METRIC

QQ-S-571F
May 18, 1994
SUPERSEDING
QQ-S-571E
May 5, 1972

FEDERAL SPECIFICATION
SOLDER, ELECTRONIC (96 TO 485°C)

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers fluxed and non-fluxed solders in the form of bars, ingots, ribbon, wire, paste, and special (preforms) for use in two classes of electronic product applications, General and High Purity (see 1.2.2).

1.2 Classification.

1.2.1 Type designation. The type designation shall be in one of the following forms, and as specified (see 6.6). The Sn63Pb37 alloy is shown for example only. The exact alloy to be specified shall be selected in accordance with 3.2.

Beneficial comments (recommendations, additions, selections) and any pertinent data which may be of use in improving this document should be addressed to: US Army Research Laboratory (ARL) Electronics & Power Sources Directorate (EPSD), ATTN: AMSRL-EP-RD, Fort Monmouth, NJ 07703-5601, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 3439

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Solid solder (no flux)

Sn63Pb37	W	S
Composition (1.2.1.1)	Form (1.2.1.2)	Flux type (1.2.1.3)

Flux-cored solder

Sn63Pb37	W	R	P2
Composition (1.2.1.1)	Form (1.2.1.2)	Flux type (1.2.1.3)	Core condition and flux percentage (1.2.1.4)

Solder paste

Sn63Pb37	P	R	A2
Composition (1.2.1.1)	Form (1.2.1.2)	Flux type (1.2.1.3)	Powder mesh size and flux percentage (1.2.1.5)

1.2.1.1 Composition. The composition is identified by a two-letter symbol(s) and a number. The letters represent the chemical symbol for all major component metallic elements in the solder. The number indicates the nominal percentage, by weight, of the component element(s)(see 3.2.1).

1.2.1.2 Form. The form is indicated by a single letter, in accordance with table I.

TABLE I. Form

Symbol	Form 1/
B	Bar
I	Ingot
P	Paste
R	Ribbon
S	Special 2/
W	Wire

1/ see 6.7 to 6.7.2 inclusive, as applicable.
2/ includes pellets, preforms, etc. (see 6.6).

1.2.1.3 Flux type. The flux type is indicated by a letter or combination of letters, in accordance with table II.

TABLE II. Flux types

Symbol	Flux types
S	Solid metal (no flux)
R	Rosin flux
RMA	Mildly activated rosin flux
RA	Activated rosin or resin flux
WSF-O	Organic, water soluble flux (WSF-O); does not contain polyglycol(s)
WSF-1	All other organic water soluble fluxes; may contain polyglycol(s)
LR	Low residue fluxes; this type has a low solids content and is intended to minimize the residue which remains after soldering operations
AC	Non-rosin or non-resin flux 1/

1/ Type AC includes acids, organic chloride, inorganic chloride, etc. and is equivalent to Type "IS" per ASTM B-32.

1.2.1.4 Core condition and flux percentage (applicable only to flux cored solders except as noted). The core condition and flux percentage are identified by a single letter and number, in accordance with table III.

TABLE III. Core condition and flux percentage

Condition Symbol	Condition		
D - - - - - - - - - - -	Dry powder		
P - - - - - - - - - - -	Plastic		
Percentage symbol	Flux percentage		
	Nominal	Minimum	Maximum
<1 - - - - - - - - -	0.6	0.4	0.8
1 - - - - - - - - - - -	1.1	0.8	≤1.5
2 - - - - - - - - - - -	2.2	>1.5	≤2.6
3 - - - - - - - - - - -	3.3	>2.6	≤3.9
4 - - - - - - - - - - -	4.5	>3.9	≤5.0
6 1/ - - - - - - - -	6.0	>5.0	≤7.0

1.2.1.5 Powder mesh size and flux percentage (applicable only to solder paste). The powder mesh size and flux percentage is identified by a single letter and a number, in accordance with table IV.

TABLE IV. Powder mesh size and flux percentage 1/

Size symbol	Powder mesh size	
A	100	
B	200	
C	325	
Percentage symbol	**Flux percentage**	
	Minimum	Maximum
1	1.0	≤5
2	>5	≤10
3	>10	≤15
4	>15	≤20
5	>20	≤25
6	>25	≤30
7	over 30	

1/ Other mesh sizes may be used based on agreement between the buyer and the seller.

1.2.2 Class designation. Solder alloys covered by this specification shall be identified by the following application classes:

1.2.2.1 Class 1 - General applications. Class 1 soldering applications are equipments where continued performance is critical, where downtime cannot be tolerated, and/or where the equipment is a life support item. Military electronic hardware falls into this class.

1.2.2.2 Class 2 - High purity applications. Class 2 soldering applications are those applications where extreme solder purity is absolutely necessary. An example of this would be the attachment of an integrated circuit die chip to the substrate of an integrated circuit package.

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.

Federal Specifications:

- NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-way and 4-way (Partial).
- TT-I-735 Isopropyl Alcohol.
- QQ-S-698 - Steel, Sheet and Strip, Low-Carbon.
- PPP-B-585 - Boxes, Wood, Wirebound.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 - Boxes, Shipping, Fiberboard.

PPP-C-96 - Cans, Metal, 28 Gage and Lighter.
PPP-T-60 - Tape, Packaging, Waterproof.
PPP-T-76 - Tape, Packaging, Paper (For Carton Sealing).

Federal Standards:

FED-STD-123 - Marking for Shipment (Civil Agencies).
FED-STD-151 - Metal; Test Methods.
FED-STD-313 - Material Safety Data Sheets, Preparation and the Submission of.

Military Specifications:

MIL-P-116 - Preservation, Methods of.
MIL-S-13949/4 - Sheet, Printed Wiring Board, Laminated, Base Material GF, E-Glass Reinforcement, Majority Difunctional Epoxy Resin Flame Resistant, Metal-Clad or Unclad.
MIL-F-14256 - Flux, Soldering, Liquid, Paste Flux, Solder Paste and Solder Paste Flux (For Electronic/Electrical Use) General, Specification For.

Military Standards:

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-130 - Identification Marking of U.S. Military Property.
MIL-STD-147 - Palletized Unit Loads.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-2000 - Standard Requirements for Soldered Electrical and Electronic Assemblies.
MIL-STD-45662 - Calibration Systems Requirements.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.1.1 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DoD-SD-6 - Provisions Governing Qualification (Qualified Products List).

(Application for copies should be addressed to Defense Printing Service Detachment Office, Building 4D (DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094).

CFR, Title 29, Chapter XVII, Part 1910 - Code of Federal Regulations.

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-0001.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

THE INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

IPC-T-50 - Circuit, Interconnecting & Packaging Electronic, Terms & Definitions.
IPC-MF-150 - Metal Foil for Printed Wiring Applications.
IPC-SF-818 - General Requirements for Electronic Soldering Fluxes.
IPC-SP-819 - General Requirements and Test Methods for Electronic Grade Solder Paste.

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 7380 Lincoln Avenue, Lincolnwood, IL 60646).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-B32 - Metal, Solder, Standard Specification for.
ASTM-B36 - Plate Brass, Sheet, Strip, and Rolled Bar.
ASTM-B152 - Copper Sheet, Strip, Plate, and Rolled Bar, Standard Specification for.
ASTM-D3953 - Steel, Flat & Seals, Strapping.
ASTM-D465 - Acid Number of Rosin, Test Methods for.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187).

(Non-Government standards and other publications are normally available from the organizations that prepare or 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 document and the reference cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Solder(s) and flux(es) furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List (QPL) at the time of award of contract (see 4.5, 6.3 and DoD-SD-6).

3.2 Material.

3.2.1 Solder alloy. When tested as specified in 4.7.2 through 4.7.2.2, as applicable, solder alloy composition shall be as specified in table V(A). All alloys are designated as Class 1 or 2 applications (see 1.2.2.1 and 1.2.2.2). The elements for which there are percentage values listed in table V(A) for an alloy are considered to be the component elements of that alloy. Only the component elements of an alloy are considered to be desirable and all other elements are classified as impurities for that alloy. Each solder alloy shall be a homogeneous mixture of its component elements. The nominal percentage by weight of each component element of alloy shall be the percentage value listed for that element in table V(A). The actual percentage by weight of each component element shall not vary from the nominal value by more than the tolerance identified for that element in the notes for table V(A). When percentage value for an element of an alloy is tabulated as a range, the approximate midpoint of the range shall be considered the nominal value of that element for that alloy.

3.2.1.1 Allowable impurity levels - Class 2 solder alloys. For Class 2 solder alloys, the combined total percentage by weight of all impurity elements shall not exceed 0.05%. The combined total amount of each of the following two groups of elements shall not exceed 0.0005%:

Group 1: Be, Hg, Mg, and Zn
Group 2: As, Bi, P, and Sb.

3.2.1.2 Allowable impurity levels - Class 1 solder alloys. For Class 1 solder alloys, the percentage by weight of each of the following elements, when classified as an alloy impurity, shall not exceed the percentages indicated:

Ag:	0.10	Bi:	0.10	In:	0.10	S:	0.005
Al:	0.005	Cd:	0.005	Ni:	0.010	Sb:	0.50
As:	0.030	Cu:	0.080	P:	0.010	Sn:	0.250
Au:	0.080	Fe:	0.020	Pb:	0.20	Zn:	0.005

3.2.2 Flux.

3.2.2.1 Types. Flux types and forms incorporated in or on soldering materials covered by this specification shall conform to all requirements of MIL-F-14256. If solvents or plasticizers are added, they shall be non-chlorinated and shall not deviate from requirement(s) of MIL-F-14256. Type AC, previously included in QQ-S-571, shall be procured as type "IS" per ASTM B32.

3.2.2.2 Composition. Types R, RMA and RA fluxes shall be composed of gum rosin, wood rosin or tall oil rosin having a minimum acid number of 130 (see 4 7.13), dissolved in or plasticized by a nonhalogenated solvent. Modified natural rosins meeting the requirements of this specification are acceptable. Manufacturers of flux shall maintain records indicating the acid value of all rosin used to formulate their products in compliance with MIL-F-14256. Water soluble flux shall be composed of an organic activator dissolved in a nonhalogenated solvent or water (deionized or distilled). For paste fluxes and solder-paste fluxes, nonreactive rheological control additives necessary to achieve required viscosity are permitted. No additional additives are permitted in Type R fluxes. Additives may be added to other flux types for the purpose of improving the fluxing/foaming or spreading action. Paste fluxes and solder-paste fluxes shall meet all of the requirements for their respective liquid flux.

3.2.2.3 Type WSF-0. Type WSF-0 flux shall contain no polyglycol materials. Flux manufacturers shall certify their product(s), covered by this specification, contains none of the polyglycol family material(s) as defined in 6.2.

3.2.2.4 Type WSF-1. Type WSF-1 flux may include polyglycol materials.

3.2.2.5 Type LR. Flux manufacturers may classify certain formulations of nonrosin-based, rosin-based or water soluble fluxes as low residue (LR) fluxes for use in manufacturing processes which minimize or eliminate cleaning operations. Type LR fluxes shall be free of ionic and non-ionic halide(s) and/or halogen(s). During qualification, fluxes classified as low residue shall be tested for surface insulation resistance, both after cleaning and without cleaning. The results of both tests shall be reported separately in the qualification report. In the material data sheet, manufacturers of low residue fluxes shall provide recommendations on whether the flux should be cleaned. In addition, the material data sheet should also describe known material incompatibility with commonly used solvents, saponifiers and other cleaning materials.

3.2.2.6 Core. The core shall be of any construction and symmetrically disposed in the solder. It shall also be continuous, homogeneous and uniform in cross section. The core shall be sealed within the solder at both ends by crimping or other means (see 4.7.1.1.1.1). Core condition D shall be a dry powder core; core condition P shall be a plastic core.

3.2.3 Flux activity classification (see 4.7.9, 6.1.2.1, and 6.1). The type of flux used in the fabrication of electronic assemblies can impact on part compatibility, post soldering cleaning requirements and long-term assembly reliability. In order to help flux users determine assembly/process compatibility, flux manufacturers qualifying product(s) to this specification shall classify their product(s), when tested per 4.7.9, into the following categories:

L = low or no flux/flux residue activity
M = moderate flux/flux residue activity
H = high flux/flux residue activity

This classification will be included on the Qualified Products List (QPL) for informational purposes.

3.2.3.1 Rosin flux nonvolatile content (applicable to Types R, RMA and RA). The flux manufacturer shall certify that a minimum of 51.0% of the nonvolatile content is rosin. For an optional test method to verify certification, see 4.7.12 and 6.9.2.

3.2.3.2 Resistivity of water extract (applicable to Types R, RMA, RA, WSF-0, and WSF-1). When the flux is tested as specified in 4.7.5, the mean of the specific resistivities of the water extracts shall be at least 100,000 ohm-centimeters (ohm-cm) for Type R and Type RMA flux and 50,000 ohm-cm for Type RA.

3.2.3.3 Halide content (applicable to all flux types). Halides of interest are chlorides (Cl), bromides (Br) and fluorides (F). In order to control these within acceptable limits and prevent possible corrosive effects, testing for Cl^-, Br^- and F^- shall be performed per 3.2.3.4, 3.2.3.5, and 3.2.3.6.

3.2.3.4 Silver chromate paper test. There shall be no significant reaction to halides. The presence of halides is indicated by a color change of the paper to off-white or yellow white (see 4.7.6.1). Additional testing is required if the flux fails the silver chromate paper test (see 3.2.3.6). A flux, other than Types R and LR, cannot fail for halide content based solely upon the failure of the silver chromate paper test. Type RA flux will normally fail this test, serving as an indicator that it is classified/labeled correctly.

3.2.3.5 Tests for fluorides. A qualitative test is required for all fluxes. To pass, Type R and Type LR flux must test negative when evaluated as indicated in 4.7.6.2. Flux testing positive shall be further tested quantitatively to determine the concentration of fluoride present (see 4.7.6.4).

3.2.3.6 Halide ion testing for combined chloride (Cl) and bromide (Br) content. If a flux fails the silver chromate paper test (see 3.2.3.4 and 4.7.6.1), a quantitative test for the chloride and bromide ions shall be performed (see 4.7.6.3). The following limits for either one or a combination of these ions shall apply:

for RMA - 0.040 milliequivalents per gram (meq/g) of solids
for RA - 0.284 milliequivalents per gram (meq/g) of solids
for WSF - 0.284 milliequivalents per gram (meq/g) of solids
for LR - no detectable halides

Type R and Type LR flux must test negative when evaluated as indicated in 4.7.6.3. If fluoride is found (see 3.2.3.5 and 4.7.6.2), its concentration, expressed in meq/g solids, shall be added to the concentration of the chloride and/or bromide ion(s), expressed in meq/g, if also present. Any single ion or combination of the ions of fluoride, chloride and/or bromide shall not exceed the above limits.

3.2.3.7 Paste flux and solder-paste flux viscosity. There are no specific requirements regarding viscosity. If required, based on agreement between the buyer and the seller, viscosity data shall be determined per 6.9.1.

3.2.3.8 Isopropyl alcohol. Where addition of a solvent is needed to perform testing as specified herein, isopropyl alcohol (IPA) conforming to TT-I-735 shall be used.

3.2.3.9 Organic residue. There are no specific requirements regarding organic residue detection. If required, based on agreement between the buyer and the seller, organic residue detection shall be determined per 6.9.3.

3.3 Flux reliability tests.

3.3.1 Copper mirror test. Samples of flux shall be subjected to the copper mirror test in accordance with 4.7.7. The results shall be reported as one of the following:

Condition A - No complete breakthrough, as evidenced by white background showing through anywhere in the test spots. This condition includes discoloration of the copper due to a superficial reaction or a reduction of the thickness of the copper film without complete breakthrough.

Condition B - Complete copper removal (breakthrough) in 50% or less of the area of the test spots.

Condition C - Complete copper removal (breakthrough) in more than 50% of the area of the test spots.

Types R, RMA and LR fluxes pass this test with Condition A test results and fail the test with Condition B or C test results. Types RA, WSF-O and WSF-1 fluxes pass this test with Condition A, B or C test results. The resultant data will be included on the Qualified Products List (QPL) for informational purposes.

3.3.2 Surface insulation resistance (SIR). The test specimens shall be made from glass epoxy resin substrates per MIL-P-13949/4. When tested as specified in 4.7.10 under conditions of 85 ±2°C and 85% relative humidity (RH), nominal, for a duration of 7 days (168 hours), test specimens shall have a minimum of 50 megohms resistance at T = 96 and 168 hours and a minimum of 500 megohms two hours after the final temperature and humidity conditions have stabilized at 25°C and 50% RH. Resistance readings shall be actual values rather than an average of the tested coupons.

3.3.2.1 Inspection for visual defects. Upon the completion of surface insulation resistance testing, each coupon shall be examined using 10X to 30X magnification with back lighting. Dendritic growth, dark spots, blue-green discoloration (corrosion) or other conditions demonstrating electrochemical migration shall be considered a failure when inspected per 4.7.10.1.

3.3.3 Corrosion test. When tested as specified in 4.7.8, there shall be no evidence of corrosion for flux Types R, RMA, and RA. Failure of this test by flux Types WSF-O and WSF-1 shall not be cause for rejection. Evidence of a light blue, green, or blue-green discoloration at the interface of the solder and copper coupon for Type LR fluxes consisting of up to 2% ACS reagent grade adipic acid in isopropyl alcohol with no additional activators, resins, wetting agents, or other additives, shall not be cause for rejection. Type LR flux must pass the copper mirror and silver chromate paper tests to be accepted. The results of corrosion testing for all flux types shall be reported.

3.3.4 Solder paste (applicable only to flux Types R, RMA, RA, WSF-0, WSF-1, and LR). Solder paste shall consist of solder alloy powder suspended in a flux media such that it has a smooth and uniform texture and shows no caking or separation of flux and solder metal or it can be reconstituted by spatulation (see 4.7.1.1.2). The term 'solder alloy powder' shall be interpreted to mean powder which has been made from prealloyed solder metal so all of the powder particles are the same metal alloy. The term 'prealloyed solder metal' shall be interpreted to mean solder metal in which its component elements were homogeneously mixed (alloyed) in a liquid state and maintained homogeneous to the maximum extent possible during cooling to a solid.

3.3.4.1 Solder powder mesh size. When the extracted solder powder is tested as specified in 4.7.4, the mesh size shall be specified (see 1.2.1 and 1.2.1.5).

3.4 Flux percentage (applicable only to flux Types R, RMA, RA, WSF-0, WSF-1, and LR. When flux-cored solder or solder paste is tested as specified in 4.7.14, the flux percentage by weight shall be as specified (see 1.2.1, 1.2.1.4, and 1.2.1.5, as applicable).

3.5 Fluxing action.

3.5.1 Solder pool (applicable to flux Types R, RMA, RA, WSF-0, WSF-1, LR, and AC). When flux-cored solder or solder paste is tested as specified in 4.7.15.1, the flux shall promote the spreading of the molten solder over the coupon to form integrally thereon a coat of solder which shall feather out to a thin edge. The complete edge of the solder pool shall be clearly visible through the flux residue, and there shall be no evidence of spattering, as indicated by the presence of flux particles outside the main pool of residue.

3.5.2 Solder spread (applicable only to flux Types R, RMA, RA, WSF-0, WSF-1 and LR). When tested as specified in 4.7.11, the solder spread test results shall be expressed in square millimeters (mm^2). The following minimum requirements shall apply: Type LR, no requirement, but shall be reported; all other types, 90 mm^2.

3.6 Dryness (applicable only to flux Types R, RMA, and RA). When flux-cored solder or solder paste is tested as specified in 4.7.16, the surface of the residue shall be free from tackiness, permitting easy removal of applied powdered chalk.

Table V(A). Solder alloys. 1/

ALLOY COMPOSITION

ALLOY NAME 2/	ALLOWABLE IMPURITY LEVEL 2/	Sn%	Pb%	Au%	In%	Ag%	OTHER COMPONENT ELEMENTS	°C SOL	LIQ 3/	FORMER NAME4/
Sn99 5/	class 1	99.9	.....	.....	....	....	....	x	232	
Sn96.3Ag3.7	class 1	R 96.3	.....	.....	....	3.7	....	x	221	Sn96
Sn95Sb05	class 1	R 95.0	.....	.....	....	....	Sb=4.0 to 6.0%	235	240	Sb5
Sn95Ag04Cd01	class 1	R 95.0	.....	.....	....	4.0	Cd=1.0%	216	219	
Sn90Pb10	class 1	90.0	R 10.0	.....	....	....	....	183	213	
Sn70Pb30	class 1	70.0	R 30.0	.....	....	....	....	183	193	Sn70
Sn70Pb18In12	class 1	R 70.0	18.0	.....	12.0	....	....	153	163	
Sn63Pb37	class 1	63.0	R 37.0	.....	....	....	....	x	183	Sn63
Sn62Pb36Ag02	class 1	62.0	R 36.0	.....	....	2.0	....	x	179	Sn62
Sn60Pb40	class 1	60.0	R 40.0	.....	....	....	....	183	191	Sn60
Sn60Pb38Cu02	class 1	R 60.0	38.0	.....	....	....	Cu=2.0%	183	190	
Sn50Pb50	class 1	50.0	R 50.0	.....	....	....	....	183	216	Sn50
Sn50Pb49Cu01	class 1	50.0	R 48.5	.....	....	....	Cu=1.5%	183	215	
Sn50Pb32Cd18	class 1	50.0	R 32.0	.....	....	....	Cd=18.0%	x	145	
Sn48In52	class 1	R 48.0	.....	.....	52.0	....	....	x	118	
Sn43Pb43Bi14	class 1	43.0	R 43.0	.....	....	....	Bi=14.0%	144	163	
Sn42Bi58	class 1	R 42.0	.....	.....	....	....	Bi-58%..	x	138	
Sn40Pb60	class 1	40.0	R 60.0	.....	....	....	....	183	238	Sn40
Sn35Pb65	class 1	35.0	R 65.0	.....	....	....	....	183	246	Pb65
Sn35Pb63Sb02	class 1	35.0	R 63.2	.....	....	....	Sb=1.8%	185	243	Sn35
Sn34Pb20Bi46	class 1	34.0	R 20.0	.....	....	....	Bi=46.0%	x	100	
Sn30Pb70	class 1	30.0	R 70.0	.....	....	....	....	183	254	Pb70
Sn30Pb68Sb02	class 1	30.0	R 68.4	.....	....	....	Sb=1.6%	185	250	Sn30
Sn30Cd70	class 1	R 30.0	.....	.....	....	....	Cd=70.0%	140	160	
Sn20Pb80	class 1	20.0	R 80.0	.....	....	....	....	183	277	Pb80
Sn20Pb79Sb01	class 1	20.0	R 79.0	.....	....	....	Sb=1.0%	184	270	Sn20
Sn20Au80	class 1	20.0	.....	R 80.0	....	....	....	x	280	
Sn18Pb80Ag02	class 1	18.0	R 80.1	.....	....	1.9	....	178	270	
Sn16Pb32Bi52	class 1	16.0	R 32.0	.....	....	....	Bi=52.0%	x	96	
Sn10Pb88Ag02	class 1	10.0	R 88.0	.....	....	2.0	Sb=0.20% max.	268	290	Sn10
Sn05Pb95	class 1	5.0	R 95.0	.....	....	....	....	308	312	Sn5
Sn05Pb93.5Ag1.5	class 1	5.0	R 93.5	.....	....	1.50	....	296	301	

See footnotes on Page 15.

Table V(A). Solder alloys (continued). 1/

ALLOY COMPOSITION

ALLOY NAME 2/	ALLOWABLE IMPURITY LEVEL 2/	Sn%	Pb%	Au%	In%	Ag%	Other Component Elements	°C SOL	LIQ 3/	FORMER NAME 4/
Sn05Pb92.5Ag2.5	class 1	5.0	R 92.5	.....	....	2.5	....	280	284	
Sn03Pb97	class 1	3.0	R 97.0	.....	....	....	....	314	320	
Sn03Pb95Ag02	class 1	3.0	R 95.0	.....	....	2.0	....	305	306	
Sn02Pb96Sb02	class 1	2.0	R 96.0	.....	....	....	Sb=2.0%	299	307	
Sn01Pb97Ag02	class 1	1.0	R 97.5	.....	....	1.5	Sb=0.40% max.	x	309	Ag1.5
In99	class 1	.....	.....	.....	99.9	....	....	x	157	
In80Pb15Ag05	class 1	.....	R 15.0	.....	80.0	5.0	....	149	150	
In70Pb30	class 1	.....	R 30.0	.....	70.0	....	....	160	174	
In60Pb40	class 1	.....	R 40.0	.....	60.0	....	....	174	185	
In50Pb50	class 1	.....	R 50.0	.....	50.0	....	....	180	209	
In40Pb60	class 1	.....	R 60.0	.....	40.0	....	....	195	225	
In25Pb75	class 1	.....	R 75.0	.....	25.0	....	....	250	264	
In19Pb81	class 1	.....	R 81.0	.....	19.0	....	....	270	280	
In18Au82	class 1	.....	.....	R 82.0	18.0	....	....	451	485	
In05Pb92Ag03	class 1	.....	R 92.5	.....	5.0	2.5	....	300	310	
Au97Si03	class 1	.....	.....	R 96.8	....	....	Si=3.2%	x	363	
Au88Ge12	class 1	.....	.....	R 88.0	....	....	Ge=11.0 to 13.0%	x	356	
Ag06Pb94	class 1	.....	R 94.5	.....	....	5.5	Sb=0.40% max.	304	380	Ag5.5
Ag03Pb97	class 1	.....	R 97.5	.....	....	2.5	Sb=0.40% max.	x	304	Ag2.5
Sn20Au80	class 2	20.0	.....	R 80.0	....	....	....	x	280	
Sn10Pb88Ag02	class 2	10.0	R 88.0	.....	....	2.0	....	268	290	
Sn05Pb95	class 2	5.0	R 95.0	.....	....	....	....	308	312	
Sn05Pb94Ag02	class 2	5.0	R 93.5	.....	....	1.50	....	296	301	
Sn05Pb93Ag03	class 2	5.0	R 92.5	.....	....	2.5	....	280	284	
Sn03Pb97	class 2	3.0	R 97.0	.....	....	....	....	314	320	
Sn03Pb95Ag02	class 2	3.0	R 95.0	.....	....	2.0	....	305	306	
In19Pb81	class 2	.....	R 81.0	.....	19.0	....	....	270	280	
In18Au82	class 2	.....	.....	R 82.0	18.0	....	....	451	485	
In05Pb92Ag03	class 2	.....	R 92.5	.....	5.0	2.5	....	300	310	
Au97Si03	class 2	.....	.....	R 96.8	....	....	Si=3.2%	x	363	
Au88Ge12	class 2	.....	.....	R 88.0	....	....	Ge=11.0 to 13.0%	x	356	

See footnotes on page 15.

Table V(A) Footnotes:

1/ Except where otherwise indicated, component elements in each alloy shall have a tolerance of ± 0.20% when their tabulated percentage is less than or equal to 5.0% and a tolerance of ± 0.50% when their tabulated percentage is greater than 5.0%. The tolerance shall be interpreted to mean the amount that a component element in an alloy may vary from its tabulated value (e.g., the actual percentage of a component element having a tolerance of 0.50% must fall within the following limits: (tabulated percentage - 0.50) to (tabulated percentage + 0.50). When the value for a component element is tabulated as a percentage range, the nominal value shall be the approximate midpoint of the range and the actual percentage of that element in the alloy shall not be less than the lower limit of the range and not be higher than the upper limit of the range. The tolerance for tin in Sn99 shall be +0.10/-0.05%. The letter "R" appearing with a NUMBER for an element of an alloy (e.g., R 10.0) denotes that the element makes up the REMAINDER of the alloy; the NUMBER indicates the approximate percentage of that element in the alloy.

2/ Class 2 alloy impurity levels shall conform to requirements of para 3.2.1.1. Class 1 alloy impurity levels shall conform to requirements of para 3.2.1.2.

3/ Liquidus (LIQ) and Solidus (SOL) temperature values are provided for information only. They are not intended to be a requirement in the formulation of the alloys. Although efforts have been made to document the correct liquidus and solidus temperatures for each alloy, users of this document are advised to verify these temperature values for critical applications. Eutectic alloys are marked with an "x" in the SOL columns.

4/ The presence of a former alloy name indicates that the current alloy is substantially the same as the former alloy. An asterisk indicates that the limits for antimony were changed per interim amendment 6 to this document.

5/ Alloy Sn99 is included in QQ-S-571 for use in replenishing tin in wave soldering pots and is not suitable for use as a stand-alone solder because of a potential for dendritic growth (tin whiskers) or TIN PEST problems.

Table V(B). Solder alloy temperature range from solid to liquid.

°C SOL	°C LIQ	ALLOY NAME	°C SOL	°C LIQ	ALLOY NAME	°C SOL	°C LIQ	ALLOY NAME
X	96	Sn16Pb32Bi52	180	209	In50Pb50	183	277	Sn20Pb80
X	100	Sn34Pb20Bi46	183	213	Sn90Pb10	x	280	Sn20Au80
X	118	Sn48In52	183	215	Sn50Pb49Cu01	270	280	In19Pb81
X	138	Sn42Bi58	183	216	Sn50Pb50	280	284	Sn05Pb93Ag03
X	145	Sn50Pb32Cd18	216	219	Sn95Ag04Cd01	268	290	Sn10Pb88Ag02
149	150	In80Pb15Ag05	x	221	Sn96Ag04	296	301	Sn05Pb94Ag02
X	157	In99	195	225	In40Pb60	x	304	Ag03Pb97
140	160	Sn30Cd70	x	232	Sn99	305	306	Sn03Pb95Ag02
144	163	Sn43Pb43Bi14	183	238	Sn40Pb60	299	307	Sn02Pb96Sb02
153	163	Sn70Pb18In12	235	240	Sn95Sb05	x	309	Sn01Pb97Ag02
160	174	In70Pb30	185	243	Sn35Pb63Sb02	300	310	In05Pb92Ag03
X	179	Sn62Pb36Ag02	183	246	Sn35Pb65	308	312	Sn05Pb95
X	183	Sn63Pb37	185	250	Sn30Pb68Sb02	314	320	Sn03Pb97
174	185	In60Pb40	183	254	Sn30Pb70	x	356	Au88Ge12
183	190	Sn60Pb38Cu02	250	264	In25Pb75	x	363	Au97Si03
183	191	Sn60Pb40	178	270	Sn18Pb80Ag02	304	380	Ag06Pb94
183	193	Sn70Pb30	184	270	Sn20Pb79Sb01	451	485	In18Au82

Table V(B) Footnote:

Except where otherwise indicated, component elements in each alloy shall have a tolerance of ±0.20% when their tabulated percentage is less than or equal to 5.0% and a tolerance of ±0.50% when their tabulated percentage is greater than 5.0%. The tolerance shall be interpreted to mean the amount that a component element in an alloy may vary from its tabulated value (e.g., the actual percentage of a component element having a tolerance of 0.50% must fall within the following limits: (tabulated percentage -0.50) to (tabulated percentage +0.50). When the value for a component element is tabulated as a percentage range, the nominal value shall be the approximate midpoint of the range and the actual percentage of that element in the alloy shall not be less than the lower limit of the range and not be higher than the upper limit of the range. The tolerance for tin in Sn99 shall be +0.10/-0.05%. The letter "R" appearing with a NUMBER for an element of an alloy (e.g., R 10.0) denotes that the element makes up the REMAINDER of the alloy; the NUMBER indicates the approximate percentage of that element in the alloy.

3.7 Dimensions (applicable only to ribbon and wire solder). The dimensions shall be as specified (see 6.6 and 6.7.1). For wire solder, the tolerance on the specified outside diameter (see 6.6) shall be ±5 percent or ±0.05 mm, whichever is greater.

3.8 Unit weight. The unit weight of all forms of solder, as applicable, shall be as specified (see 6.6 and 6.7.2).

3.9 Marking. Federal specification bar and ingot solder forms shall be marked with the manufacturer's name or code symbol and the type designation, in accordance with MIL-STD-130. The spools, packages, and containers of other solder forms shall be marked with the manufacturer's name or code symbol, the type designation, and the nominal weight of the spool, package, and/or container, in accordance with MIL-STD-130.

3.10 Safety and health requirements. Fluxes formulated for this specification shall contain only nonhalogenated solvents. These might possibly include an alcohol or water. It is mandatory that flux be used only in well ventilated areas, well away from any possible source(s) of ignition such as open flame(s), spark(s) or any electrostatic discharge. Applicable local and federal regulations concerning handling, storage, and disposal of hazardous material shall be reviewed and invoked to insure safety of all personnel possibly exposed to any flux, associated solvents, additives, gases, vapors or smoke particles resulting from its use. Before using or disposing of any materials which might contain these chemicals, they shall be evaluated in accordance with the CFR, Title 29, Chapter XVII, Part 1910. The flux manufacturer and user shall determine if the flux and or solder constituents, by-products, residues and materials for disposal are hazardous.

3.11 Workmanship. Solders and fluxes shall be compounded and processed to insure that each batch (lot) is uniform in quality and free from deleterious material and other defects that could adversely affect shelf life, serviceability or appearance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the solder/flux manufacturer is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the flux manufacturer may use in house or any other facility 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 this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any additional specific inspection requirement(s) in the specification shall not relieve the contractor of the responsibility of insuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Test equipment and inspection facilities. Testing, measuring inspection equipment and facilities, of sufficient accuracy, quality and quantity to permit performance of the required inspection(s), shall be established and maintained or designated by the solder/flux manufacturer. Establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

(a) Materials inspection (see 4.3).
(b) Qualification inspection (see 4.5).
(c) Quality conformance inspection (see 4.6).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table VI, used in compounding the solder, are in accordance with the applicable referenced specifications prior to such compounding. The certification and verifying data applicable to a qualification test sample shall be made a part of the qualification test report.

TABLE VI. Materials inspection

MATERIAL	REQUIREMENT PARAGRAPHS	METHOD OF INSPECTION
All Types	3.2.1	4.7.1 4.7.7
Type LR	3.2.2.5	4.7.1
Type WSF	3.2.2.3 and 3.2.2.4	4.7.1
Solvent 1/	3.2.2.1	4.7.1
Additives 2/	3.2.2.1 through 3.2.2.5	4.7.1

1/ verification of solvent as nonhalogenated
2/ verification of presence or absence of additives

4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in "GENERAL REQUIREMENTS" of MIL-STD-202.

4.5 Qualification inspection (applicable to Type S solder and flux-cored wire solder and solder paste, flux Types R, RMA, RA, WSF-O, WSF-1, and LR). Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on samples produced with equipment and procedures normally used in production. A report which meets the requirements of 4.5.6 shall be submitted for initial qualification.

4.5.1 Qualification by similarity. Manufacturers may qualify a solder set by similarity if the flux used in the solder has been previously qualified to MIL-F-14256. Manufacturers requesting qualification by similarity shall identify the government letter which notified the company of the qualification approval and perform the following tests of table VII: alloy composition (4.7.2 through 4.7.2.2), flux percentage (4.7.14) and solder pool (4.7.15).

4.5.2 Sample size. 1 kg (minimum) sample of either solder paste or form W (1.6 $\pm$2 mm nominal thickness) solder shall be submitted for qualification inspection. Solder paste shall be flux percentage symbol 2; flux-cored solder shall be flux percentage symbol 3 (see table III, para 1.2.1.4). For qualification inspection a 500 ml sample of liquid flux shall be furnished in a sealed container. A sample of approximately 200 ml of paste flux or solder-paste flux shall be furnished in a sealed container for viscosity testing (see 3.2.3.7). A sufficient size sample of paste flux or solder-paste flux shall be furnished in a separate sealed container to be subjected to qualification testing with the exception of viscosity. Samples shall remain sealed, except for purposes of testing to minimize loss of volatiles or solutes from evaporation.

4.5.3 Inspection routine. The samples shall be subjected to the inspections specified in table VII.

4.5.4 Failures. One or more failures shall be cause for refusal to grant qualification approval.

TABLE VII. Qualification inspection

Examination or test	Requirement paragraph	Method paragraph
Visual and dimensional examination:		
Core	3.2.2.6	4.7.1.1.1.1
Solder paste	3.3.4	4.7.1.1.2
Dimensions 1/	3.7	4.7.1.1.1
Unit weight	3.8	4.7.1.1.1, 4.7.1.1.2, and 4.7.1.1.3
Marking 2/	3.9	4.7.1.1.3
Workmanship	3.11	4.7.1.1.1, 4.7.1.1.2, and 4.7.1.1.3
Material:		
Alloy composition	3.2.1	4.7.2 to 4.7.2.2 incl, as applicable
Resistivity of water extract 3/	3.2.3.2	4.7.5
Halide content 4/	3.2.3.3	4.7.6
Solder powder mesh size 4/	3.3.4.1	4.7.4
Viscosity	3.2.3.7	6.9.1
Flux percentage 4/	3.4	4.7.14
Fluxing action:	3.5	4.7.15
Solder pool 4/	3.5.1	4.7.15.1
Spread factor 4/	3.5.2	4.7.15.2
Dryness 3/	3.6	4.7.16
Effect on copper mirror 4/	3.3.1	4.7.7
Corrosion	3.3.3	4.7.8

1/ applicable only to wire solder
2/ applicable only to bar and ingot solder
3/ applicable only to flux Types R, RMA, RA, WSF-0, and WSF-1
4/ applicable to all flux types

4.5.5 Failure(s). One or more failures shall be cause for refusal to grant qualification.

4.5.6 Retention of qualification. To retain qualification, the manufacturer shall forward a report at 12-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

(a) A summary of the results of the tests performed for inspection of product for delivery, groups A and B (see 4.6), indicating as a minimum, the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.

(b) A summary of the results of tests performed for qualification verification inspection, groups C and D (see 4.6), including the number and mode of failures. The summary shall include results of all qualification verification inspection tests performed and completed during the 12-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the Qualified Products List.

Failure to submit the report within 30 days after the end of each 12-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the manufacturer shall immediately notify the qualifying activity at any time during the 12-month period that the inspection data indicates failure of the qualified product to meet the requirements of this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit representative solder to testing in accordance with the qualification inspection requirements.

4.5.7 Extent of qualification. Because of the high degree of similarity within the following sets of QQ-S-571 solders, reasonable assurance of product conformity to the QQ-S-571 requirements can be achieved by requiring companies to submit to qualification inspection only one solder of each set for the required qualification inspections. Qualification of one solder in a set provides the basis for qualification by similarity for all of the manufacturer's QQ-S-571 solders in that set. Furthermore, the qualification of any set of fluxed solders (including solder pastes) by a manufacturer provides the basis for qualification by similarity of the set of fluxed solders. However, no additional solders in any set will be considered qualified until written requests for qualification by similarity have been initiated by the manufacturer and approved by the Government qualification agency for QQ-S-571. Requests for qualification of solders by similarity shall be submitted in accordance with procedures for submittal of requests for qualification of products per DoD-SD-6. In addition to the information and certifications required by DoD-SD-6, requests for qualification of solders by similarity shall list each solder for which such qualification is desired and shall identify the Government letter which notified the manufacturer of the qualification approval of the solder qualified by inspection which is to serve as the basis for the qualification of the additional solder by similarity.

Solder Sets

a. Solder pastes with Type R flux.
b. Solder pastes with Type RMA flux.
c. Solder pastes with Type RA flux.
d. Solder pastes with Type WSF-0 flux.
e. Solder pastes with Type WSF-1 flux.
f. Solder pastes with Type LR flux.
g. Solder pastes with any other type flux.

h. Solders in other forms with Type R flux.
i. Solders in other forms with Type RMA flux.
j. Solders in other forms with Type RA flux.
k. Solders in other forms with Type WSF-0 flux.
l. Solders in other forms with Type WSF-1 flux.
m. Solders in other forms with Type LR flux.
n. Solders in other forms with any other type flux.
o. Solders, solid core, non-fluxed.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A, B, C and D inspections.

4.6.1.1 Unit of production. The unit of production shall consist of either spools, coils, cans of solder, bars, or ingots having the same type designation and produced from the same batch of raw materials under essentially the same conditions.

4.6.1.2 Inspection lot.

4.6.1.2.1 Groups A, B, and C inspections. An inspection lot, as far as practicable, shall consist of all the solder of the same type designation, produced from the same batch of raw materials under essentially the same conditions, and offered for inspection at one time.

4.6.1.2.2 Group D inspection. An inspection lot shall consist of all the solder of the same core mixture, produced from the same batch of raw materials under essentially the same conditions, and offered for inspection at one time.

4.6.1.3 Group A inspection. Group A inspection shall consist of the examination specified in table VIII.

4.6.1.3.1 Sampling plan. Group A inspection shall be performed on 100% of the production batch or containers comprising the lot.

4.6.1.3.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be reinspected. Such lots shall be separate from new lots and shall be clearly identified as a reinspected lot(s).

TABLE VIII. Group A inspection

Examination	Requirement paragraph	Method paragraph
Visual and dimensional examination:		
Core	3.2.2.6	4.7.1
Solder paste	3.3.4	4.7.1
Dimensions 1/	3.7	4.7.1
Unit weight	3.8	4.7.1
Marking 2/	3.9	4.7.1
Workmanship	3.11	4.7.1

1/ applicable only to ribbon and wire solder
2/ applicable only to bar and ingot solder

4.6.1.4 Group B inspection. Group B inspection shall consist of the tests, as applicable, specified in table IX and the sample shall be selected from inspection lots which have passed group A inspection.

4.6.1.4.1 Sampling plan. A sufficient quantity for testing of flux shall be taken from every batch or one batch each month, whichever is less frequent.

4.6.1.4.2 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects or screen out containers of defective materials and submit for reinspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected.

TABLE IX. Group B inspection

Test	Requirement paragraph	Method paragraph
Flux percentage 1/	3.4	4.7.14
Fluxing action:	3.5	4.7.15
Solder pool 1/ 2/	3.5.1	4.7.15.1
Halide content 3/	3.2.3.3	4.7.6.

1/ applicable to all flux types
2/ applicable to all compositions
3/ applicable only to flux Types R, RMA, WSF-0, WSF-1, and LR

4.6.1.4.3 Disposition of samples. Samples which have been subjected to group B inspections shall not be delivered on the contract or purchase order.

4.6.2 Qualification verification inspection. Qualification verification inspection shall consist of groups C and D. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.3), delivery of products which have passed groups A and B shall not be delayed pending the results of these qualification verification inspections.

4.6.2.1 Group C inspection. Group C inspection shall consist of the test specified in table X. Group C inspection shall be made on samples selected from inspected lots which have passed the groups A and B inspections.

TABLE X. Group C inspection

Test	Requirement paragraph	Method paragraph
Alloy composition	3.2.1	4.7.2 to 4.7.2.2 incl, as applicable

4.6.2.1.1 Sampling plan. Samples shall be selected from the first lot and then from one lot in every 25 or once a year, whichever is more frequent, in accordance with table XI. For spools and coils, the test sample shall be taken from the second two meters of length.

TABLE XI. Sampling plan for group C inspection

Size of lot (pounds)	Number of samples (spools, coils, containers, or pieces)
Up to 0.50 metric tons	3
Over 0.50 to 4.5 metric tons	5
Over 4.5 metric tons	10

4.6.2.1.2 Failure(s). If one or more samples fail to pass group C inspection, the sample shall be considered to have failed.

4.6.2.1.3 Disposition of samples. Samples which have been subjected to group C inspection shall not be delivered on the contract or purchase order.

4.6.2.2 Group D inspection. Group D inspection shall consist of the tests, as applicable, specified in table XII. Group D inspection shall be made on samples selected from inspection lots which have passed the groups A and B inspections.

TABLE XII. Group D inspection

Test	Requirement paragraph	Method paragraph
Solder powder mesh size 2/	3.3.4.1	4.7.4
Fluxing action:	3.5	4.7.15
Spread factor 1/ 3/	3.5.2	4.7.11
Dryness 1/	3.6	4.7.16
Effect on copper mirror	3.3.1	4.7.7
Corrosion	3.3.3	4.7.8

1/ applicable only to flux Type R, RMA, and RA
2/ applicable only to solder paste
3/ applicable only to all tin/lead alloys

4.6.2.2.1 Sampling plan. One pound of flux-cored solder or solder paste shall be selected for each flux mixture from the first lot and thence from one lot in every 50 lots, or once each 24 months, whichever is more frequent.

4.6.2.2.2 Failures. If the sample fails to pass any of the applicable group D inspections, the sample shall be considered to have failed.

4.6.2.2.3 Disposition of samples. Samples which have been subjected to group D inspection shall not be delivered on the contract or purchase order.

4.6.2.3 Noncompliance. If a sample fails to pass groups C or D inspections, the supplier shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, groups C and D inspections shall be repeated on additional samples (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstituted; however, final acceptance shall be withheld until groups C and D reinspections have shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.6.3 Inspection of preparation for delivery. Sample packages and packs and the inspection of the preservation-packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

4.7 Methods of examination and test. Liquid fluxes shall be tested as formulated by the flux manufacturer. Some tests such as resistivity of water extract (see 4.7.5), qualitative test for fluorides (see 4.7.6.2) and halide content (see 4.7.6) will require dissolving paste flux or solder-paste flux in isopropyl alcohol (IPA) for rosin based flux and distilled water for organic type fluxes. Paste fluxes and solder-paste fluxes shall be tested in a 35%, by weight, diluted solution. For tests/evaluations of paste flux and/or solder-paste fluxes, except where dilution is necessary, if a drop of liquid is indicated, a dab or smear of similar volume may be substituted. When 0.5 ml, or similar amount is indicated, 0.5 g or similar approximate solid to liquid volume ratio may be substituted to achieve the intent of the test.

4.7.1 Visual and dimensional examination.

4.7.1.1 Solder.

4.7.1.1.1 Ribbon and wire solder (solid and flux-cored). Ribbon and wire solder shall be examined to verify that the dimensions, unit weight, and workmanship are in accordance with the applicable requirements (see 3.7, 3.8 and 3.11).

4.7.1.1.1.1 Core (flux Types R, RMA, RA, and AC) (see 3.2.2.6). The core shall be examined for end sealing. Five ± 1 cm pieces of flux-cored solder shall be cut at approximately 0.60 meter intervals along the ribbon or wire until five such 5 ±2 cm pieces are obtained from each spool, coil, or cut length, as applicable. For core condition D, care shall be taken that the solder be cut over a contrasting color surface so that any spilled powder is visible. Both ends of each 5 ±2 cm piece shall be examined visually for continuity, homogeneity, dimensional uniformity, and core condition.

4.7.1.1.2 Solder paste. Solder paste shall be examined for smoothness of texture (no lumps), caking, separation of flux and solder, unit weight, and workmanship in accordance with the applicable requirements (see 3.3.4, 3.8, and 3.11) or must be capable of being reconstituted by spatulation.

4.7.1.1.3 Bar and ingot solder. Bar and ingot solder shall be examined to verify that the unit weight, marking, and workmanship are in accordance with the applicable requirements (see 3.8 to 3.11, inclusive).

4.7.1.2 Flux. The flux shall be examined to verify that the workmanship is in accordance with the applicable requirements (see 3.11).

4.7.2 Alloy composition (see 3.2.1).

4.7.2.1 Sample preparation.

4.7.2.1.1 Solid, ribbon and wire solder. Each sample of solid, ribbon or wire solder shall be melted in a clean container, mixed thoroughly, and poured into a cold mold, forming a bar approximately 6.35 mm thick. The mixed sawings shall be prepared for analysis as specified in 4.7.2.1.3.

4.7.2.1.2 Flux-cored, ribbon and wire solder and solder paste. Each sample of flux-cored, ribbon or wire solder or solder paste shall be melted in a clean container and mixed thoroughly. After the flux has risen to the top, the alloy shall be poured carefully into a cool mold (care being taken to allow the flux and alloy to separate completely), forming a bar approximately 6 mm thick. The bar shall be cleaned of flux residue, and the mixed sawings shall be prepared for analysis as specified in 4.7.2.1.3.

4.7.2.1.3 Bar and ingot solder. Each sample piece shall be cut in half, and one half marked and held in reserve. The remaining half shall be melted in a clean container, mixed thoroughly, and poured into a cool mold, forming a bar approximately 0.60 mm thick. Saw cuts shall then be made across the bar at equal intervals of not more than 2.5 cm throughout its length. If it is impracticable to melt the bar or ingot as specified above, saw cuts shall be made across each piece at equal intervals of not more than 1 inch throughout its length. No lubricants shall be used during sawing. The sawings shall be mixed thoroughly. The sample shall consist of not less than 156 grams of mixed sawings.

4.7.2.2 Method. The alloy composition shall be determined by any suitable method, including wet-chemical or spectrochemical-analysis techniques, or both. When wet-chemical or spectrochemical-analysis techniques are used, they shall be in accordance with FED-STD-151, methods 111 and 112, as appropriate.

4.7.3 Flux extraction (applicable to all flux types).

4.7.3.1 Flux-cored solder. The flux core shall be extracted as follows: cut a length of the flux-cored solder weighing approximately 150 grams and crimp/seal the ends, if necessary, to prevent leakage. Wipe the solder surface clean with a cloth moistened with acetone. Place the sample in a beaker, add sufficient distilled water to cover the sample, and boil for 5 to 6 minutes. Rinse the sample with acetone and alloy to dry. Protecting the solder surface from contamination, cut the sample into approximately 1 cm (max) lengths without crimping the cut ends. Place the cut lengths in an extraction tube of a chemically clean Soxhlet extraction apparatus and extract the flux with reagent grade, 99 percent isopropyl alcohol, or other suitable solvent, until the return condensate is clear. The resistivity of water extract (see 4.7.5) and effect on copper mirror tests (see 4.7.7) shall be performed using a test solution prepared by concentrating the solids content in the flux extract solution. Concentrate, by evaporation of excess solvent, to approximately 35 percent by weight for Types R, RMA and RA and 10 percent by weight for Types WSF-0, WSF-1 and LR in isopropyl alcohol (or other suitable solvent). The exact solids content of the test solution shall be determined on an aliquot, dried to constant weight in a circulating air oven maintained at 85 ± 3°C. This test solution should also be used for the chlorides and bromides test.

4.7.3.2 Solder paste. The flux shall be extracted as follows: place 200 cubic centimeters of reagent grade, 99 percent isopropyl alcohol or other suitable solvent to assure complete dissolution of flux and efficacy of the test procedure, in a chemically clean Erlenmeyer flask. Add 40 ±2 grams of solder paste to flask, cover with a watch glass, and boil for 10 to 15 minutes using medium heat. Allow the powder to settle for 2 to 3 minutes and decant the hot solution into a funnel containing filter paper, collecting the flux extract in a chemically clean vessel. (Note: The solution in isopropyl alcohol does not necessarily have to be clear.) The solder powder shall be saved for the mesh size determination. The resistivity of water extract (see 4.7.5) and effect on copper mirror tests (see 4.7.7) shall be performed using a test solution prepared by concentrating the solids content in the flux extract solution. Concentrate, by evaporation of excess solvent, to approximately 35 percent by weight for Types R, RMA and RA and 10 percent by weight for Types WSF-0, WSF-1 and LR in isopropyl alcohol (or other suitable solvent). The exact solids content of the test solution shall be determined on an aliquot, dried to constant weight in a circulating air oven maintained at 85 ±3°C. This test solution should also be used for the halide test (see 4.7.6).

4.7.4 Solder powder mesh size (applicable only to solder paste) (see 3.3.4.1.). The solder powder obtained as specified in 4.7.3.2 shall be dried completely so that all particles are separated. A minimum of 99 percent of the powder shall pass through the appropriate size sieve (see 1.2.1.5) in order to be classified for that mesh size.

4.7.5 Resistivity of water extract (see 3.2.3.2). This test will require dissolving paste flux or solder-paste flux in isopropyl alcohol (IPA) (see 3.2.3.8) for rosin based fluxes. Five watch glasses and five acid/alkali resistant graduated beakers shall be thoroughly cleaned by washing in hot water and detergent solution and rinsing several times with tap water followed by at least five distilled water rinses.

CAUTION: All beakers shall be covered with watch glasses to protect the contents from contaminants. The beakers' dimensions shall assure that, when the conductivity cell is immersed in 50 ml of liquid contained therein, the electrodes are fully covered. Each cleaned beaker shall be filled to the 50 ml mark with distilled water. The beakers shall be immersed in a water bath maintained at 23 ±2°C. When thermal equilibrium is reached, the resistivity of the distilled water in each beaker shall be determined at this temperature with a conductivity bridge using a conductivity cell having a cell constant of approximately 0.1. The resistivity of the distilled water in each beaker shall be at least 500,000 ohm-cm. If the resistivity of the water in any beaker is less than 500,000 ohm-cm, the complete process shall be repeated. Retain two of these beakers as controls. Add 0.100 ± 0.005 ml of liquid flux, diluted paste flux, or diluted solder-paste flux to each of the other three beakers by means of a calibrated dropper or microsyringe. The heating of all five beakers shall be started simultaneously. When the contents of each beaker comes to a boil, the boiling shall be timed for one minute followed by a quick cooling of the beakers under running tap water or by immersion in ice water until cool to the touch. The cooled, covered beakers shall then be placed in a water bath maintained at 23 ±2°C.

When thermal equilibrium has been reached, the solution resistivity for each of the five beakers shall be determined at this temperature as follows: thoroughly wash the conductivity cell with distilled water and immerse it in the water extract of one sample. Make an instrument reading. Thoroughly wash the conductivity cell in distilled water and continue measuring resistivities of the remaining control and water extract samples in the same manner.

The resistivity of each of the controls shall not be less than 500,000 ohm-cm. If the control value is less than 500,000 ohm-cm, it indicates that the water was contaminated with water soluble ionized material(s) and the entire test shall be repeated. The mean and standard deviation of the specific resistivities of the flux extracts shall be calculated and recorded as resistivity of water extract.

4.7.6 Halide content (see 3.2.3.3). This test will require dissolving paste flux or solder-paste flux in isopropyl alcohol (IPA) for rosin based fluxes and distilled water for water soluble fluxes. When run, the silver chromate qualitative test for chlorides and bromides and the purple lake qualitative test for fluorides shall be in accordance with 4.7.6.1 and 4.7.6.2, respectively. The results of these qualitative tests will indicate which specific halides, if any, need to be further analyzed by quantitative testing procedures. When needed, the concentration of chlorides/bromides and fluorides shall be run in accordance with 4.7.6.3 and 4.7.6.4, respectively. The total concentration of halides in a sample shall be reported as the sum of the concentration of fluorides plus the concentration of chlorides/bromides.

4.7.6.1 Qualitative test for chlorides and bromides (silver chromate paper test (see 3.2.3.4)). The silver chromate paper test, a qualitative test for chlorides and bromides, shall be performed in accordance with IPC-TM-650, Test Method 2.3.33. If the silver chromate paper test results indicate the presence of chlorides/bromides in the flux sample, the concentration of chlorides/bromides shall be determined in accordance with 4.7.6.3.

4.7.6.2 Qualitative test for fluorides (purple lake spot test (see 3.2.3.5). The zirconium-alizarin purple lake test, a qualitative test for fluorides, shall be performed in accordance with the following procedure:

prepare a fresh zirconium-alizarin lake on three sections of a white spot plate by adding one drop each of the following:

a. a solution of 0.05 g of sodium alizarin sulphonates thoroughly dissolved and mixed in 50 ml of water

b. a solution of 0.05 g of zirconium nitrate thoroughly dissolved and mixed in 50 ml of water acidified with 10 ml of hydrochloric acid

c. water.

Add one drop of the solution of the flux to be tested to each of the spots. A change in color of the lake to yellow is an indication of fluoride(s) present in the flux sample. If the purple lake test results indicate the presence of fluorides in the flux sample, the concentration of fluorides shall be determined in accordance with 4.7.6.4.

4.7.6.3 Quantitative test for chlorides and bromides (see 3.2.3.6). The combined concentration of chlorides and bromides shall be determined by one of the following methods:

a. IPC-TM-650, Test Method 2.3.35, which shall be followed in its entirety except that the following formula shall be substituted for the formula listed in section 5.2.1 of the test method:

$$\text{Halides } (Cl^{-} \text{ and } Br^{-}) \text{ as meq/g solids} = \frac{100 \times V \times N}{M \times S}$$

where:

V = the volume of 0.1N solution of silver nitrate in ml
N = the normality of the silver nitrate solution
M = the mass of the flux sample, in grams
S = the percentage of solids (non-volatile components) in the flux

b. ion chromatography which can determine Cl^-, Br^-, F^- and other anions in one test

c. potentiometric titration.

4.7.6.4 Quantitative test for fluorides (see 3.2.3.5)). The concentration of fluorides shall be determined in accordance with IPC-TM-650, Test Method 2.3.35.2, ion chromatography, or a specific ion electrode method. The procedure given by the manufacturer of the fluoride ion electrode is to be followed.

4.7.7 Effect on copper mirror (see 3.3.1). Testing of fluxes for effect on copper mirror shall be performed in accordance with IPC-TM-650, Test Method 2.3.32.

4.7.8 Corrosion test (see 3.3.3). The corrosive properties of flux residue shall be determined in accordance with IPC-TM-650, Test Method 2.6.15.

4.7.9 Flux activity (see 3.2.3, 6.1.2.1 and 6.1). The flux activity shall be classified in accordance with IPC-SF-818 using data from the tests accomplished per this specification.

4.7.10 Surface insulation resistance (see Figure 1 and 3.3.2). Testing of fluxes for surface insulation resistance shall be performed in accordance with IPC-TM-650, Test Method 2.6.3.3 Class 3, with the following additions and modifications:

a. An IPC-B-24 bare (nonsolder coated) comb pattern on a MIL-P-13949/4 type glass/epoxy resin substrate shall be used for testing.

b. Three boards shall be used for each sample flux. The test assemblies shall be coated with the as-formulated liquid flux, or a 35 percent by weight dilution of paste flux or solder-paste flux.

Note: Two test sample specimens are required for SIR testing of Type LR flux (see 3.3.2).

c. They shall be soldered with the comb pattern test circuitry in contact with the solder (i.e. circuit side down). They shall be cleaned using a procedure to be documented in the qualification test report. The temperatures and times for the soldering operation and the cleaning procedures (material and equipment used, times, and temperatures) shall also be documented in the qualification test report (see 4.5).

d. Three additional unprocessed boards shall be used for controls.

e. Test boards shall be fixtured and oriented in the chamber in order to minimize interference with the air flow and protect critical areas from water droplets.

f. Provision shall be made to insure adequate shielding of test boards from airborne water particles while the test boards are in the chamber.

g. The chamber conditions shall be ramped up to test conditions as follows: the chamber shall be at 25°C and 50% RH when the test boards are inserted. The test boards shall stabilize for 2 hours, then the initial resistivity (T_i) shall be measured and recorded. The temperature shall then be ramped from 25°C to 85°C over a 30 minute period; during this ramp-up period the humidity may drop to as low as 10-20% RH. After stabilizing at 85 ±2°C for 2 hours, the humidity shall then be ramped to 85% RH over a 30 minute period. When these conditions have stabilized for 2 hours, the -50 ±2.5 VDC bias shall be applied and the 168 hour exposure shall begin (T_o). A measurement shall be taken at 96 hours (T_1) (see 3.3.2). Figure 1 shows the temperature/humidity profile to be used for SIR testing.

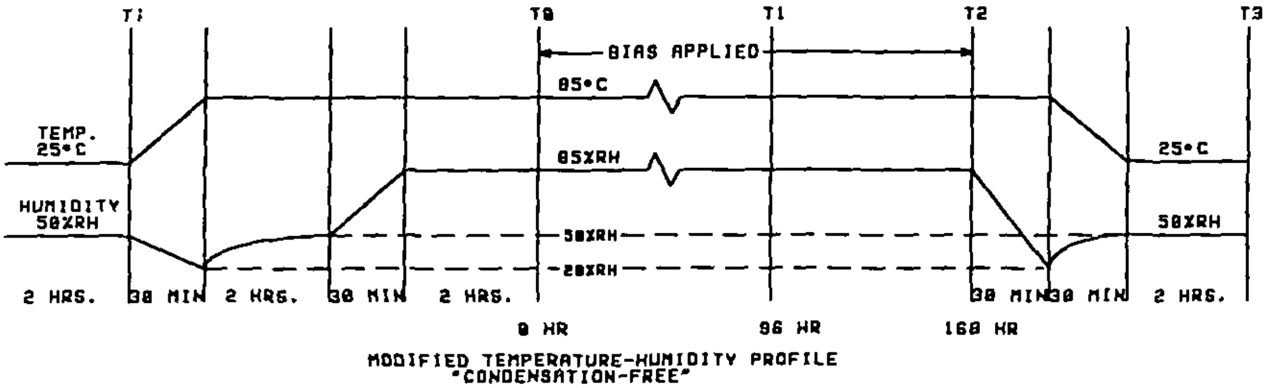
h. All measurements of test patterns on each test board shall be made at +100 ±2.5 VDC, with a 1 minute electrification time and the bias voltage off.

i. At the end of the 168 hour exposure, the bias voltage shall be turned off for the remainder of the test and the resistivity shall be measured and recorded (T_2) (see 3.3.2). The conditions shall then be ramped down to ambient conditions as follows: the humidity shall be ramped from 85% RH to 20% RH over a 30 minute period. The temperature shall then be ramped from 85°C to 25 ±2°C over a 30 minute period. The humidity shall be set to and stabilized at 50% RH.

j. Two hours after the chamber has stabilized at 25°C and 50% RH, the final insulation resistance shall be measured (T_3) (see 3.3.2).

Test results shall include all of the data for each flux and all test patterns (including the control boards). The data shall not include patterns excluded in accordance with 4.7.10.1. Upon completion of surface insulation resistance testing, each specimen shall be examined under 10X to 30X magnification with back lighting. Any surface condition considered a failure shall be reported and also visually recorded using color photographs at a minimum magnification of 10X. For reference purposes higher magnification may be used for visual/photographic enhancement.

4.7.10.1 Classification of visual defects. Examine each test pattern which fails these requirements (see 3.3.2.1). If the failure was caused by a sliver, solder ball or other process or material which is not related to flux chemistry or cleaning, then the anomaly shall be documented and that pattern shall be excluded from the data set. No more than two test patterns may be excluded. Documentation describing the failing test result shall be excluded from the data set. No more than two test patterns may be excluded. Documentation describing the failing test result, the results of the examination, and the rationale for excluding a test pattern (i.e. excluding the test data) shall be submitted to the qualifying activity with the qualification report. The documentation shall include a color photograph of the anomaly which shall be taken at a minimum magnification of 10X.



Ti = initial measurements - made after two hours conditioning at 25°C/50% RH
T0 = all test timing referenced to start of this measurement sequence (no measurement necessary)
T1 = 96 hour measurement - made 96 hours after T0
T2 = 168 hour measurement - made 168 hours after T0
T3 = dryout measurement - made 2 hours after chamber has stabilized at ambient conditions (25°/50%)

Figure 1. Typical temperature-humidity profile for SIR testing.

4.7.11 Solder spread testing (see 3.5.2). The solder spread shall be determined by means of a flux wetting/spread test (static method) as follows: five (5) replicates of 0.254 mm thick 70/30 brass (per ASTM-B36 C26000 HO2) coupons, 38 mm wide x 76 mm long, may be cleaned with oil free #00 steel wool. Using a flat strip of brass, bend the opposite ends parallel to the curve of the metal coil to stiffen and flatten the test coupon. Cut a 30 mm length of Sn60Pb40 1.60 mm diameter Type S solid wire solder meeting the requirements of QQ-S-571. Wrap the cut length of solder around a 3 mm diameter mandrel. Place the preformed solder in the center of the test coupon. Place one drop (0.05 ml) of flux on the test coupon inside the preformed solder.

A solder pot containing at least 4 kg of solder and no less than 25 mm in depth shall be maintained at 260 ±5°C. Carefully place the coupon on the surface of the solder bath for 15 seconds. Remove the coupon in a horizontal position and place on a flat surface allowing the adhered solder to solidify undisturbed. Remove all flux residue with a suitable solvent. Measure the solder spread area by comparing to circles (pre-drawn) with areas similar to those listed in table XIII which is intended to aid in defining areas in mm^2. The mean of the spread of all five samples tested is to be reported and must meet the minimum requirement (see 3.5.2).

4.7.12 Solids content process control test. There is no specific requirement for solids content; however, a suggested test for process control is in para 6.9.2.

4.7.13 Determination of acid number (see 3.2.2.2). Acid number shall be determined per ASTM-D465.

TABLE XIII. Areas defined in mm^2.

RADIUS in mm	DIAMETER in mm	AREA in mm^2
5.00	10.00	78.54
5.21	10.41	85.28
5.33	10.67	89.28
5.35	10.70	90.00
5.49	10.99	95.03
5.64	11.28	100.00
5.75	11.43	103.87
5.99	11.99	113.09

4.7.14 Flux percentage (applicable only to flux Types R, RMA, RA, AC, WSF-0, WSF-1 and LR)) (see 3.4). A minimum of 20 grams of solder (weighed within an accuracy of 5 milligrams (mg)) shall be placed into a clean, preweighed, porcelain crucible. (For flux-cored solder, the surface shall be wiped with a clean cloth, the sheared ends shall be sealed, and the solder shall be coiled into a small ball by winding it upon itself.) The weight of the solder alone shall be denoted as Wa. The crucible and solder shall be heated until the solder is completely molten. The molten solder shall be stirred several times to free any entrapped flux. (For solders containing a low percentage of flux, an oil having a high boiling point may be used to aid in the separation of the flux from the solder.) The solder shall be allowed to cool until it solidifies. The solder shall be cleaned thoroughly, using chemical solvents for the flux until the solder is free from any flux residues. The solder shall be dried and its weight determined in air in grams within an accuracy of 5 mg. This weight shall be denoted as Wb. Flux percentage shall be calculated as follows:

$$\text{Flux percentage, by weight} = \frac{Wa - Wb}{Wa} \times 100$$

4.7.15 Fluxing action.

4.7.15.1 Solder pool (applicable to flux Types R, RMA, WSF-0, WSF-1, LR, and AC) (see 3.5.1). For each sample being tested, three 10 sq cm coupons shall be cut from 0.13 mm thick sheet copper in accordance with ASTM-B152. For flux Type AC only, the coupons shall be cut from cold-rolled commercial sheet steel, approximately 1.60 mm-thick conforming to finish number 2 regular bright finish of QQ-S-698. The coupons shall be cleaned by using a suitable solvent. Both surfaces of each coupon shall be cleaned to a bright finish, using a 10 percent fluoroboric acid dip. The coupons shall be washed with tap water and dried thoroughly with a clean cloth. Approximately 0.2 grams of flux-cored solder or approximately 2 grams of solder paste shall be placed in the center of each coupon. (The area of the solder paste shall not exceed that of a 9.50 mm diameter circle.) The solder shall be melted in an oven maintained at 215 $\pm$10°C. The solder pool shall be visually examined for thickness of edge. When the test is completed, each coupon shall be inspected for evidence of flux spattering.

4.7.15.2 Spread factor (applicable to solders with flux Types R, RMA, WSF-0, WSF-1 and LR) (see 3.5.2).

4.7.15.2.1 Preparation of coupon. Five coupons 2-inch square shall be cut from 0.13 mm-thick electrolytic copper sheets in accordance with IPC-MF-150. The coupons shall be cleaned in a 10 percent fluoroboric acid dip. One corner of each coupon shall be bent upwards to permit handling with tweezers. The coupons shall not be handled with bare hands. The coupons shall be cleaned and then oxidized for 1 hour in an electrically heated convection or conduction oven at 150 $\pm$5°C for testing of flux Types R, RMA, WSF-0, WSF-1 and LR, and 205 $\pm$5°C for testing of flux Type RA. All coupons shall be at the same level in the oven. All coupons shall be removed from the oven and placed in tightly closed glass bottles until ready for use.

4.7.15.2.2 Procedure.

4.7.15.2.2.1 Flux-cored solder. Ten or more turns of 1.6 mm diameter flux-cored solder shall be tightly wrapped around a mandrel. The solder shall be cut through with a sharp blade along the longitudinal axis of the mandrel. The rings shall be slid off the mandrel and the helix removed by flattening each ring. The diameter of the mandrel shall be of such a size so as to produce a ring weighing 0.500 $\pm$0.025 gram. Ten rings shall be prepared. A solder ring shall be placed in the center of each one of the five coupons. The coupons shall be placed horizontally on a flat oxidized copper sheet in a circulating-air oven at 215° $\pm$10°C for 6 minutes, -0, +10 seconds, with all coupons being at the same level. At the end of 6 minutes, the coupons shall be removed from the oven and allowed to cool. Excess flux residue shall be removed by washing with alcohol. The height, H, of the solder spot shall be measured to the nearest 0.01 mm, and the results averaged. Five additional solder-ring specimens shall be melted together in a small, porcelain combustion boat on a hot plate. The molten solder shall be stirred several times to free any entrapped flux. After cooling, the solder slab shall be removed from the boat, the excess flux removed by washing with alcohol, and the loss of weight in water determined to the nearest 0.1 mg.

4.7.15.2.2.2 Solder paste. The coupons shall be removed from the bottles and weighed to the nearest 0.001 gram. A metal template having an internal diameter of 6.4 $\pm$.3 mm shall be placed in the center of each coupon and each opening shall be filled with solder paste. The excess solder paste shall be wiped off the washer using a spatula and then the washer shall be removed carefully. The coupons with solder paste shall be reweighed to the nearest 0.001 gram. (Note: The thickness of the washer shall be such that the solder weighs from 0.45 to 0.55 gram.) The coupons shall be placed horizontally on a flat oxidized copper sheet in a circulating-air or nitrogen atmosphere oven at 205 $\pm$5°C for 6 minutes, -0, +10 seconds, with all coupons being at the same level. At the end of 6 minutes, the coupons shall be removed from the oven and allowed to cool. Excess flux residue shall be removed by washing with alcohol. The height, H, of the solder spot shall be measured to the nearest 0.01 mm and the results averaged. An amount of solder paste equal to the total weight of solder paste on the five coupons shall be melted in a small, porcelain combustion boat on a hot plate. The molten solder shall be stirred several times to free any entrapped flux. After cooling, the solder slab shall be removed from the boat, the excess flux removed by washing with alcohol, and the loss of weight in water determined to the nearest 0.1 mg.

4.7.15.2.2.3 Calculation. The loss in weight of the solder slab in water shall be divided by five. This is the volume, V, of the solder to the nearest 0.001 cc. The diameter, D, of the equivalent sphere is 1.2407 $\sqrt[3]{V}$. The spread factor shall be calculated in accordance with the following formula:

$$\text{Spread factor (percent)} = \frac{D - H}{D} \times 100$$

4.7.16 Dryness (applicable only to flux Types R, RMA, and RA (see 3.6). The dryness test shall be performed on samples prepared in accordance with 4.7.15.2.1 and 4.7.15.2.2 (as applicable), except that after heating the coupons in the oven, the flux residue shall not be removed. The coupons shall be allowed to cool for one-half hour. Powdered chalk shall be dusted onto the surface of the residual flux and the ability to remove the chalk from the surface of the flux by light brushing shall be observed.

4.7.17 Inspection of packaging and marking.

4.7.17.1 Materials inspection. All materials to be used in packaging shall be inspected in accordance with the applicable material specification.

5. PREPARATION FOR DELIVERY

5.1 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.6).

5.1.1 Level A.

5.1.1.1 Cleaning. Solder shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Solder shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. Preservatives shall not be used.

5.1.1.4 Unit packaging. Solder shall be packaged by the procedures specified herein in accordance with MIL-P-116, method III, insuring compliance with the general requirements paragraph under methods of preservation (unit production) and the physical protection requirements paragraph therein.

5.1.1.4.1 Ribbon and wire solder. Unless otherwise specified (see 6.6), ribbon and wire solder shall be wound on spools having sufficient strength and durability to maintain proper support.

5.1.1.4.2 Pellet, powder, and paste solder. This solder shall be packaged in type V, class 1 cans conforming to PPP-C-96 in quantities of one or five pounds net weight as specified (see 6.6). Plan B exterior coating shall be used.

5.1.1.4.3 Bar and ingot solder. Bar and ingot solder shall be bulk packaged in the quantities specified (see 6.6). The unit container shall also suffice as a shipping container and meet the requirements of 5.2 for the level of packing specified (see 6.7).

5.1.1.4.4 Special forms. Preservation-packaging for special forms (other than pellets) shall be as specified in the contract or purchase order (see 6.6).

5.1.1.5 Intermediate packaging. Not required.

5.1.2 Level C. Solder shall be clean, dry and packaged in a manner that will afford adequate protection against corrosion, deterioration, and physical damage during shipment from source of supply to the receiving activity. For bar and ingot solder, the unit container shall also suffice as a shipping container and meet the requirements of 5.2 for the level of packing specified (see 6.6).

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.6).

5.2.1 Level A.

5.2.1.1 Ribbon and wire solder. The packaged ribbon and wire solder shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. In lieu of the closure and waterproofing requirements in the appendix of PPP-B-636, closure and waterproofing shall be accomplished by sealing all seams, corners, and manufacturer's joint with tape, two inches minimum width, conforming to PPP-T-60, class 1, or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636, using nonmetallic or tape banding only.

5.2.1.2 Pellet, powder, and paste solder. Cans of solder shall be packed in accordance with the level A packing requirements for filled cans in the appendix of PPP-C-96. Solder shall be packed as specified in 5.2.1.1 when packaged in containers other than cans.

5.2.1.3 Bar and ingot solder. Bar and ingot solder shall be packed in snug fitting nailed wood boxes conforming to PPP-B-621, class 2. The boxes shall be modified to include full double end panels. Blocking shall be provided as necessary. The gross weight shall not exceed 200 pounds. Box closures and strapping shall be in accordance with the appendix of PPP-B-621.

5.2.1.4 Special forms. Packing for special forms (other than pellets) shall be as specified in the contract or purchase order (see 6.6).

5.2.2 Level B.

5.2.2.1 Ribbon and wire solder. The packaged ribbon and wire solder shall be packed in containers conforming to PPP-B-636, class domestic, style optional, special requirements. Closures shall be in accordance with the appendix thereto.

5.2.2.2 Pellet, powder, and paste solder. Cans of solder shall be packed in accordance with the level B packing requirements for filled cans in the appendix of PPP-C-96. When packaged in containers other than cans, solder shall be packed as specified in 5.2.2.1.

5.2.2.3 Bar and ingot solder. Bar and ingot solder shall be packed as specified in 5.2.1.3 except that the nailed wood boxes shall conform to PPP-B-621, class 1. Alternately, the box shall conform to PPP-B-636, class domestic. The box shall be closed in accordance with the appendix to PPP-B-636.

5.2.2.4 Special forms. Packing for special forms (other than pellets) shall be as specified in the contract or purchase order (see 6.6).

5.2.3 Level C. Solder, packaged as specified in 5.1.1 or 5.1.2, shall be packed in shipping containers in a manner that will afford adequate protection against damage during direct shipment from the source of supply to the receiving activity. These packs shall conform to the applicable carrier rules and regulations.

5.2.4 Unitized loads. Unitized loads, commensurate with the level of packing specified in the contract or order, shall be used whenever total quantities for shipment to one destination equal 40 cubic feet or more. Quantities less than 1.12 cubic meters need not be unitized. Unitized loads shall be uniform in size and quantities to the greatest extent practicable.

5.2.4.1 Level A. Solder, packed as specified in 5.2.1, shall be unitized on pallets in conformance with MIL-STD-147, load type I, with a fiberboard cap (storage aid 4) positioned over the load.

5.2.4.2 Level B. Solder, packed as specified in 5.2.2, shall be unitized as specified in 5.2.4.1 except that the fiberboard caps shall be class domestic.

5.2.4.3 Level C. Solder, packed as specified in 5.2.3, shall be unitized with pallets and caps of the type, size, and kind commonly used for the purpose and shall conform to the applicable carrier rules and regulations.

5.3 Marking. In addition to any special marking required by the contract or purchase order (see 6.6), spools, coils, cans, and unit containers shall be marked with the type designation, manufacturer's code, and net weight. In addition, spools and coils shall be marked with the dimensions of the ribbon or outside diameter of the wire, as applicable.

5.3.1 Civil agencies. For civil agencies, marking for shipment shall be in accordance with FED-STD-123.

5.3.2 Military activities. For military activities, each unit package, exterior container, and unitized load shall be marked in accordance with MIL-STD-129.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2, and 5.2.3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Army procurements.

5.4.2.1 Level A and B packing. For level A packing when quantities per destination are less than a unitized load, the fiberboard containers shall not be banded but shall be placed in a close fitting box conforming to PPP-B-601, overseas type; PPP-B-621, class 2, style 4, or PPP-B-585, class 3, style 2, or 3. Closure and strapping shall be in accordance with applicable container specification except that metal strapping shall conform to ASTM-D3953, type I, class B. When the gross weight exceeds 91.20 kg or the container length and width is 1.2 x .6 meters or more and the weight exceeds 45.60 kg; 76.20 x 101.6V mm skids (laid flat) shall be applied in accordance with the requirements of the container specification. If not described in the container specification, the skids shall be applied in a manner which will adequately support the item and facilitate the use of material handling equipment. For level B packing, fiberboard boxes shall be weather resistant as specified in level A and the containers shall be banded (see 5.2.1.1, 5.2.1.2, 5.2.2.1 and 5.2.2.2).

5.4.2.2 Level A and B unitization. For level A and B unitization, the fiberboard caps shall be weather resistant and softwood pallets conforming to NN-P-71, type V, size 2, shall be used (see 5.2.4.1 and 5.2.4.2).

5.4.3 Navy procurements. For Navy procurements the use of polystyrene loose fill material (such as strips, strands and beads) is prohibited for packaging and packing applications.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Solder and fluxes covered by this specification are intended for use in the assembly of electronic circuitry and associated electrical equipment in order to provide functionally good solder joints by means of tin-lead solders. Additional solder alloys are included for special purpose electronic assemblies. For fluxing/soldering purposes, a soldered joint is that which functions as both a mechanical and an electrical connection point. It is considered to be an electrical connection (i.e. in grounding applications) through a printed wiring board. Additional solder alloys are included for special purpose electronic assembly use. Appropriate tests and visual examination should be used to insure the post-cleaning absence of deleterious flux residues. To insure maximum reliability and service life, soldering fluxes used in the solder coating, assembly, and/or repair of electronic equipments and components should be selected and used in compliance with the requirements of the applicable soldering process specifications and standards.

6.1.1 Rosin flux.

6.1.1.1 Type R flux. This type of flux is the purest rosin based flux obtainable. It does not contain additives to provide increased fluxing action. Type R residues, although very low in reactivity, could affect subsequent testing and coating or bonding operations (if required). Type R flux residues should therefore be removed completely after soldering if subsequent operations require residue-free surfaces.

6.1.1.2 Type RMA flux. This type of flux contains additives to provide a more active fluxing action than Type R flux. Since Type RMA is an activated flux, its residues should be completely removed. Appropriate tests and visual examination should be used to insure the post-cleaning absence of deleterious flux residue(s).

6.1.1.3 Type RA flux. Type RA fluxes may contain corrosive materials which could adversely affect electronic/electrical properties of components and/or circuitry if not completely removed after soldering. Type RA should only be used in the event Types R or RMA have been determined to be inadequate, and only with approval from the procuring activity. Appropriate tests and visual examination should be used to insure the post-cleaning absence of deleterious flux residue(s).

6.1.2 Water soluble flux. Water soluble fluxes must be carefully selected and integrated into the fluxing, cleaning, and cleanliness testing processes used for manufacture. They have been incorporated into this document since they may be easier to remove than rosin fluxes and may also reduce the need for chlorofluorocarbon based cleaning systems. Careful evaluation of the flux and its interaction with the elements of the assembly process should be made and maintained on an on-going basis.

6.1.2.1 Types WSF-0 and WSF-1. These fluxes are water soluble and may contain corrosive materials which could adversely affect electronic/electrical properties of components and/or circuitry if not properly removed. Tests as specified in IPC-TM-650, Test Methods 2.3.38, 2.3.39 and MIL-STD-2000 for non-rosin fluxes and visual examination should be considered to insure that the post soldering cleaning process removes all residual deleterious substances.

6.1.2.2 Type WSF-1. Type WSF-1 flux may contain polyglycols (see 1.2). Some concentrations of polyglycols (see 6.3) have been shown to cause long term reliability problems unless removed by an adequate post soldering cleaning process. Failure may occur through dendritic growth and dielectric breakdown between circuit conductors. Care should be taken when utilizing polyglycol containing flux with plastic parts. In general, when used with epoxy glass-based printed wiring board materials they should be thoroughly cleaned and residues removed. Polyglycol contamination cannot be detected by an ionic cleanliness test (see 6.1.2.1).

6.1.3 Type LR. These types of fluxes are often designed to be left on the assembly, without the requirement of cleaning. If Type LR flux is not cleaned, then the manufacturing process must be such that contamination that can jeopardize the product's reliability is not introduced to the assembly. That is, all of the starting materials shall be clean of any conductive, corrosive, contaminant, and the process flow shall be controlled so that mishandling does not contaminate the assembly. The material safety data sheet should be referred to for compatibility information. When low residue fluxes are used to reduce or eliminate cleaning processes during hardware manufacture, assemblers must perform tests to verify the flux is compatible with the assembly process, process materials, and conformal coating. In addition, performance tests should be used to verify that post-production residues do not adversely affect hardware electrical performance.

6.2 Terms and definitions. Terms and definitions shall be in accordance with IPC-T-50, including the following:

Paste flux. A flux formulated in the form of a paste to facilitate its application.

Solder paste. Finely divided particles of solder, with additives to promote wetting and to control viscosity, tackiness, slumping, drying rate, etc, that is suspended in a paste flux.

Solder-paste flux. Solder paste without the solder particles.

Polyglycol (see 3.2.2.3 and 3.2.2.4). Materials containing polyethylene glycol or primary derivatives of polyethylene glycol, or a material generally derived by the reaction of organic acids, amines, alcohols, phenols, or water with ethylene or propylene oxides, or their derivatives. This family of materials includes, but is not limited to, polyethylene glycol, polypropylene glycol and a wide range of polyglycol surfactants. This family of materials does not include glycols (e.g. ethylene glycol), polyols (e.g. glycerine), or mono-, di-, or triglycol ethers.

6.3 Qualification. With respect to solder products requiring qualification, awards will be made only for products that, prior to the time set for opening bids, have been tested and approved for inclusion in the applicable Qualified Products List (QPL) whether or not such products have actually been so listed by that date. The attention of suppliers is called to this requirement (see 3.1). Solder manufacturers are urged to have their product(s), proposed for use by the Federal Government, submitted for qualification testing (see 4.5) and subsequent inclusion on the Qualified Products List (QPL) associated with this document. The activity responsible for the Qualified Products List is the Army Research Laboratory (ARL) EPS Directorate, ATTN: AMSRL-EP-RD, Fort Monmouth, NJ 07703-5601. Information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-EQ), 1507 Wilmington Pike, Dayton, OH 45444 and DoD SD-6 (see 2.1.1).

6.4 Ozone depleting chemical (ODC) elimination. Department of Defense Directive 6050.9 (Chlorofluorocarbons and Halons) and Department of Defense Instruction 5000.2 (Part 6, Section 1, Defense Acquisition Management Policies and Procedures) require the elimination of ozone-depleting substances from defense industry production lines. These documents are available from the Defense Printing Service Detachment Office, (DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.

6.5 Alloy compositions.

6.5.1 Sn96Ag04. This is a special-purpose, lead free, solder with a higher joint strength than tin-lead solders.

6.5.2 Sn63Pb37. This is the tin-lead eutectic. It is used for soldering printed circuits where temperature limitations are critical and in applications where an extremely short melting range is required.

6.5.3 Sn62Pb36Ag02. This is a special-purpose solder widely used for soldering silver-coated ceramics.

6.5.4 Sn60Pb40. This corresponds closely to the tin-lead eutectic (see 6.6.2) and has a narrow melting range.

6.5.5 Sn40Pb60. This alloy is frequently used for dip soldering and also for wiping solder joints.

6.6 Ordering data. Purchasers should select the preferred options as defined herein and include the following information in procurement documents:

(a) title, number, and date of this specification;

(b) type designation (see 1.2.1);

(c) detail requirements for special forms (see 1.2.1.2);

(d) dimensions of ribbon and wire solder (see 3.7);

(e) unit weight (see 3.8);

(f) levels of preservation-packaging and packing required (see 5.1 and 5.2);

(g) preservation-packaging and packing requirements for special forms (see 5.1.1.4.4, 5.2.1.4, and 5.2.2.4);

(h) special marking, if required (see 5.3).

6.7 Commercially-available sizes of forms (see table I and 6.6). Approximate dimensions and weights are as indicated in 6.7.1 and 6.7.2. Other sizes may be available and can be procured under this specification.

6.7.1 Forms R (ribbon) and W (wire). Form R is available in widths up to approximately .50 mm and in thickness from 0.04 to 2.54 mm. Form W is available in most standard American Wire Gage sizes to AWG 30 (approximately 0.20 mm diameter). Higher flux percentages may not be available in the smaller wire sizes. Forms R and W are furnished on spools or cards weighing approximately 0.5, 2.3, 4.6, 11.0, 14.0 and 23.0 kg.

6.7.2 Forms B (Bar) and I (Ingot). Forms B and I solder products are available in but not limited to the nominal dimensions and weights indicated in table XIV. Solder bars and ingots are formed in a variety of sizes and shapes. Bars are generally long and slender while ingots tend to be short and thick. The weight of bars and ingots will vary significantly from the nominal values listed in table XIV. This results from manufacturers using one set of molds for all solder alloys and from depth tolerance variations when molten solder is poured into the molds. Also significant are variables in the density of solder alloys as determined by the formulation of the various alloys).

TABLE XIV. Forms B and I

Form	Length	Width	Thickness	Weight
	MM	MM	MM	kilogram (kg)
Bar:				
Top--------	343.0	19.1	10.0	0.50
Bottom-----	343.0	16.0	10.0	0.50
Ingot:				
Top--------	140.0	64.0	38.0	2.30
Bottom-----	114.0	38.0	38.0	2.30

Tolerances: Weight: +0.30/-0 kg; Length: ±20%;
Width and Thickness: ±33%.

6.7.3 Transportation description. Transportation descriptions and minimum weights applicable to this commodity are:

Rail:
Solder, not otherwise indexed by name.
(Specify tin content.)
Carload minimum weight 18 metric tons.

Motor:

Solder, not otherwise indexed.
(Specify tin content.)

Truckload minimum weight 16.2 metric tons, subject to Rule 115, National Motor Freight Classification.

6.8 Ventilation. Most fluxes contain organic acids, volatile organic compounds (VOC) and flammable solvents, such as turpentine or alcohols. Fluxes, therefore, are respiratory irritants and should be used with caution only in well-ventilated areas away from possible ignition sources such as flames or sparks. Solvents used to remove fluxes should also be considered as hazardous materials and treated in an appropriate manner. Most solders contain lead or other materials the use and disposal of which may require conformance to federal, state and or local regulations.

6.9 Optional tests.

6.9.1 Paste flux and solder-paste flux viscosity (see 3.2.3.7). The viscosity needed for a particular paste flux varies widely. This depends on a number of variables and electronic assemblers will have to customize the viscosity requirement to their manufacturing process. The viscosity of paste flux and/or solder-paste flux shall be determined using the procedure specified in IPC-SP-819, para 4.5 through 4.5.2.4. Fine dot dispensing and pin transfer application methods typically need viscosities in the range of 200,000 to 450,000 centipoise. Larger dot dispensing and screen printing application methods typically also need viscosities in the range of 200,000 to 450,000 centipoise. Stenciling application methods typically need viscosities in the range of 900,000 to 1,500,000 centipoise.

6.9.2 Flux solids content determination (see 4.7.12). An optional means to determine the solids content of flux is IPC-TM-650, Test Method 2.3.34.

6.9.3 Organic residue detection (see 3.2.3.9). An optional means to determine the solids content of flux is IPC-TM-650, Test Methods 2.3.38 and 2.3.39.

6.10 Subject term (key word) listing.

Solder
Flux
Rosin
Resin
Soldering
Electronic

6.11 Material safety data sheets. Contracting Officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent mailing addresses for submission of data are listed in Appendix B of FED-STD-313 (see 2.1).

6.12 Changes from previous issue. Due to the extensive changes, asterisks are not used in this revision to identify changes with respect to the previous issue.

CONCLUDING MATERIAL

Custodian:
Army - ER
Navy - SH
Air Force - 99

Preparing activity:
Army - ER

Review Activities:
Army - MI, CR

Air Force - 84
DLA - GS
GSA/FSS

Project: 3439-0846

User Activities:
Navy - AS, OS, MC, YD
Air Force - 80

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8 In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER QQ-S-571F	2. DOCUMENT DATE (YYMMDD) 940518

3. DOCUMENT TITLE
SOLDER, ELECTRONIC (96 TO 485°C)

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial	(2) AUTOVON
Peter O'Day	(908) 544-3296	995-3296

c. ADDRESS (Include Zip Code)	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:
US Army Research Laboratory ATTN: AMSRL-EP-RD Ft Monmouth, NJ 07703-5601	Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340