BREATHABILITY MEASUREMENTS OF FIREFIGHTER PROTECTIVE CLOTHING

Uwe Reischl, Francis N. Dukes-Dobos, Thomas E. Bernard and Kai Buller

Department of Environmental and Occupational Health
College of Public Health
University of South Florida
Tampa, Florida

INTRODUCTION

Firefighter protective clothing is made of water impermeable materials thus limiting evaporative and convective heat loss from the body. If the metabolic heat generated during physical activities exceeds the capacity to eliminate the heat from the body, the firefighter will be at risk of becoming incapacitated due to excessive heat stress.

The ventilation of the airspace between the skin and the protective clothing, i.e. breathability, depends on the location and magnitude of openings at the neck, wrist, the front of the coat, ankles, and at the waist of the pants. Utilizing the test method developed by Reischl and Dukes-Dobos (1) measurements were performed to establish the effect of the above mentioned openings on the breathability of the firefighter protective clothing.

METHOD

A male manikin was dressed in a firefighter protective garment made by Morningpride Mfg. Co., including a turnout coat and turnout pants, and was exposed to wind-tunnel air flow conditions of 0.5 m/sec. in four orientation angles (0^0, 90^0, 188,278). Breathability was measured at eleven location on the manikin. Six garment closure configurations were tested (Table I). Measurement procedures were repeated three times and the means calculated. The mean values of the four orientation angles were then averaged to obtain an overall mean ventilation value for each garment configuration.

RESULTS

Table I shows the effect of closing and opening different features of the garment. The greatest increase of the ventilation at the chest was achieved by opening the turnout coat in the front and at the collar, however, this did not influence the garment ventilation at the arms and back. Opening the sleeves at the wrist resulted in only a small increase in arm ventilation. Opening the pants at the ankles resulted in a more substantial increase of ventilation both at the legs and at the crotch. When the belt was removed from the pants and replaced by suspenders, ventilation increased at all five sites but most significantly at the back, legs and crotch.

CONCLUSIONS

Breathability measurements of firefighter protective clothing provided quantitative data on the increase in garment ventilation due to the opening of the cuffs at the sleeves, at the pants, opening of the turnout coat in the front and at the collar. Wearing suspenders increased the ventilation throughout the garment. Thus, appropriate use of these openings and replacing the belt with suspenders can reduce heat stress imposed upon the firefighter significantly.

TABLE I Ventilation in five regions of a firefighter protective garment using six closure configurations

GARMENT COMPONENT	CLOSURE CONFIGURATION #1	#2	#3	#4	#5	#6
Sleeve Cuffs	C	C	C	C	C	O
Pant Cuffs	O	O	C	C	C	C
Coat in front and the collar	C	O	O	O	C	C
Suspenders	yes	yes	yes	-	-	-
Belt	-	-	-	yes	yes	yes
BODY REGION	Ventilation Rate (l/min.)					
ARMS	1.59	1.29	0.97	L02	0.95	1.33
CHEST	2.69	10.17	10.69	11.41	2.22	2.14
BACK	352	3.64	3.14	0.95	1.00	1.28
LEGS	3.68	4.34	3.34	1.34	0.38	1.35
CROTCH	5.36	5.94	4.10	2.02	2.91	2.79

* C = Closed
O = Open

REFERENCE

1. Reischl, U., Dukes-Dobos, F.N., Spaul, W k , Hall, E.G., Sheehan, K, and Birciw, C. Improvement of Ventilation by Increasing Ambient Airflow and by Opening Collar and Cuffs of a Semipermeable Protective Garment Proceedings of the 10th International Ergonomics Association, Vol. II, pp. 523-525, Sydney, Australia, 1988.