

24 August 2004

European Commission - DG Environment, Unit G4  
Consultation Directive 2002/95/EC  
B-1049 Brussels, Belgium

STAKEHOLDER CONSULTATION ON ADAPTATION TO SCIENTIFIC AND TECHNICAL PROGRESS  
UNDER DIRECTIVE 2002/95/EC ON THE RESTRICTION OF THE USE OF HAZARDOUS  
SUBSTANCES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

**SUBMISSION BY ROCKWELL COLLINS**

Rockwell Collins is a leader in aviation electronics and communications for government and commercial applications. Rockwell Collins is a global company providing aviation electronics for the world's aircraft manufacturers such as Airbus and Boeing, and more than 400 airline customers, as well as a major share of the world's military forces. The company maintains headquarters and manufacturing operations in the United States in addition to locations in Europe, Australia and Mexico. Rockwell Collins provides world-class customer support through Collins Aviation Service, which offers training, technical support and total customer service solutions through a global network of more than 60 service centers and service bases.

Summary

Rockwell Collins requests that an additional exemption be provided for electrical and electronic equipment (EEE) that is used in the aviation sector (also known as "avionics"). Although such EEE may be covered by other exemptions under the WEEE/RoHS Directives (such as the military/security exemption and the "part of other equipment" exemption), it is important that any doubt as to the status of these applications be eliminated. An exemption, as explained below, is fully justified by Article 5(1)(b) of the RoHS Directive, because in the case of avionics substitution is technically and scientifically impracticable, and the negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the environmental, health, or consumer safety benefits thereof.

As explained in more detail below, substitutes for the RoHS-restricted substances, which have not been adequately tested, raise issues in respect of reliability and

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performance of EEE for aircraft and other aviation-related applications. Given the critical nature of these applications, RoHS-driven substitution would create serious risks, including risks of failure or malfunctioning of EEE in civil and military aircraft and serious risks for safety and the environment. It goes without saying that aircraft and aviation safety, and minimization of accident and crash rates, are important public policy objectives. An exemption for aviation-related application is therefore essential, since the negative environmental, health and consumer safety impacts of aviation accidents clearly outweigh the benefits derived from the general bans imposed by the RoHS Directive. This exemption should remain in place until the reliability and performance of substitutes has been thoroughly assessed and confirmed.

#### Risks Associated with RoHS Compliance in Avionics Sector

Rockwell Collins has examined the RoHS Directive and supports its general objective. However, Rockwell Collins has identified certain serious compliance issues in connection with aviation-related applications of its EEE. These issues are such that it would be irresponsible for Rockwell Collins to produce EEE for aviation applications compliant with the RoHS Directive.

Rockwell Collins has been actively investigating the feasibility of compliance and implementation issues associated with the RoHS Directive 2002/95/EC. However, a technical assessment of the currently available substitute materials shows that it is not feasible to replace lead, cadmium and hexavalent chromium in avionics. There are no assurances that all quality, reliability and qualification requirements that are essential in aviation, could be met, if we were required to meet the RoHS deadline of July 1, 2006. These issues are also of great concern to aviation regulators and government agencies around the world. Examples of critical avionics applications that require high reliability are: electronics for the cockpits and cabins of civil aircraft, such as weather radar, collision avoidance systems, and cockpit-to-cabin/cabin-to-cabin communication systems. We therefore request that avionics applications be exempted from the general prohibition on the use of lead, cadmium, and hexavalent chromium, and added to the Annex to the RoHS Directive.

Specific concerns that Rockwell Collins has identified to date include the following:

#### 1. Viable alternative substitute materials

No substitute materials have been identified, characterized, and approved for avionics applications. Alternatives to the RoHS-restricted substances that do exist need to be carefully evaluated before they can be considered for actual substitution. Material properties, processing parameters, and costs of alternates have not yet been adequately assessed.

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Cadmium, for example, is used with silver in electrical contacts used to switch high currents to retard contact erosion. There is no substitute that provides equal performance and reliability. Also, as discussed further under 2, below, no feasible and equally reliable substitutes currently exist for broadly replacing lead-based solders.

## 2. Reliability of Industry Proposed Lead-free Solder Alloys

Rockwell Collins avionics products are designed for a life span that is much longer than the life span of most EEE. Product useful lives of 15 to 20 years, or more, are the general rule. This, of course, has implications for the solder used in such avionics products.

For the solder alloy family – Tin/Silver/Copper (SAC) – that has been identified as providing substitutes for RoHS-restricted substances no long-term reliability data has yet been generated. Given the long useful life of the products, such testing is complicated, but accelerated aging tests may provide a basis for projecting performance over a 20 years use life.

The following primary weaknesses of SAC have been identified:

- higher surface mount reflow temperature
- slower wetting rate
- costly raw material
- low ductility
- environmental concerns relating to silver

The reliability of SAC is strongly dependent on the use of temperature. Compared to tin lead, reliability is highly dependent upon package type and use environment. The higher processing temperatures required by SAC solders have a negative impact on the moisture sensitivity levels of components. When components are removed from their hermetic packaging they begin to absorb moisture from the air. If too much moisture is absorbed, they can explode during reflow soldering due to the rapid formation of steam inside the component. The moisture sensitivity level indicates assembly houses how long a component can sit before it must be used. If this time limit is exceeded, the component must be baked. Higher processing temperatures have been shown to greatly reduce the moisture sensitivity level of components. In addition, re-baking increases the costs of the assembly process.

Further, higher processing temperatures required by SAC may also have a negative impact on the reliability of plated-through holes. It is not unusual for a printed circuit board to see five thermal cycles during assembly. These include two reflow passes,

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a wave solder pass, and a rework cycle that includes both a removal and a replacement thermal cycle. Preliminary results from NEMI<sup>1</sup> and Alcatel<sup>2</sup> suggest that their higher reflow temperatures have a significant negative impact.

The main concern is that often heat-induced defects are latent, and not detected at initial inspection, and can therefore result in catastrophic field failures at some point in the future. Given that avionics applications have a 15-20 years lifespan, this uncertainty cannot be risked. Rockwell Collins therefore feels that it would be irresponsible to make its avionics products RoHS-compliant.

Possibly, new lead-free solutions will be discovered, or solutions will be found which will enable SAC to be safely and reliably used in avionics applications. However, risk of failure is currently too high to justify the use of SAC in avionics applications before the numerous issues expressed above have been resolved. Flight and life critical product integrity may be compromised if lead-free solder alloys are implemented prior to the completion of long-term solder alloy characterization efforts.

### 3. Material Compatibility Questions

The implementation of a lead-free solder alloy will impact every aspect of the printed wiring assembly process. Flux materials must be characterized and understood, cleanliness studies must be completed to avoid long term corrosion issues, process equipment degradation must be addressed, and the impact of electronic component finishes must be understood. Reliability still has to be assessed in similar but non-mission critical lead-free electronic products.

### 4. Costs and benefits and advantages and disadvantages of lead-free substitutes

Disadvantages of SAC include: 1) higher reliability risks and, thus, higher aviation accident rates, 2) higher energy consumption, 3) the negative environmental impact from silver mining will be increased, and 4) higher production costs (raw material cost and new equipment cost). These disadvantages, of course, could result in enormous costs to society. More generally, in the case of avionics, all RoHS-driven substitution involves significant risk, since the reliability of substitutes has not been adequately tested. Any benefits of substitution will be small, given the small portion of avionics relative to all electronics and the very long useful life of the products.

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<sup>1</sup> www.nemi.org.

<sup>2</sup> J. Smetana, "Peak Temp Requirements for Lead-Free Components and J-Std-020", HDPUG Fall Meeting, 2003, Scottsdale, AZ.

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5. Restrictions that apply to this substitute

To our knowledge, no legal restrictions apply to SAC. However, SAC has not been adequately tested to ensure that it meets the stringent reliability requirements required by avionics applications.

Conclusions

Rockwell Collins is working diligently and proactively to find solutions to the material and process issues raised by implementation of the RoHS Directive. However, the product integrity of Rockwell Collins flight and life critical avionics products cannot be compromised. An exemption for avionics applications is therefore necessary.

Rockwell Collins is willing and ready to provide additional information and explanation in respect of the issues discussed above.

Please do not hesitate to contact us if you have any questions.

Respectfully submitted  
on behalf of Rockwell Collins,

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