Simultaneous testing of protection and comfort of protective suits

Monique Oldenburg, Tiny van Houwelingen and Peter Reffeltrath
TNO Defence, Security and Safety, the Netherlands
CBRN protective clothing

- Protective properties
  - CWA
  - BWA
  - TICs

- Comfort properties
  - Thermo physiological burden
  - Psychological burden
Testing at TNO in the past

• Location Rijswijk
  • Manikin
  • Protective properties
    • Methyl salicylate vapor, MeS
      • simulant for mustard agent
    • Tenax
      • porous polymer well adsorbing MeS
    • Climate chamber

• Location Soesterberg
  • Volunteers
  • Comfort properties
    • Climate chamber
Disadvantages

• Different test methods
• Different locations
• Different subjects (manikin vs. volunteers)

integration of test methods needed
Test method development (1)

- Location: test chamber Rijswijk
- Subjects: volunteers
- Measured comfort parameters:
  - Core temperature
  - Heart rate and heart rate variability
  - Skin temperature
  - Subjective performance parameters

suit not tested in this study
Test method development (2)

- Measured protection parameters:
  - MeS penetration
  - Sampling with Tenax
  - Method similar to
    - NFPA 1994
    - ASTM F2588-06 (MIST)

- Walking movement
  - Similar to mannequin but more realistic

- Experiments with (MeS) and without (blank) MeS exposure
Results (1)

- Human vs manikin (protection-wise)
Results (2)

- Thermo physiological measurements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Blank</th>
<th>MeS</th>
<th>Significant difference?</th>
<th>Mental stress?</th>
</tr>
</thead>
<tbody>
<tr>
<td>skin temperature</td>
<td>32.4</td>
<td>33.3</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>core temperature</td>
<td>36.8</td>
<td>36.9</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>heart rate</td>
<td>76</td>
<td>80</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>heart rate variability sitting</td>
<td>12</td>
<td>11</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>heart rate variability walking</td>
<td>8</td>
<td>7</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>
Results (3)

• Subjective performance parameters
  • No effect MeS exposure
  • Experienced exertion
  • Comfort
  • Thermal comfort
Results (4)

- Thermo physiological and subjective performance parameters
  - Increased heat stress with MeS
    - Note: skin is more perceptive for CWA when wet and warm (sweat)
  - No increased mental stress
    - No significant effect because of knowledge low toxicity MeS

- Comfort vs. protection
  - Total heat stress relatively low
    - Possibility to trade in a little comfort to gain protection
  - What are the consequences of higher protection and/or comfort?
    - Further investigations
Conclusions

• Test method developed
  • Integration protection and comfort measurements
  • More complete test package for protective clothing

• Exposure to methyl salicylate vapor results in
  • increased heat stress
  • unchanged mental stress

• More information/knowledge exchange over know-how bases protection and comfort/thermo physiology
  • Road to finding the right balance

• Further investigations needed
  • Effect increasing and decreasing protection/comfort
    • Effects of additional clothing/equipment
  • Psychological effect exposure to chemical substances
Thank you for your attention!