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iNEMI Revised Statement of Work (SOW) Environmentally Conscious Electronics TIG Halogen-Free Project

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Purpose:

Identify technology readiness, supply capability and standards development opportunities for “halogen-free” alternatives to conventional printed wiring board materials based on market segment requirements.

Background and Motivation:

The European Union’s Restriction on the use of certain Hazardous Substances (RoHS) Directive prohibits the use of polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) in nonexempt electronic equipment. These compounds can be used as flame-retardants and some of these substances have been shown to present unacceptable risks to human health and the environment.

Although PBBs and PBDEs are typically not used in circuit board materials, stakeholders are beginning to urge the electronics industry to take a precautionary stance on the use of other non-regulated halogenated organic substances, such as the use of brominated epoxies for circuit board applications.

Goals of the Project:

1. Identify commercially viable materials
2. Benchmark past work and key in on critical knowledge gaps and technical issues
3. Design test vehicles and test methodologies
4. Leveraging prior investigations, carry out the necessary testing to characterize viable materials
5. Analyze results
6. Publish recommendations

Is / Is Not:

| This Project IS | This Project Is NOT |
|--|--|
| Technical evaluation of key electrical and mechanical properties | EHS assessment |
| Focused on those attributes which are of most value to supply chain. | Biased towards specific laminate suppliers, geographies, or market segments. |
| Build on learning from prior investigations | Repeat of prior work |
| Recommendations for standards development or further investigation | Standard Development |
| | Open to non-NEMI members |

Scope of Work:

Phase I: Design - COMPLETED

Review prior work and make recommendations for testing needed. Investigation should take into account needs of electronic product sectors represented by iNEMI membership.

1. Identify candidate materials

Poll the supplier base, keying in on candidate materials that are commercially viable with consideration for market segment applications.

2. Identify key performance characteristics and test criteria

Assess prior studies and identify critical knowledge gaps or technical issues. Make recommendations for performance tests needed. Review results of prior industry and member company investigations.

3. Design test vehicle(s) and test methodologies, leverage standards where possible:

Specify test vehicle criteria required for performance testing. Agree on a minimal number of test vehicle designs and test requirements.

Phase II: Test

Develop, manage, and execute performance testing.

1. Develop evaluation plan and schedule

Outline key mechanical and electrical performance characteristics, and resource and time constraints. Focus on Electrical Characteristics, Delamination and Via Reliability. Output broadband frequency dependant dielectric constant and loss tangent of candidate halogen free laminate materials (10KHz - 20GHz)*

Determine compatibility of candidate laminate materials with higher temperature assembly process reflow environments (mixed solder: 245 C / Pb-free, 260C).

2. Procure parts and test vehicles

Obtain needed evaluation materials. Consider lead times needed to synch with evaluation schedule. Solicit participation from supply partners.

3. Assign teams to carry out completion of the testing in a standardized fashion

Each test should be carried out in a manner that produces meaningful results. Industry standards should be followed where applicable. Testing should be coordinated to allow correlation of results and sharing of test materials.

4. Perform mechanical and reliability testing on test vehicles.

Leverage capabilities and expertise of participating members and supply partners. Follow test procedures carefully and record positive and negative results.

Phase III: Results

Compile results, assess significance, make recommendations, and publish report.

1. Assess technology readiness / identify gaps

Flag unexplored issues and identify technical risks that need to be resolved before materials can be widely adopted. Make recommendations for future work.

2. Assess manufacturing capability and supply capacity

Work with suppliers and EMS's to identify barriers to supply chain viability. Interpret implications of performance testing in terms of manufacturing capability.

3. Publish results

Compile and edit concise summary of methods, meaningful results, and recommendations. Goal is to roll the final report to members by the end of 2007 with a public release at APEX in Feb 2008.

Schedule:

Phase I (Design) Feb 1 '06 – Sept 30 '06

| | |
|---------------------|--|
| Phase II (Test) | Feb 15 '07 – OCT 19 '07 |
| Phase III (Results) | Oct 22 '07 – Nov 30 '07 |
| Release Results: | Dec '07 (iNEMI members) Feb '08 (APEX-Public) |

Participant Profile:

iNEMI's member companies will encourage the participation of individuals from different disciplines and divisions within their organizations to contribute on the range of tasks outlined in the project plan. The group should contain members from or work closely with representatives of:

- OEMs
- Component and board manufacturers
- Assembly EMS providers
- Rework equipment providers
- Dielectric material suppliers

Resources Required from Participants:

The Halogen-free Project asks each participating company to commit to the following:

- 1) Provide at least one man-month or equivalent in-kind support (e.g. materials, test samples, equipment, etc.) annually.
- 2) In the event project expenses are incurred, the costs will be shared evenly among participants.
- 3) Design and /or assemble test samples for evaluation, and/or carry out tests and evaluations as negotiated and agreed to, with other members of the project, to fulfill the Statement of Work.
- 4) Document results and publish findings to iNEMI members.
- 5) Commit to internally promote the adoption within the participating company and its' supply chain partners of any recommended standards, tools, or processes that that are developed.

Specifications and Standards:

Several standards bodies that have worked to define “halogen-free” are listed below:

- **JPCA** (Japan Printed Circuit Association) JPCA-ES-01-1999 defines criteria and method for “halogen-free”
 - **Br < 0.09wt% (900ppm)**
 - **Cl < 0.09wt% (900ppm)**

- **IEC** (International Electrotechnical Commission)
 - Finalized requirements of IEC 61249-2-21:
 - **900 ppm maximum Cl**
 - **900 ppm maximum Br**
 - **1500 ppm maximum total halogens**

- **IPC - 4101B** has adopted the IEC definition of halogen-free
 - **900 ppm maximum Cl**
 - **900 ppm maximum Br**
 - **1500 ppm maximum total halogens**

Note: fluorine, iodine, and astatine (other Group VIIA halogens) are not restricted in the industry definition of “halogen-free”.