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MILITARY SPECIFICATION

FLUX, SOLDERING, LIQUID, PASTE FLUX, SOLDER PASTE AND SOLDER-PASTE FLUX, (FOR ELECTRONIC/ELECTRICAL USE) GENERAL SPECIFICATION FOR

1. SCOPE

1.1 Scope. This specification covers liquid fluxes, paste flux and solder-paste flux used in the preparation of solder joints for electrical/electronic circuits (see 6.1 through 6.1.8.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Research Laboratory (ARL) EPS Directorate, 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

1.2 Classification. Flux covered by this specification will be of the following types, as specified:

Type R	-	rosin base (see 3.2.1); this type is equivalent to flux Type R of QQ-S-571.
Type RMA	-	mildly activated rosin base (see 3.2.1); this type is equivalent to flux Type RMA of QQ-S-571.
Type RA	-	activated rosin base (see 3.2.1); this type is equivalent to flux Type RA of QQ-S-571.
Type WSF-O	-	organic, water soluble flux (WSF-O) (see 3.2.1.1); does not contain polyglycol(s)
Type WSF-1	-	all other organic water soluble fluxes; may contain polyglycol(s) (see 3.2.1.2)
Type LR	-	low residue fluxes (see 3.2.1.3); this type has a low solids content and is intended to minimize the residue which remains after soldering operations.

2. APPLICABLE DOCUMENTS

2.1 Government documents

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

SPECIFICATIONS

FEDERAL

QQ-S-571	-	Solder; Tin Alloy, Tin-Lead Alloy and Lead Alloy.
PPP-C-2020	-	Chemicals, Liquid, Dry and Paste; Packaging Of.
TT-I-735	-	Isopropyl Alcohol.

MILITARY

MIL-P-13949	-	Plastic Sheet, Laminated, Metal Clad for Printed Wiring Boards, General Specification for.

STANDARDS

FEDERAL

FED-STD-313 - Material Safety Data Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities.

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-2000 - Standard Requirement for Soldered Electrical & Electronic Assemblies.
MIL-STD-45662 - Calibration Systems Requirements.

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Defense Printing Service Detachment Office, Standardization Documents Order Desk, Building 4D, Code NPM-2, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.1.2 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).
CFR, Title 29, Chapter XVII, Part 1910 - Code of Federal Regulations.

(Application for copies should be addressed to Defense Printing Service Detachment Office, Standardization Documents Order Desk, Building 4D, Code NPM-2, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B36 - Standard Specification for Brass Plate, Sheet, Strip and Rolled Bar.
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).

THE INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

IPC-B-24	-	Surface Insulation Resistance (SIR) Test Board.
IPC-T-50	-	Terms and Definitions for Interconnecting and Packaging Electronic Circuits.
IPC-TM-650	-	Test Methods Manual.
IPC-SF-818	-	General Requirements for Electronic Soldering Fluxes.
IPC-SP-819	-	General Requirements for Electronic Grade Solder Paste.

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

(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 references 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. Flux furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable Qualified Products List at the time of award of contract (see 2.1.2, 4.5, 6.4, and DoD SD-6).

3.2 Material.

3.2.1 Flux 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 4.7.7), 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 this specification. 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/ spreading action. Paste fluxes and solder-paste fluxes shall meet all of the requirements for their respective liquid flux.

3.2.1.1 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 6.3.

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

3.2.1.3 Type LR. Flux manufacturers may classify certain formulations of rosin or water soluble fluxes as low residue fluxes for use in manufacturing processes which minimize or eliminate cleaning operations. Type LR fluxes shall be halide free. 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 describe known material incompatibility with commonly used solvents, saponifiers, and other cleaning materials.

3.2.2 Flux activity classification (see 4.7.3.7, 6.1.4, and 6.1.8). 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 4.7.3.7, 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.

3.2.2.1 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 4.7.6 and 6.1.7.2.

3.2.3 Resistivity of water extract (applicable to Types R, RMA and RA). When the flux is tested as specified in 4.7.2, 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.

3.2.4. 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 3.2.4.1, 3.2.4.2, and 3.2.4.3.

3.2.4.1 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 4.7.3.1). Additional testing is required if the flux fails the silver chromate paper test (see 3.2.4.3). 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.

3.2.4.2 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 4.7.3.2. Flux testing positive shall be further tested quantitatively to determine the concentration of fluoride present (see 4.7.3.4).

3.2.4.3 Halide ion testing for combined chloride (Cl) and bromide (Br) content. If a flux fails the silver chromate paper test (see 3.2.4.1 and 4.7.3.1), a quantitative test for the chloride and bromide ions shall be performed (see 4.7.3.3). 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 4.7.3.3. If fluoride is found (see 3.2.4.2 and 4.7.3.2), 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.

3.2.5 Paste flux and solder-paste flux viscosity (see 6.1.7.1). There are no specific requirements regarding viscosity. If required, based on agreement between the buyer and the seller, viscosity data shall be determined per 6.1.7.1.

3.2.6 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.

3.2.7 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 6.1.7.3.

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 4.7.3.5. 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 4.7.4 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.

3.3.2.1 Inspection for visual defects. Upon the completion of surface insulation resistance testing, each specimen shall be examined using 7X to 10X magnification with back lighting. Dendritic growth, dark spots, blue-green residue, light colored residue and other conditions demonstrating electrochemical migration shall be considered a failure when inspected per 4.7.4.

3.3.3 Solder spread. When tested as specified in 4.7.5, the solder spread test results shall be expressed in square millimeters (mm^2). The following minimum requirements shall apply: Type LR, 50 mm^2; all other types, 90 mm^2.

3.3.4 Corrosion test. When tested as specified in 4.7.3.6, there shall be no evidence of corrosion for flux Types R, RMA, RA and LR. The results of corrosion testing for all flux types shall be reported. Failure of this test by flux Types WSF-O and WSF-1 shall not be cause for rejection.

3.4 Safety and health requirements. Fluxes formulated per 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 sources of ignition such as open flames, sparks or an 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 constituents, by-products, residues and materials for disposal are hazardous.

3.5 Workmanship. The flux shall be compounded and processed to insure that it 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 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 his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in 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 requirements 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. Test/measuring equipment and inspection facilities, of sufficient accuracy, quality and quantity to permit performance of the required inspection(s), shall be established and maintained or designated by the 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 4.4).

b. Qualification inspection (see 4.5).

c. Quality conformance inspection (see 4.6).

d. Packaging inspection (see 4.8, 5.1 and 5.2).

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

4.4 Materials inspection. Materials inspection shall consist of certification supported by data verifying that the materials listed in Table I used in compounding the flux, are in accordance with the applicable referenced specifications or requirements prior to such compounding. The verifying data and certification applicable to a qualification test sample shall be made a part of the qualification test report.

4.5 Qualification inspection. Qualification inspections shall be performed at a laboratory acceptable to the Government (see 6.4) on samples produced with equipment and procedures normally used in production. A report which meets the requirements of 4.5.4 shall be submitted for initial qualification.

4.5.1 Sample size. A 500 ml sample of liquid flux shall be furnished in a sealed container for qualification inspections. A sample of approximately 200 ml of paste flux or solder-paste flux shall be furnished in a sealed container for viscosity testing. A sufficient size 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.

TABLE I. Materials inspection

MATERIAL	REQUIREMENT PARAGRAPHS	METHOD OF INSPECTION
All Types	3.2.1	4.7.1 4.7.7
Type LR	3.2.1.3	4.7.1
Type WSF	3.2.1.1 and 3.2.1.2	4.7.1
Solvent 1/	3.2.1	4.7.1
Additives 2/	3.2.1 through 3.2.1.3	4.7.1

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

4.5.2 Inspection routine. The sample shall be subjected to the inspections specified in Table II.

4.5.3 Failure. One or more failures shall be cause for refusal to grant qualification.

4.5.4 Retention of qualification. To retain qualification, the supplier 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 4.6.1.3 and 4.6.1.4), indicating the number of lots that have passed and the number that have failed. The test results of all reworked lots shall be identified.

b. A summary of the results of tests performed for qualification retention inspection, Group C (see 4.6.2.1), including the number and mode of failures. The summary shall include results of all qualification retention inspection tests performed and completed during the 24-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 24-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity at any time during the 24-month period that the inspection data indicates failure of the qualified product to meet the requirements of this specification. If no production has 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 flux to testing in accordance with the qualification inspection requirements.

TABLE II. Qualification inspection.

EXAMINATION OR TEST	REQUIREMENT PARAGRAPH(S)	METHOD PARAGRAPH(S)
Visual examination	3.5	4.7.1
Material composition	3.2.1	4.3, 4.4
Flux activity	3.2.2	4.7.3.7
Resistivity of water extract	3.2.3	4.7.2
Halide content	3.2.4	4.7.3 through 4.7.3.4
Flux reliability		
Copper mirror test	3.3.1	4.7.3.5
Surface insulation resistance	3.3.2	4.7.4
	3.3.2.1	4.7.4.1
Solder spread	3.3.3	4.7.5
Corrosion	3.3.4	4.7.3.6
Packaging and marking	5.1 and 5.2	4.7.1 4.8.2

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of Groups A and B inspection.

4.6.1.1 Inspection lot. An inspection lot shall consist of all containers of flux produced from the same batch of component

materials under essentially the same conditions and offered for inspection at one time.

4.6.1.2 Batch. As far as practicable, a batch shall consist of all flux produced by one continuous production run or by a blend of two or more continuous production runs.

4.6.1.3 Group A inspection. Group A inspection shall consist of the examination specified in Table III.

TABLE III. Group A inspection.

EXAMINATION	REQUIREMENT PARAGRAPH	METHOD PARAGRAPH
Material composition	3.2.1 through 3.2.1.3	4.3 4.4
Visual	3.5	4.7.1

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 containers of defective materials and submit for reinspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected.

4.6.1.4 Group B inspection. Group B inspections shall consist of the tests specified in Table IV.

TABLE IV. Group B inspection.

TEST	REQUIREMENT PARAGRAPH	METHOD PARAGRAPH(S)
Flux activity classification	3.2.2	4.7.3.7
Resistivity of water extract	3.2.3	4.7.2
Halide content	3.2.4	4.7.3 through 4.7.3.4
Effect on copper mirror	3.3.1	4.7.3.5
Solder spread	3.3.3	4.7.5
Corrosion	3.3.4	4.7.3.6

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.

4.6.1.4.3 Disposition of samples. Samples that have been subjected to Group B inspection shall not be delivered on the contract or purchase order.

4.6.2 Qualification retention inspection. Qualification retention inspection shall consist of Group C inspection. Except when the inspections show noncompliance with the applicable requirements (see 4.6.2.1.3), delivery of products that have passed Groups A and B shall not be delayed pending results of these qualification retention inspections.

4.6.2.1 Group C inspection. Group C inspection shall be performed each 24 months and shall consist of the examinations and tests specified in Table V. Group C inspection shall be performed on a sample selected from an inspection lot that has passed Group A and B inspections.

TABLE V. Group C inspection.

EXAMINATION OR TEST	REQUIREMENT PARAGRAPH	METHOD OF INSPECTION
Flux reliability Surface insulation resistance	3.3.2 and 3.3.2.1	4.7.4
Packaging and marking	5.1 and 5.2	4.7.1 and 4.8.2

4.6.2.1.1 Failures. If a sample does not pass any one of the Group C inspections, it shall be considered to have failed.

4.6.2.1.2 Disposition of samples. Residual flux samples that have been subjected to Group C inspection shall not be delivered in accordance with the contract or purchase order.

4.6.2.1.3 Noncompliance. If a flux sample fails Group C inspection, the manufacturer shall notify the qualifying activity

and the cognizant inspection activity of such failure. Corrective action shall be taken, as warranted, on the materials and process(es). Corrective action shall also be taken regarding all product units that can be corrected and that were manufactured using essentially the same material(s) and process(es) and are considered subject to the same failure evidenced by the samples tested. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity, has been taken. After corrective action has been taken, Group C inspection shall be repeated on additional sample units (all tests and examinations, or the test which the original sample failed, at the option of the qualifying activity). Group A and B inspections may be reinstituted; however, final acceptance and shipment shall be delayed until Group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

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 4.7.2), qualitative test for fluorides (see 4.7.3.2) and halide content (see 4.7.3) 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.

4.7.1 Visual examination of materials. The flux shall be examined to verify that the workmanship is in accordance with the applicable requirements (see 3.5). The sample containers of flux shall be examined to verify that the construction, fill, and marking are in accordance with the applicable requirements and that there is no evidence of leakage.

4.7.1.1 Estimation of equivalent sample size for test methods. For tests/evaluations of paste flux and/or solder-paste fluxes (except where dilution is necessary (see 4.5.1)) where 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 gram to ml volume may be substituted to achieve the intent of the test.

4.7.2 Resistivity of water extract (see 3.2.3). This test will require dissolving paste flux or solder-paste flux in isopropyl alcohol (IPA) (see 3.2.6) for rosin based fluxes and distilled water for water soluble fluxes. Five (5) watch glasses and five (5) 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 (5) 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.

4.7.3 Halide content (see 3.2.4). 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 4.7.3.1 and 4.7.3.2, 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 4.7.3.3 and 4.7.3.4, 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.

4.7.3.1 Qualitative test for chlorides and bromides (silver chromate paper test (see 3.2.4.1)). 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 4.7.3.3.

4.7.3.2 Qualitative test for fluorides (purple lake spot test (see 3.2.4.2)). 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 4.7.3.4.

4.7.3.3 Quantitative test for chlorides and bromides (see 3.2.4.3). 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.

4.7.3.4 Quantitative test for fluorides (see 3.2.4.3)). 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.

4.7.3.5 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.

4.7.3.6 Corrosion test (see 3.3.4). The corrosive properties of flux residue shall be determined in accordance with IPC-TM-650, Test Method 2.6.15.

4.7.3.7 Flux activity (see 3.2.2, 6.1.4 and 6.1.8). The flux activity shall be classified in accordance with IPC-SF-818 using data from the tests accomplished per this specification.

4.7.4 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% 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 3.2.1.3).

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 4.5.4).

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 airflow 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_0). 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.

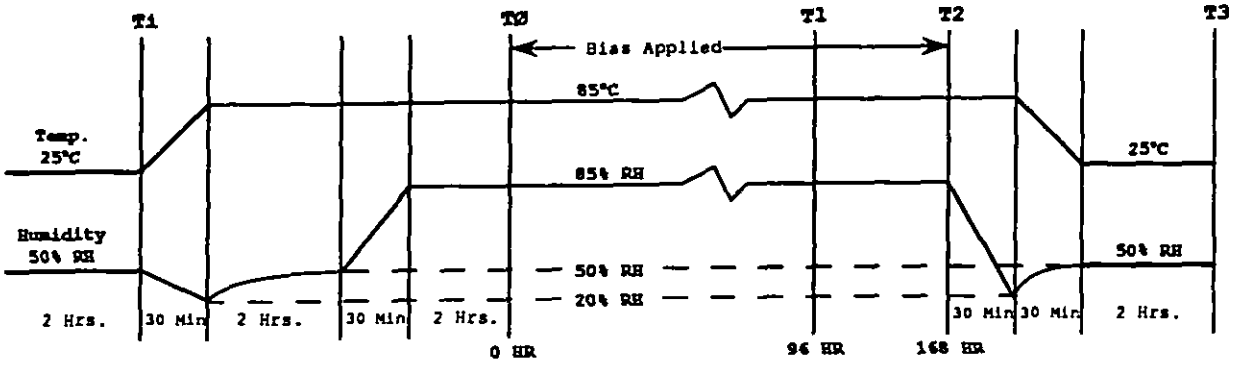
h. All measurements of test patterns on each test board shall be made at +100 ±2.5 VDC, with a 1 minute electrification time and the bias voltage off.

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 control. The data shall not include patterns excluded in accordance with 4.7.4.1. Upon completion of surface insulation resistance testing, each specimen shall be examined under 7X to 10X 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.

4.7.4.1 Classification of visual defects. Examine each specimen which fails these requirements (3.3.2 and 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, 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.



Modified Temperature-Humidity Profile "Condensation-Free"

T1 - Initial Measurements - Made after two hours conditioning at 25°C/50% RH.
TØ - All test timing referenced to start of this measurement sequence (no measurement necessary).
T1 - 96 Hour Measurement - Made 96 hours after TØ
T2 - 168 Hour Measurement - Made 168 hours after TØ
T3 - Dryout Measurement - Made 2 hours after chamber has stabilized at ambient conditions(25°/50%).

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

4.7.5 Solder spread testing (see 3.3.3). The solder spread shall be determined by means of a flux wetting/spreading 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 VI which is intended to aid in defining areas in mm². The mean of the spread of all five samples tested is to be reported and must meet the minimum requirement (see 3.3.3).

4.7.6 Solids content process control test. There is no specific requirement for solids content; however, a suggested test for process control is in paragraph 6.1.7.1 and 6.1.7.2.

4.7.7 Determination of acid number (see 3.2.1). Acid number shall be determined per ASTM D465.

4.8 Inspection of packaging and marking.

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

TABLE VI. Areas defined in mm².

RADIUS in mm	DIAMETER in mm	AREA in mm²
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

4.8.2 Packing inspection. Inspection of packing, marking for shipment and storage shall consist of the examinations specified in Table VII, "Packing Inspection Provisions." Lot formulation shall consist of all packs made of the same materials during an identifiable period and submitted at one time for acceptance.

5. PACKAGING

5.1 Packaging. Packaging shall be in accordance with PPP-C-2020, commercial level, paragraphs 3.2.3 and 3.3.3.

5.2 Marking. Marking shall be in accordance with MIL-STD-129. In addition to any special marking required by the contract or purchase order, individual containers shall be marked with the manufacturer's name, date of manufacture, shelf life (i.e. 3 years

at 25°C), code symbol, qualification test report number and type as specified in 1.2 (see 6.2).

5.3 Compliance with transportation regulations. Most fluxes covered by this specification are flammable and have other hazardous characteristics (see 3.5). Special precautions and regulations for transportation are applicable. Specific carrier guidelines regarding greater volume and/or weight, special hazardous marking and documentation, unit packaging limits and the destination shall be followed (see PPP-C-2020, paragraph 3.6).

TABLE VII. Packing Inspection Provisions.

No.	Characteristic	Method of Inspection
101	Intermediate container not as specified	Visual
102	Improper closure of intermediate container	Visual
103	Shipping containers not in accordance with specification	Visual
104	Excessive cube	Visual
105	Improper blocking and bracing	Visual
106	Closure not in accordance with specification	Visual
107	Weight and size exceed container limitations	Weigh and measure
108	Strapping not in accordance with specification, incorrectly applied, omitted	Visual
109	Marking omitted, incorrect, or illegible	Visual

6. NOTES

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

6.1 Intended use. Fluxes covered by this specification are intended for use in the assembling of electronic circuitry and associated electrical equipment by means of tin-lead solders. For

fluxing purposes, a soldered joint is that which functions as both a mechanical and an electrical joint. It is considered to be an electrical connection (i.e. in grounding applications through a printed wiring board).

6.1.1 Type R flux. This type of flux is the most pure 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.

6.1.2 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).

6.1.3 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).

6.1.4 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.

6.1.4.1 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 6.1.4).

6.1.5 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 is not introduced to the assembly.

That is, all of the starting materials shall be clean, 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.

6.1.6 Assurance of flux removal. Appropriate tests and visual examination should be used to insure the post-cleaning absence of deleterious flux residues.

6.1.7 Optional tests.

6.1.7.1 Paste flux and solder-paste flux viscosity (see 3.2.5). 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.

6.1.7.2 Flux solids content determination (see 4.7.6). An optional means to determine the solids content of flux is IPC-TM-650, Test Method 2.3.34.

6.1.7.3 Organic residue detection (see 3.2.7). An optional means to determine the solids content of flux is IPC-TM-650, Test Methods 2.3.38 and 2.3.39.

6.1.8 Recommendations on flux use. 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. When Type LR (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.

6.1.8.1 Selection of water soluble fluxes. 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.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. title, number and date of this specification

b. the applicable issue of the Department of Defense Index of Specifications and Standards (DODISS) to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1 through 2.2)

c. type of flux required (see 1.2)

d. paste flux viscosity required (see 3.2.5 and 6.1.7.1)

e. applicable marking (see 5.1 and 5.2)

f. commercial preservation and packing (see 4.8 through 5.2)

g. when first article packaging inspection test reports require acquisition activity approval prior to production unit packing

h. part or identifying number (PIN). The PINs to be used for items acquired to this specification are created as follows:

M	14256	X	XX
Mil Spec	No.	Type (i.e. R, RA, RMA, WSF-0, WSF-1)	Form (i.e. L(Liquid) FP (Paste Flux) SP (Solder-Paste Flux)) LR (Low Residue)

6.3 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. Materials with polyether linkages, such as 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.

6.4 Qualification. With respect to flux 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). Flux 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 2.1.2).

6.5 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.

6.6 Ozone depleting chemical (ODC) elimination. Department of Defense Directive 6050-9 Instruction 5000.2 (Part 6, Section I) requires the elimination of ozone-depleting substances from defense industry production lines.

6.7 Subject term (key word) listing.

Flux
Rosin
Resin
Soldering

6.8 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 2.1.1).

6.9 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 - EC
Air Force - 11

Review Activities:
Army - MI, CR
Navy - SH
Air Force - 84, 99
DLA - GS, IP

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

Preparing activity:
Army - ER

Project: 3439-0815

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	2. DOCUMENT DATE (YYMMDD)
	MIL-F-14256F	930426

3. DOCUMENT TITLE FLUX, SOLDERING, LIQUID, PASTE FLUX, SOLDER PASTE AND SOLDER-PASTE FLUX (FOR ELECTRONIC/ELECTRICAL USE), GENERAL SPECIFICATION FOR

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)	
US Army Research Laboratory Electronics and Power Sources Directorate	(1) Commercial (908) 544-3296	(2) AUTOVON 995-3296
c. ADDRESS (Include Zip Code) ATTN: AMSRL-EP-RD Fort Monmouth, NJ 07703-5601	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	

DD Form 1426, OCT 89 *Previous editions are obsolete.* 198/290