

DEVELOPMENT AND EVALUATION OF CLOTHING FOR SLAUGHTERHOUSE WORKERS

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INTRODUCTION

Almost 20.000 people are working in cooled rooms in the danish meat industry. The work clothing used at present are not maintaining the workers thermally comfortable, and they also complain about the fit of the clothing [1, 2]. The clothing ensembles worn comprise a white unisex outer layer, that is owned and washed by the slaughterhouse. Underneath this layer the workers wear underwear and/or a middle layer of their own clothing. This personal clothing has seldom been bought for use at work. Often the workers do not have the knowledge on how to optimize their clothing. They perceive that the clothing is either too cold or too warm, that it does not fit their body form, that it is too narrow during performance of movements, that the length of the legs and sleeves cannot be adjusted because they seldom receive the same clothing after laundry. Often workers do not know what qualities to look for when selecting clothing, and they are not aware, that a bad fit of a garment often has a significant impact on the thermal function of the clothing ensemble decreasing its protective ability.

Due to international consumer demands the air temperature in several slaughterhouse rooms will in the future be decreased from 10°C to 2 - 5°C. This enhances the need for better work clothing as protection against cold. The purpose of the present project was to develop a clothing concept that both fulfill the veterinary requirements and maintain the worker thermally comfortable, while being comfortable and functional to wear during work in the cold areas of the meat industry.

ANALYSIS OF REQUIREMENTS

Various interests and requirements from Veterinary Authorities, meat industry management and workers were analysed, considered and given priority before the development of the new clothing concept. The veterinary requirements concerning cleaning of the clothing having absolute priority, specifies that the outer clothing layer must be laundered at 70°C. In addition, this garment must not have parts that are difficult to clean (e.g. velcro). Similar requirements are not posed on middle and inner layer.

The requirements of the clothing concept about thermal function, freedom of movement, and functionality during use were established partly on the knowledge collected in two former studies in the danish meat industry [1, 2], and partly on an ergonomic analysis of the various work situations. For the individual worker the thermal conditions often change. The activity level varies. Many workers are moving between rooms with different temperatures. In the future job rotation will be more common. For optimal thermal function the insulation of the clothing ensemble must be correct and the thermal variability in working conditions requires adjustability of the clothing insulation. A range of insulation values were calculated from IREQ and PMV, based on matched values of climate and activity level, which would offer thermal comfort in a variety of jobs in the slaughterhouse. To minimize sweating and the risk of cooling from wet clothing, the clothing ensemble must absorb and carry surplus sweat effectively away from the skin keeping it dry.

The clothing must protect against localized thermal influence. Cold air falling from cooling systems placed under the ceiling is a major nuisance for many workers complaining over cooling of the back of the neck, the shoulders and the back. The new clothing concept must have additional insulation at these places. The design must add insulation on the back of the neck and in a flexible way let the clothing fit tightly when the head is bent forward e.g. during cutting. Sleeves must be designed for half-bent arms stretched forward in order to secure sufficient insulation of the elbows during work. Similarly, there must be extra insulation over the knees because the textile in the sitting position is stretched over the knee. This is especially important for forklift drivers, where the cooling can be significant during driving.

Handling of wet objects or bloody meat is common and the clothing must therefore in some jobs be waterproof or water repellent in certain areas. As waterproof clothing hinders the passage of water vapor through the clothing layers it was decided this protection should be done with special parts as apron, cuffs, or rubber boots. Workers can then protect themselves according to specific needs.

In order to allow for freedom of movement, the clothing must have a good fit and size and be designed in a way so it functions on a person while performing work movements and being in various positions. Clothing

should not restrict movement, and should not have the tendency of tightening aroundjoints or riding up at the waist, during flexion of the limbs and trunk, respectively. The model design must aim at being loose-fitting and a little baggy as this both will result in better freedom to move and a better ventilation of the clothing ensemble. To obtain a better fit the model should be designed for men and women, respectively, as almost 1/3 of the workers in the meat industry are women. 17% of the danish women and 35% of the danish men are slightly overweight [3]. The extra weight is frequently placed on the stomach in men, while women store fat in the thighs, hips and breasts. In larger sizes extra room is therefore needed at different places. Big sizes must also be produced with short sleeves and legs.

DEVELOPMENT

It was decided to work with a 3-layer clothing concept because the insulation of this could be adjusted by removing garments. For every layer a choice was made regarding material, design and local protective needs.

Underwear: The literature did not show evidence of any textile material being preferable for the thermal conditions in the slaughterhouses. A study was therefore performed with subjects sitting for an hour at 10°C dressed in a 2-layer clothing system, where the underwear had been humidified to simulate previous sweating. Of the five underwear textiles tested the subjects seemed to cool least in a double-layer construction. Following a market survey some promising textile materials were selected for measurement of their physical characteristics. The textile properties were compared with the requirements the materials had to fulfill in the slaughterhouse clothing, and two elastic double-layer materials were selected. The design was tight fitting long-johns and crewneck with a high collar that could be opened for ventilation in front with a short zipper. Double cloth was sewn in over the shoulders and upper back, over the lower back, over the elbows and the knees. The crewneck had the back lengthened downwards.

Middle layer: Two textile materials were selected: a pile and a quilted material. Both materials existed in well constructed jacket and trouser models with sufficient room for unrestricted movements to take place. In addition, a vest covering the outer part of the upper arm was sewn in the pile material.

Outer layer: Two materials were selected for the outer layer: a quilted polyester material and a woven polyester/ cotton material. Two different models were designed, which had double cloth over the shoulders/ upper back, over the elbows and the knees. The jacket was long enough to cover the buttocks, it had a high collar, it had ribbed cuffs at the wrist, and a hole in the armpit. The quilted model had a long pleat in the middle of the back and could be opened in one side with a zipper. The other model had pleats where the sleeves was sewn to the back of the jacket and on the back, and it was closed with buttons in front. The design of the trouser models in the two materials was identical with ribbed cuffs at the ankles, extra room over the front of the knee, pleats in front over the abdomen, an adjustable waist band, and three pockets on the inside. Both models were designed in a male and a female version.

TESTING AND EVALUATION

A 3-step evaluation of the new clothing system was conducted. First, the range of insulation values within which the ensemble could be adjusted was measured on a thermal manikin and found to be within the range of insulation values estimated from IREQ and PMV. Then the function of various garment combinations during alternating activity and climate resulting in periods of sweating was evaluated on subjects in a climatic chamber. Based on these results the quilted middle layer was excluded. Eventually, the clothing concept comprised of 2 outer layer alternatives, a middle layer and 2 underwear alternatives was tested by 26 workers with quite different job functions in the meat industry. Their evaluations were very positive. Almost everyone expressed that thermal comfort and overall function were considerably better in the new clothing ensemble than in their usual. Based on their comments some minor adjustments were made to the design.

CONCLUSION

With the new clothing system developed in concurrence with observed requirements it was possible to ameliorate the thermal work conditions for many workers in the meat industry. The new design reduces the effect of draught and improves the overall thermal comfort.

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