On the Average, I'm OK.

Localized residues can be concentrated enough to cause catastrophic failures

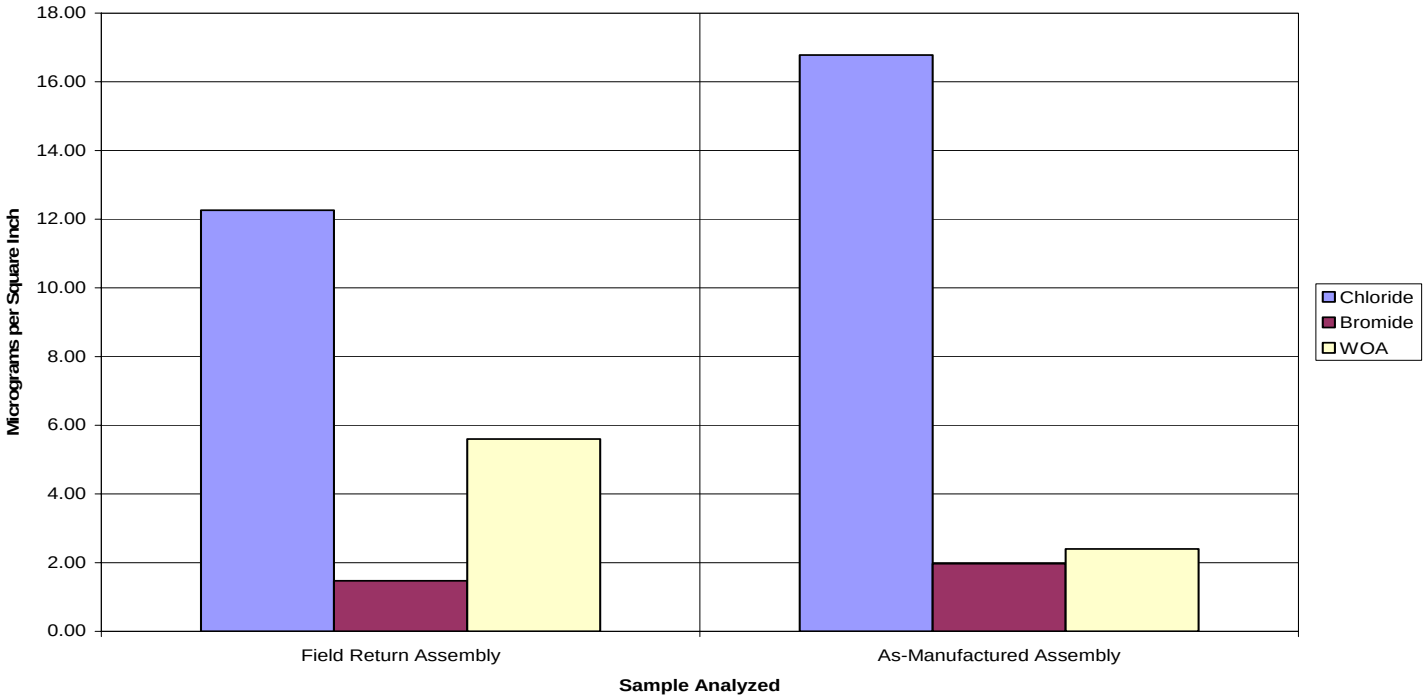
Foresite Inc.

In this month's case study, we look at a problem concerning corrosion, metal migration, and electrical leakage, potentially affecting over 100,000 assemblies (field and inventory) with more produced every day. Needless to say, this involves a disaster of epic proportions with a fairly frantic customer. The assemblies are exposed to the outdoor environment, all across the United States. The assembly is not conformally coated. The enclosure was vented, but was pretty well sealed. In service, the enclosure usually ran five degrees hotter than the surrounding environment, so condensation inside the enclosure was rare. The units began to fail in the field in as little as three weeks from electrical leakage and rampant corrosion and metal migration.

The bare boards were FR-4, HASLed, with LPI solder mask. The assemblies were processed with a component adhesive for SMT parts, water soluble solder paste, and a water soluble flux with aqueous cleaning, in an overseas location. There were no ionic cleanliness requirements imposed and no burn-in requirements levied (no kidding).

Chart 1 shows the initial evaluation of a corroded field return and an as-manufactured assembly with no field exposure. The bromide and weak organic acid (WOA) residues were typical of a WSF process, and were not a factor in any subsequent testing. The chloride values presented in chart 1 were typical of dozens of field returns and as-manufactured situations. When the as-manufactured assemblies were tested at 85ºC / 85% RH, they universally failed from electrical leakage, corrosion and metal migration. As a reference, we recommend that assemblies processed with water soluble fluxes have chloride levels no greater than 5.0 micrograms per square inch.

Initial Analyses
Chart 1



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We worked with the assembler to have the units all remedially cleaned at two cleaning houses. Chart 2 shows the cleanliness levels after what we considered to be a reasonable deionized water cleaning process. Patting ourselves on the back, we figured we chalked up another success. Then the customer called that there were still failures, especially in the portion of the assembly containing a quad flat pack (QFP) (see figure 1).

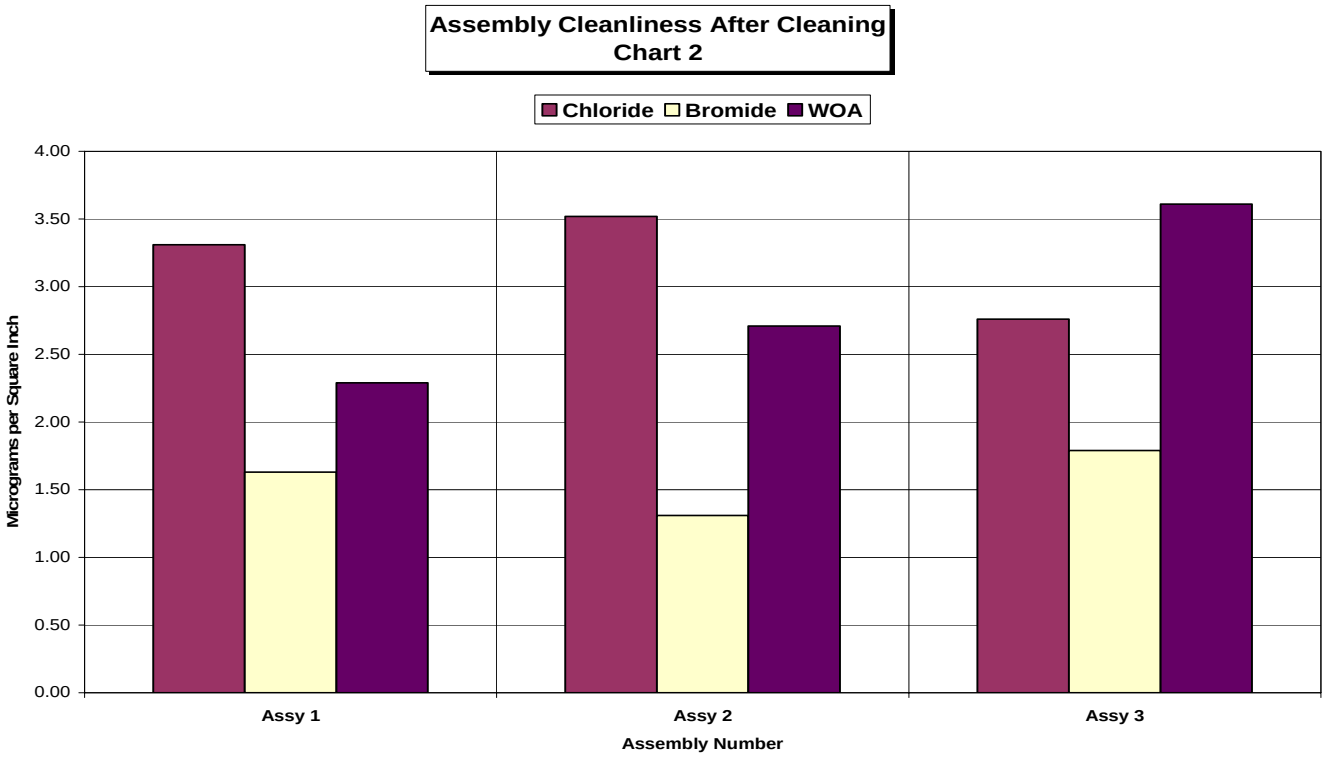
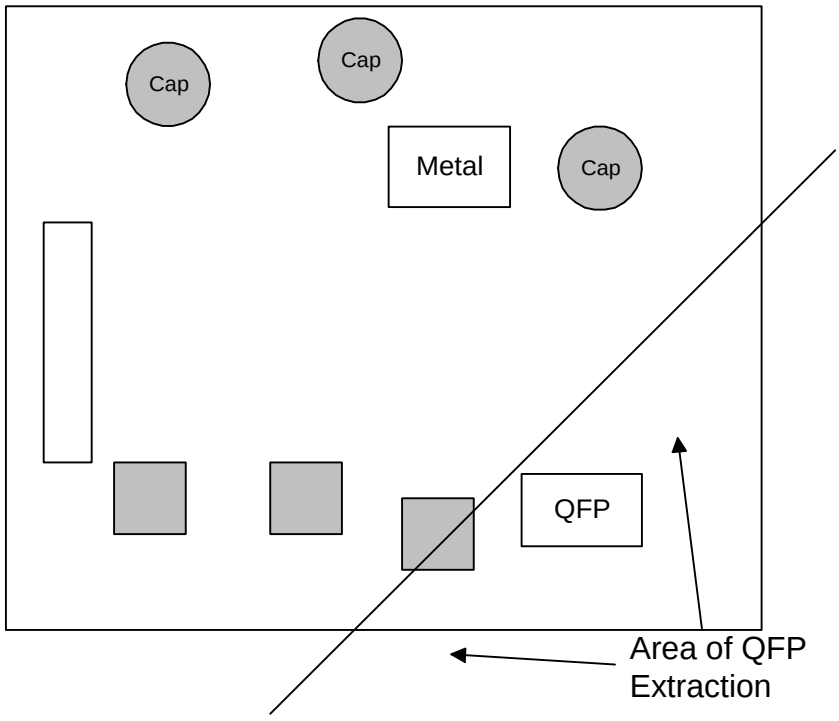
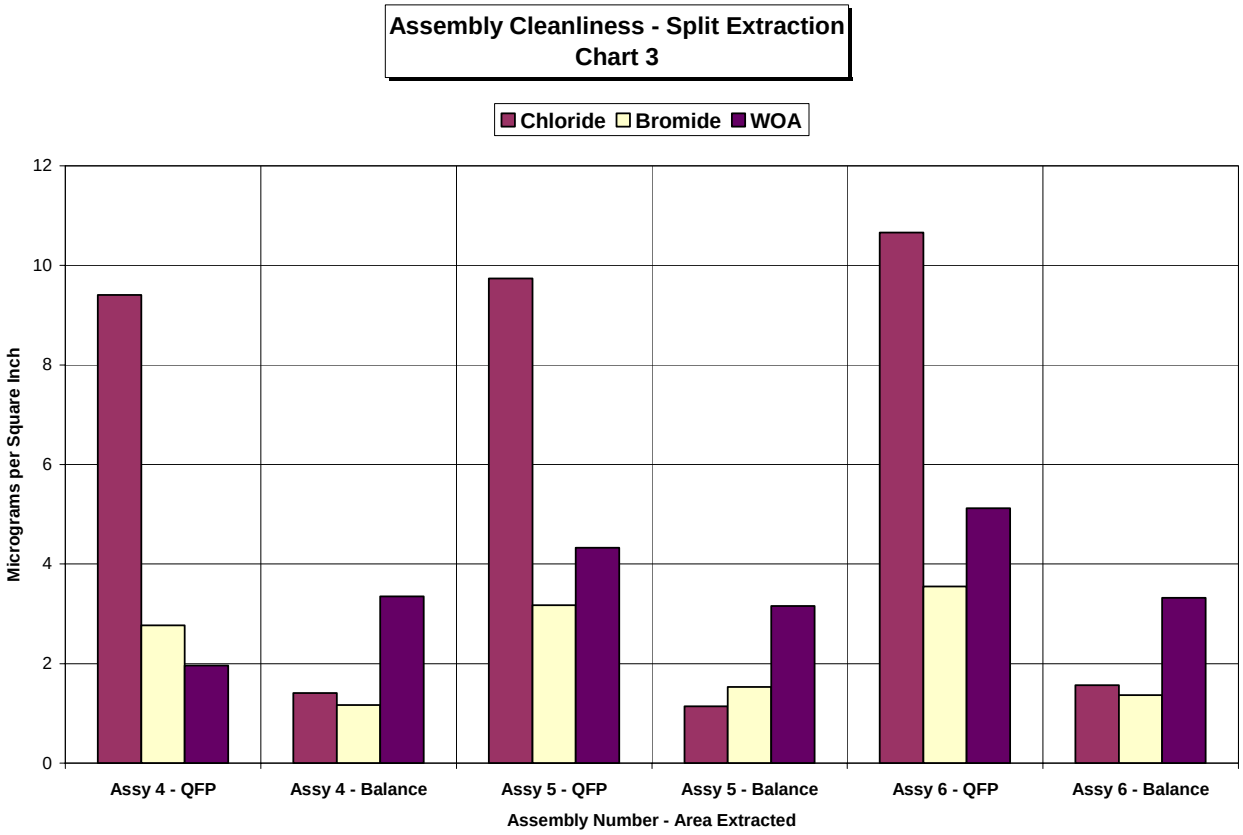


Figure 1 →

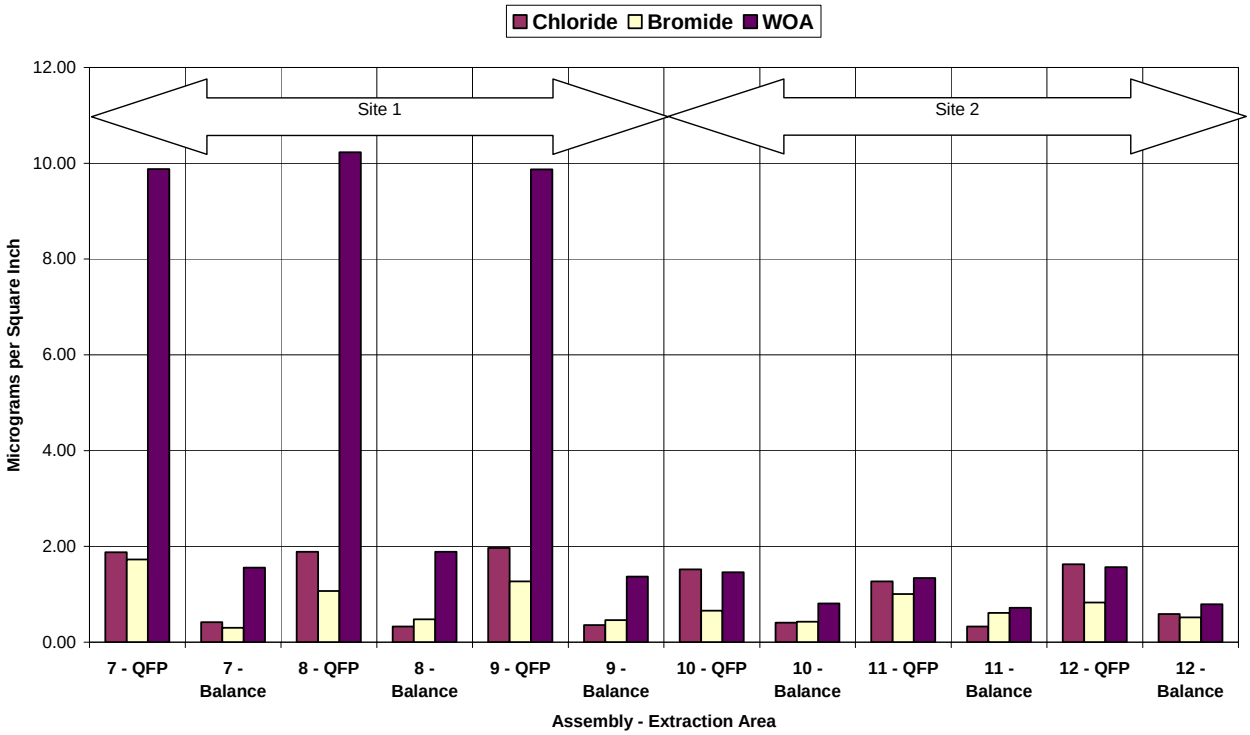


We began to do two extractions on each problem assembly: the first extraction isolated the QFP area of the assembly and the second extraction looked at the remainder of the assembly. Chart 3 shows the primary residues detected in the two areas. We saw that there were some intense halide residues in the QFP, which caused electrical leakage and corrosion under humid conditions. The earlier extractions had not shown this problem because the localized concentration of ionic residues was averaged out over a larger surface area. The same effect happens in ionic cleanliness testers (e.g. Omegameter).



The deionized water cleaning process was not sufficient to remove the flux residues in the QFP area. An effective saponifier was added to the wash process (6% - 10% concentration). Chart 4 shows the cleanliness after saponified cleaning, using the split extraction evaluation method. The saponified cleaning process now resulted in chloride levels which we considered to be acceptable. All such cleaned assemblies have passed testing at 85ºC / 85% relative humidity under power with no signs of electrical leakage, corrosion, or metal migration. The customer is now in the process of remedially cleaning 350,000 assemblies and working to get their contract assembler under control.

Assembly Cleanliness After Saponified Cleaning
Chart 4



What is the moral of the story?

- Buying assemblies with no cleanliness specs or burn-in testing is not wise
- A global or whole-assembly extraction will not always give you the whole picture, or give the best measure of cleanliness
- Even a good deionized water cleaning process may need chemical assistance (saponifier) to remove residual water soluble flux
- Different areas of an assembly have different sensitivities to contaminants; QFPs, LCCs, etc., are generally very sensitive to halides

Lest we be too quick to snicker up our sleeves at this company, the situation is far more common than you might guess. Levying cleanliness requirements by ion chromatography on bare boards or assemblies, or requiring burn-in testing as part of a quality assurance program, costs MONEY. Who is in control at <u>your</u> company – the engineers or the accountants?

Since this case was first developed in 1998, Foresite has worked to develop an extraction tool and technique to examine localized areas of circuitry. To find out more about this new technology, see our website at www.residues.com/C3.html .

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