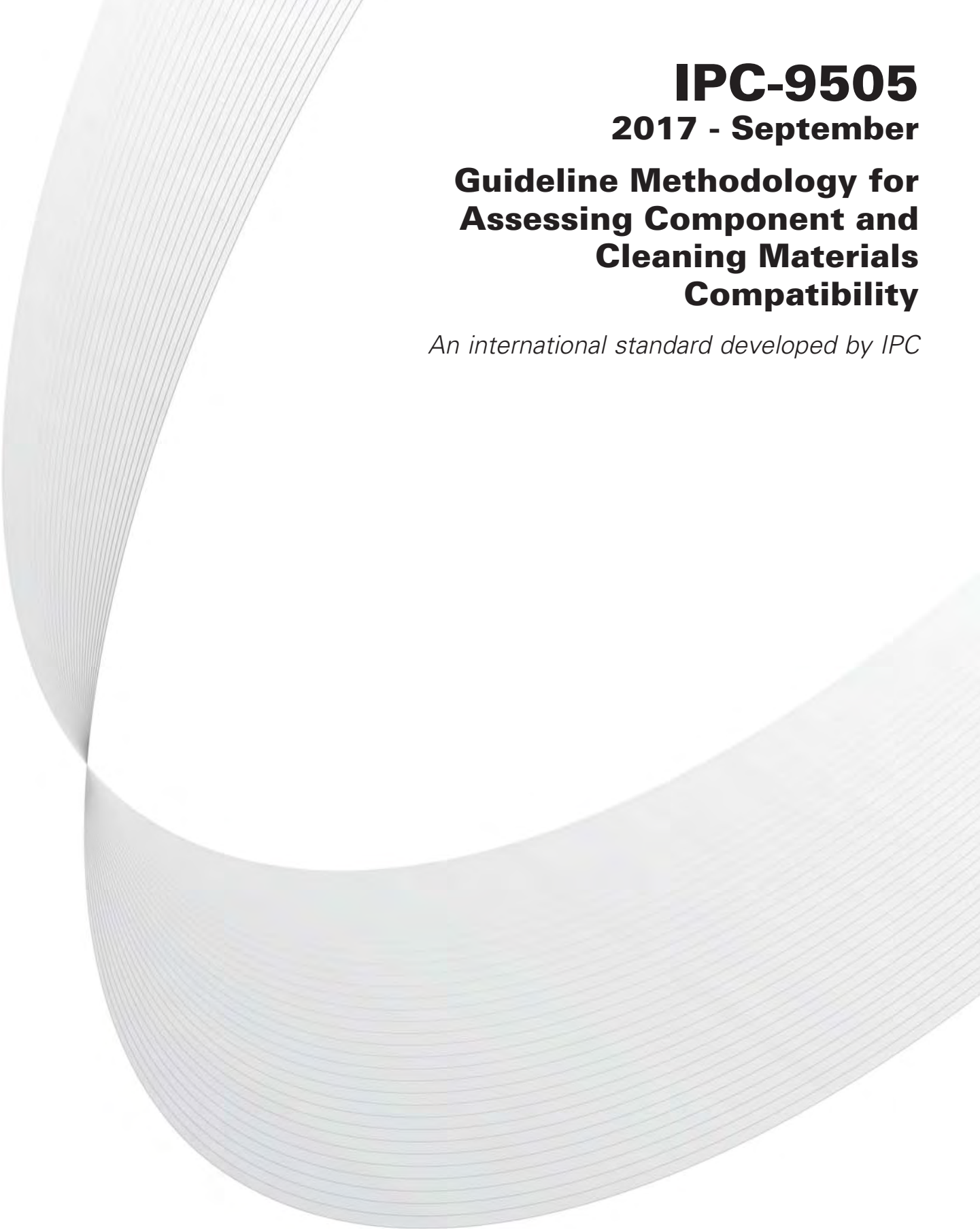




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Guideline Methodology for Assessing Component and Cleaning Materials Compatibility

An international standard developed by IPC

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Guideline Methodology for Assessing Component and Cleaning Materials Compatibility

Developed by the Cleaning Compatibility Task Group (5-31j) of the
Cleaning and Coating Committee (5-30) of IPC

Users of this publication are encouraged to participate in the
development of future revisions.

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Guideline Methodology for Assessing Component and Cleaning Materials Compatibility

1 SCOPE

1.1 Purpose This document establishes uniform methods for testing electronic and electrical component parts, including both static and dynamic cleaning exposure tests to determine resistance to deleterious effects from exposure to the cleaning agent and mechanical energy used to deliver the cleaning agent to the part. For this document, the term “component parts” includes such items as capacitors, resistors, switches, relays, transformers, inductors, and others.

This document develops and delineates the details of the test methodology (methods) for general electronic assembly cleaning chemistry type compatibility with electronic assembly materials. The “new” methods and procedures may be used in place of Mil-Std-202 method 215 which does not accurately represent modern cleaning chemistries used in electronic assembly manufacturing processes.

This document is designed to be used for proactive (compatibility) and reactive (incompatibility) test methods. Compatibility is the interaction between materials sets which do not negatively impact the end use product. This may include removal of flux while not interacting with the markings required for product use. Incompatibility is the interaction between materials sets which negatively impact the end use product. This may include removal of protective coatings and critical type markings.

1.2 Scope To specify suitable conditions obtainable in the laboratory that give test results equivalent to the actual service conditions existing in the field, and to obtain reproducibility of the results of tests. The tests described herein are not to be interpreted as an exact and conclusive representation of actual service operation in one geographic location, since the only true test for operation in a specific location is an actual service test at that point.

To describe in one scope (1) all the test methods of a similar character which appeared in the various joint or single-service electronic and electrical component parts specifications, (2) those test methods which are feasible for use in several specifications, and (3), the recognized extreme environments, particularly temperatures, barometric pressures, etc., at which component parts will be tested under some of the presently standardized testing procedures. By so consolidating, these methods may be kept uniform and thus result in conservation of equipment, man-hours, and testing facilities. In achieving these objectives, it is necessary to make each of the general tests adaptable to a broad range of electronic and electrical component parts.

The test methods described herein for environmental, physical, and electrical tests **shall** also apply, when applicable, to parts not covered by an approved military specification, military sheet form standard, specification sheet, or drawing.

2 APPLICABLE DOCUMENTS

2.1 IPC¹

IPC-B-25A Multi-purpose 1 & 2 sided test pattern

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-B-52 Standard Test Board

IPC-A-600 Acceptability of Printed Boards

IPC-A-610 Acceptability of Electronic Assemblies

IPC-TM-650 Test Methods Manual²

2.3.42 Solder Mask Resistance to Solvents and Cleaning Agents

Mil-Std 202G Method 215K Resistance to Solvents

1. www.ipc.org

2. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/test-methods.aspx)

IPC-SM-840 Qualification and Performance of Permanent Solder Mask

IPC-CH-65B Guidelines for Cleaning of Printed Boards and Assemblies

TT-I-735 Isopropyl Alcohol

MIL-PRF-680 Degreasing Solvent

3 BACKGROUND

Engineers and others responsible for the cleaning process must be aware of possible material compatibility problems. The information contained in this section seeks to provide the process engineer with awareness of the material compatibility risks when cleaning electronic hardware. Factors of concern are circuit board laminates, surface finishes, components, metal alloys, adhesive bond strength, part markings, plastics, the mix and configuration of materials in the assembly and the impact of entrapped contaminants. Other factors must also be considered, such as the chemical characteristics of the cleaning material, cleaning temperature, impingement energy, and exposure time to the cleaning process, including rework cycles. The possible interactions of all these factors are especially challenging today with the much wider availability of board and component lead finishes, as well as joining metals. The difficulty of locating data on each and every possible combination of factors associated with this issue creates a high level of complexity.

3.1 Problem Statement Electronic assembly process ranges from the very simple to the very complex, and involve a wide range of materials. Each step in the process, and each material used will have some impact on the assembly, most affecting the chemical residues remaining on the assembly surface. Material compatibility effects can be influenced by solder paste/fluxes selections, cleaning solutions, labels, adhesives, masking materials, component residues, out-gassing residues, etc. One size does not fit all applications. To understand process limits, improved test methods are needed.

Electronic assemblies require solder masks, components, substrates, assembly materials, alloys, coatings, bonding and stacking materials of the test results. Additionally, assemblers identify components by using markings, labels or other identifiers. These components and markings may experience deleterious from exposure to the cleaning agent and mechanical energy needed to clean the part; therefore, understanding the material compatibility effects and planning for interactions is critical.

Surface mount technology development and innovation continues in response to market pressures for higher functionality, cost reduction, cycle time reduction, and improved quality. To achieve increased functionality, assemblies are becoming increasingly more dense, today's circuit assemblies pack more performance into smaller board designs. Advanced package designs require an increasing number of interconnects to support power requirements and bandwidth. Smaller component packages, tighter area array pitches, and standoff height reductions increases the risk of dendrite formation and electrochemical migration". Surface area to z-height ratio is a critical metric for consideration. As this ratio increases removing residue from these areas becomes more difficult.

As shown in Figure 3-1, component standoff height is continuing to decrease, becoming more difficult for chemistries to clean underneath them and to ensure a thorough rinse afterward. In the figure (3-1), the height off the board of components is continuing to decrease, making it more difficult to get cleaning chemistries underneath them and then rinse them thoroughly out once cleaned. High pressure spray impingement is often needed to penetrate and create a flow channel. Higher chemical and energy levels tax material compatibility.

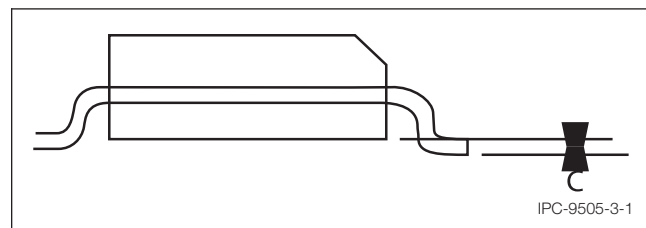


Figure 3-1 Depiction of Clearances Between PCB & Component

Tin-Lead materials have been used throughout industry for years. With the recent legislated push to Lead-free material sets, different flux residues are now present on surfaces to be cleaned. The chemistry of cleaners must be more aggressive to remove these flux residues to maintain the reliability required for rigorous applications of products, especially within the aerospace and defense industries.

Assembly materials consisting of adhesive, fluxes, and solder alloys may vary depending on the mounting, attachment of components, assembly type and component grouping. Assembly residues resulting from the choice of soldering method, flux, and solder, should be considered during cleaning. The choice of flux that is compatible with the solder method and solder will itself determine the cleaning methods used. Final cleanliness will be determined by the end-use environment, and in some cases, the contract quality requirements.

3.2 Compatibility/Incompatibility This document can be used to prove the compatibility of something you want to remove but also prove (check) for incompatibility. There is a wide range of materials and component mechanical forms that should be considered.

Compatibility of the cleaning process is desired for assembly materials and components, including, but not limited to the items listed in Table 3-1.

Table 3-1 Items Requiring Cleaning Process Compatibility

Solubility/Cleaning Efficacy of Solder Paste, Flux, Rework Residues
Solubility/Cleaning Efficacy of other Assembly Process Soils and Finger Soils
No Damage to Printed Wiring Board Laminates
No Damage to Alloys
No Damage to Labels/In Process Markings
No Damage to Electrical Components

Incompatibility of the cleaning process with materials and components, include, but are not limited to, the following factors:

Cleaning Process Design (Classification) – Typical risk by cleaning process equipment, materials and methods, that may impact product reliability due to an overly aggressive or inadequate cleaning process (refer to Table 3-2).

Table 3-2 Cleaning Process Classification

Aggressive Cleaning Process	Moderate Cleaning Process
Cleaning agent with high solvency/high reactivity	Cleaning agent with moderate solvency/low reactivity
High wash temperatures	Moderate wash temperatures
Long wash times	Moderate wash times
High levels of mechanical energy	Moderate levels of mechanical energy

Assembly Design – Typical challenges posed by assembly designs for cleaning process include:

- Entrapment of cleaning solution (and dissolved soils) and rinse agent (water) underneath low standoff components, components with bottom terminations, inside of “open architecture” components such as coils, transformers and connectors and inside of non-hermetically sealed devices (refer to Table 3-3).
- Entrapment of soils underneath low standoff components and components with bottom terminations due to high impingement energy required to clean flux entrapped under bottom terminations or limited accessibility to the underside of components to remove the residue (refer to Table 3-3).
- Removal of or damage to materials on an assembly due to chemical and physical incompatibility with the cleaning process equipment and cleaning agents (refer to Table 3-3).

Table 3-3 Cleaning Process Incompatibility Considerations

Materials Incompatibilities	Mechanical Form Incompatibilities
Component Markings	Connectors
Labels – Tape	Embedded Components
LEDs	QFN/LGA – Low Component Stand-Off
Wire and Cable	Packages
Bonding/Staking/Coating Materials	Wire and Cable
Adhesives	Relays
Display Materials	Non-Hermetic Packages
CSP Underfills	Other Component Structures
Chip-on-Board Encapsulants	
Surface Mount Adhesives	
Thermal Management Materials	
Conformal Coating	

4 CURRENT INDUSTRY STANDARD TEST METHODS

Section 4 rewrites the current standards to bring attention to limitations and to point out areas from which the current standards can be improved.

4.1 MIL-STD-202G: Method 215K

4.1.1 Resistance to Solvents MIL-STD 200G method was published February 8, 2002. The goal of this method is to provide component suppliers a standard for validating the suitability of part markings with cleaning agents (solvents). The method calls out a common solvent, semi-aqueous cleaning agent and an aqueous cleaning agent for running validation tests for the suitability of part markings. Since the time when this standard was written, lead-free, miniaturization and bottom termination components have increased cleaning complexity. In response to these complexities, both cleaning agents and mechanical energy systems have been changed to remove residues. The current standard test protocol, in many cases, does not account for current cleaning agents and mechanical impingement forces being used within the assembly process.

4.1.2 Purpose The purpose of this test is to:

- A. Verify that markings or color coding will not become illegible or discolored on the parts (including printed wiring boards) when subjected to solvents and processes normally used to clean solder-flux, fingerprints, and other contaminants from printed-wiring and terminal-board assemblies.
- B. To verify that component protective coatings and encapsulant materials are not degraded to the point where electrical or mechanical integrity is disturbed when subjected to solvents and processes normally used to clean solder flux, fingerprints, and other contaminants from printed wiring and terminal board assemblies.

4.1.3 Formulation of Solvents The formulation of solvents is considered typical and representative of the solvents used in printed wiring assembly processing of electronic components. Processing conditions are representative of processes used for printed wiring assembly. Note: The problem is that the solvents called out in MIL-STD 202G, Method 215K and the processes listed in this standard are not representative of cleaning materials and cleaning processes used within industry to clean electronic assembly process residues. This creates a false standard for component suppliers. To address this issue, the standard and test methods need to be updated.

4.1.4 Materials Solvent solutions. The solvent solutions used in this test **shall** consist of the following (see table for summary).

- a. A mixture consisting of the following:
 1. One part by volume of isopropyl alcohol, American Chemical Society (ACS) reagent grade, or isopropyl alcohol in accordance with TT-I-735, grade A or B, and
 2. Three parts by volume of mineral spirits in accordance with MIL-PRF-680, type I, or three parts by volume of a mixture of 80 percent by volume of kerosene and 20 percent by volume ethylbenzene
- b. This solvent has been deleted. When a suitable replacement solvent has been determined, it will be added as solution b.
- c. A terpene defluxer consisting of a minimum of 90 percent d-limonene and 10 percent surfactant.
- d. A mixture consisting of the following:
 1. Forty-two parts by volume water, 1 megohm-cm minimum resistivity.
 2. One part by volume of propylene glycol monomethyl ether (glycol ether PM, 1-methoxy-2-propanol).
 3. One part by volume of monoethanolamine.

4.1.5 Vessel The vessel for solvent immersion **shall** be a container made of non-reactive material and of sufficient size to permit complete immersion of the specimens in the solvent solutions.

4.1.6 Brush The brush **shall** be a toothbrush with a handle made of a non-reactive material. The brush **shall** have three or four long rows, 1 and 1/8 ± 1/8 inch in length, of hard bristles. Each row **shall** contain eight to twelve tufts, the free ends of which **shall** lie substantially in the same plane. The brush **shall** be used with a single solvent and when there is any evidence of softening, bending, wear, or loss of bristles, it **shall** be discarded.

4.1.7 Test Procedure The specimens subjected to this test **shall** be divided into three groups of approximately equal size.

- a. The first group **shall** be exposed to the solution specified in 4.1.4 (a).

The solution **shall** be maintained at a temperature of $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The specimens **shall** be completely immersed for 3 minutes +0.5, -0 minutes in the specified solution contained in the vessel. Immediately following immersion, each specimen **shall** be tested as follows: The bristle portion of the brush, specified in 4.1.6, **shall** be dipped in the solution until wetted and the specimen **shall** be brushed with normal hand pressure (approximately 2 to 3-ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied. The brush stroke **shall** be directed in a forward direction across the surface of the specimen being tested. Immediately after brushing, the procedure **shall** be repeated two more times, for a total of three immersions, followed by brushing. After completion of the third immersion and brushing, the specimens **shall** be air-blown dry. The specimens **shall** be inspected in accordance with 4.1.11 to determine the extent, if any, of deterioration that has occurred.

- b. This solvent solution has been deleted.

- c. The second group **shall** be exposed to the solution specified in 4.1.4 (c).

The solution **shall** be maintained at a temperature of $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The specimens **shall** be completely immersed for 3 minutes +0.5, -0 minutes in the specified solution contained in the vessel specified in 4.1.5. Immediately following immersion, each specimen **shall** be tested as follows: The bristle portion of the brush, specified in 4.1.6, **shall** be dipped in the solution until wetted and the specimen **shall** be brushed with normal hand pressure (approximately 2 to 3-ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied. The brush stroke **shall** be directed in a forward direction across the surface of the specimen being tested. Immediately after brushing, the procedure **shall** be repeated two more times, for a total of three immersions, followed by brushing. After completion of the third immersion and brushing, the specimens **shall** be rinsed in approximately $25\text{ }^{\circ}\text{C}$ water and all surfaces air-blown dry. The specimens **shall** be inspected in accordance with 4.1.9 to determine the extent, if any, of deterioration that has occurred.

- d. The third group **shall** be exposed to the solution specified in 4.1.4 (d).

The solution **shall** be maintained at a temperature of $63\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$. The specimens **shall** be completely immersed for 3 minutes +0.5, -0 minutes in the specified solution contained in the vessel specified in 4.1.5.

Immediately following immersion, each specimen **shall** be tested as follows: The bristle portion of the brush, specified in 4.1.6, **shall** be dipped in the solution until wetted and the specimen **shall** be brushed with normal hand pressure (approximately 2 to 3-ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied. The brush stroke **shall** be directed in a forward direction across the surface of the specimen being tested. Immediately after brushing, the procedure **shall** be repeated two more times, for a total of three immersions, followed by brushing. After completion of the third immersion and brushing, the specimens **shall** be rinsed in approximately $25\text{ }^{\circ}\text{C}$ water and all surfaces air-blown dry. The specimens **shall** be inspected in accordance with 4.1.11 to determine the extent, if any, of deterioration that has occurred.

4.1.8 Optional Exposure Procedure for the Third Group The test specimens **shall** be located on a test surface of known area which is located 6 ± 1 inches (15 ± 2.5 centimeters) below a spray nozzle which discharges 0.16 ± 0.005 gpm (0.62 ± 0.02 liters per minute) of solution per in^2 (6.5 square centimeters) of surface area at a pressure of 20 ± 5 lbs/ in^2 (138 ± 34 kilopascal). The solvent **shall** be held at a temperature range of $63\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$. The specimens **shall** be subjected to this spray for a period of 10 minutes. After completion of the spray exposure, the specimens **shall** be thoroughly rinsed in water and all surfaces air-blown dry and inspected in accordance with 4.1.11 to determine the extent, if any, of deterioration that has occurred. If this optional procedure is specified, brushing of the samples in the third group is not required. If a conflict arises from the use of the spray option, the brush method of 4.1.4 **shall** be used as the referee procedure. The measurements shown in parentheses are not exact equivalents and are shown for convenience only.

4.1.9 Immersion Test for Components With Marking Protected by a Sleeve Material Components with a protective sleeve **shall** be divided into three groups as specified in 3, and each group **shall** be subjected to testing using the solution defined for that group. Each solution **shall** be maintained at a temperature of $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, except the solution in 4.1.4 **shall** be maintained at a temperature of $63\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$. The specimens **shall** be completely immersed for 3 minutes +.5, -0 minutes in the specified solution contained in the vessel specified in 4.1.5. Immediately following immersion, each specimen **shall** be tested as follows: The bristle portion of the brush specified in 4.1.6 **shall** be dipped in the solution until wetted and the specimen **shall** be brushed with normal hand pressure (approximately 2 to 3-ounce force applied normal to the surface) for ten strokes on the sleeve directly above the area of the marking. Immediately after brushing, the specimens **shall** be inspected in accordance with 4.1.11 to determine the extent, if any, of deterioration that has occurred.

repeated two more times for a total of three immersions followed by brushing. The brush stroke **shall** be directed in a forward direction across the sleeve area above the marking. After completion of the third immersion and brushing, the specimens **shall** be air-blown dry. The specimens **shall** be inspected in accordance with 4.1.11 to determine the extent, if any, of deterioration that has occurred, including the sleeve.

4.1.10 Open Construction Parts and Parts not Intended for PCB Mounting Parts of open construction which are susceptible to internal damage by immersion in solvents and parts not intended for mounting on printed circuit boards **shall** be divided into three groups as specified in 3, and each group **shall** be subjected to testing using the solution defined for that group. Each solution **shall** be maintained at a temperature of $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, except for the solution in 4.1.4, which **shall** be maintained at a temperature range of $63\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$, and **shall** be contained in the vessel specified in 4.1.5. Each group **shall** be tested as follows: The bristle portion of the brush specified in 4.1.6 **shall** be immersed in the respective solution for each group until wetted. The marking area of the specimen to be tested **shall** then be immediately brushed with normal hand pressure (approximately 2 to 3 ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied (test area not to exceed one half inch square). The brush stroke **shall** be directed in a forward direction across the marked surface. This test **shall** be repeated twice for a total of three times for each specimen. The specimens **shall** then be inspected in accordance with 4.1.11 to determine the extent of deterioration, if any.

4.1.11 Examination and Measurements

4.1.11.1 Marking Resistance to Solvents After subjection to the test, any specified markings which are missing in the whole or in part, faded, smeared, blurred, or shifted (dislodged) to the extent that they cannot be readily identified from a distance of at least 6 inches with normal room lighting without the aid of magnification or with a viewer having a magnification no greater than 3X **shall** constitute failure.

4.1.11.2 Component Protective Coating, Encapsulation Material and Sleeve Material Resistance After subjection to the test, the specimen **shall** be examined for cracks, separations, crazing, swelling, softening, and degradation of body material, end caps and seals if present, or any other damage or degradation that has occurred due to solvent exposure and which affects the mechanical integrity or reliability **shall** constitute a failure. The examination **shall** be made with a viewer having a magnification of 10X maximum.

4.1.12 Summary

The following details are to be specified in the individual specification:

- a. The number of specimens to be tested
- b. Optional procedure for the third group allowed

4.1.13 Limitations Method 215K calls out standard solvents for component suppliers to test and develop a material compatibility threshold. The solvents selected for this standard may no longer be applicable to cleaning methods needed to remove process residues. The procedures for applying the solvents are not applicable to cleaning energies required to deliver, penetrate and remove process residues under bottom terminations. The limitations of this method do not match the requirements that suppliers need in order to build their products and components to assure material compatibility with the cleaning process.

Table 4-I Summary Table for Resistance to Solvents

Solvent 1	Solvent 2	Solvent 3	Solvent 4
1 part (by volume) of isopropyl alcohol (ACS) reagent grade or TT-I-735, grade A or B and 3 parts (by volume) or mineral spirits per Mil-Prf-680, type I, or three parts (by volume) of a mixture of 80% (by volume) of kerosene and 20% (by volume) ethylbenzene.	The solvent has been deleted.	Terpene defluxer.	42 parts (by volume) of water; 1 part (by volume) of propylene glycol monomethyl ether; 1 part (by volume) of monoethanolamine.
Immersion 3 + 0.5, -0 minutes, 25 °C ± 5 °C.		Immersion 3 + .5, -0 minutes, 25 °C ± 5 °C.	Immersion 3 + .5, -0 minutes, 60 °-70 °C.
Brush 10 strokes (wet bristle) 2 to 3 oz.		Brush 10 strokes (wet bristle) 2 to 3 oz.	Brush 10 strokes (wet bristle) 2 to 3 oz.
Immersion 3 + 0.5, -0 minutes, 25 °C ± 5 °C.		Immersion 3 + .5, -0 minutes, 25 °C ± 5 °C.	Immersion 3 + .5, -0 minutes, 60 °-70 °C.
Brush 10 strokes (wet bristle) 2 to 3 oz.		Brush 10 strokes (wet bristle) 2 to 3 oz.	Brush 10 strokes (wet bristle) 2 to 3 oz.
Immersion 3 + 0.5, -0 minutes, 25 °C ± 5 °C.		Immersion 3 + .5, -0 minutes, 25 °C ± 5 °C.	Immersion 3 + .5, -0 minutes, 60 °-70 °C.
Brush 10 strokes (wet bristle) 2 to 3 oz.		Brush 10 strokes (wet bristle) 2 to 3 oz.	Brush 10 strokes (wet bristle) 2 to 3 oz.
		Rinse with water.	Rinse with water.
Air blow dry.		Air blow dry.	Air blow dry.
Inspect at 3X maximum for marking.		Inspect at 3X maximum for marking.	Inspect at 3X maximum for marking.
Inspect at 10X maximum for part damage.		Inspect at 10X maximum for part damage.	Inspect at 10X maximum for part damage

4.2 IPC-TM-650, Method 2.3.42

4.2.1 Solder Mask Resistance to Solvents and Cleaning Agents

4.2.1.1 Scope TM-650, Method 2.3.42, is used to determine the ability of a solder mask to resist degradation by solvents and cleaning agents.

4.2.1.2 Test Specimens Six (6) IPC-B-25A boards coated with solder mask on the top side. Five are to be tested and one is to be held as a control. The IPC-A-25A-G-KIT artwork package provides the Gerber files necessary for the fabrication of the standard IPC-B-25A test board used with this test method.

4.2.1.3 Apparatus and Reagents

Reagent Grade 2-Propanol (Isopropyl Alcohol)

Deionized Water (DI Water) with resistivity 2 meg-ohm cm and 10 meg-ohm cm

10% Alkaline Detergent [by volume], which **shall** be comprised of:

- 5% akanolamine
- 2.5% 2-butoxyethanol
- 2.5% glycol ether
- 90% DI Water

Monoethanolamine

Miscellaneous laboratory-ware (e.g., beakers, funnels, storage bottles, graduated cylindres) including:

- A hot plate capable of heating up to 65 °C [149 °F]
- A thermometer capable of measuring accurately up to 100 °C [212 °F]
- A vent hood, or performed with adequate ventilation

Thermometer with measurement uncertainty less than 2 °C [3.6 °F] and precision better than 1 °C [1.8 °F]

4.2.1.4 Procedures

4.2.1.4.1 Chemical Exposure

4.2.1.4.1.1 Prepare the solvents and cleaning agents as outlined in Section 4.2.1.3 and Table 4-2.

4.2.1.4.1.2 Completely immerse one test specimen in each of the solutions shown in Table 4-2. A new specimen is to be used for each chemical.

4.2.1.4.1.3 After immersion, hang the specimens to dry for ten minutes at ambient laboratory conditions.

Table 4-2 Outline of IPC-TM-650, Method 2.3.42

Solvent/Cleaning Agent	Temperature °C [°F]	Time (minutes)
Isopropyl alcohol	Ambient Laboratory Conditions	2
• 75% Isopropyl alcohol • 25% DI Water	46 ± 2 °C [115 ± 3.6 °F]	15
10% Alkaline Detergent [4.2.3.3]	57 ± 2 °C [135 ± 3.6 °F]	2
Monoethanolamine	57 ± 2 °C [135 ± 3.6 °F]	2
DI Water	60 ± 2 °C [140 ± 3.6 °F]	5
D-Limonene	Ambient Laboratory Conditions	2

TM-650, Method 2.3.42, provides a solid framework for testing solder mask compatibility. The list of Solvent/Cleaning Agents needs to be updated to current technologies in use today. Time and energy also need to be modified.