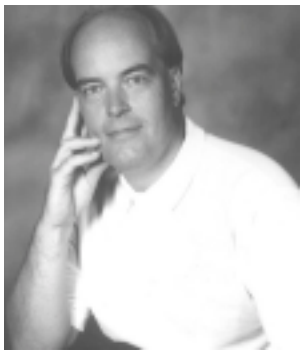


No Clean Technology - Company Introduction with Success not Failure

Bob Willis

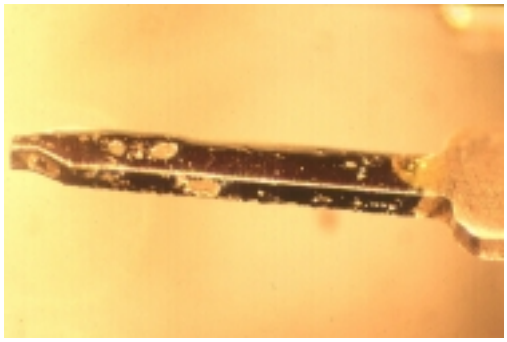
No clean assembly is and will continue to be the most popular production process, eliminating the necessity to clean products after assembly. It is fair to say that most companies now appreciate that no clean can be a reliable process, provided that controls are in place for manufacture.

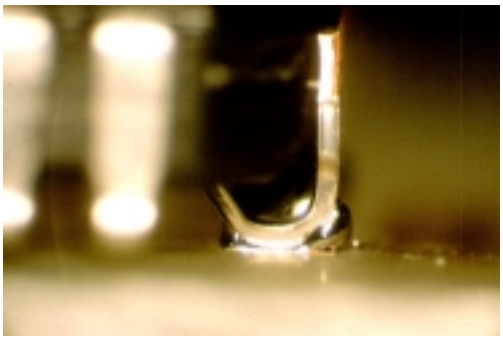
Care also needs to be taken when selecting materials for the intended application. There are companies using no clean in combination with conformal coating, many automotive products are no clean and the medical industry also use no clean processes.

Basically a no clean liquid low solids flux is a material with less than 2% solids, although a solids content of above 5% is still low and often left on the board surface it is not typical of a low solids flux today. Solid's is the amount of flux material suspended in the alcohol or cattier solvent which may be IPA or a mixture of solvents. Alternatively it may be distilled water as used in VOC materials.

Component Terminations

The key issue with components is component lead solderability. Low residue materials do not tolerate poor solderability of component or board finishes. You need to actively work to reduce storage times and monitor soldering yields against component quality levels and the age of the parts. This will provide a good long-term view of the solderability of different termination materials for future selection. Generally the quality of parts in the industry is good but there is questionable stock that is supplied. In most investigations the solderability of the components has not deteriorated due to long storage times on site, it was poor when received.





The examples show poor solderability found when moving over to no clean materials on both conventional and surface mount terminations

Wave Solder Pallets

One issue with many engineers when moving to no clean is "do I need a cleaning process for tooling?" You may well need it but what can we do to reduce the problem? If solder pallets are used minimise PCB edge support areas. This reduces surface contamination around the edge of the boards. It also reduces the area for solder balls to form due to spitting at the wave.

Determine how pallets are going to be cleaned in a no clean process. Often in high volume production you need a cleaning process, not for the boards but for the production tooling. If pallets are not cleaned the residues build up in the fixtures leading to positioning problems and handling issues.

Avoiding excessive flux traps in pallets during contact with the wave; this promotes excessive underboard gassing which leads to surface mount solder skips, test pad skips and of course solder balls. If there is a lot of underboard gassing from the flux it is not possible to see if the solder mask is gassing during wave contact. This also increases the amount of residue forced into the gap between the board and pallet.

In Circuit Test

Check the frequency of pin and fixture maintenance and pin pressures before changing materials. No clean will require more frequent fixture cleaning; this is a fact. Trials on contact resistance between the test pin will show differences in reading as flux builds up and at some point will result in failures.

If you change your PCB surface finish often or if test points are skipped during wave soldering, poor contact resistance will be found. This is caused by difference in the surface of the coating and the flux not being displaced by the wave. Make sure you understand the test side of manufacture before you change materials, or you will be blamed for all those failures.

Visual Inspection

Generally solder joints may appear duller, which is not a reason for rework and rejection. With any reduction in the amount of protective coating provided by the flux this can occur. As a solder joint is formed during reflow, wave or hand soldering oxide formation may occur leading to a change in the cosmetic surface of the joint. The solder spread and degree of wetting can be seen to decrease during paste reflow with no clean products. With care during product selection and correctly defining the reflow profile, the activation point in the paste/flux chemistry the spread can be equal to or better than standard products. Through hole fill in wave soldering of plated through boards can also be seen to decrease this no clean. This is one of the first things that people notice as they move to different fluxes, spray fluxing or changing the board finish from tin/lead to another coating.

When using no clean and spray fluxing the key is making sure that you achieve flux penetration into the through holes. Checks on proper application is leading to flux entering the holes. It is easy to soak the board, with care flux can penetrate the holes and evenly cover the base of the board. A set-up procedure for wave soldering and spray fluxing can be downloaded at www.bobwillis.co.uk or alternatively there is an interactive CD-ROM on wave soldering available from the SMART Group www.smartgroup.org

Rework and Repair

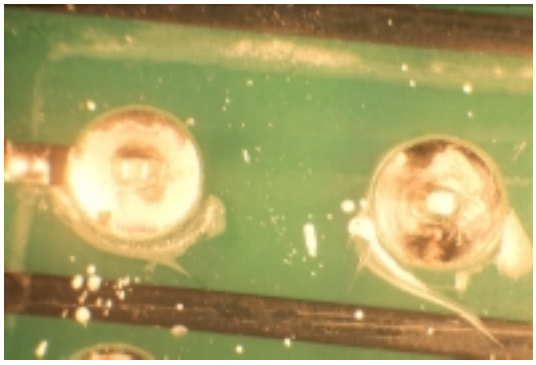
Care needs to be taken with rework of large surface mount components. Excessive liquid flux application can lead to surface corrosion. This is due to the limited heat application to vaporise the flux from the surface of the board. Most examples of surface corrosion investigated by the author are related to the volume of the material applied to the surface of the board and components. The correct method of flux application should be defined to reduce excessive application, the use of flux pencils in a rework cell is far better than a bottle and a needle nozzle.

Surface corrosion due to excessive flux application on connector and through hole terminations

You also need to consider the flux in de-soldering braid, do not allow refluxing of braids when they become unsolderable, purchase some new braid which will also make de-soldering quicker. Always ensure the solder braid is solderable and used in strict date rotation. It is common practice for operators to keep their own stock due to limited availability in the company. Ideally the fluxes used in manual soldering and rework should all come from a single supplier like all the consumable materials, making them responsible for the total process and its reliability.

Re-train staff to expect that the solder flow is different with low residue wires. This is particularly true with alternative solder finishes like gold over nickel. Make sure staff and engineers switch off irons when not in use as tips tend to oxidise more readily. There is no need with modern soldering irons to have them on all the time as they have a fast heat-up time. Any soldering iron tip will oxidise unless it is well timed, a common problem with tips as they get smaller, they can appear to loose their effective wetting.

Care also needs to be taken with solder spitting which will result in solder balls on the surface of the board. This often comes as a result of trying to speed up the soldering process to overcome the fast oxidation rates.



Example of spitting during manual soldering where staff were not shown how to use the new materials in production

Process Control

Monitoring flux application on to the printed board assembly is important to achieve clean products but also to control the economics of the process which is why many people go to the no clean in the first place. Excessive spraying of flux on to the boards can lead to overspray which can spoil the visual appearance of the board and can lead to reliability issues on open components. Normally today corrosion of products is based on too much flux, poor pre-heat control or the wrong application for a no clean process.

Ionic contamination testing will work as a control mechanism but you cannot just use the IPC or MIL standard for acceptance criteria. You need to use the system to establish and set your processes criteria which is a different thing altogether. Basically the ionic measuring systems can be used and calibrated against the flux setting and the board types. Over a period of time criteria can be set. In the case of a no clean process with nitrogen it is possible to get test results between 5-15ug/cm^2

Reliability Testing

SIR testing can be used to confirm product reliability based on established IPC test methods. It should be borne in mind that these tests have already been conducted by suppliers to qualify their materials. It may be more beneficial to do SIR testing in line with IPC but relate it more to the production processes with test vehicles on test boards going through the production process or test patterns on production boards that can be evaluated off line.

Ionic contamination tests can be used as a method of monitoring the amount of flux applied to boards or after soldering and compared with the SIR results. The results are a reference for process control but not a measure of reliability based on any standards, any company can use this technique for controlling a process when the in-house criteria has been established for both SIR and ionic measurement.

The key, as previously stated, in wave soldering is controlling the quantity of flux applied, the time and temperature applied during soldering process as this will impact on the results. In the case of test boards of a known cleanliness level, repeatable results can be found with ionic measurement after the wave soldering. This technique has been used to control spray fluxing and preparation fluids, a mixture of alcohol and adipic acid over the years and obtain control reading between 3-5 ug/cm^2

No clean manufacturing process can work very well and be a extremely reliable process for both wave and reflow products. They can also work with selected conformal coating process providing the process is in control. The key is good up-front engineering to eliminate the practical problems which do exist. Defining a plan on the implementation is the first stage, but this is a good strategy for any new process, material or technology; unfortunately some engineers do not have a plan.

Bob Willis is a process engineer providing engineering support in conventional and surface mount assembly processes. He runs production lines for suppliers at exhibitions and also provides seminar and workshops world wide. Bob has one of the largest collection of training videos, interactive CD-ROMs and training material in the industry. Bob will be presenting four Master Classes at APEX in California, USA he will also be presenting classes at SMT Nuremberg in Germany for those engineers visiting the show. For further information on how Bob may be able to support your staff contact him via his web site **www.bobwillis.co.uk**