Measuring and controlling the mining environment for worker health and safety

4th Biennial Conference

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Date: 10 October 2012
Recent statistics of the mining industry:

- 123 Fatalities in 2011
- 3299 Injuries in 2011
- Approximately 2000 fatalities from silicosis reported per annum
- Approximately 1500 workers diagnosed with Noise Induced Hearing Loss (NIHL)

➢ Still room for improvement
CMI Human Factors

Factors affecting the health and safety of Mine Workers

- Stress
- Physical Strain
- Fatigue
- Ergonomics
- Silica/Dust
- NIHL
- Heat
- Accidents
- Planisa

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Swiss-Cheese Model illustrates how accidents occur
Why do accidents happen?

Current situation when accident occurs:

- Investigation
- Cause: Worker is usually blamed
- Solution: Training
- Problem: Recurrence of the same accident…

- Improper investigation to get to the root cause of the problem
Human Factors Accident Classification System – Mining Industry

HFACS-MI framework for accident analysis

Outside Factors

Organisational Influences

Unsafe Leadership

Precondition for unsafe acts

Unsafe acts

Latent system failures: environmental, operators, personnel factors

Errors and violations by individual

Regulatory factors imposed by the government; political and economic pressures

Deficiencies in the highest level of an organisation

Potential to influence health and safety

Tool to identify the root cause and use it to prevent incidents and accidents in the South African Mining Industry
2. Workplace stress

- Linked to increased risk of disease, mental disorders, increased absenteeism, reduced productivity, and a higher accident rate
- What is the impact of workplace stress on South African Mining Industry?
  
  - CMI Research aimed at finding ways to prevent accidents caused by stress and fatigue
Workplace stress: FaceReader™

FaceReader™ Analysis

- FaceReader™ reads facial expressions
- Objective tool to measure workplace stress
- Mining pilot study successful
- Further application: indicator of fatigue
- Screen workers prior to workplace entry
  - Monitor the well-being of workers
3. Physiological Strain Index (PSI)

*How hard do mine workers work?*

- Aging, unhealthy workforce; more females
- What is the *work capacity* of the mine worker in the South African context?
- Correlate the heart rate and body temperature of the mine worker
- Initial results from gold mine indicates that workers are not exposed to excessive physiological strain (self-pacing takes place)
- Expanding research to platinum mines
Physiological Data Subject 11 (MT)

HR (bt.min⁻¹)

Temperature (°C)

Physiological Strain Index (PSI)

- In cage (05:14)
- Sitting (05:57)
- Changing and walking (06:47)
- Walk down raise (07:10)
- Moving rocks with shovel (07:37)
- Carry and installing temporary support (09:30)
- Moving rocks with shovel (09:55)
- Transport packs and build permanent support (10:35)
- Walk up raise (13:50)
- Transport packs and build permanent support (10:35)

Time (hh:mm:ss)
4. Planisa

- Improvise to cope with the inefficiencies and organisational constraints
- Either an instruction or self-initiated action
- CMI: Focus groups and questionnaires
  - How does making a plan impact on the health and safety of mine workers?

*Boer maak ’n plan...*
5. Airborne Pollutants

Respirable Crystalline Silica (RCS):
- Causes silicosis: debilitating lung disease
- International drive to eliminate silicosis
- Milestone 2013: No new cases of silicosis from previously unexposed individuals
- Approximately 2000 fatalities from silicosis per annum
Respirable Crystalline Silica:
• MHSC projects to evaluate dust control measures
• Evaluating size-selective samplers
• Representative samples
• High speed and improved accuracy of silica analysis
• ISO Working Group on Silica measurements
  ➢ Standardisation across the South African mining industry
Diesel Particulate Matter (DPM):

- Classified as carcinogen in June 2012
- No occupational exposure limits in South Africa
- Use international limits as guideline

➢ Limitations: aging fleet of engines and poor quality fuel

Scanning electron microscope image of DPM (10 µm magnification)
Airborne Pollutants: DPM

DPM research to fill knowledge gaps:

- Exposure model to assess health outcomes
- Engine deterioration in terms of DPM
- Organic Carbon fraction
- Correlation between tail gas and DPM emissions
- First DPM project of this nature

➢ Determine current situation of DPM exposure in the South African mining context

Source of DPM: diesel powered equipment
6. Air and Dust Laboratory: SANAS Accredited Facility

- Part of the Mega Lab within CSIR
- State of the art equipment
- Support to CSIR researchers **and** services to industry
- Silica (i.e. quartz) analysis using XRD and Infrared
- Only Laboratory in South Africa that can measure DPM
- Workplace and environmental air quality analysis
- Water testing, micro analysis etc.
Through our research we aim to:

- Eliminate silicosis
- Reduce DPM exposure
- Reduce accidents and incidents
- Monitor the physical well-being of mine workers
- Manage worker capacity

➢ **Provide relevant solutions for real problems within the mining industry**
Thank you

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