Performance of Protective Clothing: Fourth Volume

James P. McBriarty and Norman W. Henry, editors

ASTM Publication Code Number (PCN)
04-011330-55

ASTM
1916 Race Street
Philadelphia, PA 19103
Foreword

This publication, *Performance of Protective Clothing: Fourth Volume*, contains papers presented at the symposium titled, Performance of Protective Clothing: Challenges for Developing Protective Clothing for the 1990s. The symposium was held in Montreal, Quebec, Canada on 18–20 June, 1991. The symposium was sponsored by ASTM Committee F-23 on Protective Clothing and in cooperation with The Institut de Recherche en Sante et en Securite du Travail de Quebec (IRSST). James P. McBriarty of ICI Americas in West Deptford, NJ and Norman W. Henry, III of E. I. du Pont de Nemours in Newark, DE presided as symposium chairman and co-chairman, respectively, and are both editors of the resulting publication.

About the Cover

The cover illustration was provided with permission from The Mine Safety Appliances Company, Pittsburgh, PA.
Contents

Overview—J. P. McBriarty AND N. W. Henry xiii

HAZARDS AND METHODS

AEROSOLS

Model of Aerosol Protection Offered by Permeable Protective Garments—
P. D. FeDeLe 3

PHYSICAL RESISTANCE

Measurement and Control Method for Cutting Resistance of Protective Gloves—
F. Payot 17

Development of a Method to Evaluate the Puncture Resistance of Protective
Clothing Materials—J. Lara, N. F. Nelisse, S. Cote, AND H. J. Nelisse 26

BIOLOGICAL

Ability of 1000 mL Water Leak Test for Medical Gloves to Detect Gloves With
Potential for Virus Penetration—H. R. Kotilainen, W. H. Cyr,
W. Truscott, N. M. Gantz, L. B. Routson, AND C. D. Lytle 38

Dry Test Method for Rating the Penetration of Viruses Through Porous Materials
Used in Protective Clothing by Health Care Workers—A. M. Placencia
AND J. T. Peeler 49

The Resistance of Clothing Materials to Biological Liquids—N. W. Henry, III AND
D. C. MonTEFiori 58

Protective Clothing for Health Care Workers: Liquidproofness Versus
Microbiological Resistance—P. L. Brown 65

A Comparison of Methods for Measuring the Liquid Barrier Properties of Surgical
Gowns—E. A. McCullough AND L. K. Schoenberger 83

An Interlaboratory Comparison of Standard Test Methods for Medical Gloves—
CHEMICAL


A Comparison of the Liquid Penetration Test with Other Chemical Resistance Tests and its Application in Determining the Performance of Protective Clothing—J. O. STULL, D. F. WHITE, AND T. C. GREIMEL 123

Assessment of the Resistance of Protective Gloves to Chemicals—J. C. MAHIEU AND F. BARAT 141

Testing the Resistance of Protective Clothing Materials to Nitroglycerin and Ethylene Glycol Dinitrate—J. LARA AND D. DROLET 153

PESTICIDES

Pesticide Resistance and Thermal Comfort Tests of Protective Clothing in Agriculture—T. HINZ AND G. JAHNS 162

Methyl Parathion Residues in Protective Apparel Fabric: Effect of Residual Soils on Decontamination—J. M. LAUGHLIN 174

Analysis of 2,4-D Glove Permeation Under Controlled Environmental Conditions—R. P. MOODY 189


THERMAL AND HEAT


Method for Assessing the Insulation Properties of Gloves Against Contact Heat—J. PAUREAU AND M. ROLLIN 237

Protective Clothing Development at New Zealand Aluminium Smelters Ltd.—J. E. COUGHLAN 252


Sweat Accumulation in Clothing in the Cold—R. NIELSEN 281
FIELD TESTS

A Field Study of the Clothing Used at Cold Work Places—B. W. OLESEN

Field Test Evaluation of ASTM Standard F-1154 With Chemical Protective Suit Ensembles—J. H. VEGHTE AND S. STORMENT

NEW AND IMPROVED TESTS

New Comprehensive Performance Standards for Chemical Protective Gloves, Boots, and Other Types of Protective Clothing—J. O. STULL


Glove System for Cold/Wet Environments—D. S. HERMAN, L. P. WELLS, A. D. SCHWOPE, AND J. C. SAWICKI

EVALUATIONS


An Evaluation of a Permeation Field Test Kit to Aid Selection of Chemical Protective Clothing—J. O. STULL, J. H. VEGHTE, AND S. B. STORMENT

Application of Three ASTM Test Methods to Measure Thermal Resistance of Clothing—M. BOMBERG

The Effect of Seams and Closures on Pesticide Penetration Through Fabric—C. A. DIMIT, E. P. EASTER, AND J. O. DeJONGE

Evaluating the Performance of Exhaust Valves for Vapor-Protective and Chemical Protective Dive Suits—D. F. WHITE, T. C. GREIMEL, AND J. O. STULL

Development and Evaluation of Experimental Nonwoven Breathable Barrier Fabrics—L. C. WADSWORTH AND L. M. SALAMIE


The Evaluation of Protective Clothing as Chemical Barriers for Mixers/Loaders and Applicators in Agricultural Field Tests Designed to Meet FIFRA GLP Testing Standards—B. G. OAKLAND, D. J. SCHABACKER, R. B. DODD, AND R. H. ROSS
The Introduction of Fire Resistant Workwear Programs in Alberta—G. R. Smith and P. Clark

Comparative Responses to Exercise-Heat Stress of Two Chemical Protective Garments—W. R. Santee, B. S. Cadarette, D. W. Schamber, and R. R. Gonzalez

The Effectiveness of Decontamination Procedures Used by Asbestos Abatement Workers—D. J. Jose and C. H. Salzenberg

Evaluation of Carbonaceous Adsorbent Coated Fabric as a Barrier to Pesticide Penetration for Dermal Exposure Reduction in Pesticide Application—E. P. Easter and M. A. Koals


Physiological and Biophysical Properties of a Semipermeable Attached Hood to a Chemical Protective Garment—R. R. Gonzalez, W. R. Santee, and T. L. Endrusick


Thermal Constraints Related to the Wearing of Protective Clothing-Body Ventilation by Fresh Air—J. Bittel, A. M. Hanniquet, and H. Frossard

Clothing Insulation Prediction in Hypobaric Environments—S. Kw. Chang and R. R. Gonzalez

The Function of Semipermeable Membrane in Cold—H. P. Anttonen, E. V. Hiltunen, and J. T. Virtanen


Ergonomical


Some Ergonomics Issues in the Design of Personal Protective Devices—J. D. A. Abeysekera
Movement Analysis as the Basis for the Development and Evaluation of a Protective Coverall Design for Asbestos Abatement—S. P. ASHDOWN AND S. M. WATKINS 660

An Evaluation of Fit of Protective Coveralls Manufactured to a Proposed Revision of ANSI/ISEA 101—V. B. KEEBLE, M. B. PREVATT, AND S. A. MELLIAN 675

DESIGN, EVALUATION, AND PERFORMANCE

Effect of Fabric Finish on the Adhesion of Molten Metal to Wool—T. D. PROCTOR AND H. THOMPSON 692

New Developments in the Design and Evaluation of Flame Retardant Clothing for Protection Against Molten Aluminum Splash Hazards—R. SHARKEY 698

Energy as Performance Criterion for Chain Saw Protective Clothing—J. ARTEAU AND D. TURCOT 703


Robotic Mannequin Technology for Enhanced Product Testing—B. A. FECHT AND D. W. BENNETT 734

Evaluating Textiles and Apparel for Controlling Contamination in Cleanrooms—S. MEHTA, S. P. HERSH, P. A. TUCKER, AND A. C. BULLERWELL 742

The Effect of Wear and Laundering on Flame-Retardant Fabrics—H. MAKINEN 754

Wash Durability of FR Cotton—W. F. BAITINGER 766

The Durability of Flame Resistant Fabrics in an Industrial Laundry Environment—D. H. LOFTIN 775

DECONTAMINATION

A Technique to Determine Chemical Contamination in Chemical Protective Clothing—T. R. CARROLL, A. D. SCHWOPE, AND R. T. MCCARTHY 785

The Use of Bleach Pre-Treatment in Chlorpyrifos Residue Removal From Cotton Workwear—H. M. PERKINS, K. B. RIGAKIS, AND E. M. CROWN 799

The Efficiency of Cold Water Machine Washing in Removing Glyphosate From Work Garments—O. SAMUEL AND J. G. GUILLOT 811

Statistical Fit Models of Methyl Parathion Decontamination from Applicator Clothing—J. M. LAUGHLIN 818
Residue Removal of Granular Formulation Atrazine and its Dust From Workers' Protective Clothing by Laundering—C. J. KIM AND O. WANG 830

Repellent Treatments on Stretchable and/or Inherently Flame Retardant Fabrics—J. K. DIX AND B. A. DELONG 840

Personal Protective Equipment Decontamination for Hazardous Waste Operations and Emergency Response—S. Z. MANSDOF 849

PROGRAMS AND ASSESSMENTS

PROGRAM

Protective Clothing Program Management—C. WIERNICKI 857

SELECTION


Selection and Development of Protective Clothing for Fire Fighters—A Case Study for Users' Assessment of Standards, Tests, and Performance Requirements—M. F. ROTMANN 885

Selection and Use of Molecular Parameters to Predict Permeation Through Fluoropolymer-Based Protective Clothing Material—C. M. HANSEN, C. B. BILLING, JR., AND A. P. BENTZ 894


ASSESSMENTS

Assessment of the Potential for Reducing Occupational Injury Through Protective Clothing—R. M. LAING, J. D. BURRIDGE, AND C. A. WILSON 924

Protective Clothing Use in the Lawn Care Industry—C. N. NELSON, J. L. LEFTON, AND D. E. SCOTT 933

BUSINESS

A Suggested Strategy to Increase Employee Use of Protective Clothing—D. J. BURNS AND C. N. NELSON 946

Estimation of the Cost of Using Chemical Protective Clothing—A. D. SCHWOPE
AND E. P. RENARD

INTERNATIONAL STANDARDS

Activities of CEN TC 162 WG2: Clothing for Protection Against Heat and
Flame—R. COLE

European Directives and Standards Relating to Personal Protective Equipments—
A. MAYER

European Standardization of Protective Clothing—P. W. HEFFELS AND
B. G. ZIEGENFUB

Protective Clothing Standards Development in China—G. FANG, X. MING, Z. YULI,
AND X. SHIRONG

Author Index

Subject Index
The Fourth International Symposium on the Performance of Protective Clothing is now past. This symposium was truly international in that presentations representing ten different countries were given, and for the first time it was held outside of the United States. Special thanks should be given to our Canadian friends and members of The Institut de Recherche en Santé et en Sécurité de Travail de Québec (IRSSI) for co-hosting the symposium and arranging the special events. Thanks should also be extended to all reviewers who helped select the papers contained in this Special Technical Publication (STP).

Approximately 270 attendees were registered for this three-day symposium that featured keynote speakers, a banquet dinner, boat cruise, and an international fireworks competition. One hundred and twenty presentations were given on all aspects of protective clothing including its evaluation and use against physical, chemical, and biological hazards. Also, for the first time, a poster session was held so that an informal exchange of information could take place between attendees and those not interested in making a platform presentation. Overall, both the platform presentations and poster session were well received.

Previous symposia focused on protective clothing standards development over the last ten years, while this symposium’s theme was “Challenges for Developing Protective Clothing for the 1990s and Beyond.” Indeed, many of the presentations and posters reported on new developments and novel approaches for evaluating the performance of protective clothing. Other presentations addressed protective clothing programs and physiological stresses associated with wearing clothing in extreme environments. One new area of testing on biological resistance clothing for health care workers was recognized by having a separate session in which papers were presented on evaluating clothing materials to biological liquids and viruses. Another separate session was devoted to international standards development, since issues pertaining to European standardization, as well as international acceptance of performance standards, need to be considered in our global economy today. Representatives from European and Asian countries gave an update on their progress in protective clothing standards development.

The papers in this STP have been organized and are presented according to areas of special interest. The first area has papers that cover methods for determining resistance of clothing materials to specific hazards. Aerosol, physical, biological, chemical, pesticide, thermal, and heat resistance are among the topics discussed. New and improved test methods for evaluating resistance of clothing to these hazards focused attention on some of the challenging problems users may encounter while wearing protective clothing. The next area contains papers describing field test methods and other new methods for evaluating garment design, comfort, dexterity, physiological stresses, and effective performance. From the user’s perspective, this area is one of the most important, since it addressed concerns about the effectiveness of clothing in practical situations where flexibility and durability are needed. Also included in this area are several papers on decontamination. The next area contains papers that addressed protective clothing programs, selection, risk assessment, and strategies. Examples of an ideal protective clothing program are reported. These examples provide a decision logic for the selection, care, and service life of clothing. Also included is a paper describing a computer-based system. The final area contains papers describing current efforts for international standardization of protective clothing. Papers by representatives from the European, Scandinavian, and Asian countries are reported. These papers describe standards
development and the need for international cooperation as we enter the 1990s and the global market.

While there are many challenges ahead, international standardization of protective clothing in our global market is certainly one of the most difficult issues. Another issue is a question raised by one of the keynote speakers, "Can we survive in protective clothing?" Answers to these can only be resolved by cooperative efforts between standard setting organizations such as ASTM, ISO, and others that allow for the opportunity to exchange information by sponsoring symposia such as this one. Other symposia will follow that will provide the forum for open communication between all our international friends. Clothing is one of man's basic needs, and as our technology and business needs change so will our standards for protective clothing performance. So now that the events and acquaintances that we enjoyed and made at the symposia are past, let's focus on the future direction of standards development in protective clothing. Hopefully, the thoughts and ideas captured and published in this STP will lead us in the right direction. Remember that many of the accomplishments of man would not be possible without protective clothing.

Norman W. Henry, III,
E. I. du Pont de Nemours,
Newark, DE, co-chairman and editor.