Formaldehyde
Strategy for compliance with occupational exposure limits in the engineered wood industry

Action Guide - Background and principles

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Berufsgenossenschaft Holz und Metall (BGHM)

- statutory accident insurance for the German wood- and metalworking industry
- corporation under public law
- assumes the employer’s liability of about 220,000 companies
- accident insurance for more than 4.5 Mio. employees

- **DGUV** - umbrella association of the German accident insurances
### basic „operating figures“ of the BGHM

<table>
<thead>
<tr>
<th>Category</th>
<th>end 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>enterprises</td>
<td>215.147</td>
</tr>
<tr>
<td>employees</td>
<td>4.734.901</td>
</tr>
<tr>
<td>expenditure</td>
<td></td>
</tr>
<tr>
<td>Pensions to employees und surviving dependants</td>
<td>1.154 Mio. EUR</td>
</tr>
<tr>
<td>Restoration of health (rehabilitation) and payments</td>
<td>521 Mio. EUR</td>
</tr>
<tr>
<td>Prevention</td>
<td>197 Mio. EUR</td>
</tr>
<tr>
<td>Staff of the BGHM</td>
<td>3.285</td>
</tr>
</tbody>
</table>
Designation and structure:

Formaldehyde
chem. compound: Methanal

CH$_2$O

Formaldehyd
(CAS-Nr.: 50-00-0)
Occurrence:

- Mammalian cells
- Intermediate product in metabolism
  Approximately 50 grams are formed and degraded per day in humans
- Photooxidation in the atmosphere
- in fruits such as apples or grapes
- Wood

Formation:

- incomplete burns
- Oxidation processes of organic substances
Formaldehyde - chemical characteristics:

- **Molar mass**: 30.03 g/mol
- **Physical state**: gaseous
- **Density**: 0.82 g/cm³ (~20 °C)
- **Melting point**: ~117 °C
- **Boiling point**: ~19 °C
- **Vapour pressure**: 0.43–0.44 MPa (20 °C)
- **Solubility**: easily soluble in water
  => Use almost exclusively as aqueous solution
- **Production**: BASF ca. 600,000 t/Jahr
  EU approx. 4 Mio t/Jahr
  worldwide approx. 21 Mio t/Jahr
Formaldehyde - characteristics and effects

- colourless, pungent smelling gas
- toxic by inhalation, ingestion and contact with skin
- odour threshold: 0.05 - 1 ppm
- Threshold concentration for nasal and pharyngeal irritations: ca. 1 ppm
Formaldehyde - characteristics and effects

- Irritates eyes, skin and respiratory tracts
- Skin sensitizing effect
- Threshold concentration for nasal and pharyngeal irritations: ca. 1 ppm
- Threshold value Eye irritation: 0.5 - 1 ppm
- Irritation of tears: 4 - 5 ppm
### New classification of formaldehyde:

with the 6th ATP of the CLP regulation, (EU) No. 605/2014:

<table>
<thead>
<tr>
<th>CMR characteristic</th>
<th>Classification of the substance</th>
<th>Classification of the mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>mutagenicity</td>
<td>Muta. 2; H341</td>
<td>Konz. ≥ 1 % Muta. 2; H341*</td>
</tr>
<tr>
<td>carcinogenicity</td>
<td>Carc. 1B; H350</td>
<td>Konz. ≥ 0,1 % Carc. 1B; H350*</td>
</tr>
</tbody>
</table>

valid from: 01.01.2016
Occupational exposure limit value (OELV):

Germany: published in March 2015 in the TRGS 900 to the Gefahrstoffverordnung
(german ordinance on hazardous substances)

<table>
<thead>
<tr>
<th>substance identity</th>
<th>OEL</th>
<th>peak limitation</th>
<th>change date</th>
</tr>
</thead>
<tbody>
<tr>
<td>formdehyde</td>
<td>200-001-8</td>
<td>0.3</td>
<td>0.37</td>
</tr>
</tbody>
</table>

The german ‘Gefahrstoffverordnung’ does not have a deadline for the implementation of new classifications!

10 EU countries have already implemented an OEL of 0.3 ppm (Czech Republic, Germany, Sweden, Belgium, Finland, Denmark, Italy, Spain, Slovakia, and Portugal)
Shift mean value:

- occupational exposure limit (OEL): 0.3 ppm (0.37 mg/m³)
  - first OEL for a carcinogenic hazardous substance !!!
  - indicates the concentration of a substance at which acute or chronic adverse health effects are not expected to occur in general (§ 2 Abs.7 GefStoffV)
- Time Weighted Average (TWA) values for usually daily eight-hour shift

- Short term Exposure Limit (STEL) peak limitation for one shift
  - peak limit value 2:
    => per shift 4x15 min. max. 0.6 ppm (0.74 mg/m³)

- Important: the TWA value must always be observed!
Activities with CMR -substances:

- „special precautions“ in activities with substances Carcinogenic, Mutagenic and toxic to Reproduction (GefStV)
- if OEL formaldehyde cannot be safely maintained:
  - Substitution requirement: Substitution with less hazardous substances
  - Minimisation requirement: Continuously reducing the extent of exposure
  - No return of extracted air to work areas (TRGS 560)
  - Exposure assessment, must be carried out and documented
  - Hazardous areas, defining and marking (No access for unauthorized persons)
  - Personal protective equipment, provide and use
  - occupational medical precaution must be offered
Support and activities of the BGHM:

• **Exposure assessment**
  Exposure descriptions for individual branches by evaluating the measurement data latest for carpentry, furniture industry, …
  ([www.bghm.de/de/arbeitsschutz/fachinformationen/gefahrstoffe-und-biologische-arbeitsstoffe/](www.bghm.de/de/arbeitsschutz/fachinformationen/gefahrstoffe-und-biologische-arbeitsstoffe/))

• **Control measurements** by BGHM possible

• **Selection of measurement methods**

• **Exposition register** (TRGS 410)
Situation in the engineered wood industry:

- Existing, partly decades old plants
- Sometimes significant exceedances of limit values
- Substitution of formaldehyde currently not feasible
- Technical protective measures:
  - High time and cost expenditure for implementation
  - Must be individually adapted
  - Effectiveness difficult to predict
  - After-treatment of the extracted air required
- Loads not continuous and constant
- Difficult exposure assessment

=> Action Guide
Objective of the Action Guide:

Protection of workers from over-exposure

Content:
- Description of framework conditions for plant operators
- Procedure for risk assessment
- Carrying out the exposure assessment
- Selection of suitable measurement methods
- Necessary safety precautions
Strategy for compliance with the new limit values:

**Determination and identification of the work area**

**Green:**  
< 0.3 ppm - OEL (occupational exposure limit) is safely maintained  
- free access without time limit  
- no protective precautions required

**Green/Red:**  
0.3 ppm ≤ 0.6 ppm - STEL (Short term Exposure Limit)  
- stay restrictions  
- Protective masks must be carried with you

**Rot:**  
> 0.6 ppm - OEL is exceeded  
- obligatory wear of protective masks when entering

=> Employees are enabled to identify critical areas and protect themselves
Example: Forming line:

Sub-division of working areas:

advantage:  
- Employees can identify risk areas
- Protective measures can be adapted to exposure
- Basis for further measures

disadvantage:  
- increased determination effort
- Variations according to product, process and time
**Protection hierarchy:**

**S-T-O-P principle:**

- Substitution
- Technical:
  - Enclosure, extraction
  - Prohibition of air return
  - ...
- Organizational
  - Access restrictions
  - Labelling
  - Training and instruction of employees
  - Exposure register
  - ...
- Personal protective equipment
  - If necessary, wearing obligation for PPE,
  - Occupational medical precaution
  - ...
**Personal protective equipment:**

- **Half masks**
  + light
  + low breathing resistance
  + can be "stored" on the man
  - limited use

- **Full-face masks**
  + good protection
  - high breathing resistance
  - heavy
  - medical examination necessary
  - low acceptance

- **Full-face masks with supporting fresh air**
  + good protection
  + no breathing resistance
  - heavy
  - medical examination necessary
  - increased costs
Résumé:

The Action Guide enables:

• systematic protection of employees against formaldehyde
• Sensitisation and visualisation for employees
• Basis for targeted further protection measures (S-T-O-P)
• standardised procedure in all plants
Thank you for your attention!

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