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PUBLIC HEALTH PROBLEMS IN THE INDUSTRIALIZATION OF THE WEST AFRICAN SUB-REGION

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CONTENTS

INTRODUCTION

1. Objective

1.1. Industrial development is becoming an increasingly important factor in African countries, but its effects on health should not be underestimated.

Indeed, the rising level of living, the creation of fresh networks of penetration, reduced leisure time and current industrial techniques, have brought Governments face to face with important problems of public health, the complexity of which varies with a number of factors such as climate, tradition and, more particularly, the level of health already attained. A solution to some of these problems may be found in the experience of more developed countries, while other problems require investigation in the nature of scientific research in regard to methods of approach.

1.2. In any case, the phenomena of industrialization may have immediate or cumulative effects. Two extremely important elements emerge: the stability of manpower and the worker's maximum output.

These two elements depend solely on the good faith of the employer and on the extent to which the worker is capable of shouldering his responsibilities. Conclusive studies carried out in Africa have shown that, as industry develops, so must man's entire environment develop in the immediate interests of business and of the national economy as a whole. Government action is therefore necessary at the outset if disastrous consequences are to be averted and the beneficial effects of industrialization programmes to extend to all, even beyond national frontiers.

2. Arrangement of the paper

This paper, which is primarily concerned with public health problems in the fourteen countries of the West African sub-region, is arranged in the following manner:

2.1. Joint resolutions adopted by African Governments in the past.

2.2. The probable cost of a long-term public health programme in the sub-region.

2.3. Current work in co-operation with WHO and other United Nations agencies.

2.4. General problems relating to drinking water, drainage, domestic refuse and industrial hygiene.

2.5. The specific problem of industrial refuse disposal.

2.6. Future economic prospects: the industrial use of all manner of waste products in the West African sub-region.

2.7. Summary.

2.8. Policy of programmes and recommendations.

3. Joint resolutions

3.1. Niamey, 1961: Symposium on Hygiene and Sanitation in relation to Housing, conducted by the Secretariats of the World Health Organization (WHO) and the Commission for Technical Co-operation in Africa (CCTA).

The Symposium recommended that:

(a) health education should be closely associated with housing;

(b) favourable results in matters relating to housing should be exchanged among African countries;

(c) in regard to the distribution of drinking water, steps should be taken with a view to producing and treating small supplies of drinking water; these projects to be planned and executed on a regional basis;

(d) a more economical method should be sought for the treatment of water and waste matter, having regard to financial conditions;

(e) essentially useful studies on composting should be undertaken;

(f) the Symposium should adopt the recommendations formulated in the first report of the Expert Committee on the Public Health Aspects of Housing (WHO Technical Report Series, 225);

(g) full details of the programmes carried out in Puerto Rico and Venezuela should be communicated to Governments.

3.2. Addis Ababa, 26 April - 5 May 1962: Workshop on Urbanization in Africa.

In regard to urban hygiene, the Workshop recommended that:

(a) "in the earliest stages of any local or regional planning study the public health authorities should be asked to advise on the various problems concerning human activities, including the choice not only of industrial but also of residential areas, with special reference to social services and workers' needs in their places of employment;"

(b) "among other urgent measures required to alleviate existing urbanization problems, priority should be given to the provision of adequate health services and in particular abundant and safe water supplies and sewage disposal, since these are basically concerned with the preservation of life and the maintenance of public health."

Moreover, at the opening meeting Mr. Zawde G. Heywot, Governor of Addis Ababa, pointed out that "while the population of Africa as a whole is still rural, in some of our cities we are already confronted with the problems of housing, inadequate services, ill health, social demoralization, broken families and unemployment".

He recommended that the Workshop "should consider the dual problems of inadequate finances and dearth of trained personnel which confront all developing countries, evolve ways of making the maximum co-ordinated use of technical personnel, both international and national, and suggest measures to overcome the problem of lack of funds".

3.3. Addis Ababa, 14 - 22 July 1964: Regional Symposium on Rural Community Water Supply Development, under the auspices of the "United States Agency for International Development".

The symposium was an important source of information on activities in rural areas. The delegates stressed the lack of funds and personnel and the need for medium-level technicians and qualified engineers.

It was useful to realize the difficulties surrounding the choice of an economic method for the treatment of water, and US/AID recommendations confined themselves to the desirability of conducting research on the spot as a means of reaching economic and correct solutions.

4. The cost of sanitation in the sub-region

For the next ten years it is impossible to envisage a programme that encompasses the three essential factors of environmental sanitation: drinkable water, the disposal of excreta and the disposal of domestic waste water. Rational improvements should be introduced, because existing conditions are a serious handicap both to industrialization and housing. That is why the sanitation programme has been spread out over a reasonable economic period of ten years, at a rate that should make it possible to meet the needs of 50 per cent of the population forecast for 1980. Improvements are anticipated in the distribution of an adequate supply of drinking water and in the sanitary disposal of infected human faeces, which in rural areas lead to contamination of the soil and of water supply sources. The problem of the drains network in towns and large settlements has been postponed until such a time as the need really makes itself felt, as the logical outcome of domestic waste water disposal.

4.1. Distribution of drinking water

The rapid process of urbanization and economic development in the West African sub-region is the result of investments in an accelerated programme of drinking water distribution plus investments in industrial and agricultural projects. WHO has continuously stressed the necessity of financial and operational planning with a view to improving the existing systems, constructing new networks and producing larger water supplies.

The sub-region's water reserves, as FAO technical surveys point out, should certainly be studied and determined, in order to avoid exceeding the resources available. It is to be hoped not only that the studies already undertaken will be continued, but that they will be carried out with modern equipment such as used in the developed countries.

It would be an extremely costly error to overlook the importance of problems that may arise and the solution of which rests entirely on solid technical experience: the siting of industry, reafforestation, multiple-purpose projects, the location of new settlements, town extension limits, and the effect of evaporation on underground water.

The existence of water points, their altitude and volume, as well as the quality of the reserves, are essential matters in the physical planning of the fourteen territories.

Cost of ten-year programme (in US dollars)

Total population forecast for 1965	97,960,000
" " " " 1980	147,730,000
i.e. a yearly increase of 2.8 per cent	
Estimated population in 1970	112,400,000
" " " 1975	131,200,000
Population served in 1965, 30 per cent	29,400,000
" to be served in 1980, 50 per cent	73,900,000
Annual population to be served over a ten-year period	4,450,000
Annual expenditure, at the rate of US$30 per inhabitant	133,500,000

The surveys conducted by WHO showed that in 1963 only 30 per cent of the population were adequately supplied with drinking water, and that average construction costs in rural and urban areas were 30 dollars per inhabitant. These figures will probably still be valid in 1970, by which time the preparations should be completed and work should start in a systematic way.

	US$
Annual depreciation (4 per cent)	5,400,000
Annual interest on capital (5 per cent)	6,700,000
Annual cost of operation, etc. (1 per cent)	1,400,000
Total annual charges	147,000,000

The interpolation of ECA figures would mean that by 1970 the sub-region's gross domestic production (GDP) would be approximately 13,881 million dollars for a total population of 112.4 million, i.e. 115 dollars per inhabitant.

Annual expenditure on the programme would be 1.30 dollar per inhabitant, i.e. 1.1 per cent of the GDP value over the proposed ten-year period.

This shows that, having regard to the development programme envisaged by ECA, the supply of drinking water can be financed over a period of twenty to thirty years. The rational planning of the projects, under the responsibility of an autonomous central agency, is undoubtedly the primary objective and will enable Governments to guarantee the transaction with an international development organization.

As regards financing, each country in the sub-region should be studied separately and the practical value of its socio-economic development projects should be clearly established in the light of the investment sought.

The future administration of water supply systems is bound to be the crucial point in financing.

To what extent will the project be remunerative? The outlook is reassuring when one considers the industries already established and the ambitious development projects relating to economic diversification.

In rural areas, profitability is extremely uncertain, and the administration of the project should be the responsibility of the communities themselves, while in towns excellent results can be achieved through a sound understanding of the balance that must be maintained between capital investment and operational, maintenance, administrative

and amortization costs. The planning of drinking water supplies should therefore go hand in hand with the gradual training of such staff as hydraulic engineers, water treatment operators, operational supervisors, and administrative officers thoroughly conversant with the accounting for which they are responsible.

It may be estimated that 15 per cent of the proposed annual expenditure will be allocated to labour and inland transport, so that $22,000,000 would go back into circulation.

4.2. Sanitary latrines

Sanitary latrines may be regarded as practically non-existent in the parts of the West African sub-region described as rural.

At a time when countries are preparing to step up their industrial development, health conditions should be such as to enable workers to make an effective contribution to their national economy. One of the benefits which community development services are undoubtedly able to provide is the construction of sanitary latrines, and, with the willing co-operation of the population, the programme can be extended from urban areas to the most remote settlements.

Cost of ten-year programme (in US dollars)

Total population forecast for 1980	147,730,000
Estimated rural population in 1980 (80 per cent)	118,200,000
Population to be served in 1980 (50 per cent)	59,100,000
Number of houses to be served, at the rate of five inhabitants per house	11,820,000
Annual number of family sanitary latrines to be constructed over a period of ten years	1,182,000
Annual expenditure at the rate of $6.50 per unit	7,700,000

The total annual cost of the proposed public health programme is $154,700,000, i.e. $1.40 per inhabitant or 1.2 per cent of the GDB value; this is entirely within the sub-region's total estimated resources.

The cost of $6.50 per unit is necessarily borne by the Government. Each unit consists of a reinforced concrete base 1.20 m x 1.20 m x 0.08 m and two aluminium plates. Transport accounts for 10 per cent of construction costs. This low price, based as it is on the system of mutual aid, will ensure the cleanliness and durability of the product.

The following figures, in US dollars, relate to the Ghanaian and Liberian projects.

TABLE 1

Ghana

Cost of construction per capita/annum	Cost of maintenance per capita/annum	Type of watering point	Characteristics
-	0.42	Well	Complete system
9.10	0.60	"	Extension
17.10	0.60	River	Complete system
6.00	0.70	Well	" "
3.75	-	Stream	Extension
3.00	-	River	"
4.15	-	"	Complete system

TABLE 2

Liberia

Cost of construction per capita	Maintenance per capita/ annum	Operation per capita/ annum	Administration per capita/annum	Type	Characteristics
45.60	1.94	0.67	0.55	River	Complete treatment
2.70	-	-	-	"	Water point and hand pump
2.40	-	-	-	Well	Water point and hand pump
1.00	-	-	-	"	Improvements

Particulars regarding the cost of supplying African communities with drinking water will be given in a special survey to be completed in the course of 1966.

5. Collaboration by WHO and other Specialized Agencies

It can thus be seen that the conferences held have contributed an appreciable amount of information and that they have to some extent shown the trend of housing programmes in regard to their public health aspects.

It is certain beyond a doubt that a public health programme cannot reinforce truly economic industrial development in the absence of a public health structure and of technical training for operational health staff.

What to tackle first, what direction to take, how far to go, these are the questions which Governments are discussing and solving with the full co-operation of the WHO Regional Office at Brazzaville.

Special attention is devoted to the adequate presentation of the statistical data on which the evaluation of programmes is based.

The national planning of health services is increasingly becoming part of the economic and social projects of countries such as Liberia, Mali, Niger and Sierra Leone.

One sees real enthusiasm about matters relating to environmental hygiene, and more particularly about drinking water and the training of a sanitary section within the Ministry of Public Health.

The following types of project are being developed in the West African sub-region:

Training: eight countries, three of which (Senegal, Sierra Leone and Togo) have local training schools.

Organization of Central Offices: two countries, i.e. Ivory Coast and Mali.

Plan for the supply of drinking water: nine countries, including Ghana which has received substantial aid for the development of the Accra-Tema metropolitan zone.

Construction of sanitary latrines: five countries.

Bilharziasis control: some slight activity in Ghana.

Construction and improvement of wells: seven countries.

Altogether, five fellowships were granted for the training of health officers in overseas countries, from 1 July 1964 to 30 June 1965. These were granted to Dahomey (one), Liberia (one), Senegal (one) and Togo (two).

Ministries of public health are assisted by ten sanitary engineers and three sanitary officers.

The following table shows allocations from the regular budget and the technical assistance budget, in US dollars, over the period from 1948 to 1964:

TABLE 3

Country	Total expenditure	Regular budget	Technical Assistance budget
Dahomey	189,384	37,731	72,808
Gambia	54,489	6,576	47,913
Ghana	1,911,501	316,874	681,417
Guinea	248,382	32,103	216,279
Ivory Coast	156,436	75,589	68,785
Liberia	1,521,915	598,387	558,921
Mali	506,715	201,390	232,432
Mauritania	469,331	96,670	154,142
Niger	232,736	44,308	160,593
Nigeria	2,264,696	630,469	1,255,778
Senegal	203,717	87,706	115,521
Sierra Leone	631,457	178,587	313,170
Togo	1,151,035	321,710	415,552
Upper Volta	162,286	25,800	130,748
	9,703,980	2,623,900	4,424,059

Co-operation in the field of environmental health consists in overcoming the chief obstacles to long-term planning, i.e. inadequate statistics, the dearth of skilled staff, and the need to establish a balance between the capital invested and operational costs.

This painstaking work is performed by WHO in co-operation with some of the main United Nations specialized agencies, i.e. FAO, the ILO, UNESCO and UNICEF. Contacts with AID have proved very fruitful, while WHO's links with the Economic Commission for Africa are becoming increasingly important in economic and social planning.

Reference should be made to FAO's new policy in Africa, which is to seek WHO co-operation in rendering assistance to Governments by means of the "Special Funds", in order to safeguard public health interests in projects to be carried out by FAO.

Four of these projects concern the West African sub-region:

Dahomey - agricultural survey and demonstration in the Oueme valley.
Dahomey/Togo - study of the Mono River basin.
Guinea - study of programme for reclaiming land suitable for rice-growing in the coastal area.
Nigeria - study of an artificial lake at Kainji.

6. Sanitation problems

Agriculture is the main source of income for West African countries. Agricultural and industrial development is contingent on the development of vast stretches of virgin soil. This gives rise to fresh economic and public health problems, which lay further responsibilities on Governments, i.e. malaria, bilharziasis and helminthiasis control; the supply of drinking water in settlements; the construction of dams and roads; drainage; the siting and building of new villages, and adequate living conditions for workers.

Drinking water

6.1. Experience has shown that industrial development is utterly impossible unless priority is given to programmes relating to drinking water under the three basic aspects of quantity, quality and capital cost.

The FAO African Survey[1/] raises some important points regarding the water resources of this West African sub-region. According to the distribution of rainfall, the four zones delimited comprise the entire group of fourteen countries:

(a) The Saharan zone, where surface flows are extremely rare (Northern Mauritania, Mali and the Niger). The future outlook for water supplies has been given special attention by the WHO Regional Office for Africa;[2/]

(b) The sub-Saharan and Sahelian zones, characterized by discontinuous surface flows (Northern Senegal and Upper Volta, Southern Mauritania, Mali and the Niger). Evaporation and infiltration are the most important problems;

(c) The Sudanian and Guinean zones, characterized by heavy rainfall, mountain erosion and the flooding of valleys (Guinea, Gambia, Southern Senegal, Ivory Coast, Dahomey, Ghana and Northern Nigeria), alternating with intense drought;

(d) The Guinean zone, which is the most favourable and promising owing to the regularity of its seasons and the large and steady flow of its rivers (Sierra Leone, Liberia, the southern area of the Ivory Coast and Ghana).

1/ Report on the possibilities of African rural development in relation to economic and social growth.

2/ A report on the present situation with regard to community water supplies in Africa, south of the Sahara, with recommendations for the expansion of the programme (document AFR/EH/2 (63)).

It is therefore evident that, if separate and unjustified expenditure is to be avoided, drinking water projects should be planned with regard to irrigation and industrialization requirements. This will necessarily entail very costly technical processes in the construction of storage dams, the recharge of aquifers and multiple-purpose pumping.

In the future, the tendency will undoubtedly be to develop under ground water and surface flows in a methodical manner, and here research, which is usually costly, will play an extremely important part in solving the complex problems of water, in order to ensure its competitiveness with other branches of production that yield a more immediate return, such as electricity and transport, two further factors of enormous importance to modern industry.

For general information purposes, a table on the comparison of treatment processes applicable in a rural environment is reproduced from a WHO publication:[1/]

TABLE 4

Process	What it accomplishes	Construction cost	Operation cost	Operation attention
Holding reservoir	Turbidity reduction; bacteria reduction	High	Low	Low
Slow sand filter	Turbidity reduction; bacteria reduction	High	Relatively low	Medium
Aeration	Expulsion of gases, iron precipitation	High	Low	Low
Corrosion control	Reduction in corrosiveness	High	Low	Low
Chlorination	Reduction in bacteria	Low	Relatively high	High

1/ Wagner, E.G. & Lanoix, J.N. (1959) Water supply for rural areas and small communities.

For reasons of economy, slow sand filtering deserves special attention in the study of urban projects, bearing in mind the required capacity and the costs of operation and maintenance.

With the need for more economical materials, fibro-cement and plastic pipes are becoming increasingly popular.

Nigeria has already taken this initiative, as can be seen from the following table reproduced from a WHO report on "The Production of Plastic Pipes in Nigeria":

TABLE 5

Diameter inches	100 ft. Nipol Plastic Pipes						100 feet		
	Normal Gauge			Heavy Gauge			Galvanized Pipes*		
½	£ 2	5	10	£ 3	11	0	£ 4	12	6
3/4	£ 4	4	0	£ 4	18	2	£ 5	12	6
1	£ 5	9	0	£ 6	15	10	£ 6	8	0
1 ¼	£ 7	1	6	£10	4	6	£ 8	3	9
1 ½	£ 9	3	0	£12	7	0	£10	2	11
2	£15	18	0	£19	1	6	£13	17	6

* Quoted from Disengoff West Africa Ltd. Price List, Lagos.

It should be pointed out that the increased use of plastic pipes all over the world has as yet given rise to no public health problems. Each country should, however, test it for the following characteristics: (a) expansion under the effect of heat and (b) resistance to attack by rodents. Attached to this document are a sketch showing an apparatus used for making hypochlorite solution and a graph giving the corresponding curves of flow. This apparatus, which was devised and produced in Venezuela, is inexpensive and may prove very useful in connexion with drinking water projects throughout the continent.

Drainage

6.2. This term is generally used to describe the sanitation and development of land. The technical process and its cost vary according to the work to be carried out and the purpose it is to serve. Drainage more particularly concerns the siting of towns and villages, and in Africa it represents a serious problem in coastal areas owing to over-population and soil erosion.

The following general points should receive the attention of the public health authorities:

(a) thalwegs, particularly those followed by swift and turbulent water-courses in cycles beyond the recollection of a generation;

(b) land-slide protection, especially in the Sudanian and Guinean zones;

(c) earth works in the construction of roads, railways, airports, etc.

(d) control of lakes below dams;

(e) surveying of land not only around towns, villages and industrial installations, but throughout the sphere of influence.

It is regrettable that these preliminary surveys are conducted in a hasty manner and only during fine weather.

Waste disposal

6.3. As usual, the main obstacle to refuse and used water disposal is the shortage of funds. Hence the necessity of giving priority to the sanitary drainage system for the disposal of liquid refuse from dwellings, commercial institutions, schools and factories. The construction and laying of drainage is very low, owing to the size of the sections required.

Stabilization ponds

6.3.1. The use of stabilization ponds is a practicable and inexpensive solution for treatment projects wherever cheap land is available. The following table allows a comparison of the cost involved with that of the conventional methods. The cost of land is included.

TABLE 6

Country	Purification method	Cost of installation per 1000 gallons (in US dollars)	Cost of operation and maintenance per annum/capita (in US dollars)
United States of America a/	Primary	183	1.00 to 4.00
	Secondary	391	1.00 to 4.00
	Pond	175	0.20 to 1.00
Northern Rhodesia a/	Conventional	700 - 2,800	-
	Pond	72 - 140	Negligible
Kenya c/	Pond	180	Negligible
Swaziland d/	Conventional	560	-
	Pond	98	Negligible
Zomba Project Malawi e/	Pond	51	Negligible
Uganda	Pond	Not available	Negligible

a/ Symposium held at Kansas City, Missouri, 1 - 5 August 1960.

b/ Symposium held at Niamey in 1961.

c/ East African Medical Journal, Vol. 37, No.10.

d/ Report of Department of Public Works, 1964.

e/ Report on a project for a new capital by Messrs. Brian Colquhoun, London, May 1965.

As far back as 1959, there were more than 650 such installations in the United States of America. In Africa, excellent results have been obtained with the ponds installed in Swaziland, Kenya, Northern Rhodesia, Malawi and Uganda, where this programme is part of government policy.

The development has certainly not been entirely smooth, the main difficulty lying in the practice of the conventional methods, which have already proved themselves and are subjects of basic study in the training of sanitary engineers. The same hesitation exists at the moment in the African countries despite the conclusive statements made at the Niamey Symposium in 1961 by the delegates of Northern Rhodesia. In our day it must be understood that the pond process is at least as efficient as the conventional processes and that research has placed it from the very first on the list of methods at the disposal of engineers who are animated by the desire to develop economic public health prospects in countries that will shortly be confronted by serious problems of industrial waste disposal.

Briefly, the pond is merely an earth basin, not roofed over, the liquid being removed either by evaporation or by piping off the effluent. The impermeability of the ground is ensured by using material such as asphalt and varieties of plastic.

There is no doubt as to the efficiency of these ponds. The lagoons of the Nairobi airport, Kenya, receiving 55,000 gallons of liquid per day, gave the following mean reductions:

Effluent from the primary pond	76 per cent of BOD[1/]
Effluent from the secondary pond	83 per cent of BOD
Final reduction in coliform density	98 per cent

(a) Recharge of ground water

The future of ground water cannot be ignored in the northern area of the West African sub-region and in the Saharan, sub-Saharan and Sahelian zones, where conditions are similar to those of Texas (United States of America).

1/ The amount of oxygen consumed in the biochemical oxidation of organic matter.

"But there is no doubt that the day will come when, as in the Nile basin, the available water of the Niger will fall short of requirements. It is to be expected that the water development methods at present in use in Africa will continue to be applied, but new techniques are likely to emerge too.

The importance of ground water should increase, and the development of a market economy would allow a larger utilization of underground water for irrigation".

These are some of the results arrived at by FAO in its 1962 Africa Survey.

Fruitful experiments have already been made in connexion with the use of effluents from purification ponds to recharge ground water as well as in irrigation. If the quantity of water available is a serious and even a crucial problem, thought should obviously be given to controlling and improving available resources, particularly when vast industrialization programmes are in hand.

The Dan area project in Israel shows the benefit that such a policy can bring: a 10 per cent increase in the ground water is expected.

The problems of chemical pollution by industrial waste are doubtless very important. However, the establishment of standards of tolerance with regard to toxicity for drinking water, which must finally be made in all industrial countries, will make it possible to establish the additional techniques, thanks to which economic solutions can be established.

(b) Public health aspects

As far as can be seen, public health has fairly numerous interests in the installation of purification ponds:

(a) Reduction of pathogenic bacteria;

(b) Toxicity of fish drawn from the ponds;

(c) Infection of swimmers;

(d) Rate of multiplication of mosquitoes, particularly of malaria vectors;

(e) Utilization of effluent for culinary purposes or as drinking water;

(f) Degree of contamination of agricultural products irrigated by the waters from the ponds; this point is based solely on the probable risks and has not so far been of any great practical value.

No public health problems will be raised if the study of lagoons is entrusted to sanitary engineers whose knowledge and experience are beyond dispute.

6.3.2. The choice of the treatment method should, however, be left to the experience of the engineer, in the hope that he will be able to avoid over-sophistication.

A long-term scheme has been suggested, that of recovering algae for culture and use as food and fertilizers by the photosynthesis of stabilization ponds.

The present report considers it too early for Africa to launch into expenditure such as would be involved by the surveys and research required for establishing practical and economic methods of carrying out so ambitious a project. It is advisable to wait until the ponds are constructed and their valuation permits the adoption of the essential technical criteria. For the time being it should merely be regarded as a quasi-essential instrument for the solution of certain Africa health problems. Experts are perfectly aware of the possibility of making immediate use of the nutrients contained in effluents from stabilization ponds (a) for investigations regarding underground water in the Saharan, sub-Saharan and Sahelian zones, a highly desirable programme whatever the cost; (b) for irrigation proper, and (c) for the development of grasslands, in order to allow or improve livestock production.

6.4. Industrial hygiene

The range of this subject transcends the scope of the present report. Nevertheless, the responsibilities of industry in regard to the health of workers cannot be overlooked. Whether industrial development is at an early stage or has reached full maturity, it is in the employers' interest to pay special attention to the health of their labour force, in order to ensure the stability of manpower and maximum industrial output. Their responsibilities include that of providing a health service and ensuring the physical and mental well-being of their staff.

Working and housing conditions also deserve serious consideration, and the responsible doctor should use his authority to analyse the industrial methods used and the conditions governing the worker's entire environment. The engineering in turn should ensure the hygiene of buildings and installations. His responsibilities extend to standards of ventilation, lighting, the drinking water and toilet water system, and all conditions relating to safety in workshops, in the equipment used, and particularly in mining.

The main occupational hazards have been classified as follows:[1/]

(1) Excessive heat, cold or humidity.

(2) Compressed air.

(3) Dust, fumes and gases.

(4) Poisons.

(5) Excessive noise.

(6) Poor illumination and extreme light.

(7) Repeated motion, pressure, shock.

(8) Infections.

(9) Accidents.

(10) Poor plant sanitation.

1/ Classification of V.M. Ehlers and E.W. Steel.

A solution to these problems has already been found in the developed countries, but African public health authorities would hardly benefit by systematically applying the technical methods used in France, the United Kingdom, Germany, the USSR or the United States of America. The problems are essentially those of tropical countries and the solutions should bear in mind the social conditions of the peoples of Africa.

7. Control of pollution caused by industrial waste

Most African countries are approaching industrialization at a stage of civilization when public health principles are increasingly imperative and rapidly becoming part and parcel of economic development.

The problems relating to industrial waste disposal are linked with two factors which are destined to exert considerable influence on the solution of those problems in the near future: (a) the comparatively small size of industry as compared with industry in Europe or the United States of America, where research has already led to the adoption of the requisite measures of control and legislation; (b) the conservative mentality of businessmen who are apt to regard any expenditure on the treatment of industrial waste as an obstacle to capital investment in industry.

The list of projects suggested by ECA for the period extending from 1966 to 1975 comprises:

Chemical product and fertilizer industry	660,000 tons
Mineral oil refinery	1,000,000 "
Iron and steel	1,400,000 "

Of these three types of industrial waste, some are of vegetable and others of mineral origin. The disposal of the waste matter can take place in lakes or water-courses or in the existing drainage systems. The question then arises as to what measures should be taken against pollution caused by such industrial waste.

The Ministry of Public Health should take the initiative in determining the size of the problem and adopting any necessary measures to reduce the quantity and harmful effects of industrial waste.

Some industries are already operating, while many others are on the list of future projects. In any case, future industrial waste may include the following types, with the attendant complex problems of water pollution control:

Organic origin: Waste matter from canneries, paper and textile mills, breweries, mineral drink and dye plants; abattoirs, laundries, and dairies; plants where sisal and maize are treated, and tanneries.

Chemical origin: Waste matter from plants producing wood pulp, synthetic products, vegetable oil, insecticides, polyethylene, pharmaceuticals; mineral oil refineries, and wool scouring and steel pickling plants.

Waste disposal facilities entail certain hazards and costs that should be mentioned:

(a) Disposal in lakes. The dilution phenomena might indicate that preliminary treatment was unnecessary. It is nevertheless advisable to bear two hazards in mind: in the first place, the degree of pollution may be cumulative and in time make lake water unfit for drinking or for the development of further industries; secondly, any lake pollution may extend to water points connected with the lake, through under-ground infiltration;

(b) Disposal in rivers. The difficulties are similar to those that arise in regard to lakes.

(c) Disposal by means of the existing sewage systems. Within certain limits in regard to quality and volume, effluent industrial waste not previously treated is very acceptable and may even be of bacteriological advantage to the treatment of domestic waste. The nature and quantity of raw industrial waste may have very unpleasant effects, such as the deterioration of drainage, surplus organic matter, an increase in the

demand for oxygen, pH anomaly, and the clogging of filtering basins. In this case, the question is obviously: who will bear the cost of repairs and improvements? The State? Industrial companies?

The concentration of industrial waste at New Jersey (United States of America)[1/] gives an idea of the extent of the problem:

TABLE 7

(average weight of waste per employee/day for each type of industry)

Industry	Total solids lb	Suspended solids lb	Settleable solids lb	Settleable solids sludge per cent	Soluble solids lb	Colloidal solids lb	O_2 consumed lb
Tannery	15.81	1.92	0.51	8.50	13.89	1.41	1.73
Chemical manufacturing	27.73	1.18	0.33	10.07	26.55	0.85	1.53
Organic	2.95	0.39	0.10	8.54	2.56	0.29	0.20
Steel pickling	28.80	0.62	0.15	11.78	28.18	0.47	0.25
Dye	12.48	0.87	0.05	4.50	11.61	0.82	3.00
Distillery	92.3	29.16	4.32	10.96	63.14	24.84	31.89
Dairy	13.05	0.92	0.03	1.38	12.13	0.89	3.03
Laundry	12.28	3.61	0.05	3.75	8.90	3.56	1.55
Averages	16.48	1.61	0.17	7.44	14.60	1.34	1.67
Average without distillery	13.29	1.07	0.11	6.93	11.87	0.89	1.09
Average without distillery or dairy	13.33	1.10	0.14	-	11.84	0.88	0.92

1/ Rudolfs and Setters, Industrial Wastes in New Jersey, New Jersey Agr., Expt. St. Bull. 610, New Brunswick, N.J.

Unlike the present treatment of domestic refuse, treatment of industrial waste could certainly be approached not only from the public health angle, but also with a view to recovering the by-products and thus ensuring a reduction both in investments and market prices.

Although methods vary according to the nature of the industrial waste, they may be summarized as follows: chemical sedimentation, coagulation, filtration, activated sludge, secondary sedimentation, final sedimentation, neutralization of acidity and alkalinity.

Here again, owing to the cost of the conventional methods, stabilization ponds are preferable, not only for preliminary treatment should that prove necessary, but for the combined treatment of industrial and domestic water waste, since that combination may contain several types of waste.

8. An economic field for the future: the industrial use of all kinds waste products in the sub-region

The conversion of waste into building material has already received attention in a number of countries at different economic levels: the United States of America, Canada, Pakistan and Italy.

The present report gives no specific definition of the term "waste" and allows for all manner of technical possibilities, according as agricultural or industrial by-products, or by-products of human or animal metabolic origin, are concerned.

The problem

8.1. The urban population of the West African sub-region, which in 1963 was estimated at 9 million inhabitants, should increase by 3 per cent per annum, reaching 11 million in 1970 and 12 million in 1975.

It is anticipated that the surplus rural population will pour into urban centres, which would have 28 million inhabitants by 1970 and 40 million by 1975.

The estimated housing required to keep pace with this demographic growth would be as follows:

TABLE 8

Year	Urban area	Rural area	Total
	(in millions)		
1965	1.8	16.2	18.0
1970	5.6	16.2	21.8
1975	8.0	16.2	24.2

The addition of sanitary costs would mean that a limit would be reached which would make it difficult to balance expenditure out of the financial resources available.

Prospects of using waste products as building materials in the sub-region

8.2. To realize these prospects, it is necessary first of all to define the present position as regards wooden panels and permanent materials such as bricks and cement blocks.

A. Wooden panels

The present report deals with only three more or less interchangeable materials, i.e. plywood, particle board and compressed or non-compressed fibreboard.

(1) Plywood. There are six plants operating in the following countries:

One in the Ivory Coast, with an output of 7,300 m^3 per annum, used in the production of pre-fabricated houses for the local market;

Four in Ghana, producing 7,800 m^3 per annum, mainly for export;

One in Nigeria, producing 26,000 m^3 per annum, for export.

All plywood requirements are imported into the following nine countries: Mauritania, Senegal, Gambia, Guinea, Togo, Dahomey, Mali, the Upper Volta and the Niger.

(2) Particle board. Consumption, which is negligible, is confined to the Ivory Coast. Imported particle board costs between US$100 and 115 per ton. In comparison with the quantity of sawnwood used, the present consumption of particle board seems low (it is used in the construction of houses).

Senegal has shown some interest in imports of particle board, and its geographical position and industrial level make it a likely market for that material in West Africa.

Savannah-covered areas such as Northern Nigeria, Ghana, etc., offer excellent prospects for the creation of this type of industry, based on research regarding the new material, because the annual domestic demand, ranging from three to five thousand tons, cannot be covered by the meagre forest resources available.

(3) Fibreboard. The outlook for the fibreboard industry is encouraging in Nigeria, Ghana and Sierra Leone, where the present needs of housing and furniture production would be covered by mass production. The shortage of coniferae in those countries, however, is a serious drawback, and the door will remain wide open to large-scale imports.

B. The brick-manufacturing industry

Geological investigations to estimate the quantity of soil containing a suitable proportion of clay and sand have not yet been carried out on an appropriate scale.

Efforts have been made to meet the demands of building enterprises in some West African countries, e.g.:

Ghana, where sizable beds of clay, located near Accra, are being fully exploited;

The Ivory Coast, where deposits have been estimated at 1,700,000 m^3; cost of exploitation Fr. CFA 6 per m^3;

Mali, where prospection seems fairly promising;

Senegal, where clays of very fine quality have been discovered in the region of the Senegal and Casamance Rivers;

The Upper Volta, which has very great possibilities.

Brick-works, some of them at cottage-industry level and others on an industrial scale, are operating in Ghana and Senegal.

Whether bricks have a future as a building material is a difficult question to answer for the sub-region as a whole, since the present output would have to be increased.

The economic importance of a study on the production of building materials

8.3. There are two ways of setting up local industries and thus reducing African imports of processed wood: the development of forest resources, however costly that may be, and the systematic recovery of waste matter which has the specific properties required.

Types of waste that can be used

8.4. (1) Rice husks. Resistance tests have conclusively demonstrated the technical possibility of using rice husks rather than sand in the production of cement blocks as light building material.

In 1962-1963, 1.4 million tons of rice were produced, i.e. approximately 0.3 million tons of rice husks. Rice production is not very large, and the use of its by-product might act as an incentive to further production.

Millet, which has the same physical characteristics as rice, can also be used for the manufacture of boards and cement blocks. The sole difficulty lies in the fact that cement and resin are both imported.

(2) Ground-nuts. The disposal of ground-nut shells is even more problematical than the disposal of rice husks, in view of the difficulties encountered in using it as a fuel or a fertilizer, because of its persistent oil content. The successful use of ground-nut shells in the manufacture of particle board has been demonstrated by laboratory tests and commercial production. In the not too distant future, research may find a way to give this material the properties that would make it able to sustain competition and become a popular commercial product.

The potential production of a plant would be at least 240,000 tons.

If it is borne in mind that 250 lb[1/] of shells can supply 100 sq. ft. of 3/4-inch board with a density of 0.64 gramme/cm^3, it should be possible at present to produce, in the West African sub-region, approximately 200,000 tons of board manufactured from ground-nut shells, in 40 plants, each with an annual output of 5,000 tons, i.e. approximately 16 tons per day.

It has been estimated[1/] that in Africa a daily output of 12 tons of board of the type mentioned above would require initial investments in the region of $240,000, with a production cost of approximately 9 cents per sq. ft., not taking into account certain factors more likely to fluctuate such as marketing cost and capital depreciation.

(3) Coffee husks

The physical structure of the husks makes it possible to manufacture particle board offering great advantages from the aesthetic viewpoint.

The manufacture of particle board is contingent on the local production of resin.

1/ Experimental data from Tropical Products Institute, London.

The prospects for the local market are very encouraging.

(4) Combination of vegetable waste. This would make it possible to obtain boards with a resistance considerably higher than that obtained by the use of one selected type of husk.

(5) Sawdust. Sawdust is an outstanding competitor in the manufacture of light concrete. The advantage of concrete manufactured from sawdust lies not only in the density obtained, but also in its insulating properties and the possibility of pre-fabricating panels of larger dimensions than those of ordinary reinforced concrete.

(6) Bauxite. Bauxite is the ore from which alumina (Al_2O_3) is obtained. Owing to the stability of alumina and the temperature necessary for its production, it can be used in the manufacture of fibre-bricks.

Public health aspects

8.5. The manufacture of building materials from various waste products raises the following problems for the public health authorities: (a) water pollution control; (b) the development of the cultivation of swamp rice, requiring the elimination of breeding grounds of mosquitoes which are vectors of malaria and other diseases; (c) sufficient skilled staff for supervision work, and (d) the necessary number of sanitary engineers and (d) the necessary number of sanitary engineers and chemists to devise practical and economic techniques.

9. Summary of the main points

9.1. Joint resolutions adopted at conferences

(a) There is a close relationship between housing, hygiene and health. Efforts should be made to co-ordinate sanitary education and devise economic methods for basic projects, drinking water supplies and the treatment of liquid and solid waste.

(b) In order to avert the enormous difficulties which urbanization brings in its wake, it is necessary to organize sanitary services and to place heavier responsibilities on the public health authorities in industrial as well as residential areas.

(c) Local investigations are a useful means of securing economic and correct solutions regarding the treatment of drinking water in rural areas.

9.2. The cost of rural sanitation in the sub-region

On the basis of a ten-year programme:

(a) Supply of drinking water to rural communites: 23.2 million dollars per annum.

(b) Sanitary latrines: 7.7 million dollars per annum.

Total cost of rural sanitation: 30.9 million dollars per annum, i.e. 0.34 dollar per inhabitant for the sub-region's rural population of 90 million.

9.3. Collaboration by WHO

(a) Assistance in statistics, training of sanitary staff, organization of water and sewage services, setting up of health services in Ministries of Public Health.

(b) Execution of pilot projects.

(c) Co-operation with FAO in safeguarding public health interests with Special Fund money.

9.4. Sanitation problems

(a) Drinking water. In view of the distribution of rainfall, the water resources of the sub-region should be carefully studied. The techniques involved are expected to be very costly, and the economy of most of the projects should be based on the combined objectives of drinking water, irrigation and industry.

It is important that reserves should not be diminished in the interest of production. Thought should also be given to the local manufacture of piping and plastic accessories.

(b) Drainage. It is essential that a preliminary study be made of the safety of areas lying in the Sudanian and Guinean zones, in order to protect the valleys against unforeseen mountain erosion.

(c) Solid and liquid waste disposal

Owing to the shortage of funds, the construction of sanitary drainage in towns should be given priority. Stabilization ponds offer vast possibilities of economy in sanitation projects. They are as effective as the conventional methods, and the proper use of such ponds affords protection against public health problems.

(d) Industrial hygiene. This ensures the stability and maximum output of the labour force.

Public health is threatened by a great number of industrial hazards.

Responsibility rests with doctors and sanitary engineers, who must be familiar with the industrial process used.

It is advisable to avoid adopting any solutions imported from developed countries and to deal with the problems in the light of their essentially tropical and social characteristics.

(e) Control of pollution caused by industrial waste

The size of industry and the mentality of businessmen are obstacles to this control.

A number of industries are already operating, some are planned for 1966-1975, and many others will develop in the future.

The mass of industrial waste will steadily increase the danger of water pollution.

Any Government that ignores this problem will assume moral and material responsibility especially as pollution may spread to adjoining countries through the infiltration of underground water as well as rivers and streams.

In order to secure the co-operation of industry, the treatment of industrial liquid waste might be approached not merely from the standpoint of public health, but also with a view to recovering any by-products and thus reducing both investments and market prices.

(f) The use of all kinds of waste products

The problem consists in:

The population explosion, with consequent overpopulation and pressing urbanization difficulties;

The housing shortage, which is becoming increasingly acute and which cannot be financed out of government funds.

Forest resources are rapidly diminishing and re-development costs are very high. A study of statistical data shows that as from 1975 it may no longer be possible to cover export needs without drawing on local reserves. The use of all kinds of industrial waste will become a necessity.

The laboratories have already decided in favour of:

Rice husks for the manufacture of light cement blocks;

Ground-nut shells for the manufacture of particle board;

Coffee husks for the manufacture of cheap aesthetic board;

A combination of vegetable waste;

Sawdust for the manufacture of light concrete boards and dynamite, and as an additive in the manufacture of linoleum, glues and plastic materials.

Bauxite for the manufacture of fibre-bricks.

These industries involve some sanitation problems which should be dealt with in the recommendations relating to the projects.

10. Programme trends and recommendations

10.1. The programmes are entirely contingent on the adoption of a policy, and the definition of that policy must be in keeping with the environment and the resources available, i.e. funds, manpower, transport, raw materials, etc.

10.2. In the matter of industrial hygiene, it is essential that workers should have security and a certain degree of comfort and that minimum standards should be adopted on a scientific basis in the matter of ventilation, light, acoustics and the conductivity of new materials.

Research should be conducted on the spot rather than in overseas laboratories, if the results are to correspond to the objectives.

10.3. As regards sanitation, Governments would do well to seek the assistance of the WHO Regional Office at Brazzaville in training sanitary staff, executing pilot projects, evolving methods of assessing sanitary conditions in housing and industry, and devising systems for the financing of programmes relating to the supply of drinking water and to liquid waste disposal.

10.4. If serious obstacles are to be avoided in setting up industries which consume large quantities of water, the following points should be borne in mind:

(a) the possible or desired quantity of drinking water per inhabitant in urban and rural areas;

(b) the chemical, physical and bacteriological standards which should be adopted;

(c) the determination of water points (surface and ground water), with capacity at lowest level and altitude above sea level.

10.5. If ministries of public health are to be worthy of that name, they should so chart their activities as to become the true promoters of health in industrialization programmes.

The recommendations made in this report will therefore bear upon three essential points to be dealt with by this Conference:

(1) The adoption and definition of a policy that will facilitate action by public health authorities in the various phases of industrial development. The results will undoubtedly hinge on what action is taken rather than on any legislation.

(2) The necessity of dealing under workable and economic conditions with problems of industrial hygiene such as the security and comfort of workers, absenteeism caused by physical impediment, and the maximum output of workshops.

(3) The desirability that Governments should give early attention to the matter of discussing the campaign against pollution caused by industrial waste discharge.

Such action might appear premature, but if its various phases are considered, it will be realized that it is closely linked with the economic development of the countries concerned.

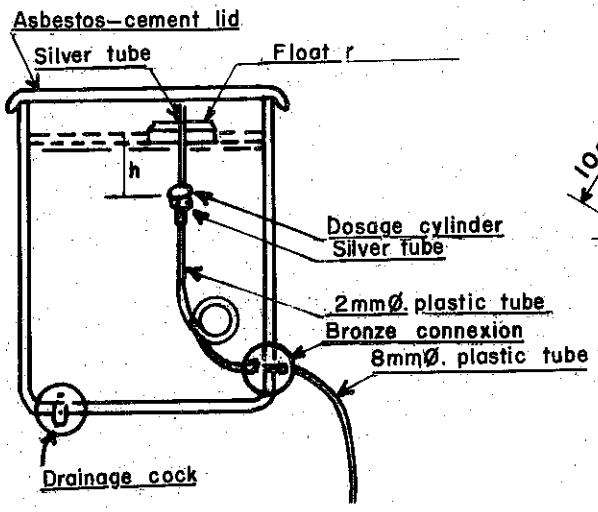
Thus, in the preliminary phase, an inventory of the existing types of industrial waste will make it possible to determine the size and trend of the problem. In the second phase, investigations carried out by chemists and engineers will make it possible to ascertain the practicability of:

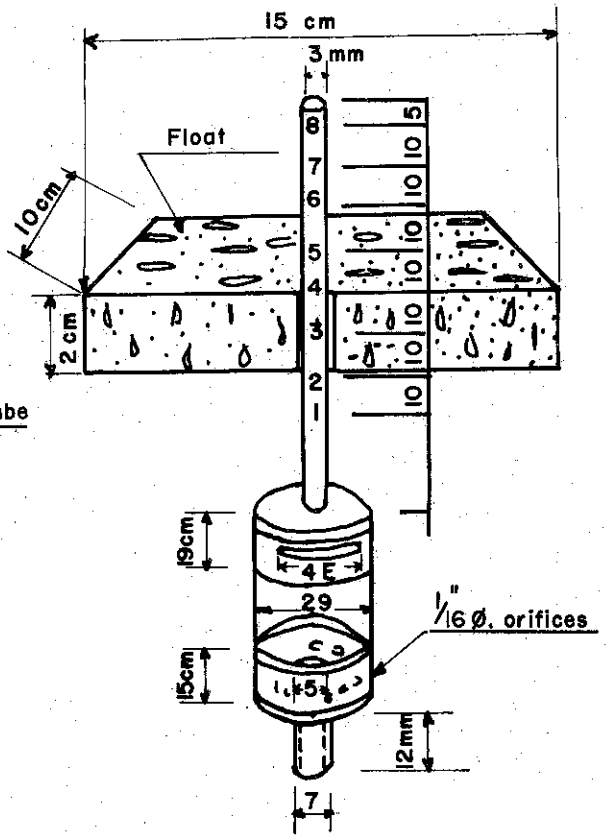
(a) providing adequate and economic treatment and cancelling unforeseen expenditure arising from difficulties in the treatment of domestic refuse;

(b) recovering useful organic and inorganic by-products by means of intermediate installations in plants, mills and factories;

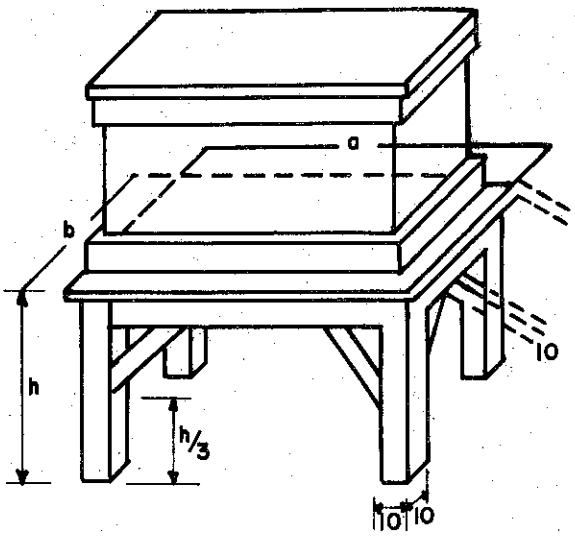
(c) using industrial waste discharge for irrigation purposes after the final treatment required. In the event of any definite indication of pollution, the third phase of the action taken by the public authorities will be to draw up and promulgate laws that will enable ministries of public health to fulfill their task in the promotion of public health.

APPARTUS USED FOR MAKING HYPOCHLORITE SOLUTION



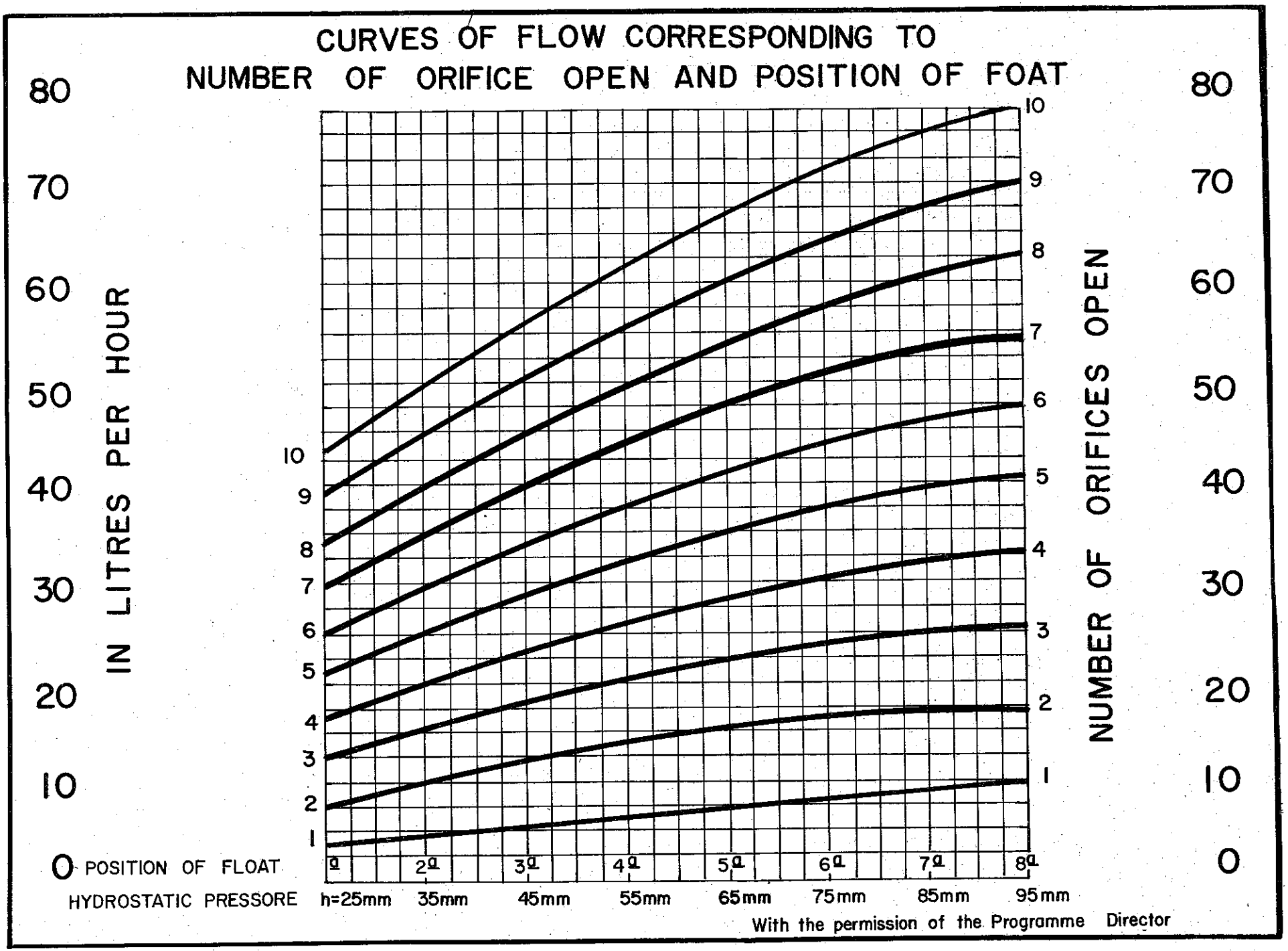


MINIMUM DIMENSIONS OF PLATFORM



Maxiumum flow	Tank Capacity	a	b	h
Litres/Second	Litres	metres	metres	metres
5	150	0.70	0.55	0.60
10	250	0.80	0.70	0.60
20	500	1.15	0.90	0.50
30	750	1.20	1.05	0.40
40	1000	1.35	1.15	0.40

NB: These data have been reproduced with the permission of the Directorate of Rural Housing Programme in Venezuela.
It should be remarked that this apparatus, with dimensions established by experiment, would be quite suitable for any other larger gravity system



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