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SwitchProtect: A concept of switching between permeable and impermeable: A numerical evaluation of protection and thermal burden

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Armed forces equip their soldiers with special personal protective clothing (PPC) in case of a scenario involving chemical, biological, radiological, or nuclear (CBRN) agents. The protection requirements for these CBRN PPC's focus mainly on chemical and biological agents in gas/vapour, aerosol, and liquid states. The highest level of protection is offered by an impermeable suit fully encapsulating the user. However, these suits strongly reduce heat and mass transfer and thereby substantially increase thermal burden on the user. Most permeable CBRN PPC systems offer substantially higher levels of thermal burden compared to a standard (none-protective) battle dress uniform, although there are exceptions, e.g., Blücher's light CBRN suit.

The European Defence Agency (EDA) sponsors the SwitchProtect project aiming at developing a PPC system that can switch from a permeable (low thermal burden) state to an impermeable (high protection) state. At this early state of the projects no fully functional physical prototypes exists yet, therefore, the first phase of this project focussed on understanding the protective performance of the impermeable state as well as the thermal burden of the permeable state. This is pursued through (i) the development of two numerical models one for the protection and one for the thermal burden, (ii) defining, and if possible, measuring of the boundary conditions, and (iii) simulations.

The models were successfully created and where possible, the models were validated. The results from simulations indicate that the SwitchProtect concept uniquely combines optional protection with a minimum effect on thermal burden. Moreover, the protection time in case of sarin and sulfur mustard was derived for an asymmetric challenge concentration (NATO AEP-72) using dermal toxic threshold from the NATO AEP-52. The protection times derived allowed sufficient time for the user to move to a safe area, even for the highly dermally toxic sulfur mustard. The simulations regarding thermal burden were carried out for all warm NATO climates (NATO AECTP-200) with soldier virtually carrying out a strenuous task (500 W, NATO ATP-65). The thermal burden simulations indicates a thermal burden close to that of a standard battle dress uniform for the SwitchProtect concept in permeable state. In addition, the thermal burden was considerably lower compared to an impermeable suit. Future work will focus on creating a physical prototype.