



Occupational exposure limits: Are we really protecting the health of workers?

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It all starts here



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1. Definition of Occupational Exposure Limits (OELs) and their intended use?
2. Types of OELs
3. History of OELs
4. Establishment ("setting") of OELs
5. Limitations of OELs
6. Comparison of South African OELs with those of other countries
7. Conclusion: Are we really protecting the health of workers by making use of OELs?

Definition of OELs and their intended use?

- OELs is a measure to protect worker health –
- to prevent development or occurrence of occupational diseases
- or other adverse effects, including
 - irritation of the airways and the eyes,
 - headache,
 - sedation and
 - narcotic effects

Definition of OELs and their intended use?

- Regulatory measures to control exposure to workplace stressors
- Intended to protect worker health
 - 8 hours/day
 - 5 days/week
 - \pm 40 years

Types of OELs

- Considers the respiratory system (inhalation) as route of exposure
- Long-term *vs* short-term exposure limits
 - Long-term exposure limits
 - Average exposure over a reference period, usually 8 hours
 - TWA₈-OEL
 - Short-term exposure limits
 - Usually 15 minutes
 - STEL or Ceiling limits

History of OELs

- **>2000 years:** Chemical exposures may cause diseases
- **1883:** Very first OELs was developed for carbon monoxide in Germany
- **Up to early 1900s:** Real progress prevented by lack of chemical sampling and analysis methods
- **1912:** Kobert published a list containing 20 OELs
- **1916/7:** Permissible exposure limits to quartz for gold miners (South Africa) - 8.5 m particles/ft³
- **1921:** US Bureau of Mines publishes 33 OEL's
- **1942:** American Conference of Governmental Industrial Hygienists (ACGIH) tabled OELs for 63 toxic substances
- Real development in the last 70 years.

Setting of health based OELs

- An OEL that will protect the health of workers
- Based on the toxicokinetics and toxicodynamics of the particular substance in the human body
- Toxicokinetics describe
 - absorption
 - distribution
 - metabolism (biotransformation)
 - excretion of the substance
- It also determines the averaging time for exposure monitoring

Setting of health based OELs

- The toxicodynamics relate to the effect(s) of the substance on the body and at what dose
- These effects include:
 - Local toxic effects (skin, eye, respiratory tract, etc.)
 - Systemic toxic effects, any organ system
 - Acute toxicity, e.g. irritation, asphyxiation, narcosis
 - Sensitization
 - Genotoxicity/Mutagenicity
 - Reproductive or developmental toxicity
 - Neurotoxicity
 - Subacute/subchronic toxicity
 - Chronic toxicity and oncogenicity (cancer)

Setting of health based OELs

- Where do we get all this information?
 - Animal exposure studies – extrapolating data to humans
 - Human exposure studies
 - Epidemiological studies - retrospective
- Information used in a complex manner to incorporate safety margins and uncertainty factors to establish an OEL
- "Setting an OEL is an estimated game of numbers"
- **Example:** ACGIHs TLVs (Threshold Limit Values)

Setting of non-health based OELs

- But, evident in the setting of OELs of most countries or organizations is consideration of
 - socio-economic factors
 - technical and practical feasibility
- Balancing risk to health against cost and effort of reducing exposure
- Input of business in setting of OELs is evident
- End up with OELs which may not be as protective, i.e. there is still a risk to health at the OEL set
- **Example:** OELs of both the South African mining industry and general industry

Limitations of OELs

1. Apply to occupational exposure
 - Not applicable to environmental exposure where more susceptible groups exist, e.g. pregnant women, children and old aged
2. Apply to healthy adult male workers
 - Infected with HIV, tuberculosis, etc.?
 - Females?
 - Caucasian?
3. They may not protect all workers, e.g. hypersensitive workers, genetically susceptible workers
 - Smokers
4. They generally relate to airborne exposure
 - Skin exposure?

Limitations of OELs

5. Extended work shifts and shift cycles, i.e.
 - 8 hours vs 12 hours?
 - 5 days/2 days rest vs rotating day/night/rest shifts
6. Set for normal or slightly pressurized atmospheric conditions
 - Deep mining?
 - Altitude?
7. They are set based on “incomplete” toxicological data available
 - Low level, chronic exposure to a substance?
8. Based on the best available scientific information at the time of being set and are liable to change

Limitations of OELs

9. Set for only a fraction of all substances currently in use

10. Generally refer to single substances, limited guidance may be given on mixed exposures

- Exposure in most workplaces not to a single substance

11. Non-health based OELs – incorporate socioeconomic factors, technical and practical considerations

12. Not an index of toxicity –

- Cannot compare toxicity of two substances based on their OELs
- Lower OEL \neq more toxic

Comparison of OELs

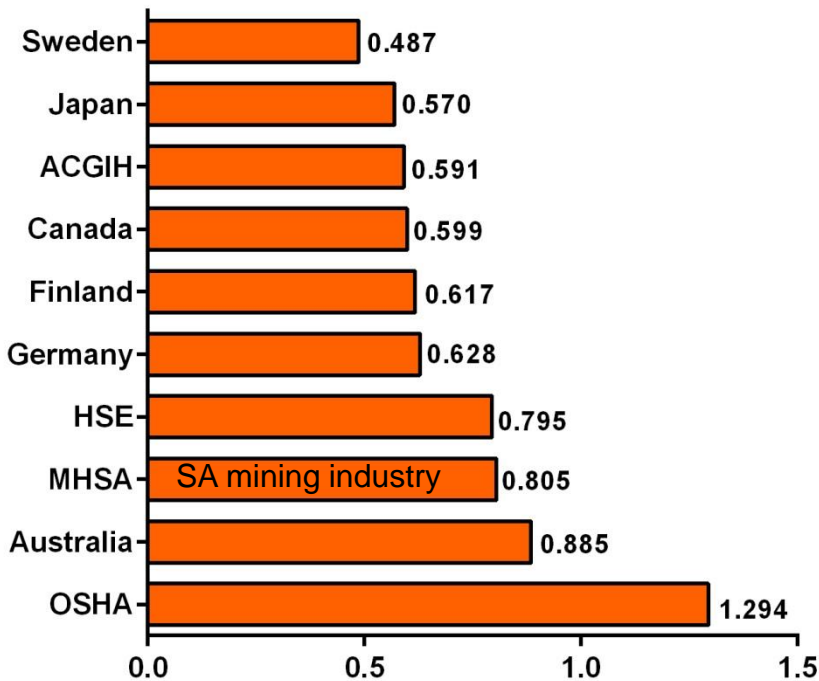
- Studies indicate large and unsystematic differences between decisions made and values set for substances with similar adverse health effects¹
- Compared South African OELs for substances with those of developed countries
 - Regulations for Hazardous Chemical Substances (RHCS) applicable to the general industry
 - Mine Health and Safety Act (MHSA) applicable to the mining industry
- A geometric means method was used in which the difference in OELs for two countries/organisations were expressed as a ratio²⁻³

1. Hansson and Ruden, *Toxicology* (2006); 2. Hansson, *Risk Analysis* (1997);
3. Schenk *et al.*, *Regul Toxicol Pharmacol* (2008)

Comparison of OELs

- <1: comparative country has a lower overall OEL level
- > 1: comparative country has a higher overall OEL level

RHCS vs

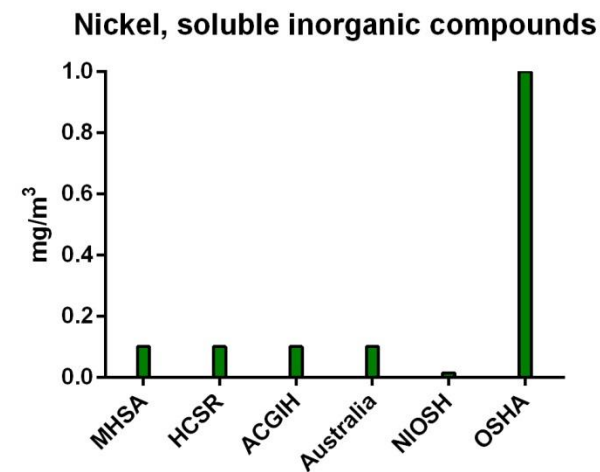
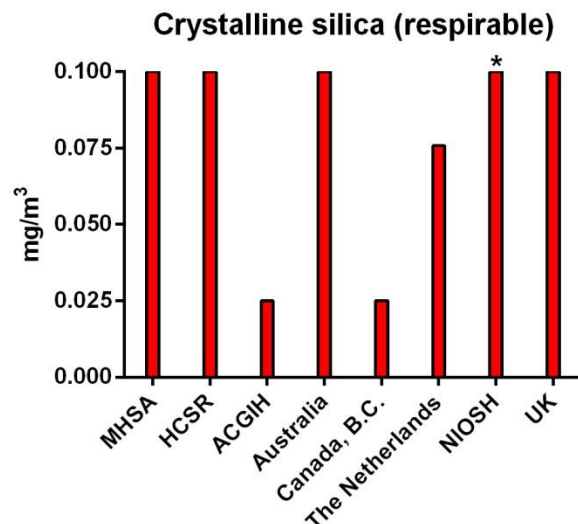
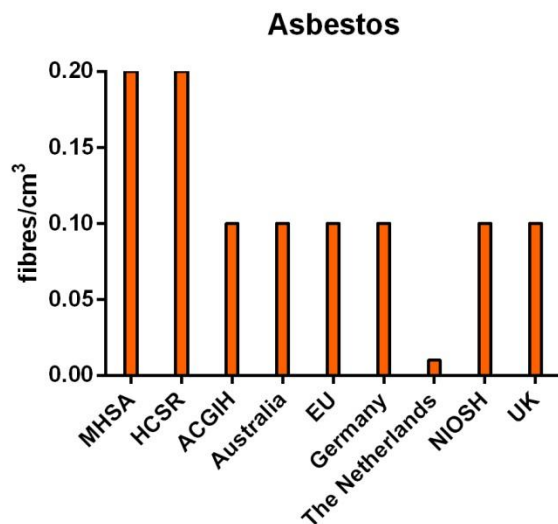


- Lowest OELs set by Sweden, Japan and ACGIH
- Small difference between UK (HSE), RHCS and MHSAs
- $MHSA_{ave} \approx 9.4\%$ lower
- Time lags between updates are one of the most prominent factors relating to levels of OELs
- OSHA (USA) outdated

Comparison of OELs

- Evident is a lowering of OELs with time as new scientific evidence arises³
 - Recently updated = lowering of OELs
- Frequent updates necessary
 - MHSA – last updated in 2006 - 9 years ago
 - HCSR – with the exception of OEL for silica, not updated since publication in 1995 - 20 years ago

Comparison of OELs



- The Netherlands lowest = 0.01 f/cm³
- **MHSA and RHCS 20x higher**
 - Proposed NIOSH and OSHA OEL of 0.05 mg/m³
 - Debate in UK: Experts vs HSE
 - **MHSA and RHCS 4x higher than proposed OEL**
- NIOSH (USA) lowest = 0.015 mg/m³
- **MHSA and RHCS 6.7x higher, OSHA 67x higher**

Conclusions

- Based on the way OELs are set and their limitations presented, do we really protect the health of (South African) workers?

The answer is **NO!**

- Time lag between exposure and development of disease is evident – asbestos and silica serve as examples
- History shows we are reacting following exposure and eventual development of disease
- What will next follow asbestos and silica in compensation court cases?
- Health based OELs need to be set and there should be compliance to them if the health of workers are to be protected



Thank you

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