Process Doctor

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What's My Risk?

Determining the root cause of a field failure.

Many quality control engineers seek to determine their product performance risk, depending on factors that include:

- Process uses fluxes that passes J-STD-004.
- Process uses solder paste that pass J-STD-004.
- Process passed the J-STD-001 B-36 SIR process qualification.
- Incoming bare boards pass cleanliness testing with a 2.9 µg/in^2 of NaCl equivalents in the Omegameter 600R.
- Assemblies pass cleanliness testing with a 3.1 µg/in^2 of NaCl equivalents in the Ionograph 500 M.
- Each assembly meets the IPC-A-610D inspection criteria.
- Every part of the plant is ESD-protected.
- Quality plan shows processes are in control and meeting Six Sigma requirements.
- Process uses HALT testing to prove long-term reliability.
- Process uses ESS testing to assess quality issues.

The product performance on a six-month-old program, a controller assembly used in a telecom application, is seeing the following issues:

- Large numbers of drained clock batteries on units out of the box.
- Intermittent performance reported from installers and units in the field the first month.
- Monthly increases in no trouble found (NTF) returns (up to 17%).
- At months five and six, 38% of the fielded hardware has been returned for drained batteries, intermittent performance, corrosion and shorting on fielded assemblies in moderately controlled operating environments.
- SEM/EDS analysis shows carbon, oxygen, bromide, tin and copper.
- FTIR shows a match to the liquid no-clean flux.

What is the root cause? The sensitive area of the circuit near the connector is isolated as having the performance problem (**Figure 1**). New components hand-soldered into failed locations perform well. Cleaning with a brush and IPA between the leads improves the performance for a few hours in the humidity chamber (without cleaning, the boards fail in 20 min. in a 40°C/90% RH conditions, whereas brush cleaning permits 3 hrs. in a biased state).

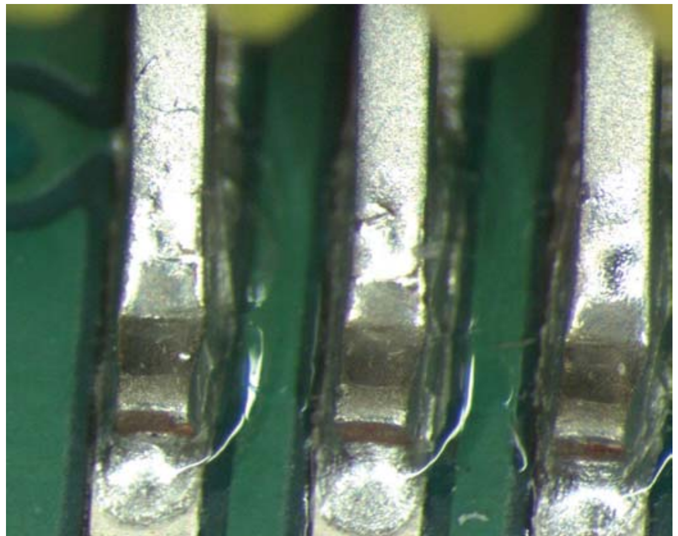

Figure 1. Sensitive circuit area on the bottom-side SMT of a no-clean assembly. The area is next to the connector, which is wave-soldered in a selective pallet.

Further, C3 extractions of localized areas around the sensitive area of the circuit show very high levels of WOA residues (229 µg/in^2) as compared to other areas on the bottom-side SMT area, away from the selective pallet, with WOA levels at 11.3 µg/in^2 and 9.41 µg/in^2. The area inside the selective soldering process that was in contact with the wave solder showed WOA levels of 44.35 µg/in^2 and 37.19 µg/in^2. The amount of clear flux around the leads was greater near the selective solder area. Capacitors were growing dendrites on the top and side of the component next to the area of selective solder. The use of a water-based, low-solids no-clean flux with a pH of 2.4 applied with a spray-fluxing process during the wave soldering and pallets that leave a white and clear residue in the pallet area after soldering is the root cause of the performance problem.

This residue is drawn into the areas defined by the selective solder pallet that are designed to protect the bottom-side SMT components from the wave solder area. The capillary forces of the flux will wick into the areas nearby, and the pallet thermally protects the residues from seeing the proper temperature to heat-activate the flux and drive the water from the activator, therefore leaving behind a strong acid with moisture-absorbing elements and creating a leakage and corrosion pathway with the partially heat-activated fluxes. No-clean low-solids flux residues are insulative and benign if they are properly heated (per the manufacturer's recommen-

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dations). But when fluxes are not completely heat activated, they stay moisture-absorbing, conductive and in this case, corrosive.

What permitted flux residue to be present on the assembly and not create failures during testing or in the cleanliness testers? A small, localized area that for product validation was hand-soldered in place and run on the proto line. The cleanliness tester analyzes a large board area, whereas in this case only a small area was covered by the connector opening, leaving a small pocket of flux in a sensitive area. ■