

# Lead-free solder pot contamination

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Lead-Free Wave and  
Selective Soldering  
Workshop

# RoHS requirement – solder purity

- Solder contamination limits of concern
  - 0.1% Pb
  - 0.01% Cd
- Due diligence for RoHS compliance
  - Prudent to have regular solder pot assay results recorded
  - Most solder suppliers will offer free solder sample analysis
- Take a small sample of solder with an uncontaminated tool from the centre of the running wave
  - Take sample after all de-dross operations are complete
  - Leave wave running for several minutes before taking sample

# Example solder analysis results – Sn63/Pb37

## CERTIFICATE OF ASSAY

Element	Symbol	Maximum % Recommended In Use	Quantity % detected
Tin	Sn	-	62.82
Lead	Pb	-	Balance
Antimony	Sb	0.200	0.030
Copper	Cu	0.250	0.091
Zinc	Zn	0.0020	0.0006
Iron	Fe	0.0100	0.0041
Nickel	Ni	0.0100	0.0043
Bismuth	Bi	*	0.014
Cadmium	Cd	0.0020	0.0002
Silver	Ag	*	0.0106
Gold	Au	0.2500	0.0270
Arsenic	As	0.0100	<0.0003
Aluminium	Al	0.0010	<0.0001
Indium	In	*	0.0012

\* No limits Specified

# Example solder analysis results – SnAg3.8Cu0.7

## CERTIFICATE OF ASSAY

Element	Symbol	Quantity % detected	IPC-J-STD-006B (SAC305)
Tin	Sn	Balance	-
Lead	Pb	0.055	0.1
Silver	Ag	3.64	3.2
Copper	Cu	0.702	0.7
Antimony	Sb	0.013	0.05
Bismuth	Bi	0.005	0.04
Nickel	Ni	0.0037	0.01
Iron	Fe	0.0165	0.02
Cadmium	Cd	0.0002	0.002
Zinc	Zn	0.0007	0.003
Gold	Au	0.0007	0.05
Arsenic	As	0.0059	0.03
Aluminium	Al	<0.0001	0.005
Indium	In	0.0035	0.1

# Solder contamination

## - some possible performance problems (1)

- Aluminium
  - Increases dross rate, reduces fluidity and wetting power, may cause grainy or fragile joints and aggravates corrosion
- Cadmium
  - RoHS
  - Increases dross rate, reduces fluidity and wetting power, increased solder bridges and icicles, may cause grainy or fragile joints
- Zinc
  - Similar effects to Cd and Al
- Cumulative effect if all 3 elements present at higher than normal levels

From G.Leonida "Handbook of PCB Design, Manufacture , Components & Assembly"



# Solder contamination

## - some possible performance problems (2)

- Copper
  - Highly soluble in molten solder
  - Copper will be added from PCB traces and component leads soldered—need to monitor and control (use copper-free top-up alloy?)
  - Reduces fluidity, may cause grainy or brittle joints
- Gold
  - Also highly soluble in solder – ENIG PCBs?
  - Reduces fluidity and can cause grainy or brittle joints
- Cumulative effect if both elements present at higher than normal levels

From G.Leonida “Handbook of PCB Design, Manufacture , Components & Assembly”



# Solder contamination

## - some possible performance problems (3)

- Iron

- Reduces wetting power and creates grainy joints.
- Possible formation of FeSn needles – assembly reliability issue
- Result of Sn content readily attacking untreated ordinary stainless steel grade parts - happens even with SnPb, but the higher tin content of lead-free alloys and the higher temperatures make this attack much more aggressive

- Nickel

- May cause grainy joints
- Also a result of tin attack on untreated stainless steel
- Perhaps also from ENIG PCBs
- Nihon Superior SN100C SnCu-based lead-free alloy deliberately adds a small amount of Nickel (0.05% - note this is above the 0.01% IPC limit for Ni in SAC305 and SnPb solders) which is claimed to reduce both copper dissolution and stainless steel erosion

From G.Leonida "Handbook of PCB Design, Manufacture , Components & Assembly"



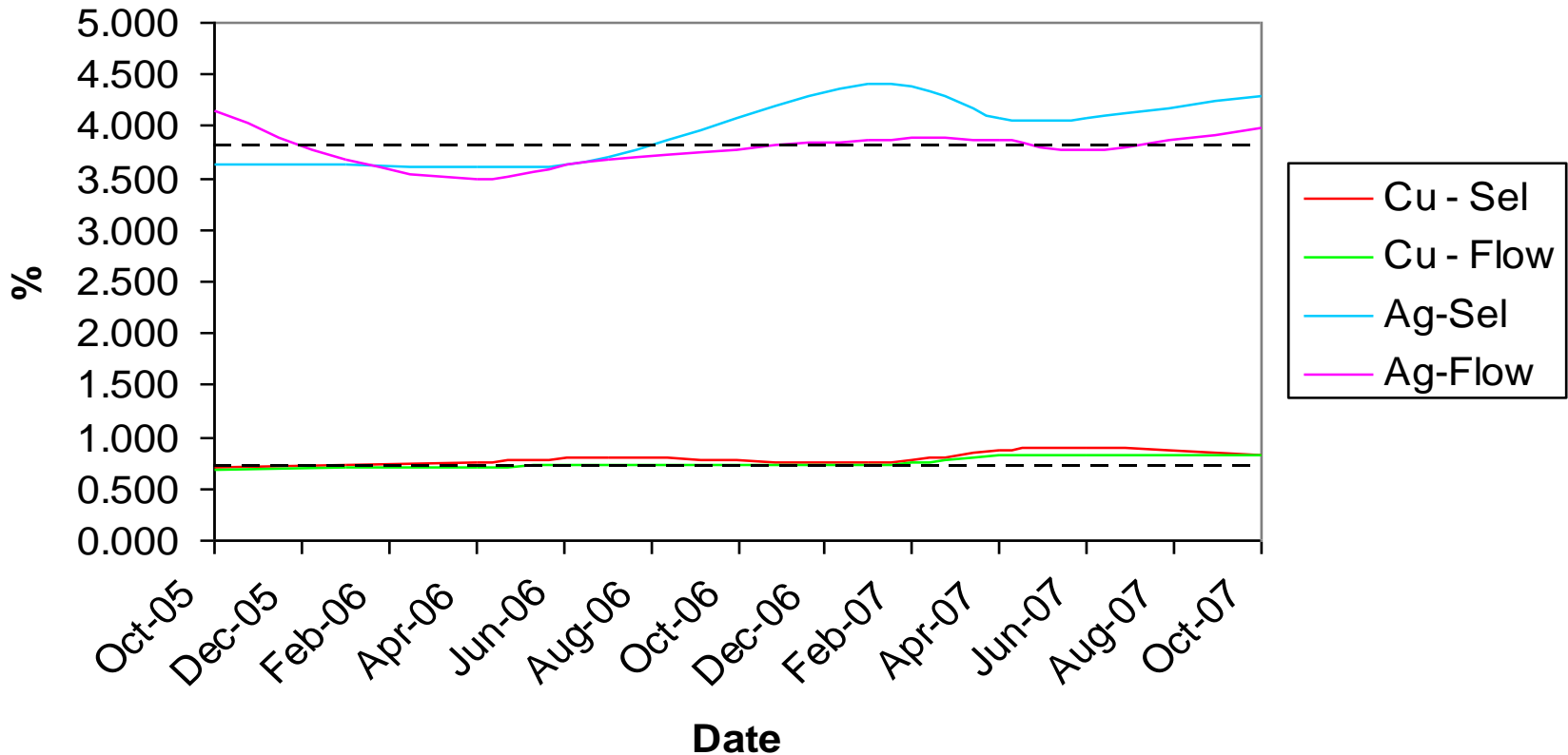
# Chamber of Horrors – published pictures





# Solder analysis results – SnAg3.8Cu0.7

## Copper and Silver Content in SAC387



# Useful tool for checking solder pot assays

<http://www.kester.com/en-us/leadfree/SACCalculationRev7.xls>

## SELECTIVE SOLDER



Solder Analysis Results		Wave Soldering Impurities	Dip Soldering Impurities
Element	Weight %		
Sn	94.74		
Ag	4.30		
Cu	0.84		
Au	0.003	OK	OK
Sb	0.012	OK	OK
Cd	0.000	OK	OK
Zn	0.001	OK	OK
Al	0.000	OK	OK
Fe	0.008	OK	OK
As	0.004	OK	OK
Bi	0.005	OK	OK
Ni	0.032	Exceeds	Exceeds
In	0.003	OK	OK
Pb	0.051	OK	OK

Total 100.000 OK Au, Cd, Zn and Al impurities combined

Ending Composition After Bar Additions			
Element	Weight %	Wave Soldering	Dip Soldering
Sn	95.38		
Ag	3.80		
Cu	0.74		
Au	0.003	OK	OK
Sb	0.011	OK	OK
Cd	0.000	OK	OK
Zn	0.001	OK	OK
Al	0.000	OK	OK
Fe	0.007	OK	OK
As	0.003	OK	OK
Bi	0.004	OK	OK
Ni	0.028	Exceeds	Exceeds
In	0.002	OK	OK
Pb	0.045	OK	OK

OK Au, Cd, Zn and Al impurities combined

### SAC Alloy desired

Element	Weight %	
Sn	95.50	Must be Manually entered
Ag	3.80	Weight of Solder to Add
Cu	0.70	
Must = 100	100.00	

Solder Pot Mass 40

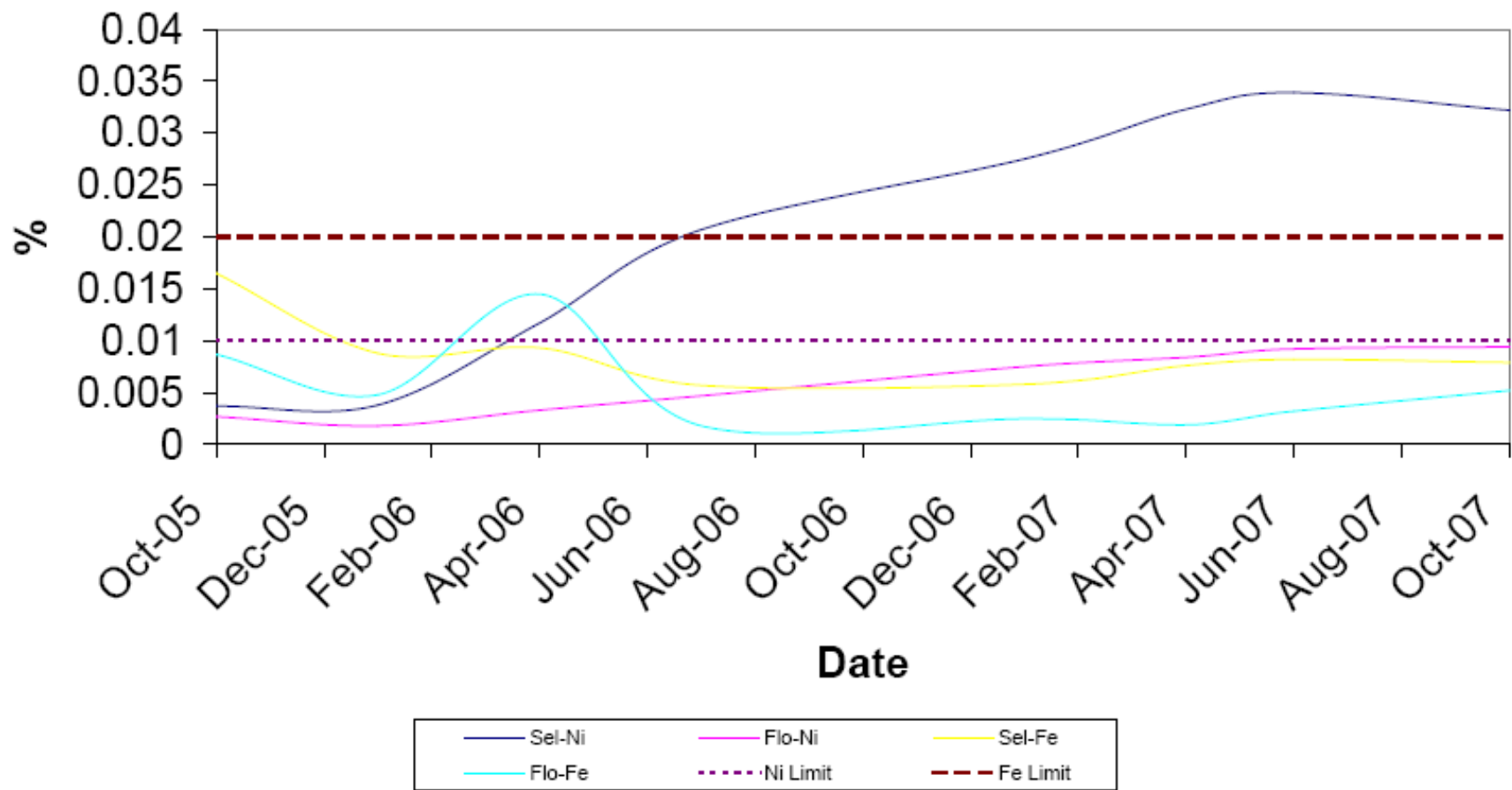
Sn97Cu03 to Add	0
Pure Tin to Add	5 Add bar as volume needs to be replaced
Sn95Ag05 to Add	0

Impurity specifications are those stated in IPC J-STD-001.

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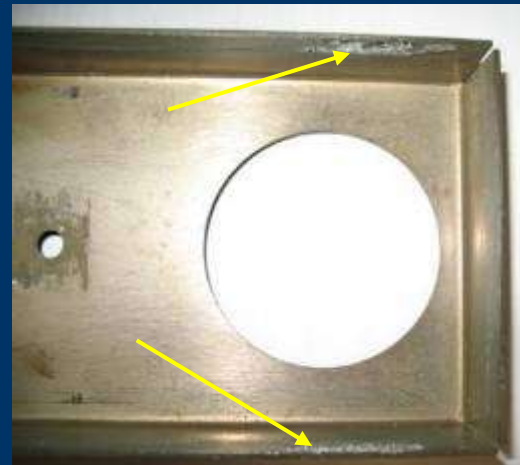
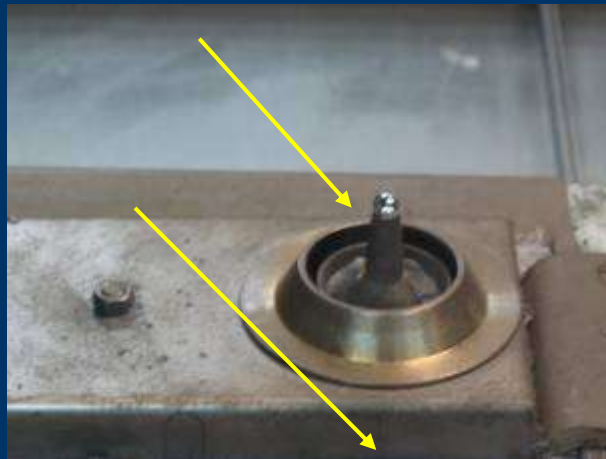
# Solder analysis results – SnAg3.8Cu0.7

## Nickel and Iron content in SAC387



# Selective solder – nickel contamination source (1)

- Nitrogen Shroud above solder pot – erosion around nozzle mount
  - Made from plain 316 stainless steel even though fitted to a machine supplied as “certified lead-free compatible”
  - Same problem with machine in our US factory
  - Had to replace with Chromium Carbide treated version



## Selective solder – nickel contamination source (2)

- Pumphouse around impeller came loose
  - 2 out of 3 stainless steel screwheads completely eroded away
  - Replaced with titanium screws which we sourced ourselves



- Separate analysis of dross from this machine showed high levels of Iron contamination (10X that in solder sample)
  - **IMPORTANT TO DE-DROSS REGULARLY AND DO IT WELL!**

# Wave solder – nickel/iron contamination?

- Pump, Impeller, wave ducting and nozzle replaced with new
  - No obvious signs of erosion on removed parts however



New parts for  
old

# Any Questions?

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