Position of the European Extractive Industry on the proposed reduction of occupational exposure limit values for nitrogen oxides (NO and NO2) at the workplace

The Scientific Committee on Occupational Exposure Limits (SCOEL) has adopted new recommendations on occupational exposure limits (OEL) for nitrogen dioxide (NO2) and nitrogen monoxide (NO) in June 2014: for NO2 a value of 0.5 ppm (8-hour Time Weighted Average/TWA) and 1 ppm (15 min/ short term exposure); for NO a value of 2 ppm (8-hour TWA).

If the occupational exposure limits recommended by SCOEL were to be ultimately adopted at EU-level, then the current OEL values in a number of EU Member States would be disproportionately reduced by between 75 and 98 % (see table below). This would seriously impact the mining sector's competitiveness and might even endanger the very existence of European underground mining industry.

Present limit value (8 hour TWA)	NO_2	Reduction in %
Austria	3 ppm	83
Belgium,	3 ppm	83
Bulgaria	4 ppm	87
Finland	3 ppm	83
France	3 ppm	83
Germany (Limits suspended))	5 ppm	90
Greece	5 ppm	90
Ireland	5 ppm	90
Portugal	3 ppm	83
Spain	2 ppm	75
Sweden	2 ppm	75
United Kingdom	3 ppm	83

NO	Reduction in %
25 ppm	92
25 ppm	92
20 ppm	90
25 ppm	
25 ppm	92
25 ppm	92
25 ppm	92
25 ppm	92
25 ppm	92
25 ppm	92
25 ppm	92
35 ppm	94

12 Avenue de Broqueville ≡ B - 1150 Brussels ≡ Belgium
VAT BE 0459 110 403 ≡ e-mail: secretariat@euromines.be
Tel. +32 2 775 63 31 ≡ Fax: +32 2 770 63 03 ≡ www.euromines.org

Canada	3 ppm		25 ppm	
South Africa	3 ppm		25 ppm	

The European raw materials extractive industry considers the recommended occupational exposure limits to be

1. scientifically insufficiently justified,
2. technically and economically unfeasible, and
3. not measurable.

1. Scientifically insufficiently justified

The current SCOEL recommendation has taken into account the relevant, known studies. In contrast to the previous dominance of toxicological considerations which extrapolated results of animal experiments to humans, now – according to the SCOEL Methodology Document (SCOEL, METH, 2013) – both summary documents consider epidemiological studies. The two studies conducted in the German potash mining and coal mining industries have been taken into account. Whilst the study carried out in the coal industry (Morfeld (2010) et al., and Dahmann (2009) et al.) has been well recognised as the “leading study", the previous study in the potash industry (Lotz (2008) et al. and Dahmann (2007) et al.) is used only indirectly.

More ongoing relevant studies for the assessment of human data are in progress, but not completed at this time.

At the Institute of Occupational and Social Medicine, Aachen, University Hospital Aachen, under Prof. Thomas Kraus, controlled exposure experiments on humans are being carried out with concentrations at exposure levels of 0 to 1.5 ppm NO2. This study was launched by the European Association for Research on Environment and Health in the Transport Sector e. V. (EUGT). From this study, important results can be generated which will be of great importance for the derivation of a possible limit value for NO2. Results of this study will be available in the second half of 2014. It is expected that no adverse effects on the test persons occur at concentration levels of up to 1.5 ppm NO2.

Furthermore, the Institute of Prevention and Occupational Medicine of the German Social Accident Insurance – Institute of the Ruhr-University Bochum (IPA), under Prof. Thomas Brüning and Prof. Jürgen Bünger, in collaboration with the Institute for the Research on Hazardous Substances (IGF) of the Berufsgenossenschaft (BG) Raw Materials and Chemical Industry, under Dr. Dirk Dahmann, is also conducting an exposure study in the underground potash mines of K+S Aktiengesellschaft. In this study, the effects of the gaseous components (NO2, NO, CO2 and CO) and dust on the underground workers will be evaluated. The IPA is the occupational health research institute of the BGs and accident insurance institution of the public sector in Germany. The study is expected to be completed in 2015.

SCOEL has informed us in a letter dated 7 July 2014 that, "when relevant new information is publically available that has a clear impact on the OEL derivation, SCOEL is ready to prepare an addendum containing the new data and discussing their consequences for the evaluation. This may result in a revision of the recommendation". In view of the length of the decision-making process and the significant impact of these recommendations on the raw materials extractive industry, we ask that the SCOEL and the European Commission consider the results of the aforementioned studies as a necessary step in the decision-making process and before adopting the final proposal of any new limit values.

Furthermore we insist to point out, that the results of the studies conducted by BASF and the United States Environmental Protection Agency were not adequately taken into account by SCOEL when recommending an OEL for NO2.

In the derivation of the 0.5 ppm OEL recommendation for NO2, the results of the 13-week inhalation study (BASF, 2006 b) should be given more weight. SCOEL has already expressed that the "BASF study has not been used for the primary derivation of the OEL, but only as secondary and supporting information" due to some weaknesses of this study, although the study fulfils all existing OECD-standards and all criteria of scientific toxicological research. SCOEL stated that there have been "problems in the analytical measurement of NO2 concentrations" (SCOEL/SUM/53, 2014, S. 12).

This assessment is based on a misunderstanding. Although the measured exposure levels were higher than originally planned, the quality of the measurements cannot be doubted. In this study, there is de facto no problem with the measurement of concentration levels during the experiment. SCOEL correctly states that, in the 13-week inhalation study up to an exposure of 2.15 ppm NO2, no substance-induced effects on the parameters of BALF (bronchoalveolar lavage fluid) or in terms of cell proliferation or apoptosis in the lung were observed (SCOEL/SUM/53, 2014, p. 10). The NOAEL (No Observed Adverse Effect Level) of more than 2 ppm found in the BASF study is therefore not considered sufficiently in the overall recommendation and should play an appropriate role in the derivation of an OEL. The exposure levels measured are correct and not "overestimated" (SCOEL/SUM/53, 2014, p.12).

It should be emphasised that this study did not include exposures higher than 2.15 ppm, so that it is not clear what the NOAEL (Lowest Observed Adverse Effect Level) could be. Moreover, a LOAEL could not be determined. For the study, the value of 2.15 ppm is thus an estimate of the NOAEL from below, without being able to exactly determine it.

Furthermore, the United States Environmental Protection Agency (U.S. EPA) published a study in 2008 entitled "Integrated Science Assessment for Oxides of Nitrogen – Health Criteria and the Annexes", which states that, "Human clinical studies generally did not find direct effects of NO2 on lung functionality in healthy adults at levels as high as 4.0 ppm." These results must also be taken into account in the recommendation of an OEL for NO2.

From a scientific point of view it must be concluded that after reviewing all the valid scientific literature, it is not scientifically justified to fix the occupational exposure limits for NO and NO2 on the basis of the current SCOEL recommendation.

Furthermore, the regular occupational health check-ups of workers in underground mines in Germany (more than 60,000 workers) have not shown any evidence of obstructive lung disease caused by employment in the mining industry. Apart from thorough medical examinations by company physicians, the main lung function parameters, vital capacity, forced vital capacity, forced expiratory volume in the first second and expiratory maximum flow and the flow values for 25 %, 50 % and 75 % of the volume of the forced vital capacity, are determined regularly.

The Swedish mining industry operates 14 mines in production and approx. 7000 workers in the production. All of them are monitored regularly and no evidence has been found that would justify a further reduction is required.

2. Technically and economically unfeasible

The ambient concentration of NO and NO2 in workplaces in the underground mines of the mining industry arises predominately from the ordinary utilisation of explosives and from vehicles and mobile machines equipped with diesel engines. The concentrations vary from mine to mine: in general, the exposure levels range for NO2 from between 1 and 3 ppm, up to 5 ppm as a peak value, and for NO from between 10 and 15 ppm, up to 25 ppm as a peak value.

Extraction by drill and blast method

Industrial explosives, which always meet the standards for best available technology, are used for advancing tunnels and for the extraction of raw materials. The type and quantity of explosives used are depending on the technological and geological conditions as well as on the type of raw materials to be extracted.

The mining industry is strongly interested – mainly driven by economic factors – to optimise the use of explosives and to make cost savings by:

- reducing the purchase costs of explosives,
- minimizing the powder factor (use of explosives per unit mass of crude salt),
- reducing the costs of drilling and blasting,
- reducing the costs for underground ventilation air flow.

Today's explosives used in mining have been steadily developed over the years and now emit much less NO and NO2 compared with previous generations of explosives.

The significant reduction of exposure to nitrogen oxides resulting from blasting is naturally associated with higher emissions of carbon monoxide, due to the chemistry of explosives. This comes into conflict with the current discussion on carbon monoxide limit values in the mining industry. The mining industry is keen to further encourage the manufacturers of industrial explosives to further reduce the formation of NO and NO2.

However, it is anticipated, that additional technically achievable reductions will not be sufficient to guarantee compliance with the currently proposed limit values for NO and NO2.

In addition to extraction by drilling and blasting, in some underground mines selective and full-cut heading machines are used when economic. For example, this procedure is preferred in the construction of headings, if it is technically possible, economically reasonable and where there is no risk to safety.

Therefore, in some areas prone to CO2 outbursts in the Hessian potash districts, extraction with partly unmanned (in the moment of initiation) drilling and blasting technology is applicable exclusively. Other technical alternatives to drilling and blasting do not exist. Henceforth, there will be an ongoing need for use of explosives in mining in future.

Ventilation engineering

One of the main energy cost factors in underground mining is ventilation. Therefore, mining companies strive to optimize ventilation systems. In this context, the clearance of work places at the face after blasting has to be considered. If the measurability of even lower limit values for NO and NO2 would be given, then there would be an additional ventilation clearing time period of approximately 60 minutes before the next shift could start working. This would result in significantly higher operating costs at all mines.

Extrapolated to the 4,000 employees in underground German potash and rock salt mines, with an average annual salary of about € 50,000 and 220 man shifts/year each of 8 hours/shift, this would lead to additional costs of € 25 million per year.

Furthermore, the total air flow in underground mines would need to be increased considerably. This would result in higher operating costs. In some cases, the increase in the total mine air flow would simply not be possible. Shafts, with their predetermined cross sections and air flow resistances, are limiting factors here and determine by far the largest share of energy consumed in underground ventilation.

Where this would be possible first indications would suggest in one case an estimated costs for measures in the ventilation system as investment costs for the extension of the ventilation system and automatic control of ventilation approx. 2.900 000 Euro (single cost) and additional operation and maintenance costs in the order of 700 000 Euro / year.
Moreover, the electricity supply for increased total air flow for mine ventilation would lead to higher CO2 emissions at power plants.

Use of diesel engines

In the mining industry, electric drives for mobile equipment have been used for decades. However, due to the geological conditions and the flexibility required of mobile machines, only limited possibilities exist for a further increase in the electrification level. An alternative for electric mining machinery powered via cables with battery-powered machinery is not possible due to the current state of battery technology in many mines.

For example, batteries, with its limited capacity and operating time, cannot power machines which has to be designed for cross weights of up to 80 tonnes used for an eight-hour operation on roadways with gradients of up to 28 % in potash mining. The potential to replace diesel-engined vehicles by electrically driven ones is therefore limited. In practice, diesel powered vehicles are needed mainly for the extraction of minerals as well as for material and personnel transport.

It is in the best interests of mining companies to use advanced diesel engine technologies and more efficient systems for exhaust after treatment. Nevertheless, the potential for reducing emissions from machinery with diesel engines is limited. In addition, the replacement of mobile equipment technology requires high investments, which is not to justify given the strong global competition in the mining industry.

In the hard coal mining industry, diesel-engined vehicles are mainly used for transport of materials and people. These vehicles cannot be replaced by another technology used in uneven areas. Highly efficient operations could no longer be supplied by necessary materials for capacity reasons. In level flat bedded areas, they could only be replaced at very high cost (about forty machines).

In the mining industry, the measures necessary to achieve the proposed limits for NO and NO2 are technically and economically not feasible. Reduction of NO and NO2 concentrations at underground workplaces to the proposed limits would have unsustainable economic impact for the affected mining activities.

Hard Coal Mining

- Production will be end by 2018. It is therefore necessary to evaluate all necessary actions in the light of this sunset date.

- For the remaining period up to 2018, cost increases of € 20 million can be expected based on the sixty ongoing conventional headings by blasting.

- Diesel-engined locomotives would have to be replaced by electric locomotives in flat bedded areas with costs of € 18 million. The lead times and necessary infrastructure upgrade would be disproportionate given the remaining life of the German hard coal mining industry to 2018.

- A substitution of diesel-engined monorails is not feasible due to the lack of alternative technology as well as the possible length of procurement and construction periods compared with the remaining life of the German hard coal mining industry to 2018.

Potash and Rock Salt Mining

In potash and rock salt mining, the ventilation air flow, theoretically, would have to be increased by a factor between 25 and 125 in order to comply with the proposed limit values for NO and NO2. In theory, this would be possible by building a large number of new shafts with large cross sections, as well as by numerous additional powerful ventilators. Practically, however, such an approach is not feasible. The sinking of new shafts would require an investment of several billion Euros – for a shaft with a depth of 600 metres, the construction cost can be estimated at 40 to 80 million € plus the cost of special production facilities and infrastructure. The supply of sufficient ventilation air would result in significantly higher energy costs and would require the construction of new power plants for the supply of electricity needed. This would lead to significant additional emissions of greenhouse gases (CO2) which would conflict with climate policy targets.

In addition, the increased ventilation air flows would lead to unacceptable underground air velocities with speeds of "hurricane force" in the shafts and drifts underground. Under such conditions, regular work would no longer be reasonable or even impossible. Therefore, legislation stipulates a maximum ventilation air speed of 6 m/sec in frequently operated underground roadways for man riding and transport to a maximum.

In addition to the aforementioned mining sectors, slate mining, fluorspar and baryte and other mines would have to be shut down.

Metal Mining

In metal mining the use of diesel engines is necessary. Today there are no alternatives for some operations. For example a fully loaded rock truck can have a weight more than 500 tonnes. Under these circumstances it's not possible to use electric alternatives. The mining industry welcome and support research and development about new alternative engines. There is cooperation between mining industry and vehicle industry in this purpose. Tests of new alternative liquids for example biofuels has been done. Measurements of the exhaust don't give reduction of the levels for NO, NO_2 , CO or carbon particles. Exhaust emission control like filter gives lower content of particles but sometimes a higher level of NO and $NO_{2.}$

Many metal mines in Europe are deep, 1000 meters or more. The ventilation system is very complicated in a mine and change from one day to another because of the mining procedure. The dimension and extension of the ventilation system is important today but it will be even more important if it should be possible to reach the purposed levels for NO, NO_2 and CO. The calculated cost for one mine for investment and extension of ventilation system is approx. 3 million Euro and increasing operation/maintenance is approx. 700 000 Euro / year.

The proposed short time level of 1 ppm is completely impractical with current technology due to machinery achieving peak levels at start-up.

3. Not measurable

In contrast to the summary document concerning NO2 dated June 2014 (SCOEL/SUM/53), there is no proof available that it is now possible to check compliance with the new recommended threshold limit value of 0.5 ppm by ambient measurement in the workplace. SCOEL stated in its summary document that a new measurement technology („sensor") with a lower detection limit of 0.04 ppm is available. This is not backed up by the scientific literature but instead by a particular company's technical specification. All available practical experience shows that even if the new sensors had the indicated sensitivity, calibration according to the state-of-the-art European Standard (CEN Norm EN 482) is impossible at this time. Consequently, all exposure results in the range of 0.5 to 1 ppm and below can only be regarded as qualitative and are therefore not suitable for compliance-checking against national or European threshold limits. Questions concerning the cross-sensitivity with mixed gases, which are generally found in mining operations, are also not answered.

Directive 98/24/EC "on the protection of the health and safety of workers from the risks related to chemical agents at work" dated 7 April 1998 regulates that the "limit values shall be established or revised, taking into account the availability of measurement techniques,...". The recommended occupational exposure limits for NO and NO2 can currently not be reliably monitored at the workplaces in any underground mining operation with the measuring technology presently available and practically in use.

The requirements of European Standard EN 482 include the expanded measurement uncertainty and the minimum measurement range of a device. For so called comparison measurements or monitoring measurements of limit values, minimum measuring ranges are generally required to be between one tenth and twice the limit value, wherein the relative uncertainty for values up to half of the limit value may be up to 50 % and for higher values up to 30 % and less. SCOEL also recognises the requirements of this European Standard: "It is accepted that no measurement difficulties are foreseen when the limit of quantification of the method fits the requirement set by the EN 482 to be above a tenth of the OEL proposed. " (SCOEL, METH, 2013, p. 15). The instruments, currently used, can measure values for NO and NO2 at a level of 1 ppm (detection limits of direct-indicating method). Therefore, when determining the proposed 0.5 ppm NO2-OEL a concentration of 0.05 ppm must be measurable with a defined and reliable accuracy.

Conclusion

The indicative limit values for NO and NO2 at workplaces of 2 ppm and 0.5 ppm recommended by SCOEL are scientifically insufficiently justified, technically not measurable and controllable and neither technically nor economically feasible from the perspective of the extractive industry. With respect to the final decision on proposals for the indicative exposure limits for NO and NO2 at work, the industry calls for:

- recognition of the results of the studies conducted on the effects of NO and NO2 exposure to humans at higher exposure levels;
- consideration of the technical measurability and controllability of NO and NO2 in underground mines in reality;
- account to be taken of the technical and economic feasibility of the indicative limit value proposals in underground mining in Europe.

In case that the occupational exposure limits for NO and NO2 recommended by the SCOEL were to be ultimately adopted at these levels, then the affected extractive industry would have really big problems to remain competitive in a global market. It would lead to economically unjustified investments and higher operating costs which would cause sudden and permanent losses for mining companies. Probably some mines (especially small companies which are more exposed to competition) would have to be shut down. The impact on the employment situation in Germany alone would be significant:

- Approximately 30,000 direct employees in the underground mining industry in Germany would lose their jobs;
- Approximately 60,000 indirect employees, especially in structurally weak regions, would be affected.

The present recommendations for NO and NO2 exposure limits jeopardise at least 90,000 jobs in Germany. Since these jobs would be mostly lost in structurally weak regions, considerable structural problems would arise due to the loss of business.

In terms of the foregoing arguments, the mining industry cannot accept the intended reduction of the indicative limit values for NO and NO2 at workplaces.