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Federal Department of Defence,
Civil Protection and Sport DDPS

Federal Office for Civil Protection FOCP
SPIEZ LABORATORY

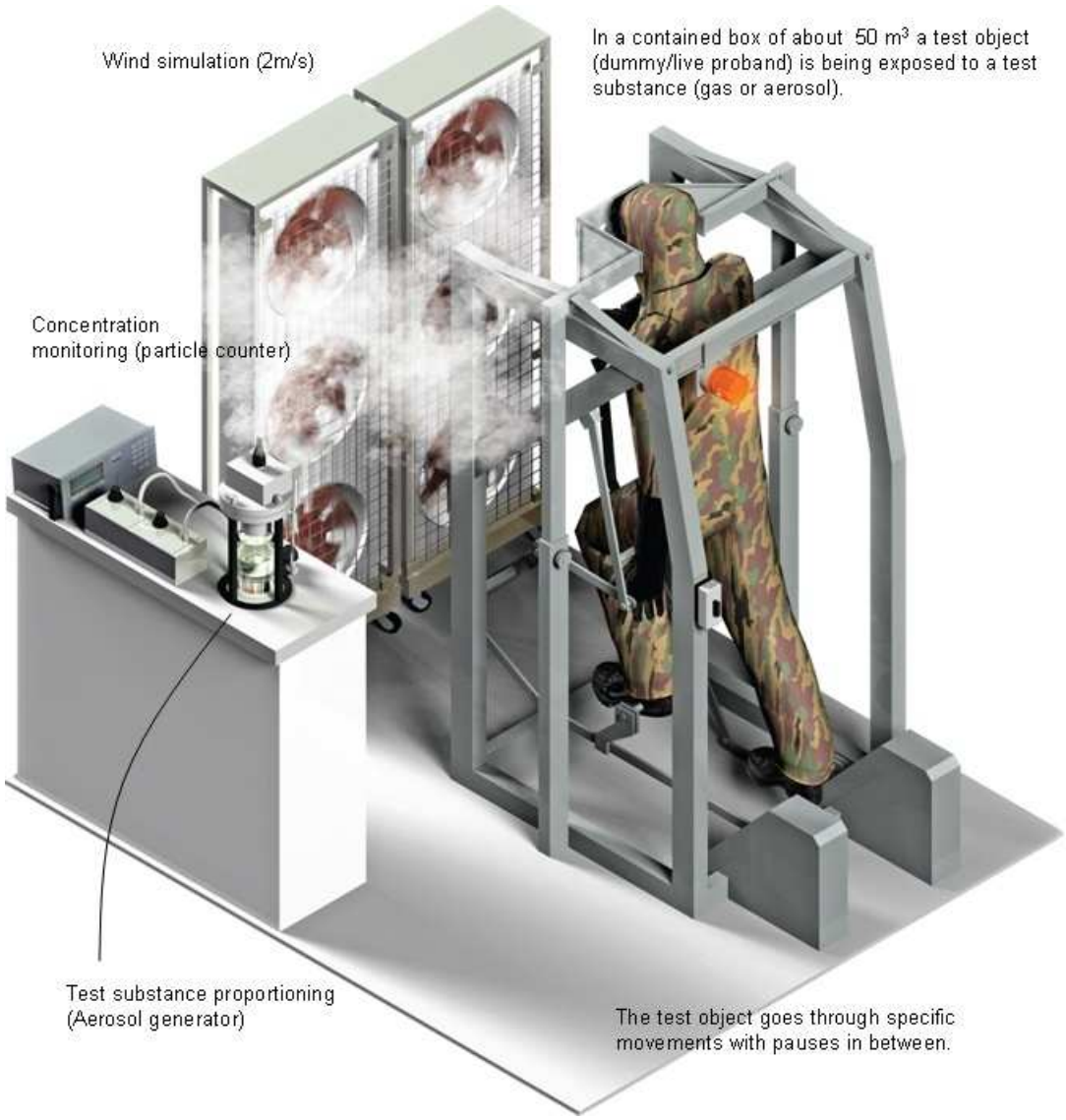
Fact Sheet

11.05.2010

Integral Testing of Chemical Protection Suit against Gas or Aerosol (ICP)

Summery

The protection factor of a chemical protection suit is the measurable indicator of its effectiveness. An integral test determines it for gases or aerosols. For specific scenarios, this value allows to assess whether a protection suit grants adequate protection or not. In addition, one gains statements about weakness of suits due to not optimized design or bad manufacturing.



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Reference: 343.1-FachinfoPS

1. Introduction

A protection suits consists of different components. Each of them has to satisfy material tests. For example: The penetration of yperite[1] through fabric (YPAP) or the leakage of a face piece (mask). Under real field conditions the overall protection factor is generally lower than it is assumed out of material tests. Therefore, it is very important and necessary to carry out integral tests that mimic field conditions.

The „Man-In-Simulant Test (MIST) Program", developed by the United States, has closed this vacancy [1]. The SPIEZ LABORATORY adapted this method to its own "Integral Test for Chemical Protection Suits" (ICP). In contrast to the classical method, this one can alternatively carry out with gas or aerosol.

Normally, we test by order of armasuisse protection suits used by the Swiss Army. We collaborate with the "Bundeswehr Research Institute for Protective Technologies and NBC Protection" (WIS) in Munster and with industrial partners to evaluate new protection suits.

2. Test Setup

2.1. Test object

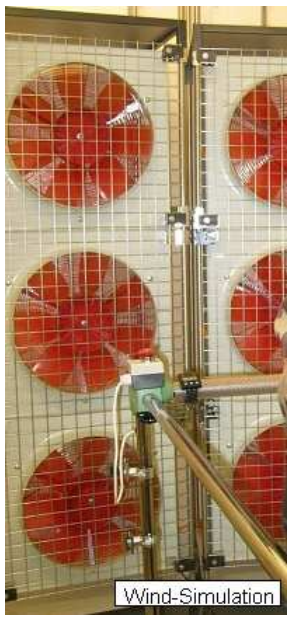
The test can be performed either with a dummy (mannequin) or a live person (proband). The results obtained with the dummy are expected to be more reproducible. But because a protection suit normally fits a live person better, the determined overall protection factor is higher there.
The dummy is fixed to a frame through the visor of the mask. As long as the mask is tight, no testing substance will flow into the suit through the mask. Bindings (snowboard) connect hands and feet to a motor that moves the arms and legs. Gloves and boots are undamaged.

2.2. Motion Sequence

The dummy mimic only a simple motion sequence (walking, resting). The proband absolves a more complex motion sequence (walking, creeping, elevating, climbing, and resting). A standard test period is three hours with the dummy or two hours with a proband.

2.3. Wind Simulation

The wind is simulated by six ventilators and reaches 2 m/s. The 50 m^3 big chamber is filled with the testing substance distributed uniformly by the ventilators. Climatic conditions (humidity, temperature) are not be simulated.



[1] mustard gas, HD

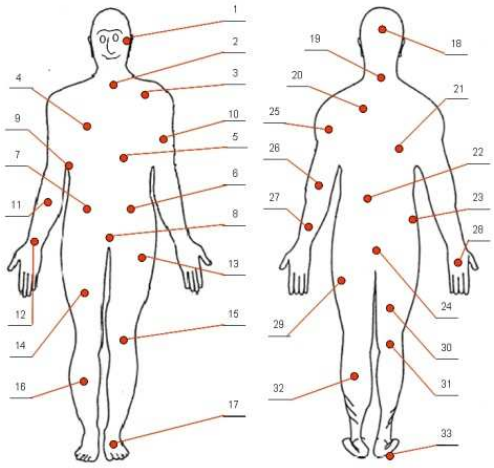
2.4. Testing Substance

Methyl salicylate (MeS) is used as testing substance for “gas”. It is continuously metered by means of an HPLC pump and evaporated by a covered filament. The average concentration is 55 mg/m^3. The continuous metering is necessary as the test cell has a slight vacuum which is maintained by a constant extracted air. The concentration is monitored with a Thermo-FID.

Di-2-Ethylhexyl-Sebacat (DEHS) is used as testing substance for “aerosol”. It is produced with an aerosol generator. Particles larger than 4 µm are deposited in a cyclone. A continuous metering is not possible. Therefore, the dosing is gradually. The mean concentration is 50 mg/m^3 and it is gravimetrically determined. The concentration gradient is pursued with an optical particle counter.

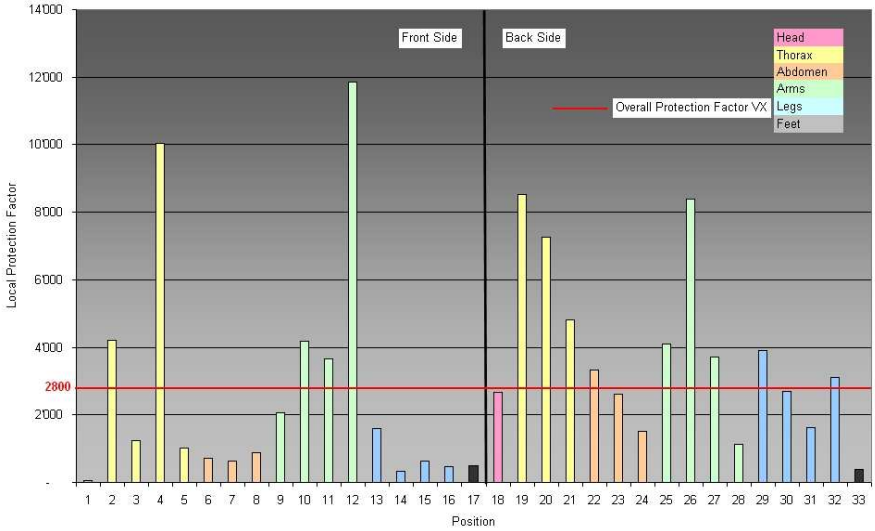
2.5. Sampling/Analysis

The proband/dummy wears underwear on which at 33 different positions passive samplers are placed. Testing substance that passes through the clothing is absorbed by the samplers and is afterwards analyzed by GC-MS. Thermal desorption (TDS, MeS) or liquid extraction (DEHS) is used to relieve it. The calibration of the GC-MS corresponds to the dose of the corresponding testing substance. The samplers are exposed to a stationary gas, respectively aerosol of known concentration and are analyzed. The amount of adsorbed substance increase when the samplers are flowed by it, especially in case of the aerosol.



3. Interpretation

The goal is to obtain a statement about the effectiveness of a suit. This is done in the form of a calculated protection factor. In addition, weaknesses of the suit are revealed. This information can be used to develop more powerful suits or to show the influence of false application.



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3.1. Local Protection Factors

The local protective factor is the ratio of outer to inner dose at each sampling position. It shows directly weak points of the suit or leaks. By weighting the local protective factors on the sensitivity of the corresponding area of skin to sulfur mustard (HD) gives the MRED[2]. Dose over this limit are harmful and an effect like reddened skin will occur.
Since blister agents act locally, the protection performance is based on the principle of the weakest link.

3.2. Overall Protection Factor

Nerve agents are absorbed through the skin and act throughout the body. Therefore, an overall protection factor is calculated. It is a weighted average of the regional area of skin and its sensitivity to VX (BRHA[3]-method).

4. Tested Protective Suits

Swiss Armed Forces • CSA90 • CSA2000/SA99 • FSA06 • SSA08 • Pilotenanzug leicht	Cooperation WIS/D • Overgarment (TL 8415-0172) • ABC-Schutzanzug leicht (TL 8415-0283)
SiLab/EEVBS • MURU BSL4/2 (Delta Protection) • Chemturion™ Mod.3525 (ILC Protection) • Alki Lite-Safe-Pro (HvO ISSI) • SARATOGA (R)	further • NBC/F • MCA FM30K • Safeguard 3002-A1 • Tychem® F-Prochem III • CLD 500

We can offer our customers a wide range of testing services and professional advice on all their individual NBC protection equipment needs. We are regularly commissioned by armasuisse to test the NBC protective material used by Swiss Armed Forces. Close cooperation also exists with the WIS[4] and other institutes.

For further information:

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Publications:
[1] Technical Assessment of the Man-In-Simulant Test (MIST) Program, National Academy Press, Washington, D.C, 1997 (ISDN 0-309-05940-2)

[2] MRED: Minimum Required Exposure Dosage
[3] BRHA: Body Region Hazard Analysis
[4] WIS: Wehrwissenschaftliches Institut für Schutztechnologie