WOODHEAD PUBLISHING IN TEXTILES



Textiles for cold weather apparel

Edited by J. T. Williams







Contents

	Contributor contact details	xi
	Woodhead Publishing in Textiles	XV
	Introduction	xxi
Part I	Material and design issues in cold weather clothing	
1	Comfort and thermoregulatory requirements in cold weather clothing R. ROSSI, Empa Materials Science and Technology, Switzerland	3
1.1	Introduction	3
1.2	Human thermoregulation in the cold	4
1.3	Clothing and comfort	6
1.4	Thermal and tactile comfort in the cold	7
1.5	New trends in thermoregulatory textiles for cold protection	14
1.6	References and the could not be to apply	15
2	Thermal insulation properties of textiles and	
	clothing	19
	G. SONG, University of Alberta, Canada	
2.1	Introduction	19
2.2	Thermal comfort	20
2.3	Heat transfer in fabrics	21
2.4	Moisture transport in fabrics	23
2.5	Fibre properties and thermal insulation	24
2.6	Yarn/fabric structure and thermal insulation	25
2.7	Predicting heat and moisture transfer in fabrics	27
2.8	Conclusions	30
2.9	References	30

Developments and demongravion of Afficially belonged substant

vi	Contents

3	Assessing fabrics for cold weather apparel: the case of wool R. M. LAING, University of Otago, New Zealand	33
3.1	Introduction	33
3.2	Developments and demonstration of efficacy of wool apparel	35
3.3	Summary and future trends	48
3.4	Sources of further information and advice	51
3.5	References	52
4	Coating and laminating fabrics for cold weather apparel	56
	R. LOMAX, Baxenden, a Chemtura Company, UK	
4.1	Introduction	56
4.2	Historical aspects and evolution of the modern industry	57
4.3	Breathable membranes	61
4.4	Manufacture and properties of coated and laminated fabrics	67
4.5	Testing of coated and laminated fabrics	72
4.6	Environmental issues Current applications	76 78
4.8	Future trends	80
4.9	Sources of further information and advice	81
4.10	References	82
5	The use of smart materials in cold weather apparel J. Hu and Murugesh Babu K., Hong Kong Polytechnic University, Hong Kong	84
5.1	Introduction	84
5.2	Design requirements for cold weather clothing	85
5.3	Types of smart fibres and fabrics	89
5.4	The use of shape-memory materials	92
5.5	The use of phase-change materials	101
5.6	Future trends	107
5.7	References and further reading	109
6	Biomimetics and the design of outdoor clothing V. KAPSALI, University of the Arts London, UK	113
6.1	Introduction	113
6.2	Inspiration from nature additional language base extragonal and the	114
6.3	Biological paradigms for outdoor clothing	118
6.4	Future trends	128
6.5	Sources of further information and advice	128
6.6	References	129

7	Designing for ventilation in cold weather apparel N. GHADDAR and K. GHALI, American University of Beirut, Lebanon	131
7.1	Introduction: importance and function of ventilation in cold	
	weather apparel	131
7.2	Water vapour transport through cold weather textiles at low	
	temperatures applied usual subsequidos and his become a	133
7.3	Layering cold weather clothing	135
7.4	Mechanism of ventilation in cold weather	136
7.5	Factors affecting ventilation	142
7.6	Recommendations and advice on clothing design for	
	ventilation	147
7.7	Future trends	149
7.8	References	149
7.9	Nomenclature	151
8	Factors affecting the design of cold weather	450
	performance clothing J. BOUGOURD, University of the Arts London, UK and	152
	J. McCann, University of Wales, Newport, UK	
8.1	Introduction	152
8.2	Traditional design development processes	153
8.3	Stages in the process	155
8.4	Case studies: motorcycling and climbing	184
8.5	Future trends	190
8.6	Acknowledgements	191
8.7	Sources of further information and advice	191
8.8	References Fueltage printiple	191
Part II	Evaluation and care of cold weather clothing	
9	Standards and legislation governing cold	
11.5	weather clothing	199
	H. MÄKINEN, Finnish Institute of Occupational Health, Finland	
9.1	Introduction	199
9.2	Development of legislation and standards	200
9.3	Directives on personal protective equipment	201
9.4	European standards for cold protective clothing	203
9.5	Cold protective clothing standards outside Europe	212
9.6	Future trends	212
9.7	Sources of further information and advice	213
9.8	References	214

	•
VIII	Contents

10	Laboratory assessment of cold weather clothing G. HAVENITH, Loughborough University, UK	217
10.1	Introduction	217
10.2	Clothing properties relevant in cold	219
10.3	Material/fabric testing	220
10.4	Garment and ensemble testing: physical apparatus	223
10.5	Garment and ensemble testing: human subjects	229
10.6	Special applications	233
10.7	Future trends	239
10.8	References	240
11	Evaluation of cold weather clothing using manikins	244
	E. A. McCullough, Kansas State University, USA	
11.1	Introduction	244
11.1	Manikin tests vs. fabric tests	244
11.3	Thermal manikins	245
11.4	Measuring the thermal resistance of cold weather clothing	210
11.1	systems	246
11.5	Measuring the evaporative resistance of cold weather clothing	2.0
2210	systems	249
11.6	Moving manikins	251
11.7	Using manikins under transient conditions	251
11.8	Temperature ratings	253
11.9	Conclusions	253
11.10	References	254
12	Human wear trials for cold weather protective	
	clothing systems	256
	I. HOLMÉR, Lund University, Sweden	
12.1	Introduction and the second se	256
12.2	Types of human wear trials	257
12.3	Discussion	270
12.4	Sources of further information and advice	271
12.5	References	272
13	Care and maintenance of cold weather protective	
	clothing	274
	N. KERR, J. C. BATCHELLER and E. M. CROWN, The University of Alberta, Canada	
13.1	Introduction	274
13.2	Home (domestic) laundering procedures	276
13.3	Professional textile care	281

,

	Contents	ix
13.4	Problem areas for maintenance of cold weather clothing	285
13.5	Care of cold weather clothing – case studies	289
13.6	New developments	295
13.7	Sources of further information and advice	296
13.8	References	298
	Appendix: Examples of home laundry detergents tailored	
	for special purposes	301
	P. J. Donwy and T. Vuskinkin, Earle de schologie	
Part III	Cold weather clothing applications	
14	Cold weather clothing for military applications R. A. Scott, Colchester, UK	305
14.1	Introduction	305
14.2	History of military cold weather operations	306
14.3	General military clothing requirements	307
14.4	Incompatibilities in combat clothing systems	309
14.5	Biomedical aspects of protective combat clothing	310
14.6	Underwear materials	311
14.7	Thermal insulation materials	312
14.8	Waterproof/water vapour permeable materials	316
14.9	Materials for current UK combat clothing systems	320
14.10	Military hand- and footwear for cold climates	321
14.11	Research and development of future materials	323
14.12	References	326
15	Protective clothing for cold workplace	
	environments	329
	I. HOLMÉR, Lund University, Sweden	
15.1	Introduction	329
15.2	Directives and standards	330
15.3	Protection requirements	331
15.4	Clothing for cold protection	336
15.5	Sources of further information and advice	340
15.6	References	340
16	Footwear for cold weather conditions	342
	K. KUKLANE, Lund University, Sweden	
16.1	Introduction	342
16.2	Criteria for cold protective footwear	343
16.3	Feet in cold	344
16.4	Foot and footwear related injuries in cold	348

X	Contents	

16.5	Footwear insulation	350
16.6	The effect of moisture in the footwear	355
16.7	Design of cold protective footwear	361
16.8	Socks	367
16.9	References ************************************	370
17	Gloves for protection from cold weather P. I. DOLEZ and T. VU-KHANH, École de technologie supérieure, Canada	374
17.1	Introduction: key issues of gloves in cold environments	374
17.2	Design, structure and materials used for hand protection in	
150	cold environments	376
17.3	Effect of cold temperatures on physical and mechanical	
	properties of materials	381
17.4	Protection properties	383
17.5	Functionality and comfort	386
17.6	Applications/examples	388
17.7	Future trends	390
17.8	Sources of further information and advice	391
17.9	Acknowledgments alarmator musikus kanada	392
17.10	References	392
	Index assumed bloomed makened but should be should smaller	399