four-year project is 1) to develop a validated predictive model for estimating dermal exposure for use in generic risk assessment for chemicals; and 2) develop a practical dermal exposure risk assessment and management toolkit for use by small and medium-size enterprises and others in actual workplace situations.

The work has been divided in four major parts: 1) a qualitative survey of processes, tasks, populations, and determinants of dermal exposure throughout Europe; 2) a quantitative survey of dermal exposure in selected situations with appropriate methodology; 3) development of a (set of) dermal exposure model(s) validated with biological monitoring with well-chosen compounds and tasks; and 4) development of a risk assessment and management toolkit.

The results will be of great help to industry and competent authorities, as well as to occupational hygienists in the field.

266

DEVELOPMENT OF A CHECKLIST TO EVALUATE DERMAL EXPOSURE TO CHEMICAL AGENTS. B. van Wendel de Joode, TNO Nutrition and Food Research Institute/Wageningen University, Zeist/Wageningen, Netherlands; H. Kromhout, R. Vermeulen, D. Heederik, Wageningen University, Wageningen, Netherlands; D. Brouwer, TNO Nutrition and Food Research Institute, Zeist, Netherlands; J. van Hemmen, TNO Nutrition and Food Institute, Zeist, Netherlands

Prior to estimating dermal exposure quantitatively it is useful to assess dermal exposure qualitatively. This should be done using a systematic approach. Unlike respiratory exposure to airborne contaminants, standardized protocols to assess dermal exposure are nonexistent.

The aim of this study is to develop a checklist to qualitatively assess dermal exposure to chemical agents. The checklist is based on a conceptual model for dermal exposure recently developed within the European Dermal Exposure Network (DEN). This model focuses on the exposure pathways, describing the transport of contaminant mass from the source to the surface of the skin. The checklist identifies exposure routes and assesses the exposure intensity by means of systematic task observations. Also, attention is paid to possible exposure determinants such as agent-specific characteristics, contact frequency, protective clothing, and personal hygiene.

The output of this checklist is a judgment on whether or not dermal exposure to a certain chemical is present and results in a relative ranking of exposed jobs/tasks. Consequently, the checklist helps to determine the most adequate measurement methods and strategies, and it forms, if deemed necessary, a starting point for exposure-reducing measures.

Currently, the reproducibility of the checklist is investigated in different industries comprising several tasks and exposure circumstances. We expect the checklist to be a useful and reliable instrument for the qualitative evaluation of dermal exposure.

267

A CRITIQUE OF GLOVE SELECTION ASSUMPTIONS. T. Klingner, Colormetric Laboratories, Inc., Des Plaines, IL

The use of chemical-resistant gloves and clothing is the primary method employed to prevent skin exposure to toxic chemicals in the workplace. The glove selection decision process is normally based on manufacturers' chemical permeation data. Many factors, such as temperature, flexing, pressure, and product variation between suppliers, question the reliance on this process. Passive dermal monitoring is recommended to evaluate glove performance during "actual use" conditions and can bridge the gap between laboratory data and real-world performance.

268

METHODS FOR ASSESSING THE RISK, AND FOR DEVELOPING NUMERICAL GUIDELINES FOR EVALUATING DERMAL EXPOSURE TO SURFACE CONTAMINANTS. J. Paull, U.S. Environmental Protection Agency/Region 9, San Francisco, CA

It is generally acknowledged that percutaneous absorption can contribute significantly to total absorbed dose in many workplace situations, and that for some substances it can play the determining role in worker exposure. However, present methods for assessing dermal exposure lag far behind those available for assessing airborne exposures and inhalation risk. As a result, there are few numerical standards or guidelines for evaluating dermal exposure to surface contaminants in the workplace.

The purpose of this research was to construct a dermal exposure model, having relatively modest data requirements, which relates absorbed dose to surface contaminant concentrations. The exposure model permits the estimation of health risk resulting from skin exposure to any surface contaminant for which certain basic toxicological parameters are known or, conversely, may be used to derive acceptable concentrations for surface contaminants by limiting absorption through the dermal and ingestion routes to specified doses.

A comprehensive literature review was conducted to support the use of the exposure model with default input parameters (e.g., surface area contact rate, transfer efficiency from dermal-to-oral route, transfer efficiency from surface-to-skin) that represent reasonable maximum exposure values. Acceptable toxicologically derived absorbed doses, together with the other exposure inputs for the model, were then used to develop numerical criteria for evaluating surface concentrations, as represented by conventional wipe samples. The resultant numerical criteria, referred to as risk-based screening levels (RBSLs), were developed for a set of 21 representative substances, including 12 inorganics and metals, and nine organics and pesticides.

Experimental data from a human volunteer study involving dermal exposure to the pesticide chlorpyrifos were used to validate the model, and the results of a Monte Carlo analysis demonstrated that the degree of uncertainty associated with the estimated RBSL values was acceptable for risk assessment purposes and could be further reduced using site-specific data.

269

USE OF AN OBJECTIVE MATHEMATICAL APPROACH TO FACILITATE ASSIGNING SKIN NOTATIONS. M. Boeniger, H. Ahlers, B. Lushniak, R. Mickelsen, A. Morton, C. Reh, NIOSH, Cincinnati, OH; D. Schwerha, G. Qiao, NIOSH, Morgantown, WV

Past procedures for recommending skin notations (SNs) have been criticized for being inconsistent, subjective, and poorly documented. At this time, recommending a SN relies on empirical data, the quality and relevancy of which may be highly variable.

To overcome these limitations, a mathematical approach may be used which requires readily available or obtainable physical data such as molecular weight and solubility. Data from the modified "Robinson model" were compared with the calculated systemic dose received by inhalation at the occupational exposure limit (OEL), assuming 75% retention and absorption.

The need for a skin notation was conservatively calculated for a skin exposure dose assuming a skin area of 360 cm2 (contact surface of both palms plus fingers) exposed for eight hours. If the ratio of dermal to inhalation dose was equal to or greater than 1, the need for a SN was suggested.

The OEL SN assignments by ACGIH, NIOSH, ECETOC, and several European nations were compared to the model predictions. Although the great majority of results using this model agreed with internationally assigned SNs, some discrepancies were identified. For instance, it is estimated that the dermal-to-inhalation dose ratio for benzene (at the ACGIH TLV®) is 49:1, yet there is no assignment of a skin notation to benzene by HSE or NIOSH.

On the other hand, the model predicted no need for a skin notation for 1,3-dichloropropene (ratio 0.47:1) although ACGIH, ECETOC, and NIOSH recommend a SN assignment for 1,3-dichloropropene, which ostensibly is based on a single animal LD50 experiment.

In conclusion, this mathematical approach may facilitate assignment of skin notations, particularly when adequate empirical data do not exist. Although predictive approaches to assigning skin notations might have current limitations, model refinement can be improved as access to toxicological data continues.

270

IN-USE TESTING AND INTERPRETATION OF PERFORMANCE OF CHEMICAL-RESISTANT GLOVES. T. Klingner, Colormetric Laboratories, Inc., Des Plaines, IL

Choosing glove materials for duration of wear is typically decided after comparing laboratory testing data; often verification of this choice is not performed by testing the glove during actual use. Methods are available to assess the extent of in-use permeation, but the implementation of such testing us unlikely to advance without guidelines of acceptable quantities of permeation for comparison.

This paper reviews methods for in-use testing of glove performance and suggests ways to generate skin exposure guidance limit values that are health-based. Approaches are suggested to estimate guidance values for chemicals that are systemically absorbed as well as for chemicals that are irritants and sensitizers and directly affect the skin. Using available data sources, guidance values could be generated for most of the occupationally significant compounds.

271

FACTORS AFFECTING THE EXTENT OF DERMAL ABSORPTION OF VAPOURS. K. Jones, L. Dodd, Health & Safety Laboratory, Sheffield, United Kingdom

We previously reported that solvent vapors can be absorbed through the skin. The extent varies markedly and depends on the chemical. For some chemicals, the extent of absorption is significant (e.g., for 1-methoxy-2-propanol, dermal absorption accounts for up to 14% of the total absorbed dose). We have conducted a second study using 2-butoxyethanol to investigate the influence of environmental parameters (e.g., temperature, humidity, clothing) on the dermal absorption of vapors. As for the first study, the extent of dermal absorption was determined by biological monitoring to measure the resultant body burden of the chemical.

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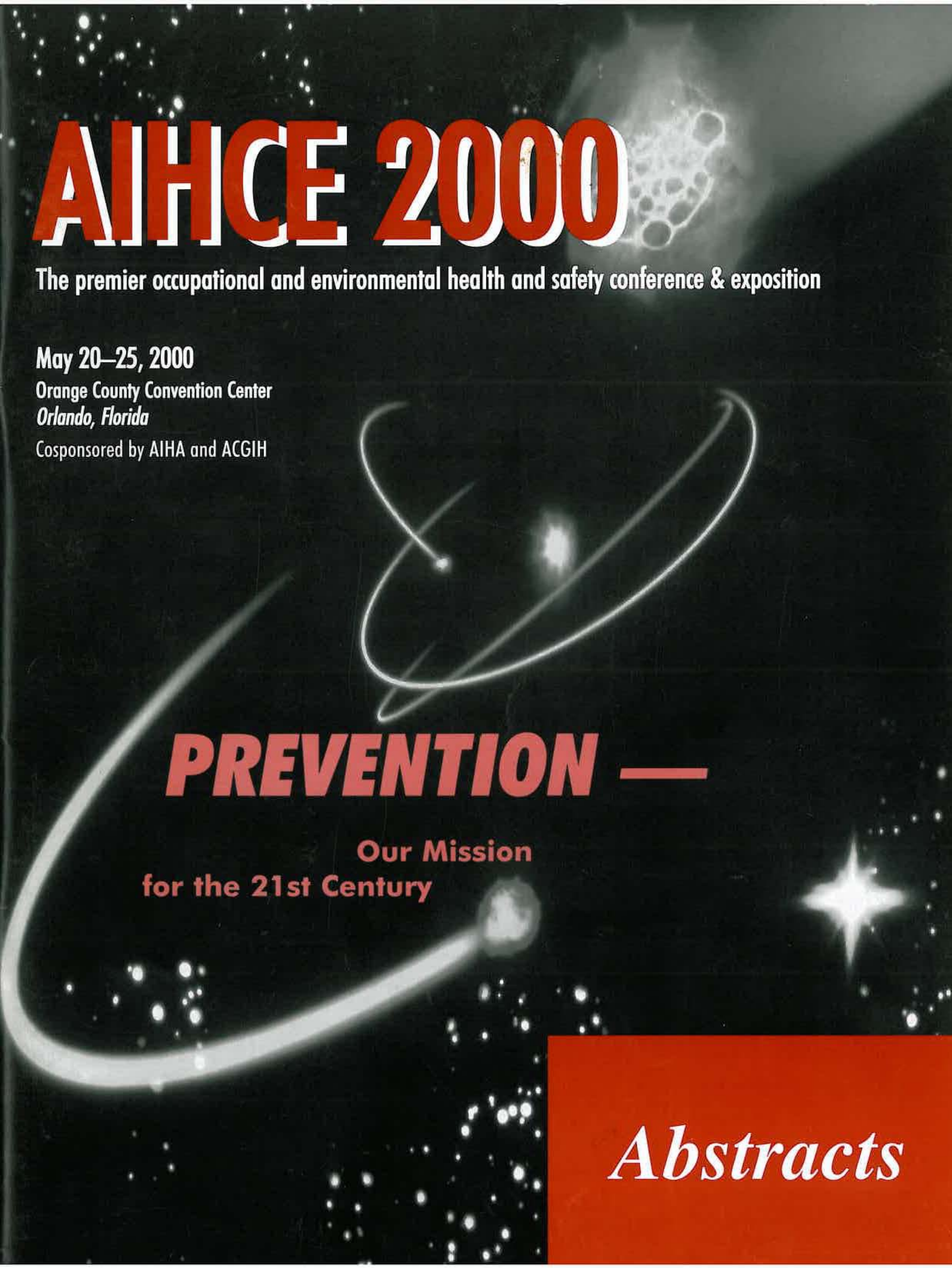

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