

Safety in Mines Research Advisory Committee

Final Report

IDENTIFICATION OF HEALTH HAZARDS IN MINERAL PROCESSING PLANTS RELATING TO CHRONIC EXPOSURE TO MULTIPLE CHEMICALS

SIMRAC PROJECT HEALTH 804

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**Dr Willie van Niekerk
Dr Marlene Fourie
Dricky Simpson
Willem Retief
Wilma van Niekerk
Greta Mouton**

INFOTOX (Pty) Ltd

Executive Summary

The entire Health 804 project is presented on a CD-ROM, and it is therefore appropriate that this report provides only an executive summary of the contents.

Project Health 804 is an extension of Projects Health 603 and Health 709. Health 603 focused on health hazards associated with heavy metals in 15 types of mineral processing plants, and Health 709 addressed the issue of silicosis in silicon smelters. The studies highlighted that assessment of exposure to heavy metals provides an incomplete picture of potential health risk if a more holistic view of total chemical exposure is not taken. For example, it is incomplete to assess exposure to heavy metals without considering the impacts of the dust or acid mists in which the metals are carried, or the presence of sulphur dioxide together with calcium oxide. The plant surveys conducted under Project Health 603, and especially Health 709, played an important role in observing these issues, and the methodologies that were developed provided an essential framework for making occupational health risk assessment and management in mineral processing plants more complete, relevant, and useful. The approaches used in the previous projects were therefore used and expanded to cover the major chemical hazards associated with routine operations in mineral processing plants. Health 804 was designed as an extension to Health 603, expanded to include the issue of silicosis associated with Health 709, and the cyanide gold extraction process was added.

The project has been designed to produce an interactive CD-ROM. Within the software recorded on the CD, links were created from process flow sheets of the mineral processing plants to relevant information on chemical hazards and potential occupational health risks in the various nodes of the processing plants. Because all potential users of the CD-ROM might not have access to the Internet, information sheets on toxicology and methods to monitor and manage occupational health risks were recorded. Because it is anticipated that Internet access will become more and more available in the future, and because toxicological information and some other data are updated from time to time, links to relevant international websites were also recorded on the CD. The data are in the public domain and this report has no commercial interest or value. Links to websites of commercial companies in the field of occupational hygiene were not included, but these can be accessed through the ASOSH website.

Mineral processing plants consist of operations that are unique to a particular type of activity such as the bio-leach process for gold recovery, and certain unit operations that may be common to different plants such as spray painting and degreasing. The process flow diagrams developed form a good basis for refinement to include all the chemical hazards relating directly to the processes. In addition, more general unit operations can be cross-referenced between industries where they are employed.

The mineral processing plants covered in Health 804 are:

- Carbon steel process with blast furnace and basic oxygen furnace;
- Carbon steel process with direct reduced iron and electric arc furnace;
- Typical copper recovery circuit;
- Typical ferrochromium production process;
- Typical ferromanganese production process;
- Bacterial oxidation circuit for the pre-oxidation of refractory gold ores;
- Carbon-in-pulp circuit for gold recovery;
- Typical gold cyanide leach process;
- Nickel, copper, and cobalt refining process;
- Typical phosphate rock production process;
- Platinum group metal refining;
- Silicon smelter process;
- Typical stainless steel process;
- Typical titanium dioxide production process;
- Vanadium pentoxide production: the salt-roast process;
- Vanadium slag production process; and
- Typical circuit for zinc recovery from concentrate.

The following generic unit operations have been described:

- Abrasive blasting;
- Asbestos;
- Brazing and soldering;
- Casting;
- Coal burning;
- Metal surface cleaning;
- Degreasing;
- Electroplating;
- Flocculants;
- Hot forging;
- Machining;
- Grinding, polishing, buffing;
- Oils, greases and waxes;
- Painting;
- Welding,
- The Söderberg electrode; and
- Diesel vehicles.

Following the concept of process flow diagrams, each type of mineral processing plant was divided into a set of unique and generic unit operations. Potential exposure points were identified for the range of chemicals of interest. The flow diagrams were not intended to represent specific plants of companies that assisted in providing information, but the data were presented in generic context. Therefore, specific plants and companies are not referred to.

For the toxicological assessment, criteria documents of the National Institute for Occupational Safety and Health (NIOSH), the American Conference of Governmental Industrial Hygiene, the US Environmental Protection Agency (USEPA), the World Health Organisation (WHO), various textbooks, and journals in the open literature were studied. Close to 200 toxicology charts were produced. Toxicity classifications were made with regard to target organs, to give an idea of where multiple chemicals could have additive effects on the same target organ system. The following classification of target organ systems was used:

- Renal system;
- Nervous system;
- Liver;
- Gastrointestinal tract;
- Respiratory tract;
- Haematopoietic system;
- Bone;
- Endocrine system;
- Muscle;
- Eye;
- Skin;
- Cardiovascular system;
- Immune system;
- Reproductive system, and
- Others where the above systems could not be clearly associated.

A general structure for occupational health risk management has been included under the main menu, including guidelines for monitoring and quality assurance. South African exposure guidelines are listed in the toxicology charts.

All the information was compiled on a CD-ROM in a format that allows interaction and guidance through the various process steps, linking the various elements that are relevant in the hazard identification, exposure assessment, and risk quantification. Information available to the public on websites has been downloaded and incorporated into the SIMRAC electronic document. Since the information is the work of agencies of the United States Government, the United Kingdom and elsewhere, and in the public domain, SIMRAC does not have copyright on those items, which shall remain in the public domain. The format of the CD-ROM will enable a person to work through the chemical hazards associated with a mineral processing plant, linking to the background information to understand the concepts, thereby achieving a more holistic view of health hazards and risk management. However, it remains the responsibility of the Managements of the mineral processing plants to employ occupational hygienists and medical professionals to implement their monitoring and health risk management strategies.

The CD-ROM represents Version 0.1, and will have to be taken through a phase of assessment for completeness and accuracy. It is envisaged that the information will have to be updated from time to time, and it is likely that the scope and contents will expand over time.

A separate CD-ROM is provided that contains all the technical program documentation. This is also Version 0.1.

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