UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

SAHU, *et al.*,	:	Index No. 07 Civ 2156 (JFK)
Plaintiff,	:	**DECLARATION OF DR. JURGEN H. EXNER IN OPPOSITION TO DEFENDANTS' MOTION FOR SUMMARY JUDGMENT AND IN SUPPORT OF PLAINTIFFS' MOTION PURSUANT TO FEDERAL RULE OF CIVIL PROCEDURE 56(d)**
-against-	:	
UNION CARBIDE CORPORATION, *et al.*,	:	
Defendant.	:	
	:	

DECLARATION OF DR. JURGEN H. EXNER

I, Jurgen H. Exner, have personal knowledge of the Bhopal site and have reviewed a number of documents relating to it. If called upon to do so in a court of law, I would testify to the following.

This statement primarily addresses two issues related to *Sahu v. Union Carbide Corporation and Madhya Pradesh State*, 07 Civ. 2156 (JFK): the process information provided by Union Carbide Corporation (UCC) for production of Sevin at Bhopal, India, as described in the references, and the likelihood of groundwater pollution from the solar evaporation ponds associated with the Bhopal plant.

1. I am a chemist with 37 years of experience in waste management and site restoration and seven years of experience with a major chemical company doing process development, production, and waste management from 1968-1975. From this experience, and from evaluating the chemical processes of two major pharmaceutical companies and several batch chemical producers during the 1970's, I understand the procedure for designing chemical processes and facilities for handling waste streams resulting from these. I have led science and engineering teams that developed seven chemical processes from the laboratory to pilot plant to full production. A brief resume is attached.

2. I am familiar with the Bhopal experience and the Union Carbide India Limited (UCIL) Bhopal site. In 2004-2005, I worked under sub-contract to Burmeier Ingenieure of Germany as a member of an international team that evaluated the condition of the Bhopal site and its environs. I visited Bhopal twice in that period and contributed to a report assessing the level of site contamination, potential hazard to the local population, and proposed remedial measures. We recommended additional studies to address the degree of existing groundwater contamination. I have reviewed the documents listed below and make the following statements based on the information therein, my observations in Bhopal and my experience.

3. UCC provided a process design for production of Sevin that included treatment and disposal of wastes. (*E.g.* Heck H, A155-162). It is common industry practice that the design of a process goes through several phases before a chemical plant is built. In this phased approach, the engineering process flow diagram, the key document showing the process technology, includes mass balances for chemicals, equipment sizing and materials of construction, and piping and instrument diagrams.

4. An integral part of a process engineering document includes the procedure for handling wastes from the process. From an engineering perspective, waste disposal must be included in the process design because all wastes must have a treatment, recycle, or disposal method.

5. Detailed design follows and implements process design and usually is the final phase before construction of a chemical plant. Detailed design takes into account the

physical layout of equipment and local conditions in documenting the plans for actual construction.

6. The manufacture of chemicals generates waste streams from the chemical processing and from general equipment operation. Both influence the design of a chemical process.

7. During chemical reactions, the desired product is formed concurrently with by-products. Each chemical process generates a variable quantity of waste per pound of product depending on the efficiency of the chemical reaction and on the attention of plant operators in carrying out the chemical operations. In order to achieve the desired product purity, separation and purification steps are almost always necessary during chemical manufacture. Liquid and solid chemical process wastes are generated during the separation of the product from reagents, from impurities in reagents, and from reaction by-products. These wastes may include unrecovered filtrates, process water washes, solvents, spent catalysts, spent adsorbent and drying agents, filter cakes, distillation pot residues and overheads, off-specification product, scrubber solutions, and vacuum system condensate. Therefore, waste generation, treatment, chemical recycle, and waste disposal become an important part of the process design. All process design must address the wastes from chemical operations and associated processing steps.

8. Inadvertent spills to land, equipment, and buildings from leaking pipes, pumps, and valves also generate wastes and must be addressed in process design.

9. During the 1960's, environmental awareness in the US increased, culminating in legislative actions and establishment of US EPA in 1970. As a result, major chemical companies modified their approach to wastes and waste disposal. Waste and its disposal were considered necessary but always relegated in importance relative to the production of the desired chemical. Often process designs relegated waste to a simple statement, "to disposal". This approach changed in the early 1970's, and chemical industry included specific waste handling and disposal methods as part of their process engineering design. With respect to Bhopal, UCC specified a neutralization pit followed by evaporation of aqueous wastes in a solar evaporation pond. This waste treatment was implemented by UCIL.

10. Aspects of the process design, including the type of plant and its wastewater disposal pit, contributed to the contamination of the Bhopal site and of the groundwater.

11. UCC designed evaporation ponds for waste disposal into the process for Sevin production, and these ponds were a highly likely contributor to groundwater pollution. Groundwater at the site and the environs is contaminated from leakage of the evaporation ponds and from spills inherent in the operation of the plant. Organochlorine compounds remain in the soil of the evaporation ponds, and organochlorine chemicals and carbamates have been detected in the groundwater of the area. The evaporation ponds are known to have leaked. (Heck H, A240-241; Heck I, A344). I have evaluated 100-200 contaminated sites around the world. Evaporation and storage ponds often leaked and

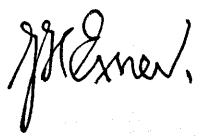
were major contributors to groundwater pollution. Some of the storage areas for liquids that I have observed leaked despite supposedly impermeable clay confining layers or attempts at confinement with plastic sheeting.

Documents Reviewed:

Heck R, A2901-2922; Heck R, A2759; Heck H, A155-162: Heck H, A227-232; Heck R, A2713-2716; Heck R, A2737-2750; Heck R, A2879-2900; Heck N, A1604-1653; Heck Q, A2695-2696; Heck H, A105-148; Heck H, A152-153; Heck R, A2722-2725; Heck H, A240-241; Heck I, A344; Heck H, A288-290; map of Bhopal (available at http://cseindia.org/webexclusives/bhopal_mapnew.jpg); S. Johnson, R. Sahu, N. Jadon, C. Duca, 2009, "Contamination of soil and water inside and outside the Union Carbide India Limited, Bhopal," Centre for Science and Environment, New Delhi, India, December 2009; H. Burmeier, J. Exner, F. Schenker, 2005, "Technical Assessment of Remediation Technologies for the Cleanup of the Former Union Carbide Site in Bhopal, India," April.

I declare under penalty of perjury pursuant to the laws of the United States of America that the foregoing is true and correct.

Executed this 16th day of January, 2014 at Alamo, CA, USA.



Jurgen H. Exner

CURRICULUM VITAE

JURGEN H. EXNER

PROFESSIONAL QUALIFICATIONS

Dr. Exner has 37 years of experience in hazardous waste management and seven years in the chemical industry. He has experience in assessing environmental information and developing effective solutions based on regulatory, economic, technical, social, and legal considerations. His chemical research and production experience help him assess waste generation during diverse chemical manufacturing operations. He has expertise in site investigation, sampling and analysis, feasibility studies, in remediation, and in the application of thermal, chemical, physical, and biological treatment methods to solve environmental problems. He has special expertise in persistent organic pollutants (POP) such as chlorinated dioxins and PCB. He has evaluated and commercialized technology by combining market and regulatory knowledge with process development skills. He has carried out laboratory treatability, pilot plant and field demonstrations through startup of operations. Dr. Exner has built and managed technical groups and developed management strategy for entering new market areas. He provides peer review for government and technical publications.

BACKGROUND

12/1992 to present

President and Principal, JHE Technology Systems, Inc., Alamo, CA
Environmental consulting in litigation support and expert witness involved: evaluation of chemical processes for waste generation and pollution by-products, examination of site contamination, fingerprinting, validity of remediation selection, consent agreements, selection of remediation contractors, cost of remediation, often associated with dioxin or other POP contamination. Proposal evaluation, technology startup operations and operational problems, cost overruns, the state of knowledge of groundwater contamination.

Management strategy for environmental protection and restoration, technology evaluation, and commercialization of new technology. Management strategy and alternative technology evaluation for soil and groundwater restoration for a $60-300 million remediation company over the last 18 years. Summary of treatment methods for persistent organic pollutants in Asia. Expert review of remediation options at Bhopal, India. Reviewed soil and groundwater contamination at four Superfund sites and recommended treatment and containment systems for vadose and unsaturated zones, LNAPL and DNAPL. Evaluated fate of 200

pollutants in industrial surface impoundments. Developed and managed design and construction of a treatment process for uranium and radium-contaminated wastewater at a Superfund site. Prepared RCRA corrective measures study for a $12 million site contaminated with dioxins. Evaluated treatment alternatives for PCB-contaminated soil at remote locations. Regulatory assistance on two Superfund sites. Liability evaluation for international oil company.

9/1991-12/1992

Senior Vice President, Technical Development and OHM Analytical Services Corp., OHM Corporation, Walnut Creek, CA

In addition to OHM activities described below: Troubleshoot technical projects nationally, interface with clients in diverse industries as chief technical officer, develop strategy in response to government regulations, build technical capability. Managed $6 million company analytical services group in Findlay, OH.

8/1988 to 9/1991

Senior Vice President, Technical Development, OHM Corporation, Walnut Creek, CA

Built and managed a central technical group that consulted with clients and OHM operations on technical issues related to remedial design and restoration of contaminated sites. Managed group of 15-40 at three locations. Developed new business in thermal treatment, bioremediation, solidification, and *in situ* vapor extraction by defining technical needs, markets, permit strategies, and marketing approaches. Engaged in joint venture development, acquisitions, and developed several technology demonstrations with major clients. Directed major technical projects in biological, thermal, chemical, physical, and solidification projects on chlorinated dioxins, PCB, PCP, creosote, chlorinated and hydrocarbon solvents in soil and groundwater.

2/1986 to 8/1988

Vice President, Technology, International Technology Corporation, Martinez, CA

Directed technical personnel at three locations. Acquired groundwater bioremediation group for *in situ* solvent treatment and established bioremediation capability. Directed technology assessment and development, commercialized new technology. Directed dioxin assessment, site investigation, and remediation activities in U. S. and Europe.

1983 to 1986

Technical Director, IT Corporation, Martinez, CA

Established company strategy in dioxin and PCB cleanup. Directed sampling, analytical, industrial hygiene, engineering, R&D, and immediate

removal activities for cleanup of dioxin, chlorinated solvents, and PCB-contaminated soil, groundwater, and buildings for industrial clients and EPA:

Work plan for remedial investigation, feasibility study, and decontamination of chlorinated solvents, pesticides, and dioxin in chemical plants in New Jersey and Hamburg, Germany. Extensive sampling and analysis in every conceivable matrix were followed by risk assessment, alternatives evaluation, regulatory and public discussion, and engineering design. Evaluation engineering in investigations and remediation of numerous dioxin-contaminated sites in Missouri.

1980 to 1983

Engineering Manager, IT Enviroscience, Knoxville, TN
Managed 12 engineers and scientists engaged in waste management activities. Program director of $1.4 million EPA project to develop data on the fate of chemicals in biological treatment plants and for demonstration of anaerobic processes. The laboratory's chemical and engineering support activities included chemical treatment, such as oxidation and stabilization, and physical separations such as adsorption, distillation, and membrane techniques.

1975 to 1980

Senior Environmental Specialist, Hydroscience, Inc., a subsidiary of Dow Chemical, Knoxville, TN
Conceived, developed, and managed design and startup of a chemical process for the destruction of tetrachlorodibenzo-p-dioxin. A plant was constructed and startup completed within 20 months of the initial laboratory work. The project included chemical research, sophisticated analytical methods development and application, safety and industrial hygiene, engineering scaleup, interaction with regulatory agencies, and startup troubleshooting.

Pollution Prevention, Source Control and Waste Minimization – Examine chemical production units, process flow sheets, plant equipment, and determine potential sources of waste. Verify by sampling and analysis. Develop solutions to waste generation. Developed a pollution abatement program for a plant site contaminated by EDC and polybrominated biphenyls. Work involved housekeeping and spill prevention, stormwater runoff, process waste characterization, and development of a carbon adsorption pretreatment process. At another specialty chemicals manufacturer, a survey of process flow sheets and plant inspection identified wastes and disposal options, decreased waste load and costs by one third. Surveyed non-incinerable wastes of two

major pharmaceutical manufacturers and devised organic chemical and heavy metal recovery processes.

1968 to 1975

Research Specialist/Project Leader, Halogens Research Lab, The Dow Chemical Company, Midland, MI

Developed dibromonitrilopropionamide biocide for cooling towers and paper mills. Registered the product with EPA and FDA, provided environmental fate and detoxification chemistry, pilot testing and waste reduction, market assessment, field trials, developmental sales, and customer contacts. Plant design data eliminated several waste streams and recovered valuable constituents.

Worked out the fundamental chemistry of the process for multi-million pound per year flame retardant chemical. Followed this process from laboratory through pilot plant to new plant design, worked out optimum operating conditions and initiated analytical and instrumental methods development.

Process improvements and plant operation for decabromodiphenyl oxide plant doubled plant capacity.

Directed effort toward new uses for halogen compounds and co-invented oil well completion fluid that reached 100 million lb/year.

Carried out fundamental research in the chemistry of highly acidic media, reaction kinetics, solvent effects on organic reactions, carbonium ion chemistry, synthesis of halogenated flame retardants, effects of solvation and ion pairing on chemical equilibria, and computer analysis of chemical models.

ACADEMIC BACKGROUND

Ph. D., Organic Chemistry, University of Washington
NSF Graduate Fellowship

B. S., Chemistry, with highest distinction, University of Minnesota
Phi Beta Kappa, Tau Beta Pi, Phi Lambda Upsilon, Honeywell Award, Alfred P. Sloan Scholarship

Distinguished Service Award, Division of Environmental Chemistry, ACS

Fellow of the American Chemical Society, 2011.

PUBLICATIONS

Dr. Exner has published over 40 technical papers, holds eight patents, has edited three books on hazardous waste, and given numerous presentations and invited

lectures. Participated in workshops by the National Academy of Science and the National Science Foundation, lectured for U.S. EPA and ACS, member of U.S. Air Force Ad Hoc Committee on Hazardous Waste (1984), member National Research Council Mixed Waste Committee 1995-1999. He was on the Editorial Board of the Journal of Hazardous Waste and Associate Editor of the Journal of the Air & Waste Management Association, and was twice Chair of the Division of Environmental Chemistry of the American Chemical Society, 1996-1997 and 2008-2009, and Councilor, 1998-present. He was chair of the ACS Board Committee on Environmental Improvement from 2003-2005, leading environmental issues for the world's largest scientific organization. He has organized and chaired scientific symposia, the most recent being on "Treatment of Persistent Organic Pollutants" at Pacifichem (sponsored by USA, Japan, Korea, Canada, Australia, New Zealand societies), Honolulu, December 2005, and at the ACS National Meeting in 2009. He has participated in many international symposia, the most recent of which are the Vietnam Conference on Dioxins, Hanoi, 2004, the 1st Balkan Symposium on Chemistry and Environment, Montenegro, June 2007, and the 2009 EuCheMS Conference in Stockholm, Sweden.

P. Dejonghe, A. Clarke, J. Exner, K. Hansen, J. Lighty, R. Samelson, M. Steindler, B. Thomson, "The State of Development of Waste Forms for DOE Mixed Wastes," National Academy Press, Washington, DC, 1999.

P. Flathman, D. Jerger, J. Exner, Eds., "Bioremediation: Field Experience," Lewis Publishers, 1994.

J. Exner, "Solving Hazardous Waste Problems: Dioxins," American Chemical Society, 1987.

J. Exner, "Detoxication of Hazardous Waste," Ann Arbor Science, 1982.