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Číslo 2

Roger Barker, Shawn Deaton, Gail Liston, Donald Thompson. *A CB Protective Firefighter Turnout Suit*. S. 135–152.

This paper describes research that developed a prototype chemical and biological (CB) protective firefighter suit. It is presented as a case study demonstrating an integrated systems approach to designing, developing and evaluating a protective clothing ensemble based on end user requirements. It includes a discussion of the process that was used to gain an understanding of firefighter performance needs for a structural turnout suit that also incorporated chemical protection. It describes the design features of the turnout suit that were developed to meet these expectations as well as the program of testing and evaluation used to characterize garment performance. It discusses ensemble level performance evaluations in instrumented fire manikin tests and man-in-stimulant test procedures. It describes studies conducted to determine the impact of prototype garment design features on heat stress, wear comfort and ergonomic function in structural firefighting applications.

Paul Brasser. *Optimizing the Protection Against the Physiological Burden of CBRN Clothing*. S. 153–168.

Soldiers can wear chemical, biological, radiological and nuclear (CBRN) protective clothing to be protected agaist warfare agents. The disadvantage of that clothing is that higher protection introduces higher physiological burden. Therefore an optimum between comfort and protection must be found. Models of all relevant processes were created to find this optimum. The airflow profile around a cylinder with clothing—representing a dressed human body part—was modelled. This flow profile was used for calculating the agent vapour breakthrough through the clothing and for calculating the deposition of agents onto the skin (as indicators for protection). The flow profile was also used for calculating the temperature profile around the body part and the relative humidity underneath and in the clothing (as representative for physiological burden). As a result a tool was created, which can be used to identify the optimum properties of CBRN protective clothing, depending on the intended mission of the soldiers.

Patricia I. Dolez, Chantal Gauvin, Jaime Lara, Toan Vu-Khanh. *The Effect of Protective Glove Exposure to Industrial Contaminants on Their Resistance to Mechanical Risks*. S. 169–183.

In several industrial environments, mechanical risks are often combined with various contaminants such as oils and greases, which may reduce the performance of protective gloves against mechanical hazards. However, glove properties are characterized on new and clean specimens, and little is known about their residual resistance once contaminated and over time. In this study, a series of protective gloves used in metalworking companies and garages were exposed to relevant oils and greases. Used gloves were also obtained from a food processing center and a garage. Their residual resistance to mechanical risks (cutting, puncture and tearing) was evaluated using standard test methods. Results revealed in some instances a large decrease in resistance to mechanical risks. Since a corresponding change in the material aspect may not always be easily observable, this may lead to serious safety breaches. These findings demonstrate the need to further the research in this domain.

Kirsi Jussila, Anita Valkama, Jouko Remes, Hannu Anttonen. The *Effect of Cold Protective Clothing on Comfort and Perception of Performance*. S. 185–197.

The physiological properties of clothing designed to provide protection against cold, windy and damp conditions affect comfort. The weight, thickness, stiffness of the fabrics and friction between the clothing layers affect physical performance. The comfort and perception of performance associated with 3 military winter combat clothing systems from different decades (the new M05 system, the previous M91 system and traditional clothing) were observed during a winter military manoeuvre. Subjective experiences concerning comfort and performance were recorded for 319 subjects using questionnaires. The most challenging conditions for comfort and performance were perspiration in the cold and external moisture. The new M05 system provided warmer thermal sensations ($p < .010$), dryer moisture sensations in the presence of external dampness ($p < .001$), dryer perspiration moisture sensations ($p < .050$) and better perception of physical ($p < .001$) and mental performance ($p < .001$) than the other systems. Careful development of the clothing system guarantees good comfort and performance during cold exposure.

Kalev Kuklane, Valter Dejke. *Testing Sleeping Bags According to EN 13537:2002 : details That Make the Difference*. S. 199–216.

The European Standard on sleeping bag requirements (EN 13537:2002) describes a procedure to determine environmental temperature limits for safe usage of sleeping bags regarding their thermal insulation. However, there are several possible sources of error related to this procedure. The main aim of this work was to determine the influence of the various measuring parameters on the acuity of the respective parameters in order to judge the requirements. The results indicated that air velocity, mattress insulation and time between unpacking the bag and measurement had a significant impact on the result, with a difference of up to 5–15% in thermal insulation between minimum and maximum allowable parameter levels. On the other hand, manikin weight, thickness of the artificial ground and presence of a face mask were found to have a negligible influence. The article also discusses more general aspects of the standard including the calculation methods used.

Corinne Keiser, Peter Wyss, René M. Rossi. *Analysis of Steam Formation and Migration in Firefighters' Protective Clothing Using X-Ray Radiography*. S. 217–229.

X-ray radiography was used to quantify evaporation and moisture transfer in a multilayer firefighter protective clothing system with defined wetted layers exposed to low thermal radiation. Evaporation was faster and took place at higher temperatures if the moisture was located in the outer layers of the clothing system. Moisture that evaporated in the

outer layers of the clothing system was found to move inwards and condense in the inner layers and on the cap of the measurement cell. Results found in this study correlated well with the findings of our former study based on simple temperature distribution measurements to determine moisture transfer in protective clothing layers at low level thermal radiation.

Peter Bröde, Kalev Kuklane, Victor Candas, Emiel A. Den Hartog, Barbara Griefahn, Ingvar Holmér, Harriet Meinander, Wolfgang Nocker, Mark Richards, George Havenith. *Heat Gain From Thermal Radiation Through Protective Clothing With Different Insulation, Reflectivity and Vapour Permeability*. S. 231–244.

The heat transferred through protective clothing under long wave radiation compared to a reference condition without radiant stress was determined in thermal manikin experiments. The influence of clothing insulation and reflectivity, and the interaction with wind and wet underclothing were considered. Garments with different outer materials and colours and additionally an aluminised reflective suit were combined with different number and types of dry and pre-wetted underwear layers. Under radiant stress, whole body heat loss decreased, i.e., heat gain occurred compared to the reference. This heat gain increased with radiation intensity, and decreased with air velocity and clothing insulation. Except for the reflective outer layer that showed only minimal heat gain over the whole range of radiation intensities, the influence of the outer garments' material and colour was small with dry clothing. Wetting the underclothing for simulating sweat accumulation, however, caused differing effects with higher heat gain in less permeable garments.

Emiel A. Den Hartog, George Havenith. *Analytical Study of the Heat Loss Attenuation by Clothing on Thermal Manikins Under Radiative Heat Loads*. S. 245–261.

For wearers of protective clothing in radiation environments there are no quantitative guidelines available for the effect of a radiative heat load on heat exchange. Under the European Union funded project ThermProtect an analytical effort was defined to address the issue of radiative heat load while wearing protective clothing. As within the ThermProtect project much information has become available from thermal manikin experiments in thermal radiation environments, these sets of experimental data are used to verify the analytical approach. The analytical approach provided a good prediction of the heat loss in the manikin experiments, 95% of the variance was explained by the model. The model has not yet been validated at high radiative heat loads and neglects some physical properties of the radiation emissivity. Still, the analytical approach provides a pragmatic approach and may be useful for practical implementation in protective clothing standards for moderate thermal radiation environments.

Katarzyna Majchrzycka, Beata Gutarowska, Agnieszka Brochocka. *Aspects of Tests and Assessment of Filtering Materials Used for Respiratory Protection Against Bioaerosols : part I : type of Active Substance, Contact Time, Microorganism Species*. S. 263–273.

This paper presents the results of a study on antimicrobial activity of polymer filter nonwovens produced by needle-punching or melt-blowing with an addition of disinfecting agents. The first part of the paperdiscusses how the biocidal activity of nonwovens is a function of the active agent added to the nonwovens,the duration of the contact of microorganisms with nonwovens and the type of microorganisms. The types of fibres and disinfecting agents had a considerable effect on the biocidal activity of nonwovens. The biocidal effect of nonwovens increased with the duration of their contact with microorganisms. Fibre activity differed considerably depending on the species of the

microorganism. The microorganisms most sensitive to biocidal activity of the active filter nonwoven were S. aureus, M. flavus and E. coli. There were no biocidal effects on spore-forming bacterium B. subtilis.

Katarzyna Majchrzycka, Beata Gutarowska, Agnieszka Brochocka. *Aspects of Tests and Assessment of Filtering Materials Used for Respiratory Protection Against Bioaerosols : part II : sweat in the Environment, Microorganisms in the Form of a Bioaerosol*. S. 275–280.

The second part of the article presents the results of a study of antimicrobial activity of filter nonwovens with an addition of biocides, as a function of the presence of sweat in the environment and the method of microbe deposition on a nonwoven in the form of a liquid and a bioaerosol. At the same time, the filtration efficiency of nonwovens against microorganisms in the form of a bioaerosol was tested with the dynamic method. The results showed that the addition of sweat on the surface of a nonwoven resulted in an insignificant decrease of biological activity that still remained high. Moreover, an active nonwoven showed biostatic and biocidal activity only when microbes were deposited on the surface in the form of a solution. The nonwoven did not show any biological activity after deposition of microorganisms with the dynamical method in the form of a bioaerosol.