WORKSHOP SUMMARY

The workshop programme can be found in Annex 1, while Annex 2 provides the list of participants.

After the opening sessions (see Annex 3 and Annex 4), following consideration of the workshop objectives and other background items (see Annex 5), and following a brief report on a similar workshop convened recently in Dresden by UNEP (see Annex 6), the workshop was conducted as a series of modules.

Module I: Training and Communication in Toxic Chemicals Management

Tishya Chatterjee (NETTLAP TNN) introduced the module by noting the contrasting situation between developed countries and developing countries in South Asia (see Table 1). In the developed countries, the level of industrial standardisation and awareness is such that toxic chemicals, when used in industrial processes, can now be followed through life-cycles of clearly identifiable processes and products. Populations are mobile and highly aware of environmental implications to the extent that people in partnership with industries manage toxic chemicals. In fact environmental management for eco-friendly production has become a new business thrust on the developed world. Communicating information on the use (and abuse) of toxic chemicals can be disseminated in quite a general manner, without having to tailor packages for specific audiences as would be the case in regions of say, South Asia.

This is because in South Asia populations are more static and traditionally attuned mainly to local issues. Industries are mostly just a step ahead of trade and into low-tech manufacturing. Investments are low with low economies of scale and with very short term returns in view. The imports, manufacture, storage, use, transport and disposal methods of toxic materials are generally in the category of "trade secrets". Users do not often have a long term stake in the raw material, process or the product. Technologies using or producing these toxic chemicals are of the batch process design not allowing steady predictions of toxic concentrations in throughputs and outputs. Typically, with massive information gaps at the local level, effects of mishandling toxic chemicals can have and has had disastrous local effects, as in India.

Therefore, it is submitted that in the toxic chemicals management area, communication and interaction of both knowledge and skills should ideally commence bottom-up. Information generation and dissemination should start at the impact-points, leading up to formal, segregated and modular approaches at tertiary and higher levels. This is a rather neglected approach in the South Asian region.

It was stressed that in the management of toxic chemicals, education and training must reach potential victims and users faster and the greater the focus of information content on local conditions the more effective is the communication.

A bottom - up information network can therefore be an effective tool to supplement established communication methods in environmental areas. This is very true for the toxic

Table 1

Contrasts in Toxic Chemicals Management Between Developed and Developing Countries

Developed	Developing/South Asia
1. High industrial standardisation	1. Low industrial standardisation.
2. High Environment Awareness	2. Low environment Awareness and weak implementation of environment laws.
3. Industry-people led environment standards. Business Orientation in Environmental management.	3. Government led standards and enforcement.
4. Toxic chemicals - L.C.A. through raw material - process - product disposal/purchase - destruction/recycle	4. Toxic chemicals use is a "trade secret".
5. Chemical processes and product - well identified and linked.	5. Batch processing technology - trade oriented and order dependant production Adhoc.
6. Local information already incorporated into regional/national databases.	6. Local information not available or is in a highly dis-aggregated form.
7. Mobile population.	7. Less mobile population - local issues more relevant than national.
8. Modular training useful - environmental status similar everywhere.	8. Modular training to be supported with local interactive platforms.Supplying local information up and down.
9. Impersonal Communication Systems - electronic etc.	9. Very personal communication effective. Need for permanent, established interaction.

chemicals management sector, as risks and consequences have a shorter time span than general environmental impacts. While global databases could be used as references at distributed network nodes, national, tertiary level and regional databases on toxic chemicals should ideally be built up from ground level monitoring and analysis and after stakeholder interaction. TCM encompasses vast policy, enforcement, educational, training, information, health, geographic spread and waste reduction / cleaner production implications that can best be communicated at the local levels and to those directly affected. This is necessary more for the developing countries.

Thus the training, educational and information base at the local level needs strengthening. While this is true of almost all environmental and developmental initiatives, perhaps in the area of toxic chemicals management with the related accident and health implications, there is an urgency to find and train sub-regional and local catalysts to carry out the downward and upward information exchange, forming a network of communication within identified geographic areas.

Nilay Chaudhuri then spoke on the classification and labelling of chemicals or wastes. He stressed that hazardous chemicals and wastes need to be identified based on certain principles. The principle of branding a chemical or waste as hazardous gained significance as the associated risk of handling such chemical or waste was more and more appreciated. Toxicity, reactivity, explosiveness and inflammability are the key characteristics in deciding a chemical or waste as hazardous. According to the International Register of Potentially Toxic Chemicals (IRPTC), there are more than 8 million known chemicals, with about 77,000 in common use. Each year between 1,000 and 2,000 new chemicals are released on to the market (UNEP, 1992). To know the extent and nature of hazards associated with a chemical one may refer to IRPTC in Geneva (a unit of UNEP, Nairobi) and obtain a detailed information regarding the properties of the chemicals.

Although the data sheet of a chemical as obtained through IRPTC contains all relevant properties, it is still be difficult to identify from the data sheet if the chemical is declared hazardous based on reactivity, explosiveness, inflammability or corrosiveness. Knowledge about ascertaining reactivity explosiveness inflammability and corrosiveness is therefore important, as is the nature and extent of toxicity. In the presentation the properties of a chemical that is listed in an IRPTC data sheet were explained. The presentation also described the methods for measuring reactivity, explosiveness, inflammability and corrosiveness and also the nature and extent of toxicity.

Soli Arceivala presented a case study based around an inventory of industries and their hazardous waste disposal in Medak District (near Hyderabad), in India. The study involved estimation of volume and characteristics of hazardous wastes, identification of the present disposal methods and their shortcomings and identification of suitable disposal methods and secure landfill sites. Of the 3284 industrial units investigated, 282 (8.5%) were categorised as polluting and 111 (3.4%) as potential toxic and hazardous waste generators. The majority of the latter were involved in the manufacture of drugs and pharmaceuticals. In all, some 17,000 MT of hazardous wastes were generated each year. The largest categories were: i) waste containing water soluble chemical compounds of lead, copper, zinc, chromium, nickel, selenium, barium and antinomy; ii) sludges arising from treatment of wastewaters containing heavy metals, toxic organics, oils, emulsions, and spent chemicals and incineration ash; iii) phenols; iv) off specification and discarded products; and iii) wastes from paints, pigments, glue, varnish and printing ink.

Table 2 provides details of waste generation per tonne of product for selected units in the drug and pharmaceuticals industry.

Other data presented included waste storage methods, wastewater treatment methods, and treatment and disposal methods adopted. For the latter, burning was most common.

The study then went on to identify suitable disposal methods and the quantities involved and to identify secure landfill sites. Table 3 categorises wastes for incineration and landfill.

Features of new landfill sites that were considered included: population within 500m, distance to nearest drinking water well, distance to nearest surface water or tank, depth to ground water, soil permeability, depth to bedrock, susceptibility to seismic activity air pollution potential, intensity of use of site by nearby residents, distance to nearest buildings, presence of roads and railways for access, land use zoning, ownership, approximate area of land available for a secure landfill, growth potential and any other critical environmental feature.

The results of this investigation was considered by participants to make an excellent case study.

The importance of combining international databases and classification systems with local knowledge was underlined by **Nilay Chaudhuri**. He presented guidelines for preparing postgraduate-level training courses in classification and labelling of chemicals and wastes. Such a course must emphasise the appropriate definition of hazardous chemicals as well as their associated toxicity. Students in such courses must obtain a very clear idea of the basic properties of a hazardous chemical, such as reactivity, corrosivity, flammability and explosiveness. They should also have easy access to material safety data such as that provided by the IRPTC. These databases should be made easy to access, read, understand and apply.

The final presentations in the module were demonstrations of relevant computer databases. The Hazardous Substances Handling Rules (HASHAR) package, as demonstrated by **V.S. Chary**, was developed in Hyderabad, India. It provides ready access to handling rules for both hazardous chemicals and hazardous wastes and documents the various actions and steps to be taken so as to satisfy the rules laid down by the Indian Government. Preventative, protective and safety rules are given for specific chemicals in use by industry. As such the package is a useful training and applications tool for industry.

Mahesh Pradhan demonstrated the ESCAP Database on Pesticides and the Environment. This package was considered to be a useful supplement to the IRPTC and ICPIC databases.

A discussion on training and related matters followed the formal presentations on toxic chemicals management. There is increasing evidence of a bottom-up approach being

Table 2

Waste Generation per Tonne of Product for Selected Units in the Drug and Pharmaceuticals Industry

Product	Industrial Units	Product Capacity MT y[1]	Quantity in kg/Tonne of Product				
			Solids	Semi Solids	Solvents	Boiler Ash	ETP Sludge
Paracetamol	a) Unit 1	100	985	-	-	-	-
	b) Unit 2	250	930	-	-	730	-
	c) Unit 3)	720	550	-	-	507	-
	d) Unit 4	144	1000	-	-	-	-
	e) Unit 5	300	1000	-	-	-	-
Average Quantity of Waste			893	-	-	618	-
Sulphamethaxazole	a) Unit 1	300	146	-	-	365	-
	b) Unit 2	48	60	-	-	3800	-
	c) Unit 3	12	500	-	-	2500	-
Average Quantity of Waste			235	-	-	2222	-
Ibuprofen	a) Unit 1	120	-	-	-	1520	-
	b) Unit 2	120	-	-	-	3040	-
	c) Unit 3	90	-	-	-	1338	-
Average Quantity of Waste			-	-	-	1966	-
Trimethoprim	a) Unit 1	9	243	-	-	-	2230
	b) Unit 2	48	76	-	-	1140	152
	c) Unit 3	36	96	101	-	-	1013
Average Quantity of Waste			138	101	-	1140	1131
Analgin	a) Unit 1	180	32	-	-	-	152
	b) Unit 2	240	21	-	20 lit	1375	138
Average Quantity of Waste			26.5	-	-	-	145
Medendazole	a) Unit 1	24	-	-	-	7562	-
Acetyl Sulphanyl Chloride	a) Unit 1	360	-	-	-	110	640
	b) Unit 2	150	-	-	-	140	-
Average Quantity of Waste			-	-	-	125	-
Theophyline	Unit 1	21	471	189	314	-	47
Frussenide	Unit 1	18	367	37	-	-	27500
Norflaxacin	Unit 1	24	0 5	277	-	27500	1128
Ciproflaxacin	Unit 1	-	-	-	-	66000	5280
Sodium azide	Unit 1	132	530	-	-	-	-
Trimethoxy Benzine Acid	Unit 1	36	458	183	-	-	37
Chromium Diphosphate	Unit 1	18	278	-	-	-	-
Methyl isothiocyanate	Unit 1	36	18	-	-	-	-

Table 3

Categorisation of Wastes for Incineration and Landfill
Units: MT y^{-1}

	Incineration	Landfill
Solid	3,743	6,726
Semi-solid	1,158	474
Solvents	821	Nil
Electroplating Sludges	Nil	4,082

used to resolve impact problems associated with industrial use of toxic and hazardous substances. For example, in India environmental impact assessment procedures require public declaration of the possible impacts of an industry and the actions to be taken by the industry to be taken to improve the surrounding environment. In many countries there are trial and operational programmes to bring industry, the public and government agencies together. However, it was generally felt that in the region a bottom-up information flow has not yet been adopted as a method for strengthening university and professional training curricula.

The presentations and general discussions raised the following important points:

- in tertiary level training related to toxic chemicals management existing knowledge and databases have to be supplemented by training in practical skills using case studies and simulations of locally relevant industrial practices.

- there are indeed training implications in how to use databases, but the real challenge is to train people to interpret the output of databases; there is great intrinsic value in a database as a teaching tool, over and above the technical output it provides, but how can databases be used to teach something other than its original use?

- most situations involve multiple rather than single chemicals; thus such factors as synergistic effects must be highlighted in training programmes.

- given the substantial geographical spread of information and stakeholders in the South Asian region tertiary level training institutions should gather information and develop case studies based on local areas and incorporate these into existing teaching curricula. This approach would lead to a network of knowledge bases capable of developing and imparting relevant information to both trainees and to local citizens.

- simulation exercises, problem-solving, group-exercises and interactive teaching methods would be very useful for educated audiences, but these need to be modified by tertiary level trainers for use with uneducated and illiterate audiences.

Module II: Training and Communication in Chemical Safety and Process Risk Assessment

Garislav Chkolenok provided details of the databases and training packages and programmes related to IRPTC and the International Programme for Chemical Safety (IPCS). IRPTC are also active in promoting the Amended London Guidelines for the Exchange of Information on Chemicals in International Trade. The IRPTC data base and training is an essential tool for disseminating information on chemicals to industries and the public and one which can be used by government in the evaluation of potential hazards and risks in industrial activities involving chemicals and wastes.

K.V. Raghavan identified the following as the major issues in the management of potentially toxic chemicals: scientific classification of toxicity and related attributes; events to be considered include accidental chemical releases from piping and installation failures, process fires and explosions and from cascade or domino effects, long and short term exposures in process installations and storage and transportation hazards; toxicity and other hazards; and the toxic products of decomposition. Chemical toxicity parameters include brief exposure to potentially lethal concentrations and prolonged exposure to low concentrations. Useful parameters are the Threshold Limit Values (TLV) for airborne chemical concentrations to which personnel are exposed over a lifetime without adverse effects. Lifetimes are a typical working week, 15 minute short term exposure and instantaneous for fast acting chemicals.

The management of information on potentially toxic chemicals was also highlighted. Relevant information is contained in the open literature (e.g. publications of safety councils and institutes concerned with occupational safety and health), is sometimes classified or restricted (such as that in environmental impact assessment reports or post-accident reports) or is available in unpublished form (e.g. manufacturers' information sheets, medical reports, expert views).

The presentation also covered methods for risk and safety assessment. Various hazard identification and rating criteria were reviewed, along with the more fundamental studies that provide the relevant support data. These include animal toxicity studies and methods for generating human toxicity information.

Devendra Wagley presented a case study on environmental chemistry with reference to air pollution in Nepal and in Kathmandu in particular. The intention of the presentation was to develop awareness as to the ill effects of various chemical air pollutants and to demonstrate the need for systematic monitoring of toxic air pollutants. Tertiary level students were presumed to be the target audience as they can benefit from such information. Aspects of vehicular and industrial emissions were covered along with recommendations for remedial measures.

The most effective medium of communication, in view of meagre facilities available, was assumed to be class-room lectures. Provision of slide projector and overhead projector would be an added advantage. In order to motivate the audience about the topic photographs of the city before and after smog formation is recommended for presentation.

Mohan Gewali also presented a case study, one related to the chemical analysis of effluents from industries in Kathmandu. This was in support of a presentation designed to introduce the fundamentals of water pollution and environmental chemistry to tertiary level educators and trainers. Topics covered are the types and effects of water pollution, water quality parameters and waste water treatment. Again the most effective communication method would be the classroom lecture supported by overhead and slide projectors.

Participants in training programmes offered by tertiary institutions should have some first hand experience of simple laboratory techniques in water analysis. A prospective participant would thus benefit from spending 2 to 4 weeks in a government or university laboratory observing and undertaking simple analytical techniques. Participants should also be acquainted with local environmental problems. Thus awareness can be developed through the use of local case studies and the analysis of local data. In this way participation in the training programme will be more meaningful.

The basic research presented in the preceding two case studies from Nepal represent early days in the study of environmental impacts from industrialisation and urbanisation but they serve provide useful materials for both students and trainers alike.

At the end of the module a discussion was held. The point was made that all chemicals are inherently hazardous. This cannot be controlled, but the associated risk can be. Risk is the probability that the hazard will be realized. A significant question is the extent to which risk assessment should be included in training programmes related to the management of toxic chemicals. Such a topic is much more advanced than toxic chemicals and hazardous waste management in general.

It was recognised that even trainers need technical knowledge and training before appropriate use can be made of advanced training manuals. The fundamental content of a training manual was considered to include sources of relevant information, database management, toxicological properties of relevant chemicals, classification and labelling of toxic chemicals (including definitions that are practical, legally enforceable and quantifiable and the parameters and critical levels in ranking systems), nature of applications of toxic chemicals in industry, the types of accidents that can lead to slow or instantaneous releases, the tools and techniques of hazard and risk assessment, case studies and lists of available training aids.

Module III: Training and Communication in Emergency Response and the Integrated Management of Toxic Chemicals

The training of undergraduate and graduate industrial chemists and chemical engineers in chemical safety and emergency response/management is important if, as working professionals, they are to have an appreciation of the potential hazards they will "manage" (in an industrial and environmental sense) and the possible consequences to workers, the community and the environment when planning and training of personnel and the local public in these areas is ignored.

It is apparent that the record of industrial accidents in recent times is not good. The United Nations Environment Program (UNEP) in 1990 compiled the following figures : "Counting only disasters with more than 100 dead, 400 injured, 3500 evacuated or 70,000 deprived of drinking water, the last three five-year periods have seen the numbers of major accidents world-wide rise from 4 (1974-78), to 10 (1979-83), and then to 16 (1984-88). Of the latter, 13 were in developing countries. It is clearly time for a major new initiative to curb the damage caused by industrial accidents".

The two papers presented in the module looked at some training methods in the area of chemical safety and emergency response. But it is inappropriate to look in isolation at these topics. They must be studied and viewed as part of a much bigger picture which includes other important aspects in the total management of toxic chemicals and hazardous wastes. This is what is typically called the "Integrated Management of Hazardous Materials"

The presentation by **Paul Clarey** illustrated some of the curriculum and methods of training given to undergraduates in the Bachelor of Applied Science (Environmental Management of Hazardous Materials) at Deakin University, Victoria, Australia. This degree, the first of its type in Australia, attempts to integrate a variety of practical scientific and managerial skills into the framework of a science degree. The course was designed by representatives from government, industry, the unions, and academia to fill a perceived niche in undergraduate training. The methods and curriculum presented should be adaptable to most tertiary educational environments.

The integrated management of hazardous materials involves a holistic approach through consideration of all relevant areas in undertaking a scientific assessment or making a management decision. Hence, in addition to the common considerations applied to toxic chemicals and hazardous wastes (where/how to store and dispose of them) there needs to be awareness of such topics as industrial processes, appropriate land use planning, risk assessment techniques for process industry, chemical hazard and risk analysis, occupational health and safety, emergency response planning and waste minimisation.

The exercises on awareness and preparedness for emergencies at the local level, as presented by **Fritz Balkau**, also highlight the need to avoid looking at one issue in isolation from the rest and also to avoid becoming preoccupied with niceties of some of the technical questions where these may not be relevant to the problem at hand. The process developed by UNEP called APELL (Awareness and Preparedness for Emergencies at a Local Level) is designed to assist government/industry and the public in responding to technological accidents.

Module IV: Training and Communication in Hazardous Waste Management

Management of hazardous waste includes the effective control of generation, storage, transport, treatment, recycling and disposal. Legislation and regulations establish a control mechanism for the management of hazardous wastes, as well as spelling out clearly the responsibilities of various parties on the handling and disposal. Prevention and minimisation of waste generation should play a major role in the overall integrated management strategy and planning.

The presentations and discussions in the module were broadly divided into two themes - Prevention and Minimisation of Hazardous Waste Generation and Hazardous Waste Management Treatment and Other Aspects. Session activities included: plenary introduction to hazardous waste Management, background information on specific issues, references and directory of resource materials, hazardous waste generation based on industrial production data, interactive discussions and questions and answers.

In his presentation describing a new approach to training in hazardous waste management, **Andrew Tay** noted that different methods have been developed by educationalists to enhance the learning ability of students and trainers. All have their merits and limitations to achieve a specific objective. To train or educate adults on new topics an "active" learning process is far better than "passive' learning approaches, particularly in the environmental management area as effective solutions will call for practical inter- and multi-disciplinary problem solving approaches. Thus a training programme should include technical, legal, social and economic aspects.

These considerations have been put into action in the project casework approach (PCW) to training in hazardous waste management. PCW is mainly a blend of three types of active learning methods: a) the "prospective" project method; b) the "retrospective case method; and c) "interactive" group work. The use of prestructured tasks for group work is intended to generate sufficient motivation and pressure to build feasible solutions under pressure of time. Thus, instead of merely providing technical information, PCW seeks to develop and strengthen participants' decision-making capacities in complex environmental issues. Three steps are used. The first is assessment of a problem by taking into account available resources and existing constraints, risks and opportunities. The second step is to devise strategies for action, analyzing, costing and comparing various feasible options. The final step is to select a most viable alternative based on the available resources and constraints. These steps are mainly performed by the trainees themselves.

The PCW approach thus stresses problem analysis and assessment, development of strategies, selection of options and reasoning. The participants acquire knowledge of hazardous waste management by working on a real world problem and by developing a viable solution based on available resources and constraints.

Anwarul Islam gave a presentation which described the need for the prevention and minimization of hazardous wastes and the means by which this could be achieved. With the development and increase of various chemical uses, and growing generation of hazardous wastes, hazardous waste management is becoming more and more important. In most of the South Asian countries the best option to start with in terms of hazardous wastes management is prevention and minimization of hazardous wastes, because only in that way it will be manageable with limited resources and management capabilities. Countries do not have adequate understanding, legal and institutional capabilities to manage the problem and to achieve the goal to prevent and minimise hazardous wasters. Adequate measures need to be taken to improve the situation, among which dissemination of knowledge and training in the relevant field are very important. One of the main priorities in ensuring environmentally sound management of hazardous wastes is to provide awareness, education and training programmes covering all aspects of society. There is also a need to undertake research programmes to understand the nature of hazardous wastes, to identify their potential environmental effects and to develop technologies to safely handle those wastes. Finally there is a need to strengthen the capacity of institutions that are responsible for the management of hazardous wastes.

R.M.U. Senarath presented a case study on the broad environmental management context within which hazardous wastes are managed in Sri Lanka.

T. Chakrabarti introduced the concepts of life cycle analysis (or assessment and cleaner production and addressed two technical issues: a) waste minimization techniques based on source reduction and recycling (on-site and off-site); and b) pollution prevention through plant maintenance. The aim is to avoid an end-of-pipe solution costs to meet command and control requirements as well as application of recycle and reuse technologies which have a favourable payback period.

Since prevention and minimization of hazardous waste require an integrated approach involving the regulatory process, executive level management and application of suitable technology, the target audience in any training programme included representatives from industry, regulatory bodies, academia and the legal profession. The presentation included case studies on waste minimization in caustic and chlorine industry, textile industry and dyes, nickel, copper and chromium recovery from wastes and utilization of fly ash. The concept of an environmentally balanced industrial complex was also described. This approach enables the pollution problems of one industry to be transformed into an asset for another industry by using the waste as raw material thereby achieving lower production costs and the elimination of adverse environmental effects.

Lakshmi Raghupathy described how in India the Environment (Protection) Act (1986) was enacted to provide a single focus for all environmental issues and to plug loopholes in the earlier enactments. Section 3(2) (vi) and (vii) gives the responsibility to the Central Government to lay down procedures and safeguards for handling hazardous substances, which include hazardous chemicals, hazardous wastes and hazardous micro-organisms. Separate sets of regulations (rules) have been made for these categories of hazardous substances. The principal objective of the regulations are the prevention of the major accidents arising from industrial activity, the limitation of the effects of such accidents, both on humans and the environment and the harmonisation of the various control measures and the agencies to prevent and limit major accidents.

An important feature of the regulations is that the storage of hazardous chemicals not associated with the process, is treated differently from process use and a different list of hazardous chemicals applies. Division of industrial activity into process activity and isolated storages is important for the application of controls within the regulation. Three levels of control are prescribed in the rules: a) Low Level Requirements - 434 Chemicals are subject to general or low level requirements; b) Medium Level Requirements - 179 chemicals and three classes of compounds are subject to medium level controls. These apply to potentially hazardous activities using hazardous chemicals in specified quantities; and c) High Level Requirements - 17 chemicals and three classes of compounds are subject to specific or high level requirements. They are potentially more hazardous and threshold limits are specified.

Much of the legislation, including the regulations, arises from the lessons learnt from Bhopal disaster. These include: no comprehensive legislation to be followed in the event of major disaster; lack of preparedness for disaster while handling potentially hazardous chemicals; lack of industrial safety practices; poor maintenance; no emergency preparedness plans; no literature information/database on MIC or its pyrolytic products in respect of toxicity information; absence of environmental monitoring; and community not informed - no community awareness. It is clear from the experience that emergency planning is just one aspect of the total planning for the safety. This planning has to be done by those who are responsible for handling hazardous chemicals, the local authorities in charge of emergencies, the State Governments and the Central Government.

In order to respond during a chemical emergency, a coordinated effort at the local level, State level and Central level is needed. All available resources need to be mobilised to overcome the crisis in the shortest possible time. With this aim in view, in India a crisis management plan has been prepared.

In another case study, **D. Badgaa** described how over recent decades industrialization, including mining and construction of cities and settlements, has resulted in contamination of air, soils and water in the urban areas of Mongolia. It is now imperative to reuse natural resources and introduce waste-free technologies if pollution is to be avoided. An important task is to obtain and analyse data on the content of solid and liquid wastes, smoke, dust and hazardous chemicals deposited from cities, factories and household and cleaning facilities in order to re-use such wastes and thereby help avoid further contamination of the environment. Such action would lead to economical effectiveness in general.

For these reasons a series of programmes are ongoing in the field of environmental education. These include: incorporation of special courses of study in ecology and natural resources in programmes of all secondary schools, colleges and higher educational institutions; plans to establish an environmental institution which will provide specialized, college level environment training; a programme of seminars and courses for environmental inspectors, with duration ranging two weeks to three months; and the use of all possible means to raise public awareness (TV, radio and publications).

One example presented came from the results of analysing dried leather industry sludge from industrial Kombinat in Ulaanbaatar. Sludge production reaches 30,000 tons per annum. The sludge has a beneficial effect on some aspects of soil fertility and plant growth as it contains Ca, Mg, K, N, P and OM. But since the sludge contains a higher amount of Na, K, Cl and Cr it exhibits a deleterious effect. So it is intended to produce a calcium humate fertilizer by removing Cr and Cl from the sludge.

P.V.R. Subrahmanyam discussed institutional capacities for hazardous waste management, especially from the points of view of information dissemination and human resource development. He argued that comprehensive information support and creation of a trained manpower base are two important requirements for successful implementation of hazardous waste management programmes in developing countries. In his presentation he also suggested an approach for networking of information resources within a country and among all the participating countries of Central and South Asia region. Human resource development can take place through training and through the use of training packages provided for the trainers of all the key role players in hazardous waste management. In these ways it is possible to meet the objectives of UNEP Network for Environmental Training at the Tertiary Level in Asia and the Pacific (NETTLAP).

Ajantha Perera described a training module on hazardous solid waste disposal, based on a case study for Colombo, Sri Lanka. The module would be of interest and value to both undergraduate and graduate students. They will be informed of the situation in the country, on the deficiencies in hazardous solid waste management, its consequences, and the need for improvement and possible remedial measures. Through the knowledge gained they will be stimulated to become involve in further research work to find remedial measures either to eradicate or drastically reduce the problem to manageable level. The trainers of the undergraduate and postgraduate students can communicate this material through lectures, supported by field visits, laboratory experiments, slides, videos. The case study and the examples utilized in the presentation can be replaced by others according to the country concerned.

The total amount of waste collected within the city of Colombo each year exceeds 200,000 tons. In fact the annual collection at present is increasing at a rate of 10,000 tons per year. The waste includes waste collected from households, solid waste generated by industries as by products (including sludge from the liquid waste treatment plants), clinical waste from medical care in hospitals, medical centres and clinics as well as containers of agrochemicals from the agricultural sector. No specific legal requirements have yet been identified with regard to waste disposal. All waste is accepted at solid waste dumping sites of municipal councils.

The module develops an understanding of sanitary landfills, including the five major aspects of a sanitary landfill design -leachate control, liners, covers, gas control and the after use of the site. Also included are procedures is selecting a landfill site, mitigation measures, and a detailed case study of a 12 hectare landfill site established in 1987. The approach taken in this module is influenced by the fact that many of the scientists in a developing country who either write an environmental impact assessment report for a sanitary landfill or those in authority who decide regarding acceptance or disapproval of a sanitary landfill generally have never seen an actual sanitary landfill in operation. Therefore it is important that such people be trained at a well operating landfill site. They should be informed of the costs and the benefits of such an operation.

Feroze Ahmed provided materials which he considered would help address the problems associated with hazardous waste management in developing countries, namely: poor control in storage, handling, transportation and disposal; waste generating units are scattered in small qualities; producers of wastes are not aware of the short and long term effects of the hazardous wastes they produce; limited organizational capacity, skills and financial resources are available for the management of hazardous wastes; and many other problems receive more attention for socioeconomic reasons.

In his presentation he reviewed the treatment processes for hazardous wastes, including physical treatment, chemical and thermal treatment, biological treatment, and he outlined disposal options.

Module V: Activities of International and Regional Organisations

Toru Tamura described activities in environmental technology development and transfer at UNEP's International Environmental Technology Centre in Osaka, Japan.

In a paper **Choei Konda** described ESCAP's activities in the field of toxic chemicals and hazardous waste management. ESCAP is giving particular attention to enhancing capacities in developing countries in the region as issues of related to toxic chemicals and hazardous wastes are associated with one of the priority environmental problems in the region. In the presentation emphasis was placed on hazardous wastes rather than toxic chemicals. A summary of the present state of waste management in the region was presented followed by an outline of the main activities of ESCAP in the field.

The following characteristics of waste issues in developing countries as compared with those in developed countries are also applicable to the ESCAP region:

(1) Difference in quantity and quality of wastes;
(For example, the quantity is less; paper/plastics are less and garbage/earth and sand are more than developed countries.)

(2) Weakness in financial base;
(Cleaning costs pose heavy financial burden for local governments in developing countries.)

(3) Much involvement of informal sectors such as street vendors, day labourers and scavengers; and

(4) Less collecting service in slum and squatter areas.

Lack of information necessary for hazardous waste management is one of the most crucial problems in the region. This comes from lack of human resources such as manpower and expertise and financial resources for implementing policies and regulations on waste management, as well as lack of public awareness and political indifference.

Module VI: Environmental Training Methods and Materials

Paul Clarey presented some thoughts on training methods and curriculum development in toxic chemicals and hazardous wastes, based largely on a comprehensive programme at Deakin University in Australia. The Bachelor of Applied Science (Environmental Management of Hazardous Materials) course started in 1990. The degree requires students to undertake a major in Chemistry, a variety of core and elective "hazmat" subjects and an optional study stream which can comprise of another science major (e.g. biology) or a double major in chemistry or any other subjects, science or non-science that the student wishes to take.

In 1992 a Graduate Diploma in Environmental Management was introduced. This gives postgraduate students the opportunity for some general training in environmental management. Only a small number of "hazmat" units are available to students in this course.

In response to considerable interest, both at home and abroad, Deakin University is currently developing a Graduate Certificate in the Environmental Management of Hazardous Materials. This consists of the four core "hazmat" subjects, as follows :

Integrated Management of Hazardous Materials
Risk Assessment of Hazardous Materials
Environment Protection, Occupational Health and Safety
Environmental Impact Assessment and Land Use Planning

These subjects will be prepared in both on-campus and off-campus modes for delivery in Australia and overseas. These subjects are an extremely useful adjunct to the training of industrial chemists and chemical engineers at an undergraduate or postgraduate level, providing them with the basic skills for integrated environmental management of toxic chemicals and hazardous wastes.

A brief description of the four hazmat "subjects" and some of the tasks that students are required to undertake were presented. Considerable effort has gone into designing a group of subjects which integrate the essential disciplines required to manage hazardous materials in an environmentally sound manner. The need for professionals with this training within industry and government is recognised and the best way to ensure such training takes place is for it to be taken up by various tertiary institutions within Asia and the South Pacific. Deakin University offers its *Graduate Certificate in the Environmental Management of Hazardous Materials* as one model which will be developed and explored further with the purpose of ultimately providing and tailoring it for the local needs and situations of developing nations in Asia and the South Pacific.

Fritz Balkau demonstrated some interactive training methods which can be used to enhance teaching on the subject of the management of toxic chemicals and hazardous wastes. These methods can be used in conjunction with the resource packages developed by UNEP for training in a variety of topics such as hazardous waste, contaminated land, industrial accidents, cleaner production, and selected industry activities such as leather tanning and battery recycling.

Due to limited time in the sessions the demonstrations were necessarily short. Nevertheless, they gave good insight into how these methods can be used by individual trainers.

Demonstrations included:

1. Use of pre-session notes and work exercises to familiarize students with the subject and the exercises, thus making the classroom sessions more immediately productive.

2. the use of a short quiz (available also as a computer version in the UNIDO Training Kit) to test students' comprehension of basic facts, definition of terms, understanding of issues, and so on. The quiz can then be used as the basis for further discussion and explanation of key points. Trainers can easily develop their own quiz on other subjects.

3. Groupwork problem-solving (demonstrated with two groups of 8 persons) on i) how to design a waste survey questionnaire, and ii) comparative environmental assessment of two candidate landfill sites. These exercises demonstrated the complexity of decision-making in the environmental management area. Groupwork technique is useful in the situations where a single individual is unable to bring all the insights and experience into a complex decision. A plenary report back session allowed others to share the experience, and bring ideas from different groups into the discussion.

   Previous groupwork exercises on i) hazard identification for a plastic factory and ii) risk communication and technical intervention on an abandoned store of chlorine cylinders had demonstrated the usefulness of groupwork discussion in creating a better understanding of industrial hazard situations. The first of these two exercises also demonstrated the importance of interpreting environmental information correctly. The second exercise underlined the difficulty in risk communication that is experienced by many scientific professionals. In both cases report-back and plenary discussion are an essential part of the exercise.

4. A groupwork and panel combination demonstrated some techniques for situations where the scientific basis is complex - in this case the example was the use of waste generation coefficients to generate data for decision-making. The workgroups considered which of the available coefficients was most suitable for various applications. Discussion of the conclusions by an expert panel brought additional insights into the discussion and revealed that there is often no absolutely right answer. The use of a panel allows many aspects of the problem, both scientific and the application sides, to be explored by students more effectively than could be done by a single instructor. A panel also takes on particular importance in that it provides trainees with a forum to put questions.

5. Environmental project work was introduced through the example of a waste audit in a leather tannery. The audit data from a tannery case study are used to develop pollution avoidance and minimization options, and to prepare an overall cleaner production plan for the company. Such projects could be done individually or by a group. Results can be presented by way of a written report and/or through seminar presentation. The latter allows further learning

through discussion, expert panels, peer review etc.

6. Methods for making field work more productive were discussed in a plenary session moderated by **John Hay**. Preparation of students, use of report forms and check lists, prior discussion with site managers and follow-up discussions were among the options reviewed.

A number of other interactive methods are available, as shown in Table 4. Many of the methods described above are included in the trainers' packages now being developed by UNEP and other organizations. The packages contain case studies and work exercises, short background papers and overhead transparencies, and extensive reference sections. Some simple guidance is also included on how to enhance personal teaching performance. UNIDO, WHO and ILO have also produced some training manuals on selected topics - see Annex 7.

It is important to remember that the packages provide resources to trainers and that they are not curricula.

The session concluded with a discussion by workshop participants about the applicability of the packages and the methodologies demonstrated. It was again stressed that interactive methods are particularly applicable where skill-building in environmental management is desired, but even in knowledge-building they can be very useful in reinforcing what is learned. There was considerable desire on the part of individual trainers to use the UNEP packages, with many requests for copies being received. The need for eventual feedback on the use of these packages in the region was also stressed. This will require ongoing interaction between the developers and the users of the training packages.

Module VII: Concluding Session

A number of activities and tasks were completed in this session:

a) *Brainstorming on Needs and Attributes of a Site Visit*

Points raised included the need for a planning meeting and the need to be knowledgable about the plant and about the contact person or site counterpart. The latter should be informed of the requirements associated with the visit. A prior visit to the site can be used to test approaches and self assess the likely outcome of the visit. Information such as maps, flow charts and mass flows should be requested in advance. Depending on the purpose, a surprise visit might be in order in some cases. Participants should also be well briefed, being provided with clear objectives. Practicable sampling methods need to be used. On site demonstrations are normally helpful. Photographs are a useful way of enhancing a visit report as they aid the memory as well as help with visualization. A check list can be appropriate, but they have some limitations. A log sheet may be more useful as a method for recording times, actions and observations including relevant codes of practice. A site visit report is an appropriate way to ensure the findings are retained.

b) *Brainstorming on Essential Elements of a Training Package*

Discussion focused on such aspects as content, methodologies, tools, learning aids and assessment methods. It was recognized that scientific emphasis is on knowledge whereas the management emphasis is on skills. Technical training is at the transition between them. Under

Table 4

Technical Themes and Applicable Training Methods

* applicable method

Short lecture	*	*	*	*
Group work (case study)	*	*	*	*
Other group work	*	*	*	*
Brainstorm		*		
Panel	*	*	*	*
Report back; answers	*	*	*	*
Country report	*	*	*	*
Field work		*	*	*
Technical visit		*	*	*
Project work	*	*	*	*
Questionnaire	*	*	*	*
Cameo/case study	*	*	*	*
Audience questions	*	*	*	*
Class calculation	*	*	*	*
Transparency	*	*	*	*
Slides		*	*	*
Video		*	*	*
Computer	*	*	*	*
Posters	*	*	*	*

content a number of themes were identified: environmentally sound management of toxic chemicals and hazardous wastes, standards, waste minimization, properties and toxic nature of hazardous wastes, defining comprehensive legislation, emergency action, regionally relevant databases, existing data and information, chemical safety and literature. Priority themes might include foundation principles and knowledge, management of chemical safety, environmentally sound management of hazardous materials, prevention and minimization of hazardous materials and environmental impact assessment. Theme priorities should be matched to target groups.

The content dictates the training methods to be used. Methods highlighted included: networking, how to deliver material, interactive packages, case studies, safety measures, feedback, video, past events, simulations, modelling, lectures, manuals, site seeing, problem solving, ranking methods and priority setting.

Other points raised in the discussion were the need for more intensive postgraduate courses and the fact that training programmes already exist for most aspects of toxic chemicals and hazardous waste management, but these programmes are not available in or accessible to all countries. A modular approach to training packages and courses is desirable. Training of staff requires the infusion of practical knowledge and skills. Visitors to institutions can be useful resource persons in training programmes. Local training programmes provide orientation and promote interest.

c) *Review of Teaching Resource Kits*

Two teaching resource kits prepared for NETTLAP, one related to the management of toxic chemicals and the other to the management of hazardous wastes, were assessed by workshop participants.

d) *Ongoing Support for NETTLAP Activities*

NETTLAP activities related to training in the management of toxic chemicals and hazardous wastes will continue to facilitated by the Thematic network Coordinator, assisted by the two Thematic Network Nodes. The intention is to have a follow-up Training and Resources Development Workshop in 1996 for participants from South and Central Asia. Meanwhile, a similar workshop is planned for 1995 for participants from East and Southeast Asia and the Pacific.

UNEP has established a Small Windows Project (see Annex 8). This funds environmental education and training activities undertaken in developing countries. Participants were urged to apply for funds to support relevant training activities at a national or sub-regional level.

e) *Pledges for Future Action*

In order to encourage effective follow-up to the workshop, each participant was asked to make an individual pledge in response to the questions: i) what will <u>you</u> do? and ii) what would you wish to do as a member of a joint activity? The individual pledges may be found in Annex 9.

f) *Workshop Evaluation*

Each participant completed a formal evaluation questionnaire (see Annex 12) and submitted this during or immediately after the final session. The questionnaire was designed to assess participants' expectations of, and actual experiences in the various aspects of the workshop programme and activities.

For each question the quantitative responses have been aggregated and the resulting data presented as a series of graphs (Figs. 10.1 through 10.16). The left hand diagram in each graph indicates whether participants felt that the session or activity was above or below their expectations. This information was derived from the individual responses to a request for each participant to indicate the extent to which they expected the session or activity to be relevant and then score the actual experience. Thus the expectation and experience responses are scored directly, while the information on whether the session or activity was above or below expectations is derived from the differences between these two responses. This relative information may thus reflect more correctly the actual opinions of the participants.

The reactions of participants to other aspects of workshop organization and implementation are also available via the questionnaire.

Detailed information on the participants' responses and an analysis of the results can be found in Annex 10. The following is a summary of the findings.

Most participants considered the workshop to be above average in terms of relevance, usefulness and practicality. For the majority of the participants the workshop reached or exceeded their expectations. A majority of participants also considered the presentations by participants from countries in South and Central Asia to be relevant or better. In general the contributions exceeded expectations. The keynote presentations and the methods used were generally considered to be relevant, useful and practical. The assessment shows that the keynote presentations met or exceeded expectations of most participants.

In general the materials and other resources made available at the workshop were judged to be relevant, useful and practical. Participants were almost equally divided as to whether availability of these resources exceeded or failed to fulfil expectations. The majority of the participants considered the concepts and skills covered at the workshop had been above average in innovativeness. Their expectations in this respect were generally exceeded.

Most participants considered that the workshop had a useful impact on their future environmental training and education activities. In this respect the workshop always met or exceeded participant's expectations.

Workshop organisation received a high score from the majority of the participants, indicating that in general they thought it was very good and well organised. In terms of organisation the workshop met or exceeded the expectations of all participants.

Table 5 provides the number of participants indicating given response to each category.

Closing Session

A list of materials displayed or distributed at the workshop may be found in Annex 11.

The workshop was closed following concluding remarks by Dr G.V. Subrahmanyam, Mr T. Chatterjee and Prof. John Hay.

Table 5

Number of Participants Indicating given Response to each Category

	Excellent	Satisfactory	Fair	Poor	Very Bad	No Response
Pre Workshop Planning/Liaison	9	6	2	1	0	2
Travel Arrangements	13	2	1	0	0	4
Meeting Facilities	16	2	0	0	0	2
Quality of catering/food etc	15	2	0	0	0	2
Assistance given by UNEP/ROAP staff	15	3	0	0	0	2
Assistance given by EPTRI staff	16	2	0	0	0	2