

GUIDELINES ON MANPOWER PLANNING  
IN ENVIRONMENTAL HEALTH

*Health man.  
E.W. Health  
Spudis*

*Least personnel*

Report on a Study for the  
WHO Regional Office for Europe

by

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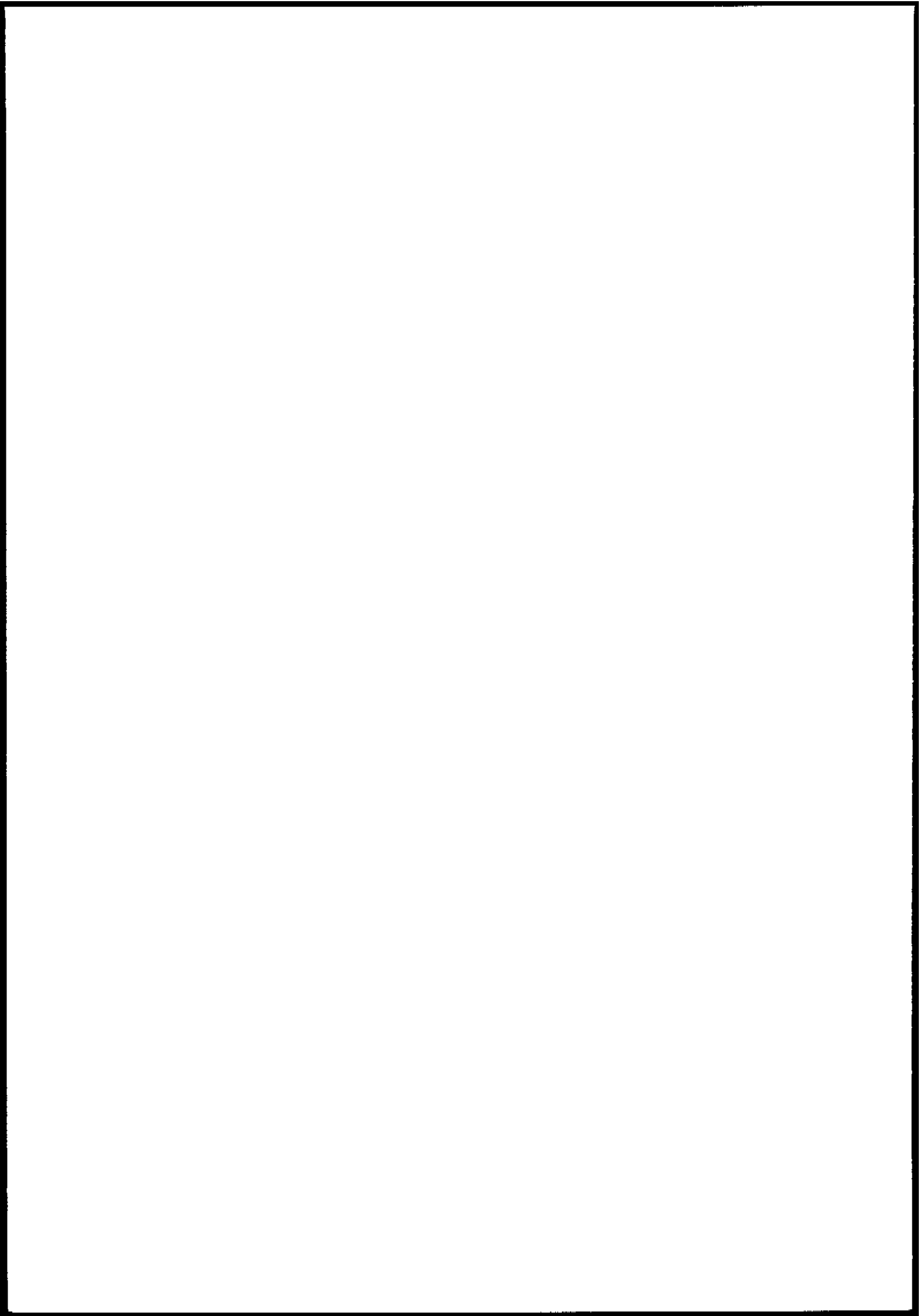
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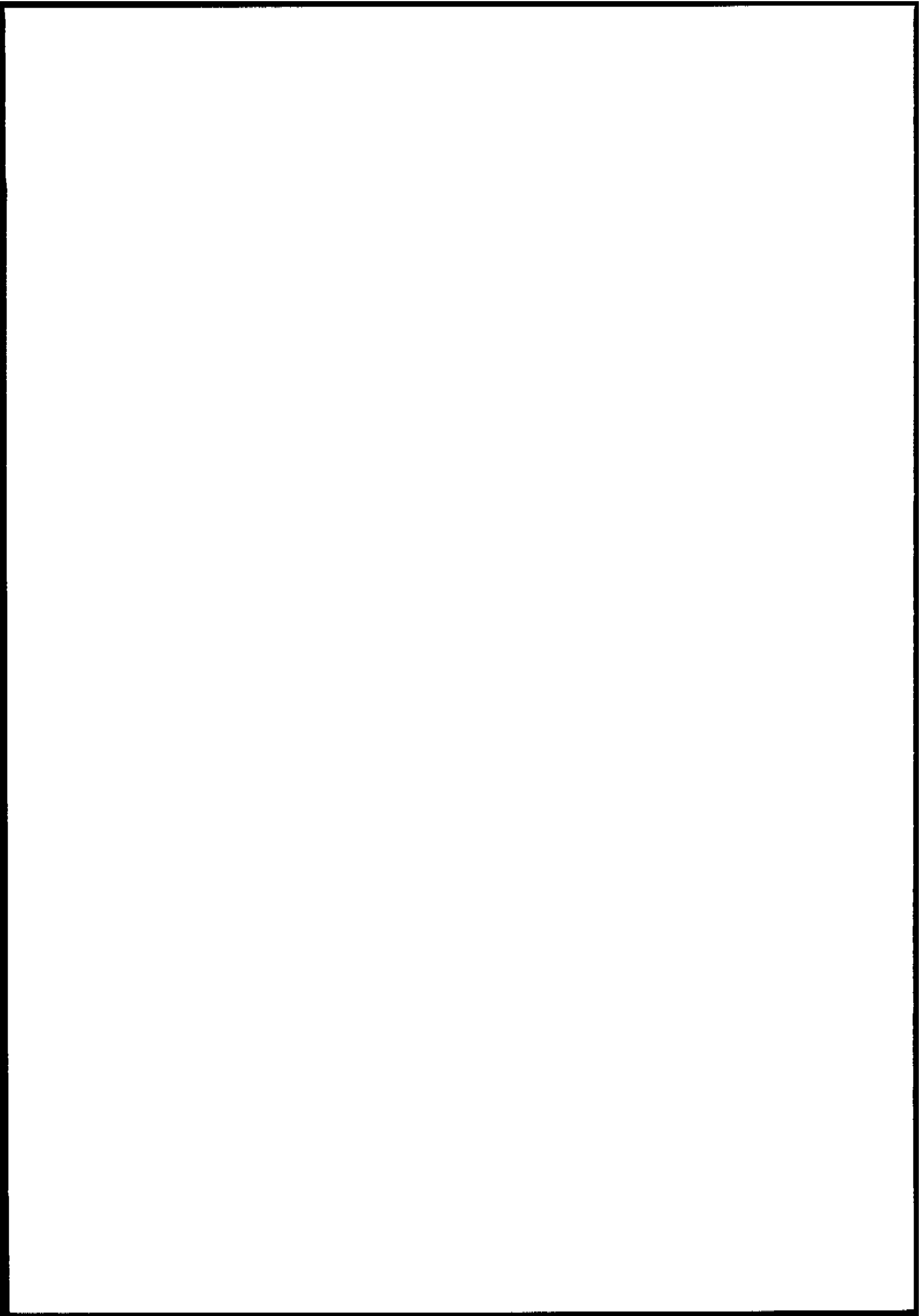


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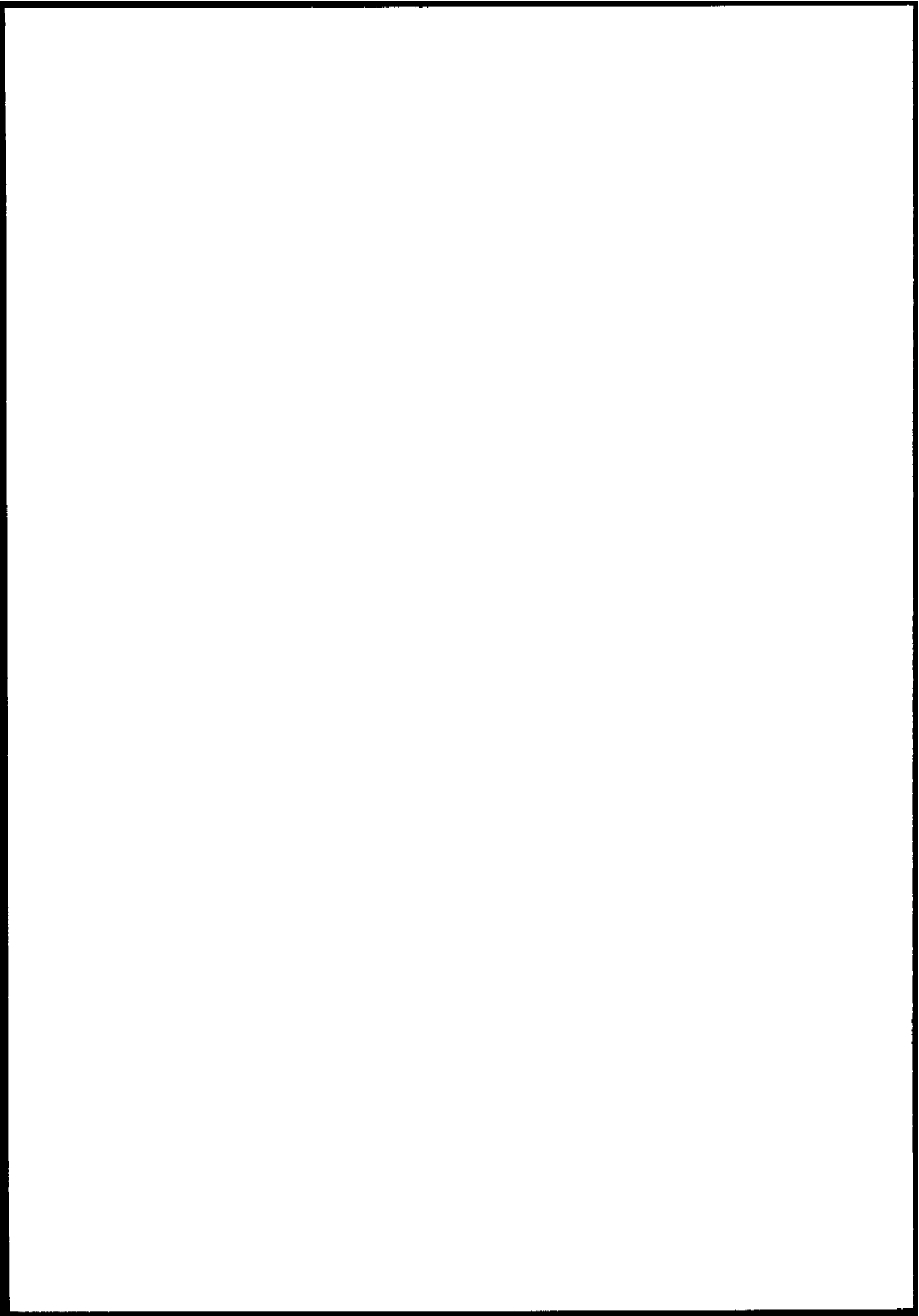
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## 1. INTRODUCTION

The present report forms part of the activities of the regional project on manpower requirements in environmental health, which started in 1973.

An initial activity of the project was the performance of pilot surveys in the following areas:

- City of Leicester, United Kingdom
- Bydgoszcz province, Poland;
- Gothenburg and environs, Sweden;
- Frankfurt am Main, Offenbach and Hanau, Federal Republic of Germany.

The immediate objectives of the surveys were:

- (a) to obtain data on the personnel currently employed in various functions related to the protection and promotion of environmental health in selected pilot areas;
- (b) to identify the manpower mixes involved;
- (c) to develop indices and useful correlations for the different categories of personnel required and parameters for the extent of services rendered, and generally to develop methodology for forecasting manpower requirements.

In December 1976 a meeting was held in Copenhagen to review the earlier activities and to make recommendations on further work including training<sup>a</sup>. With regard to the pilot survey results reported in 1974, the following points were noted:

- (a) The pilot areas were too small and were unrepresentative of the countries as a whole.
- (b) The surveys did not go far enough in trying to correlate area characteristics with staffing patterns; by aggregating the wide range of environmental programme components into relatively few "activities" the surveys were simplified but the relationship between the components and the types and numbers of manpower required was lost to some extent.

It was felt that the extent of the services rendered in the community should be broken down into the various component activities so that it might then be possible to correlate the type and number of staff employed for each activity. Such correlations were considered very useful in forecasting manpower requirements, provided services and facilities likely to be developed within a community over subsequent years were also taken into account.

Finally it was proposed that a draft guide be prepared showing the availability of approaches to manpower estimation other than that of the questionnaire. It was pointed out that in view of the relative low accuracy of all such forecasts, an adequate estimation might be obtained from expert consensus based on appraisal of the likely demand for facilities and services resulting from an interaction of various determinants over quite a short time.

Thus the purpose of the present report is to conclude the above work, particularly by breaking down and working out staff correlations for control activities related to:

- foodstuffs;
- water supplies;
- waste water;
- recipients;
- solid wastes;
- air and noise pollution;
- occupational health.

<sup>a</sup> See WHO Regional Office document ICP/SES 003 of 20 June 1977.

The procedure indicated in the report is expected to provide a basis for estimating manpower requirements in relation to desirable levels of service and facilities.

## 2. MODEL AREAS

In some environmental health activities it is difficult to establish a clear correlation between the area covered and the manpower requirements for specific activities. Waste water purification is an example. The manpower required to carry out this activity depends only on the type of sewage collection and purification. Other activities, such as occupational health control, depend on the area they take place in that there are differences in the standards set in different areas. Here an "area" is understood to mean a country or a part of a country, as different parts of a country do not necessarily have the same characteristics. Therefore a model approach is appropriate for the development of guidelines; and for this purpose two types of model areas have been developed, as described below:

### 2.1 Highly developed area

Population: The density is 200 per km<sup>2</sup>, with 80% living in cities and towns and 20% in rural areas.

Economy, trade and industry: 40% of the population depend on industry, 5% on farming, fishing, forestry and production of raw materials, and 50% on the service sector. The GNP was about 5000 US dollars per person in 1973.

Land use: Cities and towns account for 15% of the total area, farmland for 40%, forests, lakes and mountains for 35% and land in other uses for 10%.

Sewerage in cities and towns: 100% is collected and treated in community systems, compared with 50% in rural areas.

Water supply: In cities and towns 100% of water is supplied in community systems compared with 50% in rural areas. Ground water counts for the minor part of the supply.

Solid wastes: In cities and towns 100% is collected compared with 50% in rural areas.

### 2.2 Less developed area

Population: The density is 100 per km<sup>2</sup>, with 50% living in cities and towns and 50% in rural areas.

Economy, trade and industry: 30% of the population depend on industry, 50% on farming/fishing, forestry and production of raw materials, and 20% on the service sector. The GNP was about 2500 US dollars per person in 1973.

Land use: Cities and towns account for 5% of the total area, farmland for 40%, forests, lakes and mountains for 45% and land in other uses for 10%.

Sewerage: Collection in community systems is 100% in cities and towns, and nil in rural areas.

Water supply: In cities and towns 100% of water is supplied through community systems, and in rural areas 20%. Ground water accounts for the minor part of the supply.

Solid wastes: Collection is 100% in cities and towns and nil in rural areas.

Both areas have standards (national or WHO) for all activities in the environmental health sector and it is assumed that the number of persons employed in this sector should be great enough to maintain and control the standards.

## 3. MANPOWER FOR DIFFERENT CONTROL ACTIVITIES

### 3.1 Foodstuffs

#### 3.1.1 Public Control

Organization. Public control of foodstuffs is regarded as the responsibility of well trained food inspectors supported by laboratories which take care mainly of microbiological examinations and, in some specialized units, chemical and toxicological examinations. They are also to some extent advisory bodies to local authorities (district and municipal) in matters where their knowledge is needed.

The extent of the work done by laboratories depends on the education of the employees, so those without chemists are assumed to carry out chemical food analysis to a very limited extent and are equipped only with simple chemical apparatus.

The laboratories which do employ chemists are expected to carry out a broad range of chemical and physical food investigations and to extend this service to areas which have units without engineers trained in chemistry.

With regard to the size of the laboratories, both a lower and a higher limit should be respected. With regard to the lower limit, it is considered that an area should have a population of 50 000 to justify employing more than one person with specific professional education level. The upper limit has been put at a population of 800 000 and it is assumed that this number is to be found in a rather limited area, for example a part of a capital city. The reason for choosing this upper limit is that the persons employed in the laboratory must have a good knowledge of the geography, structure and population of the area.

It is assumed that the local authorities and the central authority either do not perform any food control in excess of that performed by the laboratory (which is under the administration of a municipality or a district) or that the authorities carry out additional control to such a limited extent and on such special matters that this does not influence the specification of manpower requirements. It is further assumed that the authorities are responsible for administration only according to current law and that they collect the necessary information for the purpose with the control units. There is one important exception to this rule, namely the control performed in slaughterhouses. The manpower need for public control in these factories is not analysed as the range of education required varies so much from country to country that it would be difficult to establish definite and practical guidelines.

Manpower. On the above assumptions, the relation between the population in areas of different sizes and the staff of the laboratories has been worked out (Table 1).

Remarks:

The heading "veterinarians, microbiologists etc." refers to these specialists and other persons with academic training in food technology and food hygiene enabling them to perform work which is expected to be carried out by laboratories without chemists.

"Chemists" are expected to deal with activities (analysis, investigation, calculation) in their sections of a laboratory. In small units (for 100 000 population) the chemist is always expected to have academic training in chemistry. As a rule this will also be the case for engineers in units for 200 000 population. In larger units the training of the chemists ought to be differentiated according to the technical field concerned: water purification technology, water reclamation technology etc.

The term "technicians" refers primarily to laboratory workers but also other technicians at a similar level, for example biology assistant.

The term "others" refers to office staff, cleaners etc.

3.1.2 Control in private factories

Normally there is a great difference between the aims of public food control systems and those of systems in private factories. Public control is based on the test sampling to ensure that standards and other regulations are observed while private control is primarily working control.

However it is very difficult to specify the manpower needed for the working control. It depends both on the type of factory and on the size of the production in the factory. In the following types of factory it is assumed that one chemist/veterinarian and one technician will always be needed for working control:

- dairies;
- meat factories;
- fishmeal and similar factories;
- slaughterhouses.

Other modest-sized food factories are not assumed to need a staff exclusively responsible for working control. In these factories control is performed by a person who has other jobs as well. But when the factory has reached a certain size it is necessary to employ persons whose only job is working control of the products, e.g. in breweries.

Table 1. MANPOWER REQUIREMENTS FOR FOOD CONTROL

Population served	Manpower requirements	Microbiologists, veterinarians etc.	Chemists	Technicians	Others
50 000		3			2
100 000		4		5	2
200 000		8	1	10	8
300 000		13	1	18	13
400 000		17	3	24	16
500 000		20	4	30	19
600 000		23	4	35	23
700 000		27	5	40	27
800 000		31	5	45	31

### 3.2 Water supplies

#### 3.2.1 General remarks on manpower

The following evaluation of manpower requirements for water reclamation, treatment and distribution is based mainly upon information from about 100 Danish waterworks and from Danish consulting engineers working abroad. The treatment capacity of the waterworks varies from 200 000 m<sup>3</sup>/year to 100 000 000 m<sup>3</sup>/year which, with a daily water consumption of 200 litres/person/day, are appropriate for a town of 2700 - 1 400 000 population. The majority of the waterworks are of 200 000 - 3 000 000 m<sup>3</sup>/year (for 2700 - 41 000 population) capacity. Thus the reliability of the estimates is greatest in this interval.

Moreover information from about 25 waterworks treating about 3600 - 14 600 m<sup>3</sup> (for 50 and 2000 population) has been collected.

The estimation does not reflect any use of the water in industry as this normally does not influence reclamation and distribution.

#### 3.2.2 Manpower requirements

Total manpower requirements for water reclamation and distribution, waterworks operation and administration are given in Table 2.

##### Remarks:

The table does not show manpower requirements for waterworks supplying less than 1 000 population. This does not mean that these small waterworks have no need for care but rather that this is normally provided best and at lowest cost by arrangements with local private firms. It is assumed that a waterworks does not engage an employee until it reaches a size suitable for supply of 1000 population or more. The first employee will normally divide his time between work on the pipelines and on the waterworks. It is also supposed that the executive committee of very small waterworks does the administrative work as a secondary activity.

Table 2. MANPOWER REQUIREMENTS FOR WATER SUPPLY

Size of waterworks (m <sup>3</sup> treated per year x 1000)	Manpower requirements	Reclamation and piping before and after treatment in waterworks	Waterworks		Technical/administrative functions
			Surface water	Ground water	
3.7					
7.4					
37					
74		1/2	1	1/2	
148		1/2	1	1/2	
222		1/2	1 1/2	1/2	1/2
370		1	3 1/2	1 1/2	1
740		2	4	2	1 1/2
1 480		3 1/2	4 1/2	2 1/2	1 1/2
3 700		5	6 1/2	4 1/2	2 1/2
7 400		8	11 1/2	8 1/2	4
14 800		10	20	16	9
37 000		35	60	50	22
74 000		65	120	100	40

In the estimate of manpower requirements for reclamation pipeline work, only daily control and minor repairs are taken into consideration, new construction and contract work being excluded. Also, as frequent control and care of one or a few surface water reclamation structures are considered to require the same number of staff as infrequent control and care of numerous bores for ground water reclamation, no distinction is made between the two types of construction. It might seem reasonable to estimate manpower requirements for care and repair of pipelines in terms of the number of men per km of pipeline. No statistics reliable enough for this purpose have been found, but the available information indicates a manpower requirement of one man per 30 - 50 km of pipeline.

Normally a waterworks for surface water requires more frequent care, control and repair than one for ground water - hence their larger manpower requirement. However there are great variations because of differences in age of the waterworks, the degree of automation, the quality of the raw water etc.

### 3.2.3 Qualifications

In Table 3 the manpower requirements for water supply given in Table 2 are classified according to qualifications.

#### Remarks:

The term "skilled" refers to smiths, pipe fitters, plumbers, electricians and the like. For large works (7 400 000 m<sup>3</sup> or more per year) the term also covers laboratory technicians and other staff in a laboratory.

The term "engineers" refers to engineers and other highly qualified staff (such as chemists and economists).

The reason why waterworks for surface water require more unskilled workers than those for ground water is that their operation and maintenance (e.g. transportation and dosing of chemicals) is normally more labour intensive.

### 3.3 Waste water

Two aspects of waste water disposal are considered separately

- (1) operation of systems for transport and treatment of waste water;
- (2) manpower requirements for control of the above activities.

#### 3.3.1 Transport and treatment

##### 3.3.1.1 Public control

The common practice is for transport and treatment of waste water in the public sector to be undertaken at the local (municipal) level of administration. Three degrees of treatment are considered:

- M: primary treatment - mechanical treatment by screening and sedimentation;
- B: secondary treatment - normally M plus biological treatment by trickling filters or activated sludge;
- C: tertiary treatment - chemical treatment by precipitation of phosphorous compounds after either M, B or M plus B.

Manpower requirements for more simple biological processes as lagoons, oxidation ditches and variants of these processes are not evaluated, as they are not considered to be typical for the model areas described.

Chlorination or ozonation of waste water may be appropriate following secondary or tertiary treatment when discharging to fresh water recipients. However as these processes are considered to be highly automated, the need of manpower for their operation at treatment plants is correspondingly low and is therefore not taken in account.

More advanced treatment, e.g. by activated carbon, ion-exchange, reverse osmosis etc. is thought to find only little application in practice and is not taken in account.

Nitrogen removal by nitrification/denitrification or other processes is also excluded. If applied in specific cases the manpower demand may be estimated in the same manner as for tertiary treatment by phosphorous precipitation.

The existing information on manpower for waste water disposal gives an incomplete picture. A number of surveys of the current manpower situation in treatment plants have been made in Europe and the USA; but only in the USA and Norway have efforts been made to lay down guidelines for the desirable number of personnel in the plants.

Table 3. QUALIFICATIONS OF MANPOWER FOR WATER SUPPLY

Manpower requirements Size of works, (m <sup>3</sup> treated per year x 1000)	Reclamation and piping before and after treatment in waterworks			Waterworks				Technical/administrative staff	
				Surface water		Ground water		Skilled	Engineers and administrative equivalent
	Unskilled	Skilled	Engineers and equivalent	Unskilled	Skilled	Engineers and equivalent	Unskilled		
3.7		1/2			1				
7.4		1/2			1				
37		1/2			1 1/2				
74					3 1/2			1/2	
148					3 1/2			1 1/2	
222					3 1/2			1 1/2	
370		1			3 1/2			1	
740		2			3 1/2			1 1/2	
1 480		3 1/2			3 1/2			1 1/2	
3 700		5			4			2 1/2	
7 400	1	6	1		6 1/2	1		3	1
14 800	1	7	2		12	2		6	3
37 000	9	20	6		30	6		15	7
74 000	20	30	15		55	15		30	10

Table 4 gives estimates based on Norwegian figures (1), supplemented with data on current Danish practice.

It should be mentioned that the Norwegian estimates and those in this report are somewhat lower than the corresponding American figures. Also, since the estimates are subject to considerable uncertainty and since the manpower needed in a specific situation also depends on local conditions, detailed estimates are made for B treatment only.

Under same headings the requirements are broken down according to four different staff groups (1) depending on the duties performed, namely:

- I: civil, mechanical or chemical engineers at senior chief level;
- II: civil, mechanical or chemical engineers with special education as plant operators;
- III: high grade mechanical technicians and other technicians, e.g. laboratory technicians or craftsmen with special training as small plant operators or as operators for single units in larger plants;
- IV: craftsmen working on repair and maintenance of standard equipment (pumps, valves, pipes, screws etc.) and semiskilled personnel with some training in special fields of plant operation.

The necessary manpower is also listed for different treatment plant sizes.

Remarks:

Manpower for operation of treatment plants comprises staff for technical administration, for operation of the different processes including sludge treatment and disposal, and for laboratory work on the plants.

The size of plants is expressed in terms of the equivalent population served.

Tertiary treatment is considered appropriate for plants of a size greater than 1000 p.e.

Manpower for functions such as bookkeeping, secretarial jobs, cleaning, canteen work etc. is not included.

Small plants (6000 p.e.) may be operated either by staff from large plants in the municipality or by staff responsible for a number of small plants. Part-time operators, e.g. staff with their main duties in the road department, are not included.

Municipal engineers and staff having an overall responsibility for the operation of the treatment plants are not included in the table.

In small communities, maintenance of standard equipment is considered to be the responsibility of local firms.

Specialized maintenance of equipment is supposed to be the responsibility of suppliers or other specialized firms.

Staff for maintenance of buildings and structures are not included.

3.3.1.2 Control in industry

Waste water from industry may be viewed in three main groups according to pollution content:

- A: cooling water;
- B: waste water with a content of easily degradable organic matter;
- C: waste water with inorganic pollutants or organic pollutants which are not easily degradable including toxic and/or hazardous wastes.

Table 4. MANPOWER REQUIREMENTS FOR OPERATION OF WASTE WATER PLANTS AND PUMPING STATIONS, PIPELINES, OUTFALLS ETC.

Population served	Secondary treatment B				Primary treatment M % less manpower	Tertiary treatment C % more manpower	Pipelines pumping stations, outfalls etc.	
	Total manpower	Staff groups					Total manpower	Staff groups
		I	II	III				
50	1/4		1/4					
100	1/4		1/4		20%			
500	1/3		1/3					
1 000	1/2		1/4	1/4			1/4	1/4
3 000	1		1/4	1/2			1/4	1/4
6 000	2		1/4	1	30%		1/2	1/2
10 000	3		1/2	1			3/4	3/4
20 000	4		1/2	1			1	1
40 000	7	1		2		20%	1 1/2	1 1/2
100 000	11	2	3	6			2	1 1/2
200 000	16	3	4	9	35%		3	2
500 000	25	1	3	15			4	3
1 000 000	35	1	4	22			6	4

#### A. Cooling water

In most cases cooling water is discharged without treatment, i.e. without lowering the temperature before discharge. In some cases it may be necessary to let the water pass through ponds or the like to adjust the temperature before discharge. Cooling towers are supposed to be used only where the cooling water is recirculated.

As a consequence of the above, no special manpower requirements are considered for treatment of cooling water.

#### B. Easily degradable organic pollution

Waste water with a content of easily degradable organic matter mostly originates in food, feeding stuff and associated products. Often the amounts of waste water are very large with high concentrations of organic matter.

Under Danish conditions, with a mixed industrial load but a rather high proportion of food and feeding stuff industries and a low proportion of heavy industry, it has been found that industry in general contributes a load of easily degradable organic matter to the sewerage systems which is 1 - 2 times the load from persons served by the systems (2).

The load of settleable matter and nutrients (phosphorus/nitrogen) is also estimated to be of the same order of magnitude (1-2 times the load from persons served by the systems). Generally speaking the waste water receives no treatment except some screening or passage through sieves before being discharged to the sewers.

Some major industries in this context are:

- dairies;
- slaughterhouses;
- foodstuff and canning industries (vegetables, fruits, fish, animal products);
- fishmeal and fishoil factories;
- feeding stuff factories;
- sugar factories;
- chocolate and other confectionary factories;
- starch factories (potato, maize etc);
- breweries.

The waste water may be treated at factories, public treatment plants or both, the choice depending on local conditions and especially cost.

In principle, whether the waste water is treated by the industry itself or in public treatment plants, the demand for manpower is not affected. In regions with mixed industries and foodstuffs production it may consequently be assumed that treatment of industrial waste water of type B doubles or triples the need of facilities and manpower for household waste water only.

Waste water of type B may to some extent be used for irrigation, e.g. by spraying on crops, after removal of larger particles and settleable matter. If such procedures are applied to any substantial degree, the manpower demand estimated above should be adjusted accordingly.

Fish farms represent a special problem, often discharging large amounts of organic pollutants in relatively low average concentrations directly into recipient waters. Improved feeding stuff and improved methods of treatment including sedimentation of the waste water before discharge seem to be generally necessary. Fish farm operators should be required to obtain adequate training, possibly by an authorization system.

#### C. Inorganic pollutants

In industrial waste water a wide variety of inorganic and not easily degradable organic pollutants may be found, and in varying amounts and concentrations. Estimates of the necessary facilities and manpower for their treatment are probably impossible to make in general terms but have to be done by laborious analysis for each type of industry. Although the subject is outside the scope of this report, some major industries producing waste water of type C may be mentioned:

- mining industries;
- steel and metal works and associated industries;
- galvanizing and electroplating industries;
- industries producing inorganic and organic basic chemicals;
- oil refineries and petrochemical industries;
- fertilizer industries;
- tanneries.

### 3.3.2 Manpower requirements

"Self control" of operations must be carried out by those responsible for a treatment plant (municipality or industry) and its extent should be specified in the authorization. Such control is thus considered to be part of the operation of plants and systems and the necessary staff are reflected in the figures given in section 3.3.1. The laboratory work necessary for the control is only included in the figures insofar as it is carried out in the plant; however this is generally not the case, since it is normally the responsibility of special laboratories as mentioned below.

In this context, however, control is defined as control by outside authorities, which is presumed to be carried out at three levels: local/municipal, regional and state.

The manpower for control is estimated for "unit populations" of 500 000 persons. This is considered to be a reasonable size of a "unit region" for the purposes of this report. Such a region may be composed of a variable number of communities. The control work in a region is not the same if the region is composed of one big city with a few very large treatment plants and numerous industries or is characterized by small cities and towns or areas with a large rural population. The manpower estimates relate to an intermediate (average) situation of a fairly industrialized region with most of the population living in small cities and towns but also with a substantial rural element. The figures are believed to be suitable for an extrapolation to state or country level but should of course be applied with care in a specific region.

For the system of control it is considered that:

- local/municipal authorities control treatment and discharges in industries and private enterprises;
- regional authorities control public treatment plants and discharges;
- state or central authorities collate the data to ensure uniformity and coordination on state/country level, and control treatment plants (if any) operated by regional authorities.

Control is focused on the discharge end of the systems. Inlet control and operational control of the single units in the treatment plants are also thought to be carried out to a moderate extent to check the efficiency of plant operation.

Manpower needed at the three control levels excluding laboratory personnel is estimated in Table 5. Manpower is grouped according to functions, in four typical categories as follows:

- I: civil, mechanical or chemical engineers, other chemists, biologists, physicians and veterinarians;
- II: same as I, except physicians and veterinarians;
- III: laboratory technicians, other technicians, craftsmen with special training in instrument maintenance and operation and sampling techniques, all having some training in sewerage plant operations;
- IV: craftsmen with some training in sampling techniques and sewerage plant operations.

Table 5. MANPOWER NECESSARY FOR CONTROL OF WASTE WATER TREATMENT AND DISCHARGE IN A UNIT REGION OF 500 000 POPULATION

Control authority	Manpower requirements				
	Total	Groups			
		I	II	III	IV
Local/municipal	10	1	2	4	4
Regional	5 1/2	1/2	1	2	2
State/central	1/2 - 1	<1/4	1/2		

The necessary laboratory work in the waste water field, in connexion with "self control" and control by outside authorities, is considered to be carried out at authorized laboratories (private or public), there being one or a few in each unit region. Often it is expedient to combine different activities in the laboratories. Larger and more specialized laboratories may also be suitable but the distance for sample transport sets a practical limit. Some analyses must be done at highly specialized central laboratories. Manpower for laboratory work in a unit region of 500 000 population is estimated in Table 6.

Staff in the group should typically be:

- I: chemical engineers, chemists, pharmacists, veterinarians;
- II: same as category I;
- III: laboratory technicians;
- IV: laboratory workers.

Table 6. MANPOWER FOR LABORATORY WORK IN WASTE WATER CONTROL FOR A UNIT REGION OF 500 000 POPULATION.

Total	Manpower requirements				Type of laboratory
	Groups				
	I	II	III	IV	
13	1	2	6	4	Regional laboratory
3	1/4	1	1	1	Highly specialized control laboratory with reference duties

### 3.4 Recipients

Recipients in this context are defined as "surface waters receiving discharges of waste water". In principle all streams and lakes and coastal marine waters in areas that are not sparsely populated may be regarded as recipients since they will all receive waste water (in the form of surface run-off, if nothing else) from farmland polluted by nutrients and organic matter.

Control is considered to comprise mainly:

- (a) determination of long-term trends in rivers and streams by biological evaluation;
- (b) determination of long-term trends in lakes and coastal water by examination of bottom fauna and flora;
- (c) determination of long-term trends in all waters by chemical analysis of sediment (mainly with respect to organic matter and nutrients);
- (d) measurement of primary production and biomass of phytoplankton at selected stations in lakes and more enclosed coastal areas;
- (e) measurement of physical and chemical parameters in water at selected stations in rivers and streams, lakes and coastal areas (mainly for transparency, temperature, oxygen and nutrients);
- (f) analysis of the hygienic quality of water (mainly for E. coli and coliforms) at bathing beaches.

For (a) (b) (c) and (f), stations should be selected to give representative coverage. For (d) and (e), relatively few but carefully selected stations are suitable.

Control frequencies are supposed to be of the order once every one or two years for (a) (b) and (c). Sampling under (d) (e) and (f) should be done frequently enough to allow a statistical evaluation on an approximately yearly basis.

Control authorities may be at local, regional or state level. In principle manpower requirements should not be affected by the level at which the control is executed - assuming that if control is performed by the local authorities it would be necessary anyway for small communities to join forces for the purpose. Since a large part of the waste water discharged will usually come from municipal treatment plants, it seems reasonable for control to take place at regional and central level, and this is presumed in the following analysis.

As in section 3.3.2 manpower is estimated for a standard unit region of 500 000 population; the remarks in that section as to the representativity of such regions also apply to the following estimates. The manpower is again grouped according to functions, the categories being as follows:

- I: civil and chemical engineers, other chemists, biologists, physicians and veterinarians;
- II: same as I;
- III: laboratory technicians, other technicians and craftsmen with special training in instrument maintenance and operation and sampling techniques (and in biological evaluation techniques for some personnel);
- IV: craftsmen with some training in sampling and biological evaluation techniques and boatmen (for motorboats).

Table 7. MANPOWER REQUIREMENTS FOR CONTROL OF RECIPIENT IN A UNIT REGION OF 500 000 POPULATION.

Control authority	Manpower requirements				
	Total	Groups			
		I	II	III	IV
Regional	19	1	5	3	10
State/central	3	1/4	1	1/2	1

Remarks:

- Central authorities are assumed to carry out some general surveying, especially in more open marine waters.
- Manpower in specialized institutions and firms carrying out water quality and hydraulic surveys are not included as their function is not regarded as part of control activities but part of the work necessary to determine the size of treatment plants, outfalls etc.

Table 8. MANPOWER FOR LABORATORY WORK IN RECIPIENT CONTROL FOR A UNIT REGION OF 500 000 POPULATION.

Type of laboratory	Manpower requirements				
	Total	Groups			
		I	II	III	IV
Regional laboratory	8	1	1	4	2
Highly specialized central laboratory with reference duties	3	1/4	1	1	1

Remarks:

It is assumed that sorting and counting of biological material are not carried out at the laboratory.

3.5 Solid wastes

The handling of solid wastes may be divided into three main fields:

- collection and transport;
- treatment;
- final disposal.

Collection and transport will not be discussed, since these may be considered simple operations from the viewpoint of manpower requirements and training. In other respects this is of course an important field requiring due consideration as to organization and mechanization.

Solid wastes may be considered in a number of categories, as follows:

- (a) household garbage;
- (b) scrapped household items (e.g. furniture, refrigerators);
- (c) wastes from gardens, parks, beaches, streets etc.;
- (d) wastes from offices, shops, trade enterprises etc.;
- (e) wastes from hospitals and the like;
- (f) industrial solid wastes;
- (g) scrapped cars, trucks, machinery from industry and agriculture etc.;
- (h) scrapped structures, building materials, sand, gravel etc.;
- (i) sewage sludge;
- (j) oil and chemical wastes.

Final disposal is considered to be carried out at controlled waste tips. At such tips the environment is efficiently protected against pollution, i.e. the wastes delivered are controlled as to composition and amount, are placed on the tip in a controlled manner and are shredded/ crushed, compacted and finally covered with earth. Ground and surface waters are protected against seepage from the tip.

Tips specifically for wastes of category (h) referred to below as "filling materials", may be considered as exceptions and operated with control only as to waste composition and possibly dust control. Some category (f) wastes, without organic content and with only a slight pollution potential, may also be deposited in filling materials tips. Filling materials may often be valuable for land reclamation etc., particularly in coastal areas.

In cases where incineration is performed, there is still a need for controlled waste tips and filling materials tips. Only wastes of categories (a) (d) and (e) may be considered fit for normal incineration together with some wastes of categories (b) (c) and (f). The rest of the wastes must be deposited. Also, the slag and fly ash from the incinerators must be deposited. Category (j) wastes are exceptions which must be treated in special plants for regeneration or destruction, e.g. by incineration, or in some cases be taken to special depots. The manpower for handling these wastes both in the phase of collection and in the special treatment plants and depots is not considered here.

A large amount of the wastes in category (g) are suitable for reuse after treatment by specialized industries together with part of the wastes of categories (b) (d) (e) and (f), e.g. paper and glass. Manpower requirements in these industries are not considered.

In the light of the foregoing remarks, disposal may be organized for the following categories of wastes:

- A: household garbage;
- B: other wastes fit for incineration;
- C: wastes which must generally be deposited at controlled tips, including sewage sludge.
- D: filling materials;
- E: oil and chemical wastes;
- F: materials from scrapped cars, trucks, machinery etc. fit for reuse.

Manpower for regions of different sizes and for a combination of incineration and tipping is shown in Table 9, and that for tipping only in Table 10. The manpower is grouped as in the preceding section.

Table 9. MANPOWER REQUIREMENTS FOR A COMBINATION OF INCINERATION, CONTROLLED WASTE TIPPING AND FILLING MATERIALS TIPPING.

Population served	Manpower requirements				
	Total	Groups			
		I	II	III	IV
25 000	9		1/2	2	7
50 000	13	1/2	1/2	3	9
100 000	20	1/2	1	4	14
200 000	35	1	2	7	25
500 000	65	1	4	10	50

Remarks:

It is assumed that all A and B wastes are incinerated in one regional plant. The slag together with C wastes is deposited at one regional tip. Wastes of category D are deposited at a number of filling materials tips distributed over the region, with control only as regards composition, e.g. consisting only of an authorization for certain trucking companies to deliver materials to the tips. Wastes of categories E and F are not considered.

The staff groups are as follows:

- I: engineers or equivalent;
- II: engineers with special training as plant operators;
- III: technicians and craftsmen with special training as plant operators or unit-operators;
- IV: craftsmen working in the repair and maintenance of standard equipment and semiskilled staff with some training in special fields of plant operation.

Table 10. MANPOWER REQUIREMENTS FOR A COMBINATION OF CONTROLLED WASTE TIPPING AND FILLING MATERIALS TIPPING.

Population served	Manpower requirements				
	Total	Groups			
		I	II	III	IV
25 000	3		1/2		2
50 000	4		1/2	1/2	3
100 000	5	1/2	1	1	4
200 000	9	1/2	1	1	6
500 000	17	1	2	2	12

Remarks:

It is assumed that all A, B and C wastes are deposited at one regional controlled waste tip. Those of category D are deposited at a number of filling materials tips distributed over the region, with control only as regards composition.

The staff groups are as follows:

- I: Engineers, other technicians and equivalent;
- II: same as one;
- III: craftsmen and semiskilled staff with some training, e.g. as compactor operators;
- IV: semiskilled and unskilled staff.

3.6 Air and noise pollution

3.6.1 Public control

Environmental pollution control is assumed to comprise land resources management, and protection of the urban and recreational environment. Air quality control is assumed to comprise continuous monitoring for SO<sub>2</sub>, dust, nitrogen oxides and carbon monoxide at strategic points in towns with 20 000 or more inhabitants. Noise pollution control is assumed to take place in the vicinity of residential or recreational areas: along roads with heavy traffic; around airports; and around noisy industries.

The organization of the control may vary without causing any change in the number of staff needed; but it is considered advantageous to locate them with laboratories for food control (see section 3.1.) as many facilities may be used for both services and the basic education of the staff is often the same, which makes mutual discussions among them advantageous and desirable. The control staff are also supposed to act in an advisory capacity in community and county councils.

As in the case of food control, lower and higher limits of population covered by the same administration for environmental pollution, air quality and noise control have been set, the lower limit being 100 000 and the higher limit 800 000. The reasons for choosing these limits are the same as those stated in section 3.1.

On the above assumptions, the correspondence between the population in areas of different sizes and the staff of the administrations has been determined (Table 11).

Remarks:

The term "engineers and equivalent" refers to engineers, pharmacists, biologists, agronomists, landscape architects and others with an academic education enabling them to carry out analyses, investigations and calculations to solve the problems involved.

Table 11. MANPOWER REQUIREMENTS FOR AIR AND NOISE POLLUTION CONTROL

Population served \ Manpower requirements	Engineers and equivalent	Technicians	Others
100 000	2	4	1
200 000	3	7	2
300 000	4	10	4
400 000	7	15	7
500 000	14	20	10
600 000	21	25	13
700 000	27	30	17
800 000	34	35	20

The term "technicians" refers primarily to laboratory workers but also to other technicians at similar level such as biology assistants.

The term "others" refers to office staff, cleaners and the like.

3.6.2 Private control

This function mainly concerns industries with air and noise pollution problems. Normally there is a great difference between public control and private control in this domain, the former being based on testing of samples to ensure that standards and other regulations are kept while the latter is primarily a working operation as in the case of food control, however, it is very difficult to specify manpower requirements for such working control. It depends on the type of factory and the type of production.

In the following types of factories it is assumed that one engineer and one technician will always be needed for the purpose:

- iron and steel works;
- shipyards;
- cement works;
- oil refineries;
- artificial fertilizers factories;
- factories for pesticides and the like;
- cellulose and paper factories;
- medicine factories.

Some establishments need not employ staff specifically for control if they are of modest size, as the control can be performed by an employee who has other duties; otherwise a person with independent control duties is required. These establishments include:

- iron foundries;
- galvanizing and electroplating plants;
- factories producing or destroying chemicals;
- factories impregnating wood;
- factories manufacturing grain and the like;
- tanneries.

### 3.7 Occupational health control

Occupational health control functions are assumed to include:

- advising factories, local occupational health safety councils, labour organizations and the public in occupational health matters;
- assisting ministries in the preparation of laws and regulations;
- ensuring that laws and regulations are observed.

In many countries organizations for effective occupational health control are still in the planning stage and experience as to the number and training of the manpower involved is sparse. As for many other fields, the control is assumed to be partly public and partly private.

#### 3.7.1 Public control

Such control is regarded as partly central and partly local.

The duties of the central authority are typically the provision of advice and support to the government on complex matters. The manpower for a central authority serving a population of 5 000 000 is estimated at:

- 60 professionals including engineers, physicians, psychologists, toxicologists, environmental health officers and the like;
- 60 office staff, instructors and the like.

The local authorities are regarded primarily as bodies advising factories and checking the observance of laws and regulations. As the local authorities must have a detailed knowledge of factories in their regions, these should not be too large. Regions with 250 000 - 500 000 population would be reasonable. For a region with about 250 000 population the authority would need:

- 7 professionals including engineers, physicians and the like;
- 3 technicians, office clerks and the like.

#### 3.7.2 Private control

The number of accidents in the different types of industries varies greatly. So in practice it is not possible or necessary to carry out occupational health control systematically but only where many accidents occur, namely in:

- food producing industries, especially slaughterhouses;
- iron and metal industries;
- the transportation industry;
- the building and construction industry;
- the chemical industry;
- stone and glass industries;
- sewerage and solid waste disposal plants.

All the above should have some kind of occupational health control, with only the organization and extent of the control depending on the size of the undertaking.

In small industries it is assumed that an occupational health council would be formed composed of representatives from all groups of employees (management, office staff and workers), all with training in occupational health (through participation in courses etc.). Larger industries would employ engineers, physicians and health inspectors with specialization in occupational health according to their size and the problems involved.

4. Remarks on use of guidelines

It should be stressed that the figures given in the guidelines should not be applied too strictly as they are subject to uncertainty which may generally be estimated to vary by plus or minus 50%. These great uncertainties are not surprising as there can for instance be great variations from one region to another in the degree of automation in the processes considered and the staffing policy of the authorities. Therefore the guidelines should primarily be used to:

- (1) check the appropriateness of manpower levels in the different environmental health fields, under the present circumstances;
- (2) evaluate future manpower demand in these fields in relation to new activities or when changes in organization, procedure or level of services are considered.

However detailed studies must be made in each case when precise evaluations are required.

#### REFERENCES

1. Norges Teknisk-Naturvidenskabelige Forskningsraads (NTNF).: Orientering om NTNF's utvalg for drift av renseanlegg (Report on NTNF's experience in water purification plants). Oslo, 1976.
2. Miljøministeriet. Kommunernes 10-årige investeringsplaner 1972-82. Copenhagen, 1974.