CBRN Decontamination

State-of-the-art solutions
Agenda

- Factors affecting the decon efficiency
- The Family of CBRN Decontamination Agents
- Specific Technological Solutions for Decontamination of Sensitive Equipment
- Decontamination Systems
- Conclusion
Factors affecting the decon efficiency

Contamination
- Information about the contamination
- Kind of contaminants
- Contamination level (g/m²)

Decon conditions
- Character of the subject to be decontaminated
  - Temperature
  - Sunlight
  - Rain
  - Wind
  - Time
  - Humidity

Subject of decon

Subjective factors
(human factor)
- Psychological
- Physiological
- Personal (quantity)
- Training level

Regulations

Decontamination technology
- Decon procedure
- Decon hardware

Decontaminants
- Decon chemicals
- Specific properties
- Limitations
The Family of CBRN Decontamination Agents by Kärcher Futuretech
(1) One universal chemical agent for C, B and RN decon

(2) Or a complete family of highly effective rapid-action agents for the

- removal of radioactive contamination,
- inactivation of relevant pathogenic microorganisms and
- detoxification of highly toxic chemical warfare agents
The family of CBRN decontaminants

CBRN Decon Agents

- C decon agent
- B decon agent
- RN decon agent

CBRN decon agent

GDS 2000  BDS 2000  RDS 2000

CBRN decon agent

RM 21

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Temperature range for the application

CBRN Decon chemicals

NATO requirement:

-30 °C to +49 °C

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GDS 2000

C decontaminant
- non-aqueous decon agents
- developed by Kärcher
- industrially produced
- ready for use
- for quick and effective decon of all known CWA (incl. thickened CWA)
- decon effects comparable to those of decon emulsions and DS2
- logistically easier to handle
- completely transform the CWA within one or a few minutes
- good material compatibility
- usable with all DS2 applicators
- effective even on wet surfaces
- biodegradable
- water pollution class 1 (low hazard for water)
Amount of decontaminants needed for decon of one tank:

- **German Emulsion**: 200 - 600 litres, 10 - 30 min
- **TDE 202 Emulsion**: 200 - 600 litres, 10 - 30 min
- **GDS 2000**: 12 - 24 litres, 5 - 10 min
DECONTAMINATION

- DECOCONTAIN
  - 20" Containerised Decontamination System
Test Results - Decon efficiency against CWA (in %)

<table>
<thead>
<tr>
<th>Kind of coating</th>
<th>THD</th>
<th>TGD</th>
<th>VX</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUR (CARC)</td>
<td>99.1</td>
<td>99.1</td>
<td>&gt;99.9</td>
</tr>
<tr>
<td>Alkyd (NCARC)</td>
<td>99.95</td>
<td>99.9</td>
<td>&gt;99.97</td>
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</table>

Test Conditions:
- CWA challenge: 10 g/m²
- Exposure time: 180 minutes
- Amount of GDS 2000: 0.1 - 0.2 ltr/m²
- Reaction time: 10 minutes
BDS 2000

B decon agent system
Examples for Hazardous Concentrations

- **Smallpox**: only few virons could induce disease = decontamination to 100 virons/m² not acceptable

- **Anthrax**: Infectious dose (inhaled) may be about 10.000 spores = decontamination to 100 spores/m² is said to be a safe level

- There is no possibility to check contemporary the decontamination level

- A safe level is near sterile conditions
Which is the most effective Agent?

- Peracetic acid (PAA) is the only active agent which does not show any gap against any kind of microbial pathogens

- Resistances have never been observed for PAA

- Effective even at low temperatures in contrary to aldehydes, organic acids and chlorine separators
Schemabild der mikrobiziden Wirkung von A) Wasserstoffperoxid (WPO) und B) Peressigsäure (PES)

A) WPO - Angriff
- Deaktivierung des AO am Katalase-Schutzschild

B) PES - Angriff
- Durchdringung des Katalase-Schutzschildes

Wasserstoffperoxidmolekül
- Aktivsauerstoff molekular gebunden
- Aktivsauerstoff in Aktion

Peressigsäuremolekül
BDS 2000

- B decontaminant system bases on a special thermally stable peracetic acid (SC 250) and a buffer system (Alcapur)

- Possible to apply the new B decontamination system in two different ways:
  → foam
  → fog
Peracetic acid (PAA)

Highly effective microbiocide, kills viruses (enveloped and non-enveloped), bacteria, spores (incl. anthrax) and fungi

Rapid effect at low concentration

Highly effective at low temperature

Harmless residue and environmentally safe (Residuals are acetic acid, water and oxygen)

By adding a liquid buffer additive the corrosion is inhibited and the odour is minimised

\[
\text{PAA} = \text{CH}_3\text{COO}^-\text{OOH}
\]
After Usage of BDS 2000
RDS 2000
RN decontaminant
new highly effective RN decon agent

common development of WISABC-SchutzBw and Kärcher

specific combination of an aqueous surfactant solution system with appropriate complexing agents, oxidants or other auxiliary substances

two-component concentrate with
  - sugar surfactant polyglucosides and
  - citric acid - citrate buffer

application as decon foam with HP decon modules

water pollution class 1 (low hazard for water)

biodegradable

compared with other RN decontaminants RDS 2000 shows a considerably higher level of efficiency
Decon tests with La-140

Contamination: 100 %

Residual contamination after decon: < 1 %
Residual Radioactivity after RN Decon with different Decon Agents

- RDS 2000
- TT/Citr.
- A1/A2

Reaction Time [min]
RM 21 – Cleaning Agent for persons

RM 21

- **Range of application:**
  - Neutral cleaning agent for persons

- **Active ingredient:**
  - Non-ionic surfactants
  - Isopropyl alcohol
Customer benefit:

- Cleaning result
  - Extreme chemical resistance against hardening salts of water as well as against alkalis, acids and oxidizing agents
- Usage
  - Mild, dermatologically tested on human skin in accordance to the cosmetic guidelines of the European Union
Specific Technological Solutions for Decontamination of Sensitive Equipment
CBRN System survivability

Hardness

Decontaminability  Compatibility

Subject to be decontaminated

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Vacuum decon technology

Vacuum process for decon of sensitive personal equipment

C decontamination
- by removing chemical warfare agents up to 10 g/m² by evaporating and desorption from the surface of the equipment
- immobilization of the CWA vapour in the CBRN filter unit
- temperatures up to 70 °C limited by the thermal resistance of the personal equipment
- vacuum down to 1 Pa (vapour pressure of VX: 14 Pa at 20 °C)

B decontamination
- by degrading biological warfare agents and vectors (insects etc.) by pressure induced impact of gaseous PAA based decontaminant BDS 2000
- temperatures up to 70 °C limited by the thermal resistance of the personal equipment
- vacuum down to 1 Pa, dosing of gaseous B decontaminants, depending on their specific properties at higher pressure levels
Decon mechanism C decon process

contamination → (semi-) dry decontamination

absorption

cut view of housing at a sealing edge

vacuum process
Tests carried out show for C contaminated subjects (CWA challenge: 10 g/m²) after the vacuum decon procedure a residual content and a desorption rate of CWA that can be below the relevant NATO test criteria (acc. STANAG 4360) depending on the equipment properties, kind of warfare agent to be decontaminated and decontamination conditions (vacuum, temperature).

The vacuum decontamination technology represents practically a chemical-free “dry” decontamination of CWA.

After the vacuum chamber is being loaded with the relevant sensitive equipment the decontamination procedure runs practically automatically so that the personnel requirement is low in comparison.

The C decontamination is based on removing chemical warfare agents by evaporating and desorption from the surface of the equipment by

- temperatures up to 70 °C (limited by the thermal resistance of the sensitive electronic equipment) and
- vacuum down to 1 Pa (0.01 mbar).

For security reasons the removed gaseous products are immobilized in a special CBRN filter unit.
The Spore - the microbiological fortress

- 7 nearly water free, chemically and thermically resistant barriers need to be penetrated before reaching DNA
- Affecting by high concentration of strong oxidants led to a nearly impermeable layer of oxydanted spore elements
- Additional strategies to effectively inactivate the spores by affecting the DNA are needed

Source: Structure of a gram positive ripe spore according Schlegel [4], p.80f.
Mechanism of the B decon process

- **Vacuum based B decon technology**
- **Vacuum chamber**
- **Dosing of vaporized PAA**
- **Vacuum process**
- **Spore**
- **Destroying the DNA**
- **Passing through the wall**
# Vacuum based B decon technology

## B decontamination tests

| **Test microorganism:** | **Bacillus subtilis (ATCC 6633)**, produced in acc. DIN EN 14347.  
BWA challenge: $1 \times 10^7$ CFU/m² (AEP-7, Ed. 5, 6-10, 4.) |
|-------------------------|------------------------------------------------------------------|
| **Equipment:**          | Vacuum decontamination module VDM 135  
with integrated low temperature vaporizer module  
for selective evaporation of the B decontaminant |
| **B decontaminant:**    | BDS 2000 component 1  
NSN 6850-12-373-5844 (thermally stabilized PAA formulation) |
| **Temperature:**        | 70 °C |
| **Process time:**       | 28 min |
| **Sporocidal effect:**  | Kill rate $> 1 \times 10^7$ CFU/m² determined on the basis of DIN 58933-3 |
Free programmable process parameters
- body temperature: ambient up to 200 °C
- surface temperature (direct heating by IR-emitter) up to 150 °C
- preheating time, several process step times and flush times with associated evacuation levels
- B decontaminant dosing measuring the partial pressure increase
- self decontamination and recovery programs

VDM 135
1 main switch/ emergency off
2 process start button
3 signal lamps filling nozzle for B decon agent
4 display for chosen program, remaining time current pressure etc.
5 manometer
6 filling nozzle for B decon agent
7 infrared emitters
8 vacuum chamber, capacity 135 litres
9 guidings for basket for sensitive equipment
10 front door with handle for white and black side

Product Family

VDM 135
L x W x H: 900 x 800 x 900 mm
P: 7 kW
M: 400 kg

VDM 265
L x W x H: 1,200 x 800 x 1,650 mm
P: 11 kW
M: 650 kg

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Implementation in delivered decon systems

- **DSSM**
  - View: “dirty side”
  - View: “clean side”

- **TEP 90**
  - Charging with contaminated sensitive equipment

- **VDM 135**
  - Module for sensitive equipment in working position

- **VDM 265**

- **LDS**
  - Lightweight Systems for DSO

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Development Vacuum-Decontamination

- automated cubical form
- small loading basket
- Not for large scale decontamination of devices
- secure procedure

Optimization of the procedure based on recent research and experience

- better heat transfer / perfusion
- more efficient exploitation / less weight

since 2005

since 2009
Decontamination Systems by Kärcher Futuretech
CBRN Protection Systems Decon Devices

**Spraying Devices**

- **DS 10**
- **DS 10 S**
- **DS 5**
- **AMGDS Mini**

**Fogging Devices**

- **Swingfog SN 50**
- **Turbo Sprayer**

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<table>
<thead>
<tr>
<th>CBRN Protection Systems Dekontamination Modules</th>
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<tbody>
<tr>
<td><strong>HP- Modules</strong></td>
</tr>
<tr>
<td>MPDS</td>
</tr>
<tr>
<td>JSTDS-SS</td>
</tr>
<tr>
<td>SCS 1801 DE</td>
</tr>
<tr>
<td><strong>Application</strong></td>
</tr>
<tr>
<td>AMGDS 1000</td>
</tr>
<tr>
<td>AMGDS 2000</td>
</tr>
<tr>
<td>Decon Shuttle</td>
</tr>
<tr>
<td><strong>Water Heating</strong></td>
</tr>
<tr>
<td>HWM 3000</td>
</tr>
<tr>
<td>HWM 35C</td>
</tr>
<tr>
<td><strong>Mediclean 2000 se</strong></td>
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Trailer- oder Rackbased CBRN Protection Systems

### Trailer
- RIDS 1400 G/GT
- DJT 2000

### Rack
- CDS 1000 GDS
- RILDS
## Container Based CBRN Protection Systems

<table>
<thead>
<tr>
<th>HEP 90</th>
<th>Decocontain 3000</th>
<th>MOSDM</th>
<th>TEP 90</th>
</tr>
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<tbody>
<tr>
<td>DSSM</td>
<td>Decocontain 3000 GDS</td>
<td></td>
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</tr>
<tr>
<td>Decon Pers</td>
<td>Decocontain 3000 ELS</td>
<td></td>
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</tbody>
</table>
Special Projects CBRN Protection Systems

HMDV 3000

RIV 1500

USC AB-DEKO

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Container – based Systems

TEP 90

20 – 40 / h  20 / h  20 / h  4 – 8 / h  1.500 m² / h  3 / h

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Container – based Systems

TEP 90

Description:

- Highly mobile, rapidly deployable decontamination system
- Modules used are primarily based on proven technology used for CBRN defence within the NATO
- Consistent modular design
- Loading crane with work basket for persons
- Operating personal needed: 8
Container – based Systems

TEP 90

Vehicle and Road Decon Modul
Equipment Decon Modul
Personal Decon Modul

Interior Decon Modul (Decon Shuttle)
Container – based Systems

TEP 90
Module 1

Decontamination of vehicles
Container – based Systems

TEP 90
Module 1

Decontamination of road sections
Container – based Systems

TEP 90
Module 2

Decontamination of Equipment
Container – based Systems

TEP 90
Module 3

Decontamination of Persons
Interior decontamination
Container – based Systems

TEP 90

According to NATO requirements:
-30 °C to +49 °C
Conclusion

New Decontamination Capabilities

- hot gas / hot steam chamber (up to 170°)
- vacuum chamber
- spray / extraction method

Conclusion

- state-of-the-art
  - Worldwide employability
  - High performance capability whether employed individually or together
  - Reduced timelines for preparation, decontamination and after-action activities
  - Self-sufficiency, flexibility, modularity and mobility
  - Effective use of water resources thanks to low consumption
  - No more ecologically harmful and aggressive decontaminants
  - Reduced number of operating personnel and reduced workload