

Performance of **Protective Clothing**

Barker/Coletta
editors



ASTM STP 900

PERFORMANCE OF PROTECTIVE CLOTHING

A symposium
sponsored by
ASTM Committee F-23
on Protective Clothing
Raleigh, NC, 16-20 July 1984

ASTM SPECIAL TECHNICAL PUBLICATION 900
Roger L. Barker, North Carolina State
University, and Gerard C. Coletta,
Risk Control Services, editors

ASTM Publication Code Number (PCN)
04-900000-55



1916 Race Street, Philadelphia, PA 19103

Library of Congress Cataloging-in-Publication Data

Performance of protective clothing.

(ASTM special technical publication; 900)

"ASTM publication code number (PCN) 04-900000-55."

Papers presented at the First International
Symposium on the Performance of Protective Clothing.

Includes bibliographies and index.

I. Clothing, Protective—Testing—Congresses.

I. Barker, Roger L. II. Coletta, Gerard C.

III. ASTM Committee F-23 on Protective Clothing.

IV. International Symposium on the Performance of
Protective Clothing (1st : 1984 : Raleigh, N.C.)

V. Series

HD7395.C5P47 1986 687'.16 86-10706

ISBN 0-8031-0461-8

Copyright © by AMERICAN SOCIETY FOR TESTING AND MATERIALS 1986
Library of Congress Catalog Card Number: 86-10706

NOTE

The Society is not responsible, as a body,
for the statements and opinions
advanced in this publication.

Foreword

The papers in this publication, *Performance of Protective Clothing*, were presented at the International Symposium on the Performance of Protective Clothing, which was held in Raleigh, North Carolina, on 16-20 July 1984. The meeting was sponsored by ASTM Committee F-23 on Protective Clothing. This symposium was the first to bring together all areas of interest in the field of protective clothing for occupational exposures, and other such symposia are planned.

The symposium chairmen were Roger L. Barker, North Carolina State University School of Textiles, and Gerard C. Coletta, Risk Control Services. Both men also served as editors of this publication.

Related ASTM Publications

ASTM Performance Standards for Textile Fabrics, 1983, 03-413083-18

ASTM Standards for Electrical Protective Equipment for Workers, 1985,
03-618085-21

A Note of Appreciation to Reviewers

The quality of the papers that appear in this publication reflects not only the obvious efforts of the authors but also the unheralded, though essential, work of the reviewers. On behalf of ASTM we acknowledge with appreciation their dedication to high professional standards and their sacrifice of time and effort.

ASTM Committee on Publications

ASTM Editorial Staff

Helen P. Mahy
Janet R. Schroeder
Kathleen A. Greene
William T. Benzing

Contents

Introduction	1
PERMEATION RESISTANCE OF CHEMICAL PROTECTIVE CLOTHING MATERIALS	
Comparison of Two Methods Used to Measure Permeation of Glove Materials by a Complex Organic Mixture—STEPHEN L. DAVIS, CHARLES E. FEIGLEY, AND GEORGE A. DWIGGINS	7
Use of Infrared Spectroscopy in Permeation Tests—JIMMY L. PERKINS AND MICHAEL C. RIDGE	22
A Proposed Basis for Characterizing and Comparing the Permeation Resistance of Chemical Protective Clothing Materials— MARK W. SPENCE	32
Test Method for Evaluating Adsorptive Fabrics—DIRK M. BAARS, DANA B. EAGLES, AND JEFFREY A. EMOND	39
How Protective Is Protective Clothing?—NORMAN W. HENRY III	51
Testing of Candidate Glove Materials Against Metal Cutting Fluids— KRISTER FORSBERG, KNUT G. OLSSON, AND BJÖRN CARLMARK	59
Experiences from Developing a Data Base on the Protective Effects Against Chemicals of Gloves Made from Rubber and Plastic Materials—GUNH MELLSTRÖM	67
Influence of Film Thickness on the Permeation Resistance Properties of Unsupported Glove Films—C. NELSON SCHLATTER AND DREW J. MILLER	75
Protective Clothing Permeation Testing: Calculations and Presentation of Data—JOSEPH E. WINTER	82

RESISTANCE TO PESTICIDES—FIELD PERFORMANCE AND CLEANING
PROCEDURES

- Protective Clothing and the Agricultural Worker**—ALAN P. NIELSEN
AND RICHARD V. MORASKI 95
- California Pesticide Applicators' Attitudes and Practices Regarding
the Use and Care of Protective Clothing**—
MARGARET H. RUCKER, KAYE M. MCGEE, AND
TATYANA CHORDAS 103
- Effectiveness of Selected Work Fabrics as Barriers to Pesticide
Penetration**—DONNA H. BRANSON, GEORGE S. AYERS, AND
MAUREEN S. HENRY 114
- Efficiency of Protective Clothing for Pesticide Spraying**—
GLYN A. LLOYD 121
- Fabric Parameters and Pesticide Characteristics That Impact on
Dermal Exposure of Applicators**—JOAN M. LAUGHLIN,
CAROL B. EASLEY, ROGER E. GOLD, AND ROBERT M. HILL 136
- Effects of Barrier Finishes on Aerosol Spray Penetration and Comfort
of Woven and Disposable Nonwoven Fabrics for Protective
Clothing**—NANCY E. HOBBS, BILLIE G. OAKLAND, AND
MELVIN D. HURWITZ 151
- Effect of Laundering Procedures and Functional Finishes on Removal
of Insecticides Selected from Three Chemical Classes**—
JULIE L. KEASCHALL, JOAN M. LAUGHLIN, AND ROGER E. GOLD 162
- Effect of Functional Finish Barriers on Pesticide Penetration**—
KAREN K. LEONAS AND JACQUELYN O. DEJONGE 177
- Distribution of Malathion and Methyl Parathion on Cotton/Polyester
Unfinished and Durable-Press Fabrics Before and After
Laundering as Determined by Electron Microscopy**—
S. KAY OBENDORF AND CAMILLE M. SOLBRIG 187
- RISK ASSESSMENT OF CHEMICAL EXPOSURE HAZARDS IN SELECTING
PROTECTIVE CLOTHING
- Risk Assessment of Chemical Exposure Hazards in the Use of
Chemical Protective Clothing—An Overview**—
S. ZACK MANSDORF 207

Bioassay for Testing Protective Glove Performance Against Skin Absorption of Organic Solvents—ANDERS BOMAN AND JAN E. WAHLBERG	214
Permeation of Chemicals Through the Skin—ARTHUR D. SCHWOPE	221
Managing the Selection and Use of Chemical Protective Clothing—GERARD C. COLETTA AND MARK W. SPENCE	235
Selection of Chemical Protective Clothing Using Permeation and Toxicity Data—KRISTER FORSBERG	243
Chemical Protective Clothing Field Evaluation Methods—STEPHEN P. BERARDINELLI AND MICHAEL RODER	250
TESTING THE CHEMICAL RESISTANCE OF SEAMS, CLOSURES, AND FULLY ENCAPSULATED SUITS	
Evaluation of Chemical Protective Garment Seams and Closures for Resistance to Liquid Penetration—STEPHEN P. BERARDINELLI AND LEN COTTINGHAM	263
Testing Fully Encapsulated Chemical Suits in a Simulated Work Environment—CHARLES E. GARLAND, LYNN E. GOLDSTEIN, AND CAMPBELL CARY	276
Survey of Use and Maintenance Procedures for Chemical Protective Total Encapsulation Garments—JEFFREY A. MOORE	286
Polychlorinated Biphenyl Decontamination of Fire Fighter Turnout Gear—KARL C. ASHLEY	298
LABORATORY MEASUREMENT OF THERMAL PROTECTIVE PERFORMANCE	
A Critical Appraisal of Test Methods for Thermal Protective Clothing Fabrics—BARRY N. HOSCHKE, BARRY V. HOLCOMBE, AND A. MARIETTE PLANTE	311
Do Test Methods Yield Meaningful Performance Specifications?—BARRY V. HOLCOMBE AND BARRY N. HOSCHKE	327
Protection Offered by Lightweight Clothing Materials to the Heat of a Fire—MEREDITH M. SCHOPPEE, JUDITH M. WELSFORD, AND NORMAN J. ABBOTT	340

**Predicting the Thermal Protective Performance of Heat-Protective
Fabrics from Basic Properties—ITZHAK SHALEV AND
ROGER L. BARKER** 358

**New Test Method for Determination of Emissivity and Reflection
Properties of Protective Materials Exposed to Radiant Heat—
ARNE SCHLEIMANN-JENSEN AND KRISTER FORSBERG** 376

EVALUATING MATERIALS FOR THERMAL PROTECTIVE CLOTHING

**Protective Performance of Polybenzimidazole-Blend Fabrics—
RANDALL E. BOUCHILLON** 389

**The Contribution of Wool to Improving the Safety of Workers
Against Flames and Molten Metal Hazards—LADO BENISEK,
G. KEITH EDMONDSON, PARVEZ MEHTA, AND
W. ALDEN PHILLIPS** 405

**Thermal Insulative Performance of Single-Layer and Multiple-Layer
Fabric Assemblies—WILLIAM F. BAITINGER AND
LUDMILLA KONOPASEK** 421

**Advances in Flame-Retardant Safety Apparel—VLADIMIR MISCHUTIN
AND DAVID BROWN** 438

**Performance of Protective Clothing: Development and Testing of
Asbestos Substitutes—BAL DIXIT** 446

CLOTHING SYSTEMS FOR INDUSTRIAL AND FIRE-FIGHTING APPLICATIONS

**Some Characteristics of Fabrics for Heat Protective Garments—
JOHN F. KRASNY** 463

A Method for Testing Fabrics with Molten Metals—PHILIP S. JAYNES 475

**Functional Integration of Fire Fighters' Protective Clothing—
JAMES H. VEGHTE** 487

**U.S. Navy Protective Clothing Program—NORMAN F. AUDET AND
KENNETH J. SPINDOLA** 497

HEAT STRESS, FIT TESTING, AND OTHER PERFORMANCE REQUIREMENTS
FOR PROTECTIVE CLOTHING

Efficacy of Heat Exchange by Use of a Wetable Cover over Chemical Protective Garments— RICHARD R. GONZALEZ, JOHN R. BRECKENRIDGE, CLEMENT A. LEVELL, MARGARET A. KOLKA, AND KENT B. PANDOLF	515
A Dynamically Insulated Heat-Protective Clothing Assembly— JOHN DAVIES	535
Anthropometric Fit Testing and Evaluation— JOHN T. McCONVILLE	556
Anthropometric Methods for Improving Protection— KATHLEEN M. ROBINETTE	569
Anthropometric Sizing and Fit Testing of a Single Battledress Uniform for U.S. Army Men and Women— CLAIRE C. GORDON	581
Incendiary Behavior of Electrostatic Spark Discharges from Human Beings— NORMAN WILSON	593
SUMMARY	
Summary	607
INDEXES	
Author Index	621
Subject Index	623

ISBN 0-8031-0461-8