# INTEGRATED *AIR* COOLING SYSTEM - A NEW CONCEPT IN INDIVIDUAL COOLING DEVICES

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## INTRODUCTION

The physiological hazards of elevated body core temperature and the associated reduction in performance have prompted a search for an effective external cooling system. Under conditions where surrounding airconditioning is not feasible, individual cooling is the most practical solution to alleviate heat stress.

The effectiveness of individual air cooling systems (IACS) has been studied extensively (1-4). These systems consist of cooled air provided through an open - weave fabric vest to the thorax. In most systems air is delivered to the cooling vest at flow rates of 10 to 15 cfm. Besides the convective heat transfer of the cool air it employs also the natural heat dissipating mechanism.

The purpose of this study was: a) to evaluate the effectiveness of a new IACS which is integrated in the suit, in reducing the physiological strain, and b) to study the physiological burden imposed by the system when it is not operated by sweat evaporation.

## METHODS

Three teams of **4** male subjects (1**8-20** yrs) were exposed at rest in an armored vehicle to a hot climate (45°C;50% RH). The participants were dressed in a Nomex coverall, Nomex summer gloves, and a Gentax helmet. The IACS consisted of textile made tubes integrated into the coverall distributing cooled air around the torso. Inlet air **flow** was 18 cfin and inlet air temperature was 18°C. Exposure lasted 120 min; cooling system was switched on only after 60 min of exposure to the hot environment. Control exposure was similar but without the IACS turned on; the results were compared also to those obtained with suits to which the IACS was not integrated. During the exposures, rectal temperature was recorded every 5 min. Skin temperatures were measured every 15 min with a three point thermocouple skin harness (chest, calf and forearm) and mean weighted skin temperature was calculated according to Burton (5); heat storage **(AS)** was calculated from changes in body temperature. Heart rate was recorded every 2 min by an ECG unit (UNIC, CIC). Sweat rate was determined from weight loss and was adjusted for water intake and urine output.

## RESULTS

Rectal temperature (Tre) elevated during the 1st hour (without cooling) of exposure by about 0.5°C which is similar to the increase in Tre in the control exposures. By the end of the 2nd hour Tre was maintained at near baseline levels while during the control exposures it continued to elevate and did not reach a steady state (Tre>1.0°C above baseline). Heart rate (HR) and skin temperature (Tsk) responses showed similar patterns and returned to near base line levels with cooling. Noteworthy, HR and Tsk returned to near baseline levels within 15 min of IACS operation. The rate of heat storage **(AS)** was about 140W without cooling and only about 10W with the cooling system. Mean sweat rate was about 1100 g/h without cooling and only 600 g/h with cooling. The results of control exposure were similar to results obtained in suits without the IACS.

## CONCLUSIONS

The results of the present study further confirm that IACS is effective in alleviating heat stress particularly under low metabolic rates. The feasibility of integrating a manifold in the coverall without hampering normal body temperature regulation under heat stress when the IACS is shut off is also shown. Other devices which are based on a cooling vest consist of an extra layer to the clothing ensemble and add extra insulation; thus, interfere with heat dissipation. The system described is based on minimal tubing which do not add to clothing insulation and therefore does not interfere with heat dissipation.

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