



JG-PP Email

Joint Group on Pollution Prevention

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Pages:

***JG-PP Lead-Free Solder Project
Teleconference Minutes
June 17, 2003***

Comments:

Attached please find the minutes from the June 17, 2003, Lead-Free Solder teleconference. If you have questions about the minutes, please contact MSgt Richard Hricko or Brian Greene. Please further distribute as necessary.



MEMORANDUM FOR RECORD

Subject: Teleconference Summary and Minutes – June 17, 2003

Material(s) Identified: Lead

Process Identified: Electronics soldering

Methodology Phase: II - Technical, III - Business

Summary:

On June 17, 2003, technical representatives from the Boeing Company, Hill Air Force Base, ITB, Inc., NASA Jet Propulsion Lab, NASA Marshall Space Flight Center, Northrop Grumman, Raytheon, Redstone Army Arsenal, Robins Air Force Base, Rockwell Collins, Sypris Solutions, Texas Instruments and Wright Patterson Air Force Base participated in a meeting with representatives from the Aeronautical Enterprise office and the Joint Group on Pollution Prevention Working Group and their contractors. One objective of the teleconference was to review comments received on the Joint Test Protocol from active participants and address any stakeholder issues still outstanding. In addition, the teleconference was used to review the specifics of components, solders and boards to be used for the building of the test vehicles. Clarifications were made and group consensus was obtained as to which board finish will be used and how to anchor the hybrid component as well as which tin-copper alloy to use. Other issues discussed included the tentative planning of on-site meetings at Boeing and Rockwell Collins.

Prior Decisions:

- 5/9/01 – Lead as used is tin-lead (Sn/Pb) solder was chosen as the target HazMat.
- 6/20/01 – A Joint Test Protocol (JTP) will be developed for qualifying lead-free solder alloy used in the manufacture of lead-free printed wiring assemblies (PWAs)
- 11/1/01 – A second JTP will be developed for qualifying lead-free solder alloy used in the rework of lead-containing PWAs.
- 3/7/02 – By consensus, the solder alloys currently recommended for testing are:

Wave Solder:

- Sn/0.7Cu
- Sn/3.9Ag/0.6Cu *NEMI Alloy*
- *Baseline Sn/37Pb*

Reflow:

- Sn/3.9Ag/0.6Cu *NEMI Alloy*
- Sn/3.4Ag/1.0Cu/3.3Bi *NCMS Study*
- *Baseline Sn/37Pb*



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Manual Solder

- Sn/0.7Cu
- Sn/3.9Ag/0.6Cu *NEMI Alloy*
- Sn/3.4Ag/1.0Cu/3.3Bi *NCMS Study*
- *Baseline Sn/37Pb*

Tinning of CLCC20s

- Sn/3.9Ag/0.6Cu *NEMI Alloy*
- Sn/3.4Ag/1.0Cu/3.3Bi *NCMS Study*

- 10/1/02 – Because of numerous similarities in the testing procedures, all the PWA manufacturing and rework requirements will be folded into just one JTP.
- 02/27/03 – JTP distributed for endorsement

Next Teleconference:

Next Meeting: TBD

Minutes:

Mr. Brian Greene (ITB, Inc.) opened the teleconference by explaining the objective of the teleconference was to discuss business and technical issues still remaining to be resolved for the lead-free solder project. A roll call was taken.

Discussion Topics:

I. *Joint Test Protocol*

1. JTP endorsement status
 - a. Mr. Brian Greene (NASA AP2 Office, ITB, Inc.) opened the discussion by stating that the JTP endorsement process has been moving along in a successful manner. Endorsed JTPs have been received from several participants.
2. Comments and proposed changes to JTP (Please see attachment entitled “April 2003 Comments to February JTP.doc”)
 - a. Mr. Greene stated that comments have been received from (a) participants that have endorsed the JTP and (b) from participants that have received the JTP and did not endorse it. Based on comments received from project participants, a new modified version of the JTP has been completed but not yet distributed.
 - b. Mr. Greene referred to Mr. Warren Assink (Wright Patterson Air Force Base) and MSgt Richard Hricko (Wright Patterson Air Force Base –Aging Aircraft Division) for their input on JTP changes and the next step for the JTP. MSgt Richard Hricko stated that he is no longer receiving JTP comments and that the JTP should be ready for posting of the JG-PP web site in the near future.
 - c. Mr. Greene then directed the telecon participants attention to the Microsoft Word document “April 2003 Comments to February JTP.doc”, attachment one to the June 17,



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2003 meeting agenda which was distributed to the group. Mr. Greene stated that he would like to review a few of the comments and get input from the group at large.

i. Issue (*Defense Supply Systems Center, Columbus*):

According to DSSC, "We saw no mention of the component lead finishes used on the actual parts to be soldered or why immersion silver was the only surface finish used on the bare printed wiring boards in any of these documents."

June 17, 2003 Telecon Discussion:

- a) Mr. Reza Ghaffarian (NASA – JPL) stated that the component and board surface finishes are one of the most critical aspects of the test vehicle and could be the cause of an early critical failure if an improper surface finish is used.
- b) Mr. Dave Hillman (Rockwell Collins) stated that a lot of critical thinking has gone into the selection of the component and board surface finishes. Component and board finishes reflect at this time the most dominate lead-free finishes used through out the electronics industry. The finishes that have been selected by the group are finishes that OEMs are seeing right now or will be seeing in the near future. Rockwell Collins has been using immersion silver board finishes heavily for two years. The particular silver immersion surface finish being used on the test vehicle is specific immersion silver chemistry from MacDermid and specified the thickness tolerances for the finish.
- c) Mr. Tom Woodrow (Boeing-Seattle) stated that he agreed with the component and board finish choices that have been made. Mr. Woodrow went on to point out problems that other board finishes might have. OSP for instance could possible completely disappear from the board after one reflow cycle at tin-lead solder temperatures, causing the board to lose wettability for the wave solder process. Immersion tin has the same problem as OSP and also has a potential to form tin whiskers. Gold over nickel has problems with the possibility of receiving a batch, which has black pad on it.
- d) Mr. Hillman stated that he would add solderability to the component characterization table that he is currently building.
- e) Mr. Ghaffarian raised the question of tin whisker formation. He stated that the formation of tin whiskers is a key issue for military and aerospace electronics and we need to keep a close eye on the solder joints during testing and post-test analysis s any whisker formation can be documented.
- f) Mr. Hillman stated that as part of the thermal cycle testing, tin whisker formation would be monitored closely.

ii. Issue (*Defense Supply Systems Center, Columbus*):

According to DSSC, "Only epoxy resin printed boards are used for the printed wiring assembly (PWA)"

June 17, 2003 Telecon Discussion:

NOTE: Prior to the teleconference, Mr. Dave Hillman (Rockwell Collins) commented that the lower Tg laminate was intentionally selected to represent legacy assemblies. The rework segment of the JTP has a specific goal of understanding legacy assembly interactions and the potential solder alloy contamination issues.



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- a) The group agreed that with the current resources available it would be best to leave the JTP unchanged for this issue.

- iii. **Issue (ASC/YT (Training aircraft Program Office)):**
ASC commented, "There is incomplete information on quality assurance and inspection of the lead-free circuit boards."

June 17, 2003 Telecon Discussion:

- a) Mr. Hillman stated that he is planning to perform component characterization on the components as an in-kind contribution. One characterization process on the assembled boards that has not been accounted for is the cross sectioning of components for the measuring of the solder joints. Mr. Hillman stated that he would ask his management if this service could be provided as in-kind from Rockwell Collins. It was recommended that two assembled boards would be randomly selected and one of each type of part on those PWAs would be cross-sectioned.
- b) Mr. Tom Woodrow stated that cross sectioning is a required characterization process for the lead-free solder project.
- c) Mr. Greene stated that the JTP would be modified to state that cross sectioning would be done as a post assembly characterization process.
- d) Mr. Hillman will ask the board vendors about supplying the X-out coupons. This request will be added to the purchase order. Worst-case aspect and worst-case thickness analysis will also be requested from the board vendor.
- e) Mr. Assink stated that a vice president from Northrop Grumman Engineering Systems endorsed the JTP. Comments were provided with the endorsement to include concern over whether the group had selected enough new age technology or are there too many legacy technology components on the test vehicle.
- f) Mr. Hillman respectively disagreed with the comments and stated that the board materials and board finish are very common to Class 3 military electronics. Components were selected in an attempt to represent a broad range of applications. A few components on the test vehicle were selected because it is known that they will fail early allowing the group to see the reactions of the solder to the testing early on in the project. The group also selected chip scale packages as well as ball grid array components, which are very state of the art components.

II. Testing

- 1. Near-term activities and funding picture
 - a. Procurement of testing materials and board build
 - a) Mr. Greene stated that NASA and the Air Force have come to an agreement as how to proceed with the project with regards to funding. NASA will fund all FY03 activities, which includes funding for all procurement activities. Mr. Hillman will purchase all the components, boards and all other materials needed which are not donated as in-kind contributions. Mr. Hillman will also provide the characterization activities that he has agreed upon as in-kind. Once Mr. Hillman has completed the activities require he will be sending all materials to Ms. Lety Campuzano-Contreras



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(Boeing-Irving). Ms. Campuzano-Contreras has agreed to provide all of the assembly and rework of the test vehicles as in-kind contribution.

- b) Mr. Greene briefly reviewed the current project schedule stating that the government purchase orders should be to Mr. Hillman in the month of July allowing Mr. Hillman to procure all the components and solders. One component that has a long lead-time is the LCCC (Leadless Ceramic Chip Carrier). The leads on the LCCC must be re-tinned with the Tin-Silver-Copper and Tin-Silver-Copper-Bismuth solder alloys. The LCCC components will be received with a gold finish and there is concern that the gold on the leads could create a gold embrittlement issue. Ms. Campuzano-Contreras could have all the components, solders, boards and materials by December of 2003 to begin the assembly process.

- b. Lead-Contamination during rework procedures
 - a) Mr. Greene stated that stakeholders have expressed an interest in knowing how much lead remains on the board following the rework procedure. Primary interest is in determining if there is a lead contamination issue with the rework procedure and how will the lead affected the lead-free reworked solder joints. Mr. Woodrow can perform a test in which solder joints are cut from a test vehicle, dissolved in acid and then a spectroscopy procedure would be preformed. This procedure would be an additional cost to the project.
 - b) NASA and F-15 stated that this additional procedure would be a necessary requirement to have. Mr. Greene would see if NASA's budget would allow this additional cost item.

- c. The number of IPC coupons needed for Surface Insulation Resistance Testing
 - a) Mr. Greene explained to the group that since the project is getting solder from four different vendors there is the possibility that four different fluxes will be supplied, one from each solder vendor. This will raise the number of IPC boards needed for SIR testing from 35, as stated in the JTP, to 45. The number 45 is derived from the following, 10 boards per each of the four flux types plus five baseline boards.
 - b) Mr. Woodrow stated that the SIR test is designed to test how much flux residue is left on the board and how well you clean the board, it has very little to do with the solder alloys being tested.
 - c) Mr. Woodrow brought up the issue of coating the IPC boards in a protective coating due to the amount of time that will pass between when the boards are ordered and when they would be processed. It is proposed that the IPC boards be order with a OSP coating on them. The group agreed that the IPC boards should be ordered with an OSP protective coating on them.

- d. Hybrid attachment
 - a) Mr. Greene raised the question as to what adhesive should be used to anchor the hybrid components to the test vehicle. Anchoring of the hybrid component is a requirement of the F-15 program. The hybrid component has so much mass that it the weight of the component could cause solder joint failure or accelerate the failure process. Also the hybrids could go flying off the test vehicle during vibration and mechanical shock testing. In order to keep the hybrid component from damaging surrounding components the hybrids would be anchored in place. Mr. Mark Stibitz (Raytheon F-15) stated that they usually use double backed adhesive #415.
 - b) Mr. Hillman asked the question to Ms. Campuzano-Contreras as to whether the hybrid component would have to be hand placed rather than placed by the



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automation process. The hybrids may have to be placed on the test vehicle post automation processing. Ms. Campuzano-Contreras suggested spot anchoring the hybrids at their corners. Mr. Stibitz stated that he did not have a problem with that process procedure. Mr. Stibitz indicated that as long as the bonding method was as good as the tape method that is currently used, he did have a preferred anchoring procedure or substrate. The group agreed to use the hybrid anchoring procedure that Ms. Campuzano-Contreras currently uses during processing.

e. Solder and Fluxes

- a) Mr. Greene asked Ms. Campuzano-Contreras if she had anything new to report on the procurement of the solders. Ms. Campuzano-Contreras stated that she had talked to Senju and Heraeus and both companies have agreed to supply solder to the project as in-kind contributions. Arrangements should be made to have the solder at the Boeing-Irving facility in October.
- b) Mr. Woodrow brought up for the group's discussion the issue of fluxes. The issue is what type of flux should the project use, no-clean flux or something else. If a no-clean flux is used should the project clean any way. Mr. Hillman stated that he would like to see a low residue material that is a cleanable no-clean flux. The group agreed that the flux should be a low residue cleanable flux. Ms. Campuzano-Contreras will provide information on the fluxes available once she receives this information from the vendors.

f. Stencils for lead-free solders

- a) Mr. Greene brought up for discussion the issue of stencils, in particular the specifications for the stencils with regards to thickness and aperture size. Mr. Hillman stated that he uses stencils that have an aperture to board pad ratio of one to one. To date Mr. Hillman has not had any problems with this ratio. There could be an issue with stencil thickness with regards to the LCC components. Typically a six-millimeter stencil is used, in this case solder distribution for the LCC components would be on the thin side. A seven-millimeter stencil would be best for the LCC components but this could distribute too much solder on the CSP pattern. Mr. Ghaffarian stated that a mini stencil could be used for the components that require a different solder thickness than the rest of the components on the board. Mr. Ghaffarian also suggested the use of a plastic stencil. It was agreed that as we get closer to the build date issues relating to the stencils would be worked out.
- b) Mr. Greene stated that Vitronics-Soltec is willing to provide the wave soldering process as in-kind. Vitronics-Soltec uses the Sn/0.7Cu+Ni (~ 0.05Ni) solder alloy, SN100C, from NIHON Superior. This alloy is considered a stabilized tin-copper alloy and has superior properties over other tin-copper solder alloys. This solder has better wetting properties and a better visual appearance over the other straight tin-copper alloy. Improved wettability also decreases the pot temperature needed during the wave soldering process. Lower pot temperature equates to a longer process time, which results in a better final product. NEMI is currently using this solder for a large lead-free wave-soldering project. The addition of the nickel reduces the corrosiveness of the tin-copper solder alloy on the soldering equipment, pot and nozzles.
- c) Mr. Woodrow and Mr. Hillman voiced that choosing the Sn/0.7Cu+Ni (~ 0.05Ni) solder alloy is not a change of the original alloy selected but an improvement of the current tin-copper alloy. Currently industry is switching to the Sn/0.7Cu+Ni (~ 0.05Ni) over the conventional tin-copper alloy. 450 electronics manufacturing



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installations are currently using the Sn/0.7Cu+Ni (~ 0.05Ni) solder alloy which indicates that this is the tin-copper solder alloy preferred by industry. If the Sn/0.7Cu+Ni (~ 0.05Ni) solder alloy is not used finding pure tin-copper solder alloy would be difficult, the test vehicles may have to be processed in Holland, increasing the cost to the project. For more information on this alloy please see (<http://www.nihonsuperior.co.jp/english.htm>)

- d) Mr. Warren Assink, HQ AFMC, voiced concern that we were changing the solder alloy after the JTP was endorsed. However, all technical representatives on the teleconference agreed with the recommendation to use the Sn/0.7Cu+Ni (~ 0.05Ni) solder alloy for wave soldering operations.

III. Future Meetings

1. Future activities and funding picture
 - a. General interest/plan for meeting at Rockwell Collins and/or Boeing to view work
 - a) Mr. Greene stated that he would send out the updated schedule so that the group could tentatively plan for future meetings including possible site visits. Below is a list of possible meeting location and dates. If anyone is interested please contact Mr. Greene or Mr. Kessel.
 - Visit to Rockwell Collins in October to view components and component characterization data.
 - Visit to Boeing-Irving to view the PWA assembly in November or December.
 - Visit to Boeing-Seattle for a testing kick-off meeting in November or December.
 - Mid-2004 data review meeting, location to be determined.

IV. Government Management of the Project

1. For those that hadn't already heard, the Aging Aircraft group out of Wright Patterson Air Force Base, represented by MSgt Richard Hricko, is the new government manager for the lead-free solder project. The near-term function and operation of the project is not changing, however.

- **MSgt Richard Hricko**
Gov't Project Manager, AE/JG-PP Lead-Free Solder
Supt. Aging Aircraft Avionics Flight
Wright Patterson Air Force Base, OH
Phone: (937) 255-7210 ext 3537
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Attached: Action Items



New Action Items:

LFS.03.06.01

Date Due: 07/07/2003
Responsibility: Dave Hillman (Rockwell Collins)
Required Action: Determine if coupons will be supplied with the boards from the vendors.
Comments:

LFS.03.06.02

Date Due: 07/07/2003
Responsibility: Lety Campuzano-Contreras (Boeing-Irving)
Required Action: Provide information on the fluxes, which will be available to the project once she receives this information from the vendors.
Comments:

LFS.03.06.03

Date Due: 07/07/2003
Responsibility: Brian Greene (NASA AP2 Office; ITB, Inc.)
Required Action: Obtain Data on the Sn/0.7Cu+Ni (~ 0.05Ni) solder alloy and distribute it to the group
Comments:

Open Action Items:

LFS.02.12.07

Date Due: 12/13/02
Responsibility: OEM Representatives
Required Action: OEM's are to identify headquarters and management points of contact for a meeting to held in January.
Comments: No meetings are presently planned.
04/21/03 – Warren Assink asked to keep the action item open

LFS.02.11.04

Date Due: 12/01/02
Responsibility: OEM Business Representatives
Required Action: Report to B. Greene and MSgt Richard Hricko the nature and extent of the intended contributions, either direct cash or in-kind, to the lead-free solder testing effort over 2003-04
Comments: **In Progress:** In-kind contributions were discussed at a March 30, 2003 small-group meeting in Anaheim, CA. at a following larger group telecon on April 21, 2003, and between NASA and Air Force at a May 28 Government business meeting in Dayton. The following are representative in-kind contributions, totaling over \$300,000, offered specifically for the 2003-2004 testing activities.

Lead-Free Solder Action Items Status
As of 06/17/03

Test Activity	Rockwell Collins	Boeing -Irving	Boeing-Seattle	Boeing-Anaheim	Raytheon
PWA Design	X				
PWA Assembly & Rework		X			
PWA Characterization		X			
Pretest PWA		X			
Combined Environments Testing (MIL-STD-810F Method 520.2 Procedure I)					?
Thermal Cycling: Manufacturing -20°C to +80°C (IPC-SM-785)			X		
Surface Insulation Resistance (IPC-TM-650, Method 2.6.3.3)				X	

LFS.02.08.13**Date Due:** 09/30/02**Responsibility:** ITB, Inc. (Brian Greene)**Required Action:** Distribute expected contributions from stakeholders once cost estimate is better defined**Comments:** In progress: Basically close once action item LFS.02.11.04 is completed.

04/21/03 – Brian Greene reviewed latest cost estimate at this telecon. Following is the latest cost summary.

03/30/03 – OEM funding and in-kind contributions were reviewed and discussed. Testing facilities have been tentatively agreed upon.

11/12/02 - B. Greene presented a summary of the estimated cost of testing and the current amount that that Government indicated they would fund. The shortfall would need to be made up by the OEMs and/or the scope of the testing reduced. A new action items was taken for OEMs to assess the nature and extent of their contributions.

Action Items Closed June 17, 2003**LFS.02.10.03****Date Due:** 11/01/02**Responsibility:** All technical representatives**Required Action:** Identify to Brian Greene and MSgt Richard Hricko their organizational business point of contact, if other than themselves**Comments:** Closed June 17, 2003. No further project business meetings are envisioned. All of the OEM contributions will be in-kind, and NASA and Air Force are working their respective Agency's for funding.