

AMERICAN CHEMICAL SOCIETY DIVISION OF CHEMICAL HEALTH AND SAFETY

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L.J. Doemeny, Chairman
D.B. Walters, Secretary

● MONDAY MORNING AND AFTERNOON - SYMPOSIUM ON THE LITERATURE OF LAB SAFETY AND HEALTH - M.E. GREEN, Presiding

1. HEALTH AND SAFETY LITERATURE -- WHO REALLY CARES? Howard B. Foxcroft, Foxcroft Consultations, 12920 Matey Road, Wheaton, MD 20906

Health and safety literature will be reviewed with respect to three types of users:

1. the prophylactic user -- who wonders how accidents and health risks may be controlled or prevented before the facts;
2. the postmortem user -- who wants to know what happened after the facts;
3. the optimistic user -- who, in spite of numerous "horror stories" still believes chemical and other materials can be synthesized, handled, transported, reacted, and disposed of safely, for the benefit of mankind.

The above review will be seen in the context of "cost-effective" or "benefit-risk" analyses, dictated by the current economic considerations.

2. WHAT SHOULD A LAB SAFETY BOOK ACCOMPLISH? A. Weatherish & P. Research Center Sunbury on Thames Middlesex Tel6 7LM England

Chemical safety books need three attributes to be of real use to chemists and their managers. First, they must persuade all levels of management and laboratory workers that sound safety practices are an essential and integral part of effective technical operations. Second, they must provide well-presented information relevant to the wide range of chemicals and experimental techniques now encountered in the laboratory.

Third, they must provide references to further sources of more detailed information necessary to develop this general attitude into a higher level of understanding wherever possible.

User response to previous editions has played a part in shaping the new third edition of the Royal Society of Chemistry's HANDBOOK IN THE CHEMICAL LABORATORY, and the author looks forward to suggestions for further improvements.

3. PRUDENT PRACTICES FOR HANDLING HAZARDOUS CHEMICALS IN LABORATORIES. Elaine C. McRae, Beckell Laboratory for Toxicology and Industrial Medicine, Du Pont Co., Wilmington, DE 19898.

A National Research Council (NRC) Committee recently issued a report of the above title. The report was prepared in response to chemists' concern about long-term toxicities of many chemicals used in research laboratories. It provides guidelines for safe handling and disposal of hazardous chemicals in laboratories. It discusses the full range of chemical hazards, including risks from fire, explosion, acute toxicity, and chronic toxicity (e.g., carcinogenicity).

MONS 002279

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No facilities or procedures can make chemical operations totally free of hazards. However, the laboratory can be a safe place to work if there is institutional determination to have a strong safety program; active participation in it by the whole staff; good ventilation, including an ample supply of well-designed hoods; appropriate protective clothing; and storage, handling, and disposal of all chemicals in ways that recognize that every chemical can be toxic under some circumstances. The report's guidelines are a practical alternative to detailed regulations on individual chemicals.

4. PROBLEMS IN ACQUIRING AND INTEGRATING CHEMICAL SAFETY AND HEALTH INFORMATION FOR HANDBOOK OF LABORATORY SAFETY AND OTHER REFERENCES. Morgan V. Steers, Morgan V. Steers & Associates, Inc., 140 Melbourne Ave. SE, Minneapolis, MN 55419

Developing useful and readily usable tables of chemical hazard information presents two challenging problems: how to acquire hazard information that is useful and how to present the information in a format that is easy to use.

Laboratory scientists as well as chemical manufacturers have acquired data about the health and safety hazards of chemicals, but the data is frequently not available in the open literature. Laboratory chemical exposures, spills, splashes, unexpected reactions, fires and explosions are seldom reported, and manufacturers are not able or willing to publish all the hazard data they have.

Presenting chemical health and safety information in convenient tables involves selection of pertinent data and integration of the data in a logical format. The Tables of Chemical Hazard Information in the Handbook of Laboratory Safety represent one step in an ongoing effort to present chemical health and safety information on many chemicals commonly used in laboratories.

Future tables should add information on toxicity, shelf life, management of spills, and waste disposal methods that are both practicable and acceptable.

5. A TEXTBOOK FOR TEACHING CHEMICAL SAFETY. AMES DUNE Dept of Chemistry The City College-CUNY N.Y., N.Y. 10031

Despite the increasing awareness that chemical laboratory workers, including students, are subject to various environmental risks, safety instruction continues to be a haphazard activity. Often it is limited to the first indoctrination hour of the first laboratory period, when the student is only dimly aware of the content of the course. Furthermore, the usual emphasis is on immediate dangers, such as fire, while the hazards of chronic exposure are relegated, implicitly, to a secondary role.

Broader and more intensive instruction in safe chemical practice can best be given in a separate course. At the City College, we offer a one semester, one credit course that uses the text by Green and Park (Safety in Working with Chemicals, Macmillan, N.Y. 1978) and instruction by a faculty member and guest speakers. The same text is recommended as a supplement to other laboratory courses.

A short book of this sort, that is neither superficial nor encyclopedic, can offer far more than sets of safety rules. Its aim is to teach the subject of chemical safety in a way that will provide understanding of the fundamental concepts of safe practice.

6. CHEMICAL SAFETY LITERATURE: INTRODUCTION TO DISCUSSION. Michael E. Green, City University of New York, City College, New York, N.Y. 10031

Chemical safety literature has recently expanded greatly, with a number of new books appearing. Some of these are reviewed during this symposium. It is worth considering the reasons for the rise in interest in chemical safety which lie behind this increase in literature, as well as the possibilities of implementing some of the recommendations. Suggestions on the latter point, as well as some speculations on the

former, will be welcomed during the discussion. Points of similarities in approach, as well as differences, will be considered also, along with the reasons for these similarities and differences.

7. PANEL DISCUSSION OF CHEMICAL SAFETY LITERATURE (no authors)

Participants in this symposium and persons attending this symposium will discuss both those books written by the authors who have presented papers and the literature of Laboratory Safety in general. Points that might be discussed include: Which books are better for certain groups of readers, what should a laboratory safety book accomplish, should a safety book set a minimum or an ideal, what experience have the attendees had with using these books?

All interested persons registered at the Meeting are welcome to participate in the discussion. Prepared comments, up to ten minutes in length, may be presented at this session by arrangement with the symposium chairman during the morning session.

● TUESDAY MORNING - SECTION A - SYMPOSIUM ON FUNDAMENTAL PRINCIPLES OF INDUSTRIAL HYGIENE AND ANALYTICS - J.C. POSNER, Presiding

8. DESORPTION OF ORGANIC ANALYTES FROM ACTIVATED CARBON-PROBLEMS AND SOLUTIONS.
Judd C. Posner, Ph.D. National Institute for Occupational Safety and Health, 4676
 Columbia Parkway, Cincinnati, Ohio 45226.

The vast majority of industrial hygiene samples for organic vapor analysis are performed by collecting an air sample on activated charcoal, desorbing with CH_2 , and subsequently analyzing by G.C. Inherent in this methodology is the assumption that all analytes collected behave independently of one another. Early work supported this hypothesis, but later studies have cast some doubt on this premise. This presentation will concern itself with the demonstration of the effects of loading, desorption volume at constant weight of sorbent, and the presence or absence of other adsorbed species, on desorption efficiency. Suggestions are also made as to methods for dealing with these factors. Specifically methods are suggested for linearizing the loading-desorption efficiency relationship, for increasing desorption efficiency by varying desorption parameters and for eliminating the problem of the dependence of desorption efficiency for certain classes of compounds on the presence or absence of coadsorbed species.

9. STRATEGIES FOR EVALUATING AIRBORNE EXPOSURES TO ACUTELY-TOXIC CHEMICALS. E.M. Rapaport and R.C. Spear. Dept. of Biomedical and Environmental Health Sciences, School of Public Health, University of California, Berkeley, CA 94720.

Short-term occupational exposures to chemicals vary considerably in magnitude over time. It is important that this short-term variability be considered in establishing strategic criteria which define an acceptable (or unacceptable) situation when the chemical is acutely toxic. The argument is developed that the traditional strategy of an absolute ceiling limit is unworkable since any environment can be declared unacceptable if a sufficiently large number of samples is collected. It is proposed that acute-exposure limits be defined instead as air concentrations that can be exceeded by an explicit fraction of the population of exposures. An "exceedance" rate of 5% is recommended provided that exposure limits incorporate appropriate safety factors which are relatively large for potent acute toxins and are small for irritants. The implications of this strategy are analyzed with some existing ceiling limits proposed by NIOSH.

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10. MONITORING EMPLOYER EXPOSURE TO LOW VAPOR PRESSURE ORGANICS: SAMPLING AND ANALYTICAL METHODS. C. C. Andersen. SRI International, 333 Ravenswood Avenue, Menlo Park, California 94025

The collection and preservation of samples of low vapor pressure organic materials is a difficult problem for industrial hygiene sampling. Materials normally assumed to exist as aerosol in the workroom may actually have a significant vapor contribution to the total employee exposure. Unless precautions are taken to collect both aerosol and vapor, the measurements may be low. If samples are collected on a filter, vapor losses to the cassette walls may occur after sampling. For sampling method evaluation, an assumption is made as to whether the material will be collected as a vapor or an aerosol, or whether both phases will be measured. This is based either on published vapor pressure data, or on experimental determinations of whether aerosol is present. We have studied a number of sampling and analytical methods for low vapor pressure organics. This paper will discuss the techniques for developing and evaluating methods of this type, and the problems of extending results of laboratory testing to field samples.

11. ON THE COMPLEXITIES OF OBTAINING REPRESENTATIVE AEROSOL SAMPLES. C. J. Fairchild. Los Alamos National Laboratory, Industrial Hygiene Group, MS 494, Los Alamos, NM 87545

Particulate air samples are often collected under anisokinetic sampling conditions or in crosswinds. Moreover, sampling probes or air filter inlets are often designed with little consideration of the conditions of sampling. For particles less than 3 μ m aerodynamic diameter representative samples may be obtained with normal care; however, as particle size increases careful design of the sampling system becomes necessary. The important system parameters in most aerosol sampling are angle of aerosol approach, sampling and aerosol stream velocities, Stokes number of the particles, and the wall deposition in the sampler.

The theoretical aspects of aerosol sampling, including recent work by Davies, Bellamy and Levin, and Rajendran, will be reviewed and related to experimental results from several investigators, as well as to recent experiments at the Los Alamos National Laboratory concerning the sampling efficiencies and wall deposition losses of several air sampling filter cassettes. The latter tests were performed in a unique chamber in which the samplers were moved through an aerosol to generate a relative wind. Sampling results, when corrected for wall deposition, agreed with recent theories of air sampling. This work also shows that, although not amenable to theoretical analysis wall deposition losses may be empirically predicted for a particular sampling system.

12. SYNTHESIS AND EVALUATION OF NEW POLYMERIC SORBENTS FOR COLLECTION AND ANALYSIS OF VAPOR-PHASE ORGANICS IN AMBIENT AIR. E. D. Pellizzari, S. Demissu and A. Schindler. Analytical and Physical Sciences Divisions, Research Triangle Institute, P. O. Box 12194, Research Triangle Park, NC 27709.

Commercially available polymeric sorbents are limited as collection media for vapor-phase organics in ambient air. Thus, a synthesis and testing program has been initiated to develop better sorbents, and more than 100 polyimide polymeric sorbents have been synthesized. Polyimide polymers have been evaluated using a battery of test procedures; the selection of ultimately the best for application to air pollution problems. In a parallel fashion, the new polymers are characterized using a testing procedure which yields information about the physical and thermodynamic properties of solute-sorbent interactions and this information will be used to predict the "best" chemical polymeric structure for the collection and analysis of organics in air.

The testing procedure has four levels. Level I (screening) is devised to sort the polymers according to specific desired properties. Level II (testing) selects the most promising polymers for trapping organics and generates the chemical data base for the rationale and polymer structure property correlations. Level III (detailed testing) provides data on physico-chemical properties of the sorbent. Level IV (supplemental testing) provides additional data on the physical chemical properties of solute-sorbent interactions.

The synthesis and testing procedures will be discussed and examples given. This research was supported by EPA Contract No. 68-02-3440.

MONS 002282

13. FURTHER CHARACTERIZATION OF SORBENTS FOR ENVIRONMENTAL SAMPLING
K. R. Madsen, J. F. Piecowicz, J. C. Harris, and P. L. Levins.
Arthur D. Little, Acorn Park, Cambridge MA 02140

This paper gives results of an ongoing experimental program to evaluate the breakthrough characteristics of sorbent resins for sampling of organic vapors using an elution analysis chromatographic technique. Potential interferences likely to exist in typical industrial workplaces were evaluated. The effect of water vapor at relative humidities of 75-82% on retention of polar and nonpolar species on two commonly used sorbents (XAD-2 and Tenax-GC) has been studied. To achieve an assessment of possible competitive effects on adsorption, mixtures of analytes were tested for possible decrease in breakthrough volumes. Effects on XAD-2 were small, but the volumetric capacity of Tenax-GC was substantially decreased. Other sorbents were characterized for potential use in vapor sampling: coconut based charcoal, petroleum based charcoal, silica gel, Ambersorb XE-340, XE-347, and XAD-8. Retention volumes for XAD-8 and silica gel were roughly comparable to those of XAD-2 and Tenax-GC; those of the charcoals and the Ambersorbs were 2 to 4 orders of magnitude higher. Recovery of sorbate from charcoals is known to be poor in some cases, however, and recovery from the Ambersorbs is suspect but under investigation.

14. FLOW RATE DEPENDENCE STUDIES OF SORBATE RETENTION AND BREAKTHROUGH VOLUMES ON POROUS POLYMERS BY GAS CHROMATOGRAPHY. J. W. King, CPC International, Summit-Argo, IL 60501, P. L. Levins and J. F. Piecowicz, Arthur D. Little, Inc., Acorn Park, Cambridge, MA. 02140.

Elution gas chromatographic data has proven of value in ascertaining the breakthrough and capacity characteristics of sorbent media utilized in environmental and work-place sampling methodology. Retention volume data obtained by the elution GC method are frequently determined at carrier gas flow rates under 100 ml/min, a flow rate considerably different from that specified in many NIOSH and EPA sampling procedures. The results presented in this paper will show that the peak maxima specific retention volume, V_R , and hence the breakthrough volume for sorbates, are flow rate dependent and that considerable error may be introduced into sampling methods based on GC-derived elution and breakthrough curves. Retention volume data obtained at flow rates up to one liter per minute for selected solutes on Tenax and XAD-2 will be presented. A gradual decrease in V_R is observed for all the sorbates eluting on XAD-2, up to flow rates of 400 ml/min. An additional loss in retention volume (up to 20% of the original V_R) is noted upon increasing the flow rate to 600 ml/min, before V_R approaches a limiting value. Retention volumes for the same solutes show a linear increase with increasing flow rate on Tenax-GC a trend similar to reported results on Poropak supports. The effect of sorbent surface area and pore volume, as well as sorbate type and adsorption coefficient on the results will be discussed. A correlation will be made between the results presented in this paper and similar flow rate effects observed in gas-solid chromatography and diffusional resistance studies in GC polymer thermodynamics research.

16. A RETROSPECTIVE LOOK AT THE NIOSH STANDARDS COMPLETION PROGRAM. Dale M. Coulson, Ellen C. Sunderson, and C. Clarine Anderson. SRI International, 333 Ravenswood Avenue, Menlo Park, California 94025.

A five-year experimental study of sampling and analytical methods for toxic substances in workplace environments under NIOSH sponsorship is summarized. Approximately 400 substances, including gases, liquids and solids, were studied. Stabilities of collected samples ranged from very stable to so unstable that derivatization was required during sampling. The common types of samples used for personal exposures in workplace environments are discussed. Special problems with individual substances and with classes of compounds are discussed. The design and operation of systems for dynamic generation of test atmospheres required at least as much research as the actual sampling and analytical methods. The general protocol for development of validated procedures is discussed.

● TUESDAY MORNING - SECTION B - SYMPOSIUM ON CHEMICAL EXPOSURES IN SMALL SCALE INDUSTRIES: SMALL IS DANGEROUS - S.A. BERGER, Presiding

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16. TOXICITY OF CHEMICALS USED IN THE JEWELRY AND WATCHMAKING INDUSTRIES. Solman A. Burger, City University of New York, John Jay College of Criminal Justice, 445 West 59 Street, New York, N.Y. 10019.

The retail business of merchandising jewelry and watches is often accompanied by their repair and servicing. In jewelry repairing and manufacturing, a wide variety of chemicals are used in the processes of cleaning, plating and polishing. These include acids, plating baths of different metals, abrasives and other polishing materials. In watch restoration, several organic solvents are used in watch cleaning such as ammoniated and low boiling organic distillates, benzene, carbon tetrachloride, as well as cyanide.

The particular solvents and chemicals will be examined from the prospective of their use and degree of toxicity. The results of a survey will be discussed, relating years of exposure of the workers to these chemicals and any possible adverse health effects that they may have experienced.

17. HEALTH HAZARDS IN THE ARTS AND CRAFTS. M. McCann and M. Rossel. Center for Occupational Hazards, 5 Beekman Street, New York, New York 10038.

Professional artists and craftspeople, art teachers and students, hobbyists and often even children are working with toxic arts and crafts materials without proper precautions, and often without even the knowledge that their art materials are hazardous. Examples of commonly used arts and crafts materials containing toxic chemicals include paint removers, lacquer thinners, printing inks, silica-containing clays and stones, lead glasses and enamels, dyes and pigments, asbestos and asbestos-contaminated talcs, cadmium-containing silver solders, uranium oxide, etc. The hazard is compounded by the fact that most artists work in the home, thus potentially exposing other family members, especially children. Evidence for potentially harmful exposures and for health effects comes from many case histories, epidemiological studies and industrial hygiene studies.

18. Chemical Composition of Products used in the Auto Repair Industry. M. Farstad and R.R. Bobal. Environmental Cancer Information Center, Environmental Sciences Laboratory, Mt. Sinai School of Medicine, New York, New York 10029

Auto repair and auto body shops are, usually, relatively small businesses, in which a large number of chemical products are used. The Environmental Cancer Information Center conducted a study of over 200 chemical products used in auto repair and auto body shops, in order to determine possible health hazards associated with use of the products. Products were classified as solvents, auto body fillers, undercoats/body shields, and miscellaneous. We wrote to manufacturers and distributors of the products to obtain information on product composition. In addition, Dr. Arthur Bobal of the Laboratory staff analyzed auto body fillers for mineral content. Our report discusses the composition of auto repair/body products and the difficulties we encountered in obtaining product composition information.

19. CHEMICAL EXPOSURE IN GENERAL DENTISTRY AND IN THE PROSTHETICS LABORATORY. Charles W. Teger 3930 Richmond Avenue, Staten Island, N.Y. 10312

An examination of the typical dental office reveals that there is a large number of potentially toxic chemicals that the practitioner, staff and patients are exposed to on a daily basis. These substances include mercury, phenol, nitrous oxide, sodium hypochlorite and eupra-oxyl. In the prosthetics laboratory, the chance for exposure to chemical toxins is even greater due to the use of: strong acids, potassium cyanide, chloroform, asbestos, carbon tetrachloride, beryllium, ether and kerosene.

The uses of these substances will be evaluated as to their role in the practice of dentistry. Procedures will be discussed as a means of reducing the exposure of personnel to these chemicals. Relevant case studies will also be cited.

20. SPECIAL RISKS OF MARGINAL WORKERS. A. Saliker, Dept of Biochemistry, Albert Einstein College of Medicine Bronx, N Y 10461

Trade unions are important in decreasing work related health hazards. The main beneficiaries of health related labor legislation have been workers in large plants, because labor and health officials deal with hazards involving a lot of workers at one site. Millions of workers employed in a large number of small industrial concerns are exposed to hazards that would not be tolerated in the large well-organized industrial establishments. These hazards are tolerated because these workers are not organized or are not as articulate as other groups. Small companies have become sanctuaries for dangerous chemical and physical processes that large firms "farm out". Enforcement of health and even wage codes is not pursued in some small industry (benign neglect). The public believes that enforcement would force the small employer to close. The workers believe that a dangerous job is better than no job at all. Because industrial intoxication leads to chronic disease, these workers often do not benefit from worker's compensation. The social bureaucracy and management belittle the job related hazards. Protection of the health of this segment of society is an important social and economic goal. It can be done without harm to small business, if trade associations, government, and trade unions contribute to the economic support of health practices in small plants.

● TUESDAY AFTERNOON - SECTION A - SYMPOSIUM ON CHEMICAL HAZARD CONTROL PROGRAMS: RESOURCES AND INFORMATION - D.J. WARSICK, Presiding

21. THE BIOCHEMISTRY PROGRAM OF THE CENTER FOR ENVIRONMENTAL HEALTH, CENTERS FOR DISEASE CONTROL. David D. Hayes, Ph.D., Director, Clinical Chemistry Division, Center for Environmental Health, Centers for Disease Control, Atlanta, GA 30333.

A recent reorganization of the Centers for Disease Control (CDC) created a new Center for Environmental Health (CEH), with a mandate to "plan, direct and coordinate a national program to prevent or control environmentally related health problems occurring outside the workplace." (The National Institute of Occupational Safety and Health is a CDC center concerned with occupational health.) The CEH administers federally supported programs, conducts epidemiologic studies of risks to toxic exposure, closely supports state and local efforts in detecting and controlling toxic chemical outbreaks and environmental hazards to human health, and develops and applies epidemiologic and technologic resources to these problems. The Center's central role in epidemiologic investigations and administration and/or consultative assistance to national, state, and local preventive health programs is closely supported by a large laboratory component in human biochemistry, toxicology, and genetics. Programs in environmental and diagnostic chemistry concentrate on the development and validation of analytical techniques, the improved standardization of reference materials, and specialized laboratory services for key national health surveillance, prevalence, and intervention studies. The role of the chemistry laboratory in environmental health is discussed.

22. REMARKS ON THE ASSIGNMENT OF REPORTABLE QUANTITIES UNDER "SUPERFUND"

John L. Brugger: OII & Hazardous Materials Spills Branch, MRL-61, U.S. Environmental Protection Agency, Woodbridge Ave., Edison, NJ 08837

Under Section 102 (Reportable Quantities and Additional Designations) of Public Law 96-510, Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA" or "Superfund"), the Administrator of the U.S. Environmental Protection Agency is authorized to designate materials as hazardous substances and to specify the amounts that qualify as "reportable quantities" when released into any medium (e.g., air, land, water). The definition of hazardous substances and some bases for determining reportable quantities will be discussed; however, no statements on Agency policy will be made.

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23. WASTE EXCHANGE: Concept and Reality. Roll P. Bill, Office of Solid Waste (MS 563), U.S. Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460

The topic "Waste Exchange: Concept and Reality" discusses the philosophy of the industrial resource recovery program and the actual implementation of the concept. Various case studies of operations are addressed and the different types of waste exchanges are discussed. The financial aspects of both the information exchange (or clearinghouse) and the material exchange are compared. The legal issues affecting waste exchanges are raised. A comparison of the recent EPA rules regarding hazardous waste management and the effect on waste exchanges is made.

24. COMPUTERIZATION OF MATERIALS INVENTORY FOR INDUSTRIAL HEALTH PURPOSES. V.G. Ciaraldi, Bausch & Lomb, 1400 N. Goodman St., Rochester, NY 14602.

Increased concern for occupational health hazards has created a need to know the chemical identities of materials used in the workplace. A computerized material inventory system has been created to identify priority toxicants which enables health and safety resources to be allocated where they are most needed.

25. ON-LINE ACCESS TO ALL CHEMICAL REGULATORY MATERIAL. D.R. Eakin and F. Corbin, CRC Systems Inc., 4020 Williamsburg Court, Fairfax, VA 22032

The Interagency Regulatory Liaison Group (IRLG) identified the need for a computerized data base to provide access to regulatory material by chemical substance. They therefore sponsored the development of the Chemical Regulations and Guidelines System (CRGS) to provide government and industry with automated access to all regulatory material - statutes, regulations, standards and guidelines - that pertain to the control of chemical substances. The development of such a data base is designed to cover Federal, state and finally international regulations incrementally. The first phase, the Federal segment, is now complete and will be made publicly available by a commercial on-line vendor later in 1981.

This paper discusses the need for such a data base in the area of health and safety; and discusses the design criteria used to determine its development. The needs of both government and industry were considered.

The documents covered by the data base will be discussed together with the approach taken to describing their content. The need for a standardized vocabulary, to describe both the chemicals and their regulation will be examined and the approaches taken in CRGS discussed. The complexities of substance identification within regulation and the different approaches taken by government agencies will be illustrated. Examples of the use of CRGS will be given.

26. INFORMATION EXCHANGE FOR CHEMICAL HEALTH AND SAFETY. D.J. Mersick, B. Drago and F. Corbin, OSHA/U.S. Dept. of Labor, 200 Constitution Ave., N.W., Washington, D.C. 20210; CPSC and U.S. E.P.A.

Information forms the pivot for all health and safety activity. It has a role in early warning about environmental hazards, in consultant support, and in cooperative public awareness ventures. As available resources become more limited, regulatory agencies must rely much more on information exchange and dissemination as tools with which to fulfill their primary mission, i.e., the protection of public health and safety. Information exchange, which includes interagency sharing of public information, interagency exchange of regulatory and inspection information, and interagency cooperation in new information handling techniques and systems, results in cost savings, increased regulator productivity, and easier public access to health and safety information. The results of interagency information sharing will be discussed in relation to positive public health benefits. Present avenues for serving the chemical community through interagency information efforts will be addressed. Future interagency plans, such as a chemical regulations data base, chemical information resource sharing, and cooperative public interchanges will also be presented.

MONS 002286

● TUESDAY AFTERNOON - SECTION B - SYMPOSIUM ON NEW CONTROLS FOR LABORATORY HAZARDS -
P.M. BOLLINGER, Presiding

27. RESEARCH LABORATORIES SAFETY - A PERSONAL PRIORITY. G. D. Heindel
Eastman Kodak Company, Rochester, New York 14650

A research environment presents unique problems compared to an ordinary industrial environment for anyone trying to design or implement a safety program because of the high degree of autonomy individual researchers demand and need. This talk comprises one company's approach. Because of their autonomy, researchers make independent decisions daily regarding materials and procedures used in a project--so the safety program must be decentralized. In addition, researchers need to understand reasons for specific safety directives, so the safety program must emphasize training and information. And finally, in order to evaluate the effectiveness of the program, various feedback mechanisms are essential. This talk describes some specific approaches used for training/information and feedback and hopes to stimulate exchanges between individuals with different backgrounds and experiences.

28. DESIGN OF A HAZARDOUS MATERIALS LABORATORY COMPLEX, PART II. James M. Harless
and Kenneth E. Baxter, Radian Corporation, 8501 MoPac Boulevard, Austin, Texas 78759.

Toxicological, biological and physical evidence is indicating that an increasing number of chemicals are highly hazardous to human health and to the environment. Commensurate with these discoveries is an increasing demand for laboratory facilities in which hazardous chemicals can be manipulated with a minimum risk of exposure for operating personnel and the environment. In April, 1979, Radian Corporation began operation of its first 1400 square foot Hazardous Materials Laboratory (HML). Since that time the facility has been expanded to a 5000 square foot complex containing both controlled and uncontrolled laboratories. The controlled facilities operate at negative pressure and provide isolated chemical handling rooms, custom-designed glove boxes, analytical instrumentation, office space, chemical storage at 25°C, 5°C, -20°C, and -70°C, vault storage for extremely hazardous materials, isolated waste storage, and airlocks for moving equipment and materials into and out of the facility. All effluents are treated to reduce the concentrations of chemicals to the lowest possible levels. All critical systems such as air handlers, refrigeration units, and lighting are constantly monitored and are provided with back-up systems in case of failure.

29. FOAM HANDLING TECHNIQUE FOR CONTAINERS OF HAZARDOUS MATERIALS. C. B. Schmitt.
EC Corporation, 575 Oak Ridge Turnpike, Suite 200, Oak Ridge, Tennessee 37830.

A technique has been developed for minimizing the danger to personnel involved in handling and disposal of residues of potentially hazardous laboratory materials, such as ethers which have autooxidized to form peroxide or potassium metal which has oxidized to form peroxide or superoxide. The method consists of placing a protective metal cylinder, open at both ends, around the container and then casting a low-temperature, porous elastomer foam in the annulus space between the cylinder and the container. The metal cylinder containing the elastomer-bonded container, can then subsequently be moved using remote techniques with less hazard to personnel involved. A specific incident using this foam handling and disposal technique is described where an old 1 kg. brown-glass bottle of isopropyl ether was found in which the ether had evaporated, leaving some visible white crystals at the bottom of the bottle and around the area of the top screw cap. Control measures to prevent the occurrence of future incidents involving such potentially hazardous chemicals are described and discussed.

30. HEALTH HAZARDS IN THE CHEMISTRY PROFESSION: A QUESTION OF AWARENESS
AND FACILITIES. G. Bohacs-Olin. Prof. M.D.-Preventive Occupational
Medical Unit, Dept. of Heat Technology, Royal Institute of Technology.

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Also Head of Occupational Health and Safety Dept., Astra, Inc.,
Gödertälje, SWEDEN

Long-term adverse effects of exposure to chemical substances among workers in the chemistry profession has been underestimated. This statement, if true, must be of concern to members of the chemistry profession as well as to those responsible for developing opinions and creating policy. The presentation will be subdivided into four parts:

Part I: latest results from on-going epidemiology study concerning mortality pattern among Swedish chemistry graduates. See previous paper (Environ. Res. 33, 154-161, 1980);

Part II: Recent Scandinavian observations concerning the possibility of reproductivity hazards for personnel working in environments contaminated; such as in hospitals, chemical laboratories and in industry;

Part III: Ventilation failures as a probable cause of harmful exposure will be presented by a film on transport of particles and gases made by Allander and Ljungqvist, Royal Institute of Technology;

Part IV: Preventive measures considered necessary to insure health safety will be summarised, including preventive strategy necessary to protect the fetus of the pregnant woman will be given special consideration.

31. A SAFER DIAZOTRANSFER REAGENT. George G. Hosen, Leonard M. Weinstein, Robert Connell and Frederick M. Bollinger, Merck Sharp & Dohme Research Laboratories, Division of Merck & Co., Inc., Rahway, N. J. 07065.

The explosive power and impact sensitivity of p-tolyl azide prompted a search for an equally effective but more stable diazotransfer reagent. Thermal properties of this reagent were compared with those of four possible substitutes. Of these, the isomeric mixture of p-dodecylbenzenesulfonyl azides was safest and best-suited for large scale operations. Its preparation and use are shown by illustrative experiments.

● WEDNESDAY MORNING - SYMPOSIUM ON EPIDEMIOLOGY: I - DATA ELEMENTS AND METHODOLOGY - S. KAPLAN, Presiding

32. EPIDEMIOLOGIC USE OF OCCUPATIONAL HEALTH RECORDS: DATA ELEMENTS, SYSTEM LINKAGE AND UTILIZATION. Frank Huxley, Ph.D., Biometric Research Institute, 1010 Wisconsin Ave., N.W., Suite 505, Washington, D. C. 20007

Data from occupational health records can be categorized as identifying, classifying, confounding, or outcome variables. Identifying variables are chosen based on uniqueness, permanence, ubiquity, availability, and indispensability. Classifying variables define groups of individuals according to their characteristics, so morbidity and mortality can be compared. In occupational epidemiology, exposure parameters are the most important classifying variables. Outcome variables can be various measures, such as cause of death, disease incidence, lung function measurements, and blood chemistries. Confounding variables are those related both to the outcome variables and classifying variables (e.g., older workers generally have longer exposure and poorer health than younger workers, so age is a confounding variable.). If there is significant confounding, adjustments in the design or analysis must be made to allow valid comparisons among the study groups. The nature of outcome variables dictates the site, design, and subsequent analysis of the study. These data categories are organized into three main modules -- personnel, medical, and industrial hygiene -- which are computer-linked to provide a comprehensive data base. Principles will be illustrated with on-going studies of workers exposed to PCB and to noise.

33. METHODOLOGY OF AN EPIDEMIOLOGIC STUDY IN THE CHEMICAL INDUSTRY, Flora Decouffle, University of Arizona, 1435 N. Fremont, Tucson, Arizona 85719

An epidemiologic study of cancer mortality among persons occupationally exposed to benzene (and other agents) is used to discuss methodological

issues involved in conducting a historical cohort study in the industrial setting. The study group consists of 262 persons who were employed at a single chemical plant anytime between 1947 and 1960. The cohort was followed through December 31, 1977 to observe mortality and specific causes of death. Methodological problems include selection of the plant and characterization of its different production processes over time as they impact on epidemiologic considerations as well as definition of study subjects. Other issues involve identification and retrieval of demographic and employment information for each subject from company records and the summarization of these data for analytic purposes. Procedures for tracing individuals who left employment before the close of the study using third party record systems are mentioned, along with ways in which unsuccessful efforts are handled in the analysis. Choice of a comparison group and classification of causes of death in study and comparison groups are considered. Limitations in the study such as sample size and the absence of quantitative data on individual benzene exposure levels are discussed.

34. EPIDEMIOLOGIC STUDIES OF OCCUPATIONAL CANCERS: APPROACHES AND DATA SOURCES. Oslo Munn, Sc.D., Biometric Research Institute, 1010 Wisconsin Ave., N.W., Suite 505, Washington, D.C. 20007.

As a practical tool, epidemiology has been successful in identifying etiologic agents or risk factors for chronic diseases such as cancer. All three major types of occupational studies -- historical prospective (cohort), proportional, and retrospective (case-control) are discussed with emphasis on cohort studies. The major steps of a cohort study include feasibility analysis, study design, data collection on site, data reduction, vital status follow-up, death certificate acquisition, cause-of-death coding, data update, statistical analysis, and interpretation. A feasibility analysis with respect to cohort identification, availability of data, and sample size is necessary before implementing an industry-wide or multi-plant study. The type of data needed and their sources from existing records are discussed. Procedures, relative costs, and efficiency of various vital status follow-up methods, such as local inquiry, search through files of the Social Security Administration and State motor vehicle bureaus, are presented, as well as the procedure of requesting death certificates. The common statistical techniques and risk assessment indices are explained. Data from studies on workers exposed to benzene, formaldehyde, methyl ethyl ketone, brominated chemicals, and nickel will be used to illustrate the points.

35. EPIDEMIOLOGICAL CONSIDERATIONS IN EVALUATING HEALTH SURVEILLANCE DATA. Ruth M. Magliaro, M.D., M.P.H., Environmental Health and Safety, Smith Kline Corp., 1600 Spring Garden St., P.O. Box 7929, Philadelphia, PA 19101

Epidemiological studies in industry traditionally examine occurrence of disease or death in relation to specific chemical, physical, or other potentially hazardous exposures. Similarly, epidemiological methods can be applied in examining health effects data collected as part of routine screening procedures designed to discover pre-disease states. Alterations in health screening data can often suggest a need for further examination of exposures and further follow-up of specific groups of workers. Careful selection of control, or comparison, populations of workers is essential in analyzing health surveillance data. In some cases, an ideal control group may not be available, and comparisons must be made, not between "exposed" and "non-exposed" groups, but between multiple groups of workers with different types of varying levels of exposure. Such groups can lend themselves to valid comparisons only if factors likely to influence the health effects being measured are controlled. However, emphasis should be on controlling only those factors, other than exposure, which can be expected to influence the outcome measure.

The current study examines how health screening data may be routinely analyzed in relation to exposures, utilizing information from health surveillance in a moderate-size pharmaceutical plant. A job coding scheme, developed to facilitate combining data for workers who share similar types of exposure, is described. Selected 1980 biochemical screening test results are examined in relation to the job classification scheme.

CHAS

- WEDNESDAY MORNING AND AFTERNOON - SYMPOSIUM ON CHEMICAL HEALTH AND SAFETY, ESPECIALLY IN THE ACADEMIC LABORATORY - ORGANIZED BY DIVISION OF CHEMICAL EDUCATION, INC., JOINT WITH DIVISION OF SMALL CHEMICAL BUSINESSES - ABSTRACTS IN SECTION CHED

- WEDNESDAY AFTERNOON - SYMPOSIUM ON EPIDEMIOLOGY: 2 - SPECIFIC STUDIES AND CONCLUSIONS - N.H. FAWCETT, Presiding

36. A Retrospective COHORT STUDY OF MORBIDITY AND MORTALITY AMONG CHEMISTS. Shelia K. Hoar, National Cancer Institute, Landow Building, Room 3C07, Bethesda, MD 20205.

This retrospective cohort study examines morbidity and mortality among 3686 men who were employed as chemists in 1959. During 1964-1977, the chemists experienced lower overall mortality than other salaried employees of the chemical company (198 observed, 241.0 expected, SMR=82). A large deficit is seen in lung cancer and arteriosclerotic heart disease deaths. The chemists appear to be at slightly higher risk for death from malignancies of the colon (12 observed, 6.7 expected, SMR=178) and cerebrovascular disease (15 observed, 10.8 expected, SMR=138). The low overall mortality resulted in a larger than expected proportion of deaths due to cancer. Fewer than expected cases were diagnosed of cancer of all sites combined (61 observed, 86.5 expected, SMR=77) and of the lung (8 observed, 20.0 expected, SMR=40). The incident of melanoma and cancer of the prostate is slightly higher than expected, relative to the Third National Cancer Survey and the nonchemists, respectively. All disabilities of eight days or more were also examined. Associations between cause of illness and department group are presented. Possible explanations for the lack of anticipated excess risks and for the observed deficits are discussed.

37. Accidental environmental contamination with 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Seveso, Italy. Epidemiologic strategy for evaluation of potential adverse effects in the human population. Ruth Lillo, M.D. and Irving J. Selvin, M.D., Environmental Sciences Laboratory, Mount Sinai Medical Center, New York, New York 10029

The manufacture of trichlorophenol (TCP) in a chemical plant in Seveso, Italy was based on the treatment of 1,2,4,5-tetrachlorobenzene with Na OH, and that of the resulting sodium trichlorophenolate with HCl, yielding TCP. An accident (uncontrolled exothermic process) occurred in July 1976, and resulted in the dissemination of the contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the environment. Adverse effects on vegetation and animal life were soon observed, followed by the development of chloracne predominantly in children and young adults. The multi-organ toxic effects of TCDD are known from previous such industrial accidents and from extensive experimental studies; the marked toxicity and the potential carcinogenic and teratogenic effects prompted special efforts for multifaceted clinical and laboratory investigations of the exposed population. Liver function, neurologic status, lipid metabolism, immunologic status, glucuric acid excretion (an indicator of mixed function oxidase system enzyme induction) have received special attention. Monitoring for congenital malformations, spontaneous abortions, mortality patterns (including Cancer Registry) was also undertaken and is in progress.

38. A CASE/CONTROL EPIDEMIOLOGIC STUDY ON THE RELATIONSHIP BETWEEN THE HERBICIDE 2,4-D AND SPONTANEOUS ABORTION. D. Carmelli, SRI International, 333 Ravenswood Ave., Menlo Park, CA 94025, and R.W. Morgan, Environmental Health Associates, Inc., 2150 Shattuck Ave., Berkeley, CA 94703.

The possible association of the herbicide 2,4-D with human spontaneous abortion was examined by means of a two-stage case-control study. In the first stage a base population in which approximately half of the males are exposed to 2,4-D in the course of their work was identified via a brief postal questionnaire sent out to members of agricultural associations and employees of various industries. From this population, a subsample of 134 cases defined as women reporting a miscarriage since 1/1/78 and 311 controls (most recent live birth) were selected for fur-

ther investigations through an extensive telephone interview addressed to both husband and wife. Exposure to the herbicide, at work and at home around conception date and over the whole study period were each tested for a possible increased risk of spontaneous abortions during the study time period. In the course of the investigations we controlled: age and education of husband and wife, conception month and source list (type of occupational exposure). The association to cigarette smoking and the use of legal and illegal drugs were considered. No association between spontaneous abortions and husband or wife exposure categories for the total sample was found, but increased risk was noted in the forest group.

39. LONG TERM STATUS OF WORKERS PREVIOUSLY EXPOSED TO 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN (TCDD) IN THE MANUFACTURE OF 2,4,5-T. Marion Mues, Ruth Lillie and Irving J. Selkoff. Environmental Sciences Laboratory, Mount Sinai Medical Center, New York, New York 10029

In 1949 workers at a Monsanto Chemical Company plant had chloracne and/or serious systemic illness related to exposure to 2,3,7,8-TCDD from a reactor accident where trichlorophenol was being made for 2,4,5-T production. Chloracne continued to be a problem at this plant as long as the herbicide was manufactured there, from 1948 to 1969. In 1979 a health survey of active and retired workers at this plant was conducted. Residual chloracne was found at the time of examination in 71 (31%) of the workers surveyed. An additional 45 (20%) had a history of chloracne in the past. In approximately 50% of the workers with current or past chloracne, the condition had persisted for more than 20 years. A relationship was found between chloracne and elevated triglycerides, as well as abnormalities in some liver function tests. Heavy exposure to 2,4,5-T was found to be associated with liver function abnormalities. Additional findings from the continuing analysis will also be presented.

● THURSDAY MORNING - SYMPOSIUM ON EPIDEMIOLOGY: 3 - METHODOLOGY - S. KAPLAN, Presiding

40. EPIDEMIOLOGY: BASIC CONCEPTS. Ralph B. Cook, M.D., Dow Chemical U.S.A., Director of Epidemiology, 1003 Building, Midland, Michigan 48640

Epidemiology is etiologic research. In the course of obtaining meaningful associations between chemicals and human disease, the epidemiologist must grapple with five basic concepts: selection, misclassification, confounding, chance, and causation. The validity of any particular study depends on how well the investigator has managed these issues. Improper selection of study subjects or controls, inconsistent classification of disease state or exposure, failure to adjust for other causes of disease, inappropriate or excessive reliance on statistical techniques, and ignorance of the epidemiologic rules of causation can have profound effects on risk estimates and the resultant interpretations. In the past, the errors inherent in this observational science were thought to produce underestimates of risk. This fallacy has even been incorporated into government policy. It is now known that overestimates also can commonly be generated. The five concepts and their influence on relative risks are discussed through a series of simple numerical examples. Emphasis is placed on nondifferential and differential misclassification.

41. EPIDEMIOLOGIC METHODS IN INDUSTRY: A COMPARISON. Robert W. Muesen, M.D., 2150 Shattuck Ave., Suite 414, Berkeley, CA 94704

The measurement of health, and health effects due to employment or environmental exposure offers considerable challenge to industry, which frequently turns to the epidemiologist for a solution. The presentation will summarize the research methods available, with the strengths and weaknesses of each, especially applied to occupational situations, and indications and contraindications for common types of studies. Examples will illustrate the major pitfalls to avoid. There will be a brief discussion of statistical power and its relationship to negative epidemiologic studies, especially as they concern regulatory agencies.

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42. OCCUPATIONAL EPIDEMIOLOGY. C. P. Hen and S. P. Tsai, Gulf Science and Technology, P.O. Box 2100, Houston, TX 77001.

Epidemiology is the study of the distribution and the determinants of disease or physiological condition in human population. The epidemiologist is interested in the occurrence of disease by time, place, and persons.

Occupational epidemiology is a discipline of quantitative health risk assessment of workers by integrating and statistically treating medical, personnel, safety, industrial hygiene, toxicology, process engineering and community information.

Five major types of epidemiological programs will be described as an example of an occupational epidemiology. They are: 1) prospective epidemiology; 2) retrospective epidemiology; 3) clinical epidemiology; 4) reproductive epidemiology; and 5) applied epidemiology.

Retrospective epidemiology on mortality will be described in more detail and statistics such as Standardized Mortality Ratio (SMR), Proportional Mortality Ratio (PMR), relative and attributable risk will be discussed.

43. STUDY METHODOLOGY IN OCCUPATIONAL EPIDEMIOLOGY. William H. Gaffey, Monsanto, 500 N. Lindbergh Blvd., G242, St. Louis, MO 63166.

Although the acute effects of occupational exposure should not be ignored, chronic effects following long latent periods tend to be more serious, and more difficult to measure. Chronic effects can manifest themselves at any point on the health spectrum from asymptomatic anomalies to death. For reasons of expediency, epidemiologic studies of chronic disease in employed populations tend at the present time to study mortality. The most common type of mortality study is the cohort follow-up study, in which a living population exposed several decades ago is identified and followed to the present time. The numbers of deaths by cause which occur are compared to the numbers which would be expected in a comparable unexposed population. A second common methodology is the proportional mortality study, which looks only at the deaths in an exposed population. The percentages of deaths due to various causes are compared with the percentages to be expected in a similar sample of deaths in the general population. Both study designs present problems of interpretation. Examples of each will be discussed to illustrate these problems, which include the healthy worker effect, the survivor effect, and others.

● THURSDAY MORNING AND AFTERNOON - JOINT SYMPOSIUM ON TRANSPORTATION OF RADIOACTIVE MATERIALS - ORGANIZED BY DIVISION OF NUCLEAR CHEMICAL AND TECHNOLOGY - ABSTRACTS IN SECTION NUCL

● THURSDAY AFTERNOON - SYMPOSIUM ON EPIDEMIOLOGY: 4 - PROSPECT AND OUTLOOK - N.H. FANCETT, Presiding

44. OCCUPATIONAL DISEASE AWARENESS - THE TEACHING OF OCCUPATIONAL MEDICINE IN BRITISH AND IRISH MEDICAL SCHOOLS. Ralph W. Fancett, M.D., Ph.D., The National University of Ireland, Galway (U.S. Address, 12920 Hater Road, Wheaton, MD 20906)

Since 1775, when the relation between occupational cancer was correlated with exposures of chimney sweeps, physicians in the British Isles have been actively concerned with the effect of occupational environments on health. Currently, the interests encompass a wide spectrum from the blast furnaces and chemical plants to agriculture with corresponding variations in patterns of disease. Both industrial and agricultural occupational diseases are taught in all medical school courses, commonly titled "Social and Preventive Medicine", with some emphasis on locally prevalent diseases and treatment. A brief survey of such courses will be given. A discussion of the requirements for specialization in occupational medicine will follow. The role of the occupational physicians and the relation to epidemiology will be briefly discussed.

45. **EPIDEMIOLOGY OF REFINERY WORKERS WITH BENZENE EXPOSURES.** C. P. Wen and S. P. Tsai, M.D.s, Gulf Science and Technology Company, P.O. Box 2100, Houston, TX 77001.

Health effects of workers with chronic benzene exposures in a refinery are described. A retrospective cohort study examines the mortality experience of benzene workers (N=443) in the period 1952 to 1976 to determine if they experienced unusual death rates for specific causes indicative of exposure to benzene in the work environment. Standardized mortality ratios (SMR's) for all causes of death using the comparable US male populations as a reference population showed that benzene workers in this refinery experienced more favorable mortality than the comparable US population. Any SMR's below 100 indicate more favorable mortality. The SMR's for all causes of death were 43 for white males and 38 for non-white males. No deaths from leukemia were observed nor were deaths from any specific cancer site in statistical excess. A medical surveillance system on these benzene workers is also described with emphasis on the evaluation of 21 years of collection of hematology and blood chemistry data. There were no specific effects observed from chronic exposure to benzene. The relevance of proposed regulatory criteria to monitor blood results is discussed.

46. **THE CONFUSED EPIDEMIOLOGY OF PCBs.** William R. Gaffey, M.D., 800 N. Lindbergh Blvd., G2W2, St. Louis, MO 63166.

Polychlorinated biphenyls are a class of substances once widely used in applications requiring thermal stability, low vapor pressure and insulating properties. In 1968, about 1000 people in Japan became acutely ill from eating rice oil heavily contaminated with PCBs. Subsequently it was found that PCBs were ubiquitous in the environment. Production of PCBs in the United States ceased in the 1970's, but concern for the long term effects of PCBs continues, as does their presence in the environment. Because rat feeding studies in 1975 suggested that PCBs might cause liver cancer, several epidemiologic studies of exposed populations were carried out. Those which examined morbidity in living populations generally found no effects other than (in some studies) some cases of mild liver dysfunction. Three cohort studies of long term mortality in occupationally exposed populations were carried out. Although each of them found some excess mortality from some causes, they have in common the fact that (a) they do not agree with each other and (b) they do not confirm the rat feeding studies. The interpretation of these mortality studies will be discussed in the light of the criteria established by the International Agency for Research on Cancer for establishing occupational carcinogenesis.

47. **HEALTH STATUS OF CAPACITOR AND TRANSFORMER MANUFACTURING WORKERS WITH LONG TERM EXPOSURE TO PCBs.** Alf Fischbein, Mary S. Wolff, John Thornton, Ruth Lillis and Irving J. Selikoff, Environmental Sciences Laboratory, Mount Sinai Medical Center, New York, New York 10029

In order to evaluate the health effects from occupational exposure to PCBs, a clinical survey was conducted of 326 workers employed in a capacitor and transformer manufacturing facility where PCBs had been used since the 1940s. Aroclor 1016 and, to a minor degree Aroclor 1221 had replaced the higher chlorinated PCBs for two years prior to this study. Forty percent of the workers, half of whom were females, had been employed for 20 years or longer. Mean plasma concentrations of higher (Aroclor 1254) and lower (Aroclor 1242) congeners of PCBs were 124 ppb and 48 ppb respectively. Despite high plasma concentrations of PCBs, which correlated well with intensity of exposure, there was a paucity of clinical and laboratory abnormalities. However, there was a high prevalence of abnormal dermatological findings, including chloracne (6%) and conjunctival and palpebral abnormalities (16%). Association was found between dermatological abnormalities and plasma levels of higher congeners of PCBs. A similar relationship was demonstrated between higher congeners of PCBs and serum triglyceride levels. No evidence of porphyria or peripheral nerve dysfunction was found in a subgroup of this population. The absence of significant clinical disease is of interest when compared to the clinical syndrome of human PCB poisoning described as Yusho. Our findings give credence to the hypothesis that clinical effects ascribed to PCBs, may in part reflect a higher disease inducing potential of contaminants such as dibenzofurans.

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48. THE IRON GRIP OF LATENCY--CAN IT BE LOOSENED? Irving J. Selikoff, M.D., Environmental Sciences Laboratory, Mount Sinai School of Medicine of the City University of New York, One Gustave L. Levy Place, N.Y., N.Y. 10029

With exogenous causes of cancer there is often an inexorable acquisition of risk that persists even with the removal of the offending agent, until the subsequent clinical appearance of cancer 20 to 40 years later. The tissue imprint may not be evident but the figurative neoplastic curse of Cain is all too real. A year exposure to beta-naphthylamine in a dye plant provides a background for bladder cancer 30 years later and vinyl chloride angiosarcoma usually does not appear until 20 years or more after initial employment. Lung cancer and mesothelioma characteristically occur in the third or fourth decades after exposure to asbestos. After exposure are we doomed to inevitable cancer risk after a quiet period of incubation? This may not necessarily always be so. While cancer is not reversible, cancer risk can be. For example, if asbestos workers stop smoking, their risk of dying of lung cancer goes to about one-third or one-half of those who continue to smoke. Current findings of altered immunological status among individuals at high risk of cancer suggests the possibility of being able to counter immunosuppression in these days of thymosine and interferons. Additional theoretical perspectives are derived from observations concerning promotion in the induction of cancer. After initiation (7 imprinting) we are given a second chance, by avoiding exposure to promoters. The period of clinical latency can then be looked at in two ways: an inexorable period of increasing risk, or an opportunity to modify that risk.

- FRIDAY MORNING - SYMPOSIUM ON GENERAL SAFETY AND HEALTH TOPICS - S.W. SHALABY, Presiding

49. DETERMINATION OF FORMALDEHYDE IN AIR AS AN OXAZOLIDINE DERIVATIVE BY GAS CHROMATOGRAPHY. Eugene R. Kennedy, NIOSH, 4676 Columbia Parkway, Cincinnati, Ohio 45226; Robert H. Kutt, Jr., Centers for Disease Control, Atlanta, Georgia 30333

Production of formaldehyde in the U.S. was about 2.4 billion pounds in 1979. Because of this large volume production and reports of adverse health effects attributed to this chemical, interest in improved sampling and analytical methodology for this compound has been high. We have developed a new sampling and analytical method for formaldehyde utilizing N-benzylethanolamine (BEA)-coated Chromosorb 102 sorbent. Formaldehyde in air reacted with this sorbent coating to produce a derivative of formaldehyde, 3-benzylethanolamine. Sorbent-tube samples were desorbed with isooctane and this derivative determined by capillary gas chromatography using the splitless injection technique. Analysis was accomplished using a 75-meter Carbowax 20M fused silica capillary column. Separation of this oxazolidine of formaldehyde from other low molecular-weight aldehyde oxazolidine derivatives was possible.

The range of the method was from 0.55-2.88 mg/m³. By utilizing the split-injection technique the range was extended to at least 4.71 mg/m³. Samples were collected at a rate of 50 cm³/min for 4 hours. This volume translated to 6.6-56.5 µg of formaldehyde per sample for the range of the method. Overall relative standard deviation for the sampling and analytical method was 9.1%.

An adaptation of this sampling methodology to diffusive samplers has undergone preliminary evaluation. Discussion of these results will also be included in this presentation.

50. A NEW PASSIVE DOSIMETER FOR MONITORING PERSONNEL EXPOSURE TO POLYCYCLIC AROMATIC VAPORS. H.-J. H. Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830.

Polynuclear aromatic (PNA) compounds are emitted by a wide variety of sources (synfuel production, urban traffic, residue heating). Because some PNA compounds are found to be carcinogenic in animal laboratory tests, there is considerable interest in monitoring human exposure to these compounds. One important pathway of exposure is via inhalation of PNA vapors and aerosols. Vapors of multi-ring polycyclic compounds, however, are difficult to detect because of their low vapor pressure. Traditional monitoring techniques involve elaborate sampling procedures that pump air through particulate

filters and solid adsorbents. This paper describes a new device for the collection and detection of multi-ring PMA compounds in the vapor phase. The device is a passive dosimeter able to determine time-weighted average concentration using the principle of molecular diffusion. The PMA pollutants are adsorbed onto a filter paper treated with a heavy-atom salt. After exposure the filter paper is inserted into a spectrometer and the levels of PMA determined directly without requiring extraction. The detection method uses the room temperature phosphorescence technique. The limits of detection for several PMA compounds such as phenanthrene, pyrene, and quinoline are in the part-per-billion range for concentration in air.

Research sponsored by the Office of Health and Environmental Research, U. S. Department of Energy, under contract W-7405-eng-26 with the Union Carbide Corporation.

61. NITROGEN DIOXIDE AND SULFUR DIOXIDE MEASUREMENTS BY THE RESPIRATION POWERED PERSONAL SAMPLER. D.J. Sibbett, R.H. Moyer, and D.J. Moschandreas. GEOMET Technologies, Inc. 1801 Research Boulevard, Rockville, Maryland 20850.

Data were collected on the indoor levels of nitrogen dioxide and sulfur dioxide of three residences in the metropolitan Boston area by utilization of a novel respiration powered personal sampler. Thirteen subjects, including two children, used the sampling device at rates between 62 and 410 ml of air per minute. Sampling rates were activity dependent. NO₂ and SO₂ were collected by diffusion on coated tubes located in the sampler inlet. Collected NO₂ was determined spectrophotometrically after diazotization; SO₂ was analyzed by a luminol chemiluminescence technique. Data were compared with the results from fixed monitoring instruments on the basis of time-weighted averages in the monitored spaces. Indoor concentrations of NO₂ varied from 5.5 to 115 ppb; SO₂ varied from <0.5 to 5.9 ppb. NO₂ doses ranged from 16 to 513 µg during the test periods of approximately three hours; SO₂ from <2 to 52 µg.

62. RESPIRATOR FACEPIECE FIT TESTING - A SEMI-QUANTITATIVE PROTOCOL. O. T. Shrivastava, J. G. Loschiavo, and R. E. Hemingway. E. I. du Pont de Nemours & Co., Inc., Nashell Laboratory, Elkton Road, Newark, Delaware 19711.

A very simple detailed protocol for conducting fit testing of respirators with isomyl acetate (IAA) is described. The protocol is suitable for any respirator program regardless of its size. Standard Operating Procedures are included detailing (1) the selection of a respirator for comfort and fit, (2) the construction of a simple fit test chamber, (3) the generation of a stable test atmosphere within the test chamber, (4) exercise protocol to be used for fit testing, and (5) a unique method for preparing a stable 1 ppm concentration of IAA for checking odor sensitivity. An effort has been made to make all of the procedures simple and to utilize inexpensive readily available materials.

Respirator wearers were fit-tested by the Semi-Quantitative Protocol; those that passed were then fit-tested quantitatively. Comparative tests on over 300 individuals indicated that the Semi-Quantitative Protocol provides high assurance that protection factors larger than 100 can be assured for both half and full facepiece respirators.

63. FACIAL HAIR: ITS EFFECT ON THE FACIAL SEAL OF POSITIVE AND NEGATIVE PRESSURE RESPIRATORS. O. T. Shrivastava, J. G. Loschiavo, and R. E. Hemingway. E. I. du Pont de Nemours & Co., Inc., Nashell Laboratory, Elkton Road, Newark, Delaware 19711.

The effect of facial hair on the face seal of both half and full facepiece respirators was investigated for both positive and negative pressure types. Beard growth varied widely in length, shape, density, and texture. Over 350 employees, 100 of whom were bearded, were fit-tested quantitatively. Facial hair increased the face seal leakage by two orders of magnitude in half-mask negative-pressure respirators and by 2 1/3 orders of magnitude in full-facepiece negative-pressure respirators. Continuous-flow (positive pressure) full-facepiece respirators with air flow set at 4 cfm resulted in leakage five times greater when facial hair was present. No significant increase in leakage was noted for pressure demand or SCBA units although air loss through the face seal with facial hair present increased by 6% to 47%.

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64. RESPIRATORS - PROTECTION FACTORS ACHIEVED FOR THE WORKPLACE. A. C. Simon, O. T. Skretvedt, and R. B. Henningway. E. I. du Pont de Nemours & Co., Inc., Haskell Laboratory, Elkton Road, Newark, Delaware 19711.

Quantitative fit tests indicate the protection respirators offer in a chamber. Even though test criteria may involve movements that simulate working movements, the actual protection provided in the workplace may be different. To determine a "workplace protection factor" several different job categories were monitored by continuous sampling outside and inside the respirator. Job categories included those where respiratory protection was necessary for particulates and vapors. The workplace protection factors were compared to quantitative fit test data that was taken before and after the job period. Results indicate that properly fitted respirators maintain high protection factors even during actual work conditions.

65. ASPECTS OF AUTO CRASH BAG INFLATOR COMPOSITION SAFETY I. ACTION OF BATTERY ACID. Indu B. Mishra, Talley Industries of Arizona, Mesa, Arizona, 85201

Talley Industries of Arizona is committed to the development of automotive passive restraint systems, popularly known as Air Bags. This paper is the first in a series of publications dealing with system safety, particularly when spilled battery acid penetrates the inflator module containing the gas generant.

Pellets of sodium azide and copper oxide, used as the nitrogen generant in Air Bags were subjected to reaction of sulfuric acid solutions at concentrations in the range of 20-35 percent for prolonged periods of time. The greater portion of the sodium azide reacted to produce hydrazoic acid. The partial pressure of hydrazoic acid formed was insufficient to form copper(I) or copper(II) azides. A minute quantity of residue decomposing exothermically between 202-225°C was formed, however. This material comprised of reddish brown and bluish green crystals in hypothesized to consist of $\text{Cu}(\text{N}_3)_2 \cdot 3\text{Cu}(\text{OH})_2$ or $\text{Cu}(\text{N}_3)_2 \cdot 8\text{CuO} \cdot 7\text{H}_2\text{O}$.

Air bag inflator modules fired at intervals after addition of the sulfuric acid solution functioned successfully.

**JOINT SYMPOSIA
DIVISION OF CHEMICAL HEALTH AND SAFETY
AND RELATED ABSTRACTS FROM
DIVISION OF CHEMICAL EDUCATION, INC.**

● WEDNESDAY MORNING AND AFTERNOON - SECTION B - SYMPOSIUM ON CHEMICAL HEALTH AND SAFETY, ESPECIALLY IN THE ACADEMIC LABORATORY - ORGANIZED BY DIVISION OF CHEMICAL EDUCATION, INC., JOINT WITH DIVISIONS OF CHEMICAL HEALTH AND SAFETY AND SMALL CHEMICAL BUSINESSES - J.A. YOUNG, Presiding

58. WHAT YOU ALWAYS WANTED TO KNOW ABOUT TOXICOLOGY, BUT WERE AFRAID TO ASK. C. Boyd Shaffer. Dr. H. F. Fress, Mays, Loomis & Shaffer, Inc. Suite 204, 1901 N. Fort Meyer Drive, Arlington, VA 22209.

Students and faculty working in academic laboratories may sustain a high degree of exposure to chemical substances. Exposure to a given substance might occur only once or at most only a few times, or it might occur repeatedly over the course of the academic year. While information on the health effects of chemical substances is becoming increasingly available, it is important that the individual have at least a passing familiarity with the methods used in developing such information and an understanding of the language in which it is conveyed. The most commonly used animal species in routine toxicologic testing are rats, mice, and rabbits. The substance under investigation may be administered to the test animals by oral intubation, inhalation, or skin application, although a variety of more exotic routes are feasible. The toxicologist generally characterizes his test as "acute", "subacute", "sub-chronic", or "chronic", depending upon the number of doses and the period over which they are administered. The results of an acute test usually are expressed in terms of an ED50, i.e., that dosage of the substance most likely to produce the desired effect in 50 percent of the test population. The results of subacute or chronic tests usually are expressed in terms of a "no observable effect level" (NOEL), i.e., the highest dosage at which no statistically significant differences between test and control groups occur in any of the measured responses.

59. WHAT'S IN THE AIR? HOW MUCH IS TOO MUCH? MEASUREMENT OF TOXIC GASES, VAPORS AND PARTICULATES; LIMITS OF EXPOSURE. Milton Freilich. Chemical Manufacturers Association, 2501 M Street, NW, Washington, DC 20037.

Monitoring the concentration of potentially harmful materials in air may be appropriate when a toxic substance is stored or used regularly in the laboratory. Personal air samplers permit the collection of atmospheric contaminants during a working day. Workplace concentrations of particulates, organic vapors, and a variety of compounds can then be determined. Spot checks may be made for specific materials such as formaldehyde, hydrogen sulfide, nitrogen oxides, ozone, organic vapors, and others. The measurement of comparatively low levels of toxic materials by the methods described permit one to assess chronic hazards. Comparisons can be made with the Permissible Exposure Levels set by the Occupational Safety and Health Administration or Threshold Limit Values published by the American Conference of Governmental Industrial Hygienists.

60. PRESENT CONDITIONS: A REPORT OF SAFETY INSPECTIONS IN NEW YORK AREA COLLEGES AND UNIVERSITIES, Patricia Ann Dadden and Richard J. Ularie, Saint Peter's College, Jersey City, N.J. 07306

During the spring of 1980, the safety committee of the New York section of the A.C.S., inspected laboratories and chemical storage facilities of eleven colleges in the New York metropolitan area. The colleges inspected included community colleges, private and public undergraduate colleges, and public institutions with both graduate and undergraduate chemistry programs. During the spring of 1981, ten of these colleges were re-inspected and an additional nine colleges were inspected for the first time. The standards for these inspections are described in the A.C.S. publication, "Safety in Academic Chemistry Laboratories."

The major problem areas discovered in these inspections were found to be common to a majority of the inspected institutions and are the subject of this paper. They can be divided into five categories:

1. chemical storage, including compatibility, inventory control and disposal;
2. safety equipment, including safety showers, eye washes and fire extinguishers;
3. ventilation in storage areas and laboratories;
4. housekeeping;
5. safety education.

Details on each of these problems will be discussed, with suggestions for improvements.

61. ME? LIABLE? IT COULD EXCEED YOUR WILDEST DREAMS/NIGHTMARES

Arthur L. Liberman, International Flavors and Fragrances, Inc.
521 West 57th Street, New York, New York 10019

Any person properly charged with responsibilities toward others who causes harm to others through negligence (by omission or commission) may be liable. No reasonable person would ever deliberately cause harm to another (except perhaps in a moment of passion--not germane to this discussion), but many have, in fact, caused harm by their negligence. According to our system of justice, negligence is a failure to do what a reasonable person would have done if they were faced with the same situation knowing what you knew or what you should have known. In most suits involving liability, it is the jury that decides whether you were or were not negligent by applying the test of what a reasonable person would have done. After a brief treatment of the above details, including obligations under federal and local regulations, some interesting examples of what juries found to be negligent (and the professor or teacher thought at the time, at least, to be acceptable) will be presented. Time will be available for questions.

62. PROJECT TEACH SAFETY MODULE. M. M. Renfrew, Department of Chemistry, University of Idaho, Moscow, Idaho 83843; David W. Brooks and Thomas J. Tipton, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, Nebraska 68586.

Project TEACH introduced a safety module in 1980 to accompany other teaching assistant training modules made available in 1975. The safety module consists of a video-cassette, written materials, slides, and a collection of four references published from other sources. An instructor's guide is also included. About five hours of instruction is possible. Two features make this module distinctive. First, the videocassette begins with a vignette depicting the aftermath of an accident in a teaching laboratory and asks the viewer to decide who among the various implied parties share responsibility for the accident. Second, the materials stress academic laboratory situations. One exercise presents participants with a written experimental description very typical of early-1970 laboratory manuals. The task is to identify potential safety hazards, and to use alternative combinations of chemicals and procedures that would allow illustration of the same concepts using the same available laboratory equipment.

63. SAFE CHEMICAL STORAGE: A POUND OF PRECAUTION IS WORTH A TON OF TROUBLE. David A. Piplone and Donald D. Hedberg, Lab Safety Supply Company, P. O. Box 1368, Janesville, Wisconsin 53447.

Improper chemical storage invites a ticking time bomb into the laboratory and store-room. Cases of fires and/or explosions in laboratories and schools can be traced to unsafe storage conditions. Results of a chemical storage questionnaire completed by teachers and laboratory personnel indicate the need for accurate and prudent information for safe storage practices. Too often, chemicals are kept beyond expiration dates. Diethyl ether and potassium, for example, are known to form explosive peroxides upon standing after only three months. Yet these chemicals are kept for years with no inventory records or awareness of hazards. Arrangement of chemicals alphabetically presents another problem. While this type of arrangement is convenient for finding and retrieving an item, incompatible chemicals can be easily placed next to each other.

CHAS

Certain classes of chemicals such as acids, flammables, oxidizers, etc. require special storage procedures. Care must be taken to establish compatibility information. Five-pint bottles of nitric acid (an oxidizer) and acetic acid (a flammable liquid) are commonly stored together. Mixture of these two acids upon spillage, leakage, or breakage of bottles can lead to a dangerous fire situation. This paper will discuss storage of chemicals by class, special precautions, and proper equipment for storing flammable liquids. Simple methods for storing chemicals safely will be proposed. A chemical inventory labeling system will be presented. A checklist for surveying one's current storage practices will be described.

69. HIGH SCHOOL LABS, PERSPECTIVES ON SAFETY AND HEALTH. N. C. Mangel. Avon High School, 510 West Avon Road, Avon, Connecticut 06001.

High school chemistry teachers are responsible for the safety of naive, curious adolescents in the laboratory. A teacher may be held legally liable for negligence if a student brings suit after a lab injury. Laboratory safety problems increase with the number of different students and teachers sharing the same facilities. Short lab periods, in the lockstep scheduling characteristic of high schools, often cause students and teachers to take short cuts that can produce unsafe conditions in even well maintained laboratories. Chemistry teachers are responsible for requisitioning or ordering costly and often hazardous chemical supplies, their safe storage and, ultimately, their safe disposal in potpourrie that may demand deeper knowledge of chemicals than is required for teacher certification, unfortunately. Sources of information and practical suggestions to minimize the inherent hazards in high school labs will be discussed.

70. RISK ASSESSMENT AND HAZARD ELIMINATION FOR UNDERGRADUATE LABORATORY EXPERIMENTS. Jay A. Young, Chemical Consultant, 12916 Allerton Lane, Silver Spring, MD 20904.

The price of safety is thorough knowledge applied with constant vigilance. Unless we know and are aware of the hazardous properties of those chemicals our students use in their laboratory work, unless we apply this awareness diligently, intelligently, and with vigor at all times our students will have accidents--and some will cause injury, or worse. Many of the "experiments" that students perform can be dangerous either in the procedures used or in predictable careless handling of the chemicals and equipment by students. With some attention to reasonably foreseeable built-in hazards and to careless actions, most potential untoward incidents can be prevented. In this paper a routine set of steps is described that identifies foreseeable built-in hazards as well as likely careless actions. (The thermal decomposition of $KClO_3$ with MnO_2 as a catalyst is used as an example.) Once the built-in hazards and likely careless actions are identified, steps can be taken to minimize their probable occurrence. These precautions then become part of the routine practice in the execution of the experiment. This procedure for developing specific and appropriate precautions can be applied to familiar, stand-by, cook book "experiments" as well as to the more desirable open-end experimentation in good laboratory instruction.

71. TOXIC VAPORS AND VENTILATION PARAMETERS--EVALUATING THE LABORATORY ATMOSPHERE. Richard E. Bayer. Carroll College, 100 North East Avenue, Waukesha, WI 53186.

It is important to be able to evaluate the chemical atmospheres of scientific laboratories in order to avoid unreasonable risk. Academic institutions recognize that presently a significant amount of laboratory work is done in rooms with limited ventilation and not in chemical hoods. Available information on the toxicity of chemicals allows for the setting of acceptable levels of chemicals in teaching laboratories. Evaluation of the atmosphere requires information on the amount and rate of addition of chemical to the environment and the rate of removal from the laboratory. The rate at which chemicals leave a laboratory can be determined empirically by adding a tracer gas to the atmosphere and measuring the removal rate as a function of available ventilation. Isobutane was introduced into various laboratories and the concentration in various locations in the laboratory was monitored using G.C. tech-

niques as a function of time and available ventilation. Constants similar to those used to describe radioactive decay were easily evaluated. Once the available ventilation is characterized and this information is combined with estimates of material that will be introduced into the atmosphere, many important questions can be answered. Will a new experiment produce a high risk laboratory situation? How is available ventilation related to number of students per laboratory section? Etc.

72. HEALTH AND SAFETY DATA. DOES THE ACADEMIC COMMUNITY HAVE A RESPONSIBILITY TOWARD THE NEWS MEDIA? J. J. Wills. P.O. Box 5006, Stanford, CA 94305.

Recent symposia speakers have pointed to problems in the teaching of chemistry, in student interest and achievements, and in maintaining excellence. Favorable public attitudes toward science, particularly in connection with hazards due to chemicals, seem to have eroded considerably within the past few years. It is a major responsibility of the academic community, as part of the education process, to furnish impartial data to the public. Benefits, as well as hazards, of chemicals should be presented in an honest fashion, counteracting any possible inaccuracies and sensationalism. A program will be outlined which should help in achieving these goals. It would include motivation, basic chemical concepts, health and safety considerations, and the science-news media interface.

**JOINT SYMPOSIA
DIVISION OF CHEMICAL HEALTH AND SAFETY
AND RELATED ABSTRACTS FROM
DIVISION OF NUCLEAR CHEMISTRY AND
TECHNOLOGY**

- THURSDAY MORNING - SECTION A - SYMPOSIUM ON TRANSPORTATION OF RADIOACTIVE MATERIALS: 1 (CONTINUED) - ORGANIZED BY DIVISION OF NUCLEAR CHEMISTRY AND TECHNOLOGY, JOINT WITH DIVISION OF CHEMICAL HEALTH AND SAFETY - J. HUDIS, Presiding

63. RISK FACTORS IN THE TRANSPORTATION OF NUCLEAR FUEL AND WASTE. E. J. Canfield and R. D. Scanlon. Polytechnic Institute of New York, 333 Jay Street, Brooklyn, NY 11201.

The risks involved in the transportation of nuclear fuels and radioactive wastes are generally quite low. They include the effects of heat, weight, exposure to radiation in transport, radiation risk from accidents, and risks from common causes.

Since most trips are made by motor truck, the inherent hazards of this mode of transport are of primary concern. However, some shipments are made by train, some large shipments may be made in the future, and small quantities of medically oriented materials are carried by air transport.

Limits on radiation levels of packages are controlled by law, and must be indicated on packages. Storage and segregation provisions control these aspects of transportation.

Safety in the transportation of radioactive materials and wastes is controlled through design standards for packaging; notification; and implementation of a quality assurance program.

64. RISK AND SAFETY IN RADIOACTIVE MATERIAL TRANSPORTATION. R. E. Luna. Sandia National Laboratories, Transportation Technology Center, Division 4551, Albuquerque, NM 87185.

The risks of transporting radioactive materials (RAM) have been examined in great detail during the last twenty years. Every analysis has shown that radiological risks are small compared with most other voluntary, involuntary and natural risks assumed by man in modern society. Review of these risk evaluations reveals a variety of approaches to the problem of estimating radiological harm resulting from incident-free (normal) transportation and from accidents which could involve RAM packages. What is common to most is a tendency toward conservatism in the analysis which reflects both the technologists bent to evaluate the upper bound situation to see if he can afford its consequences and his recognition that the experience involving failure of RAM packages is so sparse that thresholds for containment failure are poorly known. This frequently results in an analysis which emphasizes the spectacular events that might occur to the exclusion of the more frequent and less threatening events which constitute the major component of the risk. The informed public is told in detail about the horrors of unlikely events, is reminded of the inevitability of accidents by the relatively frequent incidents, and then expresses his doubt of the safety in transporting RAM by restricting transport of radioactive materials near him. Thus, effective use of risk analysis requires development of a context for relating risk to safety to assure public acceptance needed for enlightened regulation of the industry.

65. VEHICULAR TESTING. R. M. Jefferson. Sandia National Laboratories, Transportation Technology Center, Department 4550, Albuquerque, NM 87185.

One of the key factors in the utilization of the many facets of nuclear energy, in the modern society, is the assured ability to transport safely the various radioactive materials involved. Since primary safety during transportation is provided by the package in which the material is shipped, it is incumbent upon those who design, develop and manufacture such packages to furnish acceptable proof of their adequacy. In an engineering sense, this is relatively straight forward. Existing, widely used and accepted analytical techniques are applied to design to well defined engineering criteria (often set by federal regulations). But, it is clearly recognized that analytical techniques are sometimes limited in their applicability and that the engineering criteria are, no matter how appropriate,

CHAS

still approximations of reality. Therefore, in order to validate the currently utilized analytical methods and to evaluate the environments encountered in severe vehicular accidents involving radioactive materials packagings, it is useful to perform staged accidents involving components, subsystems and complete transportation systems. Further, such testing allows assessment of alternative evaluation techniques such as the use of scale modeling. Experiences in vehicular testing gained over the past several years involving over 200 subscale and full scale tests are described to substantiate the conclusion that such a test program is a useful adjunct to more common design and evaluation techniques.

66. THE FRACTURE, BREAK-UP, AND AEROSOLIZATION OF ZIRCONIUM CLAD URANIUM DIOXIDE.*
J. L. Alvarez, R. W. Marshall, B. B. Kaiser and V. J. Novick. EG&G Idaho, Inc.,
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Falls, MA 02164.

The break-up of spent (radioactive) nuclear fuel (uranium dioxide, UO_2) poses a potential health hazard if the particles that are formed are respirable aerosols. This paper presents results from studies on the induced fracture of depleted (unirradiated) and spent zirconium clad uranium dioxide. The fractures and break-up were induced by crushing, impacting and explosively loading the pellets of UO_2 . Two types of studies were conducted. In the first type, the zirconium cladding was not breached. The resulting fracture pattern in the UO_2 was examined using metallographic and nondestructive surface analytical techniques. Differences in loading and stress wave motion within the samples were used to explain the observed fracture patterns. Particle size and distribution measurements were also made. In the second type of study, the cladding was breached. The resulting particles were sampled and sized using standard sieves and cascade impactors. The sized fractions were examined and characterized using optical microscopy, scanning electron microscopy (SEM), and chemical and surface analytical techniques. In the spent fuel experiments, the total radioactivity was measured, as well as individual radioisotope concentrations present on each sieve and impactor stage. Radioisotope separation from the bulk matrix was observed. *Work supported by Sandia Laboratories, Albuquerque, New Mexico and the U. S. Department of Energy under DOE Contract No. DE-AC07-76ID01570.

● THURSDAY AFTERNOON - SECTION A - SYMPOSIUM ON TRANSPORTATION OF RADIOACTIVE MATERIALS: II (CONCLUDED) - ORGANIZED BY DIVISION OF NUCLEAR CHEMISTRY AND TECHNOLOGY, JOINT WITH DIVISION OF CHEMICAL HEALTH AND SAFETY - E. CANTILLI, Presiding

75. THE TRANSPORTATION SYSTEM FOR RADIOISOTOPES. C. Brantley, New England Nuclear, 349 Albany Street, Boston, MA 02118.

It has been estimated that the retail value of radioisotopes in the United States is above \$200 million per year. Much of our health care system is dependent upon radioisotopes for research and diagnosis. The raw materials, the products and the radioactive wastes must all be transported using ground and air methods. The methods and procedures are controlled by the Department of Transportation and the Nuclear Regulatory Commission by regulations contained in Titles 49 and 10 of the Code of Federal Regulations. In addition, the STOP program of the Airline Pilots Association controls some aspects of air transportation. Over two million packages of radioactive materials are shipped each year - tens of thousands of packages containing many curies of radioisotopes as raw materials, millions of packages of products containing a few micro- to a few millicuries, and hundreds of thousands of drums of radioactive waste with a few millicuries up to a few curies of radioactivity. The major problems facing the industry are associated with the multitude of rules, the federal-state-local government conflict over routing of trucks, and the fears of the public concerning radioactivity. The successes and the problems of this system of transportation will be described.

76. SHIPMENT OF SPENT FUEL. W. R. Casey. Brookhaven National Laboratory, Safety and Environmental Protection Division, 20 Technology Street, Upton, New York 11973.

Reactors have played a major role in the research programs at Brookhaven National Laboratory for many years. Beginning in 1951 with Brookhaven Graphite Research Reactor

MONS 002302

(BNR) and continuing in 1965 with the High Flux Beam Reactor (HFBR), research programs from the Biology, Chemistry, Medical, and Physics Departments have been conducted in these facilities.

Associated with the operation of these reactors is the periodic transport of spent fuel to other government facilities for reprocessing. Up to 1976, Brookhaven had made 130 truck shipments of spent fuel elements via a route which included passage through New York City. In January 1976, the City enacted a ban on the transport of large quantities of radioactive material which required Brookhaven to seek an alternative which would bypass the City.

A second route was used for six separate shipments in the Spring of 1976. This route involved a ferry between Long Island and Connecticut and subsequent truck transport to South Carolina. Shortly thereafter, new regulations passed by the City of New London also prevented the Laboratory from using this route. No shipments of spent fuel have been made from Brookhaven since that time.

77. RADIOACTIVE MATERIAL TRANSPORTATION REGULATIONS. R.E. Cunningham, U.S. Nuclear Regulatory Commission, Mail Stop 396-55, 1717 H Street, N.W., Washington, D.C. -- 20550.

The Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT) share responsibility for the safe transport of radioactive materials. For packages containing large quantities of radioactive materials, the basic division of responsibility is for NRC to regulate package safety while DOT regulates the conditions of transport. Although there has been no known injury from radiation due to transportation accidents, the transportation of radioactive materials is controversial because of public perceptions of risk, particularly with regard to shipment of spent nuclear fuel and nuclear waste. This paper briefly describes the work that has been completed to assess transportation risk and the current status of regulations governing transportation of radioactive materials. Since understanding safety is an evolutionary process, the paper also covers work underway to improve assessment of risk and margins of safety where appropriate.

78. REGULATORY AND STORAGE PROBLEMS OF NUCLEAR MATERIALS TRANSPORTATION
R.D. Scanlon and E.J. Cantilli. Port Authority of NY & NJ, 1 World Trade Center, NY NY.

Nuclear materials and wastes are the safest materials to be transported in the realm of 'hazardous materials' transportation, as shown by data. However, public attitudes since the use of nuclear weaponry in World War II have been biased against the handling of nuclear materials.

The true problem of nuclear materials transportation is seen as being in two major areas:

- 1) The overabundance of Federal regulatory agencies involved, making for a lack of consistency and clarity in controls, and a lack of systematization of approach; and
- 2) The stockpiling of waste materials as a result of limitations placed on permits issued for the transport of such materials, with no solution to the dilemma either in development or proposed.

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MONS 002304