IPC-J-STD-001 Rev G, Amendment 1, Section 8 Cleanliness Section is Redefining the State of Cleanliness on Electronic Assemblies and Now Requires Objective Evidence of Are You "Clean Enough"

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History: How did we get here? The past has been driven by the ROSE (Resistivity of Solvent Extract) Test – Omegameter testing which was developed and designed for determining the state of cleanliness when the solder paste was either water-soluble fluxes (Organic Acids) or rosin mildly activated fluxes (RMA –Abietic Acid). The ROSE test was a very good test when the fluxes were highly soluble in a DI-water and IPA solution. It could be run over a resistivity meter to determine the change in resistivity caused by ionic contamination going into solution from the soldering of electronic assemblies. As fluxes migrated and evolved over the years, the ROSE test has become less effective in being able to measure the new flux systems being created because complex organic and inorganic compounds are being used today. The ROSE test was effective when the organic acids and abietic acid was used in flux chemistries because the main ionic constituent in the flux system was soluble in the ROSE measuring solution.

Since the 1970s, ROSE testing was used to determine "clean enough." In 2015, the J-STD-001 committee assigned a team to develop the next generation of "cleanliness" requirements. Section 8 defines the key concepts that drove the need for developing new cleanliness requirements and the need for "objective evidence."

- ROSE testing for product acceptance (pass-fail) is an obsolete practice for determining acceptably clean or clean enough
- ROSE testing for process control is perfectly acceptable, but the numbers have to MEAN something. And those values need to be scientifically/statistically determined - objective evidence and correlation analysis are needed.
- No set value or method defines the line between acceptably clean and unacceptably dirty

A qualified manufacturing process should be determined using some form of temperature-humidity-bias sort of testing (such as SIR). Qualifying a manufacturing process through chemical analysis alone (e.g., ion chromatography) does not tell you the effects of the residue under humid conditions, which is where electrochemical failures occur. Companies that have come up with ionic standards by IC also use temperature-humidity-bias (THB) testing somewhere in their qualification process. The above problem statement now shows that no one test method gives the perfect answer to the question of

"Is my electronic assembly clean enough to meet my quality reliability objective for cleanliness ?" To fully answer this new IPC-J-STD-001, Section 8 requirement, OEM and EMS companies need to use a couple of different tests to create the objective evidence and correlation analysis to determine a state of cleanliness on their electronic hardware.

Problem Statement: Bottom Terminated Components

Electronic assemblies have evolved into highly complex systems, and form factors are miniaturizing. Increased density and miniaturization increases the sensitivity of the assemblies to ionic residues (anions, weak organic acids, and cations) and may impact component reliability. A large number of surface mount components are leadless such as BTC's and LGA's (Bottom Terminated Components and Land Grid Arrays). The bottom termination can comprise a high number of interconnects and thermal planes. The z axis height/gap from the surface of the board to the bottom of the component is decreasing. Residues trapped under the bottom termination style components may not reach proper activation temperatures due to blocked outgassing channels or even due to the complexities of the pinout itself. Even when using a No-Clean solder paste, flux residues may be active due to these complexities and challenges. The challenge is both a no-clean solder paste as well as the solder pastes that are cleanable. Again, whether you use no clean paste or a cleanable solder paste one needs to have objective evidence and know their state of cleanliness on their electronic assemblies. Thus the reason why IPC added the objective evidence specification to SECTION 8 of IPC-J-STD-001.

SOLUTION: STI Opinion

Surface Insulation Resistance (SIR) is one of the best tests that allow one to determine the state of cleanliness on their electronic hardware. Surface Insulation Resistance (SIR) is a quantitative test method that has been used within the electronics industry. Electrochemical reactions at or below the surface of electronic circuits and components will affect surface insulation resistance values. The test is conducted on specifically designed test boards that are representative of production hardware. The test requires the presence of humidity and electrical bias to evaluate the mobility of ionic contamination left on the PCB during the assembly process. Sources of surface insulation contamination are numerous and can come from a multitude of sources, but SIR testing allows one to determine the state of cleanliness as it relates to surface cleanliness. SIR test methods can be used to test electrochemical reactions on incoming bare boards; residues left behind from soldering materials; reflow process conditions; No-Clean processing; cleaning processes; and effects from handling, etc. SIR is commonly performed by reliability laboratories and at some larger original equipment manufacturers (OEMs) and contract manufacturers (CMs). SIR is a highly sensitive method. IPC approved test boards and custom customer designed test boards populated with components that match up to production hardware contain sensor traces in areas where flux residue and other contaminants are present. Temperature-humidity-bias (THB) test methods quantitatively detect the activity of those residues at the test location and can be used to predict the reliability of electronics placed in service. This type of Objective evidence and correlation analysis sets the foundation for meeting the Section 8 specification for Cleanliness.

A second test is the ability to correlate SIR and Ion Chromatography (IC) testing. Ion Chromatography (IC) testing is another good test in obtaining objective evidence to show the state of cleanliness on electronic hardware and show a great understanding of how clean is clean and how clean is

clean enough to ensure long-term reliability. The ability to gather objective evidence and have a correlation analysis between test vehicles/ test cards and the actual electronic hardware sets the stage for defining the state of cleanliness on the actual electronic hardware. IC is the second test methodology that STI believes should be used in gathering the data and evidence to be used in determining the state of cleanliness. The ability to measure the anions quantitatively, weak organic acids and cations are another key data set in determining the state of cleanliness on electronic hardware.

As you now can see, STI's opinion revolves around the use of two specific tests that gives hard data numbers that can be used from initial product qualification to on-going process control to ensure repeatability and consistency from lot to lot as well as the ability to use an SPC controlled analysis for quality assurance. The objective is to gather real test data that can be used as objective evidence to determine and control the state of cleanliness from product qualification thru the product lifecycle (a lot to lot processing and warranty expectation). This type of understanding and data will help improve the manufacturing process as well as ensure cleanliness issues do not impact product warranty and reliability. As products become smaller and densities increase, the ability to understand the state of cleanliness on no clean and cleanable solder processes becomes essential…… Do you know your state of cleanliness on you're as-built electronics? Would you like to know more about how to gather objective evidence and correlate this type of data?

If you would like to know more on how to collect and correlate test data to ensure the understanding of cleanliness and meet the section 8 requirement of IPC-J-STD-001, please call or email Mark McMeen 256-705-5515 for a white paper or answers to your questions on this new requirement. The future is changing, and so does our need for test data and objective evidence.

PS- If you happen to be attending APEX 2019 and would like to learn more on this topic, new requirement and how to acquire and meet the new requirement – Please attend my paper presentation on Wednesday, January 30, 2019, at 1:30 pm to 3:00 pm in Track S20- Cleaning. See you there…….

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