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**Case study on using brominated flame retardants in circuit boards  
compared to non-halogenated alternatives**

The Swedish IVF institute<sup>1</sup> undertook a case study comparing the costs and environmental implications of using halogen-free flame retardants in the manufacture of printed wiring boards (PWB) instead of bromine-based fire safety systems. In the case study undertaken there was a cost increase ranging from almost zero to €10 per panel resulting from the move to halogen-free flame retardant systems. These increases related to costs for panel drilling, desmearing and materials. Though experience is limited with regard to producing non-halogenated PWBs, the case study indicates that costs relating to panel drilling and desmearing would remain whereas other parameters used in the study, pressing, design, and solder mask, did not change depending on the flame retardant system used.

A paper detailing the study was presented by the Swedish IVF institute at the recent “Electronics Goes Green 2004+”<sup>2</sup> conference. The case study looked at two aspects of the PWB life-cycle, the design and manufacture phases. It was carried out using the “grEEEn”<sup>3</sup> method to compare economic and environmental impacts of using halogen-free flame retardant systems instead of the traditional FR4 halogen-based system currently used by industry.

The analysis also shows a small increase in environmental impact related to the move to halogen-free FR systems but was based on current experience of using non-halogenated alternatives and did not examine toxicological data relating to the shift to non-halogenated alternatives. This increased environmental impact is due to the production of the halogen-free materials, and to additional energy used in drilling the PWB panel.

The grEEEn method applied to the case study took into account production design, PWB board manufacture (pressing, drilling, desmearing, solder mask), upstream product manufacture (resin, flame retardants) and looked at both economic and environmental issues. The process model and parameters were defined with Finnish PWB manufacturer Aspocomp Oy, who has experience of using both halogenated and halogen-free FRs.

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<sup>1</sup> “Environmental and economic implications of a shift to halogen free printed wiring boards”. C. G. Bergendahl, K. Lichtenvort, G. Johansson, M. Zackrisson, J. Nyysönen, IVF Industrial Research and Development, Mölndal, Sweden – Technical University of Berlin – Aspocomp Oy, Salo, Finland.

<sup>2</sup> “Electronics Goes Green 2004+” <http://www.pb.izm.fhg.de/izm/> see “Events” – proceedings available at this site  
[http://www.pb.izm.fhg.de/izm/040\\_Publications/020\\_Proceedings/konferenz/1\\_eqg2004.html](http://www.pb.izm.fhg.de/izm/040_Publications/020_Proceedings/konferenz/1_eqg2004.html)

<sup>3</sup> grEEEn = Cost Management System for greening Electrical and Electronic Equipment <http://www.green.it/>