

OCCUPATIONAL PROFILES OF
ENVIRONMENTAL HEALTH PERSONNEL

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CONTENTS

	<u>Page</u>
FOREWORD	vi
1. PRINCIPLES OF HEALTH MANPOWER DEVELOPMENT	1
Production	1
Management	1
Planning	2
2. ENVIRONMENTAL HEALTH PERSONNEL	4
Categories of personnel	6
Functional responsibilities	7
3. OCCUPATIONAL PROFILES OF ENVIRONMENTAL HEALTH PERSONNEL	24
Tasks	24
Knowledge needed	31
Occupational profiles	31
4. CONSTRUCTION OF CURRICULA FOR KEY ENVIRONMENTAL HEALTH PERSONNEL	44
Sanitary engineers	44
Safety and health engineers and safety officers	47
Environmental health officers	48
Environmental health technicians	49
Nonphysician primary health care workers	49
Industrial hygiene officials	50
Food inspectors	51
Water sector supervisors	51
The concept of the target curriculum	54
REFERENCES	56

FOREWORD

The aim of this volume is to bring together the views of the WHO Regional Office for Europe on environmental health manpower development. The paper is in three sections, followed by a summary and conclusions.

In section 1, the basic requirements for comprehensive health manpower development are considered in terms of planning, production and proper use of new manpower.

Section 2 reviews the main categories of environmental health personnel who, according to WHO views, are needed in industrialized countries and in middle-income developing countries.

Section 3 draws upon previous work of the WHO Regional Office for Europe to present, in a uniform fashion, occupational profiles of the main categories of environmental health personnel. These occupational profiles are used as the basis for section 4 which defines training requirements for each category identified and suggests the approach to graduate training and continuing professional education which should be adopted.

I wish to thank Dr. John F. Duffus for preparing this report.

Eric Giroult

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1. PRINCIPLES OF HEALTH MANPOWER DEVELOPMENT

The principles of health manpower development in terms of planning, production and utilization of manpower have been thoroughly discussed in WHO publications [1-3]. Planning is the process of producing practical proposals to achieve a defined improvement at a future date. Such proposals must take into account problems of implementation and must be designed to optimize situations in which objectives cannot be fully attained. The main objective will be to define the numbers of different types of personnel required to produce the desired health improvement and to relate these personnel to national, regional and local needs. A strategy must be formulated to attain this objective within a practicable time scale. This strategy must be used to identify the precise activities which must be implemented, and target times must be set for these activities to come into operation. In particular, health manpower planning will involve developments in the educational system, retraining and redeployment of existing manpower, and establishment of monitoring systems to ensure effective implementation of plans.

Production

Manpower production is dependent largely on the educational system rather than the health system. In effect, the health system has to subcontract manpower development to the educational system; the role of the health manpower planner is to provide adequate guidance to the educationalists to ensure that they can provide the right manpower to meet the needs of the health delivery system. The autonomy of educational institutions and other training agencies means that health manpower planners must incorporate in their plans some means of coordinating their activities. Planners must also take note of current educational approaches so that they are not in conflict with them. Key points to be incorporated in an effective plan include the financial implications of educational expansion, assessment of quantitative manpower requirements related to time scale of production, and definition of occupational profiles and their implications for educational curricula and programming.

Management

Manpower management deals with the recruitment, proper use and motivation of health workers. This means the production of policies for these activities, including a system for monitoring their

PRINCIPLES OF HEALTH MANPOWER DEVELOPMENT

success or failure. Such policies must take into account the distribution of manpower between different specializations, institutions and locations. They must also consider the need for supervision and continuing education, the availability of incentives and opportunities for career development, the pattern of career development (including performance evaluation), and the provision of any support needed for new manpower to function effectively.

Planning

The above activities should be directed by a health manpower unit. The prime function of this unit is planning and programming all stages of manpower development. Subsequently, it should coordinate and catalyze the implementation of the plans produced, and finally, it must monitor and evaluate their success. Ancillary activities include relevant research and development and information collection and analysis.

Planning and programming of manpower development have various aspects. Health manpower must relate not only to national health plans but also to policies for socioeconomic development, including those for education, employment, science, technology and rural development. The health manpower unit must be aware of the views of the public on health services and those who provide them, and must pass on these views to decision-makers, with interpretation of their implications for manpower development. The main national manpower unit must ensure that regional and local planning units are adequate and that coordination of the agencies responsible for manpower development and utilization is effective. Coordination aims to optimize health manpower activities. This requires establishing agreement between the institutions involved. Such agreements may cover joint meetings and assignments, distribution of responsibilities, and exchange of information, among other things. More specifically, particular attention must be paid in manpower development plans to the following:

- definition of health team composition
- definition of occupational profiles for health team members
- definition of educational objectives
- design of curricula to attain educational objectives
- assessment of available training capacity and need for expansion
- implementation of curricula
- recruitment of trainees
- evaluation of educational output
- career development.

The health manpower plan must identify objectives against which achievement can be measured, including manpower production targets, performance of tasks, and health status to be attained within a

PRINCIPLES OF HEALTH MANPOWER DEVELOPMENT

defined time. Achievement must be regularly monitored. Any shortcomings must be evaluated and appropriate action taken to correct them. No plan can be expected to have indefinite validity and provision must be made for a process of continuing evaluation and development, based on a sound understanding of current ideas and new methods of providing health care. To provide such an understanding, the manpower unit will require a research section with that remit. The research section will work closely with the section responsible for information gathering and analysis. The information section will establish the norms and procedures for data collection at the different levels of the health system and supervise its effectiveness. An important aspect of ensuring effectiveness is proper coordination between health planners and statisticians before data collection is begun. The planners must detail the objectives of the exercise, and the statistician must then define a system of data collection which will provide the information required.

ENVIRONMENTAL HEALTH PERSONNEL

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|-----|--|------------------------|
| 8. | <i>Insect and rodent control</i> | |
| | Breeding places | Control measures |
| | Infestation | |
| 9. | <i>Meat</i> | |
| | Slaughterhouses | Poultry inspection |
| | Meat inspection | Fish inspection |
| 10. | <i>Milk</i> | |
| | Pasteurization plants | Producer farms |
| | Milk product plants | |
| 11. | <i>Noise</i> | |
| 12. | <i>Public, quasipublic, recreational, business and commercial establishments</i> | |
| | Trailer parks | Boarding homes |
| | Hospitals | Day care centres |
| | Sanatoria | Nursery schools |
| | Nursing homes | Churches |
| | Homes for the aged | Bowling alleys |
| | Maternity homes | Roller skating rinks |
| | Country clubs | Theatres |
| | Hotels | Ball parks |
| | Jails | Dance halls |
| | Clubs | Motels and cabin camps |
| | Fairs | Resorts |
| | Carnivals, circuses and public exhibitions | Camps |
| | Barber shops | Recreational areas |
| | Terminals | Parks |
| | Tourist courts | Roadsides |
| 13. | <i>Radiation</i> | |
| 14. | <i>Refuse and solid wastes</i> | |
| | Collection | Method of disposal |
| | Transportation | Areas served |
| | Place of disposal | |
| 15. | <i>Schools and institutions</i> | |
| | Planning | Maintenance |
| | Operation | |

ENVIRONMENTAL HEALTH PERSONNEL

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|-------------------------------------|----------------------------|
| 16. <i>Sewage and liquid wastes</i> | |
| Sewerage systems | Privies |
| Promotion of sewer extensions | Stream pollution |
| Treatment plants | Aid in development plans |
| Septic tanks | |
| 17. <i>Subdivisions and plants</i> | |
| Water supply | Drainage |
| Sewage disposal | Land development |
| 18. <i>Swimming and bathing</i> | |
| Public swimming pools | Bathing places |
| Private swimming pools | |
| 19. <i>Water</i> | |
| Municipal distribution | Private supplies |
| Promotion of water main extensions | Geological problems |
| Source of supply | Surface water availability |
| Treatment plants | Aid in development plans |
| Pressure problems | Toxic/hazardous chemicals |
| Semipublic supplies | |

Categories of personnel

Such considerations led a WHO Expert Committee [7] to define three basic types of environmental health manpower:

1. *Full professionals* - public health physicians; sanitary, public health, and other related engineers; chemical and life scientists; public health inspectors;
2. *Subprofessional and skilled workers* - health assistants, technicians, operators, workshop and office staff corresponding to the various professional groups;
3. *Semiskilled and unskilled workers* - health aides, drivers, plant operators, storekeepers, labourers, orderlies.

To provide the personnel listed above, manpower planning is needed. This must start with an estimate of the environmental health manpower requirement. Perhaps the simplest method to apply is the ratio method in which a required manpower to population ratio is estimated. The estimate may be made by a panel of experts or by following the ratio in a country thought to have an acceptable

ENVIRONMENTAL HEALTH PERSONNEL

manpower situation. Alternatively, the requirement for environmental health personnel may be calculated in relation to another key manpower category. Thus, in the USSR the requirement for sanitary (public health) physicians is established and a fixed relative number of ancillary personnel per physician must then be provided.

Manpower requirements may also be related to service objectives. Targets are set for production and delivery of environmental services. These targets will require a certain level of manpower assuming a certain level of productivity. Setting targets in this way assumes the active role of a centralized national public health service, which may not exist in many countries.

WHO has attempted to develop staffing standards for environmental health. In 1960, it recommended four sanitary engineers per million population and one sanitary inspector per 8 000, these figures being based on the situation in the United Kingdom and the United States. This still seems to be a reasonable initial target for a country without such personnel.

The promotion of environmental health is essentially a multidisciplinary task, but a professional environmental health officer (sanitarian) is needed with the following remit [8]:

1. Improving human health and protecting it from environmental hazards.
2. Enforcing environmental legislation.
3. Developing liaison between local inhabitants and local authorities.
4. Developing liaison between local authorities and higher levels of administration.
5. Providing independent advice on environmental matters.
6. Initiating and implementing health education programmes to promote understanding of environmental effects.

Functional responsibilities

From the above remit a detailed list of functional responsibilities for environmental health officers may be derived (Table 1).

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. Range of existing activities and functional responsibilities of environmental health officers [9]

Activity	Functional responsibility
A. Water resources management ^a	Inspection of water sources.
1. Drinking-water supply (urban)	Systematic surveillance including sampling (chemical and bacteriological) of water supply for potability and purity. Epidemiological investigation in case of waterborne diseases.
2. Drinking-water supply (rural)	Planning, siting, inspection of small-scale water sources, preventive disinfection (rural). Epidemiological investigation in case of waterborne diseases.
3. Water for food industry	Systematic surveillance including sampling (chemical and bacteriological).
4. Water for other uses (recreational)	Systematic surveillance, inspection, sampling.
5. Water for other uses (transportable)	Systematic surveillance, inspection, sampling, preventive disinfection.
6. Water pollution control	
6.1 Inland waters	Monitoring and enforcement: survey, sampling of effluents from suspected sources, routine sampling of river waters for condition.
6.2 Coastal waters	Monitoring and enforcement.
7. Plumbing	Inspection and remedial action for defects in plumbing fixtures, services, pipes, taps (faucets), etc. Monitoring of plans for new constructions.

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
<i>B. Food control</i>	
1. Inspection of specific foods	
1.1 Meat at abattoirs	Post-mortem inspection of carcasses and condemnation of diseased meat.
1.2 Meat at retail level	Inspection of meat in butchers' shops and markets and seizure of unsound products.
1.3 Fish at ports	Inspection of fish landed in ports, condemnation of unsound or contaminated fish, sampling for laboratory monitoring of heavy metal and pesticide contamination.
1.4 Fish at retail level	Inspection of fish in shops and markets for soundness.
1.5 Shellfish layings	Sanitary surveys of areas, sampling of sea water and shellfish for detection of bacteriological or chemical contamination.
1.6 Shellfish purification units	Inspection of installations, sampling of sea water and shellfish.
1.7 Milk production at farms	Inspection of premises, health education of personnel, sampling.
1.8 Milk at pasteurization plants	Inspection of premises, monitoring of processes, sampling of milk, health education of personnel.

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
1.9 Poultry processing plants	Inspection of processed carcasses for disease, inspection of processes, health education of personnel.
1.10 Other foodstuffs	Inspection for soundness.
2. Inspection for registration and routine inspections of:	
2.1 Food industry premises	Application of regulations at the planning stage, routine inspections, legal action.
2.2 Abattoirs	Application of regulations at the planning stage, routine surveillance to enforce compliance.
2.3 Eating establishments	Application of regulations at the planning stage, routine surveillance, legal enforcement of regulations, health education.
2.4 Wholesale storage depots	Application of regulations at the planning stage, routine surveillance, legal enforcement of regulations, health education.
2.5 Markets	Application of regulations at the planning stage, routine surveillance, legal enforcement of regulations, health education.
3. Quality control, monitoring for bacteriological and chemical contamination	

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
3.1 Routine monitoring	Planning of sampling, interpretation of laboratory findings, follow-up action.
3.2 Measures in food poisoning outbreaks	Application of epidemiological procedures for taking food samples.
4. Field investigation of food poisoning outbreaks	Collaboration with medical and veterinary teams to determine causes of outbreaks, taking appropriate action to contain outbreaks.
<i>C. Waste management^a</i>	
1. Solid wastes	
1.1 Municipal waste collection and disposal	Organization and direction of services.
1.2 Cleaning of public places	Organization and direction of services, routine surveillance.
1.3 Disposal sites	Participation in planning, routine inspections, infestation control measures.
2. Liquid wastes	
2.1 Newly laid drains	Supervision of construction and testing.
2.2 Existing drains	Testing for defects, initiation and supervision of remedial action.
2.3 Small disposal units	Advise on planning, design and installation, routine inspections.

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
2.4 Connections to sewers	Enforcement of regulations on connections to private dwellings.
2.5 Sewage disposal installations	Routine hygienic surveillance.
2.6 Effluent sampling	Monitoring for antipollution measures, remedial action.
2.7 Industrial and other toxic wastes	Participation in industrial planning routine sampling of toxic and nontoxic wastes, initiation of action to control health and pollution hazards.
2.8 Wastewater re-utilization	Quality control of wastewater re-utilized for irrigation or other purposes.
D. Housing ^a	
1. Permanent dwellings	
1.1 Demolition	Detailed inspections, application of regulations on individual dwellings and urban renewal projects.
1.2 Reconditioning	Inspections, application of regulations, supervision.
1.3 Repairs	Inspections, schedules of work, supervision of repairs.
1.4 Overcrowding	Inspections, application of regulations.
1.5 New dwellings	Participation in planning, supervision of environmental health aspects of construction and zoning.

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
2. Temporary dwellings	
2.1 Tourist sites	Participation in planning and siting, routine inspections.
2.2 Camping sites	Participation in planning and siting, routine inspections.
2.3 Caravan dwellings	Participation in planning and siting, routine inspections.
<i>E. Epidemiological services</i>	
1. Vector control	
1.1 Rodent control ^a	Planning and supervision of specific control programmes and routine activities.
1.2 Insect and other pest control ^a	Planning and supervision of specific control programmes and routine activities, particularly where the role of vectors in outbreaks requires specific integrated rodent, arthropod or mollusc control measures.
2. Field investigations	Collaboration with medical and veterinary staff to determine causes of disease outbreaks and taking of appropriate measures to halt their spread.
3. Disinfection	Initiation and supervision of appropriate techniques, health education of public.

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
<i>F. Air quality management</i>	
1. Planning and zoning	Participation in surveys and planning.
2. Surveillance and monitoring	Siting of monitoring stations, data collection through laboratory services.
3. Enforcement of standards on emissions	
3.1 Vehicles	Routine control, legal action for enforcement of regulations.
3.2 Housing	Routine control, observations, health education, enforcement.
3.3 Industrial premises	Observation of emissions, advisory inspections, enforcement.
4. Control devices	Advisory services, routine control.
<i>G. Noise control</i>	
1. Zoning	Participation in planning for airports, industry and highways.
2. Sources of noise	Identification of sources of noise.
3. Monitoring and enforcement	Noise monitoring, advice and enforcement of regulations.
4. Installation and operation of control services	Advisory services on noise reduction, monitoring of efficiency and follow-up.

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
<i>H. Occupational health</i>	
1. Hygienic standards of workplaces	Planning approval for sanitary accommodation, water supplies, heating, lighting, etc., routine inspections, initiation of remedial action.
2. Control of hazards to workers' health	Liaison with other ministries, control of small installations in rural areas.
3. Office accommodation	Routine inspections, approval of sanitary accommodation, water supplies, restrooms, meal facilities, lighting, ventilation.
<i>I. Protection of the recreational environment^a</i>	
1. Public swimming pools	Inspections, water quality monitoring, advisory services, closure during certain epidemics.
2. Beaches and bathing areas	Sanitary surveys, water quality monitoring, pest control, closure of unsanitary premises.
3. Parks	Inspections, pest control.
<i>J. Control of frontiers, airports and seaports, and border crossings</i>	
1. Vector control	Control of vectors, collection of specimens, elimination of rats to

ENVIRONMENTAL HEALTH PERSONNEL

Table 1. (cont'd)

Activity	Functional responsibility
	comply with international health regulations.
2. Water supply	Surveys, control of transportation to ships and aircraft.
3. Food hygiene	Air and marine catering, food premises in airports and seaports.
4. Solid/liquid waste disposal	Control of disposal of aviation wastes, hygienic waste disposal within airports and seaports.
<i>K. Educational activities</i>	
1. Community participation	Motivation for active community involvement in environmental health projects by advising on and supporting education of the public.
2. School, environmental health education	Encouragement of and provision of information to teachers concerning environmental health subjects suitable for inclusion in school curricula, encouragement of student projects on environmental matters.
<i>L. Radiation health</i>	
1. Drinking water and food safety	Systematic surveillance through sampling and follow-up.

^a Functions which appear common to most environmental health officers working in the countries reviewed.

ENVIRONMENTAL HEALTH PERSONNEL

Because of the wide range of these functions, an environmental health officer will act largely in a managerial capacity, ensuring effective collaboration of the various environmental agencies and services. Table 2 lists environmental health activities and the personnel required to implement them. This table shows very clearly the considerable range of people with whom an environmental health officer must establish liaison. As indicated, the environmental health officer needs training in a wide range of activities. The depth of such training in specific subjects must be carefully judged in relation to practical requirements of the officer if this is to be possible within a reasonable training period. Completed training should lead to a university degree or equivalent qualification. Provision must also be made for postgraduate specialization.

Table 2. *Personnel required to implement environmental health activities*

Environmental health activity	Personnel required
Water quality management	Civil/building/sanitary engineers Environmental health officers/technicians Public health administrators Public health laboratory - chemists, microbiologists, biologists, technicians
Food safety	Food hygienists Food inspectors Veterinarians, chemists, food technologists, process engineers Public health administrators Public health laboratory - chemists, microbiologists, biologists, technicians
Waste management	Civil/sanitary engineers Environmental health officers/technicians Public health administrators Public health laboratory - chemists, microbiologists, biologists, technicians

ENVIRONMENTAL HEALTH PERSONNEL

Table 2. (cont'd)

Environmental health activity	Personnel required
Principles of urban and regional planning	Building/design/sanitary engineers Architects Planners Public health administrators Environmental health officers
Air quality management	Environmental health officers/technicians Public health administrators Meteorologists Chemists Physicists Engineers Physicians Statisticians
Control of noise and other physical factors	Physicists Engineers Environmental health officers/technicians Public health administrators
Radiation and chemical hazards	Industrial hygiene officials (occupational hygienists) Environmental health officers/technicians Public health administrators Toxicologists Chemists Physicists Engineers Physicians and nurses
Epidemiology	Epidemiologists Physicians and nurses Toxicologists Public health administrators Public health laboratory - chemists, microbiologists, biologists, technicians

ENVIRONMENTAL HEALTH PERSONNEL

Table 2. (cont'd)

Environmental health activity	Personnel required
Occupational health	Industrial hygiene officials (occupational hygienists) Industrial hygiene inspectors Environmental health officers/technicians Physicians and nurses Security/safety engineers Sanitary and other engineers Industrial sanitary chemists Public health administrators Safety committee members (labour-elected delegates)
Environmental health education	Public health administrators Environmental health officers/technicians Teaching professionals Professors active in public relations Physicians and nurses Sociologists

In view of the wide range of activities to be carried out by environmental health officers, the 1979 WHO Consultation [8] listed the following basic concepts to be incorporated in planning their training:

- a. general - to include the natural and social sciences, scientific bases for understanding environmental health effects and relevant health and environmental aspects;
- b. task-oriented fundamentals of environmental health - planning, management, legislation, surveillance systems, cost effectiveness, information, documentation, data collection and processing, and environmental health education of the public;
- c. task-oriented education in specific environmental health problems - depends upon the administrative structure and control systems of a particular country.

The same Consultation [8] recommended the following subjects as components of a model curriculum for environmental health officers:

ENVIRONMENTAL HEALTH PERSONNEL

1. *Water quality management*
 - 1.1 Drinking water supply
 - 1.2 Water for other uses: recreational, agricultural, industrial, or emergency purposes
 - 1.3 Water pollution control (inland and coastal)
2. *Food safety*
 - 2.1 Food production: (a) of animal origin; (b) of vegetable origin
 - 2.2 Food distribution, sale and consumption
 - 2.3 Microbiological and chemical control
3. *Waste management*
 - 3.1 Solid waste - municipal and industrial
 - 3.2 Liquid waste - municipal and industrial
 - 3.3 Recycling of solid and liquid wastes
4. *Principles of urban and regional planning*
 - 4.1 Analysis of projects
 - 4.2 Zoning
 - 4.3 Specially protected areas (coastal zones, parks, etc.)
5. *Housing*
 - 5.1 Permanent dwellings
 - 5.2 Temporary dwellings, including tourist camping sites and caravan dwellings
 - 5.3 Community institutions (e.g. schools, hospitals)
6. *Air quality management*
 - 6.1 Planning and zoning
 - 6.2 Sources of pollution
 - 6.3 Control devices
7. *Control of noise and other physical factors (e.g. vibrations, microwaves)*
 - 7.1 Planning and zoning
 - 7.2 Sources
 - 7.3 Control devices
8. *Radiation*
 - 8.1 Protection against radioactive pollution of drinking water, food, soil, air and building materials
 - 8.2 Radioactive waste disposal
9. *Potentially hazardous substances*

ENVIRONMENTAL HEALTH PERSONNEL

10. *Epidemiology*
 - 10.1 Communicable and parasitic diseases
 - 10.2 Control measures
 - 10.3 Vector control (e.g. rodents, insects)
 - 10.4 Noncommunicable diseases
11. *Occupational health*
 - 11.1 Hygienic conditions for workplaces
 - 11.2 Hazards to workers' health
12. *Application of international health regulations*
13. *Environmental health education*
 - 13.1 Enlisting community action in environmental health projects
 - 13.2 Encouraging voluntary compliance with environmental health legislation
 - 13.3 Education of food handlers
 - 13.4 Encouraging the community to adopt an improved environmental health life style.

In countries where professional environmental health officers or their equivalent do not exist, the development of adequately trained and qualified environmental health technicians may be considered an appropriate way to initiate the establishment of an environmental health officer structure [10]. Environmental health technicians are essentially midlevel personnel in charge of basic hygiene inspection of public and private premises. They should be functionally equivalent to "sanitary fletchers" in the USSR, "inspecteurs de salubrité" in France, "Gesundheitsaufseher" in the Federal Republic of Germany or "saglik memurus" in Turkey. Such technicians can carry out the essential routine inspection and reporting function in environmental health in the regular and systematic fashion necessary to prevent gradual environmental degradation and outbreaks of disease. Absence of such a structured and informed inspectorate may mean that tasks demanding a lesser type of training and qualification than that for medical officers and environmental health officers will have to be carried out by overqualified staff on a less cost-effective basis or perhaps not be carried out at all.

The essential functions of environmental health technicians have been defined as follows [10]:

1. *Food hygiene:* Responsible according to national laws and regulations for routine inspection of all premises where food is cooked, processed or prepared, or adapted for sale by retail and for human consumption either on the premises or elsewhere (excluding food-producing and -processing factories).

ENVIRONMENTAL HEALTH PERSONNEL

2. *Control of camping and caravan sites:* Responsible for inspecting sites to determine whether conditions of licence are being maintained.
3. *Communicable disease control:* Assist in control of the incidence and spread of communicable diseases.
4. *Water hygiene:* Responsible for checking, mainly by routine inspection and sampling, that a safe water supply is being produced and maintained for both dietetic and recreational (e.g. swimming pools) purposes.
5. *Pest control:* Responsible for inspecting premises for health-related pests and for pests which are indicative of poor standards of hygiene; also for inspecting, reporting and monitoring any necessary control measures.
6. *Housing:* Responsible for carrying out routine inspection of housing for fitness or unfitness for human habitation according to defined regulatory criteria.
7. *General environmental inspection and monitoring:* Responsible for initial inspections and notification of general environmental "nuisances" as defined by statute.

The derivation of an educational curriculum for environmental health technicians to qualify them to carry out the above functions has been carried out and will be discussed in section 4 of this document.

The complexity of environmental health problems necessitates continuing education to maintain expertise and update knowledge [8]. Continuing education may be of the following types:

- (a) *postgraduate specialist courses* on particular topics at universities or similar institutions. Topics might include air quality management, control of noise, vibration and other physical factors, water and wastewater management, food safety, environmental legislation, environmental data processing, toxic and hazardous chemicals in the environment, occupational health, health education, solid waste management, urban planning and environmental impact analysis;
- (b) *overview courses* of one month or more at university or equivalent institution, to update and widen perspectives on environmental health subjects;

ENVIRONMENTAL HEALTH PERSONNEL

(c) *refresher courses* lasting one day to one week, organized by government departments and professional associations. Among other things, such courses can consider case-related problems and their critical evaluation as well as new developments in specific subjects.

3. OCCUPATIONAL PROFILES OF ENVIRONMENTAL HEALTH PERSONNEL

The concept of occupational profiles and its use to derive educational curricula have been most fully described in the WHO document Manpower development for control of chemicals [11]. In compiling occupational profiles of environmental health personnel, the primary aim is to define the tasks which may be combined as the responsibility of one person in a given occupation. While the tasks should have international validity, the occupations as defined may not apply precisely to all countries. However, similar occupations usually can be found.

Tasks

Before compiling occupational profiles, a list must be made of the main tasks involved in environmental health protection. The following list subdivides these tasks into six groups: clinical medicine, epidemiology, exposure evaluation, risk assessment, advice and consultation, and management and training. The list should not be regarded as complete since the extent of the work required to protect environmental health is so great as to make completeness virtually impossible. However, hopefully most of the key tasks have been included. Similarly, the descriptions of each task are not precise definitions but are designed to give a broad indication of the nature of the task which may be expanded in various ways to satisfy the requirements of different systems of environmental health protection. Some of the more complex tasks are best done by teams of experts, but in such cases the responsibility for carrying out the task will normally remain with the leader of the team.

Tasks in Environmental Health Protection

Group 1. Tasks in clinical medicine

1. *Health surveillance of people at risk:* Regular medical examinations of people thought to be at risk from environmental hazards with a view to early detection of susceptibility to and occurrence of environmental disease.

2. *Diagnosis, management and investigation of environmental diseases:* Identification of environmental diseases from a consideration of their symptoms observed during medical surveillance and from knowledge of probable exposure to environmental hazards;

OCCUPATIONAL PROFILES

appropriate treatment of the disease and follow-up in the form of continuing treatment, if necessary, and supervision of rehabilitation. Central registration of the disease occurrence may be part of this task in order to aid future diagnoses.

3. *Health surveillance of the general population:* Routine medical examination of sectors of the general public with a view to early detection of unexpected illness caused by environmental factors.

4. *Determination of allergic and other hypersensitive effects:* Assessment of the frequency and significance of allergies and hypersensitive effects.

5. *Determination of irritation effects:* Assessment of irritant properties for the skin, mucous membranes and eyes.

6. *Clinical laboratory analysis:* Routine measurement of haematological, biochemical and functional properties of samples of blood, serum, urine and faeces, taken during medical examination to assess possible presence of environmental disease.

7. *Diagnosis of abnormal findings:* Determination of the exact nature of any abnormalities observed, including attribution to a cause or causes and assessment of the degree to which they can be regarded as harmful, paying special attention to effects which can be particularly associated with environmental factors.

8. *Ensuring good laboratory practice:* Management of clinical laboratories to ensure recruitment of competent personnel, correct training, provision of a good work environment, use of defined methods, good reporting and maintenance of records for easy retrieval of information, and continuing evaluation of work in progress.

9. *Evaluation of environmental effects on health:* Comparative study of the state of health of groups of people exposed to environmental hazards and of other groups not exposed to these hazards, applying statistical methods, with the aim of determining the degree of risk associated with the hazards and elucidating the precise nature of ill effects produced by the hazards.

Group 2. Tasks related to epidemiology

10. *Health surveillance of high-risk groups:* Routine medical surveillance of groups at higher-than-normal risk from environmental

OCCUPATIONAL PROFILES

hazards, with a view to detecting effects and maintaining records for epidemiological analysis.

11. *Health surveillance of the general population:* Routine medical examination of sectors of the general public with a view to detecting effects of environmental factors and maintaining records for epidemiological analysis.

12. *Evaluation of the health effects of environmental factors:* Comparative study of the state of health of groups of people exposed to environmental hazards and groups not exposed to these hazards, applying epidemiological methods, with the aim of elucidating any ill effects of the hazards on the general health of exposed populations.

Group 3. Tasks related to exposure evaluation

13. *Determination of chemical and biological hazards in the work environment:* Assay of chemical and biological hazards in samples from all places in which worker exposure may occur, paying attention to probable duration of exposure and making use of personal sampling equipment wherever possible.

14. *Biological monitoring of exposed organisms:* Assay of chemical and biological contaminants in body fluids and tissue samples from organisms which may have been exposed to them.

15. *Determination of environmental contamination:* Analysis of samples of air, soil, sediment or water for the presence of potentially hazardous microorganisms or chemicals, care being taken to select appropriate sites for sampling and to take samples at suitable times to allow for daily and seasonal variations; biological monitoring should be an integral part of this process where human exposure is suspected.

16. *Determination of contaminants in food and drinking water:* Analysis of food and drinking water for potentially hazardous microorganisms and chemicals, using officially approved methods and determining levels of all potentially harmful contaminants which may act together to cause illness; the term "food" includes all relevant biological materials.

17. *Development of methods:* Development of qualitative and quantitative methods for detection and assay of potential microbiological and chemical hazards.

18. *Physicochemical analysis:* Application of techniques such as gas-liquid chromatography combined with mass spectrometry, atomic

OCCUPATIONAL PROFILES

absorption or emission spectroscopy, polarography or others for the identification of chemicals or their derivatives in environmental or biological samples.

19. *Ensuring good laboratory practice:* Management of laboratories to ensure recruitment of competent personnel, correct training, provision of a good work environment, use of defined methods, good reporting and maintenance of records for easy retrieval of information, and continuing evaluation of work in progress.

Group 4. Tasks related to risk assessment

20. *Evaluation of environmental hazards:* Assessment of hazards in the natural environment and workplace, based on study of environmental health generally, on consideration of hygiene aspects of factory design and industrial processes, and on clinical, chemical and epidemiological investigations.

21. *Evaluation of adverse health effects of environmental pollution:* Interpretation of dose-effect and dose-response curves from epidemiological, microbiological and toxicological studies in relation to actual or possible contamination of the environment by potentially hazardous microorganisms or chemicals, followed by calculation of associated risk, with a view to taking appropriate practical and legal action to minimize harm.

22. *Evaluation of adverse health effects of contaminants in food and water:* Interpretation of dose-effect and dose-response curves from epidemiological and chronic toxicological studies in relation to chemicals and other contaminants in food, followed by calculation of associated risk with a view to setting or revising standards for acceptable daily intake and permissible levels of contaminants.

23. *Evaluation of notified data:* Assessment of reported data, especially those required by the competent governmental authorities before licensing the production and use of new chemicals or biological systems, with a view to defining hazards and estimating risk in order that permissible levels can be set and measures for the prevention of any possible associated harm can be described and implemented.

24. *Statistical analysis of experimental, epidemiological and chemical data:* Use of parametric and nonparametric methods to evaluate the significance of differences between populations exposed to actual or potential environmental hazards, either following tests designed with such evaluation in mind or following the collection of epidemiological data; use of such methods to evaluate the

OCCUPATIONAL PROFILES

significance of apparent correlations between health effects and exposure to environmental contaminants.

Group 5. Tasks related to advice and consultation

25. *Setting of standards:* Establishment of permissible levels of environmental contaminants on the basis of epidemiological studies, experimental animal studies and consideration of most-vulnerable groups; allowance must be made for ecological effects such as harm to animals and plants essential to man, food chain accumulation and conversion of chemicals to more-toxic derivatives.

26. *Inspection of the work environment:* Checking the work environment for exposure to hazards, taking account of all work conditions, general hygiene standards, efficiency and availability of protective equipment, and procedures for instructing workers in safe practice and for ensuring that safe practice is followed.

27. *Recommendations for safety precautions:* Preparing proposals for decontamination and proper disposal of industrial and communal wastes, for keeping levels of contaminants down to those considered safe, for introduction of new processes or substances to replace more harmful ones, for isolation of hazardous procedures, and for medicoprophylactic precautions, surveillance, disease management, etc.

28. *Management of environmental diseases:* Treatment of environmental diseases and follow-up in the form of continuing treatment, if necessary, and supervision of rehabilitation.

29. *Health education:* Instruction on the hazards associated with environmental factors, risks of contracting related occupational or environmental diseases, rules of first aid, safety precautions, hygiene standards, personal hygiene, relevant legislation, etc.

30. *Control of health aspects of the work environment:* Assessment of plans for new factories and laboratories for possible environmental hazards resulting from technical processes or experimentation and formal approval or rejection of the plans.

31. *Inspection of equipment for personal and environmental protection:* Routine checking of protective clothing, filters, scrubbers, catalytic reactors, electrostatic precipitators, etc., to ensure that they are in good condition and functioning properly to meet approved regulatory standards.

32. *Recommendations for environmental improvement:* Proposal of measures to reduce or eliminate discharge of hazardous materials or

OCCUPATIONAL PROFILES

organisms into the general environment, for decontamination of polluted areas, and for environmental changes which remove factors which may increase hazards and which introduce features to minimize them.

33. *Inspection of food production:* Checking all stages of the food production process to ensure that machinery is working properly, producing no contamination, and maintaining concentrations of ingredients at permitted levels; ensuring that only permitted additives are being used.

34. *Inspection of implementation of good laboratory practice:* Checking laboratories to ensure compliance with the rules of good laboratory practice.

35. *Licensing of chemicals:* Control by government of production and use of chemicals, taking into account all available toxicological and epidemiological information and subject to continuing revision as new knowledge comes to light.

36. *Control of production, marketing, and use of chemicals:* Regulation by producers to ensure safe manufacture and packaging of chemicals, paying attention to clear labelling and making available to prospective buyers adequate information about hazards and user protection.

37. *Implementation of control measures:* Putting into practice all measures necessary to prevent damage to health caused by adverse environmental factors, keeping them at or below permitted levels, and reducing exposure of human beings and other organisms at risk as far as practicable; also taking all practicable measures to promote a healthier environment.

38. *Enforcement of control measures:* Ensuring public awareness of relevant laws and regulations, periodic checking on compliance with these and, where necessary, application of legal sanctions such as fines, closure of offending factories or banning of hazardous activities.

39. *Preparation of laws and regulations for control of environmental contamination:* Creation of draft propositions for health protection by a consultative body of environment health specialists with the help of lawyers, a continuing process with constant revision of existing regulations in the light of new knowledge, taking into account all relevant environmental factors.

40. *Provision of emergency services:* Formation of units specialized in the diagnosis of acute environmental health effects

and in giving immediate treatment; instruction of emergency services normally dealing with other problems in the procedures to be followed when abnormal environmental health hazards are involved; ensuring availability of protective clothing for all those likely to be involved in dealing with environmental hazards.

41. *Control of disposal of toxic waste:* Selection of centres to which toxic waste can be brought and safely localized, so that it cannot subsequently be dispersed into the surrounding area; preparation and enforcement of measures to ensure that all toxic waste is brought to such centres, compulsory notification of all sites which have already been used for the disposal of toxic waste, together with a description of the nature of such waste, in order that development of such sites may be regulated to ensure public safety; preparation of guidelines to prevent mixture of wastes which might react to produce toxic gases or other products which cannot readily be contained at the disposal site.

42. *Provision of guidance in aspects of chemical and microbiological control that may have public health implications:* Advising governmental and regulatory bodies, industrial management, and those responsible for emergency services on environmental hazards and the means of minimizing risks to public health.

43. *Provision of information:* Making available, in various ways, information on all relevant facts that can be obtained (e.g. by providing literature, references or critical evaluation of available knowledge).

Group 6. Tasks related to management and training

44. *Planning and directing environmental health research:* Preparation of schemes to extend knowledge and understanding of factors affecting environmental health, especially those of current importance or likely to be significant in the foreseeable future; integration of a multidisciplinary approach to ensure that all relevant factors are considered; continuing evaluation of any scheme as it progresses in order to modify it as required to deal with unforeseen problems and act promptly on new discoveries.

45. *Training in environmental health science:* Education at all levels, as appropriate, in relevant knowledge and skills with special emphasis on enabling all tasks relating to environmental health to be performed effectively to minimize environmental risks to individuals and the general public.

Knowledge needed

Using the above list of tasks, a table can be compiled which relates each task to the areas of knowledge and the skills necessary to perform the tasks (Table 3). Each task is considered separately, and the minimum knowledge required to perform each task adequately is indicated by the Roman numerals I or II in the appropriate boxes. The numeral II designates "expert" knowledge, implying the ability to evaluate information and draw inferences based on relevant experience. The numeral I designates a lesser understanding. These designations are imprecise because the corresponding curricular detail will depend on the exact occupational requirements. This can be seen clearly in the curricula to be described later.

No attempt has been made to describe the areas of knowledge in the same way as the tasks. Most people concerned with education will have a broad idea of what each term signifies, and the precise working definition will depend upon the educational objectives of a given curriculum.

Certain areas of knowledge which are necessary to carry out the tasks listed have not been included in Table 3 because they are so fundamental as to be part of the general education of any competent person likely to be involved in environmental health protection. Thus, omission of areas of knowledge such as language and mathematics must not be taken as in any way undervaluing their importance. Communication is an essential part of the team effort required in maintaining environmental health, and mathematical competence to some level is required for every task listed. Without such basic skills, more-specialized knowledge may be of little practical use.

The extent of knowledge covered by each area name in Table 3 is not the same, and many areas could be further subdivided. One subdivision of outstanding importance in relation to the increasing problems caused by chemical contamination of the environment is analytical chemistry. While obviously understood under the heading chemistry, the importance of analytical chemistry must be stressed here because it provides the methods for identifying and quantifying environmental chemicals which support every stage of environmental health protection from prevention of damage to emergency response.

Occupational profiles

In compiling occupational profiles, the primary aim is to define the combinations of tasks which might be the responsibility of one person in a given occupation. While the tasks as defined should be internationally valid, the occupational profiles may vary from country to country but should be broadly similar. Once the tasks which characterize an occupation have been defined, Table 3

Table 3. (cont'd)

Group 1. Tasks in clinical medicine

Area of knowledge ^a	C	P	B	B	P	A	L	G	M	P	H	P	P	P	O	G	P	I	C	C	V	O	E	E	S	L	
Area of knowledge ^a	h	h	i	i	h	n	a	e	i	a	i	a	a	a	h	n	e	a	m	e	i	e	c	n	p	t	a
Task	e	y	o	o	y	a	b	n	c	l	t	s	e	t	t	a	c	n	t	m	n	i	t	c	v	i	a
	i	o	h	i	o	A	t	B	h	t	o	a	o	m	l	t	o	n	r	M	M	M	e	i	d	e	
	t	s	g	c	o	m	i	b	i	A	p	t	p	b	a	o	o	e	e	M	e	e	d	d	i	t	R
	r	y	o	l	y	S	c	i	o	n	a	t	l	y	o	y	i	b	o	d	i	i	o	i	e	c	
	s	g	i	c	l	o	t	h	o	g	s	h	c	r	e	T	i	c	c	i	c	i	o	s			
	r	e	g	y	m	l	y	e	m	l	o	x	i	n	e	y											
	y	c	e	n	y	o	g	e	m	l	o	x	i	n	e	y											
	e																										
6. Clinical laboratory analysis	I	I								I	I																
7. Diagnosis of abnormal findings	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
8. Ensuring good laboratory practice	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	
9. Evaluation of environmental effects on health	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	

Table 3. (cont'd)

Group 2. Tasks related to epidemiology

Area of knowledge	C	P	B	P	A	L	G	M	P	H	P	P	P	O	C	P	I	G	C	V	O	E	E	S	L
h i o h n a e i o a a i a a a h a a h n e e a m e l e c n p t a																									
e y o o y a b. n c l. t s e t t a c n e m n i t. c. v. d t a																									
m s l c s t e r h. t m h h r c o h u e n. M M M e i s																									
i o h i o A t o B i A p t p a o o e o a m e e m s																									
s c g e o m n. i b i A p t p a o o e o a m e e m s																									
t s y m l y c i o n a o h i c g x m l l e d d i t r																									
r y i o S s o l a t t o y y c r g i c c c l c s																									
y t y c l o t h o s. c r g i c c c l c s																									
r y e g y m l y e l o x. i n n n g																									
y n c e																									
10. Health surveillance of high-risk groups	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
11. Health surveillance of general population	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
12. Evaluation of health effects of environmental factors	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

Table 3. (cont'd)

Group 3. Tasks related to exposure evaluation

Area of knowledge	C	P	B	P	A	L	C	M	P	H	H	P	P	O	P	I	G	C	V	O	E	B	S	L
Task	h	h	i	i	n	a	e	i	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
	e	y	o	y	a	b.	n	c	l.	t	s	e	t	t	a	c	c	n	t	m	e	n	i	t.
	m	s	i	l	c	s	t	e	r	h.	t	a	m	h	r	o	o	h	u	e	n.	t.	c.	v.
	i	l	o	h	i	o	A	t	o	B	h.	t	a	o	o	m	l	o	t	o	n	r.	M	M
	s	c	g	e	c	m	n.	i	b	i	A	p	t	p	a	o	e	o	e	s	M	e	e	e
	t	s	y	m	l	y	c	i	o	n	a	o	h	i	c	g	x	m	l	e	d	d	i	t
	r	l	o	S	a	o	l	a	t	l	y	o	y	o	y	o	y	i	b	o	T	i	c	c
	y	s	g	i	o	g	o	o	h	s.	c	c	r	g	T	i	c	c	l	o	s	.		
	r	e	n	e	m	l	y	o	e	m.														
	y	c	n	e	y	o	g	y	o	g	y													
	e																							
13. Determination of chemical and biological hazards in work environment	I	I																						
14. Biological monitoring of exposed organisms	I	I																						
15. Determination of environmental pollution	I	I																						
16. Determination of chemical/biological contamination of food or drinking water	I	I																						
17. Development of methods	II	I																						
18. Physicochemical analysis	II	I																						
19. Ensuring good laboratory practice	I	I																						

Table 3. (cont'd)

Group 5. Tasks related to advice and consultation

Area of Knowledge	C	P	B	B	A	L	G	M	P	H	P	P	O	P	I	G	C	V	O	E	E	S	L	
Task	h	h	i	i	h	n	a	e	i	a	a	a	h	n	e	a	m	e	l	e	c	n	p	t
	e	y	o	y	a	b	n	c	r	l	h	t	s	e	t	t	a	c	n	t	m	e	n	
	m	a	i	c	t	e	r	h	t	m	h	r	o	o	h	u	e	n	t	c	v	i	a	
	i	o	h	i	o	A	t	o	B	i	A	p	t	p	b	a	o	o	l	e	o	M	M	
	n	c	k	e	m	n	i	b	i	A	p	t	p	b	a	o	o	l	e	o	M	M	e	
	t	s	y	i	o	S	s	o	i	a	t	t	l	y	o	y	c	r	g	T	i	c	c	
	y	a	g	i	c	l	o	t	h	o	s	c	o	y	o	c	i	i	o	n	n	e	e	
	r	e	y	e	g	o	l	y	o	m	e	l	o	x	i	n	n	e	e	y				
	y	c	e	n	y	g	e	y																
25. Setting standards	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	II								
26. Inspection of work environment	I	I																						
27. Recommending safety precautions	I	I	I	I																				
28. Management of environmental diseases	I																							
29. Health education	I																							
30. Control of health aspects of work environment	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	II				
31. Inspection of equipment for personal and environmental protection	I	I																						

Table 3. (cont'd)

Group 5. Tasks related to advice and consultation

Area of knowledge	C	P	B	P	A	L	G	M	P	H	P	P	P	O	G	P	I	C	V	O	E	E	S	L
Task	h	e	y	i	h	a	e	i	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
39. Preparation of laws and regulations for control of environmental contamination	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
40. Providing emergency services	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
41. Control of disposal of toxic wastes	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
42. Provision of guidance in aspests of chemical & microbiological control that may have public health implications	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
43. Provision of information	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I

OCCUPATIONAL PROFILES

may be used to derive the relevant areas of knowledge and the levels of attainment in these areas which must be achieved to carry out the tasks properly. It must be emphasized that where the occupational profiles indicate that an ability to carry out a task is required, this does not mean that anyone pursuing that occupation must necessarily perform the task in person: the essential responsibility may simply be to ensure that the task is carried out adequately.

The occupational profiles below are derived from the WHO document Manpower development for control of chemicals [11]. The profiles are arranged below with the key environmental health personnel identified in WHO documents and publications placed first.

Occupational profiles

Sanitary engineer: Must be able to carry out evaluation of adverse health effects of environmental pollution²¹, inspection of equipment for personal and environmental protection³¹, and make recommendations for environmental improvement³²; may be involved in control of health aspects of the work environment³⁰, implementation of control measures³⁷, and control of disposal of potentially toxic wastes⁴¹.

Safety engineer: Must be able to take part in evaluation of occupational hazards²⁰, setting of standards²⁵, recommending safety precautions²⁷, control of health aspects of the work environment³⁰, and implementation of control measures³⁷; may also be involved in control of disposal of potentially toxic wastes⁴¹.

Environmental health officer: Must be able to carry out determination of environmental contamination¹⁵, evaluate adverse health effects of environmental pollution²¹, and make recommendations for environmental improvement³²; may be involved in statistical analysis of experimental, epidemiological and chemical data²⁴, implementation of control measures³⁷, provision of emergency services⁴⁰, and control of disposal of toxic wastes⁴¹.

Environmental health technician: Essentially the same tasks as the environmental health officer but at a lower level of responsibility and supervised by a fully qualified environmental health officer.

Industrial hygiene official: Must be able to carry out determination of chemical and biological hazards in the work environment¹³, and inspection of the work environment²⁶, make

OCCUPATIONAL PROFILES

recommendations for safety precautions²⁷, carry out health education of workers and management²⁹, control of health aspects of the work environment³⁰, enforcement of control measures³⁸, and provide advice on emergency services⁴⁰.

Sanitary inspector in industrial hygiene (industrial health inspector): Must be able to carry out inspection of the work environment²⁶ and of equipment for personal and environmental protection³¹; may be involved in recommendations for safety precautions²⁷ and in control of health aspects of the work environment³⁰.

Food hygienist: Must be able to carry out determination of contaminants in food and drinking water¹⁶, evaluation of adverse health effects of contaminants in food²², and implementation of control measures³⁷; may be involved in health education²⁹.

Food inspector: Must be able to carry out the tasks of a food hygienist - primarily with a view to the sanitary control of production, processing and marketing of food products.

Water sector supervisor [12]: Must be able to carry out determination of contaminants in water¹⁶, ensure good laboratory practice¹⁹, evaluate adverse health effects of environmental pollution²¹, evaluate adverse health effects of contaminants in drinking water²², inspect the relevant work environment for exposure to hazards²⁶, recommend safety precautions²⁷, carry out appropriate health education²⁹, control health aspects of the work environment³⁰, inspect equipment for personal and environmental protection³¹, recommend steps for environmental improvement³², implement control measures³⁷, provide emergency services⁴⁰, control disposal of toxic wastes⁴¹, and provide information⁴³.

Nonphysician primary health care workers: Must be able to carry out health surveillance¹, management of common environmentally induced diseases and treatment of intoxication², health education²⁹, and provide emergency services⁴⁰.

Clinician specializing in occupational diseases: Must be able to carry out health surveillance of workers¹ and diagnosis, management, and investigation of occupational diseases²: this will involve determination of allergic and other hypersensitive effects⁴, determination of irritation effects⁵, and clinical laboratory analysis⁶; it may involve evaluating occupational hazards²⁰, statistical analysis of epidemiological data²⁴, and recommending safety precautions²⁷.

OCCUPATIONAL PROFILES

General practitioner in occupational health: Must be able to carry out health surveillance of workers¹ and diagnosis, management, and investigation of occupational diseases². This will involve determination of allergic and other hypersensitive effects⁴, determination of irritation effects⁵, and clinical laboratory analysis⁶; it may involve evaluation of occupational hazards²⁰, recommendation of safety precautions²⁷, and health education of workers and management²⁹.

Occupational health nurse: Must be able to carry out health surveillance of workers (occupational health services)¹ and will be involved in management of occupational disease and treatment of intoxication², and providing emergency services⁴⁰; may assist in the health education of workers and management²⁹.

Industrial sanitary chemist: Must be able to carry out determination of potentially toxic chemicals in the work environment¹³ and in samples from biological monitoring of exposed personnel¹⁴; may help in control of disposal of potentially toxic wastes⁴¹ by advising on methods of detoxification.

Environmental sanitary chemist: Must be able to carry out determination of chemical environmental contamination¹⁵, determination of contaminants in food and drinking water¹⁶ (and possibly cosmetics, detergents, clothes and toys) and make recommendations for environmental improvement³²; will be involved in control of health aspects of the work environment³⁰, implementation of control measures³⁷, and providing emergency services⁴⁰.

Analytical food chemist: Must be able to carry out determination of contaminants in food and drinking water¹⁶; may be involved in development of methods¹⁷ and physicochemical analysis¹⁸.

Safety committee member or labour-elected safety delegate: Must be able to contribute to recommendations for safety precautions²⁷ and may be involved in health education of workers²⁹, inspection of equipment for personal and environmental protection³¹, and implementation of control measures³⁷.

Senior administrator (public health): Must be able to carry out setting of standards²⁵, make recommendations for safety precautions²⁷ and for environmental improvement³², licensing of chemicals for use³⁵, and preparation of laws and regulations for control of chemicals and their use³⁹; must be aware of the implications of administrative decisions for planning and directing research⁴⁴ and for the provision of training⁴⁵.

4. CONSTRUCTION OF CURRICULA FOR KEY ENVIRONMENTAL HEALTH PERSONNEL

The occupational profiles for environmental health personnel, defined in terms of key tasks in the last section and used with Table 3 which relates these tasks to the knowledge and skills required to perform them, permits the identification of the components required for an educational curriculum. To construct an educational curriculum, these components must be arranged in a logical manner within an academic structure appropriate to the level of education required and to the prevailing educational system. The examples below, taken from WHO publications and documents [6,8-11], show how this can be done.

Sanitary engineers

From the occupational profile of the sanitary engineer in the list on page 41 and the relation of tasks to areas of knowledge and skills in Table 3, we find that the corresponding curriculum must include chemistry, physics, biochemistry, physiology, anatomy, microbiology, molecular biology, histopathology, haematology, pathophysiology, pathobiochemistry, pharmacy, oncology, genotoxicology, pathoembryology, immunology, general toxicology, clinical medicine, occupational medicine, environmental medicine, epidemiology, statistics, and law and regulation. At first sight, this may appear to be impossible to achieve because a complete coverage of these topics would be excessive and impractical. However, essentially these are the curricular components listed by the WHO Consultation in 1982 [6]:^a

- biostatistics
- determinants of health and diseases related to air (air hygiene)
- determinants of health and disease applied to sanitary engineering (applied hygiene)
- epidemiology

^a The superscript ^a indicates the public health components considered most relevant by the WHO consultation. The other components may be offered as options.

CONSTRUCTION OF CURRICULA

- environmental determinants of health and disease (environmental hygiene)
- food determinants of health and disease (food hygiene)
- health (of public) control on work premises
- housing determinants of health and disease (housing hygiene)
- human ecology
- industrial determinants of health and disease (industrial hygiene)
- industrial toxicology
- noise control
- parasitology^a
- principles of human physiology^a
- principles of toxicology^a
- public health and environmental legislation^a
- public health education
- public health organization and administration
- radiation protection
- rural sanitation
- sanitary biology and microbiology^a
- toxicological chemistry
- tropical determinants of health and disease
- urban determinants of health and disease (urban hygiene)
- urban ecology
- urban sanitation
- vector control^a

CONSTRUCTION OF CURRICULA

- waterborne diseases^a.

Precise definition of the curricular components will depend on the educational objectives, and this must be done by the teachers before arranging the components in an appropriate order to form a curriculum. An example of such a curriculum is that of the Technical University of Budapest (below) [6]. This curriculum does not contain all the components identified above, but it does indicate how a number of them can be arranged into a postgraduate degree course.

Postgraduate programme in water supply, sewerage and sanitary engineering. Faculty of Civil Engineering, Technical University of Budapest

Prerequisite: Degree in engineering

Duration: Two years (four semesters)

Courses:

	Hours	
	Optional	Compulsory
<u>First semester</u>		
1. Water chemistry, water hygiene	2	20
2. Wastewater chemistry	2	25
3. Applied hydrology (underground water)	2	25
4. Hydromechanics	2	20
5. Economic planning	-	10
<u>Second semester</u>		
1. Applied hydraulics	12	14
2. Applied hydrology (surface water)	8	14
3. Deep wells	12	14
4. Water supply and water treatment I	10	42
5. Environmental health I	10	20
6. Health organization and administration	-	10
<u>Third semester</u>		
1. Environmental health II	5	20
2. Biology	3	30
3. Water supply and water treatment II	18	30
4. Sewage treatment	20	25

CONSTRUCTION OF CURRICULA

5. Economy and state management of water supplies	-	10
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Fourth semester

1. Epidemiology	5	20
2. Occupational health	10	20
3. Water supply and water treatment III	10	25
4. Wastewater treatment	10	25
5. Food hygiene	-	10
6. Technology of environmental health plants	10	20

Safety and health engineers and safety officers

Use of the occupational profile and Table 3 shows that the training curriculum for such personnel must include the following components: chemistry, physics, biology, biochemistry, physiology, anatomy, microbiology, molecular biology, histopathology, pathophysiology, pathobiochemistry, pharmacy, oncology, genotoxicology, pathoembryology, immunology, general toxicology, clinical medicine, occupational medicine, environmental medicine, epidemiology, statistics, law and regulation. The detailed content of these curricular components may be derived by relevant specialists and related to the curricular proposals put forward in Education and training in occupational health, safety and ergonomics [13]:

- engineering and materials science
- principles of occupational safety
- principles of occupational physiology
- occupational toxicology
- radiation hygiene
- principles of occupational hygiene and sanitation
- principles of epidemiology
- industrial ventilation, lighting, heat and humidity
- protection against fire, explosion, inundation, harmful respirable dust and gases

CONSTRUCTION OF CURRICULA

- introduction to ergonomics and occupational/industrial psychology
- protection against noise and vibration
- prevention of accidents
- safety legislation
- accident analysis and costing
- organization of occupational safety and health
- analysis of occupational safety of work systems.

Environmental health officers

From the occupational profile and Table 3, the curricular components required for environmental health officers are: chemistry, physics, biology, biochemistry, physiology, anatomy, microbiology, molecular biology, histopathology, haematology, pathophysiology, pathobiochemistry, pharmacy, oncology, genotoxicology, pathoembryology, immunology, general toxicology, clinical medicine, occupational medicine, environmental medicine, epidemiology, statistics, law and regulations. These components can again be referred to a model curriculum suggested by a WHO consultation [8]. The model curriculum is as follows:

- water quality management
- food safety
- waste management
- principles of urban and regional planning
- housing
- air quality management
- control of noise and other physical factors (vibrations, microwaves, etc.)
- radiation
- potentially hazardous substances

CONSTRUCTION OF CURRICULA

- epidemiology
- occupational health
- application of international health regulations
- environmental health education.

Environmental health technicians

Environmental health technicians are essentially support staff for environmental health officers with the responsibility of assessing premises, persons or circumstances against predetermined statutory criteria and criteria of good practice. Hence, the educational requirements for environmental technicians are similar to those for environmental health officers but somewhat less demanding. The outline curriculum below is based on a paper prepared by C.J.C. McKay in 1983 [10]:

Technology: building construction and defects, water supply, drainage and sewerage, sewage treatment.

Environmental science: basic microbiology, epidemiology, food poisoning.

Environmental health: legal and administrative basis, caravan and camping sites, housing, pests and pest control, atmospheric pollution, water pollution.

Communication studies: reporting, environmental health education.

Nonphysician primary health care workers

Although prescribing a standard curriculum for this group is difficult since their occupational profiles depend considerably on the health problems of immediate importance in the area where they work, some important factors relevant to their training have been defined specifically for agricultural and industrial settings [13].

Possible components of training for nonphysician primary health care workers are:

Agricultural health hazards: accidents with machinery and/or hand tools; infectious and parasitic diseases; effects of exposure to pesticides and other agricultural chemicals; effects of extreme climatic conditions; lung diseases and hypersensitive

CONSTRUCTION OF CURRICULA

effects of exposure to dusts; accidents and diseases due to alcoholism, taking drugs, and smoking; effects of water and air pollution; regulations for worker protection.

Industrial health hazards: psychosocial problems (e.g. caused by labour migration); accidents with machinery and chemicals; effects of exposure to chemicals; accidents and diseases due to alcoholism, taking drugs, and smoking; effects of water and air pollution; regulations for worker protection.

Principles of prevention in health and safety: sanitation and hygiene; monitoring the environment for basic health hazards with simple methods; provision and maintenance of adequate accident-prevention measures.

Industrial hygiene officials (occupational hygienists)

Use of the occupational profile and Table 3 shows that the training curriculum for such personnel must include the following components: chemistry, physics, biology, biochemistry, physiology, anatomy, microbiology, molecular biology, histopathology, pathophysiology, pathobiochemistry, pharmacy, oncology, genotoxicology, pathoembryology, immunology, general toxicology, clinical medicine, occupational medicine, environmental medicine, epidemiology, statistics, law and regulations. The detailed content of these curricular components may be derived by relevant specialists and related to the curricular proposals put forward in Education and training in occupational health, safety and ergonomics [12]:

Undergraduate training: engineering, chemistry or medicine (with emphasis on basic sciences).

Public health and occupational health courses: environmental health, principles of work physiology and toxicology, occupational diseases, occupational psychology and health education, biostatistics, principles of epidemiology, ergonomics and occupational safety.

Fundamentals of occupational hygiene: recognition of occupational hazards, evaluation of physical agents, evaluation of air contaminants, evaluation of environmental preventive measures, evaluation of worker control measures, knowledge of administrative and legal requirements, knowledge of education and training methodology.

Food inspectors (food hygienists)

Applying the same general approach as before, the following components must be included: chemistry, physics, biology, biochemistry, physiology, anatomy, microbiology, molecular biology, histopathology, haematology, pathophysiology, pathobiochemistry, pharmacy, oncology, genotoxicology, pathoembryology, immunology, general toxicology, clinical medicine, occupational medicine, environmental medicine, epidemiology, statistics, law and regulations. Again, at first glance, this list appears to be excessive but, with careful selection of content of each component, a practicable curriculum can be devised to satisfy these requirements; an example of such a curriculum has been presented in the WHO document by P.J. Barlow [14]. The main topics in this curriculum, in order of presentation, are as follows:

THREE-YEAR COURSE FOR ALL FOOD INSPECTORS

Mathematics
Statistical methods
Introduction to computer systems and their use
Biology (including microbiology and relevant medical science)
Chemistry
Physics
Building construction
Environmental services
Epidemiology and communicable diseases
Pest control
Health education
Occupational health and safety
Food science and technology
Law and administration.

ONE-YEAR COURSE FOR SENIOR FOOD INSPECTORS

Food chemistry and biochemistry
Food microbiology
Nutrition
Production and distribution of food
Food legislation and enforcement.

Water sector supervisors (operators of water and wastewater plants)

From the occupational profile and Table 3, it can be seen that the training curriculum for this group must include the following components: chemistry, physics, biology, biochemistry, physiology, anatomy, microbiology, molecular biology, histopathology,

CONSTRUCTION OF CURRICULA

pathophysiology, pathobiochemistry, pharmacy, oncology, genotoxicology, pathoembryology, immunology, general toxicology, clinical medicine, occupational medicine, environmental medicine, epidemiology, statistics, law and regulations. The detailed content of these curricular components may be found in the report of the WHO Working Group which met in Delft in 1981 [12]. This report defined the following as required knowledge for a water sector supervisor:

1. General knowledge.

Basic ability in communication, mathematics and reading of drawings; basic knowledge of water and sewer networks and treatment systems.

Basic knowledge of management practice.

Basic knowledge of chemistry, physics, hydraulics and water consumption.

Industrial regulations, statutory requirements, standards, personnel and technical policy.

Job analyses, basic instructional techniques.

Safety regulations, first aid, safety equipment and alarm devices, emergency procedures.

Basic knowledge regarding the transmission of waterborne diseases.

Materials and handling procedures, storage safety regulations, suppliers, delivery details.

Broad knowledge of equipment.

Unit cost rates, accounting.

Contract procedures, legislation, and commercial practice.

2. Knowledge relating to pumping stations.

Good mechanical and electrical knowledge; specific knowledge relating to pumping equipment and accessories; knowledge of manufacturer's instructions.

Basic knowledge of materials, equipment and various types of joint.

Basic knowledge of hydrology, hydrogeology, hydrobiology and chemistry.

CONSTRUCTION OF CURRICULA

3. Knowledge relating to water distribution systems.

Regulations, underground services, pipe and joint materials, service water meters, valves, codes of practice, execution methods, installation practices, pipe-cutting techniques, construction equipment.

Corrosion of materials, protective coatings, cathodic protection, shuttering, special techniques (i.e. pipe jacking, horizontal boring); traffic control regulations; chlorination techniques and equipment.

Valves, hydrants, materials for construction, construction skills; bricklaying, concrete placing.

Register faces of meters, fixtures, water consumption records and accounting; understanding of system characteristics, operational storage, instrumentation and control equipment for manual and/or automatic operation and remote monitoring, data processing equipment, testing procedures.

Sampling procedures, routine water analyses, chlorination equipment, chlorine handling, safety techniques, illicit practice, laws and regulations governing house installations and household appliances, municipal by-laws, plumbing techniques, health aspects.

Local conditions.

Leak detection methods and equipment; operating characteristics of meters, installation practices, testing procedures and repair techniques, workshop practice; cleaning methods and equipment; repair techniques, in-place lining techniques; flow recorders and basic analytical techniques; protective coatings, cathodic protection, building materials, repair techniques; planning of operating labour force, appropriate equipment.

4. Knowledge relating to water treatment plant.

Basic water chemistry, hydraulics, sampling equipment and procedures, laboratory equipment and procedures, understanding of processes and design criteria; regulations, water quality standards; understanding of changes in raw water quality, health aspects; causes and effects of plant operations.

Understanding mechanical and electrical equipment and control systems; specific knowledge of operation of equipment and control devices, instrumentation and switchboards; desludging frequency,

CONSTRUCTION OF CURRICULA

operation of rapid sand filters and slow sand filters; chlorine handling, safety techniques.

Specific knowledge of maintenance of equipment, structures and pipework.

5. Knowledge relating to sewage collection systems.

Regulations relating to the provision of house connections, surveying, underground services, pipe and joint materials, codes of practice, construction techniques, pipe cutting techniques and testing procedures.

Dewatering techniques, shoring of excavation, deep excavation techniques, special techniques (e.g. pipe jacking, horizontal boring), construction equipment, traffic control regulations.

Materials for construction, construction skills; bricklaying, concrete placing, steel fixing, etc.

Basic hydraulics, local conditions; inspection methods and equipment; cleaning methods and equipment; repair techniques; sampling procedures and basic analytical techniques; planning of operating labour force, appropriate equipment.

Basic water chemistry, microbiology, hydraulics, sampling equipment and procedures, laboratory equipment and procedure, understanding of processes and design criteria; law, local regulations, required standards, river pollution, importance of sludge quality control; causes and effects of plant operation.

Mechanical and electrical equipment and control systems, specific knowledge of operation; desludging frequency, sludge characteristics; trickling filter operation; start-up procedures, activated sludge operation; operational problems.

Specific knowledge of mechanical and electrical equipment and control systems, cleaning materials and equipment.

The concept of the target curriculum [11]

Once a curriculum has been derived for a given occupation, it can be treated as a target curriculum for entrants to that occupation. The previous educational experience of the entrant can be compared to the target curriculum and components already studied to an appropriate level deleted. The components remaining can then be organized into a programme suitable for each entrant individually. Such a programme should be available for either

CONSTRUCTION OF CURRICULA

full-time or part-time study. This implies that the programme components are arranged on a modular basis. The content of each component must first be defined on the basis of educational objectives which will relate to specific occupational profiles and their requirements. The educational objectives should also be reflected in the methods of assessment adopted, since these provide the operational objectives for the students.

Having decided on the content of the curricular components and the correct assessment methods for achievement of educational objectives, the content must be organized, preferably into a modular system, that is, one in which the course content is divided into equivalent units of teaching time. The optimal unit time for a module would be a 1-week intensive full-time course; this would be equivalent to 15 lecture hours plus corresponding practical work and demonstrations. Each module must be capable of being taught as an independent course and must cover a subdivision of knowledge which has significance in its own right. Furthermore, the relationship of modules within a curricular component must be clear, particularly when one module is sequentially dependent upon another. In the context of full-time education, 15 modules would constitute a reasonable academic year. This corresponds to about 225 hours of lectures.

For a full description of the derivation of a target curriculum, its use, and the detail of its component courses and modules, the reader is again referred to Manpower development for control of chemicals [11]. This document contains the target curriculum for a senior toxicologist, but many of the modules described could also contribute to target curricula for other occupations.

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