Lead remains critical to the safety and reliability of aviation systems

Since 2017, EU air transport has seen progressive growth with air freight and mail transport becoming key sub-sectors. With this huge carriage of people and goods, the aircraft industry has a vital role in supporting Europe's economic growth, while keeping Europeans moving safely. With safety and reliability at its heart, aviation relies on conservative design rules and effective material innovation across aircraft and innumerable subsystems as well as the internal components associated with them. With its unique properties, lead has a leading role in this.

All existing aircraft systems use electronics soldered with leaded alloys and therefore must be repaired using these same leaded alloys. Solder alloys cannot be changed in an existing design without requalification of these systems. Aviation systems are built and maintained by industrial personnel, ensuring that the general public has no exposure to these solder joints.

Tin-lead alloy solder is one of the most important essential uses of lead. It has been used to assemble the avionics of every aircraft currently flying, and continues to be used in production. This is in spite of the fact that consumer electronics transitioned to lead-free solder over 10 years ago. The reason for this is that high degree of reliability required has yet to be achieved for systems assembled using alternative lead-free solder.

Avionics are the electronic systems used by aircraft to communicate, navigate, protect and drive other critical systems that ensure the aircraft can fly as planned and intended. Avionics need to operate reliably at wide extremes of temperature, altitude, pressure and under high levels of shock and vibration, for many thousands of flight hours. Tin-lead alloy solders are the only solders proven to be resistant to embrittlement and interconnect failure under such extended and harsh conditions.

Some initial steps to introduce lead-free solder in certain applications have begun, and new alloys are being developed that may one day provide equivalent performance to the lead-free alloys first adopted in the marketplace. However, existing avionics will need to be maintained and repaired using tin lead solder over the lifetime of these aircraft, which can be 30 years or more! Mixing the solder alloys (lead and lead-free) together can have as yet unpredictable consequences for interconnect reliability. Therefore, even if all new avionics were to transition away from tin lead solder in 10 years (which is by no means certain), tin-lead solder will continue to be used in maintaining existing aircraft for at least

40 years. The aerospace sector is the only industry that regularly repairs electronics at the circuit board level. These maintenance activities will need to be performed over a large number of facilities spread across most EEA member states.

Beyond integrity of the solder joints, tin-lead alloy provides another important benefit – it helps to keep aircraft safe from a threat largely unknown outside the industry – tin whiskers. Tin whiskers are tiny, highly conductive hair-like structures that can grow between the closely-spaced circuitry of modern electronics. Tin whiskers can cause short circuits that destroy these critical functions, with potential for catastrophic consequences.

The lead content in tin-lead alloy solder suppresses tin whisker formation, not only on the solder joints, but also on the numerous tin-plated components that the industry relies upon as a consequence of the restriction of hazardous substances (RoHS). Tin on components is replaced by tin-lead solder either by dipping the parts into solder, or through coverage achieved during solder assembly. Should other solder alloys be adopted, there are no printed circuit board surface treatments, post coating or solder masking that will prevent tin whiskers; no currently devised mitigations are 100% effective at preventing tin whiskers. As modern electronics are being driven to ever smaller components, the potential for short circuits occurring is increasing.

To date, no other material provides the proven safety and reliability of tin lead alloy solder. Thankfully, all soldering operations performed on avionics are performed by highly trained and certified personnel who follow strict risk management processes. They are further protected by a framework of existing legislation and industry best practice. Although the removal of lead from solder would reduce the very small, potential exposure risk to personnel, it would in fact increase the risk of aircraft and other critical systems failures, with far greater safety implications.

The electronics industry consumes just 0.5% of the world's lead and the aerospace sector is a relatively small user of electronics. That means a very small amount of lead plays a significantly large role in keeping aircraft safe.

Fact file

- The electronics industry has relied on leaded solder to connect electronic components and devices for over 50 years
- The small quantities of lead used in the civil aerospace sector helps this industry generate a **€160 billion turnover and employ over 1 million workers throughout the EU and beyond**
- Only 0.5 % of the world's lead is needed to ensure Europe's essential and safety-critical electronics are reliable

Developed in collaboration with the IPC PERM Council, this case study highlights just one of the many essential uses of lead that provide societal benefits and boost the EU's economy

For Europe's future, lead matters.

Lead Matters