Healthy Workplaces Campaign 2018-19
Manage Dangerous Substances in the Workplace
HWC Summit 2019, Bilbao
Efficient Practices of Prevention in the German Chemical Industry
Today and Tomorrow

Dr. Stefan Engel, BASF SE
on behalf of the VCI Working Group Industrial Hygiene

www.healthy-workplaces.eu
Agenda

- Introduction

- Industrial Hygiene in Practice
  - Fundamentals
  - Example of Good Practice

- Challenges
  - New and Decreasing European and National Binding Occupational Exposure Limit Values (BOELV)
  - Consequences for Exposure Assessment and Control Concepts

- Conclusions
BOELVs for Carcinogenic Substances
Numerous New or Revised BOELVs Derived in the Past 2 Years

BOELV = Binding Occupational Exposure Limit Value
Risk assessment is the well-established tool and …

- requires comprehensive information about substance properties and exposure determinants.
- is the basis for suitable and efficient exposure control.
**Substitution**
- substitution preferred
- otherwise, risk has to be minimized

**Technical Measures**
- constructional measures (segregation), technical ventilation, local exhaust ventilation, containment, etc.

**Organisational Measures**
- minimize frequency and duration of task
- minimize number of persons being exposed
- information/supervision and training

**Personal Measures**
- behaviour-based safety programs
- personal protective equipment
Industrial Hygiene in Practice (1/2)
Example: Connecting/Disconnecting Transfer Lines
What Counts:

- Risk assessment in the workplace needs to take a holistic approach.
- All workplace hazards must be adequately controlled.
- Exposure routes are decisive for suitable control concepts.
- Exposure to a chemical substance may be less critical as other workplace hazards.
- Combination of different controls measures is usual.
Occupational Exposure Limits: Continuously Decreasing over Time

Examples: 2005 - Today

**Acrylonitrile**
- **TGC =** Technical Guidance Concentration
- **AC =** Acceptable Concentration
- **BOELV =** Binding Occupational Exposure Limit Value

<table>
<thead>
<tr>
<th>Year</th>
<th>TGC (mg/m³)</th>
<th>TC (mg/m³)</th>
<th>AC (mg/m³)</th>
<th>BOELV (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>7</td>
<td>2,6</td>
<td>0,26</td>
<td>1</td>
</tr>
<tr>
<td>Today</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Benzene**

<table>
<thead>
<tr>
<th>Year</th>
<th>TGC (mg/m³)</th>
<th>TC (mg/m³)</th>
<th>AC (mg/m³)</th>
<th>BOELV (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>3,25</td>
<td>1,9</td>
<td>0,2</td>
<td>0,66</td>
</tr>
<tr>
<td>Today</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Nickel** (respirable fraction)

<table>
<thead>
<tr>
<th>Year</th>
<th>TGC (mg/m³)</th>
<th>TC (mg/m³)</th>
<th>AC (mg/m³)</th>
<th>BOELV (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0,5</td>
<td>0,006</td>
<td>0,006</td>
<td>0,01</td>
</tr>
<tr>
<td>Today</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TGC = Technical Guidance Concentration
AC = Acceptable Concentration
BOELV = Binding Occupational Exposure Limit Value

www.healthy-workplaces.eu
Air Monitoring

- Air monitoring methods must be improved to assess exposure against decreased threshold limit values.

**AC Monitoring**
- not suitable
- conditionally suitable
- suitable

**TC Monitoring**
- not suitable
- conditionally suitable
- suitable

AC = Acceptable Concentration
TC = Tolerable Concentration
Experiences from the German Risk Acceptance Concept (1/3)

Air Monitoring

- AC Monitoring
- TC Monitoring

- not suitable
- conditionally suitable
- suitable

AC = Acceptable Concentration
TC = Tolerable Concentration

Human Biomonitoring Example Benzene

Equivalence Values

TC
- 25 µg/g creatinine
- 2.5 AC

Background Values of General Population (95th percentile)

- non-smoker: 0.3 µg/g creatinine
- smoker: 3 µg/g creatinine

Limit of quantification of HBM method for benzene similar as the background values of the general population.

- Air monitoring methods must be improved to assess exposure against decreased threshold limit values.
Experiences from the German Risk Acceptance Concept (1/3)
Consequence: Monitoring Methods Partly not Applicable Anymore

Air Monitoring
- AC Monitoring
- TC Monitoring
- not suitable
- conditionally suitable
- suitable

AC = Acceptable Concentration
TC = Tolerable Concentration

Limit of quantification of HBM method for benzene similar as the background values of the general population.

Human Biomonitoring
Example Benzene
Equivalence Values
TC
25 µg/g creatinine
2.5 µg/g creatinine

Background Values of General Population (95th percentile)
- non-smoker
- smoker
0.3 µg/g creatinine
3 µg/g creatinine

Air monitoring methods must be improved to assess exposure against decreased threshold limit values.
Experiences from the German Risk Acceptance Concept (2/3)

Examples

- **OEB 5**: < 0.001 mg/m³
  - Benzotrichloride, Cr(VI) compounds

- **OEB 4**: 0.001 – 0.01 mg/m³
  - Co and Co compounds, Ni compounds, Hydrazine

- **OEB 3**: 0.01 – 0.1 mg/m³
  - Acrylamide, 4,4´-Methylendianiline

- **OEB 2**: 0.1 – 1 mg/m³
  - 1,3-Butadiene, 1,2-Dichloroethane, Ethylenoxide, 2-Nitro-propane

- **OEB 1**: 1 – 5 mg/m³
  - Caveat: Specific exposure situations for liquids not exhaustively reflected.

OEB stands for Occupational Exposure Band (Pharmaceutical Industry).
Experiences from the German Risk Acceptance Concept (3/3)

Consequence: OEB 1 and OEB 2 is Standard in Chemical Industry

OEB 1 requires …
- technical ventilation
- local exhaust ventilation (LEV)
- often closed equipment

OEB 2 requires …
- technical ventilation
- local exhaust ventilation (LEV)
- often closed equipment

OEB 3

OEB 4

OEB 5

Increasing Technical Requirements

Occupational Exposure Band (Pharmaceutical Industry)
Experiences from the German Risk Acceptance Concept (3/3)

Consequence: OEB 3 - 5 Requires Technical High-End Solutions

OEB 3 or better requires …

- closed certified equipment
- in addition use of isolators at interfaces (OEB 4 and 5)
- technical ventilation
- additional ventilation (e.g. LEV, downflow booth, etc.)
- often secondary containment

[Diagram showing Occupational Exposure Band (Pharmaceutical Industry) with increasing technical requirements from OEB 1 to OEB 5.]
Improving Primary Containment in Practice
Example: Loading of Solids into Big Bags and Small Packages (OEB 3)

Big Bag Loading

Filling of Small Packages
Improving Primary Containment in Practice
Example: Dryer Equipped with Isolator (OEB 4)

Example from Pharmaceutical Industry
Conclusions

- Safety and Health is key for successful and sustainable production in German chemical industry.

- We follow the hierarchy of controls and implement it.

- Continuously decreasing occupational exposure limit values however are very challenging and will lead us to the limits of feasibility.

- The results of impact analyses including technical feasibility must be considered in the process of setting occupational exposure limit values.

- Continuous improvement of monitoring methods and technical control measures are required.

- Improving primary containment does include R&D efforts of machine and equipment suppliers.

- Flexible combination of all types of controls including personal protective equipment is necessary and must be covered by European legislation.
Dr. Stefan Engel
BASF SE
Director Industrial Hygiene
stefan.engel@basf.com

Disclaimer

This presentation has been issued by VCI (Verband der Chemischen Industrie e.V.) in October 2019 for sharing with participants of the Healthy Workplace Campaign Summit, 12th and 13th November 2019, Bilbao. It neither claims to be exhaustive nor to be applicable to all different workplaces in member companies.

The copyright for the figures lies with the companies that provided them for the sole purpose of performing and showing this presentation during the workshop.
No representations or warranties are made with regards to its completeness or accuracy and no liability will be accepted by anyone having prepared this presentation, including VCI and its members, for damages of any nature whatsoever resulting from the use of or reliance on the information. This does not apply if damage was caused intentionally or by gross negligence by VCI or by parties assisting them or in case of bodily harm and damage caused to health or life.
Efficient Practices of Prevention in the German Chemical Industry
Today and Tomorrow

Thank you!