

## Emissions during the BHP Billiton Mozal Aluminium Smelter Fume Treatment Centre (FTC) Rebuild – A Human Health Perspective

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Rebuild – A Human Health Perspective**

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## EXECUTIVE SUMMARY

BHP Billiton Mozambique Aluminium Smelter (MOZAL) experienced structural damage to the Fume Treatment Centre (FTC) caused by unanticipated corrosion. As a result MOZAL is in the process of rebuilding the FTC, an exercise that entails a bypass of the FTC to discharge emissions from the bake furnaces directly into the atmosphere via existing stacks. This process is likely to result in increased emissions into the atmosphere. Of concern are the Polycyclic Aromatic Hydrocarbons (PAHs), of which some are probable human carcinogens. As a result MOZAL initiated a human health risk assessment (HHRA) study concerning this operation, in order to understand the potential health impacts on the surrounding communities, including Mahlampsene, Sikuama, Mussumbuluko, Djuba, Meluluane and Xinonankila.

MOZAL approached the Council for Scientific and Industrial Research (CSIR) to assist with this exercise to address the following specific objectives: a) evaluation of the different approaches to assessing risks of chemical mixtures in the environment, b) to suggest and apply the best approach to PAH risk assessment based on the evaluation of the mixtures approach, and c) to understand the choice/application of benzo(a)pyrene (BaP) as an index chemical to PAH mixtures risk assessment. In addition MOZAL requested identification of applicable atmospheric target limits/standards or guidelines for the metals found in particulate matter (PM) emitted at MOZAL.

In order to address these objectives, a literature survey was conducted to identify the relevant target limits and standards/guidelines for the metals identified in emissions at MOZAL, evaluate approaches to chemical mixtures and BaP as an index chemical. The general United States Environmental Protection Agency (USEPA) mixtures risk assessment approach which entails hazard assessment, toxicity assessment, exposure assessment and risk characterization, was applied to the MOZAL PAH mixture. Relevant toxicity databases including among others, the USEPA Integrated Risk Information System (IRIS), and the World Health Organization (WHO) were consulted.

The evaluation of atmospheric target limits and standards/guidelines for metals found in emissions from MOZAL indicates that it is difficult to recommend whether PM<sub>10</sub> or PM<sub>2.5</sub> should be monitored on a regular basis and whether PM<sub>10</sub> concentrations may be used as a proxy to determine compliance of the levels of metals in air to ambient guidelines. Guidelines for some of the metals of concern

have lower concentration limits than the guidelines for PM<sub>10</sub> and or PM<sub>2.5</sub>, indicating that using the levels of PM alone may be inadequate to determine compliance.

The USEPA provides a framework for chemical mixtures risk assessment which is broadly categorised into whole mixtures methods (WMM) and component based methods (CBM). Within each group several classes are found. The WMM comprise mixture of concern (MoC), similar mixture (SM) and sufficiently similar mixture (SSM) classes. The CBM comprise hazard index (HI) based dose-addition, response addition and interactions effects assessment. The choice for application between the two main groups, is largely dependent on data requirements and policy imperatives. For the purposes of this study, the CBM, HI, also recommended by the EPA, was selected. The dose-addition approach was applied to the non-cancer PAH risk assessment, and the HI based Relative Potency Factor (RPF) and response addition approaches were selected for the carcinogenic PAHs.

BaP was chosen as the index chemical for PAH mixtures in this study because it is the most widely studied of the PAHs. As a result, it has a substantial body of knowledge regarding its toxicological properties and health impacts. This choice is also supported by international practice concerning PAH mixtures risk assessment.

The risk assessment indicates that the dose-addition HI for non-carcinogenic PAHs are below the benchmark of 1, suggesting that chronic non-cancer health effects are unlikely to develop, even in sensitive individuals.

The screening results indicated that PAH exposure to the communities of concern was likely to result in cancer risk above the *de minimis* of 1 in one million people for  $\sum\text{PAH}_{7\text{-BaPeq}}$  and  $\sum\text{PAH}_{11\text{BaPeq}}$  and modelled BaP. Applying a more stringent benchmark of 1 in one hundred thousand people, cancer risk estimates based on the USEPA and OEHHA IUR values are below 1 in one hundred thousand. Using the WHO value the risk remains above. The main cancer risk drivers are D(a,h)A, BaP and chrysene.

The results need to be interpreted with caution given a number of assumptions inherent in the risk assessment. These concern the inclusion of non-detects in calculating average PAH concentrations; using short-term (10 November to 25 December 2010) monitored data to represent long-term (annual) exposure; assuming that PAHs classified as probable human carcinogens are in fact

carcinogenic to humans; adopting the approach which assumed additive risk, an assumption that may not be accurate given the different chemical and toxicological properties of PAHs; and the application of other agencies toxicity factors, e.g. OEHHA, in lieu of USEPA missing toxicity values. To complicate matters further, there are discrepancies between institutions such as the EPA and IARC on the carcinogenicity potential of certain PAHs, for example, naphthalene.

The contribution of MOZAL to the incremental cancer risk based on monitored data cannot be established, as all sources of PAHs, including motor vehicles, wood burning and burning of garbage contribute to concentrations in ambient air.

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