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Kuklane, Kalev; Sitvjenkins, Igors

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*Total number of authors:*
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**Clothing Evaporative Resistance Testing that Allows Detailed Feedback for Customers: A Case of the Latvian Army**

*Kalev Kuklane*[1,]*, *Igors Sitvjenkins*[2]
[1] Thermal Environment Laboratory, Ergonomics and Aerosol Technology, Lund University, Lund, Sweden
[2] Joint HQ Logistics (J-4) Department, National Armed Forces of the Republic of Latvia, Riga, Latvia
*Corresponding author: Assoc. Prof. Kalev Kuklane, E-mail: kalev.kuklane@design.lth.se

## Abstract

Two most important clothing properties are thermal insulation and evaporative resistance. Clothing insulation is not evenly distributed over the body surface. Body regions' insulation values can be measured, and the change due to walking and wind can be estimated. Today the development of the testing methods allows the same even for evaporative resistance [1, 2]. Local values can be used in advanced physiological models [3]. The major aim of this study was to provide the Latvian Army with regional evaporative resistance values of selected garment ensembles. An aim was to set up the methodology, standardised procedures and forms for regional evaporative resistance measurements, calculations and corrections at the laboratory.

A textile skin and 4 sets of clothing were tested: Set 1 – short sportswear for warm season; Set 2 – long sportswear for cold season; Set 3 – summer combat uniform; Set 4 – dry suit set. Evaporative resistance was calculated by the heat loss method as the regional evaporative resistance values were of interest. Tests were carried out at so-called homogenous test conditions where manikin surface ($T_s$) and environmental temperatures ($T_a$=$T_r$) were kept at 34 °C. Textile skin temperature ($T_{sk}$) was corrected by heat loss ($HL$): $T_{sk}=T_s-\mathrm{a}\times HL$ [2, 4]. Air velocity in the chamber was kept at 0.30±0.09 m/s. Heat loss of the whole manikin and the individual zones was corrected for surface temperature, and heat gain from environment. As skin itself has evaporative resistance then clothing evaporative resistance ($R_{ecl}$) was calculated by subtracting skin and air layer evaporative resistance from the total evaporative resistance ($R_{et}$). Clothing area factor ($f_{cl}$) was acquired according to EU Subzero project final report for this correction. Several factors were not considered: clothing insulation change due to wetness, skin thickness and material effects etc.

**Table 1.** Insulation and evaporative resistance of the tested clothing ensembles.

| Ensemble | $I_{tot}$ m²·K/W | $R_{et}$ m²·Pa/W | $i_m$ | $f_{cl}$ | $R_{ecl}$ m²·Pa/W | $R_{ecl,torso}$ m²·Pa/W | $R_{ecl,arms}$ m²·Pa/W | $R_{ecl,legs}$ m²·Pa/W |
|---|---|---|---|---|---|---|---|---|
| Air layer | 0.090 | - | - | - | - | - | - | - |
| Skin | 0.125 | 11.3 | 0.68 | 1.11 | - | - | - | - |
| Set 1 | 0.135 | 16.0 | 0.58 | 1.11 | 4.8 | 7.2 | 1.7 | 4.3 |
| Set 2 | 0.220 | 23.2 | 0.58 | 1.19 | 12.6 | 15.4 | 9.5 | 11.7 |
| Set 3 | 0.222 | 33.9 | 0.39 | 1.19 | 23.5 | 40.8 | 14.0 | 20.4 |
| Set 4 | 0.244 | 109.3 | 0.18 | 1.21 | 103.4 | 111.2 | 81.9 | 85.6 |

Note: -, not applicable.

The total insulation and evaporative resistance, permeability index and clothing area factor, and total and area specific clothing evaporative resistance values are shown in Table 1. The customer did receive the total and 14 local evaporative resistance values for each selected clothing ensemble. Various corrections in combination with unknown factors may allow wide interpretation of the methodology. There is a need to set basic standard guidelines on the specific evaporative resistance determination process.

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