

UNIVERSITY OF THE WITWATERSRAND
FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT
RESEARCH PROPOSAL

TITLE: Development of a Regulatory Mechanism for the control of exposure to Diesel Particulate Matter (DPM) in the South African Mining Industry.

SUMMARY

According to the ACGIH (American Conference of Governmental Industrial Hygienists) diesel particulate matter (DPM) is classified as an A2 carcinogen, i.e. it is a suspected human carcinogen. Furthermore, according to NIOSH (National Institute for Occupational Safety and Health - USA) whole diesel exhaust should be regarded as a potential occupational carcinogen.

Currently there are no legal standards, in the form of Occupational Exposure Limits (OELs), nor any recognized methods to measure DPM in South Africa.

BACKGROUND

The South African mining workforce consists of approximately 400 000 employees. This employment figure does not include diesel equipment manufacturers and service agents. The population at risk to DPM will be a much smaller subset of the total mining workforce and limited to mines/sections where diesel equipment is used.

The health effects of diesel exhaust emissions can be acute or chronic. The acute effects will be related to excessive exposure to toxic levels of the various components of the pollutant. The chronic effects relate to the consistent finding of the mutagenic effects of diesel exhaust emissions in *in vitro* studies as well as in laboratory animals.

A number of studies in humans have examined the link between diesel exhaust emissions and lung cancer and the conclusion that has been drawn is that diesel exhaust is probably carcinogenic, Class A2.

OBJECTIVE

To develop a regulatory mechanism for the control of exposure DPM in the South African Mining Industry.

DEFINITIONS**Carcinogens**

Substances known to cause cancer

Diesel Particulate Matter (DPM)

Particles found in diesel exhaust. Most emission regulations specify DPM measurement methods in which particulates are sampled on filters from cooled exhaust gas. The cooling causes condensation of vapors in the gas sampling train. Thus, the DPM is composed of both solid and liquid particles and is generally classified into three fractions: (1) inorganic carbon (soot), (2) organic fraction, and (3) sulfate fraction (hydrated sulfuric acid).

STUDY DESIGN

An exposure assessment will be conducted to measure the exposure of workers to diesel particulate matter, in an underground mining population at a point in time according to the Mandatory Code of Practice on Airborne Pollutants issued by the Department of Minerals and Energy (now DMR). This will determine the exposure level and also determine the Total carbon to elemental carbon ratio.

The study will also consider the dilution ratio of ventilating air to engine size for DPM.

RATIONALE

This study design is being used to determine the exposure to diesel particulate matter at selected underground mines as an indicator for control and to determine the need for further study or investigation. This study design is employed as it has low associated costs and is ethically acceptable. Results from this study could be used to benchmark the exposure levels against those of international regulatory agencies and so introduce best practice or regulatory limits and also assist with intervention strategies.

Weaknesses of the study design are:

- 1) This study will at best be able to provide a snapshot of exposure to DPM on the mines selected.
- 2) It will not be able to cover all exposure scenarios e.g. different vehicle types, vehicle maintenance levels etc.

POPULATION

Workers employed at the selected South African Mines and who are exposed to diesel particulate matter.

METHODS OF MEASUREMENT

The sampling and analysis will be conducted according to NIOSH Method 5040, using standard dust sampling pumps with the DPM sampling filters (with jeweled impactor screens for particle size selection i.e. screen out particle sizes $> 1.0 \mu\text{m}$). The number of samples done in each area will depend on the variation of the DPM levels detected. A minimum of 4 readings per area is planned.

Jobs in the mine will be classified according to exposure to DPM i.e. direct exposure (e.g. driver/operator of diesel equipment) and indirect e.g. workers exposed to diluted DPM. Personal samples will be taken according the Mandatory Code of Practice on Airborne Pollutants issued by the DME (now DMR).

Measurement of mine ventilation flow rates will be done using standard equipment such as the vane anemometer (both manual and electronic).

DATA ANALYSIS

It is seldom possible in analytical surveys of this nature to acquire sufficient data points for conventional statistical averaging of exposure levels.

- 1) The data will be described in tables,
- 2) Further data analysis will be done using the Microsoft Excel package.
- 3) Exposures will also be compared to current international regulatory requirements.
- 4) Dilution Ratios will be compared to international recommendations.

RELEVANCE

The data would produce an indication of exposure levels to diesel particulates in those selected mines, and yield ratios of Total to Elemental carbon which will assist in recommending Occupational Exposure Limits to Diesel Particulate Matter – currently there is no regulated DPM OEL in South Africa. Further recommendations on dilution ratios will assist Mine Ventilation Engineers on optimal ventilation design to control exposure to DPM.

TIME SCHEDULE (Revised November 2012 – due to operational demands and industrial unrest – discussed with Supervisor and in submitted progress report)

Task	Timeline
1. Literature Review	July to October 2011
2. DPM Sampling and Analysis	August 2011 to March 2012
3. Ventilation Flow rate monitoring	August 2011 to March 2012
4. Data collation and Analysis	January to November 2012
5. Writing of Research Report	January to June 2013
6. Submission of Report to Supervisor	July 2013
7. Submission of Research to Faculty	October 2013

Regular sessions will be set up with my Supervisor to monitor progress and guidance.

References Used:

- 1) Safety in Mines Research Advisory Committee (SIMRAC) report GEN 010 “Control of Diesel Exhaust in Underground workings”
- 2) SIMRAC report GEN 208 “Control of Diesel Exhaust in Underground workings” – this was a continuation project of GEN010. Both Gen 010 and Gen 208 looked at engineering control methods of diesel exhaust emissions and the impact low emission diesel fuel.
- 3) A cross sectional study to determine the potential mutagenic exposure from diesel exhaust emissions in underground coal mines in South Africa, Sheryl A. Kay, research report for the Diploma in Occupational Health, University of the Witwatersrand (09/2001)
- 4) US Environmental Protection Agency. 2000. Health Assessment Document for Diesel Exhaust. EPA/600/8-90/057E. Washington, D.C.: US EPA. SAB review draft. July. Online at www.epa.gov/ncea/dieslexh.htm
- 5) US Environmental Protection Agency. 1997. Health and Environmental Effects of Particulate Matter. Fact sheet. Online at www.epa.gov/ttn/oarpg/naaqsfm/pmhealth.html
- 6) DEEP Technology Transfer (Diesel Emissions Evaluation Program) www.deep.org

NB: The Harvard System for citation/referencing will be used in the Research report.