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WORKSHOP ON HAZARDOUS MATERIALS/WASTE MANAGEMENT, INDUSTRIAL
SAFETY IN CHEMICAL INDUSTRY AND EMERGENCY PLANNING: GUIDELINES
FOR GOVERNMENTS AND INDUSTRY - A PLAN OF ACTION FOR UNIDO;
22-26 June 1987, Vienna

US/GLO/85/149

Proceedings and recommendations*

Prepared by the United Nations Industrial Development Organization

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UNIDO
EXPERT WORKSHOP ON
HAZARDOUS WASTE MANAGEMENT, INDUSTRIAL SAFETY
AND EMERGENCY PLANNING

SUMMARY OF PROCEEDINGS

June 22, 1987

I. Welcoming Addresses

- A. On behalf of the Director-General of UNIDO, Dr. Domingo L. Siazon, Jr., Mr. L. Alexandrenne, Deputy Director General, welcomed the participants to the Workshop. He explained UNIDO's mandate in the field of environmental management and its cooperation with international agencies and national governments in carrying out this mandate. He expressed the hope that developing countries might avoid the mistakes of industrialized nations in the subjects addressed by the Workshop. He suggested that the policy guidelines developed by the Workshop should take into account costs as well as the use of indigenous human resources in order to be relevant.
- B. Dr. Klaus Zeller, Ambassador Extraordinary and Permanent Representative of the Federal Republic of Germany, said his government sponsored the Workshop out of the belief that the problems it was dealing with could not be solved at the national level alone. Already these problems posed a substantial burden on future generations, he noted. The Federal Republic of Germany reviews the development projects it supports for environmental compatibility and sponsors projects in land-use planning, soil erosion prevention and reforestation in developing countries. He hoped the Workshop would produce a concrete plan of action in the field for UNIDO.

C. Dr. A. Tcheknavorian-Asenbauer, Head of the UNIDO Chemical Industries Branch, said that it was now realized that UNIDO must provide technical assistance to avoid harmful by-products and accidents in the chemical industry as well as to promote its beneficial aspects. Twentyfive (25) per cent of UNIDO's technical assistance is in the chemical industry, she noted. UNIDO needs a precise programme for waste management and environmental protection in this industry. By better design and management, developing countries can prevent problems before they develop. She reviewed the technical options for reducing hazardous waste, including technology assessment and improvement, and the need for enforceable regulatory provisions. Export of hazardous wastes is not a solution in the long term, she noted.

D. Dr. Sonia Maltezou, organizer of the Workshop on behalf of UNIDO, thanked those in attendance for responding to the call for the Workshop and the Federal Republic of Germany for providing the financial support. She noted that industrial pollution control was itself an important industrial sector for developing countries. It was estimated that this industrial sector provided approximately 160,000 jobs in the USA. Further, she pointed out that this emerging sector could provide not only additional jobs but also additional foreign exchange earnings to developing countries through technology export (South to South). Dr. Maltezou proceeded with the nomination of the Workshop officers.

Dipl.-Ing. Franz Defregger, Director of the Waste Management Division of the Bavarian State Ministry for Regional Development and Environmental Affairs, would serve as chairman of the morning session, and Dipl.-Ing. Jack Brady, President of Crown Andersen Inc., Georgia (USA), of the afternoon session.

II. Nomination and Appointment of Workshop Officers

Dr. Amir Metry nominated Dr. Hans Sutter of the Federal Environmental Agency of the Federal Republic of Germany as Workshop chairman and Prof. Niels Lind of the University of Waterloo, Ontario, Canada, as his alternate chairman. He also nominated Dr. Filemon Uriarte, Director, Bureau of Science and Technology (ASEAN) and Prof. Sergio Almeida, President of Multiservice Engenharia Ltda., Rio de Janeiro, as co-chairman and alternate co-chairman respectively. Mr. Jack Brady nominated Judge Will Irwin as rapporteur. All nominations were approved.

III. Morning Session

- A. Dr. Amir Metry, President of Weston International, Inc., spoke on contemporary issues in hazardous waste management. He stated that the source of several U.S. problems was piecemeal regulation, i.e., cleaning up only one medium at a time without regard to impact on other media, e.g., sludge resulting from air pollution control which sludge is deposited on land. He suggested developing countries should avoid adopting regulatory systems before the technology is available to implement them, otherwise wastes will be stockpiled, or before it is known how they will be implemented. He reviewed the waste management cycle and the different technologies available for waste treatment.

In discussion it was suggested that the definition of hazardous waste exclude radioactive wastes and infectious wastes. Mining wastes are not included in the U.S. definition until they are characterized, Dr. Metry observed, and he also raised the question of how to classify mixed wastes, e.g., chemical wastes contaminated with radioactive wastes. He suggested that hazardous wastes be defined as those that are toxic (i.e., carcinogenic, mutagenic, and teratogenic), flammable, explosive, and reactive.

There was discussion of whether fly-ash contaminated with heavy metals should be classified as hazardous waste.

- B. Dipl.-Ing. Franz Defregger, after describing fifteen years' experience with the Bavarian system for special waste management, recommended that the definition of hazardous waste be adapted to simple analytical techniques, that it is important to have good information on amounts and kinds of wastes in order to be able to plan for a waste management system, and that government should provide legislative controls for hazardous waste management as well as subsidies for collection and treatment and technical advice.

In discussion it was pointed out that the contents of waste often do not correspond well to the wastes actually delivered.

- C. Dr. Fred Langeweg of the Netherlands Institute for Public Health and Environmental Hygiene urged more attention be paid to using clean technologies, i.e., preventing generation of waste products, both because it is more economically efficient (by saving costs of materials) and more beneficial to environmental conservation. Industry management must instill a prevention consciousness throughout its operations. He reviewed the sources of production of the 40 priority substances in the Netherlands and outlined the five main possible ways to prevent the generation of hazardous waste, based on the 1986 OTA (U.S.) study Serious Reduction of Hazardous Waste. He surveyed the factors that influence whether industries undertake reduction, noting that guidelines for doing so must be increasingly made industry and plant-specific. The importance of good two-way communication between government and industry was stressed as a means for evaluating the effectiveness of these guidelines.

In discussion it was pointed out that the U.N. Economic Commission for Europe had developed, in cooperation with UNEP,

descriptions of low and non-waste technologies in use in commercial plants as a reference for developing nations wishing to avoid difficulties encountered by developed nations.

- D. Dr. Hans Sutter, Director of Hazardous Waste Management - Clean Technologies in the Chemical Industry and Related Industries in the Federal Environmental Agency of the Federal Republic of Germany, stated that the 4th amendment of the German Waste Disposal Act in 1986 had given precedence to waste avoidance and waste utilization over waste disposal and that waste disposal is only to be carried out when avoidance or utilization is not possible.

Hazardous wastes in Germany are defined by a list giving the waste type, its characteristics, a code number, and its origin. The potential for the reduction of different categories of hazardous wastes was presented, with the observation that materials (and their costs) can be recovered by waste reduction. Where such costs cannot be recovered, retrofitting of old plants is difficult, so it is important to design new plants from a waste reduction point of view.

In discussion it was pointed out that the issue of 'reasonable' reduction would involve more than economic aspects. There is still a lack of experience regarding disputes between plant and government in resolving this issue.

It was also stressed that developing countries need to learn more about clean technologies and that there will be a conference in Egypt in early 1988 on this subject, with financial support from the government of France and UNEP.

IV. Afternoon Session

- A. Prof. W.B. Clapham of Cleveland State University, Ohio (USA),

made a presentation of data concerning hazardous waste treatment in the State of Ohio. He indicated that banning land disposal of such wastes, as well as closing or opening of facilities, will have an unpredictable impact on hazardous waste flows. In general, the chemical industry will have less trouble adjusting than others. He indicated that avoidance of decisions resulting in loss of employment will be as important in developing countries as in industrialized ones, and suggested that the process of siting of hazardous waste facilities would be important to developing countries, since siting had often proved difficult in developed nations. He also urged that waste categorization be kept simpler in developing countries than the system that had developed in the U.S.

- B. Dipl.-Ing. R. Knapp and Dr. Hrinkov made a pair of presentations describing the expansion of the Vienna hazardous waste disposal facility Entsorgungsbetriebe Simmering (EBS). They indicated that predicting the amounts and kinds of wastes to be received was difficult - influenced in part by changes in legislation and in part by trends in the economy - but was crucial to the economic viability of a facility. The experience of similar plants plus a knowledge of local economic/legal conditions were researched.

- C. Dipl.-Ing. N.K. Vestergaard of Chemcontrol, Denmark, described the collection network created in that nation at the instigation of municipalities. In his view it is important to permit households to deliver their potentially hazardous wastes (solvents, pesticide residues, etc.) for free, and to locate the deposit stations conveniently to existing sewage treatment plants or landfills so their personnel can assist with the household disposal stations. The availability of mobile collection vehicles is another important component of the collection network, which feeds all wastes to the central treatment facility in Nyborg.

In his view the most important thing for developing countries is to perform good feasibility studies to see what wastes are being generated and to keep up with changing trends of wastes generated.

In discussion he indicated that the location of small municipal collection facilities had not proved controversial but that the needed expansion of the Nyborg facility had.

- D. Dipl.-Ing. Charles Peter Naish of CIBA-GEIGY, Switzerland, discussed management of special wastes from the point of view of a producer of such wastes. In his firm there are small quantities of many different wastes. They must be sampled and carefully characterized as a basis for choosing the appropriate disposal option. There are risks posed by transporting the wastes, incinerating them (emissions) and placing them in landfills (leachates).

The treatment method selected must correspond to the nature of the risks posed by a waste. Treatment costs are not as a matter of policy to preclude adequately safe disposal. They are a factor in deciding whether the wastes may be generated in the first place. Wastes are to be handled with the same attention as raw materials and end products. Records of both internal and external transfer of wastes are maintained. Only wastes in a form compatible with the earth's crust may be landfilled in the future, and post-closure control of such landfills is an important - and difficult to predict - aspect of the cost of establishing and operating them.

He noted that in developing countries, landfills are sometimes not adequate for the disposal of special wastes but the only option authorized, thus resulting either in water contamination or costing considerable pre-disposal treatment costs. Access to such landfills is often not adequately controlled and post-closure considerations often are neglected. Incineration capacity is also frequently lacking in developing nations.

New and clean technologies are the prime need for all nations.

In discussion he indicated that in some instances, obsolete stocks of hazardous materials are returned to the point of their manufacture in Switzerland, when suitable local disposal facilities are not available. Customs or export impediments may exist in some such cases.

E. Dr. H. Zoidl of AUSTROPLAN, Vienna, reviewed current and future technologies for waste management. The former are used to treat hazardous wastes, the latter to avoid or reduce their generation. Each may be either traditional or modern. He proposed the following hierarchy of hazardous waste management options:

1. Substitution of existing technologies by alternative technologies generating less or no hazardous waste.
2. Recovery of valuable materials from separated waste streams thus reducing or eliminating the hazardous waste problem.
3. Processing of hazardous waste in an onsite or offsite hazardous waste treatment, storage- and disposal-facility.

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EXPERT WORKSHOP ON
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AND EMERGENCY PLANNING

DRAFT SUMMARY OF PROCEEDINGS

June 23, 1987

I. Morning Session: Technologies in Waste Control and Waste Reduction; Low Waste Technologies (Session Chairman - Joop van Stratum, Manager, Montair Andersen BV, Holland).

A. Jack Brady, Chairman, Crown Anderson, Inc., Georgia (USA), made a presentation on incineration of hazardous and toxic wastes. He described incineration as the most universal, least controversial disposal method for hazardous wastes, which is employed after waste reduction and pretreatment have been accomplished for the estimated 1 billion tons/yr of hazardous/toxic wastes generated worldwide (1/2 of which occurs in the U.S. and Europe). It requires secondary emission controls. There is a serious shortage of incineration capacity, in part due to the continued acceptability of disposal by landfill, in part to opposition to siting of incineration facilities, and in part to the potential liability of the operators of such facilities.

Mr. Brady reviewed the elements of incineration and the different kinds of traditional and new incineration equipment and their operating characteristics. He made clear that both gases and particulates must be removed from incinerator emissions. These components of the exhaust, as well as its temperature, make heat recovery more difficult, but some of the operating costs can be recovered.

He concluded by presenting the plans and costs of a planned facility for incineration of wood preservation wastes and wastes from hazardous waste disposal sites in Louisiana, USA. Its construction costs are projected to be \$60 million and its yearly operating expenses \$140 million for 350,000 tons of wastes. Revenues are projected to be \$200-220 million/year, thus indicating that hazardous waste incineration may be a promising field of investment for developing countries.

- B. Dr. El-Mahgary, Technical Research Center of Finland, spoke about Cost Effectiveness of Selected Low and Non-Waste Technologies for Energy Production, i.e., those most suitable for developing countries. He reviewed, from technical, economic and environmental viewpoints, low/non-waste technologies for (a) production of electricity and heat, (b) waste utilization and management, and (c) pollution control techniques. Low/non-waste technologies attempt to reduce wastes/emissions while saving raw materials and energy, thus protecting the environment while conserving resources. Dr. El-Mahgary concluded his presentation with some recommendations (1) for measures to coordinate agency activities within a nation in this field and (2) for measures to promote such technologies, e.g., ad-hoc groups of representatives of government, university, research, and industrial organizations to coordinate activities that publicize the technologies and their applications, and to cooperate internationally; and (3) for the formation of a high level policy group. He also suggested integrated energy planning, and provisions for promoting low and non-waste technology either in a single legal or economic document or in several of them. Finally, he urged coordination between UNIDO, ECE, and UNEP in the field. He suggested UNIDO should follow-up pilot projects in the countries and should sponsor an international coordination body, to suggest international activities, e.g., distribution of the ECE compendium.

In the discussion of the first two papers it was pointed out that the ECE compendium has been published and disseminated;

2-3 more technologies are added yearly. UNEP has summarized these and distributed them widely. UNEP and UNIDO are now discussing how to collect commercially viable low/non-waste technologies in use in developing countries, and how to verify that they are viable.

In response to the question whether existing boilers and cement kilns could be used for hazardous waste incineration, Mr. Brady responded that because the motivation is to produce energy or cement, boilers and kilns are inadequate to control hazardous waste incineration emissions, and also, there is incompatibility of boilers/kilns with the products of combustion. If one burns pcbs in a cement kiln for example, they will be found in the cement. He acknowledged that monitoring of ambient air quality around incinerators is to date inadequate. It is possible that some toxic substances will be found.

- C. Dr.H.J. Bart of the Technical University, Graz, made a presentation on a new liquid membrane permeation (LMP) process for recovery of metal ions, an example of a low waste technology, and compared it with conventional beneficiation processes. The LMP process can recover high percentages of metals, e.g., zinc, copper, cadmium and lead, from low tenor feed solutions such as leaching solutions from tailings and natural mine waters. Dr. Bart described the process and the conditions under which it is economically advantageous.
- D. Dr. Jorg Aadahl, President, Safeware, Inc., California, spoke about how to prevent waste of human resources. Humans depend on chemicals for well-being. Some chemicals have short and long-term negative effects on human and environmental health and on future generations. We need to be responsible to manage our activities to prevent these effects and the repetition of mistakes. The safe way is both an economical way and the only ethical way, he suggested.

Plant managers responsible for operations need tools for managing information about how to use chemicals safely. The Safechem II software data base package provides management a system for planning to reduce risks and for reacting to emergencies with approximately 1000 chemicals. The package can be operated in IBM PC's or equivalent personal computers.

In discussion, Dr. Aadahl said that if a chemical is entered in the system's data base, it can be identified from a description of its characteristics; that there is capacity in the program for entering a password for protecting confidential data; and that the program has been used by governments in connection with the issuance of permits.

- E. Dipl.-Ing. Heinz Birkenberg of Chemserv Consulting, Linz, stated that 100 million tons of phospho-gypsum are produced world-wide yearly. If it is dumped, it will contaminate fresh or sea water. It can be made into plasterboard; added to cement; converted to ammonium sulfate; and converted into sulfuric acid and cement clinker. The latter possibility may be attractive in developing countries that wish to start or expand phosphorous fertilizer or phosphoric acid plants that produce phospho-gypsum as by-product, because the conversion to sulfuric acid and cement produces two other useful products, thus saving the costs of purchasing them separately. Mr. Birkenberg described the technical and economic aspects of the conversion process, and indicated when it would be environmentally and economically advantageous.

In discussion it was observed that in many developing countries fuel is not available inexpensively enough for this process to be economic.

F. Dr. Kevin Whiting, Kaldair Ltd., England, discussed the problems of incinerating difficult hazardous wastes, e.g., those containing chlorine, fluorine, or heavy metals. He reviewed the kinds and characteristics of such wastes and their effect on the design requirements of incinerators that can dispose of gaseous, liquid, and solid hazardous wastes. Temperature, residence time, turbulence and mixing, and excess air are the principal design parameters. He described different kinds of incineration systems, their operation and uses, and presented the design and the economics of an incinerator for chlorinated wastes where waste heat and hydrochloric acid are recovered.

In discussion, he recommended that trial burns be conducted for an incinerator before it is authorized to operate, to make sure it operates as designed and in compliance with legal requirements. He indicated that his presentation was focused on incinerators designed for on-site disposal of specified wastes, rather than for commercial incineration of a variety of wastes. It is when large commercial incinerators change the materials they are burning without adequate adjustments to the incinerating conditions that environmental effects are most likely to occur, he noted.

In discussion it was suggested that hazard/risk analysis procedures should be made available to developing nations so they can evaluate the potential for accidents from particular projects and call for appropriate siting adjustments or design modifications.

II. Afternoon Session: Risk Assessment/Risk Management (Session Chairman: Prof. Hanns Abele, University of Economics, Vienna).

A. Risk Taking in Uncertain Environment by Prof. Dr. Hanns Abele, Ordinariat für Politische Ökonomie, Vienna, Austria

Dr. Abele highlighted the problem of risk allocation in a society from the economist's point of view. He started with discussing the expected utility model of the individual decision-maker being a basis for problems of a more aggregate level. A serious obstacle for a collective decision process is, however, the by now well established deficiency to process probability informations. Psychologists produced a lot of evidence that underlines this impression. In addition very often information is lacking thus further hindering the possibility of reaching national decisions. Turning to economic mechanism for the handling of externalities and managing risks, two basic solutions have been proposed: One is to rely on government regulation, the other to use a market setting and a bargaining process. Both of them can fail, however. The increasing awareness of people of the environmental hazards leads them to try to oppose being exposed to risks. This implies a serious conflict between private and public interests. Economic theory is only about to study important inputs for the design of adequate allocation mechanism. Thus a lot of research has to be done to implement the economic and social side of management of risks.

B. Modelling of Uncertainty in Hazard Assessment by Prof. Niels Lind, Director of Institute for Risk Research, University of Waterloo, Canada

The key for successful risk modelling is consistency and comparability. Uncertainties include: "Rundownness", indeterminacy, vagueness and model uncertainty. Extended Bayesian theory enables one to transfer probabilistic values (fuzzy concepts) into absolute measurable numbers with power to assess risk goes the responsibility to assign risk rationally. Discussion from the floor highlighted the issue of "perception" of risk, thus the needs for risk communication between the expert, the decision maker and the affected public.

- C. Computer-Based Information and Decision Support Systems for the Management of Hazardous Substances and Industrial Risk by Dr. Kurt Fedra, Project Leader, Int. Inst. for Applied Systems Analyses, Austria

The systems approach deals with the total life cycle of hazardous substances. The first module is data-base system (e.g. description of an accident in one industrial installation), another component is information and simulation on waste streams. Models simulate emissions on accidents and potential impact on the environment. The model evaluates alternatives and tradeoff between risk and cost. Such models are support tools for technical and non-technical decision makers.

- D. Fault-Tree Analyses and its Application to an Exothermic Reaction by Dr. U. Hauptmanns, Gesellschaft für Reaktorsicherheit, FRG

A fault tree analysis logically describes a system and undesirable events in a step-wise deduction of conditions. Reliability data are used to assign probability of such event. A key to successful application is through knowledge and experience with the evaluated operation. The results of the fault-free risk analysis can be used to redesign the process or to improve the operation to minimize risk by a factor of ten. The results are however, used as tool for the professionals to make decisions that are aimed at enhancing safety of design and operation.

- E. Risk Management in the Netherlands: A Quantitative Approach by Dr. C.J. Van Kuijen, Deputy Director for the Environment Ministry of Housing, Netherlands

The models are tools to quantify risk and support decision making concerning activities related to activities in installations and transport of hazardous substances. The process is based on: (1) identification (2) quantification (3) assessment and (4) control of risk.

The risk aspect is based on chance of occurrence and its magnitude aided by computer quantification for comparison against the specified criteria (eg $10^{-6}/\text{yr}$). The ultimate use of this analysis is policy setting and zoning for housing and hazardous waste pipelines spacing based on individual and group risk.

Discussion from the floor identified that this approach is a tool in aiding decision making in conjunction with other criteria. These criteria are now used for new plants and plant expansions based on risk exposure outside the plant boundary.

- F. Status of Development of Probabilistic Safety Criteria as Developed for Nuclear Plants and Chemical Process Industry by Dr. E. Niehaus, IAEA, Vienna

Dr. Niehaus emphasized the applicability of probabilistic safety assessment (PSA) that has been developed for the nuclear industry, to the chemical industry. This is a systematic approach to analysis and to what could go wrong and consequences thereof.

- G. Industrial Risk Assessment: The Danish Practice and Experience by Mr. Niels Vestergaard, Project Engineer, Chemcontrol, Denmark

The Danish experience indicates that a simpler approach for small plants is adequate. This is often accomplished by a few pages of analysis of hazards related to the operation. Only few plants prepared risk analysis, however since last year more plants have prepared risk analysis in accordance with the European Community Guidance. Policy setting on acceptability of risk is the decision of the Danish Parliament. The decision may be complicated by not including all aspects of risk such as transportation of hazardous materials.

H. Risk Assessment by Means of Detector Tubes in the Chemical Industry by Dr. Mohrmann, Drägewerk Aktiengesellschaft Lübeck, FRG.

Dr. Mohrmann discussed the applicability of detector tubes as a simple and practical means of risk measuring devices in the chemical industry. These are primarily applicable to gaseous phase compounds as well as qualitative determinations of some volatile compounds in liquid and in a soil matrix. Detector tubes could be also used to qualitatively test for unknown substances in situations such as spills and industrial accidents. Discussion from the floor indicated concern over the applicability of detector tubes in hazardous substances, accidents or spills. UN placards and labels are usually used by fire fighters in the US. Inexpensive portable gas chromatographs are also becoming valuable tools for detection of volatiles in the environment.

UNIDO
EXPERT WORKSHOP ON
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SUMMARY OF PROCEEDINGS

June 24, 1987

I. Morning Session: Developing Countries' Experiences, Problems, and Prospects, (Dr. Krishna Murti, Chairman, Scientific Commission for Continuing Studies on Effects of Bhopal Gas Leakage on Life Systems in India, served as Session Chairman)

A. J.G. Wain of Wain Scientific and Technological Services, Ltd., stated that developing countries where financial and technical resources for pollution control work are limited should concentrate on major sources of pollution, i.e., processing of foodstuffs and production of chemicals. Pollution control measures should consider practical aspects, financial aspects, the nature of the substances discharged, the size of the plant, and the location of the plant. They should be flexible to allow consideration of each case on its own merits. Costs of pollution control equipment should normally not exceed 25% of capital costs and 10% of operating costs, cumulative poisons are discharged, in which case these figures may be higher.

Information necessary for granting an initial licence to build may be obtained by a questionnaire covering layout, flow sheets, and mass balance of processes involved; air emissions; liquid and solid wastes; degree of recycling; and plant safety conditions. At the design stage, developers are often amenable to negotiating the inclusion of pollution control equipment. Pollution control equipment should be regarded as part of the production.

Operating or manufacturing licenses should include pollution control requirements or, where applicable, these could be included in the lease agreement.

Enforcement mechanisms need to be effective. Closure orders are more effective than fines, which firms tend to just pay.

Mr. Wain then reviewed available pollution control processes and equipment, specifically, dry and wet processes for treating gaseous emissions, processes for dealing with liquid discharges; physico-chemical processes; aerobic and anaerobic biological processes; and processes for dealing with solid waste. He then covered several means of communication to improve plant safety, e.g., identification systems (color coding, hazard warning signs); safety equipment; training; proper storage (make sure of drainage and of compatibility of materials); and working conditions. What specific control processes are chosen may best be decided by a team of technical persons experienced in all aspects of industrial process design and operation, but should be decided at the design stage.

Once equipment is in place, it must be regularly inspected and maintained. Safety equipment should be tested under field conditions, in the presence of the pollution control inspectorate.

Developing countries should use this Workshop to make themselves aware of the wide range of technical assistance available through UNIDO. They should make their requests for assistance 'sooner rather than later' that is, before industrial pollution becomes an overwhelming problem.

- B. Prof. J.M. Dave - School of Environmental Sciences, Jawaharlal Nehru University Delhi, spoke on "Industrial Management of Hazardous and Toxic Materials in Developing Countries Based on Case Studies in India".

Prof. Dave said case studies of three serious accidental releases of toxic materials in India point to difficulties with management. In order to know how to minimize such releases, it is necessary to analyse why they occur. Is management aware of the chemical, whether there was a potential for such an incident, what the status of the equipment was? Managers may have known such things, but supervisors and operators did not, it was found.

In the design of a plant, one needs to consider plant safety, protective measures, site selection, what kinds of skills are needed to handle the hazardous substances; warning systems; and disaster plans.

Agencies responsible for licensing must be aware of the levels of risks posed by kinds of industries; must have done a risk analysis on incidents and their consequences; must insist on safeguarding systems; must require availability of specific skills to handle the substances involved and to carry out the measures needed to handle accidents; inspectors need to be trained; emergency plans need to be prepared; zoning needs to consider compatibility of land uses.

The public needs to be aware of what the alarms mean, what the risks are, and what to do to avoid them. Medical people need to know how to treat people exposed to particular substances.

Agencies need to be able to obtain information from companies of hazardous materials used, with protection of trade secrets.

This conference can contribute:

- (1) guidelines on management of hazardous materials handling in industry;
- (2) a system of classification of plants by levels of risks;

- (3) the elements of risk analyses that should be required of plants;
- (4) the components of public information requirements and emergency response plans in case of accidents, including medical treatment required.

C. Prof. Asit Biswas, President, International Society for Ecological Modelling, Oxford, England, Environmental Aspects of Hazardous Waste Disposal: Problems and Prospect for Developing Countries

He stated that information on amounts and kinds of hazardous materials is unavailable and unreliable in developing countries. There is a need to see how technology is actually operating in developing countries - and it is only one factor to consider, in concert with other social, political, economic and manpower factors. Otherwise, technology transfer won't be successful.

Need to be realistic - not too sophisticated - in making proposals for developing countries. Elaborate legal systems, for example, are only a beginning. There are manpower shortages. Government officials need training to be more effective.

Monitoring systems are easy to establish. But people need to be paid adequately so they will report what the equipment actually says.

UNIDO could provide:

- (1) response with a team of experts when there is an accident;
- (2) training
- (3) environmental impact assessment methodology that is simple and inexpensive. USA approach is inappropriate in developing countries, perhaps even unreliable.

- (4) a network connecting agencies among developing countries, as well as between developed and developing countries.

In discussion, it was suggested that training of industry and public personnel is necessary for accident response. Disaster plans include training for police, fire, government agencies, and medical people, it was responded, but training plans, too, must be realistic.

It was asked if it is UNIDO's role to train people outside industry. WHO trains medical people; UNEP trains those outside industry. To this it was answered that training government officials in monitoring and pollution control would be within its mandate.

Are there no operating manuals for such plants? Would industries welcome outside assistance?

UNIDO could train people to provide training locally. External help is needed to set up the program, but training should be conducted locally.

How could UNIDO assist with improving information and controls within a plant.

International Atomic Energy Agency sends inspectors. Could an analogous inspectorate be developed for this field?

Liability is a useful additional instrument to encourage companies to establish controls. UNIDO could assist developing countries to prepare adequate liability regimes.

India's air pollution and industrial hygiene standards are indigenous, not imported from the West. Strict standards are necessary to protect Indian workers, who have lower resistance due to lower nutritional levels.

UNEP raised with OECD the idea of an international inspectorate, but OECD nations resisted energetically. UNEP

has proposed a three-point program in this field. Results of the UNEP governing Council reaction should be reported Thursday.

Governments must permit UN agencies to do things. Governing Council in 1985 did not authorize UNEP to do more than collect and distribute information on accidents.

Need is for more resources, not for more institutes. UNIDO needs assistance in finding such resources, so it can be more effective.

Awareness may be raised by Workshops and publications issued by UNIDO now. UNIDO is tentatively planning to provide teams to respond to accidents. UNIDO has an investment and a technology assessment program - but it could require more risk assessment in connection with its technical assistance.

Turnover within plants is a reason why workers are not available who know what to do in case of an accident. It is due to low wages and to political factors, including union activities. But turnover in hazardous materials in industry is higher than the average in India.

Operational manuals must be read by more than supervisors, must be made available in workers' language, and must be incorporated into the workers' responsibilities.

- D. Dr. Filemon A. Uriarte, Jr., Director, Bureau of Science and Technology, ASEAN, spoke on Hazardous Waste Management in ASEAN Nations, with an Emphasis on Small and Medium Industries.

He described ASEAN nations' growing population and industrialization, and their impact on natural resources and the environment.

ASEAN has adopted the principle of environmentally sound and sustainable development, and established four policy

guidelines. Hazardous waste management is an important part of ASEAN's third environment program, with four goals. It has proposed five projects to implement these goals; these projects need funding.

He surveyed the information available about hazardous waste in ASEAN nations, with a focus on the situation of Singapore. He observed that the gaps in this information indicated the need for greater regional and international cooperation.

Dr. Uriarte recommended that guidelines and training plans for hazardous waste management take into account the limited financial means and technical expertise in small plants, the small amounts of wastes generated, and the unavailability of space for waste treatment facilities.

- E. Dr. R.N. Chakrabarty, UNIDO Environmental Pollution Control Adviser, Bangkok, spoke on Environmental Control Measures for Toxic and Industrial Wastes of the Eastern Seaboard Industrial Complex in Thailand.

Thailand, an ASEAN nation, is fast becoming an industrialized country, as a result of development of natural gas about a decade ago. He described the proposed development of two areas on the eastern seaboard, with a focus on the multiple heavy industrial complex -- including fertilizer, mineral processing, and petrochemical plants. Environmental impact assessment studies, based on National Environment Board (NEB) criteria (which are applicable to developing countries), were carried out for each of these plants, which identified the toxic wastes to be generated. Before design of pollution control, both the method of disposal and the adequacy of control standards were considered. Disposal into the Gulf of Thailand was not favored because of already existing pollution and the existence of resort islands there. Therefore, full treatment was needed before disposal into the ocean, based on new NEB standards for the pollutants involved. Dr. Chakrabarty described the treatment systems developed for the fertilizer complex, the petro-chemical complex, and the tantalum complex.

F. Dr. Ahmed Amin Ibrahim, Head of the Central Department for Industrial Construction G.O.F.I., Cairo, spoke on the Re-use, Recovery and Recycling of Industrial Hazardous Wastes in Egypt. He reviewed various definitions of hazardous wastes, and indicated that the full range of hazardous wastes needs to be made clear to workers, supervisors and engineers. He added his own definition of hazardous waste, i.e., materials are hazardous when they exceed the assimilative capacity of the ecosystem into which they are introduced. He said ecosystems can absorb some toxic wastes, and that this capacity should be taken into account in considering how to dispose of them.

Most of Egypt's regulations are for sanitation, not hazardous waste management. Before the Aswan dam was built, hazardous materials discharged to the Nile were washed away in floods. Thereafter, treatment was required. First priority was given to 25 processes in 19 companies. He expressed the concern that treatment standards be developed with a heavier emphasis on the limited financial capabilities of developing countries. He recommended re-use of materials as a means of enhanced productivity and recycling of water as necessary in the face of the scarcity of that resource. He approved of UNIDO's efforts to prepare a manual for project evaluation, and recommended environmental impact analysis of all development projects, including those proposed with foreign investment.

He surveyed the nature and causes of risks from industrial operations, noting that in developing countries most accidents result from workers ignoring safety rules or devices.

He recommended UNIDO develop a simplified EIA manual similar to its manual on industrial feasibility studies, and conduct training of government licence-granting personnel in its use.

He also recommended UNIDO assistance in risk assessment programs; emergency response plans; information development about handling, transportation and storage of hazardous

materials; selecting low cost treatment technologies; and emphasizing recycling/re-use of industrial wastes.

He concluded by urging developing countries to emphasize recycling and environmental impact assessment and to develop their own legislation rather than adopting that of developed nations.

- G. Dr. Krishna Murti of India, session chairman, spoke on the Health Implications of Hazardous Waste Disposal. He urged health be the central reason for the efforts to control hazardous materials, or relevant results will not be achieved. Increasing industrialization of developing countries poses increased health threats to the populations of these countries. He reviewed the various sources and kinds of hazardous wastes in developing countries. The several impacts of exposure to such wastes on human health were reviewed, as were the routes of exposure. He proposed a formula for setting priorities for assessing the risk of chemicals for their health impacts, acknowledging that deciding on acceptable levels of risk is an indefinite process. He showed the specific health effects of chemicals, and discussed environmental and biological monitoring as tools for assessing the extent of human exposure. He recommended expanding epidemiological studies of the health effects of chemicals in the environment, and suggested priorities for such studies, beginning with investigative epidemiology and continuing with preventive epidemiological services.

We Need to find out what resources are available for environmental and biological monitoring, and integrate the findings of such monitoring with epidemiological studies and services, in order to formulate cogent policy for hazardous materials management, he concluded.

In the discussion of Dr. Murti's paper, health was acknowledged as of prime importance in controlling the effects of chemicals.

Occupational exposures and transportation-related accidents as kinds of exposure were mentioned as additional routes of human exposure, in addition to media-based exposures.

If hazardous wastes were not generated or handled properly, there would not need to be epidemiological studies of their effects, it was observed.

Because hazardous wastes are chemicals, it does not make sense to distinguish between their health effects.

The need for developing a mechanism for long-term identification of lands that have been used for waste disposal was mentioned. It was suggested that UNIDO could assist developing countries with finding such mechanisms, e.g., via a land records system.

In discussion of Dr. Chakrabarty's paper, it was observed that changes in the raw materials used in developing countries in industrial processes received from developed countries may make the treatment processes recommended by developed countries for those industrial processes inappropriate.

In response to Dr. Ibrahim's paper, it was suggested to include risk assessment within environmental impact assessment. It was also observed that it is difficult to know when the assimilative capacity for hazardous materials is exceeded, so that building the component of exceeding this capacity into the definition of hazardous materials is not helpful.

Unless one approaches these problems in developing countries from a holistic human health perspective, scientists cannot adequately inform the public, Dr. Murti commented.

It is especially difficult to predict the effects of mixtures of chemicals on human health, he added.

II. Afternoon Session: Developing Countries' Experiences, Problems and Prospects (con't) (Session Chairman, Dr. Asit Biswas, President, International Society for Ecological Modelling)

- A. Dr. Amir Metry, President, Weston International, Inc., spoke on a Balanced Approach towards Hazardous Waste Management in Developing Countries

One must balance environmental quality with health, economy, and energy concerns, he noted. Each nation must make its own decisions in formulating balanced policy, in the face of limited resources. Technology must be coordinated with social, political and economic considerations. Waste reduction is prime effort; recycling is second priority (keep wastes separate to facilitate this); incineration and land disposal follow. There is no such thing as a secure landfill.

The incentive for developing countries is to save the costs now, by doing waste management correctly at the onset. It is more expensive to remedy problems later.

If there are contamination problems, one must do sampling and assessment of them; decide whether to treat groundwater; do regradation/recovering; do containment, encapsulation, fixation. Costs of clean-up of inactive sites are very high, he noted.

- B. Dipl.-Ing. Peng-Ming Wu, Senior Engineer, Beijing Municipal Environmental Monitoring Center, spoke on The Present Status of Ancient and Modern Hazardous Waste Management in Beijing. She described three sources of mercury pollution in river and lake sediments, color (red) paint on ancient buildings in the Forbidden City; ancient gold plating techniques; and other materials (e.g., red powder earth) used on ancient buildings and the Red Wall of the Forbidden City. The effects of this pollution were studied in the mercury content of the hair of workers inside and outside the area, and in levels in plants and animals. Human hair levels were approximately the same,

but higher in plants from within the area. No direct health effects were determined, but it is being monitored.

After 1949, population and industrial production multiplied six fold and two hundred fold respectively in Beijing. In the past decade, toxic discharges have been reduced by more than 80% through the activities of the Beijing Environmental Protection Bureau.

- C. Dipl. Ing. Shi Qing of the State Environmental Protection Agency, PRC, listed the regulations issued by the state Council to govern hazardous chemicals. Large cities also issue their own regulations. In February 1987, the Council issued regulations for the safe management of hazardous chemicals, including explosives, compressed gases, toxicants and corrosives. Toxic and hazardous materials may not be produced in small-town plants. Plants that are to be constructed or expanded must be approved by the next higher level of government than the one where it is located. Ms. Qing described the system of registering and permitting the use, storage, transportation of hazardous chemicals, and the enforcement of these regulations. She also surveyed the standards and treatment for the ten most important of China's 40 million tons/year of hazardous wastes.

She concluded with a description of China's environmental education programs, in schools and camps and on television, as a means of raising consciousness of and compliance with environmental requirements.

- D. Prof. S. P. Mahajan, National Director, Pollution Control Research Institute, discussed Hazardous Waste Management in India

India is primarily agricultural and rural, he noted. Many industries are on a small or cottage scale, and the costs of treatment are often more than total capital investment. Many sources are uncontrolled, e.g., those in slums. Location of

many cities by rivers is also a disadvantage. Hazardous wastes have not been systematically handled.

Information, as a basis for corrective actions, is being gathered. In many industries, large and small, operations are kept secret, with the result that it is not known what materials are kept, where, how much, or what happens when they are spilled. And agencies must share the information. UNIDO could assist with the development of a data bank for this purpose.

Companies need incentives not to hide information on hazardous materials and not to avoid spending money on them rather than sanctions, he suggested.

UNIDO could give guidelines for legislation, as well, especially concerning transportation of hazardous materials.

Also needed are special guidelines for environmental impact assessment in developing countries, because their social conditions are different.

In discussion, it was pointed out that lack of coordination is not limited to developing countries. Nor is absence of information on kinds, amounts, and locations of data about chemicals on-site.

Both developed and developing countries may have a large number of small-scale industries, e.g. 370 individual platers in Delhi. Common treatment plants can be a partial solution to such small, dispersed sources of hazardous wastes. Big industries can treat their wastes themselves and spend more on doing so proportionally to size of plant.

Low waste technologies should be included in guidelines for developing countries.

Information on what chemicals companies have, in what quantities, and what risk potential there is - this is what's needed. Process information is sensitive to the companies because of their concern that it will fall into competitors' hands.

Should UNIDO focus on needs of small companies, on the assumption that larger companies can take care of themselves?

Developing countries can solve their own problems, if they want to, without asking UNIDO's assistance for them. UNIDO cannot effectively provide answers to all these problems.

UNIDO could report countries' successes in solving their own problems.

- E. Frank Varga, Head of the International Relations Branch, Chemical Complex of Borsod, Hungary, spoke on the Re-use and Annihilation of Hazardous By-Products and Wastes Derived from Different Chemical Technologies at the Chemical Complex of Borsod.

Borsod (BVK) produces \$250 million chemical products annually. Mr. Varga explained the technology by which BVK uses waste materials in each of its production processes, i.e., nitrogen-fertilizer, polyvinyl chlorides, plastic-processing, and also medicine intermediates and plant protection agents. Wastes that cannot be re-used are classed as industrial sludges, industrial solid wastes, poisons, and hazardous wastes. Mr. Varga described the handling of each, as well as BVK's waste-water treatment.

Mr. Varga concluded by offering the services of his organization in collaboration with UNIDO in the training of engineers at the BVK waste-water plant and outlined the tentative contents of the proposed 3-month program. He also offered to make BVK's personnel available for a list of specific functions, via UNIDO.

- F. Prof. Edward S. Kempa, School of Engineering, Zielona Gora, Poland, discussed Trends in Waste-water Management.

Waste water should be considered hazardous, he said, because of the presence of heavy metals, pcb's fertilizers, etc. Waste water should be treated so that it can enter water courses without objection from the standpoint of legal requirements. Technology, however, has limits to what it can accomplish by way of treatment. And economics also impose limits on what can be done. These two sets of limits will indicate reasonable treatment levels.

If plants don't spend enough on treatment, social costs are increased unless these costs are re-allocated or the plant is relocated. One means of addressing this is to require plants to discharge their wastewaters upstream of their process water intakes. He reviewed the economics of balancing firm costs and social costs, the four levels of wastewater treatment, and the health criteria for different uses of waters. He submitted preferred methods of pretreatment of industrial metal-containing wastewaters and of treating municipal wastewaters.

Trends in water treatment include intensifying biological treatment processes, via aeration; increasing anaerobic processes (but there are many questions about them); and the deactivation of sludge.

- G. Dipl.-Ing. Karl Rohrhofer, General Manager, General Water Consulting Corp., spoke about Policies and Legal Aspects of Hazardous Waste Management for Developing Countries.

He suggested regional plans for hazardous waste management focussed on local circumstances, as well as for location of new industries, followed by the preparation of a hazardous waste management plan. He recommended the designation of a company (perhaps partly publicly owned) to be responsible for operating the landfill for hazardous wastes.

Mr. Rohrhofer also presented a paper on landfill disposal of anorganic wastes from galvanizing plants in Austria.

In discussion of Prof. Kempa's paper, it was suggested that the idea of requiring a plant to discharge its wastewaters upstream of an intake was not appropriate for developing countries, but for intensively-used rivers such as the Ruhr in Germany or the Ohio in the USA.

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June 25, 1987

I. Morning Session: Industrial Safety and Training/Legal Framework
(Chairman: Prof. Niels Lind, Director, Institute of Risk
Communication, University of Waterloo, Canada).

A. Dr. Tomschik, Association of Austrian Chemical Industry, spoke
on Terminology & Legal Aspects of Hazardous Waste in Austria.

He described the development of the Austrian industry's special waste catalogue beginning in 1980. It adapted the 5-digit code and kind of waste format employed in the Federal Republic of Germany, and added a column for potential disposal possibilities, with rankings. The association also developed a separate list of hazardous wastes, after the enactment of the Austrian federal law in 1983, based on elements of the Swiss law on toxic substances and the Federal Republic of Germany's water-endangering criteria from classes II & III, and the listing of properties in the ADR.

Dr. Tomschik suggested it was important to have technical installations available for disposal of hazardous wastes at the time of enactment of legal requirements, so the public's expectations are not disappointed. If they are not available, compliance should be voluntary or suspended. He urged coordination in the implementation of the provincial laws on domestic waste disposal with the implementation of the federal law on special/hazardous wastes.

B. Dipl.-Ing. Muuka, UNIDO, made a presentation on Strategies & Policies in Management of Safety in the Petrochemical Industry

He pointed out the need to prevent accidents so that capital is not diverted from important development in order to remedy the damage from accidents. He presented lists of practical and theoretical elements of safety in the field of petrochemicals. He emphasized the importance of the interface between human and technical factors: selection of personnel to operate machinery, and dedication of management to implementing safety rules are crucial. Rules should be adapted to the functions of the personnel - more complete for supervisors, simpler for line workers.

He recommended that UNIDO could provide ad-hoc disaster follow-up teams that would disseminate reports containing recommendations for preventing disasters and conduct meetings concerning occupational safety improvements.

C. Mr. Will Irwin, Esq., spoke on Legislative Measures to Prevent and Respond to Chemical Accidents. He pointed out that the objectives of policy are embodied in laws, and therefore definition of those objectives must precede the development of legal provisions and procedures, including the lists of substances whose use or handling should be regulated. He suggested that the information about these substances be presented in a form and at a place that will be most useful for purposes of preventing and responding to accidents.

He suggested UNIDO's efforts in the field of hazardous materials be coordinated with those of other UN agencies.

He also suggested UNIDO could help provide checklists for developing countries to review in preparing their laws, based on the provisions of existing legislation and the experience in implementing it.

- D. Mr. J. Bormans, Federation of Belgian Chemical Industry, spoke on the Legal and Regulatory Aspects for Safety and Hygiene Provisions in Belgium. He described the organization of industrial safety under the 1952 amendment of Belgian law, specifying the functions of the safety service, the safety-hygiene committee, and their associated medical and fire committees.

He described the requirement of Belgian law for certifying the safety of equipment before it is put into operation.

He recommended UNIDO re-distribute its report from a Dakar conference on safety and accident prevention and coordinate with the OECD in its current preparations for a high-level meeting on this subject next year.

- E. Mr. N.C. Thanh, Thailand, discussed strategies for major accident prevention in the chemical industry in Thailand. He reviewed legislation governing the chemical industry in the nation and the agencies that implement it. He reported the results of a survey of industrial accidents in the country, noting that the fatality rate of workers in the chemical industry was 53.7/100,000, due in large measure to worker unwillingness to follow safety provisions. He described the findings of the hazardous conditions existing in and around plants and the plans for addressing those conditions.

- F. Dr.-Ing. G. Ivanus, Process and Design Institute for the Chemical Industry, Romania, spoke on Criteria for Risk Assessment and Overview of International Regulatory Aspects for Safety Provisions. His remarks were based on the experience of large petrochemical plants. He surveyed criteria for the estimation of risks and displayed a quantification of levels of risk for specific kinds of accident events and of the frequency of kinds of accidents. He presented a comparison of the standards for spacing of processing components in several nations.

In discussion, it was observed that developing countries should, to the extent possible, take an integrated, systems view when developing and implementing policies governing hazardous materials.

It was suggested that criteria for evaluation by government agencies of industry's safety plans could be developed by international organizations, although they would have to be adapted for each nation's circumstances.

II. Afternoon Session: Hazardous Waste Management Technologies/Methodologies and Water Resources Management
(Prof. S.A. Sa de Almeida, Engenheiro Civil e Sanitarista, Sao Conrado, Brazil, served as Session Chairman)

- A. Dr. P. Hacker, Head of the Department of Hydrogeology and Applied Geophysics, Bundesversuchs-und Forschungsanstalt Arsenal Geotechnisches Institut, Vienna, Austria spoke on "Transport of Hazardous Materials by Surface and Subsurface Waters - A Problem for the Security of Water Supplies"

Dr. Hacker said that the acidification and pollution burden on groundwater from fertilizers, pesticides, aromatic compounds, heavy metals, and halogenated compounds. For the assurance of future water supplies, several factors should be considered as follows:

- self purification and adsorption capacities of hard rock aquifers are much smaller than in unconsolidated (i.e. granular) aquifers. This, coupled with greater groundwater velocities in rocks, results in a significantly greater risk at relatively fast contamination transport in rock aquifers.

Prof. Lind made an announcement regarding Mr. Hans Sutter's parting statement. Please refer to Annex I.

Prof. Lind followed with the concept "Low-waste Technology" which has previously been cited as an area of extreme importance. The burden of the development of an organization will be so great that a new society should be developed. Prof. Lind then read the following information (see Annex II).

Prof. Lind then invited the UNIDO Workshop participants to sign up as members.

- B. Dr. J.H. Meyer, C. Eng., Consultant Geologist, Canada, spoke on "The Monitoring of Hazardous Waste Repositories"

Dr. Meyer said that hydrogeology, groundwater pollution and monitoring should be emphasized and that the UNIDO Workshop should place a greater emphasis on these issues. He added that monitoring of hazardous waste repositories forms an inherent part of the safety requirements governing their operational and post-operational periods.

Monitoring activities during repository operations and post-seeding periods were outlined. The use of 3-dimensional solute transport model can be used to aid in the development of monitoring strategies and understanding potential consequences of groundwater contamination. Then, the AMRAW Model was discussed. AMRAW is a compartmental model which can be used to predict radionuclide transport under the constraints of geologic time.

- C. Dr. A. Egger, AUSTROPLAN, GesmbH, spoke about "Hazardous Solid Waste Disposal in geological Environments".

The prevention of groundwater contamination should be stressed because of the sensitivity of groundwater system. Unfortunately, about 68% of the hazardous waste in Canada and the U.S. and almost 50% generated in Europe are disposed of in landfills, most of which are uncontrolled. Abandoned open dump sites, therefore, constitute a permanent potential source

for water resources contamination. Geological, hydrogeological and geotechnical surveys should be utilized for site selection of hazardous waste landfills to insure that groundwater contamination will be minimized. A list of suitable and unsuitable site characteristics which should be considered in site selection was presented.

In discussion, Mr. Bormans stated that hazardous wastes should be stressed and a classification system proposed. However, achieving uniformity in these areas is most difficult because of inconsistent criteria and measurement techniques presently used from country to country.

On the issue regarding utilizing ISO to develop a standard, Mr. Bormans stated this was not possible through ISO but perhaps UNIDO could make recommendations for unified classification. Further comments agreed that the United Nations would be an appropriate mechanism in an attempt to achieve uniformity.

Dr. Lind, the Workshop chairman announced again the creation of IACT, International Association for Clean Technologies.

- D. Dr. Padmini de Alwis, National Aquatic Resources Agency (NARA), Colombo, Sri Lanka, spoke on "Monitoring of Industrial Effluents into a River with a View to Pollution Control"

Industries in Sri Lanka which generate hazardous wastes are as follows:

- (1) paper manufacturing
- (2) textile production
- (3) electroplating
- (4) fertilizer production
- (5) spilled wastes from pesticide formulation and packaging plants

Three legislative acts have been adopted resulting in the development of standards, norms and guidelines. Basic problems associated with hazardous waste management in Sri Lanka are the lack of trained personnel, financial resources to fund waste treatment facilities and the lack of space with existing factories.

- E. Mr. Keiji Natori, Executive Director, Japan Cooperation Center for Petroleum Industry Development (JCCP), Tokyo, Japan, spoke on "Activities of JCCP in the Field of Safety and Environmental Protection"

JCCP is involved in four major activities in the downstream sector of the petroleum industry: (1) training; (2) expert services; (3) international conferences and communications; and (4) studies.

Safety is inseparable from optimally efficient retiring operation, and its absence could possibly lead to disastrous results, compensation and even the total closure operations. Because protection of the environment is required for the petroleum industry and to subsequent users of petroleum products, the development of trained human resources is essential in both safety and environmental protection. From 1981 to 1985, more than 1500 people have attended training sessions and 30 countries have used the expert services of approximately 550 JCCP experts. A list of the training courses and JCCP expert services was discussed.

- F. Dr. M.J. Suess, WHO Regional Office for Europe, commented on the hazardous waste management, occupational health and emergency planning activities of WHO. A WHO text has been published on Management of Hazardous Wastes and is available from WHO in French, Russian and German and has been translated into Chinese. Dr. Suess mentioned that if other countries wish to translate the text into additional languages, that WHO should be contacted.

WHO has developed a numerical ranking scheme on hazardous waste toxicity. Health effects and toxicity of chemicals are listed in a second monograph discussed by Dr. Suess entitled "Identification of Priority Chemicals in Hazardous Wastes prepared by Environmental Resources Limited".

The OECD is active in looking into old sites whereas WHO is working on new sites. The UNEP and WHO are involved with recommending to countries in the Mediterranean region on site disposal of hazardous waste.

WHO has organized Workshops and hazardous waste training Workshop for higher level trainers. WHO can work together with UNIDO on several areas listed by Dr. Biswas in the UNIDO Plan for Action Panel discussion.

- G. Mr. M. Gajraj from UNEP discussed the catalytic role of UNEP in the area of catastrophic events. Joint work with UNIDO and WHO in implementing, funding and operating programs was outlined. A 1-1/2 page paper was passed out which contained addresses and various roles of UN international organizations involved in the environment. Contact points, telephone and telex numbers of the organizations are listed in the pages. A draft UNEP report on hazardous waste management (currently 900 pages) is under review and should be published soon. A series of Workshop starting in 1988 (Mexico) on hazardous wastes are in the development stages.

Mr. Gajraj stated that a UNEP report on community awareness should be available at the beginning of Friday morning's session.

- H. Several questions on Prof. Hoag's presentation regarding soil venting technology were asked. Soil venting has been successfully applied to chlorinated hydrocarbon recovery in unsaturated zone soils. The technology has potential

application in underdeveloped countries as costs may be reduced by reusing several system components and as further research reduces design cost.

Dr. Metry summarized the panel discussion. He added that they will be available before the Friday morning session.

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June 26, 1987

I. Morning Session: Selected Hazardous Waste Management Technologies
- Applied and Under Research (Chairman: Dr. R.N. Chakrabarty, UNIDO
Expert, Bangkok, Thailand).

A. Dr. Vladimir Pavlovic, Prof. Mining Faculty, Belgrade,
Yugoslavia, spoke on Problems of Environmental Protection in
the Areas of Opencast Coal Mines.

Wastes from open cast coal mines are voluminous. It is
important to avoid adverse environmental consequences.

Dr. Pavlovic reviewed Yugoslavia's laws governing mining
operations and reclamation. Site operations emphasize topsoil
retention and replacement, and improvement of soils so that
they can support plant growth after mining is finished, e.g.,
by adding fertilizers. Reclamation may last up to ten years.

Air pollution from mining operations is limited to .2 mg/m³.
Water pollutants - suspended solids, oil, and pH - are
controlled, either by settling ponds or chemical reagents.

Most land is restored for agricultural purposes, although
planning permission may be given for forestry, recreation, and
other purposes.

Mr. Pavlovic mentioned the possibility of using open cast
mining sites for waste disposal.

- B. Dipl.-Ing. Francois Prudhon, Head, Regional Laboratory, INERGERLAB, France, spoke on Methodological Approach of Industrial Pollution Issues.

Soil can be subject to various effects from chemicals, e.g., biological effects, that can be appraised by ecotoxicological tests (e.g., for biodegradability). Mr. Prudhon reviewed various methods of such testing in a (laboratory, e.g., acute toxicity testing on freshwater and soil organisms.

Tests must be selected according to availability, significance, complexity, and reliability, bearing in mind the costs.

He presented illustrations of tests on fish, daphnia, bacteria, etc.

Treatability tests determine how wastes may best be treated, e.g., industrial waste products. Laboratory experiments can be performed on small amounts of wastes; these are quick and inexpensive, but may not be accurate. Or pilot experiments can be conducted; these are more easily extrapolated to an industrial scale. Costs are a factor with these tests, too.

- C. Prof. Sergio Almeida, Engenheiro Civil e Sanitaria, Brazil, spoke on A Methodology for the Determination of Risk Assessment Related to Handling of Petrochemical Products in Developing Products in Developing Countries.

He described Brazil's environmental regulatory structure. He described the environmental impact assessment methodology for an oil and gas pipeline, under circumstances typical of many developing countries. The pipeline had experienced a serious accident and had to be re-appraised. The risk analysis developed for this pipeline included environmental as well as accident-potential aspects, relying on check-lists and practice codes as well as standard risk assessment

methodologies (e.g., event trees, fault trees) to identify potential risks. Risk management recommendations followed the risk analysis, based on social or ecological risks identified and classified.

- D. Dipl.-Ing. Dr. K. Langer, Simmering-Graz-Pauker AG, Vienna, spoke on Fluidized Bed Combustion in the Pulp and Paper Industry. He indicated fluidized-bed steam boilers were employed in this industry in order to dispose of wastes, generating steam simultaneously, and to save energy. He reviewed the wastes treated, the requirements for fluidized bed combustion, and the operating results at two Austrian boiler plants.
- E. Dr. Albert Mayer, SARP Industries, France, spoke on Upgrading Technologies in the Treatment of Phenol Wastes.

Phenol wastes must be separately examined and treated in light of the particular combination of other wastes with them, since phenol rarely appears alone. Dr. Mayer reviewed the current physical, chemical and biological means for treating phenol wastes as well as the results of treating them with sewage in sewage treatment plants (in which case phenol elimination is reduced substantially unless a low phenol level is maintained). He also discussed the current method of treating oil refinery wastes, including phenols. Finally, Dr. Mayer explained the distinction between effluents (continuous flow) and dechets (discontinuous) as wastes, and presented a new method leading to condensation and precipitation of phenols as phenoplasts.

- F. Ir. P.F. van den Oosterkamp, Kinetics Technology International, The Netherlands, spoke on Dechlorination of PCB's, Dioxines, and Difurances in Organic Liquids.

A process for removing chlorinated hydrocarbons was developed as a result of experience with re-refining used oils.

The process was described in detail, and the results of conversion experiments were presented, including almost complete elimination of TCCD at temperatures of about 300°C. The economics of the dechlorination process were also presented.

- G. Dr. Karl J. Youtsey, UOP Inc., USA, spoke on Treatment and Recycling of Waste Oils and Solvents.

He presented a description of hydroprocessing (using catalysts) for the treatment of waste oils produced during refining of petroleum and coal and as a result of automotive and industrial uses of oil. The process is reliable, flexible, and profitable. The process was described as it is applied to used lubricating oils that were contaminated with PCB's.

- H. Prof. Dr. Ir. A. Buckens of Belgium presented a paper on Black Points: Detection, Evaluation and Control.

Black points are contaminated sites. The presentation covered the survey, investigation, and risk assessment of such sites, e.g., waste dumps, former factories, oil refineries, or gasoline stations. In some countries, legislation requires systematic identification of such sites. There are several levels of investigation possible. Amounts and kinds of pollutants must be identified and pathways discovered; threatened zones must then be determined. Geohydrology, soil chemistry and biochemistry are the disciplines involved in conducting these investigations, as well as remote sensing (e.g., infrared photography).

In assessing risks of such sites, the toxicity must be determined, as well as the kinds of public exposure.

Thermal, physico-chemical and microbial techniques are available for reclaiming such sites. Water used in reclamation must be treated.

In discussion, the dubious net environmental benefits of exporting wastes to other countries for incineration was mentioned.

It was suggested UNIDO support efforts for used oil recycling in developing countries.

In the Federal Republic of Germany, used oils that were recycled contained high levels of dioxin. This kind of contamination doesn't exist in used oils in developing countries.

II. Concluding Remarks

Dr. Sonia Maltezou delivered the concluding statements of the Workshop, emphasizing that the momentum achieved in this UNIDO Workshop could be translated in the near future into action and increased co-operation between North-South, South-South, East-West and into closer closer co-operation with other international agencies.

**RECOMMENDATIONS
OF THE
PANEL OF EXPERTS**

**Special Session
25 June 1987**

**UNIDO EXPERT WORKSHOP ON HAZARDOUS WASTE MANAGEMENT
INDUSTRIAL SAFETY AND EMERGENCY PLANNING**

**22 - 26 June 1987
Vienna International Centre
Vienna, Austria**

SPECIAL RECOMMENDATION PASSED ON THE 26 JUNE 1987

- A. Krishna Murti moved, and Dr. C.J. Van Kuijen seconded that the experts assembled adopt a draft recommendation. After discussion, the recommendation was adopted, as amended, by a vote of 18-4 of the 40 persons present:

THE HAZARDOUS WASTE MANAGEMENT, INDUSTRIAL SAFETY and EMERGENCY PLANNING WORKSHOP, organized by UNIDO's Chemical Industry Branch (convened in Vienna between 22-26 June 1987), having deliberated on these important issues and facing both Developing and Developed Countries

FULLY AWARE of the past and ongoing work of the UN System in the area of HAZARDOUS WASTE MANAGEMENT, INDUSTRIAL ACCIDENT PREVENTION and EMERGENCY PREPAREDNESS,

RECOGNIZING the work in the same field by other inter-governmental bodies such as the OECD and scientific national and international organizations

STRONGLY RECOMMENDS that the OECD takes account of the needs and special problems of the Developing Countries and provides all assistance possible to developing Countries through co-ordinated co-operation with appropriate international organizations such as UNIDO

This recommendation should be brought to the attention of the HIGH LEVEL meeting of the OECD, being hosted by the Government of France, on the Management of Industrial Hazards, scheduled for February 1988.

- B. The report of recommendations from the panel was moved for adoption by Prof. Clapham and seconded by Dr. Ibrahim. After several amendments, these recommendations were adopted unanimously as follows:

RECOMMENDATIONS OF THE
PANEL OF EXPERTS*

UNIDO has a crucial role to play in the areas of hazardous waste management, industrial safety and emergency planning in various industrial sectors and especially in the chemical industry.

The collective opinions and suggestions of the experts are grouped in the following categories:

- I. Policy and Institutional Issues
- II. Environmental Management Issues
- III. Application of Clean Technology
- IV. Plant Operations Issues
- V. Emergency Planning and Response
- VI. Training and Development of Human Resources

I. Policy and Institutional Issues

It is recommended that UNIDO establish position and promote adoption of policies that, when adopted by host countries, would result in environmentally sound waste management and higher level of industrial safety. Some examples include the following:

* The Panelists:

Chairman: Dr. Asit Biswas, President - International Society for
Ecological Modelling (England)

Members: Dr. Filemon Uriarte, Jr., Director - Bureau of Science
and Technology (ASEAN)

Prof. J.M. Dave, - School of Environmental Sciences
(India)

Prof. F. Mayer, - Club of Rome (Austria)

Rapporteur: Dr. Amir Metry, President - Weston International Inc.,
(USA)

- o Consider establishing a set of minimum acceptable requirements for hazardous waste management facilities including: site suitability, operational guidelines, effluent discharge limits, etc.
- o Assist decision makers in third world countries through guidance documents in the areas of estimating the cost of environmental management and accident prevention. This will enable them to make proper decisions that are based on the total cost of an industrial plant including cost to the society regarding environmental resources and public health and safety.
- o Technical assistance for environmental agencies in regard to collection and storage of adequate and reliable information, implementation of environmental regulations and institutional options for effective management of hazardous waste and enhancement of public health and safety.
- o Evaluation of the institutional feasibility of an international mandate for inspection of plant safety in a manner similar to the International Atomic Energy Agency. This can be in the form of safety audits, inspection and reporting.
- o Establishing a set of minimum requirements for health and safety for UNIDO projects. This may include: safety reports, work management plans, contingency plans, maintenance plans, etc.
- o Encourage regulatory agencies in third world countries to enforce laws concerning environmentally acceptable waste management and safe operation of industrial plants.
- o UNIDO should insist with industrialized nations that certain requirements are imposed on the export of hazardous installations. Minimum requirements would be that the plant

be licensable in its country of origin; that there is proof it can be operated safely with the human resources available in the developing country (considering cultural and educational backgrounds); that adequate training be provided for its operation and maintenance; that maintenance plans insure the plant will remain safe throughout its lifetime; and that waste management and emergency response plans have been made.

UNIDO is urged to maintain a high level of coordination with sister UN organization (such as WHO and UNEP) and other international organizations and take an active role in promoting a wholistic and interdisciplinary approach to handling environmental and health and safety issues in the chemical industry.

UNIDO could act as a catalyst in enhancing the communication between industrialized and developing countries as well as intercommunication between developing countries. This will promote exchange of experience and faster and more effective implementation of institutional and technological measures aimed at protecting the environment and enhancing public health and safety.

UNIDO should survey the status of development of hazardous waste management, risk management and industrial safety in third world countries and publish such information for the benefit of various countries.

All funds are limited, therefore UNIDO should establish a priority for expending funds in a way that results in the highest return from an economic and safety point of view. Voluntary funds should be encouraged and channeled towards such goals.

UNIDO should emphasize the social responsibility of industrialized countries in exporting technology, chemicals and products to the third world that are clean and safe to use.

II. Environmental Management Issues

UNIDO should continue and enhance its role in aiding developing countries in environmental assessment and implementation of environmental and safety requirements. Some specific recommendations by the panel of experts included the following:

- o Preparation of guidance document for preparation of simplified, non-complex industrial environmental impact assessment and safety reports for the vast number of small size industrial operations in the third world.
- o Preparation of guidance documents and manuals for hazardous waste source characterization, classification and management options.
- o Preparation of guidelines for selection of waste treatment, storage and disposal sites.
- o Preparation of guidelines for the assessment of highly pollutive industries that may be established in developing countries and potentially harmful chemicals that may enter developing countries.
- o Forming an information bank of hazardous waste management and risk assessment methods for communication among developing countries.
- o Assistance with the design and establishment of cost-efficient systems for monitoring environment quality.
- o It should be emphasized that all technical documents be short, simple, easy to read and inexpensive to implement. Preparation of such material should involve experts who are very familiar with the needs and requirements of the various user communities in developing countries.

III. Application of Clean Technology

UNIDO is urged to encourage developing countries in the adoption of clean technologies that are based on processes that produce no or low-waste or non-hazardous by-products. Some specific recommendations include:

- o Surveying various options and alternate technology that result in no or low-waste generation and publishing such reports to key decision makers.
- o Increasing the awareness of decision-makers on the hidden costs associated with waste generation disposal and post disposal corrective actions.
- o Encouraging various concepts of waste reuse and exchange in and between the developing and developed countries.
- o Establish an award for best clean waste technology and use the media to promote this cause on an international and regional scale.
- o Technology applications must be considered with social, political and economic considerations.
- o It would be useful if UNIDO undertakes the preparation of a compendium of available technologies for treatment and/or detoxification resource recovery and disposal of residuals that are most suited for developing countries.

IV. Plant Operational Issues

It is not sufficient to locate and build a safe plant; it is more important to operate it in a manner that protects the environmental and public safety. The following recommendations are presented for consideration by UNIDO:

- o Establishing guidance for proper and safe handling of hazardous materials and management of the processing plant.
- o Establish requirements for inspection of plant operations and maintenance.
- o Encourage the awareness of hazards and risks related to handling and processing chemicals from top management to the plant workers. However, the ultimate responsibility should be pinpointed at the highest responsible level.
- o Establish requirements for temporary closure, permanent closure and post closure of industrial plants and waste management facility operations. These must include plans for proper closure and post closure monitoring and measures to minimize adverse impacts in the future. These must also include a mechanism by which these plans will be known as long as the materials in a closed facility retain their hazardous nature.
- o Establish a system for classification of plants by level of risk and the appropriate elements of risk analysis required for each class.

V. Emergency Planning and Response

The experts felt the need to emphasize the great need for emergency planning and ability of industry in the third world, as well as the industrialized countries, to minimize the risk of and respond to accidents. Some of the recommendations include the following:

- o Establishing guidelines for emergency planning requirements and respond to accidents.
- o Identify experts and other resource persons to be quickly mobilized to support requests from developing countries in case of serious accidents.

- o Publish resource materials, preferably in native languages, that aid in prevention of accidents and respond to emergencies. This may include all available resource manuals and materials in specific regions.
- o Prepare educational materials in the form of slides, video tapes that document some of the major accidents (such as Bhopal) to illustrate how these accidents happen and how they could have been avoided and how to cope with them when they happen.
- o Prepare guiding material to aid local authorities in post-emergency management of the critical resources such as food, water supply, etc.
- o Development of an expert-system for safe use of chemicals and respond to emergencies such as accidents and spills and communication with the public concerning responding to such emergencies.

VI. Training and Development of Human Resources in Both Public and Private Sectors

A key to environmental protection and industrial safety is the knowledge and attitude of all levels of people working toward such goal. These include the policy makers, the managers of industrial plants, the technical community, the labor force, as well as the affected public. The experts have repeatedly emphasized the need for training and the importance of UNIDO's role as a leader and a catalyst in this field. Some specific recommendations included the following:

- o Development of human resources by training in the areas of environmental protection, risk assessment and management. This can be accomplished on the North-South as well as the South-South cooperation basis.

- o Encourage formulation of institutions and participation of established professional organizations in the area of waste reduction, use of low-waste technologies, recycling and proper management of residuals.
- o Promote health and safety awareness between top policy makers and managers to secure their commitment and their sense of urgency of this topic.
- o Develop skills of personnel in the various aspects of operation of pollution control equipment, contingency planning and responding to accidents.
- o Use of practical on-the-job and hands-on training methods to increase the proficiency of professionals and labor in safe plant operations. Local training is more valuable and cost-effective and could be focused on "real life" situations rather than classroom environment.
- o Promote communication network between professionals working in this field by publishing a directory, repeating this Workshop on an annual basis, as well as encourage UNIDO's participation in other conferences related to this subject.

UNIDO should continue and maintain close co-operation and co-ordination with the other UN and non-U.N. intergovernmental organizations concerned in the development and implementation of the above recommendations.

IV. Resolution

The following resolution was proposed by Dr. Ibrahim and adopted by acclamation:

I propose on behalf of the participants from the developing countries to thank UNIDO for preparing and conducting this

Workshop, in particular the Chemical Industries Branch of UNIDO, and, recognizing the benefits of the Workshop, advise that it be repeated periodically - at least annually.