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## Exposure to nitrogen oxides (NO/NO<sub>2</sub>) in welding

Dr.-Ing. Spiegel-Ciobanu, Vilia Elena  
Chairman of the section „Hazardous substances in welding and allied processes“  
in the BG expert committee „Metal and surface treatment“ of the DGUV



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## ■ Exposure to nitrogen oxides (NO/NO<sub>2</sub>) in welding

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## ■ Exposure to nitrogen oxides (NO/NO<sub>2</sub>) in welding

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## ■ Introduction

The Scientific Committee on Occupational Exposure Limit Values (SCOEL) under the EU Commission recommended an occupational exposure limit (**OEL**) value for **nitrogen dioxide** of **0,2 ppm** as 8 hour TWA and 0,5 ppm as STEL (15 min) in 1994.

SEG summary document mentions that nitrogen dioxide can cause genotoxic effects in vitro and in vivo.

Existing limit value in EU-countries: 2 - 5 ppm.

## ■ Introduction

This is based on short-term exposure data from different studies, as for example:

- a study by Bylin (1985) about effects of exposure to ambient nitrogen dioxide concentrations on human bronchial reactivity and lung function;
- the study by Frampton (1989) concerning the nitrogen dioxide exposure in vivo and human alveolar macrophage inactivation of influenza virus in vitro;
- the study by Sagai and Kubote (1984) on the biochemical effects on rats exposed to nitrogen dioxide.

## ■ Introduction

In January 2003, SCOEL recommended **0,2 ppm** as 8 hour TWA also for **nitrogen monoxide** as a result of the evaluation of different studies:

by Högman (1993), Frostell (1993), Mercer (1995) Azoulay (1977) and others.

- Most of these studies are based on animal experiments
- new studies initiated and carried out by the industry

At that time, the existing occupational limit value in different European countries was 25 ppm.

## ■ Generation of nitrogen oxides in welding and allied processes

Mixtures of nitrogen oxides ( $\text{NO}_x$ , NO and  $\text{NO}_2$ ) also called nitrous gases, are formed in different amounts and compositions as a function of the welding process and working conditions.



The time for conversion of NO to  $\text{NO}_2$  in air depends, however, of the concentration as well as the temperature.

Typical emission rates, according to the process, was reported by Eric Beck Hansen.

## ■ Occupational exposure to nitrogen oxides in welding

Exposure to NO,  $\text{NO}_2$ ,  $\text{NO}_x$  depends on:

- the type of processes used, e.g. on the typical emission rate for the process/material combination
- the large number of parameters at the workplace
- the workshop background level; the height of the exposure level can sometimes also be influenced by the background.

The highest hazard related to nitrogen dioxide ( $\text{NO}_2$ ) is present especially in oxyacetylene processes as flame heating, flame gauging, flame hardening, flame descaling, flame spraying. Here, very high  $\text{NO}_2$  emissions are generated. For these processes, excess of the limit values up to several times the magnitude for  $\text{NO}_2 = 5 \text{ ml/m}^3$  can be anticipated.

## ■ Health hazards and intoxication symptoms

Nitrogen oxides have a toxic effect when in contact with mucous membranes (eyes, nose, respiratory tract) and may lead to severe damage of the lung tissue.

In extreme cases, fatal poisoning (lung oedema) may result.

Different symptoms can indicate a first stage or an advanced stage of the intoxication by nitrous gases.

## ■ Occupational diseases

A research in the documentation of occupational diseases in the period from 1978 to 1996 for the occupational disease BK 4302

**“Obstructive diseases of the respiratory tract caused by chemically irritant or toxic substances”** shows:

that in spite of the classification under the subject index nitrogen dioxides, the disease could not be unambiguously attributed to the exposure to nitrogen oxides in any of these cases.

## ■ Studies concerning NO and NO<sub>2</sub> (limit value discussion)

Author	A. <u>Exposure to NO in humans</u>
Högmann et.al.	80 ppm for 10 min, no changes occurred in relation to effects on airway resistance
Frostell et.al.	40 ppm for up to 10 min, no effects occurred on vascular tone in either the pulmonary or systemic circulation
B. <u>Exposure to NO in animals</u>	
Mercer et.al.	Rats exposed continuously for 9 weeks, to 0,5 ppm NO and 2x 1,5 ppm, slight pulmonary structural changes(light microscopy), suggestive of the early stages of development of emphysema
Azoulay et.al.	Rats exposed continuously for 6 weeks to 2 ppm; animals lungs revealed some evidence of „emphysema –like“ changes(light microscopy); electrone microscope observations inconclusive

## ■ Studies concerning NO and NO<sub>2</sub> (limit value discussion)

Author	B. <u>Exposure to NO in animals</u>
Hyde D. et.al.	Dogs exposed(ten beagles) to 1,64 ppm NO (with 0,14 ppm NO <sub>2</sub> ) for 16 h/day for 68 months; alveolar air space enlargement, destruction of alveolar septa, observations indicative of „emphysema-like“ changes.
Oda H. et.al.	Mice continuous exposure to 2,4 ppm NO for 23 months; no pulmonary structural changes.
C. <u>Exposure to emission mixture in human</u>	
Lotz G. et.al.	One study on a group of 402 German salt miners exposed to salt dust, diesel exhaust emissions, NO, NO <sub>2</sub> , CO, CO <sub>2</sub> ; little evidence of serious respiratory problems.

## ■ Studies concerning NO and NO<sub>2</sub> (limit value discussion)

Author	Exposure to NO <sub>2</sub> in human
Frampton M.W. et.al.	In 4 of 9 healthy volunteers, exposure to 0,6ppm NO <sub>2</sub> for 3 h reduced the efficiency of macrophages to inactivate influenza virus
Chaney S., et.al.	Exposure of volunteers to 0,2 ppm NO <sub>2</sub> for 2h, an increase in blood glutathione content
Bylin G., et.al.	Exposure of volunteers to 0,26 and 0,5 ppm NO <sub>2</sub> for 20 min. on 4 separate days; changes in airway resistance
Rubinstein I., et.al.	Short-term exposure of healthy volunteers to 0,6 ppm NO <sub>2</sub> ; small rise in the proportion of natural killer cells in the broncho-alveolar lavage fluid
Exposure to NO <sub>2</sub> in animals	
Henschler D.,et.al.	Mice exposure to 40 ppm NO <sub>2</sub> showed no evidence of carcinogenicity in Nuclear Magnetic Resonance Imaging

## ■ Studies concerning NO and NO<sub>2</sub> (limit value discussion)

Author	Exposure to NO <sub>2</sub> in animals
Sagai M., et. al. Kubota K., et.al	Exposure of rats to 0,4 ppm NO <sub>2</sub> continuously for 27 months; biochemical and morphological changes in the lung
Isomura K.,et.al.	Rats exposed to NO <sub>2</sub> ; dose-dependent increases in mutations and in chromosome aberrations were seen in the lung cells
Kuraitis K.V., Richters A.	Short –term exposure of mice to 0,25 ppm NO <sub>2</sub> ; significant decrease in peripheral blood lymphocytes
Adkins B., et.al.	A/J mice exposed to 10 ppm NO <sub>2</sub> for 6 months; a small increase in lung adenomas (result is not consider biologically significant because of the susceptibility of mouse to lung adenomas)

## ■ Protective measures

- Reduction of the emission of nitrous gases
- Water protection equipment
- Ventilation
- Additional protective measures in confined spaces
- Other measures

## ■ Conclusion

- It is important to eliminate or to reduce the exposure to nitrogen oxides in welding and allied processes by means of appropriate local extraction or other type of ventilation, or by using of respiratory protective equipment, even sometimes this is difficult, according to the conditions at the workplace.
- The reduction of the current maximum workplace concentration to 0,2 ppm which is being discussed on EU level will lead to a regular excess of limit value for a great number of workplaces, especially in oxy-acetylene and plasma processes.



Thank you for your attention!