Copper Beryllium Alloys – The value of occupational hygiene principles when investigating an occupational health issue within aircraft maintenance operations?

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ABSTRACT

Following a positive BeLPT (Beryllium Lymphocyte Proliferation Test) biological test result for beryllium sensitisation amongst a sample of aircraft maintenance staff test, Air New Zealand embarked on a significant multi-disciplinary occupational health/hygiene project to fully understand the occupational health risk to its staff exposed to copper beryllium alloys. Following an literature review, an extensive quantitative wipe sampling programme, combined with qualitative risk assessment, was undertaken across all aircraft maintenance operations. Results indicated that while there was a small population of staff exposed to a known and controlled higher risk exposure to potential airborne copper beryllium, there was a significantly greater population and mix of tasks that were exposed to a previously un-acknowledge potential risk of copper beryllium particulate present in greasy surfaces associated with copper beryllium components, task tools and equipment.

INTRODUCTION

Background

Beryllium metal is used in a variety of alloys including the alloy copper beryllium. In the aviation industry copper beryllium has been used in a variety of components due to its strength and tolerance to wear and its' electricity conductivity (e.g. high load and stress bushes on aircraft under carriage and propeller electrical contact slip rings)

Work with copper beryllium alloy began at Air New Zealand Aircraft Maintenance Facilities in 1981 and by 1984 there was a small group of workers regularly working with it, but with little or no control. During the 1990's it was thought that the low percentage of beryllium present in the alloys (0.4–2.0%) posed little to no risk and personal exposure air samples taken at the time returned results less than the detection limit.

Following an increased international awareness of the risks associated with copper beryllium and the lowering of accepted safe personal exposure levels, the majority of machining work with copper beryllium was contracted out to external agents. This was expected to remove a greater part of the risk to staff.

In 2005 the company conducted biological sampling with a small group of workers that had worked both directly and indirectly with copper beryllium. Amongst this small sample set - a single positive BeLPT result was recorded

Following this result the company established a multidisciplinary project team, including Occupational Health and Safety Professionals, Occupational Hygienists, Senior Managers and Aircraft Engineers, to conduct an extensive survey of all aircraft maintenance worksites and review available information of where copper beryllium components are used across the various aircraft fleets.

Occupational Health Risk Associated With Copper Beryllium

The biological blood test called the BeLPT is different from most biological sampling as it indicates not just exposure – but possibly the presence of disease

Those sensitised to beryllium, detected and confirmed from two BeLPT test, - the majority go onto to develop Chronic Beryllium Disease, which is a debilitating chronic granulomatus lung disease, known to be treatable but not curable.

UNDERSTANDING THE OCCUPATIONAL HEALTH RISKS AT AIR NEW ZEALAND AIRCRAFT MAINTENANCE OPERATIONS

Developing a Sampling Strategy

Following an initial literature review by a Certified Occupational Hygienist to clarify an appropriate sampling technique, a pilot surface wipe sampling programme was completed to substantiate the techniques.

While some personal exposure air sampling was carried out this was in association with specific tasks where copper beryllium was been machined.

The wipe sampling technique that was settled on was:

- Analytical ghost wipe tissues further moistened with isopropyl alcohol, to help deal with the greasy surfaces
- A standard sample area 900cm2 to give an analytical detection of 0.0006µg/100cm^2
- Wiping the sample area in three different directions across sample area
- Samples handled separately and gloves replaced following each sample to avoid cross contamination

In association with quantitative sample collection and analysis, qualitative information for each sampling location/situation/area was also recorded. This included:

- Airborne potential
- Dermal contact potential
- Ease of release to air
- Ease of release to skin
- Surface area available
- Task related surface

- Task frequency
- Number of people affected
- Number of people occupying the area

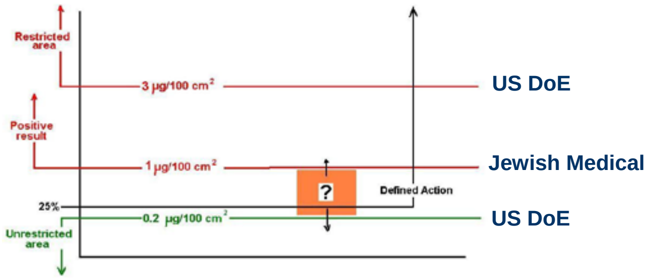
Where multiple sample areas were deemed to be homogenous, statistical techniques were used to determine the number of individual samples need to be collected to ensure a statistical significant result.

There is currently no specific guidance available for safe surface concentration levels of beryllium. From the literature review, 3 levels were identified to assist with the interpretation of results and to determine whether additional action would be required. These are shown in *Figure 1* below and are defined as:

- <0.2 µg/100cm^2 from the USA Department of Energy Standard. This was the level below which any beryllium detected was deemed to be background.
- 1µg/100cm^2 from the Jewish Medical Research Centre. In their work any level >1µg/100cm^2 was as the result of some beryllium process in the near vicinity
- >3µg/100cm^2 from the USA Department of Energy Standard. This level is used by the DOE to define areas where beryllium is worked on, but the controls in place fail to maintain levels of below 3µg/100cm^2 as "Beryllium Restricted Areas." Specific safe operating procedures and protective equipment to work in this area.

It was decided, by applying good occupational hygiene practice, that any sample result that was >0.25µg/100cm^2 should be considered for corrective action, taking into account both the quantitative result and the qualitative information gathered.

Figure 1: Selected Guideline Levels of Copper Beryllium Surface Concentration



Key Findings

Over the period of the sampling programme close to 700 wipe samples have been collected and analysed from across all part of Air New Zealand's aircraft maintenance operation.

The key findings of this sampling programme have included:

- Been able to demonstrate and define transfer pathways for copper beryllium from original component, into grease and onto either staff clothing and equipment or through to points of concentrating beryllium burden (e.g. component washing facilities)

- Been able to identify components that were previous thought to be safe but actually contained copper beryllium.
- Known high risk operations involving copper beryllium were, in general, well controlled for the operators doing the work. The concern was the potential for secondary exposure due to unrecognised and therefore uncontrolled transfer of process waste.
- There was a far larger group of staff exposed to a lower and emerging potential risk of skin contact with fine copper beryllium particles that required controls.

Many of the areas sampled that returned a high combined quantitative and qualitative risk result were easily remedied through applying ALARP (As Low As Reasonable Practical) principles and in several situations this lead to process improvements beyond just mitigating the risk associated with copper beryllium.

CONCLUSIONS

The number of samples taken in this study were significantly higher then most industries allow, Air New Zealand was willing to do this to ascertain the degree of risk and to protect its people. Results of the sampling indicate that the known higher risk operations involving copper beryllium were identified and had control plans in place, while the vast majority of lesser risk tasks and operations along with the potential to transfer and pool the beryllium burden, had not previously been sufficiently understood. There were numerous opportunities to reduce this risk to staff through ALARP principle, the second phase of BeLPT biological sampling indicates the risk may be much lower then was previously believed.
The true extent of the risk potential associated with skin exposure to beryllium will be a subject of ongoing research

References:

Deubner, D and Kent, M. (2007). Keeping Beryllium Workers Safe: An Enhanced Preventative Model. *Journal of Occupational and Environmental Hygiene,* 4, D23–D30.

Martin, J. Return to Work in Beryllium Areas: What is a “Safe” Level? National Jewish Medical and Research Centre, Denver Colorado, USA.

McCawley, M.A, Kent, M.S and Berakis, M,T (2001). Ultra fine Beryllium Number Concentration as a Possible Metric for Chronic Beryllium Disease Risk. *Applied Occupational and Environmental Hygiene*, 16(5), 631-638.

(2005) Management of Items and Areas Containing Low Levels of Beryllium. *U.S. Department of Energy Technical Standard*