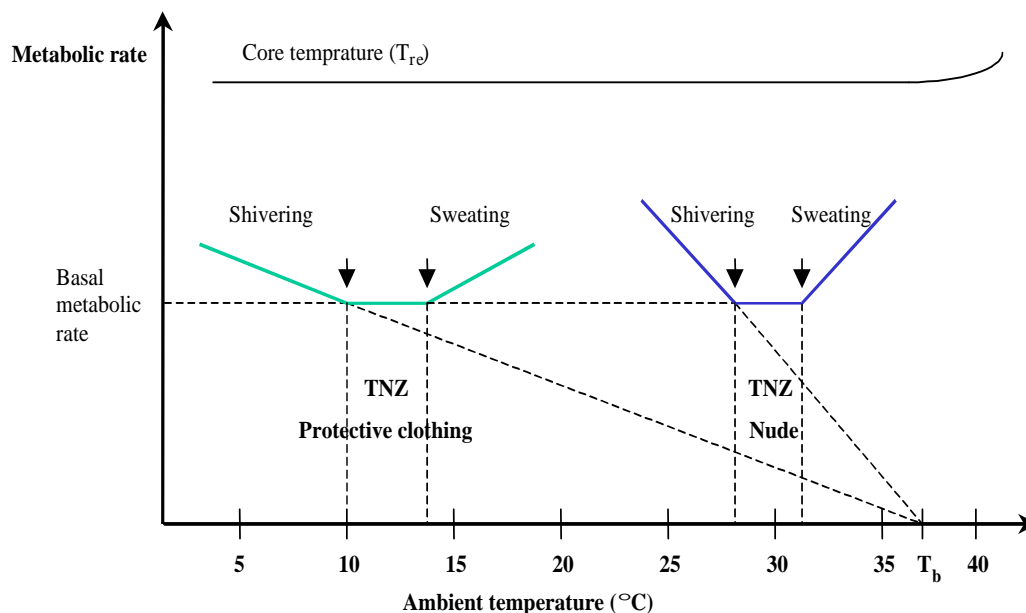


THE THERMONEUTRAL ZONE WHEN WEARING AIRCREW PROTECTIVE CLOTHING

H. Færevik¹, D. Markussen², G. Øglænd² and R.E. Reinertsen¹, ¹Department of Health and Work Physiology, Sintef Unimed, N-7465 Trondheim, Norway, and ²Norwegian University of Science and Technology, N-7491 Trondheim, Norway.

Heat stress can be a significant problem for pilots wearing protective clothing during flights because such clothing limits evaporative heat loss, which may produce fatigue and impair performance. The thermal loads in the cockpit environment and wearing a survival suit both influences the thermal stress experienced by the user. It was therefore of interest to determine the thermoneutral zone (TNZ) in subjects wearing aircrew protective clothing. In nude, resting subjects TNZ has been determined to lie between 28 and 30°C ambient temperature (T_a) (Gagge *et al.* 1967). The thermoneutral zone when wearing protective clothing has not previously been determined. We hypothesized that wearing protective clothing will affect heat exchange with the surroundings and cause displacement of the TNZ. Eight volunteer subjects participated in two randomized series of tests. In series **A** they dressed as they normally do for flights, (including helmet, two layers of underwear, and an uninsulated survival suit), in series **B** they only wore shorts. In both series heart rate, rectal and 13 skin temperatures, metabolic heat production and subjective evaluation of thermal sensation and thermal comfort were measured during one-hour exposure. In series **A** they were exposed to five different ambient conditions; 0, 10, 14, 18, and 25°C respectively. In series **B** they were exposed to seven different ambient conditions; 15, 20, 25, 28, 31, 35, and 40°C respectively. In agreement with the findings of Gagge *et al.* (1967) the criteria for thermoneutrality in nude subjects (series **B**) were fulfilled in the temperature range of 28-31°C. The TNZ was displaced downwards in subjects wearing protective clothing (series **A**) to an ambient temperature range of 10 to 14°C, where physiological parameters were lowest, with mean skin temperature at 33.6-34.1°C and VO_2 at $0.33 \pm 0.05 \text{ l} \cdot \text{min}^{-2}$, and subjects were comfortable. Wearing aircrew protective clothing causes a displacement of the TNZ from 28-31°C (T_a) (nude subjects) to 10-14°C (T_a). The results of this study can be used as a guideline for regulation of cockpit temperature when wearing protective clothing.



Gagge, A.P., Stolwijk J.A.J. and Hardy, J.D. 1967. Comfort and thermal sensations and associated physiological responses at various ambient temperatures. *Environ. Res.* 1, 1-20.

Hilde.Ferevik@unimed.sintef.no