary to assure that suppliers and services conform to prescribed requirements.

4.2 Quality conformance inspection.

4.2.1 One hundred percent inspection. Each soldered connection and its associated wiring or leads shall be visually inspected to determine conformance to the requirements specified. MIL-S-45743 provides a list of defects with reference to the applicable requirements. Any defect shall be cause for rejection.

4.2.2 Sampling inspection. Sampling for cleanliness of uncoated printed wiring assemblies, utilizing the resistivity of solvent extract method, shall be in accordance with the applicable provisions of MIL-P-46843 or MIL-P-28809.

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4.2.3 Process inspection. Surveillance shall be conducted on a continuous basis to assure that the requirements for tools, materials, handling, equipment, facilities, and processes specified are strictly adhered to. Any noncompliance shall be grounds for rejection of the material processed.

4.3 Inspection methods.

4.3.1 Visual inspection. Visual inspection shall be performed utilizing a minimum of 4X magnification. Lighting shall equal or exceed the requirement of 3.3.1.3. A clear incandescent light should be used for detection of uncovered copper. When solder connections are suspected as defective, magnification commensurate with the size of the connection shall be used to aid the visual inspection. As a guideline, magnification for visual inspection of connections in microminiature, miniature, and standard assemblies may be limited to 70X, 30X and 10X respectively.

4.3.2 Cleanliness test. The resistivity of solvent extract method for cleanliness testing of uncoated printed wiring assemblies shall be in accordance with the applicable provisions of MIL-P-46843 or MIL-P-28809.

4.4 Inspection standard. The applicable figures of MIL-S-45743 and any additional provisions provided or approved by the procuring activity, shall be utilized in determining compliance with the requirements of this specification.

4.5 Qualification and certification. Prior to performance of the requirements of this specification all soldering personnel qualification and certification shall be verified to be in accordance with 3.10.

5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6. NOTES

6.1 Intended use. It is intended that the soldering procedures covered in this specification are to be utilized for the soldering of high reliability electrical connections in critical electrical and electronic equipment of military weapons systems. This specification outlines the basic soldering procedures and process requirements which

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are to be employed. It is recognized that soldering connections exist other than those dealt with in this specification, and it is intended that these connections shall be handled under the general provisions of this specification.

6.2 Ordering data.

a. Title, number and date of this specification.

b. If certification of operators is not required (see 3.10 and 4.5).

6.3 Cleaning solvents. Cleaning solvents as listed in MIL-S-45743 have been found suitable for the removal of contaminants and residues from parts, assemblies and solder connections.

6.4 Terms and definitions. Definitions applicable to this specification shall comply with MIL-STD-429 and MIL-S-45743.

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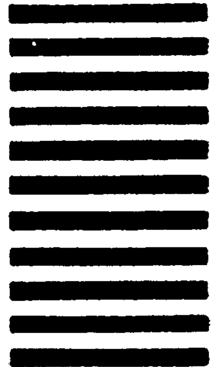

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