# ENCYCLOPAEDIA OF OCCUPATIONAL HEALTH AND SAFETY

4TH EDITION



Editor-in-Chief Jeanne Mager Stellman, PhD

Senior Associate Editor Michael McCann, PhD, CIH

Associate Editors

Leon Warshaw, MD

Carole Brabant, PhD

## Senior Editors

John Finklea, MD, Dr PH
Georges H. Coppée, MD
Vilma R. Hunt, BDS, AM
Richard S. Kraus, PE, CSP
Jacqueline Messite, MD
Steven L. Sauter, PhD
Jerry Spiegel, MA, MSc
Colin L. Soskolne, PhD

Wolfgang Laurig, Dr-Ing Benedetto Terracini, MD

Melvin L. Myers, BS, MPA

Managing Editor Chantal Dufresne, BA

INTERNATIONAL LABOUR OFFICE GENEVA



#### Copyright © International Labour Organization 1998

Publications of the International Labour Office enjoy copyright under Protocol 2 of the Universal Copyright Convention. Nevertheless, short excerpts from them may be reproduced without authorization, on condition that the source is indicated. For rights of reproduction or translation, application should be made to the Publications Bureau (Rights and Permissions), International Labour Office, CH-1211 Geneva 22, Switzerland. The International Labour Office welcomes such applications. Libraries, institutions and other users registered in the United Kingdom with the Copyright Licensing Agency, 90 Tottenham Court Road, London W1P 9HE (Fax + 44 171 436 3986), in the United States with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 (Fax + 1 508 750 4470), or in other countries with associated Reproduction Rights Organizations, may make photocopies in accordance with the licences issued to them for this purpose.

Stellman, Jeanne Mager (ed.)

Encyclopaedia of Occupational Health and Safety. 4th ed.

Geneva, International Labour Office, 1998. 4 V.

/Encyclopaedia/, /Occupational health/, /Occupational safety/. 13.04.2

ISBN 92-2-109203-8 (set)

92-2-109814-1 (V. 1) 92-2-109815-X (V. 2) 92-2-109816-8 (V. 3) 92-2-109817-6 (V. 4)

Contents: V. 1. The Body; Health Care; Management and Policy; Tools and Approaches—V. 2. Hazards—V. 3. Chemicals; Industries and Occupations—V. 4.Indexes

ILO Cataloguing in Publication Data

The designations employed in ILO publications, which are in conformity with United Nations practice, and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of the International Labour Office concerning the legal status of any country, area or territory or of its authorities, or concerning the delimitation of its frontiers. The responsibility for opinions expressed in signed articles, studies and other contributions rests solely with their authors, and publication does not constitute an endorsement by the International Labour Office of the opinions expressed in them.

The reader accepts that the parties make this documentation available without warranty of any kind. The parties do not accept responsibility for the validity or completeness of any data including inaccuracies, errors or omissions or for any consequences arising from the use of such data. Neither the authors, nor the ILO or collaborating institutions shall be liable for damages or other claims and demands arising out of the use of the data.

Reference to names of firms and commercial products and processes does not imply their endorsement by the International Labour Office or any collaborating institution, and any failure to mention a particular firm, commercial product or process is not a sign of disapproval.

ILO publications can be obtained through major booksellers or ILO local offices in many countries, or direct from ILO Publications, International Labour Office, CH-1211 Geneva 22, Switzerland. Catalogues or lists of new publications are available free of charge from the above address.

# **AUTHORS AND EDITORS**



# P.K. Abeytunga, PhD, MSc

Vice-President, Director General
Canadian Centre for Occupational Health
and Safety
Hamilton, Ontario
Canada

#### Sheila H. Akabas, PhD, MBA

Professor, Director
Workplace Center
School of Social Work
Columbia University
New York, New York
United States

#### Munehira Akita, PhD, MA

Professor of Psychology
Faculty of Social and Information Sciences
Nihon Fukushi University
Kyoto
Japan

#### Lorenzo Alessio, MD

Professor, Director
Institute of Occupational Medicine
University of Brescia
Brescia
Italy

#### Peter Arlien-Søborg, MD

Assistant Professor, Head
Department of Neurology
Hvidovre Hospital,
University of Copenhagen
Copenhagen
Denmark

#### Bruce K. Armstrong, MB, D Phil

Director
Cancer Control Information Centre
New South Wales Cancer Council
Sydney
Australia

#### Pat Armstrong, PhD, MA

Professor, Director School of Canadian Studies Carleton University Ottawa, Ontario Canada

#### Thomas J. Armstrong, PhD, MPH

Professor
Occupational Health and Industrial and
Operations Engineering
University of Michigan
Ann Arbor, Michigan
United States

#### Ian M.F. Arnold, MD, MSc

Director
Occupational Health and Safety
Alcan Aluminium Ltd.
Montreal, Quebec
Canada

# Gordon Atherley, MB, ChB, MD

President
Oberon Composer Software
Oakville, Ontario
Canada

#### Michael D. Attfield, PhD

Division of Respiratory Disease Studies National Institute for Occupational Safety and Health Morgantown, West Virginia United States

#### Rahmat Awang, Phar MD

Associate Professor, Head
Drug and Poison Information Unit
National Poison Centre
Universiti Sains Malaysia
Penang
Malaysia

#### Olav Axelson, MD

Professor
Division of Occupational and
Environmental Medicine
Department of Health and Environment
Linköping University
Linköping
Sweden

# Dean B. Baker, MD, MPH

Professor, Director
Center for Occupational and
Environmental Health
University of California-Irvine
Irvine, California
United States

#### Robin Baker, MPH

Director
Labor Occupational Health Program
University of California-Berkeley
Berkeley, California
United States

#### Isabelle Balty, MS

Technical Consultant
Directorate of Applications for Prevention
National Institute of Safety Research and
Occupational Risk Prevention
Paris
France

# Randal D. Beaton, PhD

Clinical Psychologist, Research Associate Professor School of Nursing University of Washington Seattle, Washington United States

#### Margaret R. Becklake, MD

Professor
Departments of Medicine, Epidemiology and Biostatistics and Occupational Health
McGill University
Montreal, Quebec
Canada

#### Raymond Bégin, MD

Professor of Medicine
University Hospital
University of Sherbrooke
Sherbrooke, Quebec
Canada

#### Vladimír Bencko, MD, PhD

Professor, Head
Institute of Hygiene and Epidemiology
Charles University
Prague
Czech Republic

#### Irene K. Berezesky, BA

Instructor
Department of Pathology
School of Medicine
University of Maryland
Baltimore, Maryland
United States

#### Elliott H. Berger, MS

Senior Scientist
Auditory Research Department
E-A-R/Aearo Company
Indianapolis, Indiana
United States

## Joan Bertin, JD

School of Public Health Columbia University New York, New York United States

#### Marco Biagi

Professor of Labour Law
Department of Business Administration
University of Modena
Bologna
Italy

#### Elyce Anne Biddle

National Institute for Occupational Safety and Health Morgantown, West Virginia United States

#### Annibale Biggeri, MD

Professor of Medical Statistics School of Medicine University of Florence Florence Italy

#### Donald Birmingham, MD

Professor Emeritus
Department of Dermatology
Wayne State University
Detroit, Michigan
United States

#### Helmut Blome, Dr rer nat

Deputy Director
Berufsgenossenschaftliches Institute für
Arbeitssicherheit
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Sheila B. Blume, MD, CAC

Medical Director
Alcoholism, Chemical Dependency and
Compulsive Gambling Programs
South Oaks Hospital
Amityville, New York
United States

#### Frank Bochmann, Dr

Head of Section
Berufsgenossenschaftliches Institute für Arbeitssicherheit
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Paolo Boffetta, MD, MPH

Chief
Unit of Environmental Cancer
Epidemiology
International Agency for Research on
Cancer
Lyon
France

#### Marcel-André Boillat, MD, MS

Associate Professor
Institute of Occupational Health Sciences
University of Lausanne
Lausanne
Switzerland

# Carole Brabant, PhD

Associate Editor
Encyclopaedia of Occupational Health and
Safety
International Labour Office
Geneva
Switzerland

#### Mario Braga, MD

Deputy Director
Evaluation Epidemiology unit
Agency for Regional Health Services
Rome
Italy

# Paul Brandt-Rauf, MD, ScD, Dr PH

Professor, Director
Occupational and Environmental
Medicine
School of Public Health
Columbia University
New York, New York
United States

## Sherry I. Brandt-Rauf, JD, M Phil

Assistant Professor of Social Medicine Columbia University New York, New York United States

#### Mark Braverman, PhD, M Ed

Principal
Crisis Management Group Inc.
Newton Upper Falls, Massachusetts
United States

#### William B. Bunn, MD, JD, MPH

Director of Health
Workers' Compensation and Safety
Navistar Corporation
Chicago, Illinois
United States

#### Wayne N. Burton, MD

First Vice-President, Corporate Medical Director First Chicago NBD Chicago, Illinois United States

#### Martin Butz, PhD

Head of Section
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

# LaMont Byrd, MSc

Director of Safety and Health
International Brotherhood of Teamsters
Washington, DC
United States

#### C. D. Calnan\*

Institute of Dermatology St. John's Hospital for Diseases of the Skin London United Kingdom

#### Barry I. Castleman, ScD, MSE

Environmental Consultant Baltimore, Maryland United States

# Chaiyuth Chavalitnitikul, PhD, MPH

Director

National Institute for the Improvement of Working Conditions and Environment Bangkok Thailand

# Haim Chayon, MJ

Former Director
Invalidity Department
National Insurance Institute
Jerusalem
Israel

# Kee-Seng Chia, MD, MBBS, MSc

Associate Professor

Department of Community, Occupational and Family Medicine

National University of Singapore

Singapore

#### Gerolamo Chiappino, MD

Professor, Director
Clinic of Occupational Medicine
Institute of Occupational Medicine
Milan
Italy

#### K.S. Cho, MD\*

Director
Institute of Industrial Medicine
Catholic Medical College
Seoul
Republic of Korea

#### Emmert Clevenstine, PhD, MS

International Occupational Safety and Health Information Centre International Labour Office Geneva Switzerland

#### W. Coenen, Dipl Ing

Director of Prevention
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

# Edward Cohen-Rosenthal, Ed M

Director
Work and Environment Initiative
School of Industrial and Labor Relations
Cornell University
Ithaca, New York
United States

#### Paula Coleman, BS

Curriculum Specialist
Carpenters Health and Safety Fund
Washington, DC
United States

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

Georges H. Coppée, MD

Chief of Medical Section
Occupational Safety and Health
Branch
International Labour Office
Geneva
Switzerland

D. Wayne Corneil, ScD

Director
Operations Eastern Region
Health Canada
Ottawa, Ontario
Canada

James Corry, PhD, MS

Director
Corporate Wellness and Fitness Services
Metropolitan Life Insurance Company
New York, New York
United States

Maureen P. Corry, MPH

General Director

Maternity Center Association
New York, New York
United States

John W.F. Cowell, MD, MSc

President, Chief Executive Officer
Workers' Compensation Board of Alberta
Edmonton, Alberta
Canada

Breen Creighton, LLB, PhD

Special Counsel
Corrs Chambers Westgarth
Melbourne
Australia

Marie L. Cros-Courtial, Dr d'Etat en droit

Maître de Conférence en Droit Department A.E.S. Paul Valéry University Montpellier France

Mark R. Cullen, MD

Professor of Medicine and Public Health Yale University School of Medicine New Haven, Connecticut United States

Ellen Cutler, MPA

National Director
Program Services
March of Dimes Birth Defects Foundation
White Plains, New York
United States

Monica Dahlqvist, PhD

Assistant Professor
Department of Environmental
Technology and Work Science
Royal Institute of Technology
Stockholm
Sweden

Antonio J. Dajer, MD

Neuilly-sur-Seine France

Louis Damphousse, MD, MSc

Medical Consultant Maclaren Inc. Masson, Quebec Canada

Frank Darby, MSc

Consultant in Ergonomics
Wellington
New Zealand

Alois David, MD, PhD

Associate Professor
Department of Occupational Medicine
Postgraduate Medical School
Prague
Czech Republic

Véronique De Keyser, PhD

Professor of Work Psychology, Dean of Faculty University of Liège Liège Belgium

David M. DeMarini, PhD

Environmental Carcinogenesis Division US Environmental Protection Agency Research Triangle Park, North Carolina United States

Dušan Djurić, DSc, ChE

Institute of Occupational and Radiological Health Belgrade

Yugoslavia

Mel Doyle, MPhil

Deputy General Secretary
Workers' Educational Association
London
United Kingdom

Louis-Philippe Durocher, MD, FRCPC

Professor of Dermatology
Notre Dame Hospital
Head
Dermatology Training Programme
University of Montreal
Montreal, Quebec
Canada

Robert W. Dykes, PhD

Director
Center for Research
Rehabilitation Institute of Montreal
University of Montreal
Montreal, Quebec
Canada

Lawrence D. Eicher, PhD

Secretary-General
International Organization for
Standardization
Geneva
Switzerland

G. Enderlein, Dr rer nat

Head of Group

Department of Risk Assessment and
Epidemiological Study Design

Federal Institute for Occupational Safety
and Health

Berlin
Germany

John W. Farquhar, MD

Professor of Medicine, Director
Stanford Center for Research in Disease
Prevention
Stanford University School of Medicine
Palo Alto, California
United States

Igor A. Fedotov, MD, MSc

Occupational Health Specialist International Labour Office Geneva Switzerland

Ilise Levy Feitshans, Esq.JD, ScM

Trustee
Society of Medical Jurisprudence
Global Alliance for Women's Health
Riverdale, New York
United States

Robert G. Feldman, MD

Professor, Chair
Department of Neurology
School of Medicine
Professor
School of Public Health
Boston University
Boston, Massachusetts
United States

Adalberto Ferioli, MD, PhD

Senior Scientist
Department of Occupational Toxicology
International Centre for Pesticide Safety
Busto Garolfo
Italy

#### Jonathan E. Fielding, MD, MBA, MPH

Professor of Health Sciences and Pediatrics University of California—Los Angeles Los Angeles, California United States

#### John Finklea, MD, Dr PH

Medical Officer
Center to Protect Workers' Rights
Former Director
National Institute for Occupational
Safety and Health
Washington, DC
United States

#### Vito Foà, MD

Professor of Industrial Hygiene
Institute of Occupational Medicine
University of Milan
Milan
Italy

#### G. Frada, Dr Prof\*

Director
Institute of Occupational Medicine
University of Palermo
Palermo
Italy

#### John R. Franks, PhD

Chief
Bioacoustics and Occupational Vibration
Section
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# T.M. Fraser, MD, Msc, P Eng

Professor Emeritus
Systems Design Engineering
University of Waterloo
Waterloo, Ontario
Canada

#### Herbert J. Freudenberger, PhD

Psychologist, Psychoanalyst New York, New York United States

# George Friedman-Jiménez, MD

Director

Bellevue Occupational and Environmental
Medicine Clinic
Bellevue Hospital Center
New York, New York
United States

# Howard Frumkin, MD, Dr PH, MPH

Associate Professor, Chair
Department of Environmental and
Occupational Health
Rollins School of Public Health
Emory University
Atlanta, Georgia
United States

#### Lawrence Garfinkel, MA

Former Vice-President for Epidemiology and Statistics American Cancer Society New York, New York

# Otto Geiecker, Dkfm

United States

Former Deputy Director General
Department for Internal Rehabilitation
Allgemeine Unfall Versicherungsanstalt
Vienna
Austria

#### Issachar Gilad, PhD

Professor of Industrial Engineering and Ergonomics Technion-Israel Institute of Technology Haifa Israel

# William. I. Glass, MB ChB, DIH, DPH

Occupational Medicine Specialist Christchurch New Zealand

# F. Gobbato\*

Institute of Occupational Medicine University of Trieste Trieste Italy

#### Berenice I. Ferrari Goelzer, CIH, MPH

Occupational Hygienist
Office of Occupational Health
World Health Organization
Geneva
Switzerland

#### Kristan D. Goldfein, Ed D

Manager of Corporate Wellness Merrill Lynch Inc. Adjunct Assistant Professor Teacher's College Columbia University New York, New York United States

# Bernard D. Goldstein, MD

Director

Environmental and Occupational Health Sciences Institute

Chair

Department of Environmental and Community Medicine UMDNJ-Robert Wood Johnson Medical School

Piscataway, New Jersey United States

#### David Gompertz, MD, PhD

Senior Lecturer (Honorary)
Institute of Occupational Health
University of Birmingham
Birmingham
United Kingdom

#### Joke H. Grady-van den Nieuwboer, MSc

Roessingh Rehabilitation Centre Haáksbergen The Netherlands

#### E. Grandjean, Dr med (deceased)\*

Former Director
Institute of Hygiene and Work Physiology
Zurich
Switzerland

#### Philippe Grandjean, MD, DMSc

Professor
Environmental Medicine
Odense University
Odense
Denmark

#### Peter Greenwald, MD, Dr PH

Director
Division of Cancer Prevention and Control
National Cancer Institute
Bethesda, Maryland
United States

#### Dieter Greiner, Dr jur

Deputy Director General
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Gudela Grote, PhD

Professor
Work and Organizational Psychology
Swiss Federal Institute of Technology
Zurich
Switzerland

#### Saul G. Gruner, MS

SG Gruner Associates Inc. Westport, Connecticut United States

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### Per Gustavsson, MD, PhD

Associate Professor Department of Occupational Health Karolinska Hospital Stockholm Sweden

# Winfried Hacker, Dr rer nat habil

Professor, Chair General Psychology University of Technology Dresden Germany

#### Mats Hagberg, MD, PhD

Professor Division of Work and Environmental Physiology Natlional Institute for Working Life Solna Sweden

#### David Hamerman, MD

University Professor of Medicine Albert Einstein College of Medicine New York, New York United States

# Takashi Haratani, PhD

Senior Researcher National Institute of Industrial Health Kawasaki Japan

# Jillian Haslehurst, MB, ChB

Medical Advisor Marks and Spencer PLC London United Kingdom

# Fengsheng He, MD

Professor of Occupational Medicine and Neurotoxicology, Honorary Director Institute of Occupational Medicine Chinese Academy of Preventive Medicine Beijing China

#### Catherine A. Heaney, PhD, MPH

Associate Professor School of Public Health Ohio State University Columbus, Ohio United States

# Steven Hecker, MSPH

Associate Professor Labor Education and Research Center University of Oregon Eugene, Oregon United States

#### Dick Heederik, PhD, MSc

Associate Professor of Occupational Epidemiology University of Wageningen Wageningen The Netherlands

#### Lothar A.J. Heinemann, MD, DSc

Director Centre for Epidemiology and Health Research Zepernick Germany

Adjunct Professor for Epidemiology and **Biostatistics** 

McGill University Montreal, Quebec Canada

# Rolf Helbig, Dr-Ing

Head of Engineers Institut für Arbeitswissenschaft Technische Hochschule Darmstadt Darmstadt Germany

# George P. Hemstreet III, MD, PhD

Professor of Urology College of Medicine University of Oklahoma Oklahoma City, Oklahoma United States

#### Sven Hernberg, MD

Professor Emeritus, Former Director Department of Epidemiology and Biostatistics Finnish Institute of Occupational Health Helsinki Finland

# Robert F. Herrick, ScD

Lecturer on Industrial Hygiene Department of Environmental Health Harvard School of Public Health Boston, Massachusetts United States

# Raymond Hétu, PhD (deceased)

Former Director Acoustic Group Medical Faculty University of Montreal Montreal, Quebec Canada

#### Gerd E. Heuchert, MD, Dr med sci

Professor, Head Department of Epidemiology Federal Institute for Occupational Safety and Health Berlin Germany

#### Herbert Heuer, Dr rer nat

Professor, Head Department of Occupational and Experimental Psychology Institut für Arbeitsphysiologie Dortmund Germany

#### Penny D. Higgins, RN, BS

President OH Associates, Ltd. Des Plaines, Illinois United States

## Michael J. Hodgson, MD, MPH

Associate Professor of Medicine University of Connecticut Health Center Farmington, Connecticut United States

#### Perrine Hoet, MD, MIH, MSc

Research Associate Industrial Toxicology and Occupational Medicine Unit Faculty of Medicine Catholic University of Louvain Brussels Belgium

#### Burkhard Hoffmann, DPhil

Head of Section Documentation and Statistics Hauptverband der gewerblichen Berufsgenossenschaften Sankt Augustin Germany

#### Johan Högberg, MD, PhD

Professor of Toxicology National Institute for Working Life Solna Sweden

#### Judith C. Holder, PhD

Assistant Director of Occupational Mental Health Programs Duke University Medical Center Durham, North Caroliina United States

#### Bo Holmberg, PhD

Professor Emeritus Department of Toxicology National Institute for Working Life Solna Sweden

#### Irene L.D. Houtman, PhD

Senior Researcher NIA TNO Amsterdam The Netherlands

# Ann F. Hubbs, DVM, PhD, MS

Health Effects Laboratory Division National Institute for Occupational Safety and Health Morgantown, West Virginia United States

# James Huff, PhD, MS

Environmental Carcinogenesis
Program
National Institute of Environmental
Health Sciences
Research Triangle Park,
North Carolina
United States

#### Vilma Hunt, BDS, AM

Adjunct Professor
Department of Work Environment
University of Massachusetts-Lowell
Lowell, Massachusetts
United States

#### Joseph J. Hurrell, Jr., PhD

Senior Research Epidemiologist
Hazard Evaluation and Technical
Assistance Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# **Robert Husbands**

Vocational Rehabilitation Branch International Labour Office Geneva Switzerland

#### Masayuki Ikeda, MD, PhD

Professor Emeritus of Public Health Kyoto University Kyoto Japan

# Terence G. Ison, LLD

Professor Emeritus
Osgoode Hall Law School
York University
North York, Ontario
Canada

# Masaaki Iuchi, BL

Deputy Director
Policy Planning Division
Employment Measures for the Aged
and Disabled Department
Ministry of Labour
Tokyo
Japan

#### Nikolai Izmerov, PhD

Professor of Medicine, Director RAMS Institute of Occupational Health Moscow Russian Federation

#### Regina Jäckel, MD

Department of Health Effects of Hazardous Substances Federal Institute for Occupational Safety and Health Berlin Germany

#### Peter Jacobsen, MD

Medical Superintendent
Clinic of Occupational Medicine
Rigshospitalet
Copenhagen
Denmark

#### Marek Jakubowski, PhD, MSc

Professor, Head
Occupational and Environmental Health
Division
Nofer Institute of Occupational Medicine
Lodz
Poland

# Jerry Jeyaratnam, PhD, MSc

Head Division of Occupational Medicine National University of Singapore Singapore

#### Gunnar Johanson, Dr med sci

Senior Researcher
Department of Toxicology
National Institute for Working Life
Solna
Associate Professor
Uppsala University
Uppsala
Sweden

# Barry L. Johnson, PhD

Assistant Surgeon General, Assistant Administrator Agency for Toxic Substances and Disease Registry Atlanta, Georgia United States

#### T. K. Joshi, MS, MSc

International Labour Office (Bhutan and India) New Delhi India

# Roland Kadefors, PhD

Professor
Department of Injury Prevention
Chalmers University of Technology
Göteborg
Sweden

#### Jeffrey P. Kahn, MD

President
Center for Work Stress Reduction
Farmington, Connecticut
WorkPsych Associates Inc.
Scarsdale, New York
United States

#### Craig Karpilow, MD

President
International Professional Associates, Ltd.
Seattle, Washington
United States

## Timo Kauppinen, PhD

Head of Register Unit
Finnish Institute of Occupational Health
Helsinki
Finland

# George Kazantzis, FRCP, FFCM, FFCM\*

London School of Hygiene and Tropical Medicine TUC Centenary Institute of Occupational Health London United Kingdom

#### Homayoun Kazemi, MD

Professor of Medicine
Harvard Medical School
Chief
Pulmonary and Critical Care Unit
Massachusetts General Hospital
Boston, Massachusetts
United States

# Åsa Kilbom, MD

Professor, Director
Department of Ergonomics
National Institute for Working Life
Solna
Sweden

#### Kikuzi Kimura, Dr med sci

Institute for Science of Labour Kawasaki Japan

# Howard M. Kipen, MD, MPH

Associate Professor, Director
Division of Occupational Health
Environmental and Occupational Health
Science Institute
UMDNJ-Robert Woods Johnson Medical
School
Piscataway, New Jersey
United States

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### Georg R. Kliesch

Former Director
Working Conditions and Environment
International Labour Office
Geneva
Switzerland

#### Manolis Kogevinas, MD, PhD, MSc

Associate Professor
Unit of Respiratory and Environmental
Health Research
Institut Municipal d'Investigacio Medica
Barcelona
Spain

#### Kazutaka Kogi, MD, Dr med sci

Director
Institute for Science of Labour
Kawasaki
Japan

#### David Koh, MBBS, PhD, MSc

Associate Professor
Department of Community,
Occupational and Family Medicine
National University
Singapore

# Michiel A. J. Kompier, PhD

Professor
Department of Work and Organizational
Psychology
University of Nijmegen
Nijmegen
The Netherlands

# Lawrence D. Kornreich, PhD, M SPH

President
EnviroHealth and Safety Management
Mt Arlington, New Jersey
United States

# Andreas Kranig, Drjur

Head of Section
German Accident Insurance Law
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Richard S. Kraus, PE, CSP

Principal
Petroleum Safety Consultants
Annandale, Virginia
United States

#### Leon Kreitzman, DSc, MSc

Director Maturity Marketing Ltd. London United Kingdom

#### Penny M. Kris-Etherton, PhD, RD

Professor
Department of Nutrition
Pennsylvania State University
University Park, Pennsylvania
United States

#### Karl H.E. Kroemer, Dr-Ing

Professor, Director
Industrial Ergonomics Laboratory
Human Factors Engineering Center
ISE Department
Virginia Tech
Blacksburg, Virginia
United States

#### Ilkka Kuorinka, MD, PhD

Director
Safety and Ergonomics Division
Institute for Occupational Health and
Safety Research
Montreal, Quebec
Canada

# Joseph LaDou, MD, MS

Director
International Center for Occupational
Medicine
University of California-San Francisco
San Francisco, California
United States

#### Jay Lasser, MD

President
Center for Work Stress Reduction
Farmington, Connecticut
United States

# Patricia A. Last, FRCS, FRCOG

Consultant, Women's Health Hertfordshire United Kingdom

#### Aishah A. Latiff, PhD

Director
Doping Control Centre
Universiti Sains of Malaysia
Penang
Malaysia

# Wolfgang Laurig, Dr-Ing

Professor, Director
Department of Ergonomics
Institut für Arbeitsphysiologie
University of Dortmund
Dortmund
Germany

# Robert R. Lauwerys, MD, DSc, MIH, MSc

Professor
Industrial Toxicology and Occupational
Medicine Unit
Faculty of Medicine
Catholic University of Louvain
Brussels
Belgium

#### **Antoine Laville**

Professor, Director
Laboratoire d'Ergonomie
Physiologique-Cognitive
École Pratique des Hautes Études
Paris
France

#### Marjatta Leirisalo-Repo, MD

Consultant in Rheumatology
Department of Medicine
Helsinki University Central Hospital
Helsinki
Finland

# Grace Kawas Lemasters, PhD, MSN

Professor
Department of Epidemiology and
Environmental Health
University of Cincinnati
Cincinnati, Ohio
United States

#### Richard A. Lemen, PhD, MS

Former Assistant Surgeon General, Deputy Director National Institute for Occupational Safety and Health Atlanta, Georgia United States

#### Michel Lesage, MD, CSPQ

Occupational Health Specialist International Labour Office Geneva Switzerland

#### Lennart Levi, MD, PhD

Professor Emeritus, Former Director Department of Stress Research Karolinska Institute Stockholm Sweden

#### Linnéa Lillienberg, PhD

Senior Occupational Hygienist
Department of Occupational Medicine
Sahlgrenske University Hospital
Göteborg
Sweden

#### Morton Lippmann, PhD

Professor of Environmental Medicine
Nelson Institute of Environmental
Medicine
New York University Medical Center
Tuxedo, New York
United States

# James E. Lockey, MD, MS

Professor, Director
Department of Occupational and
Environmental Medicine
University of Cincinnati
Cincinnati, Ohio
United States

#### Veikko Louhevaara, PhD

Professor of Ergonomics, Senior Researcher
Unit of Ergonomics
Department of Physiology
University of Kuopio
Finnish Institute of Occupational Health
Kuoppio
Finland

#### Michelle Madelien

Paulson and Cooper Inc. Chicago, Illinois United States

#### Mohd Isa Abd Majid, PhD

Head Toxicology Laboratory Unit National Poison Centre Universiti Sains Malaysia Penang Malaysia

#### Nicole Mamelle, PhD

Director of Research
National Institute of Health and Medical
Research
Lyon
France

#### Norman M. Mann, MD

Chemosensory Clinical Research Center Department of Medicine University of Connecticut Farmington, Connecticut United States

#### S. Zack Mansdorf, PhD

Managing Director
Liberty International Risk Services
Boston, Massachusetts
United States

#### Alfred C. Marcus, PhD

Director
Division of Behavioral Science Research
AMC Cancer Research Center
Denver, Colorado
United States

# Kazimier J. Marek, MD, PhD

Professor, Head
Clinical Department
Institute of Occupational Medicine and
Environmental Health
Sosnowiec
Poland

#### Anthony A. Marfin, MD, MPH

Division of Respiratory Disease Studies National Institute for Occupational Safety and Health Morgantown, West Virginia United States

#### Steven B. Markowitz, MD

Associate Professor, Deputy Director Division of Environmental and Occupational Medicine Mount Sinai School of Medicine New York, New York United States

#### Marco Maroni, MD

Director
International Centre for Pesticide Safety
Institute of Occupational Medicine
Milan
Italy

#### M. Masali\*

Institute of Anthropology and Ethnology University of Turin Turin Italy

#### Donald R. Mattison, MD, MS

Professor, Dean Graduate School of Public Health University of Pittsburgh Pittsburgh, Pennsylvania United States

#### A. Mayer, Eng

Department of Machinery and Protective
Devices

Research Centre National Institute of Safety Research Vandoeuvre France

#### Alan Maynard, BA, B Phil

Department of Economics University of York Heslington, York United Kingdom

# Daniel McBain, MA

Hamilton, Ontario Canada

#### Michael McCann, PhD, CIH

Senior Associate Editor
Encyclopaedia of Occupational Health and Safety
International Labour Office
New York, New York
United States

#### Robert J. McCunney, MD, MPH

Director

Environmental Medical Service Massachusetts Institute of Technology Cambridge, Massachusetts United States

#### Ross A. McKinnon, PhD

Lecturer in Pharmaceutical Biotechnology School of Pharmacy and Medical Sciences University of South Australia Adelaide Australia

#### Thomas H. McQuiston, MS

University of North Carolina Chapel Hill, North Carolina United States

#### Dick J. Meertens, Eng saf

Programme Manager
Accident Prevention and Insurance
Studies and Operations Branch
International Social Security Association
Geneva
Switzerland

#### Heather Menzies, BA

School of Canadian Studies Carleton University Ottawa, Ontario Canada

### Donna Mergler, PhD

Professor

Centre for the Study of Biological
Interactions in Health and Environment
University of Quebec-Montreal
Montreal, Quebec
Canada

#### Franco Merletti, MD, MSc

Professor of Medical Statistics
Department of Medical Sciences
University of Turin
Turin
Italy

#### Jacqueline Messite, MD

Clinical Professor
Department of Environmental Medicine
New York University College of Medicine
New York, New York
United States

#### Jean-Jacques Meyer, PhD

Professor of Ergonomics, Head of Laboratory
Vision Ergonomics Laboratory
Institute of Occupational Health Sciences
Lausanne
Switzerland

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Jarl-Erik Michelsson, MD, PhD

Loviisa Finland

#### H. Mierzecki\*

Former Chief
Institute of Dermatology
Academy of Medicine
Wroclaw
Poland

#### R. Rita Misra, PhD

Laboratory of Comparative Carcinogenesis National Cancer Institute Frederick, Maryland United States

#### Toyohiko Miura, MD

Institute for Science of Labour Kawasaki Japan

#### Willi Momm, MA

Chief
Vocational Rehabilitation Branch
International Labour Office
Geneva
Switzerland

#### John S. Morawetz, ScM

Director
ICWU Center for Worker Health and
Safety Education
Cincinnati, Ohio
United States

#### Vivian K. Morgan, BS

Acting Chief
Information Resources Branch
National Institute for Occupational
Safety and Health
Cincinnati, Ohio
United States

#### Sharon L. Morris, BA

Assistant Chair for Community Outreach
Department of Environmental Health
University of Washington
Seattle, Washington
United States

#### April E. Mott, MD

Medical Director
Chemosensory Clinical Research Center
University of Connecticut Health Center
Farmington, Connecticut
United States

#### Sonia Muchnick-Baku, MA, ScM

Director
Washington Business Group on Health
Washington, DC
United States

# Vladimir M. Munipov, MS

Chair, Professor of Ergonomics
Moscow Institute of Radio Engineering,
Electronics and Automation
Moscow
Russian Federation

#### Lawrence R. Murphy, PhD

Research Psychologist
Applied Psychology and Ergonomics
Branch
National Institute for Occupational
Safety and Health
Cincinnati, Ohio
United States

#### Karl J. Musgrave, DVM, MPH

Wyoming State Health Department Cheyenne, Wyoming United States

## Melvin L. Myers, BS, MPA

Deputy Director
Office of Extramural Coordination
and Special Projects
National Institute for Occupational
Safety and Health
Atlanta, Georgia
United States

#### Friedhelm Nachreiner, Dr rer nat

Professor of Applied Psychology Work and Organizational Psychology Unit Carl von Ossietzky University Oldenburg Germany

#### Pranab Kumar Nag, PhD, DSc, MSc

Deputy Director
Indian Council of Medical Research
National Institute of Occupational Health
Ahmedabad
India

# Daniel W. Nebert, MD, MS

Professor, Director
Center for Environmental Genetics
University of Cincinnati Medical Center
Cincinnati, Ohio
United States

Carolyn Needleman, PhD
Professor, Director
Occupational/Environmental Health
Program
Graduate School of Social Work and
Social Research
Bryn Mawr College
Bryn Mawr, Pennsylvania
United States

#### Thomas J. Nelson, BS, CIH

NIHS Inc. Ardentown, Delaware United States

#### Toshiteru Okubo, MD, Dr Med Sci

Professor, Director
Department of Environmental
Epidemiology
University of Occupational and
Environmental Health
Kitakyushu City
Japan

# Shauna Olney, LLB, BCL

Senior Legal Officer
Freedom of Association Branch
International Labour Office
Geneva
Switzerland

# Peter Orris, MD, MPH

Associate Professor of Medicine Cook County Hospital University of Illinois Chicago, Illinois United States

#### Dave W. Ortlieb, BS

Director
Safety and Health Department
United Paperworkers International Union
Nashville, Tennessee
United States

#### M. Gerald Ott, PhD, MS

Director of Epidemiology BASF Corporation Mount Olive, New Jersey United States

# Heinz Otten, Dr rer nat

Head of Section
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Muneto Ozaki

Labour Law and Labour Relations Branch International Labour Office Geneva Switzerland

### Freda L. Paltiel, CSW, MPH, CM

Former Senior Advisor, Status of Women Consultant in Health and Social Policy Health Canada Ottawa, Ontario Canada

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Sheila Pantry, OBE, BA, FLA, FIInf Sci

Sheila Pantry Associates-Information Services Consultancy Sheffield United Kingdom

# John E. Parker, MD

Chief
Examination Processing Branch
Division of Respiratory Disease Studies
National Institute for Occupational Safety
and Health
Morgantown, West Virginia
United States

#### Timo Partanen, PhD, MSc, MPH

Department of Epidemiology and Biostatistics Finnish Institute of Occupational Health Helsinki Finland

#### Glenn Paulson, PhD

President
Paulson and Cooper Inc.
Jackson Hole, Wyoming
United States

# Dennis J. Paustenbach, PhD, MS

President, Chief Executive Officer McLaren Hart/Chem Risk® Alameda, Claifornia United States

#### Neil Pearce, PhD

Associate Professor Wellington Asthma Research Group Wellington School of Medicine Wellington South New Zealand

#### Daniela Pelclová, MD, PhD

Associate Professor, Head
Department for Occupational Diseases
Charles University
Prague
Czech Republic

# Peter L. Pelmear, MD, FFOM

Active Staff Consultant
Department of Occupational and
Environmental Health
St. Michael's Hospital
Toronto, Ontario
Canada

# Edith Perlebach, MD

Head of Section
Occupational Medicine
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Debra A. Perry, M Ed

President
Perry, Winans and Company
Washington, DC
United States

#### Edward L. Petsonk, MD, CM

Chief, Clinical Section
 Division of Respiratory Disease Studies
 National Institute for Occupational Safety and Health
 Morgantown, West Virginia
 United States

#### Wai-On Phoon, MB, DIH

Professor, Head
Department of Occupational Health
University of Sydney
Sydney
Australia

#### Simon Pickvance, BA

Occupational Health Advisor
Sheffield Occupational Health Project
Sheffield
United Kingdom

#### Robert Ransom, MA

Senior Specialist
Vocational Rehabilitation Branch
International Labour Office
Geneva
Switzerland

#### Jorma Rantanen, MD, PhD

Director General
Finnish Institute of Occupational Health
Helsinki
Finland

# Carl Raskin, BA, Dip Ed

Coordinator
Global Applied Disability Research and
Information Network on Employment
and Training
Canadian Labour Force Development

Board Nepean, Ontario Canada

#### Dzulkifli Abdul Razak, MSc

Professor, Director National Poison Centre Universiti Sains Malaysia Penang Malaysia

# Paule Rey, MD, MPH

Professor Emeritus
Faculty of Medicine
University of Geneva
Geneva
Switzerland

#### Annie Rice, BSc

Director
Health Safety Environment Consultants
Petit Bornand
France

# Peter Richter, Dr rer nat

Professor
Institut für Arbeits, Organisations und Sozialpsychologie
Technical University of Dresden
Dresden
Germany

#### Wolfgang von Richthofen

Senior Labour Inspection Specialist Labour Administration Branch International Labour Office Geneva Switzerland

#### Hilkka Riihimäki, MD, Dr med sci

Director
Department of Epidemiology and
Biostatistics
Finnish Institute of Occupational Health
Helsinki
Finland

# Sally Roberts, PhD

Clinical Scientist
Centre for Spinal Studies
Robert Jones and Agnes Hunt
Orthopaedic and District Hospital
Oswestry, Shropshire
United Kingdom

# Dilys Robertson, BA

Consultant
Occupational Health and Safety
Toronto, Ontario
Canada

#### Walter Rohmert, Prof Dr-Ing

Professor Emeritus Institut für Arbeitswissenschaft Technische Hochschule Darmstadt Darmstadt Germany

# William N. Rom, MD, MPH

Professor of Medicine
Division of Pulmonary and Critical Care
Medicine
New York University
New York, New York
United States

#### Linda Rosenstock, MD, MPH

Director
National Institute for Occupational Safety
and Health
Washington, DC
United States

#### Clara Sue Ross, MD, JD

President

Environmental and Occupational Health Consultants Inc. Cincinnati, Ohio

United States

John Rudge, MBA

Senior Lecturer and OHS Programmes Coordinator School of Management University of South Australia Adelaide Australia

Jon Rudnick, MD, MPh, MSc

Corporate Medical Director **Dow Corning Corporation** Midland, Michigan United States

John W. Ruser, PhD, MA

Compensation Research Group United States Bureau of Labor Statistics Washington, DC **United States** 

Ragnar Rylander, MD, PhD

Department of Environmental Medicine University of Göteborg Göteborg Sweden

David L.S. Ryon, MD

Division of Pulmonary and Critical Care Medicine New York University New York, New York United States

Sheldon W. Samuels, AB

Former Director of Health, Safety and Environment Industrial Union Department American Federation of Labor and Congress of Industrial Organizations Washington, DC United States

Andries F. Sanders, PhD

Professor of Cognitive Psychology Department of Psychonomics Free University Amsterdam The Netherlands

Rodolfo Saracci, MD

Director of Research National Research Council Italy

# Annie J. Sasco, MD, Dr PH

Programme of Epidemiology for Cancer Prevention

International Agency for Research on Cancer

Lyon

France

#### Denis Sasseville, MD, FRCPC

Associate Professor of Medicine (Dermatology) McGill University Montreal, Quebec Canada

#### Steven L. Sauter, PhD

Applied Psychology and Ergonomics Branch

National Institute for Occupational Safety and Health

Cincinnati, Ohio

United States

#### Marianne Saux, MD

Head

Department of Occupational Medicine Director of Medical Inspection Service Ministry of Work

Paris

France

# Heikki Savolainen, Dr med sci

Professor of Occupational Medicine Institute of Occupational Health Sciences Lausanne Switzerland

#### Richard Schilling, MD, DSc

Occupational Health Consultant London United Kingdom

#### William J. Schneider, MD, MPH

Director of Health Services J.P. Morgan and Co. Inc. New York, New York United States

# Wolfram D. Schneider, Prof Dr med

Department of Health Effects of Hazardous Substances Federal Institute for Occupational Safety and Health Berlin Germany

# Steven M. Schrader, PhD

Chief

Functional Toxicology Section National Institute for Occupational Safety and Health Cincinnati, Ohio

United States

# Horst Schulz, Dipl Volkswirt

Computer and Documentation Department Hauptverband der gewerblichen Berufsgenossenschaften Sankt Augustin Germany

#### Susan Scott-Parker, BA

Chief Executive

Employers' Forum on Disability London United Kingdom

Patrick Sébastien, PhD

Scientific Director Institute of Occupational Health and Safety Research Montreal, Quebec Canada

Marie-Claire Séguret

Conditions of Work and Welfare Facilities Branch International Labour Office Geneva Switzerland

# Anna Maria Seppäläinen, MD, PhD

Division of Clinical Neurophysiology University of Helsinki Helsinki Finland

Lowell E. Sever, PhD

Program Director for Public Health Sciences Battelle Seattle Research Center Seattle, Washington United States

Erwin Seyfried, PhD

Professor of Social Psychology, Director Research Unit for Vocational Training Labour Market and Evaluation Berlin Germany

Behrouz Shahandeh, MA

Senior Adviser on Drugs and Alcohol Vocational Rehabilitation Branch International Labour Organization Geneva Switzerland

Houshang Shahnavaz, PhD, MSc

Professor of Industrial Ergonomics Director Center for Ergonomics of Developing Countries Luleå University of Technology Luleå Sweden

#### Steven Short, DO

Medical Officer
Division of Respiratory Disease Studies
National Institute for Occupational Safety
and Health
Morgantown, West Virginia
United States

#### Donald E. Shrey, PhD

Associate Professor
Department of Physical Medicine and
Rehabilitation
University of Cincinnati Medical Center
Cincinnati, Ohio
United States

#### Joel Shufro, PhD

Executive Director NYCOSH New York, New York United States

#### Ellen Silbergeld, PhD

Professor of Epidemiology and Pathology University of Maryland at Baltimore Baltimore, Maryland United States

#### Leif Simonsen, PhD

Department of Toxicology and Biology National Institute of Occupational Health Copenhagen Denmark

#### William T. Singleton, DSc, MA

Professor Emeritus of Applied Psychology Aston University Birmingham Northumberland United Kingdom

## Susan Sink, MFA

Artist Chicago, Illinois United States

## Gisela Sjøgaard, PhD, Dr med sci

Director
Department of Physiology
National Institute of Occupational Health
Copenhagen
Denmark

# Juhani Smolander, PhD

Senior Researcher
Finnish Institute of Occupational Health
Vantaa
Finland

#### David Snowball, PhD

Deputy Director General's Office Health and Safety Executive London United Kingdom

#### Marja Sorsa, PhD

Director Ministry of Education Helsinki Finland

#### Colin L. Soskolne, PhD

Professor, Director of Graduate Training
Department of Public Health Services
University of Alberta
Edmonton, Alberta
Canada

#### Jerry Spiegel, MA, MSc

Director
Pollution Prevention
Manitoba Environment
Winnipeg, Manitoba
Canada

#### Heide Stark, Dr med

Department of Epidemiology Federal Institute for Occupational Safety and Health Berlin Germany

#### Jeanne M. Stellman, PhD

Editor-in-Chief
Encyclopaedia of Occupational Health and
Safety
International Labour Office
Geneva
Switzerland

School of Public Health Columbia University New York, New York United States

#### Steven D. Stellman, PhD, MPH

Chief
Division of Epidemiology
American Health Foundation
New York, New York
United States

#### Craig R. Stenberg, PhD

Occupational/Mental Health Programs
Departments of Psychiatry and
Community and Family Medicine
Duke University Medical School
Durham, North Carolina
United States

# James H. Stewart, PhD, CIH

School of Public Health Harvard University Boston, Massachusetts United States

#### B.J. Stiles, BD, BA

President, Chief Executive Officer National AIDS Fund Washington, DC United States

#### Phillip W. Strine, BA

Special Assistant to the Assistant Surgeon General and Deputy Director, Public Health Advisor National Institute for Occupational Safety and Health Atlanta, Georgia United States

#### Zhi Su, MD, MPH

Director

Department Health Inspection and Supervision

Ministry of Health
Beijing
China

#### Haruko Suzuki

Research Information Division Institute for Science of Labour Kawasaki Japan

#### Ken Takahashi, MD, D MSc, MPH

Associate Professor
Department of Environmental
Epidemiology
University of Occupational and
Environmental Health
Kitakyushu City
Japan

#### Jukka Takala, Dr Tech, MSc

Chief
Occupational Safety and Health Branch
International Labour Office
Geneva
Switzerland

# Krishna Talluri, MB

Department of Psychiatry Duke University Medical Center Durham, North Carolina United States

#### Rachael F. Taylor, LLB

Consultant International Labour Office Geneva Switzerland

# Spomenka Telišman, DSc, MSc

Senior Scientific Consultant
Institute for Medical Research and
Occupational Health
Zagreb
Croatia

# Benedetto Terracini, MD

Former Head
Unit of Cancer Epidemiology
University Hospital and University of
Turin
Turin
Italy

#### Ulrike Tittelbach, Dr med

Department of Health Effects of Hazardous Substances Federal Institute for Occupational Safety and Health Berlin Germany

#### Lori Todd, PhD, MS

Associate Professor

Department of Environmental Science
and Engineering
University of North Carolina
Chapel Hill, North Carolina
United States

#### Angela K. Traiforos, M Ed

Executive Director
Center for Administration, Rehabilitation and Employment Services
International Association of Machinists
Upper Marlboro, Maryland
United States

# Anne Trebilcock, JD

Principal Legal Officer
Office of the Legal Adviser
International Labour Office
Geneva
Switzerland

#### Benjamin F. Trump, MD

Professor, Chair
Department of Pathology
School of Medicine
University of Maryland
Baltimore, Maryland
United States

#### Ulf Ulfvarson, PhD

Professor of Industrial Ergonomics
Department of Environmental
Technology and Work Science
Royal Institute of Technology
Stockholm
Sweden

# Eberhard Ulich, Prof Dr, Dr hc

Professor
Department of Work and Organizational
Psychology
Swiss Federal Institute of Technology
Zurich
Switzerland

#### Jill P.G. Urban, PhD

Senior Research Fellow Laboratory of Physiology University of Oxford Oxford United Kingdom

#### Antero Vähäpassi, MSc

Chief Technical Adviser
Labour Administration Branch
International Labour Office
Geneva
Switzerland

#### Harri Vainio, MD, PhD

Chief
Unit of Chemoprevention
International Agency for Research on
Cancer
Lyon
France

# José A. Valciukas, PhD

Associate Professor, Director
Psychology Internship Training Program
Lincoln Medical and Mental Health
Center
New York, New York
United States

# Kees A. van der Heijden, Dr

Director
Bilthoven Division
World Health Organization European
Centre for Environment and Health
Bilthoven
The Netherlands

# Henk van Loveren, PhD

Head
Immunobiology and Haematology Section
Laboratory for Pathology and
Immunobiology
National Institute of Public Health
and the Environment
Bilthoven
The Netherlands

#### Joachim Vedder, Dipl-Ing, MS

Department of Ergonomics Institut für Arbeitsphysiologie University of Dortmund Dortmund Germany

#### Maria Luz Vega Ruiz, Lab Law

Specialist in Labour Law and Labour Relations International Labour Office Geneva Switzerland

#### Marc Vericel, Dr d'État en droit

Master of Conference Law Faculty University of Saint-Etienne Saint-Etienne France

#### Eira Viikari-Juntura, MD, Dr med sci

Musculoskeletal Research Unit Department of Physiology Finnish Institute of Occupational Health Helsinki Finland

#### Paolo Vineis, MD

Deputy Director
Unit of Cancer Epidemiology
Main Hospital and University
Turin
Italy

#### Eva Vingård, MD, PhD

Senior Physician, Researcher National Institute for Working Life Solna Sweden

#### Serge Volkoff

Director
Centre for Research and Study on Age and the Working Population
Paris
France

# Joseph G. Vos, DVM, PhD

Head
Laboratory for Pathology and
Immunobiology
National Institute of Public Health and the
Environment
Bilthoven
The Netherlands

# Michael P. Waalkes, PhD

Chief
Inorganic Carcinogenesis Section
National Cancer Institute
Frederick, Maryland
United States

#### Gregory R. Wagner, MD

Director
Division of Respiratory Disease Studies
National Institute for Occupational Safety
and Health
Morgantown, West Virginia
United States

#### Nina B. Wallerstein, Dr PH, MPH

Associate Professor
Department of Family and Community
Medicine
University of New Mexico
Albuquerque, New Mexico
United States

# Jung-Der Wang, MD, ScD, MIH

Professor, Director

Institute of Occupational Medicine and Industrial Hygiene

National Taiwan University College of Public Health

Taipei China

#### Leon J. Warshaw, MD

Clinical Professor
Department of Environmental Medicine
New York University
New York, New York
United States

# Philip G. Watanabe, PhD, DABT

Toxicology Consultant Blaine, Washington United States

#### David Howe Wegman, MD, MS

Professor, Chair
Department of Work Environment
University of Massachusetts-Lowell
Lowell, Massachusetts
United States

# Elisabete Weiderpass, MD, MSc

Department of Cancer Epidemiology Uppsala University Uppsala Sweden

#### Merri Weinger, MPH

Office of Global and Integrated Environmental Health World Health Organization Geneva Switzerland

#### Peter J.M. Westerholm, MD

Professor in Occupational Epidemiology National Institute for Working Life Solna Sweden

# Julian Wilbourn, BSc

Scientist

Unit of Carcinogen Identification and Evaluation International Agency for Research

on Cancer

Lyon France

#### Mary S. Wolff, PhD

Professor of Community Medicine Mount Sinai School of Medicine New York, New York United States

#### Patrisha Woolard, BA

Mount Sinai School of Medicine New York, New York United States

#### Frank B. Wright

Director

European Occupational Health and Safety Law Unit University of Salford Manchester United Kingdom

#### H. Beric Wright, MB, BS

Former Medical Director
British United Provident Association
Bucks
United Kingdom

#### Michael J. Wright, MS

Director

Health, Safety and Environment Department United Steelworkers of America Pittsburgh, Pennsylvania United States

#### Lucy Yardley, PhD, MSc

Senior Lecturer in Psychology
Department of Psychology
University College-London
London
United Kingdom

# Annalee Yassi, MD, MSc

Directo

Occupational and Environmental Medicine Health Sciences Centre and Unit University of Manitoba Winnipeg, Manitoba Canada

#### Shelia Hoar Zahm, ScD

Deputy Chief

Occupational Epidemiology Branch National Cancer Institute Rockville, Maryland United States

# Jan E. Zejda, MD, PhD

Head

Department of Epidemiology Institute of Occupational Medicine and Environmental Health Sosnowiec Poland

#### Joanne Zurlo, PhD

Associate Director
Johns Hopkins Center for Alternatives to
Animal Testing
Baltimore, Maryland
United States

# **PRODUCTION TEAM**

Sarah Alvarez Maria Arteta May Ballerio-Hofman Lillian Benjamin Michel Berka Walter Benjamin Christian Bolufer Claude Chaperon Kyle Creane Denis Cullinan Johanna de Vries Robert Dees Margaret Fennessy Raymond Figuières Betty Goldman Susan Guthridge Kathleen Susan Hurst Claudia Hommel Rachael Horner Sanna Immonen Lisa Kellner Diana Signe Kline Nana-Ekua Leigh Robert Leuze Elizabeth Mahiga Christiane Melin

Jacky Merteau

John McKenna Julie Nayler Catherine H. Perring Peter Perring Bodhani Pieris Giles Reed Kirsten Reed John G. Rodwan, Jr. Nancy J. Rodwan David Rosenweig David Rowley Oriele Rovaletti Daniel Ruffieux Jacques P. Tremblet Steven Sacks Barbara Sandi Gabor Sandi Anneliese Shulte Jonathon Stampf Fred Stanton Prabha Sundaram Juan Tenorio Jennifer Valdes Tracy Weber Berit Widing-Pry Sydney G. Williams Su Zen

	w - #	

直 直

# ENCYCLOPAEDIA OF OCCUPATIONAL HEALTH AND SAFETY

4TH EDITION

2

Editor-in-Chief Jeanne Mager Stellman, PhD

Senior Associate Editor Michael McCann, PhD, CIH

Associate Editors

Leon Warshaw, MD

Carole Brabant, PhD

# Senior Editors

John Finklea, MD, Dr PH
Georges H. Coppée, MD
Vilma R. Hunt, BDS, AM
Richard S. Kraus, PE, CSP
Wolfgang Laurig, Dr-Ing
Melvin L. Myers, BS, MPA
Jacqueline Messite, MD
Steven L. Sauter, PhD
Jerry Spiegel, MA, MSc
Colin L. Soskolne, PhD
Benedetto Terracini, MD

Managing Editor Chantal Dufresne, BA

INTERNATIONAL LABOUR OFFICE GENEVA



#### Copyright © International Labour Organization 1998

Publications of the International Labour Office enjoy copyright under Protocol 2 of the Universal Copyright Convention. Nevertheless, short excerpts from them may be reproduced without authorization, on condition that the source is indicated. For rights of reproduction or translation, application should be made to the Publications Bureau (Rights and Permissions), International Labour Office, CH-1211 Geneva 22, Switzerland. The International Labour Office welcomes such applications. Libraries, institutions and other users registered in the United Kingdom with the Copyright Licensing Agency, 90 Tottenham Court Road, London W1P 9HE (Fax + 44 171 436 3986), in the United States with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 (Fax + 1 508 750 4470), or in other countries with associated Reproduction Rights Organizations, may make photocopies in accordance with the licences issued to them for this purpose.

Stellman, Jeanne Mager (ed.)

Encyclopaedia of Occupational Health and Safety. 4th ed.

Geneva, International Labour Office, 1998. 4 V.

/Encyclopaedia/, /Occupational health/, /Occupational safety/. 13.04.2

ISBN 92-2-109203-8 (set)

92-2-109814-1 (V. 1) 92-2-109815-X (V. 2) 92-2-109816-8 (V. 3) 92-2-109817-6 (V. 4)

Contents: V. 1. The Body; Health Care; Management and Policy; Tools and Approaches—V. 2. Hazards—V. 3. Chemicals; Industries and Occupations—V. 4.Indexes

ILO Cataloguing in Publication Data

The designations employed in ILO publications, which are in conformity with United Nations practice, and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of the International Labour Office concerning the legal status of any country, area or territory or of its authorities, or concerning the delimitation of its frontiers. The responsibility for opinions expressed in signed articles, studies and other contributions rests solely with their authors, and publication does not constitute an endorsement by the International Labour Office of the opinions expressed in them.

The reader accepts that the parties make this documentation available without warranty of any kind. The parties do not accept responsibility for the validity or completeness of any data including inaccuracies, errors or omissions or for any consequences arising from the use of such data. Neither the authors, nor the ILO or collaborating institutions shall be liable for damages or other claims and demands arising out of the use of the data.

Reference to names of firms and commercial products and processes does not imply their endorsement by the International Labour Office or any collaborating institution, and any failure to mention a particular firm, commercial product or process is not a sign of disapproval.

ILO publications can be obtained through major booksellers or ILO local offices in many countries, or direct from ILO Publications, International Labour Office, CH-1211 Geneva 22, Switzerland. Catalogues or lists of new publications are available free of charge from the above address.

# **AUTHORS AND EDITORS**

# A

# Ursula Ackermann-Liebrich, MD, MSc

Professor

Department of Social and Preventive Medicine

University of Basel

Basel

Switzerland

Elena Adán Liébana, Chem Eng

Occupational Health and Safety Technician
National Centre of Working Conditions
National Institute for Occupational Safety
and Hygiene
Barcelona
Spain

#### Alfred A. Amendola, PhD

Research Associate Professor, Associate Director Safety Engineering Program Texas A&M University College Station, Texas United States

#### Yngve Anderberg, MD, PhD

Fire Safety Design AB Lund Sweden

#### Ragnar Andersson, PhD, M Eng

Injury Program Director
Department of Public Health Sciences
Karolinska Institute
Sundbyberg
Sweden

#### Diego Andreoni, Dr Ing

Former Director-General Ente Nazionale Prevenzione Infortuni Rome Italy

# Jean Arteau, Ing, PhD, MSc

Researcher
Safety and Engineering
Institute for Occupational Safety and
Health Research
Montreal, Quebec
Canada

## Tomas Backström, PhD

Researcher National Institute for Working Life Solna Sweden

#### Gabriele Bammer, PhD

National Centre for Epidemiology and Population Health Australian National University Canberra Australia

#### Tamas Banky, Dr

Head of Fire Protection Scientific Department
Institute for Quality Control and
Innovation in Building
Budapest
Hungary

## Julian Barling, PhD

Professor of Organizational Behavior School of Business Queen's University Kingston, Ontario Canada

#### Rosalind C. Barnett, PhD

Senior Scholar in Residence Murray Research Center Women's Studies Program Brandeis University Waltham, Massachusetts United States

#### Peter J. Baxter, MD, MSc

Institute of Public Health University of Cambridge Cambridge United Kingdom

# François Béland, PhD

Professor
Groupe de Recherche Interdisciplinaire
en Santé
University of Montreal
Montreal, Quebec
Canada

#### Ron Bell, BSc

Head
Electrical and Control Systems Unit
Health and Safety Executive
Bootle, Merseyside
United Kingdom

#### David Bennett, PhD, MA

National Director
Workplace Health, Safety and
Environment
Canadian Labour Congress
Ottawa, Ontario
Canada

# Alan J. Benson, MSc, MB, ChB, FRACS

Consultant
Royal Air Force School of Aviation
Medicine
Farnborough, Hants
United Kingdom

#### María José Berenguer, M Chem

Head

Mass Spectrometry Laboratory National Centre for Working Conditions National Institute for Occupational Safety and Hygiene Barcelona Spain

#### Mats Berg, MD

Department of Dermatology Karolinska Hospital Stockholm Sweden

#### Kenneth I. Berger, MD

Instructor of Medicine
Division of Pulmonary and Critical Care
Medicine
New York University
New York, New York
United States

#### Ulf Bergqvist, Dr med sci, MSc Techn

Research Scientist
Department of Occupational Medicine
National Institute for Working Life
Solna
Sweden

#### Pier Alberto Bertazzi, MD, MPH

Associate Professor
Institute of Occupational Medicine
University of Milan
Milan
Italy

#### Diane Berthelette, PhD

Associate Professor
Department of Administrative Sciences
University of Quebec-Montreal
Montreal, Quebec
Canada

#### Ronald Bisset, MA, MSc

Scott Wilson Resource Consultants Edinburgh, Scotland United Kingdom

# Jacques H.M. Bittel, MD, DERBH

Chief
Human Factors Department
Army Health Service Research
Centre-Emile Pardé
La Tronche
France

#### Massimo Bovenzi, MD

Senior Physician, Contract Professor of Industrial Hygiene Institute of Occupational Medicine University of Trieste Trieste Italy

#### Carole Brabant, PhD

Associate Editor
Encyclopaedia of Occupational Health and Safety
International Labour Office
Geneva
Switzerland

#### John Brazendale, BSc, MSc

Principal Specialist Inspector Health and Safety Executive Bootle, Merseyside United Kingdom

#### Cecilia Brighi

International Policy Department CISL National Trade Union Confederation Rome Italy

#### Robert Bringer, PhD

Staff Vice-President (Retired)
Environmental Technology and Services
3M
St. Paul, Minnesota
United States

#### Peter Bruckmann, PhD

Head of Division
Environmental Monitoring
Landesumweltamt, Nordrhein-Westfalen
Essen
Germany

#### Françoise Burhenne-Guilmin, Dr Law

Head
Environmental Law Centre
International Union for the Conservation
of Nature
Bonn
Germany

#### Ronald J. Burke, PhD

Professor
Faculty of Administrative Studies
York University
North York, Ontario
Canada

#### Ahmet Çakir, Dr-Ing, F Erg S

Scientific President
Ergonomic Institute for Social and
Occupational Sciences
Berlin
Germany

#### Donald M. Campbell, FFPHM

Consultant in Public Health Medicine
Scottish Centre for Infection and
Environmental Health
Glasgow
United Kingdom

#### Robert D. Caplan, PhD

Professor of Psychology, Psychiatry and Behavioral Science Department of Psychology George Washington University

George Washington Unive Washington, DC United States

#### Pascale Carayon, PhD

Visiting Professor

Ecole des Mines de Nancy Nancy France Associate Professor Department of Industrial Engineering University of Wisconsin Madison, Wisconsin United States

#### Sue Cartwright, PhD

Senior Research Fellow
Manchester School of Management
University of Manchester
Manchester
United Kingdom

# Emilio Castejón Vilella, Ing Ind

Director
National Centre of Working Conditions
National Institute for Occupational Safety
and Hygiene
Barcelona

# Weiping Chen, MD, MSc

Spain

Health Risk Assessment Specialist Health Strategies and Research Division Alberta Health Edmonton, Alberta Canada

# V. I. Chernyuk, MD, ScD

Professor, Scientific Director Institute for Occupational Health Kiev Ukraine

#### Robert N. Cherry Jr., PhD, MS

Colonel and Director of Army Radiation Safety HQDA (DACS-SF) U.S. Army Washington, DC United States

# Eric Chivian, MD

Director
Center for Health and the Global
Environment
Harvard Medical School
Boston, Massachusetts
United States

#### Renzo Comini

Responsable
DSG Unita' Centrale Sicurezza Ed Igiene
del Lavoro
ENEL SpA
Rome
Italy

#### Cary L. Cooper, PhD, MBA, MSc

Professor of Organizational Psychology Institute of Science and Technology University of Manchester Manchester United Kingdom

# Georges H. Coppée, MD

Chief of Medical Section
Occupational Safety and Health Branch
International Labour Office
Geneva
Switzerland

#### D. Wayne Corneil, ScD

Director
Operations Eastern Region
Health Canada
Ottawa, Ontario
Canada

#### **Robert Coyle**

Principal Environmental Specialist
European Bank for Reconstruction and
Development
London
United Kingdom

#### Derrick Crump, PhD

Section Head, Indoor Air Quality
Materials Group
Building Research Establishment
Watford
United Kingdom

#### Göran Dahlström, MD

Commanding Medical Officer, Director Cold Center Kiruna Sweden

#### J.C. Davies, PhD, MSc

Principal Programmer/Analyst
Computing Services Department
University of Liverpool
Liverpool
United Kingdom

#### Nicole Dedobbeleer, ScD

Associate Professor of Research
Department of Social and Preventive
Medicine
University of Montreal
Montreal
Canada

#### Edouard I. Denisov, Cand tech sci

Senior Researcher

RAMS Institute of Occupational Health Moscow

Russian Federation

#### S.K. Dheri

Chief Fire Officer Headquarters Delhi Fire Service New Delhi India

# Leonard A. Dobrovolsky, MD, PhD, D Sci

Head

Department of Scientific and Medical Information

Institute of Occupational Health

Kiev

Ukraine

# Alexander E. Donagi, D Sc, MPH

Professor

School of Medicine

Tel Aviv University

Director

Information Centre

Institute of Occupational Safety and

Hygiene

Tel Aviv

Israel

#### Marianne Döös, BSc

Senior Researcher

National Institute for Working Life

Solna

Sweden

#### Dennis P. Driscoll, PE, MSc

President

Associates in Acoustics Inc. Evergreen, Colorado

United States

#### Dougal Drysdale, BSc, PhD

Reader in Fire and Safety Engineering
Department of Civil and Environmental
Engineering
University of Edinburgh
Edinburgh, Scotland
United Kingdom

# Walter Dümmer, MPh

Technical Advisor Chilean Safety Association Santiago Chile

# William W. Eaton, PhD, MS

Professor
Department of Mental Hygiene
School of Hygiene and Public Health
Johns Hopkins University
Baltimore, Maryland
United States

#### John Elias, MPH

Senior Occupational Hygienist
Occupational and Environmental
Medicine
Health Sciences Center
Winnipeg, Manitoba
Canada

#### Zuheir Ibrahim Fakhri, MBBS, DIH, MSc OM, MD

Occupational Health Consultant Ministry of Health Riyadh Saudi Arabia

#### Anne-Marie Feyer, PhD

Director

New Zealand Occupational and Environmental Health Research Centre Dunedin New Zealand

#### John Finklea, MD, Dr PH

Medical Officer
Center to Protect Workers' Rights
Former Director
National Institute for Occupational
Safety and Health
Washington, DC
United States

#### Brian Flannigan, PhD

Department of Biological Sciences Heriot-Watt University Edinburgh, Scotland United Kingdom

#### Dominique Folliot, MD

Deputy Head of Department Service Général de Médecine du Travail Paris France

#### **Richard Forster**

Lighting Consultant Crowthorne, Berkshire United Kingdom

#### Bernard H. Fox, PhD

Professor of Psychiatry School of Medicine Boston University Boston, Massachusetts United States

#### T.J.R. Francis, MSc, PhD, MFOM

Naval Medical Research Laboratory Naval Submarine Base Groton, Connecticut United States

# Marianne Frankenhaeuser, PhD,

MA

Professor Emeritus of Psychology University of Stockholm Stockholm Sweden

#### David Freestone, LLB, LLM

Legal Adviser, Environment
Environmental and International Law Unit
Legal Department
World Bank
Washington, DC
United States

#### Jean G. French, Dr PH

Adjunct Professor
Department of Epidemiology
School of Public Health
University of North Carolina
Chapel Hill, North Carolina
United States

# Daniel Ganster, PhD

Professor, Chair
Department of Management
University of Arkansas
Fayetteville, Arkansas
United States

#### Kenneth Gerecke

Assistant Regional Administrator
Occupational Safety and Health
Administration
US Department of Labor
Philadelphia, Pennsylvania
United States

#### Adrian Gheorghe, PhD, MSc

Professor of Industrial Management
University Polytechnic
Bucharest, Romania
Director of Research
Swiss Federal Institute of Technology
Zurich
Switzerland

#### Berenice I. Ferrari Goelzer, CIH, MPH

Occupational Hygienist
Office of Occupational Health
World Health Organization
Geneva
Switzerland

#### Des Gorman, MD, PhD

Head of Occupational Medicine School of Medicine University of Auckland Auckland New Zealand

# Marilyn K. Gowing, PhD

Director

Personnel Resources and Development

United States Office of Personnel Management Washington, DC United States

#### Per-Ola Granberg, MD, PhD

Former Professor of Endocrine Surgery Karolinska Hospital Stockholm Sweden

#### Martino Grandolfo, PhD

Director

Department of Physics Instituto Superiore di Sanità Rome

Italy

#### Casey C. Grant, PE

Assistant Vice-President
Codes and Standards Administration
National Fire Protection Association
International
Quincy, Massachusetts
United States

# Michael J. Griffin, PhD

Professor of Human Factors
Institute of Sound and Vibration Research
University of Southampton
Southampton
United Kingdom

#### Jop Groeneweg, PhD

Senior Researcher
Centre for Safety Research
Leiden University
Leiden
The Netherlands

#### Carsten Grønberg, MSc

Research Engineer RISØ National Laboratory Roskilde Denmark

#### Xavier Guardino Solá, PhD

Chief of Department
National Centre for Working Conditions
National Institute for Occupational Safety
and Hygiene
Barcelona
Spain

#### Juan Guasch Farrás

Head of Working Conditions Area
National Centre for Working Conditions
National Institute for Occupational Safety
and Hygiene
Barcelona
Spain

#### Tee L. Guidotti, MD, MPH

Professor, Director
Occupational Health Program
Faculty of Medicine
University of Alberta
Edmonton, Alberta
Canada

#### K.C. Gupta, BE

Director-General National Safety Council Bombay India

#### Niels Jørn Hahn, MSc

Managing Director
Working Group on Recycling and Waste
Minimization
ISWA
Copenhagen
Denmark

#### Kari K. Häkkinen, PhD

Development Manager Workers' Compensation Department Industrial Insurance Ltd. Helsinki Finland

## Andrew R. Hale, PhD

Professor of Safety Science
Safety Science Group
Delft University of Technology
Delft
The Netherlands

# L.D. Hamilton, MD, PhD

Professor
Biomedical and Environmental
Assessment Group
Brookhaven National Laboratory
Upton, New York
United States

# Kjell Hansson Mild, PhD

Researcher National Institute for Working Life Umeå Sweden

#### Richard Helmer, PhD, MA

Chief
Urban Environmental Health
World Health Organization
Geneva
Switzerland
Visiting Professor
University of Surrey
Guildford
United Kingdom

#### Ana Hernández Calleja

Occupational Health and Safety Technician
National Centre of Working Conditions
National Institute for Occupational Safety
and Hygiene
Barcelona
Spain

#### Ivanildo Hespanhol

Community Water Supply and Sanitation World Health Organization Geneva Switzerland

#### Raymond Hétu, PhD (deceased)

Former Director
Acoustic Group
Medical Faculty
University of Montreal
Montreal, Quebec
Canada

#### Manh Trung Ho, Ing civ

Former Assistant Director
Applications Prevention
National Institute of Safety and Research
Paris
France

#### Dietrich Hoffmann, PhD, MS

Associate Director
Naylor Dana Institute for Disease
Prevention
American Health Foundation
Valhalla, New York
United States

# Ingvar Holmér, PhD

Professor
Department of Ergonomics
National Institute for Working Life
Solna
Sweden

## Vilma Hunt, BDS, AM

Adjunct Professor
Department of Work Environment
University of Massachusetts-Lowell
Lowell, Massachusetts
United States

#### Joseph J. Hurrell, Jr., PhD

Senior Research Epidemiologist
Hazard Evaluation and Technical
Assistance Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

#### Claire Infante-Rivard, MD, PhD, MPH

Professor

Department of Occupational Health Faculty of Medicine McGill University Montreal, Quebec Canada

#### John M. Ivancevich, DBA

Hugh Roy and Lillie Cranz Cullen Chair,
Professor of Organizational Behavior and
Management
College of Business Administration
University of Houston
Houston, Texas
United States

#### C. David Jenkins, PhD, MA

Adjunct Professor of Psychiatry and Preventive Medicine and Community Health University of North Carolina Chapel Hill, North Carolina United States

#### Steve M. Jex, PhD

Associate Professor
Department of Psychology
University of Wisconsin-Oshkosh
Oshkosh, Wisconsin
United States

#### Jeffrey V. Johnson, PhD

Associate Professor of Social Science, Medicine and Occupational Health Johns Hopkins School of Hygiene and Public Health Baltimore, Maryland United States

#### Peter F. Johnson, MSc, Dipl Ed

Manager Arup Fire Engineering Melbourne, Victoria Australia

## B. Juminer, PhD\*

Faculty of Medicine Meshed Islamic Republic of Iran

#### Kirsten Jørgensen, PhD, MSc

Head of Department
Analysis and Documentation Office
Danish Work Environment Service
Copenhagen
Denmark

#### Friedrich Karl Käferstein, Dr med vet

Director

Programme of Food Safety and Food Aid World Health Organization Geneva Switzerland

#### Robert Karasek, PhD

Professor of Work Environment University of Massachusetts-Lowell Lowell, Massachusetts United States

# Waldemar Karwowski, PhD

Director, Professor of Industrial Engineering Center for Industrial Ergonomics University of Louisville Louisville, Kentucky United States

# Gwendolyn Puryear Keita, PhD

Associate Executive Director
Public Interest Directorate
Director of Women's Programs
American Psychological Association
Washington, DC
United States

#### W. Larry Kenney, PhD

Professor of Physiology and Kinesiology
Laboratory of Human Performance
Research
Pennsylvania State University
University Park, Pennsylvania
United States

# Eric P. Kindwall, MD

Associate Professor, Director of Hyperbaric Medicine Medical College of Wisconsin Milwaukee, Wisconsin United States

#### Urban Kjellén, PhD

Professor of Safety Management
Department of Industrial Economics and
Technology Management
Norwegian University of Science and
Technology
Trondheim
Norway

## Tord Kjellström, MD

Director
Office of Global and Integrated
Environmental Health
World Health Organization
Geneva
Switzerland

#### Peter Knauth, Dr-Ing

Professor, Head
Department of Ergonomics
Institute of Industrial Production
University of Karlsruhe
Karlsruhe
Germany

#### Bengt Knave, MD, PhD

Head of International Secretariat and Committee National Institute for Working Life Solna Sweden

#### Larry R. Kohler, PhD

Focal Point for Environment and Sustainable
Development
Department of Working Conditions and
Environment
International Labour Office
Geneva
Switzerland

#### Richard S. Kraus, PE, CSP

Principal
Petroleum Safety Consultants
Annandale, Virginia
United States

#### Yuri Kundiev, MD, Dr med sci

Director
Institute for Occupational Health
Kiev
Ukraine

#### Poul Lauridsen, MSc

Technical Advisor
Working Group on Recycling and Waste
Minimization
ISWA
Copenhagen
Denmark

# Wolfgang Laurig, Dr-Ing

Professor, Director
Department of Ergonomics
Institut für Arbeitsphysiologie
University of Dortmund
Germany

#### Tom B. Leamon, PhD, MSc

Vice-President
Liberty Mutual Insurance Group
Director
Liberty Mutual Research Center for
Safety and Health
Hopkinton, Massachusetts
United States



<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### Mark R. Lehto, PhD

Associate Professor School of Industrial Engineering Purdue University West Lafayette, Indiana United States

#### Lennart Levi, MD, PhD

Professor Emeritus, Former Director Department of Stress Research Karolinska Institute Stockholm Sweden

#### Sture Lidén, MD, PhD

Professor
Department of Dermatology
Karolinska Institute
Karolinska Hospital
Stockholm
Sweden

#### Soo-Yee Lim, PhD

National Research Council Associate
Applied Psychology and Ergonomics
Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

#### Kari Lindström, PhD

Research Professor
Department of Psychology
Finnish Institute of Occupational Health
Helsinki
Finland

#### Anthony Linehan, BA, FIOSH

Former Director of Field Operations
H.M. Chief Inspector of Factories
Health and Safety Executive
Dorset
United Kingdom

#### Herbert I. Linn, MS

Chief of Information Management and
Dissemination Activity
Division of Safety Research
National Institute for Occupational Safety
and Health
Morgantown, West Virginia
United States

# Gordon M. Lodde, BS

Health Physics Consultant Mount Joy, Pennsylvania United States

#### Wouter A. Lotens, PhD

Head
Department of Work Environment
TNO Human Factors Research Institute
Soesterberg
The Netherlands

#### Jacques B. Malchaire, PhD, MSc

Professor of Occupational Health
Unit of Hygiene and Work Physiology
Catholic University of Louvain
Brussels
Belgium

#### Albert Marty, HTL Mech Eng

Senior Safety Engineer for Product Certification Swiss National Accident Insurance Organization Luzern Switzerland

#### Christina Maslach, PhD

Professor
Department of Psychology
University of California-Berkeley
Berkeley, California
United States

#### R. Matthes, Dip-Ing

Head NIR Dosimetry, Scientific Secretary Institut für Strahlenhygiene Oberschleissheim Germany

#### Lucien Y. Maystre, MSc, Dip-Ing

Director
Institut de Génie de l'Environnement
Ecole Polytechnique Fédérale de Lausanne
Lausanne
Switzerland

#### Michael McCann, PhD

Senior Associate Editor Encyclopaedia of Occupational Health and Safety International Labour Office New York, New York United States

#### Neil McManus, MSc, M Eng

Consulting Industrial Hygienist
NorthWest Occupational Health and
Safety
North Vancouver, British Columbia
Canada

#### Karlheinz Meffert, Dr-Ing

Director

Berufsgenossenschaftliches Institut für
Arbeitssicherheit

Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Claude Menguy, Dip Ing

Department Manager
Materials and Environmental Stress
Central Laboratory of Electronic Industries
Fontenay aux Roses
France

#### Jacqueline Messite, MD

Clinical Professor
Department of Environmental Medicine
New York University College of Medicine
New York, New York
United States

#### Jean-Jacques Meyer, PhD

Professor of Ergonomics, Head of Laboratory
Vision Ergonomics Laboratory
Institute of Occupational Health Sciences
Lausanne
Switzerland

# James M. Miller, PE, PhD

Professor
Industrial and Operations Engineering
University of Michigan
Ann Arbor, Michigan
United States

#### Timothy H. Monk, PhD

Professor of Psychiatry
Western Psychiatric Institute and Clinic
University of Pittsburgh
Pittsburgh, Pennsylvania
United States

#### Michel Monteau

Head of Accidentology
National Institute of Research and Safety
Vandoeuvre
France

#### Carles Muntaner, MD, PhD

Assistant Professor
Institute of Occupational and
Environmental Health/Prevention
Research Center
West Virginia University
Morgantown, West Virginia
United States

# Lawrence R. Murphy, PhD

Research Psychologist
Applied Psychology and Ergonomics
Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

#### Melvin L. Myers, BS, MPA

Deputy Director
Office of Extramural Coordination and
Special Projects
National Institute for Occupational Safety
and Health
Atlanta, Georgia
United States

#### Debra L. Nelson, PhD

Professor CBA Associates Oklahoma State University Stillwater, Oklahoma United States

#### Bodil Nielsen, Dr Phil

Associate Professor
August Krogh Institute
Copenhagen University
Copenhagen
Denmark

#### Sarah A. Nunneley, MS, MD

Research Physician
Air Force Research Laboratory
Brooks Air Force Base
San Antonio, Texas
United States

# Tokuo Ogawa, MD, PhD

Professor Emeritus Aichi Medical University Nagakute Japan

#### Kristina Orth-Gomér, MD, PhD

Professor
Department of Public Health Sciences
Karolinska Institute
Stockholm
Sweden

#### Suzanne C. Ouellette, PhD

Professor of Psychology
Graduate School and University Center
City University of New York
New York, New York
United States

# Kenneth C. Parsons, PhD

Professor of Environmental Ergonomics
Department of Human Sciences
Loughborough University
Leicester
United Kingdom

#### Jonathan A. Patz, MD, MPH

Assistant Scientist, Director
Department of Environmental Health
Sciences
Program on Health Effects of Global
Environmental Change
Johns Hopkins School of Hygiene and
Public Health
Baltimore, Maryland
United States

#### Dan Petersen, Ed D

Professor
Arizona State University
President
DPA Consulting Inc.
Tempe, Arizona
United States

#### Hans-Ulrich Pfeffer, Dr

Head of Department
Environmental Monitoring
LandesumweltamtNordrheinWestfalen
Essen
Germany

#### Chaya S. Piotrkowski, PhD

Professor
Graduate School of Social Service
Fordham University
New York, New York
United States

# Thomas W. Planek, PhD, CSP

Director
Research and Statistical Services
National Safety Council
Itasca, Illinois
United States

#### Gustav Poinstingl, Dipl-Ing

Leiter des Verkehrs-Arbeitsinspektorates Bundesministerium für öffentliche Wirtschaft und Verkehr Vienna Austria

#### Tessa M. Pollard, D Phil

Lecturer in Biological Anthropology
Department of Anthropology
University of Durham
Durham
United Kingdom

#### Charles T. Pope

Area Director
Norfolk Area Office
Occupational Safety and Health
Administration
US Department of Labor
Norfolk, Virginia
United States

# Sydney W. Porter Jr., BS

Adjunct Professor
Graduate Institute of Environmental
Studies
Drexel University
Ardmore, Pennsylvania
United States

## Herbert C. Preul, PhD

Professor Emeritus
Department of Civil and Environmental
Engineering
University of Cincinnati
Cincinnati, Ohio
United States

# James Campbell Quick, PhD

Professor of Organizational Behavior University of Texas Arlington, Texas United States

# Fernando Ramos Pérez, Ind Eng

Management Engineer, Risk Prevention Specialist Labour Accident Prevention Service Valencia Spain

#### A. Raouf, PhD

Rector GIK Institute Topi, Swabi Pakistan

#### John T. Reeves, MD

Professor Emeritus
Department of Medicine and Pediatrics
University of Colorado Health Sciences
Center
Denver, Colorado
United States

# Dietmar A.J. Reinert, Dr rer nat

Head of Section
Berufsgenossenschaftliches Institut für Arbeitssicherheit
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

#### Michael H. Repacholi, PhD, MSc

Responsible Officer
Radiation Protection and Global Hazards
Assessment
World Health Organization
Geneva
Switzerland

# Toni Retsch, Dipl-Ing, ETH

Bereichsleiter-ALM2
Swiss National Accident Insurance
Organization
Luzern
Switzerland

#### Paule Rey, MD, MPH

Professor Emeritus
Faculty of Medicine
University of Geneva
Geneva
Switzerland

# J. Rioux, PhD\*

Chaire de parasitologie Faculté de médecine de Montpellier Montpellier France

<sup>\*</sup> Contributor to the 3rd edition of this **Encyclopaedia.** This biographical information has not been updated.

#### Jean-Marc Robert, PhD

Professor

Department of Mathematics and **Industrial Engineering** École Polytechnique Montreal, Quebec Canada

#### William N. Rom, MD, MPH

Professor of Medicine Division of Pulmonary and Critical Care Medicine New York University New York, New York

#### Isabelle Romieu, MD, ScD, MPH

Medical Epidemiologist

United States

Pan American Center for Human Ecology and Health Mexico City Mexico

M. Gracia Rosell, Ing TQ

Head of Gas Chromatography Laboratory National Institute for Occupational Safety and Hygiene Barcelona Spain

#### Denise M. Rousseau, PhD

Professor of Organizational Behavior Carnegie Mellon University Pittsburgh, Pennsylvania United States

Julia D. Royster, PhD

Environmental Noise Consultants Inc. Raleigh, North Carolina United States

Larry H. Royster

Department of Mechanical Engineering North Carolina State University Raleigh, North Carolina United States

#### Sven-Olof Ryding, PhD

Assistant Professor Managing Director Swedish EMAS Council Stockholm Sweden

Jorma Saari, Dr Tech Professor Department of Safety Finnish Institute of Occupational Health Helsinki Finland

Gavriel Salvendy, PhD

NEC Professor of Industrial Engineering School of Industrial Engineering Purdue University West Lafayette, Indiana United States

#### Steven L. Sauter, PhD

Applied Psychology and Ergonomics Branch National Institute for Occupational Safety and Health Cincinnati, Ohio United States

#### Gustave Savourey, MD, PhD

Research Specialist in Physiology Thermophysiology Unit Research Centre, Army Health Service-Emile Pardé La Tronche France

#### John M. Schaubroeck, PhD

Associate Professor College of Business Administration University of Nebraska Lincoln, Nebraska United States

#### Lawrence M. Schleifer, EdD

Adjunct Professor Department of Health Education University of Maryland Baltimore, Maryland United States

# Guido Schmitter, HTL

Mechanical and Safety Engineer Swiss National Accident Insurance Organization Luzern Switzerland

#### Paul Schreiber, Dr rer nat

Physicist Federal Institute for Occupational Safety and Health Dortmund Germany

#### Dietrich Schwela, PhD

Urban Environment Health World Health Organization Geneva Switzerland

#### Helmut Seidel, Dr med sci

Head of Research Group Biological Effects of Vibration and Noise Bundesanstalt für Arbeitsschütz und Arbeitsmedizin Berlin Germany

#### Hansjörg Seiler, PD, Dr jur

Court Secretary

Swiss Federal Court (Bundesgericht) Lausanne Switzerland

#### Harry S. Shannon, PhD, MSc

Professor

Canada

Occupational Health Programme Department of Clinical Epidemiology and Biostatistics McMaster University Hamilton, Ontario Senior Scientist Institute for Work and Health Toronto, Ontario

#### Victor Shantora, MSc

Director General Toxics Pollution Prevention Directorate **Environment Canada** Ottawa, Ontario Canada

#### Richard L. Shell, PhD

Professor of Industrial Engineering and Environmental Health Department of Mechanical, Industrial and Nuclear Engineering University of Cincinnati Cincinnati, Ohio United States

#### **Arie Shirom**

Professor Faculty of Management Tel Aviv University Tel Aviv Israel

#### Niu Shiru, PhD

Professor Institute of Environmental Health and Engineering Chinese Academy of Preventive Medicine Beijing China

#### Marcel Simard, PhD

Assistant Professor School of Industrial Relations University of Montreal Montreal, Quebec Canada

#### Reinald Skiba, Dr-Ing

Professor of Technical Safety/Production Bergische Universitat-Gesamthochschule Wuppertal Germany

#### David H. Sliney, PhD

Commander

Laser Hazards Branch **USA-CHPPM** 

Aberdeen Proving Ground, Maryland

United States

#### Gordon S. Smith, MB, MPH

Associate Professor

Johns Hopkins University School of Public

Health

Baltimore, Maryland

United States

#### Ian R. Smith, MSc

LAMP Coordinator

Program Development

Ontario Ministry of Environment and

Energy

Toronto, Ontario

Canada

#### Michael J. Smith, PhD

Department of Industrial Engineering

University of Wisconsin

Madison, Wisconsin

United States

#### Mike Smith, PhD

Manchester School of Management Institute of Science and Technology

University of Manchester

Manchester

United Kingdom

## N. A. Smith, PhD

Lighting Consultant

Doncaster

United Kingdom

# Colin L. Soskolne, PhD

Professor, Director of Graduate Training

Department of Public Health Services

University of Alberta

Edmonton, Alberta

Canada

# Jerry Spiegel, MA, MSc

Director

Pollution Prevention

Manitoba Environment

Winnipeg, Manitoba

Canada

#### Bengt Springfeldt, PhD

Department for Social Medicine and International Health

Karolinska Institute

Sundbyberg

Sweden

#### Jeanne M. Stellman, PhD

Editor-in-Chief

Encyclopaedia of Occupational Health and Safety

International Labour Office

Geneva

Switzerland

School of Public Health

Columbia University

New York, New York

**United States** 

# Terje Sten, Cand

Senior Researcher

Division of Safety and Reliability

Foundation for Scientific and Industrial

Research

Trondheim

Norway

# Andrew Steptoe, DPhil, DSc

Professor of Psychology

St. George's Hospital Medical School

University of London

London

United Kingdom

# Tom F.M. Stewart, BSc

Managing Director

System Concepts Ltd.

London

United Kingdom

#### Daniel Stokols, PhD

Professor, Dean

School of Social Ecology

University of California-Irvine

Irvine, California

United States

#### Jerry Suls, PhD

Professor

Department of Psychology

University of Iowa

Iowa City, Iowa

United States

#### Alice H. Suter, PhD

Principal Consultant

Industrial Audiology and Community

Alice Suter and Associates

Ashland, Oregon

United States

#### German A. Suvorov, Dr

Professor of Medicine, Deputy Director

RAMS Institute of Occupational Health Moscow

Russian Federation

#### Naomi G. Swanson, PhD

Motivation and Stress Research Section National Institute for Occupational Safety

and Health

Cincinnati, Ohio

United States

#### Gary M. Taylor

Taylor-Wagner Inc.

Willowdale, Ontario Canada

#### Benedetto Terracini, MD

Former Head

Unit of Cancer Epidemiology

University Hospital and University of

Turin

Turin

Italy

# Lois E. Tetrick, PhD

Professor

Department of Psychology

University of Houston

Houston, Texas

United States

# Töres Theorell, MD, PhD

Professor, Director

National Institute for Psychosocial Factors

and Health

Stockholm

Sweden

# Dennis Tolsma, MPH

Director, Prevention and Practice Analysis

Kaiser Permanente Medical Care Program

Atlanta, Georgia United States

Rüdiger M. Trimpop, PhD Professor

Department of Industrial and

Organizational Psychology

University of Yena

Yena

Germany

# René Troxler, Dipl-Ing, HTL/STV

Senior Safety Engineer

Swiss National Accident Insurance Organization

Luzern

Switzerland

# Tom Tseng, PhD

Manager

Toxics Prevention Division

Environmental Protection Branch

Environment Canada-Ontario Region

Downsview, Ontario

Canada

#### Arthur C. Upton, MD

Clinical Professor
Environmental and Community
Medicine
UMDNJ-Robert Wood Johnson
Medical School
Piscataway, New Jersey
United States

#### Holger Ursin, MD

Professor
Department of Biological and Medical
Psychology
University of Bergen
Bergen
Norway

# Johan Van de Kerckhove, Dr soc sci

Directo

**HIVA-VORMING** 

Professor

Katholieke Universiteit Leuven

Pellenberg

Belgium

# Mark A. Veazie, Dr PH

National Institute for Occupational Safety and Health Morgantown, West Virginia United States

#### Pierre Verger, MD, MSc, MPH

Project Manager
Laboratory of Epidemiology and Health
Risk Analysis
Institute of Nuclear Protection and Safety
Fontenay-aux-Roses
France

#### Amiran D. Vinokur, PhD

Research Scientist
Institute for Social Research
University of Michigan
Ann Arbor, Michigan
United States

#### Jean-Jacques Vogt, MD

Former Deputy Director General
Institut National de Recherche et de
Sécurité
Paris
France

#### Georg Vondracek, Dipl-Ing

Department of Industrial Machines and Control Systems Swiss National Accident Insurance Organization Luzern Switzerland

#### Peter Warr, PhD

Research Professor Institute of Work Psychology University of Sheffield Sheffield United Kingdom

#### David A. Warrell, DM, DSc

Professor, Director
Centre for Tropical Medicine
University of Oxford
Oxford
United Kingdom

#### Leon J. Warshaw, MD

Clinical Professor
Department of Environmental Medicine
New York University
New York, New York
United States

# John V. Weil, MD

Director
Cardiovascular-Pulmonary Research
Laboratory
University of Colorado Health Sciences
Center
Denver, Colorado
United States

#### Edmundo Werna, PhD

Research Fellow South Bank University Univerity of Sao Paolo Sao Paolo Brazil

#### John B. West, MD, PhD, DSc

Professor of Medicine and Physiology Department of Medicine University of California-San Diego San Diego, California United States

#### Gunnela Westlander, PhD

Professor Emeritus
Department of Psychology
University of Stockholm
Stockholm
Sweden

#### Marion Wichmann-Fiebig, MSc

Dezerucutin Schutz der Atmosphäre Landesumweltamt des Landes Nordrhein-Westfalen Essen Germany

## Gerald J.S. Wilde, PhD

Professor of Psychology Queen's University Kingston, Ontario Canada

#### Ann M. Williamson, PhD

School of Psychology University of New South Wales Sydney Australia

#### **Denis Winter**

Deputy Head Accident Studies Division Institute for Nuclear Safety and Protection Fontenay-aux-Roses France

# Ernst L. Wynder, MD

President
American Health Foundation
New York, New York
United States

#### Annalee Yassi, MD, MSc

Director

Occupational and Environmental Medicine Health Sciences Centre and Unit University of Manitoba Winnipeg, Manitoba Canada

#### D. Zannini, PhD\*

Institute of Occupational Medicine Ospedale San Martino Genoa Italy

#### José Luis Zeballos, MD, MPH

Pan American Health Organization Washington, DC United States

#### Bernhard M. Zimolong, PhD

Professor
Work and Organizational Psychology
Ruhr University
Bochum
Germany

#### Thomas Zosel, BS

Manager
Environmental Initiatives
3M Inc.
St. Paul, Minnesota
United States

#### Jozef Zurada, PhD

Assistant Professor
Computer Information Systems
University of Louisvillle
Louisville, Kentucky
United States

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# ENCYCLOPAEDIA OF OCCUPATIONAL HEALTH AND SAFETY

4TH EDITION

3

Editor-in-Chief Jeanne Mager Stellman, PhD

Senior Associate Editor Michael McCann, PhD, CIH

Associate Editors

Leon Warshaw, MD

Carole Brabant, PhD

#### Senior Editors

John Finklea, MD, Dr PH Jacqueline Messite, MD Georges H. Coppée, MD Steven L. Sauter, PhD Vilma R. Hunt, BDS, AM Jerry Spiegel, MA, MSc

Richard S. Kraus, PE, CSP Colin L. Soskolne, PhD

Wolfgang Laurig, Dr-Ing Benedetto Terracini, MD

Melvin L. Myers, BS, MPA

Managing Editor Chantal Dufresne, BA

INTERNATIONAL LABOUR OFFICE GENEVA



#### Copyright © International Labour Organization 1998

Publications of the International Labour Office enjoy copyright under Protocol 2 of the Universal Copyright Convention. Nevertheless, short excerpts from them may be reproduced without authorization, on condition that the source is indicated. For rights of reproduction or translation, application should be made to the Publications Bureau (Rights and Permissions), International Labour Office, CH-1211 Geneva 22, Switzerland. The International Labour Office welcomes such applications. Libraries, institutions and other users registered in the United Kingdom with the Copyright Licensing Agency, 90 Tottenham Court Road, London W1P 9HE (Fax + 44 171 436 3986), in the United States with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 (Fax + 1 508 750 4470), or in other countries with associated Reproduction Rights Organizations, may make photocopies in accordance with the licences issued to them for this purpose.

Stellman, Jeanne Mager (ed.)

Encyclopaedia of Occupational Health and Safety. 4th ed.

Geneva, International Labour Office, 1998. 4 V.

/Encyclopaedia/, /Occupational health/, /Occupational safety/. 13.04.2

ISBN 92-2-109203-8 (set)

92-2-109814-1 (V. 1) 92-2-109815-X (V. 2) 92-2-109816-8 (V. 3) 92-2-109817-6 (V. 4)

Contents: V. 1. The Body; Health Care; Management and Policy; Tools and Approaches—V. 2. Hazards—V. 3. Chemicals; Industries and Occupations—V. 4.Indexes

ILO Cataloguing in Publication Data

The designations employed in ILO publications, which are in conformity with United Nations practice, and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of the International Labour Office concerning the legal status of any country, area or territory or of its authorities, or concerning the delimitation of its frontiers. The responsibility for opinions expressed in signed articles, studies and other contributions rests solely with their authors, and publication does not constitute an endorsement by the International Labour Office of the opinions expressed in them.

The reader accepts that the parties make this documentation available without warranty of any kind. The parties do not accept responsibility for the validity or completeness of any data including inaccuracies, errors or omissions or for any consequences arising from the use of such data. Neither the authors, nor the ILO or collaborating institutions shall be liable for damages or other claims and demands arising out of the use of the data.

Reference to names of firms and commercial products and processes does not imply their endorsement by the International Labour Office or any collaborating institution, and any failure to mention a particular firm, commercial product or process is not a sign of disapproval.

ILO publications can be obtained through major booksellers or ILO local offices in many countries, or direct from ILO Publications, International Labour Office, CH-1211 Geneva 22, Switzerland. Catalogues or lists of new publications are available free of charge from the above address.

# **AUTHORS AND EDITORS**



# Michael Adess, PhD

Chief

Human Factors Division Commandant

United States Coast Guard Headquarters Washington, DC United States

#### M. Agamennone, Dr Ing\*

Istituto Guidio Donegani Centro Ricerche Novara Novara Italy

#### Leen Akkers

Managing Director Stichting Arbouw Amsterdam The Netherlands

#### R.G. Aldi, MASc, BSc, P Eng

Director

Quality and Environmental Affairs Hiram Walker and Sons, Ltd. Windsor, Ontario Canada

#### Priscilla Alexander, BA

Coordinator
North American Task Force on
Prostitution
New York, New York
United States

#### Sydney Allison, PhD

Communications Division Mintek Randburg South Africa

#### Judith Anderson, MSc

Research Associate
Department of EnvironmentalOccupational Health
George Washington University
Washington, DC
United States

## W. Stanley Anthony, MSc

Supervisory Agricultural Engineer
United States Cotton Ginning Laboratory
Agricultural Research Service
United States Department of Agriculture
Stoneville, Mississippi
United States

# Elías Apud, PhD, MSc

Professor
Department of Physiopathology
University of Concepción
Concepción
Chile

#### M.P. Arias, PhD, MSc

Head

Environmental Safety and Health Department Hospital Clinic Universitari Barcelona Spain

#### James R. Armstrong, CIH

Technical Services Coordinator
Ontario Natural Resources Safety
Association
North Bay, Ontario
Canada

## Ragnar Arnason, PhD

Professor
Department of Economics
University of Iceland
Reykjavik
Iceland

# Tony Ashdown, CPS, MS, CSP

Loss Prevention Manager Alpharma USPD, Inc. Baltimore, Maryland United States

#### George Astrakianakis, B Eng, M Eng

Research Scientist
Cancer Control Research
British Columbia Cancer Agency
Vancouver, British Columbia
Canada

### Jörg Augusta, Dr med

Arbeitsgruppenleiter Arbeitsgruppe Ergonomie und Waldarbeit Landesanstalt für Wald und Forstwirtschaft Gotha Germany

#### William Avery, AS

President
Systems Safety Management USA, Inc.
Orlando, Florida
United States

# Page Ayres, MS

Senior Environmental Engineer Newport News Shipbuilding Newport News, Virginia United States

#### Angela Babin, MS

Associate Director
Center for Safety in the Arts
New York, New York
United States

#### G. Bachofen\*

Chief of Branch
Division Information
Swiss National Accident Insurance
Organization
Luzern
Switzerland

#### Dean B. Baker, MD, MPH

Professor, Director
Center for Occupational and
Environmental Health
University of California-Irvine
Irvine, California
United States

#### David E. Baker, CSP

Assistant Program Director
Agriculture, Food and Natural Resources
University of Missouri-Columbia
Columbia, Missouri
United States

#### David G. Baldwin, CIH

Corporate Industrial Hygiene Manager Hewlett-Packard Company Palo Alto, California United States

#### Gail Coningsby Barazani, MPH

Former Environmental Health Consultant Chicago, Illinois United States

#### Hjálmar R. Bárdarson, MSc

State Director of Shipping Gardabaer Iceland

#### Donald Barnard, PhD

Supervisory Research Entomologist Agricultural Research Service United States Department of Agriculture Gainesville, Florida United States

#### Lynn Barroby

Breeder and Trainer of Thoroughbred Racehorses Langley, British Columbia Canada

# Subhash K. Batra, PhD

Directo

Nonwovens Cooperative Research Center College of Textiles North Carolina State University Raleigh, North Carolina United States

<sup>\*</sup> Contributor to the 3rd edition of this Encyclopaedia. This biographical information has not been updated.

#### Giuseppe Battista, MD

Professor of Preventive Workers' Medicine
Cattedra di Medicina Preventiva
dei Lavoratori
University of Siena
Siena
Italy

#### J.M. Baztarrica\*

Facultad de Servicio Social de Higiene Industrial y Medicina Buenos Aires Argentina

#### Thomas L. Bean, PhD

Safety Leader, Professor

Department of Food, Agricultural and
Biological Engineering
Ohio State University
Columbus, Ohio
United States

#### Luc Beauchamp

ONRSA North Bay, Ontario Canada

#### Bernardo Bedrikow, MD, MPH

Former Chief
Occupational Safety and Health
Serviço Social da Industria
São Paulo
Brazil

#### Louis S. Beliczky, MS, MPH

Consulting Industrial Hygienist
Technical Advisors and Consultants to
Trade Unionists
Wickliffe, Ohio
United States

## David M. Bell, MD

Assistant to the Director
National Center for Infectious Diseases
Centers for Disease Control and
Prevention
Atlanta, Georgia
United States

#### Joel Bender, MD, PhD

Vice President, Chief Medical Officer Health Sciences Owens-Corning Toledo, Ohio United States

## Deborah E. Berkowitz, BA

Director
Office of Safety and Health
United Food and Commercial Workers,
AFL-CIO
Washington, DC
United States

#### A.S. Bettenson, MA\*

Former Deputy Chief Inspector of Factories Cambridge United Kingdom

#### J.R. Bevan, Dr\*

Manager Coated Products Research British Steel Corporation, South Wales Group London United Kingdom

#### William Blackburn, MS

Senior Research Associate
College of Textiles
North Carolina State University
Raleigh, North Carolina
United States

#### H.L. Boiteau

Service d'Anesthésiologie Faculté de Médecine Nantes France

#### Denis Bourcier, PhD

Senior Principle Scientist
Environmental Affairs
Boeing Defence and Space Group
The Boeing Company
Seattle, Washington
United States

#### Madeleine Bourdouxhe, MSc

Researcher
Work Organization Programme
Institute for Occupational Health and
Safety Research
Montreal, Quebec
Canada

#### Carole Brabant, PhD

Associate Editor
Encyclopaedia of Occupational Health and Safety
International Labour Office
Geneva
Switzerland

#### P.E. Braid, PhD\*

Consultant
Laboratory Services
Occupational Health Unit
Medical Services Branch
Health and Welfare Canada
Ottawa, Ontario
Canada

#### Douglas F. Briggs, MPH, CIH

Group Manager
Safety and Health
Boeing Commercial Airplane Group
The Boeing Company
Seattle, Washington
United States

#### Jere A. Brittain, PhD

Clemson University Clemson, South Carolina United States

### T.J. Britton\*

Her Majesty's Inspector of Factories Plastics National Industry Group Health and Safety Executive Northampton United Kingdom

#### Mary O. Brophy, PhD, CIH, CPE

Former Environmental Toxicologist Syracuse Research Corporation North Syracuse, New York United States

# Jeremy Brown, MD, CM, FRCPC, FACP

Chief
Occupational Health Section
Health Services Directorate
Royal Canadian Mounted Police
Ottawa, Ontario
Canada

# Mary E. Brown, DVM, MPH

Morehouse School of Medicine-Senior Research Fellow
National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention
Cincinnati, Ohio
United States

#### Peter J. Bruno, MD, BS

Associate Professor of Medicine
New York University
Senior Consultant
Insall Scott Kelly Institute for Orthopedics
New York, New York
United States

#### Norman Brusk, JD, CIH, CSP

Health and Safety Manager
Health, Safety and Environment
Resource Partner, Inc.
Columbus, Ohio
United States

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### LaMont Byrd, MS

Director of Safety and Health International Brotherhood of Teamsters Washington, DC United States

#### Roxanne Cabral, MPH

American Federation of State, County and Municipal Employees Washington, DC United States

# I.T. Cabrera, Ing Dipl\*

Former Official International Labour Office Lima Peru

#### Buck Cameron, CIH

Director
Health Effects
Carpenters Health and Safety Fund
Seattle, Washington
United States

#### Giovanni Capelli, MD

Assistant Professor Istituto di Igiene Università Cattolica Del Sacro Cuore Rome Italy

# The Carpet and Rug Institute

Melbourne, Victoria Australia

# Melvin E. Cassady, MS, CIH

Cassady Safety and Health Services Southampton, Pennsylvania United States

#### Cesare Catananti, MD

Medical Director
Policlinico "A. Gemelli" - Istituto di Igiene
Università Cattolica del Sacro Cuore
Rome
Italy

# J.A. Catton\*

Manager
Safety, Health and Welfare
British Steel Corporation
London
United Kingdom

# Larry J. Chapman, PhD

Associate Scientist
College of Agricultural and Life Sciences
University of Wisconsin-Madison
Madison, Wisconsin
United States

# Tsun-Jen Cheng, BM, ScD

Associate Professor
Institute of Occupational Medicine and Industrial Hygiene
National Taiwan University
College of Public Health
Taipei
Taiwan, China

#### V.I. Chernyuk, MD, ScD

Professor, Scientific Director Institute for Occupational Health Kiev Ukraine

# Corky Chew, MPH, MBA

Program Manager
Environmental Technologies and
Strategies
Apple Computer, Inc.
Cupertino, California
United States

#### The Chlorine Institute, Inc.

Washington, DC United States

# John P. Chong, MD, FRCPC

Medical Director

Centre for Human Performance and
Health Promotion
Hamilton, Ontario
Canada

#### Nancy Clark, MA, CIH, CSP

Director
Center for Occupational and
Environmental Medicine
Mount Sinai School of Medicine
New York, New York
United States

#### Esther Cloutier, PhD

Researcher
Programme Organisation du Travail
Institute for Occupational Health and
Safety Research
Montreal, Quebec
Canada

# Lenora Colbert

Vice-President
National Health and Human Services
Employees Union
New York, New York
United States

#### James J. Collins, CSP, CIH

General Mills Minneapolis, Minnesota United States

#### Zaida Colon, BS

Safety and Environmental Specialist Concentrate Manufacturing Operations PepsiCo PR, Inc. Cidra Puerto Rico

#### James Cone, MD

Assistant Clinical Professor
University of California-Berkeley
Berkeley, California
United States

#### F.L. Conradi\*

Subdirector General Medicina Laboral Instituto Nacional de la Salud Madrid Spain

# George A. Conway, MD, MPH

Chief Alaska Activity Division of Safety Research National Institute for Occupational Safety

and Health Anchorage, Alaska United States

#### Georges H. Coppée, MD

Chief of Medical Section
Occupational Safety and Health Branch
International Labour Office
Geneva
Switzerland

#### Michael Crane, MD, MPH

Assistant Vice-President Occupational Health Con Edison Brooklyn, New York United States

#### **Charles Crocker**

Safety Manager Burlington Industries, Inc. Greensboro, North Carolina United States

# **Neil Dalhouse**

General Manager Health and Safety Education Program Tourism and Hospitality Industry Toronto, Ontario Canada

# Gianfranco Damiani, MD

Assistant Professor Istituto di Igiene Università Cattolica del Sacro Cuore Rome Italy

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Hugh Davies, MSc

Occupational Hygienist
Occupational Hygiene Programme
University of British Columbia
Vancouver, British Columbia
Canada

#### L. DeBoer, Dr\*

Chief Medical Adviser
Shell International Petroleum
The Hague
Netherlands

#### Paul Demers, PhD

Assistant Professor
Occupational Hygiene Program
University of British Columbia
Vancouver, British Columbia
Canada

#### Louis DiBerardinis, MS

Associate Director
Environmental Medical Services
Massachusetts Institute of Technology
Cambridge, Massachusetts
United States

#### Bertram D. Dinman, MD, ScD

Clinical Professor of Occupational Medicine Graduate School of Public Health University of Pittsburgh Pittsburgh, Pennsylvania United States

#### Basil Dolphin, MD, MPH

Medical Director
Healthworks
Muhlenberg Hospital
Bethlehem, Pennsylvania
United States

#### Kelley Donham, DVM

Department of Preventive Medicine and Environmental Health Institute for Rural and Environmental Health College of Medicine University of Iowa Iowa City, Iowa United States

#### Kyle B. Dotson, CIH, CSP, PE

Group Vice-President, Safety and Health BHP Copper San Francisco, California United States

#### Aluaro Durao, MD, OPHS\*

Chief
Occupational Health Department
Siderurgia Nacional
Lisbon
Portugal

#### Dennis Dykstra, PhD

Deputy Director General for Research Centre for International Forestry Research Jakarta Indonesia

#### Gary S. Earnest, MS, PE, CSP

Engineer Officer
Engineering Control Technology Branch
Division of Physical Sciences and
Engineering
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

#### Alan Echt, MPH

Industrial Hygienist
Engineering Control Technology Branch
Division of Physical Sciences and
Engineering
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

#### Olli Eeronheimo, MSc

Research Scientist
Finnish Forest Research Institute
Vantaa
Finland

# M.M. El-Attal, Dr, MB, ChB, DIH\*

Head
Occupational Health Department
Ministry of Health
Manama
Bahrain

#### M.A. El Kadeem, Prof\*

Production Engineering Department Faculty of Engineering Alexandria University Alexandria Egypt

#### Carl G. Elinder, MD, PhD

Associate Professor
Department of Renal Medicine
Huddinge University Hospital and
Karolinska Institute
Karolinska
Sweden

#### Daniel R. English, PhD

Unit Director
Environmental Sciences Section
Eastman Kodak Company
Rochester, New York
United States

#### Claës-W. Englund, BLL

Director, Legal Adviser
Association of Swedish Theatres and
Orchestras
Teatrarnas Riksförbund
Stockholm
Sweden

# Madeleine R. Estryn-Béhar, MD, PhD

Occupational Health Practitioner Hôpital Saint-Louis Paris France

#### J.F. Eustace, MB, DPH\*

Dean of Faculty
Occupational Medicine
Royal College of Physicians of Ireland
Dublin
Ireland

# E. Evrard, $Dr^*$

Organisation européenne pour la sécurité de la navigation aérienne Brussels Belgium

#### Lynda Ewers, PhD, CHMM

Industrywide Studies Branch
Division of Surveillance, Hazard
Evaluations and Field Studies
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# Michael J. Fagel, PhD

Corporate Safety Director Aurora Packing Co., Inc. North Aurora, Illinois United States

#### John Fajen, MS

Director of Industrial Hygiene and Ergonomics AIG Consultants, Inc. Cincinnati, Ohio United States

# M. Joseph Fedoruk, MD

Medical Director
Center for Occupational and
Environmental Health
University of California-Irvine
Irvine, California
United States

## John B. Feldman, PE, CIH, CSP, MS

Corporate Occupational Safety and Health Raytheon Company Lexington, Massachusetts United States

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# L.V.R. Fernando, MBBS, DPH, DHI\*

Adviser on Labour and Population International Labour Office New Delhi India

#### William E. Field, EdD

Professor Agricultural and Biological Engineering Purdue University West Lafayette, Indiana **United States** 

# John Finklea, MD, Dr PH

Medical Officer Center to Protect Workers' Rights Former Director National Institute for Occupational Safety and Health Washington, DC United States

# Manfred Fischer, Dr-Ing

Director of Technical Inspectorate Verwaltungs-Berufsgenossenschaft Hamburg Germany

# N. Fish, MA\*

Her Majesty's District Inspector of Factories Department of Employment and Productivity Watford United Kingdom

#### Stewart Forbes, BSc

Executive Director Canadian Centre for Pollution Prevention Sarnia, Ontario Canada

# Janet Fox, MA

Director Safety and Industrial Hygiene Con Edison Brooklyn, New York United States

# David Franson, CSP, ARM

Occupational Health and Safety Consultant Safety Management Services Company Dubuque, Iowa United States

# James S. Frederick

Industrial Hygienist Health, Safety and Environment Department United Steelworkers of America Pittsburgh, Pennsylvania United States

#### Barry R. Friedlander, MD, MPH

Senior Environmental Health Adviser Exxon Biomedical Sciences, Inc. East Millstone, New Jersey United States

# I.D. Gadaskina\*

Doktor biologičeskih nauk Rukovoditel' toksikologiceskoj laboratorii Leningradskogo Institut gigieny truda i profzabolevanij Leningrad Former USSR

# Nancy Garcia, MPH

Airline Division International Brotherhood of Teamsters Fremont, California United States

#### H. Gartmann, Dr

Medical Director Medical Services Swissair Zurich Switzerland

# Joel C. Gaydos, MD

Director Clinical Preventive Medicine United States Army Center for Health Promotion and Preventive Medicine Army Proving Ground, Maryland United States

# E. Gelpi\*

**Education Permanente** Division des structures, contenus et méthodes United Nations Educational, Scientific and Cultural Organization Paris France

# Afsaneh Gerami, BS

Environmental Health and Safety Consultant Hewlett-Packard Company San Jose, California United States

#### Gary A. Gibson, MBA

Chief Executive Officer Mines Rescue Board Sydney Australia

# Gary Gibson, BSc

Occupational Health and Safety Officer Durham Board of Education Whitby, Ontario Canada

#### Denis Giguère, MSc, DESS

Ergonomist Safety-Ergonomics Research Program Institute for Occupational Health and Safety Research Montreal, Quebec Canada

# David Gold, MOEd

Occupational Safety and Health Officer Occupational Safety and Health Branch International Labour Office Geneva Switzerland

# J.C. Graham, MFCM, MFOM, DIH\*

Chief Medical Officer H.J. Heinz Company, Ltd. London United Kingdom

# Casey C. Grant, PE

Assistant Vice-President Codes and Standards Administration National Fire Protection Association International Quincy, Massachusetts United States

## Alfons Grösbrink, Dipl-Ing

Leiter des Technischen Aufsichtsdienstes Bahnen-Berufsgenossenschaft Hamburg Germany

# Xavier Guardino Solá, PhD

Chief of Department National Centre for Working Conditions National Institute for Occupational Safety and Hygiene Barcelona Spain

# Tee L. Guidotti, MD, MPH

Professor, Director Occupational Health Program Faculty of Medicine University of Alberta Edmonton, Alberta Canada

# Paul D. Gunderson, PhD

Marshfield Clinic National Farm Medicine Center Marshfield, Wisconsin United States

# J.C. Gunther, Jr.\*

Safety and Training Engineer Imperial Highway Authority Addis Ababa Ethiopia

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.



Corporate Toxicologist
Health Sciences
Owens-Corning
Granville, Ohio
United States

#### Hans Hamrin, MSc

Senior Adviser
Mining
Atlas Copco Rock Drills AB
Stockholm
Sweden

# Jonathan T. Haney, MS

Manlius, New York United States

#### David L. Hard, PhD

Research Safety Engineer
Division of Safety Research
National Institute for Occupational Safety
and Health
Morgantown, West Virginia
United States

# Francis Hardy, PEng

Project Coordinator
Construction Safety Association of Ontario
South Etobicoke, Ontario
Canada

# D.A. Hargrave\*

Her Majesty's District Inspector of Factories Hamilton United Kingdom

# Susan Harman, MSLS, MEd

Associate Librarian
Medical and Chirurgical Faculty of
Maryland
Baltimore, Maryland
United States

#### Robert Harris, PhD CIH

Professor Emeritus
University of North Carolina at
Chapel Hill
Chapel Hill, North Carolina
United States

# Thomas E. Hawkinson, MS, CIH, ROH, CSP

Safety and Environmental Engineering Manager General Mills Minneapolis, Minnesota United States

# Dick Heederik, PhD, MSc

Associate Professor of Occupational Epidemiology University of Wageningen Wageningen The Netherlands

#### Rudolf Heinrich, PhD

Forest Harvesting, Trade and Marketing

Food and Agriculture Organization of the United Nations

Rome Italy

# Jonathan P. Hellerstein, MS, CIH, CSP

Leader
Occupational Health and Safety
Owens-Corning
Toledo, Ohio
United States

#### Samuel H. Henao

Principal Technical Assessor
National Manager of Occupational Health
Institute of Social Security
Bogotá
Colombia

# Robin Herbert, MD

Medical Co-Director

Mount Sinai Center for Environmental
and Occupational Medicine
New York, New York
United States

# Fred W. Hermann, MSc, BSc, BA

Chief Inspector of Mines
Ministry of Employment and Investment
Victoria, British Columbia
Canada

# Thomas A. Hethmon, MS, CIH, ROH

Director
Occupational Health and Safety
Phelps Dodge Corporation
Phoenix, Arizona
United States

# Jeffrey Hinksman, BA Law

Health and Safety Consultant Epsom, Surrey United Kingdom

# Matthew Hirsheimer, BS

National Safety Manager
Safety and Risk Management
Pepsi-Cola Company
Somers, New York
United States

#### Robert W. Hites, BS, AAS

Corporate Safety Analyst Delta Airlines Atlanta, Georgia United States

# Friedrich Hofmann, PhD, MD

Professor of Occupational Medicine University of Wuppertal Wuppertal Germany

# Charles M. Hohman, BSME, MBA

Technical Consultant
East Ohio Machinery Company
Newark, Ohio
United States

#### **Wendy Hord**

Occupational Safety and Health Specialist Civil Service Employees Association Latham, New York United States

#### Ninica Howard, MS

Ergonomist
SHARP
Department of Labor and Industries
Olympia, Washington
United States

# M. J. Howes, PhD

Partner
RHP Consultants
Camborne, Cornwall
United Kingdom

# Gordon Huie, MD

Insall Scott Kelly Institute New York, New York United States

# Vilma Hunt, BDS, AM

Adjunct Professor
Department of Work Environment
University of Massachusetts-Lowell
Lowell, Massachusetts
United States

# David L. Huntzinger, PhD, M Sci

Vice-President
Corporate Safety
America West Airlines
Phoenix, Arizona
United States

# Marit Husmo, MSc

Research Fellow
Norwegian College of Fishery Science
University of Tromso
Tromso
Norway

# William E. Irwin, MS, MBA

Health Physics Consultant, Radiation Safety Officer Massachusetts Institute of Technology Cambridge, Massachusetts United States

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### A. Lee Ivester, MSPH

Director
Corporate Safety and Workers'
Compensation
Fieldcrest Cannon, Inc.
Kannapolis, North Carolina
United States

#### Anthony W. Jackson, PhD

Senior Health and Safety Advisor Fossil Business Unit Ontario Hydro-Fossil Toronto, Ontario Canada

# Lars Järup, MD, PhD

Environmental Physician
Department of Environmental Health
Sundyberg
Sweden

# Norman S. Jennings, BSc

Senior Industrial Specialist
Sectoral Activities Department
International Labour Office
Geneva
Switzerland

# G. Jensen\*

Assistant Director
Danish Labour Inspection Service
Copenhagen
Denmark

# Barry L. Johnson, PhD

Assistant Surgeon General, Assistant Administrator Agency for Toxic Substances and Disease Registry Atlanta, Georgia United States

#### Steven Johnson, PhD

Specialist
Cooperative Extension
University of Maine
Presque Isle, Maine
United States

# Alan D. Jones,

Fire Services Advisor
Alberta Fire Training School
Alberta Labour
Vermillion, Alberta
Canada

# J.G. Jones, Dr\*

Group Medical Officer
British Steel Corporation, South Wales
Group
London
United Kingdom

#### D.D. Joshi, DVM, MPVM

Director
National Zoonoses and Food Hygiene
Research Center
Katmandu
Nepal

#### Marja-Liisa Juntunen, MSc

Research Scientist
Suonenjoki Research Station
Finnish Forest Research Institute
Suonenjoki
Finland

#### Mike Jurvélius, BSc

Senior Consultant ENSO Forest Development Imatra Finland

# Yu S. Kagan, MD, PhD

Head of Department of General Toxicology National Institute of Health Kiev Ukraine

# Juhani Kangas, PhD, Professor

Director of the Regional Institute
Finnish Institute of Occupational Health
Kuopio
Finland

# Valery P. Kaptsov

Russian Institute of Railway Transport Hygiene Moscow Russian Federation

## Thomas Karsky, MS

Extension Safety Specialist
Department of Biological and Agricultural
Engineering
University of Idaho
Moscow, Idaho
United States

# Timo Kauppinen, PhD

Head of Register Unit
Finnish Institute of Occupational Health
Helsinki
Finland

# Anya Keefe, MSc

Research Associate
Occupational Hygiene Program
University of British Columbia
Vancouver, British Columbia
Canada

#### Anat Keidar, PhD, CCC-SLP

Voice Laboratory Director

Vox Humana Voice Laboratory,
Head and Neck Surgical Group
New York Center for Voice and
Swallowing Disorders
New York, New York
United States

# Barry P. Kelley, PhD

Occupational Hygienist Chloride Industrial Batteries, Ltd. Manchester United Kingdom

#### Susan Kennedy, PhD

Associate Professor, Director
Occupational Hygiene Programme
University of British Columbia
Vancouver, British Columbia
Canada

# Robert W. Kilpper, PhD

Senior Toxicologist Xerox Corporation Webster, New York United States

## W. Klost, Dipl-Ing\*

Chief Engineer Arbeitssicherheit Siemens AG Berlin Germany

# L.W. Knapp, Jr.\*

Department of Preventive Medicine and Environmental Health Institute of Agricultural Medicine University of Iowa Iowa City, Iowa United States

# Stephanie Knopp, MFA

Associate Professor of Graphic Design Tyler School of Art Philadelphia, Pennsylvania United States

# Y.C. Ko, MD\*

Institute of Public Health College of Medicine National Taiwan University Taipei Taiwan, China

# Eero Korhonen, MSc

Senior Researcher
Institute of Occupational Health
Vantaa
Finland

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Ludmila P. Korotich

Leading Scientific Researcher
Department of Hygienic Research
RAMS Institute of Occupational Health
Moscow
Russian Federation

# Richard S. Kraus, PE, CSP

Principal
Petroleum Safety Consultants
Annandale, Virginia
United States

#### J. Kroeger, Dipl-Chem\*

Mutual Accident Insurance Association of the Chemical Industry Heidelberg Germany

#### J. Kubota, MD\*

Director
Occupational Health Service Center
Tokyo
Japan

#### Yuri Kundiev, MD, Dr med sci

Director
Institute for Occupational Health
Kiev
Ukraine

# Lucie Laflamme, PhD

Senior Researcher
Department of Public Health Sciences
Karolinska Institute
Sundbyberg
Sweden

#### Paul A. Landsbergis, EdD, MPH

Assistant Professor of Epidemiology
Division of Hypertension
Cornell University Medical College
New York, New York
United States

# Sverre Langård

Centre of Occupational and Environmental Medicine National Hospital Oslo Norway

# Donald V. Lassiter, PhD, MSPH

Consultant
Environmental and Occupational Health
San Jose, California
United States

# Wolfgang Laurig, Dr-Ing

Professor, Director
Department of Ergonomics
Institut für Arbeitsphysiologie
University of Dortmund
Dortmund
Germany

#### P.K. Law\*

Group Manager
British Plastics Federation
London
United Kingdom

#### Pam Tau Lee

Labor Occupational Health Program University of California-Berkeley Berkeley, California United States

# Susan B. Lee, MBA, CIH

Manager
Environmental Health and Safety
Biogen, Inc.
Cambridge, Massachusetts
United States

#### David LeGrande, MA

Director
Occupational Safety and Health
Communications Workers of America
Washington, DC
United States

#### Carol J. Lehtola, PhD

Assistant Professor
Institute of Food and Agricultural Science
Department of Agricultural and Biological
Engineering
University of Florida
Gainesville, Florida
United States

# Steven W. Lenhart, CIH

Industrial Hygienist
Division of Surveillance, Hazard
Evaluations and Field Studies
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# Yung Hian Leow, MD

Section of Industrial Dermatology Cleveland Clinic Foundation Cleveland, Ohio United States

# Charles Levenstein, PhD, MS

Professor of Work Environment Policy Work Environment Department University of Massachusetts-Lowell Lowell, Massachusetts United States

# Robert M. Lewy, MD, MPH

Director for Medical Affairs
Columbia Presbyterian Medical Center
New York, New York
United States

#### Norbert Lichtenstein, PhD

Berufsgenossenschaftliches Institut für Arbeitssicherheit Sankt Augustin Germany

## Hans Göran Linder, PhD

National Board of Occupational Safety and Health Solna Sweden

# Sydney Lipton, MS

Consultant
Port Townsend, Washington
United States

# J.W.G. Lund, MD\*

Freshwater Biological Association Windermere Laboratory Ambleside United Kingdom

# John Lund, PhD

Professor
School for Workers
University of Wisconsin-Extension
Madison, Wisconsin
United States

# Paul V. Lynch, PE

Chief, Safety Staff (Retired)
Bureau of Land Management
United States Department of the Interior
Washington, DC
United States

# G.S. Lyndon\*

Senior Area Director West Midlands Area Office Health and Safety Executive Birmingham United Kingdom

#### Paul Mackenzie-Wood, BSc

Manager, Technology Coal Mines Technical Services Mines Rescue Services Corrimal Australia

#### Susan Magor, RN, MSc

Environment, Health and Safety Concordia University Montreal, Quebec Canada

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Andreas Mahr, Dipl-Ing

Technischer Aufsichtsbeamter Bahnen-Berufsgenossenschaft Hamburg Germany

# Kathryn A. Makos, MPH, CIH

Senior Industrial Hygienist
Office of Environmental Management
and Safety
Smithsonian Institution
Washington, DC
United States

#### M. Malagié, Ing\*

Institut national de recherche et de sécurité pour la prévention des accidents du travail et des maladies professionnelles Paris France

#### Bohuslav Málek

Hygienic Institute of Prague Prague Czech Republic

# David E. Malter, MS, CIH, CSP, ROH

Malter Associates, Inc. Downer Grove, Illinois United States

# Adrienne Markowitz, MSc

Director of Health and Safety
Retail, Wholesale and Department Store
Union
United Food and Commercial Workers,
AFL-CIO
New York, New York
United States

# William S. Marras, PhD

Professor, Director
Biodynamics Laboratory
Department of Industrial and Systems
Engineering
Columbus, Ohio
United States

# Linda S. Martin, PhD

National Institute for Occupational Safety and Health Altanta, Georgia United States

# John Masaitis, CIH

Consultant New Smyrna Beach, Florida United States

#### Steve Mason, BS

Senior Manager, Chemical Technology Operations Technology Boeing Commercial Airplane Group The Boeing Company Seattle, Washington United States

#### K.R. Mathisen\*

Mechanical Engineering Division Swedish Standard Commission Stockholm Sweden

#### Toshio Matsushita, MD, PhD

Professor Faculty of Medicine Kagoshima University Kagoshima Japan

#### **Chester Matthews**

Bath Iron Works Brunswick, Maine United States

# R. Mattiussi, Dr\*

Direttore Sanitario Montedison Milan Italy

#### John May, MD

Director
New York Center for Agricultural
Medicine and Health
Mary Imogene Bassett Hospital
Coopertown, New York
United States

# Michael McCann, PhD, CIH

Senior Associate Editor
Encyclopaedia of Occupational Health and Safety
International Labour Office
New York, New York
United States

# George J. McDonald

Director of Safety and Health International Transport Workers Union of America New York, New York United States

#### **Bruce McKay**

Senior Researcher SeaWeb Montreal, Quebec Canada

# Shane McMahon, MSc

Program Manager Liro Limited Rotorua New Zealand

# Neil McManus, MSc, M Eng

Consulting Industrial Hygienist
NorthWest Occupational Health and
Safety
North Vancouver, British Columbia
Canada

# Nona McQuay, MS

Health and Safety Specialist New York State Public Employees Federation, AFL-CIO Buffalo, New York United States

# Doug J. McVittie, Dipl Eng

Manager-Technical Services
Construction Safety Association of Ontario
Etobicoke, Ontario
Canada

#### Karlheinz Meffert, Dr-Ing

Director

Berufsgenossenschaftliches Institut für Arbeitssicherheit

Hauptverband der gewerblichen Berufsgenossenschaften

Sankt Augustin

Germany

# Ronald L. Melnick, PhD

Toxicologist
National Institute of Environmental
Health Sciences
Research Triangle Park, North Carolina
United States

# Raji Menon

Research Officer Mining Association of Canada Ottawa, Ontario Canada

#### Karen Messing, PhD

Professor of Biology CINBIOSE University of Quebec Montreal, Quebec Canada

# Jacqueline Messite, MD

Clinical Professor
Department of Environmental Medicine
New York University College of Medicine
New York, New York
United States

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Mark M. Methner, PhD

Industrial Hygienist Division of Surveillance, Hazard **Evaluation and Field Studies** National Institute for Occupational Safety and Health Cincinnati, Ohio United States

# John D. Meyer, MD, MPH

Associate Residency Director Institute of Occupational and Environmental Health West Virginia University School of Medicine Morgantown, West Virginia United States

#### Jack L. Mickle, PhD

Professor Emeritus, Consultant Jack L. Mickle and Associates Boone, Iowa **United States** 

#### John Miles, PhD

Department of Agricultural Engineering University of California-Davis Davis, California United States

#### Frank Miller, PhD

Hazardous Materials Officer Environmental Health and Safety Office Columbia University Health Sciences New York, New York United States

# Gordon C. Miller, MSPH

Health, Safety and Environment Rexam, Inc. Charlotte, North Carolina United States

# Bruce A. Millies, JD, MS, CIH

Industrial Hygienist International Brotherhood of Teamsters Bainbridge Island, Washington **United States** 

## Franklin E. Mirer, PhD

Director Health and Safety Department International Union of United Auto Workers Detroit, Michigan United States

# Courtney S. Mitchell, MSc, MA

Consultant **CSM** Consulting Golden, Colorado United States

#### William S. Mitchell, MSc

Manager, Exploration Administration BHP Minerals International Exploration, Golden, Colorado United States

#### Augustine Moffitt, ScD

Vice-President Safety, Health and Environment Bethlehem Steel Corporation Pennsylvania **United States** 

# W.G. Morison, BSc, MSc

President Morwil Inc. Ontario Canada

#### K.M. Morse\*

Industrial Health Engineers, Inc. Altamonte Springs, Florida United States

#### Robert J. Mullan, MD

Medical Officer Centers for Disease Control and Prevention National Institute for Occupational Safety and Health Atlanta, Georgia United States

# Kieran Mulvaney

Editor Ocean Update SeaWeb Washington, DC United States

# Eva Munk-Madsen, PhD

Teacher, Lecturer Norwegian College of Fishery Science University of Tromso Tromso Norway

# R.A. Munoz, MSW\*

Subdirector Technical Programming Department of Education Hato Rey Puerto Rico

# Dennis Murphy, PhD, CSP

Department of Agricultural and Biological Engineering Pennsylvania State University University Park, Pennsylvania United States

# Daniel Murphy, MB, FFOM, DIH

Occupational Medical Services National Authority for Occupational Safety and Health Dublin Ireland

## Joshua E. Muscat, MPH

American Health Foundation New York, New York United States

#### Melvin L. Myers, BS, MPA

Deputy Director Office of Extramural Coordination and Special Projects National Institute for Occupational Safety and Health Atlanta, Georgia United States

# Pranab Kumar Nag, PhD, DSc, MSc

Deputy Director Indian Council of Medical Research National Institute of Occupational Health Ahmedabad India

# John D. Neefus, PhD, CIH

Industrial Hygiene Consultant Durham, North Carolina United States

# Barbara Neis, PhD

Associate Professor, Head Department of Sociology Memorial University St. John's, Newfoundland Canada

#### Christian E. Newcomer, VMD

Director, Research Associate Professor Laboratory Animal Medicine University of North Carolina Chapel Hill, North Carolina **United States** 

# A.K. Niyogi, MBDPH, DIH\*

University Grants Commission Fellow Department of Preventive and Social Medicine Institute of Medical Sciences Varanasi India

# Susan Nobel, MSW, CSW

Mount Sinai-Irving J. Selikoff Center for Occupational and Environmental Medicine Mount Sinai Medical Center New York, New York **United States** 

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

**Gunnar Nordberg** 

Department of Environmental Medicine University of Umeå Umeå Sweden

Jacqueline Nubé, Dr

Department of Psychology Faculty of Methodology University of Amsterdam Amsterdam The Netherlands

Hulda Ólafsdóttir, MS

Physiotherapist
Department of Occupational Medicine
Administration of Occupational Safety
and Health
Reykjavik
Iceland

Edward A. Olmsted, CIH, CSP

President
Olmsted Environmental Services
Garrison, New York
United States

Gary W. Olmstead, PhD, CIH, CSP

Director
Safety and Environmental Management
General Mills
Minneapolis, Minnesota
United States

David A. O'Malley, MSc

Managing Director
Diamond Environmental Ltd.
Chester
United Kingdom

George R. Osborne, CIH, CSP

Industrial Hygiene Manager Lucent Technologies Norcross, Georgia United States

Debra Osinsky, MPH

Editorial Consultant
Encyclopaedia of Occupational Health and Safety
International Labour Office
Highland Park, New Jersey
United States

Gary A. Page BS, MS, MBA

Fertilizer and Agricultural Chemicals National Safety Council Ridgewood, New Jersey United States

N.M. Pant, Dr, MBBS, DPH\*

Medical Officer Hindustan Lever, Ltd. Bombay India Jon Parish, BBA

Director
Loss Control and Environment
Lane Corporation
Altavista, Virginia
United States

Robert M. Park, MS

Project Epidemiologist
Health and Safety Department
International Union of United Auto
Workers
Detroit, Michigan
United States

Relford Patterson, MD, MPH

Medical Director
GM Truck Group-Baltimore Assembly
Plant
General Motors Corporation
Baltimore, Maryland
United States

Gerald F. Peedin, PhD

Philip Morris Professor Crop Science Department North Carolina State University Raleigh, North Carolina United States

Peter W. Pickerill, BSc, M Eng, MBA

Regional Director
Asia and Australia
MSA International
Pittsburgh, Pennsylvania
United States

Alexander C. Pittman, Jr., Dr

Con Edison Brooklyn, New York United States

Philip A. Platcow, MS, CIH

Vice-President, Senior Consultant Risk Management Sedgwick Boston, Massachusetts United States

James W. Platner, PhD, CIH

Industrial and Labor Relations Cornell University Albany, New York United States

Rebecca Plattus, JD

Political Education Director
Local 89-22-1
Union of Needletrades, Industrial and
Textile Employees
New York, New York
United States

Lou Piombino, BS

Manager Safety, Health and Environment Lipton, Inc. Englewood Cliffs, New Jersey United States

Bengt Pontén

Forest and Timber Group Dalarna University Borlänge Sweden

William Popendorf, PhD, CIH

Professor
Department of Biology
Utah State University
Logan, Utah
United States

Paulo Portich

Fundacentro Porte Alegro, Rio Grande do Sul Brazil

Peter Poschen, PhD

Forestry and Wood Industries Specialist Industrial Activities Branch International Labour Office Geneva Switzerland

Christine Proctor, MS, CIH

Proctor Occupational Safety and Health New York, New York United States

L. Prodan, *Dr\** CLUJ-NAPOCA

Romania

John Quackenbush
International Representative
International Union of Elevator
Constructors
Springfield, Virginia
United States

A.E. Quinn, BSc, LLB\*

Former Her Majesty's Inspector of Factories London United Kingdom

M.E. Radjabi, Ing\*

Assistant Director General, Labour Inspection Ministry of Labour and Social Affairs Tehran Islamic Republic of Iran

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# Vilhjálmur Rafnsson, MD, PhD

Chief Medical Director
Department of Occupational Medicine
Administration of Occupational Safety
and Health
Reykjavík
Iceland

#### Ray RaLonde, MS

Agriculture Specialist
School of Fisheries and Ocean Sciences
University of Alaska
Anchorage, Alaska
United States

# Russell B. Rayman, MD, MPH

Executive Director
Aerospace Medical Association
Alexandria, Virginia
United States

#### Beth Donovan Reh, MHS

Industrial Hygienist
Hazard Evaluations and Technical
Assistance Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# John Reimer, PEng

Environmental Protection Engineer Health Science Centre Winnipeg, Manitoba Canada

# Toni Retsch, Dipl.-Ing, ETH\*

Bereichsleiter-ALM2
Swiss National Accident Insurance
Organization
Luzern
Switzerland

# Thomas Rhodarmer, BSc

Corporate Director Environmental Health and Safety Mark IV Industries Worldwide Dayco/Mark IV Waynesville, North Carolina United States

# David Richardson, MPH, DABT

Unit Director, Applied and Regulatory Toxicology Health and Environment Laboratories Eastman Kodak Inc. Rochester, New York United States

#### Sandra Karen Richman

Safety Consultant
National Board of Directors
American Federation of Television and
Radio Artists
New Hope, Pennsylvania
United States

# Ted Rickard, MLS, CRSP

Manager of Health, Safety and Security Ontario College of Art & Design Toronto, Ontario Canada

# Knut Ringen, Dr PH

Director
Center to Protect Workers' Rights
Washington, DC
United States

# Richard D. Ringenwald, Jr., Dr

Exide Corporation Reading, Pennsylvania United States

# Jorge da Rocha Gomes

Professor Emeritus

Department of Environmental Health,
School of Public Health
University of São Paulo
São Paulo
Brazil

# John G. Rodwan, Jr., MA

International Labour Office Geneva Switzerland

# T. A. Roščina, Dr\*

First Medical Moscow Institute Moscow Former USSR

# Jonathan Rosen, MS, CIH

Director
Occupational Health and Safety Program
New York State Public Employees
Federation, AFL-CIO
Albany, New York
United States

# Beth Rosenberg, ScD

Assistant Professor
Department of Family Medicine and
Community Health
Tufts School of Medicine
Boston, Massachusetts
United States

# Monona Rossol, MS, MFA

Industrial Hygienist Arts, Crafts and Theater Safety New York, New York United States

# Pekka Roto, MD, MSc, PhD

Medical Officer
Tampere Regional Institute of
Occupational Health
Tampere
Finland

#### James R. Rubin, MS

Environmental Health and Safety Specialist Hewlett-Packard Company Fort Collins, Colorado United States

# Avima M. Ruder, PhD

Chief
Division of Surveillance, Hazard
Evaluations and Field Studies
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# L.A. Ryzik, Dr\*

Institute of Industrial Hygiene and Occupational Diseases Leningrad Former USSR

#### David M. Sack, MD

Navy Environmental Health Center United States Navy Norfolk, Virginia United States

# Joyce Salg, PhD

Senior Research Scientist
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

# Igor V. Sanotsky, MD, PhD, Prof

Adviser for Science
Institute of Occupational Health
Russian Academy of Medical Sciences
Moscow
Russian Federation

# Steven L. Sauter, PhD

Chief
Applied Psychology and Ergonomics
Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

#### E. Neil Schachter, MD

Maurice Hexter Professor of Medicine Pulmonary Division Mount Sinai Medical Center New York, New York United States

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### Ted Scharf, PhD

Division of Biomedical and Behavioral Science National Institute for Occupational Safety and Health Cincinnati, Ohio United States

# Marc B. Schenker, MD, MPH

Director
University of California Agricultural
Health and Safety Center
University of California-Davis
Davis, California
United States

# H. Schneider, Dr med\*

Former Medical Director KRUPP Hüttenwerke AG Duisburg Germany

# Scott P. Schneider, MSIH, CIH

Ergonomics Program Director Center to Protect Workers' Rights Washington, DC United States

# Rudolf Scholbeck, Dipl-Ing Univ

Head
Technical Inspection Service
Tiefbau-Berufsgenossenschaft
Munich
Germany

# Stanley H. Schuman, MD, PhD, MPH

Professor
Family Medicine
Agromedicine Program
Clemson University
Medical Director
Occupational and Environmental
Medicine Office
Medical University of South Carolina
Charleston, South Carolina
United States

# Charles Schwab, PhD

Associate Professor
Agricultural and Biosystems Engineering
Iowa State University
Ames, Iowa
United States

# W. Norman Scott, MD

Director
Insall Scott Kelly Institute
New York, New York
United States

# Jane L. Seegal

Editor
Center to Protect Workers' Rights
Washington, DC
United States

#### Rita Seguin, BA

Safety and Disability Manager Hiram Walker and Sons, Ltd. Walkerville, Ontario Canada

# Logan C. Shelman, BS, ChE, MEA

Senior Environmental Engineer
Environmental Health and Safety
Department
Newport News Shipbuilding
Newport News, Virginia
United States

# Konstantin K. Sidorov, Dr med sci

Deputy Director
Russian Registry of Hazardous Chemical
and Biological Substances
Moscow
Russian Federation

#### Itzhak Siev-Ner, MD

Orthopedic Surgeon, Physical Medicine and Rehabilitation Sheba Medical Center, Tel-Hashomer Israel Performing Arts Medicine Center Tel Aviv Israel

# **Ken Sims**

Director
Thrigby Hall Wildlife Gardens
Great Yarmouth
United Kingdom

# Donald L. Smith, CIH, CSP, PE, DEE

Nabisco, Inc. East Hanover, New Jersey United States

# N.A. Smith, PhD

Lighting Consultant Doncaster United Kingdom

# Marianne Smukowski, BS

Dairy Safety Applications Coodinator Center for Dairy Research University of Wisconsin-Madison Madison, Wisconsin United States

# Jack W. Snyder, MD, JD, MPH, PhD

Associate Professor
Emergency Medicine and Laboratory
Medicine
Thomas Jefferson University
Philadelphia, Pennsylvania
United States

# Jerzy A. Sokal, Prof, PhD, DSc

Director
Institute of Occupational Medicine and
Environmental Health
Sosnowiec
Poland

# Colin L. Soskolne, PhD

Professor, Director of Graduate Training
Department of Public Health Sciences
University of Alberta
Edmonton, Alberta
Canada

# Jerry Spiegel, MA, MSc

Director
Pollution Prevention
Manitoba Environment
Winnipeg, Manitoba
Canada

# J. Staal\*

Technical Secretary
Fédération européenne de la manutention,
Section VII: ascenseurs, lifts, Aufzüge
Amsterdam
The Netherlands

# Lorann Stallones, PhD, MPH

Department of Environmental Health Colorado State University Fort Collins, Colorado United States

# Roger Stamm, Dr

Head of Central Department
Berufsgenossenschaftliches Institut für
Arbeitssicherheit
Hauptverband der gewerblichen
Berufsgenossenschaften
Sankt Augustin
Germany

# William E. Steinke, PhD

Extension Agricultural Engineer
Biological and Agricultural Engineering
Department
University of California-Davis
Davis, California
United States

<sup>\*</sup>Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

#### Jeanne M. Stellman, PhD

Editor-in-Chief
Encyclopaedia of Occupational Health and Safety
International Labour Office
Geneva

Switzerland

School of Public Health Columbia University New York, New York United States

#### Steven D. Stellman, PhD, MPH

Chief
Division of Epidemiology
American Health Foundation
New York, New York
United States

# Frank B. Stern, BBA, MS

Senior Research Epidemiologist
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

## Laura Stock, MPH

Labor Occupational Health Program School of Public Health University of California-Berkeley Berkeley, California United States

# Ulrich Stössel, Dr phil

Academic Lecturer
Department of Medical Sociology
Medical Faculty
University of Freiburg
Freiburg
Germany

# J.M. Strother, BS

Manager
Research Analytical and Finishing
Laboratory
Fieldcrest Cannon, Inc.
Kannopolis, North Carolina
United States

# Dean T. Stueland, MD, MPH

Medical Director
National Farm Medicine Center
Marshfield Clinic
Marshfield, Wisconsin
United States

# E.A. Suchman, PhD\*

Department of Sociology University of California Santa Barbara, California United States

# F. William Sunderman, Jr., MD

Professor

Departments of Laboratory Medicine and Pharmacology University of Connecticut Medical School Farmington, Connecticut United States

# John J. Svagr, CIH

Manager
Industrial Hygiene and Safety-North
America
Safety and Risk Management Department
Kraft Foods
Rye Brook, New York
United States

#### William B. Symons, PhD

Associate Professor
Biological Systems Engineering
Department
Washington State University
Pullman, Washington
United States

# Keith Tait, CIH, CSP

Assistant Director
Corporate Health and Safety
Pfizer, Inc.
New York, New York
United States

# James S. Taylor, MD

Head
Industrial Dermatology
Cleveland Clinic Foundation
Cleveland, Ohio
United States

#### Benedetto Terracini, MD

Former Head
Unit of Cancer Epidemiology
University Hospital and University of
Turin
Turin
Italy

# Kay Teschke, PhD, MPH, CIH, ROH

Associate Professor

Department of Health Care and
Epidemiology
University of British Columbia
Vancouver, British Columbia
Canada

# Jamie Tessler, MPH

Occupational Health and Safety Consultant Brooklyn, New York United States

# Richard J. Thomas, MD, MPH

Officer in Charge, Occupational Medicine Physician Navy Environmental and Preventive Medicine Unit United States Navy Norfolk, Virginia United States

#### G. Thomas\*

Research Department British Steel Corporation Deeside United Kingdom

#### Frank H. Thorn, BS

Manager, Environmental Engineering
Environmental Health and Safety
Department
Newport News Shipbuilding
Newport News, Virginia
United States

# James R. Thornton, MS, CIH, CSP

Director, Environmental Health and Safety
Environmental Health and Safety
Department
Newport News Shipbuilding
Newport News, Virginia
United States

# Kendall Thu, PhD

Institute for Rural and Environmental Health College of Medicine Iowa City, Iowa United States

# Kjell Torén, MD

Associate Professor
Department of Occupational Medicine
Sahlgrenska University Hospital
Göteborg
Sweden

# James R. Townhill, CSP

Piedmont Environmental, Inc. Kannapolis, North Carolina United States

# John N. Trent, PhD

Wildlife Biologist
Division of Wildlife Conservation
Alaska Department of Fish and Game
Anchorage, Alaska
United States

# Don Trotter, M Eng

Professor School of Engineering Laurentian University Sudbury, Ontario Canada

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# A. Türkdogan, Ing-Chim\*

Former Industrial Safety Inspector Istanbul Turkey

# Timothy J. Ungs, MD, MS

Commandant (G-WKS-3) United States Coast Guard Headquarters Washington, DC United States

# L.J.L.D. Van Griensven, PhD

Professor Applied Mycology Catholic University of Nijmegen Mushroom Experimental Station Horst The Netherlands

# Anaide Vilasboas de Andrade

Chief of Technical Services Centro Regional da Bahia Fundação Jorge Duprat Figueiredo de Segurança e Medicina do Trabalho Salvador Brazil

#### R.F. Villard\*

Ingénieur EPUL Chargé de cours à l'Ecole supérieure technique de Genève Geneva Switzerland

# Phillip J. Wakelyn, PhD

Senior Scientist, Environmental Health Safety National Cotton Council of America Washington, DC United States

# Simon Walker, BSc, MSc

Principal **IETS** Oxford United Kingdom

# Anthony D. Walters, M Eng

Manager Coal Division Kilborn Engineering Pacific, Ltd. Vancouver, British Columbia Canada

#### Jung-Der Wang, MD, ScD, MIH

Institute of Occupational Medicine and Epidemiology National Taiwan University College of Public Health Taipei Taiwan, China

#### Lance A. Ward, BA

Corporate Director of Health and Safety Pepsi-Cola General Bottlers, Inc. Rolling Meadows, Illinois United States

# Leon J. Warshaw, MD

Clinical Professor Department of Environmental Medicine New York University New York, New York **United States** 

# James L. Weeks, ScD, CIH

Department of Occupational and Environmental Health School of Public Health and Health Services George Washington University Washington, DC United States

# Beat Wegmüller

Safety Engineer Swiss National Accident Insurance Organization Luzern Switzerland

# Merri Weinger, MPH

Office of Global and Integrated Environmental Health World Health Organization Geneva Switzerland

#### K. Welinder\*

Research Director Slipmaterial-Naxos Vastervik Sweden

# Paul Westcott, B Eng

Director, Consulting Mining Engineer MineConsult Chatswood, New South Wales Australia

# Othmar Wettmann, Dipl Forest Ing, ETH

Head Forestry Section Swiss National Accident Insurance Organization Luzern Switzerland

#### Aidan White

General Secretary International Federation of Journalists Brussels Belgium

#### Michael E. Williams, CIH, CSP, ARM

Principal Health Safety and Risk Management Services Sunnyvale, California United States

# Linda B. Wolfe, RBP

Associate Biosafety Officer Environmental Medical Service Massachusetts Institute of Technology Cambridge, Massachusetts United States

# Malinee Wongphanich, MD

Consultant on Occupational Health Department of Health Ministry of Health Nondhaburi Province Thailand

# Ray C. Woodcock, MS, CIH

Vice-President Safety and Hygiene Management, Inc. Waynesville, North Carolina **United States** 

# B. H. Xu, PhD, MD

Assistant Professor Faculty of Medicine Kagoshima University Kagoshima Japan

# Annalee Yassi, MD, MSc

Occupational and Environmental Medicine Health Sciences Centre and Unit University of Manitoba Winnipeg, Manitoba Canada

# Dennis D. Zaebst, CIH

Industrial Hygienist National Institute for Occupational Safety and Health Cincinnati, Ohio United States

# Albert M. Zielinski, CIH

Senior Technical Leader, Industrial Hygiene Lighting Environment Safety and Health Department GE Lighting Cleveland, Ohio United States

ENCYCLOPAEDIA OF OCCUPATIONAL HEALTH AND SAFETY

<sup>\*</sup> Contributor to the 3rd edition of this *Encyclopaedia*. This biographical information has not been updated.

# **AUTHORS AND EDITORS**

# A. Zober, Dr\*

Institute for Occupational Health and Social Medicine and Clinic for Occupational Diseases University of Erlangen/Nuremberg Erlangen Germany

**Craig Zwerling,** *MD*, *PhD*, *MPH*Injury Prevention Research Center College of Medicine Iowa City, Iowa **United States** 

 $<sup>^*</sup>$  Contributor to the 3rd edition of this  $\it Encyclopaedia$ . This biographical information has not been updated.



# ENCYCLOPAEDIA OF OCCUPATIONAL HEALTH AND SAFETY

4TH EDITION



Editor-in-Chief Jeanne Mager Stellman, PhD

Senior Associate Editor Michael McCann, PhD, CIH

Associate Editors

Leon Warshaw, MD

Carole Brabant, PhD

# Senior Editors

John Finklea, MD, Dr PH

Jacqueline Messite, MD Steven L. Sauter, PhD

Georges H. Coppée, MD

Jerry Spiegel, MA, MSc

Vilma R. Hunt, BDS, AM Richard S. Kraus, PE, CSP

Colin L. Soskolne, PhD

Wolfgang Laurig, Dr-Ing

Benedetto Terracini, MD

Melvin L. Myers, BS, MPA

Managing Editor Chantal Dufresne, BA

INTERNATIONAL LABOUR OFFICE GENEVA



# Copyright © International Labour Organization 1998

Publications of the International Labour Office enjoy copyright under Protocol 2 of the Universal Copyright Convention. Nevertheless, short excerpts from them may be reproduced without authorization, on condition that the source is indicated. For rights of reproduction or translation, application should be made to the Publications Bureau (Rights and Permissions), International Labour Office, CH-1211 Geneva 22, Switzerland. The International Labour Office welcomes such applications. Libraries, institutions and other users registered in the United Kingdom with the Copyright Licensing Agency, 90 Tottenham Court Road, London W1P 9HE (Fax + 44 171 436 3986), in the United States with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 (Fax + 1 508 750 4470), or in other countries with associated Reproduction Rights Organizations, may make photocopies in accordance with the licences issued to them for this purpose.

Stellman, Jeanne Mager (ed.)

Encyclopaedia of Occupational Health and Safety. 4th ed.

Geneva, International Labour Office, 1998. 4 V.

/Encyclopaedia/, /Occupational health/, /Occupational safety/. 13.04.2

ISBN 92-2-109203-8 (set)

92-2-109814-1 (V. 1) 92-2-109815-X (V. 2) 92-2-109816-8 (V. 3) 92-2-109817-6 (V. 4)

Contents: V. 1. The Body; Health Care; Management and Policy; Tools and Approaches—V. 2. Hazards—V. 3. Chemicals; Industries and Occupations—V. 4.Indexes

ILO Cataloguing in Publication Data

The designations employed in ILO publications, which are in conformity with United Nations practice, and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of the International Labour Office concerning the legal status of any country, area or territory or of its authorities, or concerning the delimitation of its frontiers. The responsibility for opinions expressed in signed articles, studies and other contributions rests solely with their authors, and publication does not constitute an endorsement by the International Labour Office of the opinions expressed in them. The reader accepts that the parties make this documentation available without warranty of any kind. The parties do not accept

responsibility for the validity or completeness of any data including inaccuracies, errors or omissions or for any consequences arising from the use of such data. Neither the authors, nor the ILO or collaborating institutions shall be liable for damages or other claims and demands arising out of the use of the data.

Reference to names of firms and commercial products and processes does not imply their endorsement by the International Labour Office or any collaborating institution, and any failure to mention a particular firm, commercial product or process is not a sign of disapproval.

ILO publications can be obtained through major booksellers or ILO local offices in many countries, or direct from ILO Publications, International Labour Office, CH-1211 Geneva 22, Switzerland. Catalogues or lists of new publications are available free of charge from the above address.

# **AUTHORS AND EDITORS**

Avraham Aladjem, DSc
Israel Institute of Occupational
Safety and Hygiene
Tel Aviv
Israel

Janet L. Collins, MD, MPH
Medical Director
Division of Occupational Medicine
Sherman Health Systems

Elgin, Illinois United States

Alexander Donagi, DSc, MPH

Professor
School of Medicine
Tel Aviv University
Director
Information Centre
Israel Institute of Occupational
Safety and Hygiene
Tel Aviv
Israel

Linda S. Forst, MS, MD, MPH

Assistant Professor School of Public Health University of Illinois at Chicago Chicago, Illinois United States

David L. Hinkamp, MD, MPH

Visiting Assistant Professor School of Public Health University of Michigan Ann Arbor, Michigan United States Niels Koehncke, BSc (hon), MD

Resident, Occupational Medicine Program
Department of Public Health Sciences
University of Alberta
Edmonton, Alberta
Canada

Kari Kurppa, MD PhD

Assistant Departmental Director
Department of Epidemiology
and Biostatistics
Institute of Occupational Health
Helsinki
Finland

Pia Markkanen, MSc, Eng

Associate Expert International Labour Office Bangkok Thailand

Debra Osinsky, MPH

Editorial Consultant
Encyclopaedia of Occupational Health and Safety
International Labour Office
Highland Park, New Jersey
United States

Beth Donovan Reh, MHS

Industrial Hygienist
Hazard Evaluations and Technical
Assistance Branch
National Institute for Occupational Safety
and Health
Cincinnati, Ohio
United States

Menachem Schwartz, BSc, MSc

General Director
Israel Institute for Occupational Safety
and Hygiene
Tel Aviv
Israel

Jeanne M. Stellman, PhD

Editor-in-Chief
Encyclopaedia of Occupational Health and Safety
International Labour Office
Geneva
Switzerland

School of Public Health Columbia University New York, New York United States

Steven D. Stellman, PhD, MPH

Chief
Division of Epidemiology
American Health Foundation
New York, New York
United States

# **PRODUCTION TEAM**

Sarah Alvarez Maria Arteta May Ballerio-Hofman Francine Benjamin Lillian Benjamin Walter Benjamin Michel Berka Christian Bolufer Claude Chaperon Kyle Creane Denis Cullinan Johanna de Vries Robert Dees Margaret Fennessy Raymond Figuières Geraldeen Fitzgerald Betty Goldman Susan Guthridge Kathleen Susan Hurst Claudia Hommel Rachael Horner Sanna Immonen Lisa Kellner Diana Signe Kline Nana-Ekua Leigh Robert Leuze Elizabeth Mahiga Christiane Melin Jacky Merteau

John McKenna

Julie Nayler Catherine H. Perring Peter Perring Bodhani Pieris Giles Reed Kirsten Reed John G. Rodwan, Jr. Nancy J. Rodwan Christian Rohrbach David Rosenweig David Rowley Oriele Rovaletti Daniel Ruffieux Jacques P. Tremblet Steven Sacks Barbara Sandi Gabor Sandi Anneliese Shulte Jonathon Stampf Fred Stanton Andrew B. Stellman Emma D. Stellman Prabha Sundaram Juan Tenorio Jennifer Valdes Tracy Weber Berit Widing-Pry Sydney G. Williams Su Zen

# **CONTRIBUTING INSTITUTIONS**

A

#### **American Health Foundation**

320 East 43rd Street New York, NY 10017 United States Tel. +1-212 551 2521 Fax +1-212 687 2339

# American Industrial Hygiene Association (AIHA)

2700 Prosperity Avenue Fairfax, VA 22031 United States Tel. +1-703 849 8888 Fax +1-703 207 3561

#### **American Petroleum Institute**

1220 L Street NW Washington DC 20005 United States Tel. +1-202 682 8308 Fax +1-202 682 8270

# Berufsgenossenschaftliches Institut für Arbeitssicherheit (BIA)

Alte Heerstrasse 111 D-53754 Sankt Augustin Germany Tel. +49-2241 231 02 Fax +49-2241 231 2234

# Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA)

Fachbereich Arbeitsmedizin Nöldnerstrasse 40/42 D-10317 Berlin Germany Tel. +49-30 5154 8180 Fax +49-30 5154 8170

# Bundesanstalt für Arbeitsschutz und Arbeitsmedizin

Fachbereich Arbeitsschutz Friedrich-Henkel-Weg 1-25 D-44149 Dortmund Germany Tel. +49-231 90 71 340 Fax +49-231 90 71 454

# Canadian Auto Workers Union (CAW)

205 Placer Court, North York Willowdale, Ontario M2H 3H9 Canada Tel. +1-416 497 4110

# Fax +1-416 495 3785

Canadian Centre for Occupational Health and Safety (CCOHS) 250 Main Street East Hamilton, Ontario L8N 1H6

Tel. +1-905 572 2981 Fax +1-905 572 2206

# **Canadian Labour Congress**

2841 prom. Riverside Drive Ottawa, Ontario K1V 8X7 Canada Tel. +1-613 521 3400 Fax +1-613 521 4655

# Center to Protect Workers' Rights

111 Massachusetts Avenue NW Washington DC 20001 United States Tel. +1-202 962 8490 Fax +1-202 962 8499

#### **CISL National Board**

Dipartimento Politiche Internazionale Via Po 21 Roma 00198 Italy Tel. +39-6 847 3357 Fax +39-6 841 3782

# Columbia University

School of Public Health New York, NY 10032 United States Tel. +1-212 305 3464 Fax +1-212 305 3405

# Hauptverband der gewerblichen Berufsgenossenschaften (HVBG)

Alte Heerstrasse 111 D-53754 Sankt Augustin Germany Tel. +49-2241 231 1150 Fax +49-2241 231 1391

#### Health and Safety Executive (HSE)

Rose Court 2 Southwark Bridge London SE1 9HS United Kingdom Tel. +44-171 717 6000 Fax +44-171 717 6717

# Institut für Arbeitsphysiologie (IfADo)

Universität Dortmund Ardeystrasse 67 D-44139 Dortmund Germany Tel. +49-231 10 84 361 Fax +49-231 10 84 402

# Institut National de Recherche et de Sécurité (INRS)

30, rue Olivier Noyer 75680 Paris Cedex 14 France Tel. +33-1 4044 3000 Fax +33-1 4044 3099

# Institut de Recherche en Santé et en Sécurité du Travail (IRSST)

505, boulevard De Maisonneuve Ouest Montréal, Québec H3A 3C2 Canada Tel. +1-514 288 1551 Fax +1-514 288 0998

# Institut universitaire romand de Santé au Travail (IST)

1005 Lausanne Switzerland Tel. +41-21 314 7421 Fax +41-21 314 7420

#### **Institute of Occupational Medicine**

Chinese Academy of Preventive Medicine 29 Nan Wei Road Beijing 100050 People's Republic of China Tel. +86-10 6301 4323 Fax +86-10 6301 4323

# Institute of Occupational Medicine and Environmental Health

13 Koscielna Street 41-200 Sosnowiec Poland Tel. +48-3 266 0640 Fax +48-3 266 1124

# Institute for Science of Labour (ISL)

2-8-14 Sugao Miyamae-ku Kawasaki 216-8501 Japan Tel. +81-4 4977 2121 Fax +81-4 4977 7504

# Istituto di Medicina del Lavoro

Università degli Studi di Milano Via San Barnaba 8 I-20122 Milano Italy Tel. +39-2 55 11 610 Fax +39-2 551 87 172

# Instituto Nacional de Seguridad e Higiene en el Trabajo

Torrelaguna 73 28027 Madrid Spain Tel. +34-1 403 7000 Fax +34-1 403 0050

# Instituto Seguros Sociales

Centro Administrativo Nacional Diagonal 40, n.º 46-A-17 Bogotá Colombia Tel. +57-1 222 4491 Fax +57-1 222 1315

# International Agency for Research on Cancer (IARC)

150, cours Albert-Thomas 69372 Lyon Cedex 08 France Tel. +33-4 7273 8485 Fax +33-4 7273 8575

# International Commission on Occupational Health (ICOH)

Lower Kent Ridge Road Singapore 0511 Singapore Tel. +65 772 4290 Fax +65 779 1489

# International Organization for Standardization (ISO)

1, rue de Varembé PO Box 56 1211 Genève 20 Switzerland Tel. +41-22 749 0111 Fax +41-22 733 3430

# International Social Security Association (ISSA)

4, route des Morillons 1211 Genève 22 Switzerland Tel. +41-22 799 6617 Fax +41-22 799 8509

# Israel Institute for Occupational Safety and Hygiene

22 Maze Street PO Box 1122 Tel-Aviv 61010 Israel Tel. +972-3 629 7314 Fax +972-3 525 2448

# National Fire Protection Association International

1 Batterymarch Park PO Box 9101 Quincy, MA 02269-9101 United States Tel. +1-617 770 3000 Fax +1-617 770 0700

# National Institute for Occupational Safety and Health (NIOSH)

Hubert H. Humphrey Building 200 Independence Avenue SW Washington DC 20201 United States Tel. +1-202 401 0721 Fax +1-202 260 4464

# National Institute for Working Life

Ekelundsvägen 16 S-171 84 Solna Sweden Tel. +46-8 730 9100 Fax +46-8 730 1967

# Nofer Institute of Occupational Medicine

8 Sw. Teresy Street PO Box 199 90-950 Lodz Poland Tel. +48-42 314 502 Fax +48-42 568 331

# Occupational Safety and Health Administration

US Department of Labor National Office 200 Constitution Avenue NW Washington DC 20010 United States Tel. +1-215 596 1201 Fax +1-215 596 4872

# Schweizerische Unfallversicherungs-Anstalt (SUVA)

Swiss Occupational Accident Insurance PO Box 4358 6002 Luzern Switzerland Tel. +41-41 419 5111 Fax +41-41 419 6170

# Scientific Research Institute of Occupational Health

Russian Academy of Medical Sciences (RAMS) 31, Prospekt Budennogo 105275 Moscow Russian Federation Tel. +7-095 365 0209 Fax +7-095 366 0583

# Sheffield Occupational Health Project

Mudford's Buildings 37 Exchange Street Sheffield S2 5TR United Kingdom Tel. +44-114 275 5760 Fax +44-114 249 1883

# **Työterveyslaitos**

Institute of Occupational Health Topeliuksenkatu 41 a A FIN-00250 Helsinki Finland Tel. +358-9 4747 383 Fax +358-9 4747 490

# United Automobile, Aerospace and Agricultural Implement Workers of America (UAW)

8000 East Jefferson Avenue Detroit, MI 48214 United States Tel. +1-313 926 5563 Fax +1-313 824 4473

# United Food and Commercial Workers

1775 K Street NW Washington DC 20006-1598 United States Tel. +1-202 223 3111 Fax +1-202 4661562

# University of Alberta

Faculty of Medicine and Oral Health Sciences Department of Public Health Sciences 13-103 Clinical Sciences Building Edmonton, Alberta T6G 2G3 Canada Tel. +1-403 492 6013 Fax +1-403 492 0364

#### World Health Organization (WHO)

20, avenue Appia 1211 Genève 27 Switzerland Tel. +41-22 791 2111 Fax +41-22 791 3111