Development Of Realistic Testing Methods For Protective Clothing

Defence, Security and Safety
From the first steps….

- Demands on the clothing
- Choosing material tests connected to the demands
- Selection of candidate materials
- Performing material tests
- Choosing the best material out of the candidates
- Selecting a design connected to the demands
....to final product

• Sewing the suits in candidate designs
• Performing tests to rank the different designs
• Choosing the best design
• Initiating production
• Choosing control parameter and performing quality control
Protective clothing at TNO (1)

• Building up knowledge on threat scenarios, materials and tests
  ➔ help on choosing materials and connected tests on the basis of your demands

• Range of material tests can be performed on candidate materials
  ➔ on the basis of results, a founded choice can be made
Protective clothing at TNO (2)

- After choosing candidate designs, TNO can perform tests to rank different designs with Whole System Test.

- After initiating production: TNO can help choosing control parameter and perform quality check [material testing].
Threat scenarios and test conditions

Operational scenarios

Requirements

Materials/suits

Threat scenarios

Tests
Material testing

- CWA, TICs and BWA @ TNO
  - CWA material testing according to AEP 38 (NATO) and TOP 8-2-501 among others
  - TICs material testing according to ISO 6529 and ASTM F739
  - BWA material testing; international methods in development

- Challenge type
  - Chemical Agent (Liquid and vapor)
  - TICs (Liquid and vapor)
  - Biological Agent Protection (Aerosols)

- Amount of challenge, duration of challenge

- Environmental conditions
Zoomed in: Chemical agent material testing

• Contamination in liquid form as well as in vapor form

• Flow under/over as well as through the material (respectively diffusive and convective flow tests)
TICs material testing

- ISO 6529 covers EN 369 (same test cell and procedure)

- Round robins confirm similarity in results of method EN 369 and EN 374

- In EN 374 same test cell is used as used in ASTM F 739
Biological agent testing: materials and subsystems

- Tests with simulants for biological agents
  - Penetration through materials
  - Deposition on cylinders after penetration
Whole system test

As said: to rank designs

• In material tests: penetration/permeation,
  In WST: penetration through material and through leakages

• Kind of suit
  • Combination trousers/parka ↔ overall ↔ coverall
  • Single layer ↔ double layer

• Closures
  • Collar
  • Cuffs
  • Closure of trouser leg/sleeves
Test description (1)

- Challenge conditions
  - simulants
  - vapor dosage

- Environmental conditions
  - wind speed

- Mannequin
  - walking / running mode
  - walking / running speed
Test description (2)

• Analysis
  • adsorption on Tenax containing samplers
  • analysis by thermodesorption/GC FID

• Samplers

Natick-sampler  diffusion tube
Examples of research (1)

- Comparison of three suits

![Graph showing comparison of dose across various body parts](image-url)
Examples of research (2)

- Effect of modifications

![Graph showing dose distribution across different body regions with and without a belt.](image-url)
Examples of research (3a)

• Also human volunteers used instead of mannequin (=MIST)

• More complex movement pattern

• Comfort and protection measured simultaneously
  • Ideal to find balance between protection and comfort

• Sizing and fit can be studied in detail
  • Disadvantage: number of needed runs is higher (higher variance)
Examples of research (3b)
Questions
Whole System Test

Functional specifications

• Temperature
  • constant, 15 - 35 °C, tolerance 1 °C, stable within 16 hrs

• Wind profile
  • homogeneous, 1 - 7 m.s\(^{-1}\), tolerance 10%

• Concentration Methyl Salicylate
  • no adsorption points in gastight chamber, 11 - 55 mg.m\(^{-3}\)

• Mannequin
  • walking / running mode and walking / running speed