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PREPARATORY WORK FOR THE ESTABLISHMENT OF A SALT PLANT

ES/CYP/75/004

CYPRUS

TERMINAL REPORT

Prepared for the Government of Cyprus by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

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United Nations Development Programme

PREPARATORY WORK FOR THE ESTABLISHMENT OF A SALT PLANT

IS/CYP/75/004

Project findings and recommendations

Prepared for the Government of Cyprus by the
United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of C. L. Malhotra, salt expert

United Nations Industrial Development Organization
Vienna, 1976

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Cyprus is the Cyprus pound (£C). During the period covered by the report (1975), the value of the £C in relation to the United States dollar was $US 1 = £C 0.37.

A mil is one thousandth of a Cyprus pound.

The following exchange rates are used in the conversion of other country currencies to United States dollars:

Country	Currency	Exchange rate per US dollar in 1975 (mean value)
Kenya	Shilling (KSh)	7.38
Nigeria	Naira (N)	0.615
United Republic of Cameroon	CFA franc (CFAF)	215.00
United Republic of Tanzania	Shilling (TSh)	7.38
Zambia	Kwacha (K)	0.6428

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Note

The expert carried out this mission in accordance with a request of the Government of Cyprus for assistance in setting up a solar salt manufacturing plant at Larnaca Bay. As the proposed plant site posed a number of problems, however, the Government has since requested assistance in assessing a new plant site at Akrotini Lake. The parts of this report that concern the Larnaca site may therefore no longer be of interest. The parts that deal with the domestic requirements for salt in Cyprus and the possibilities for the export of salt, however, should still be relevant.

SUMMARY

This is the report of the expert's second mission to Cyprus. The project "Preparatory Work for the Establishment of a Salt Plant" (IS/CYP/75/004) was requested by the Government of Cyprus following an earlier mission, "Assistance to Modernize and Expand Salt Production" (IS/CYP/73/005), in which the expert had prepared an assessment for establishing a salt plant in the Larnaca Lake area with a capacity of 20,000 tons per annum. The work of technical investigations was undertaken in co-operation with the various departments concerned of the Government of Cyprus and has largely been completed.

The domestic requirements for salt in Cyprus for human, agricultural and industrial needs for the years 1978, 1980 and 1985 have been estimated to be 12,500, 14,200 and 17,100 per annum respectively. The estimates take into account the requirements of the proposed caustic chlorine plant (7,000 tons of chemical-grade salt). On the basis of these estimates, the Government has decided to establish a solar salt plant of 20,000 tons-per-annum capacity.

At present salt is imported into most of the countries of east, central, southern and western Africa for human and agricultural consumption from various European countries. The prices of both indigenous and imported salt in these countries are high.

Ghana, Kenya and the United Republic of Tanzania appear able to meet the future demand for salt in the neighbouring countries of Africa since the Governments of these countries are making strenuous efforts to develop their salt industry for their own requirements and also for export. Therefore, future requirements of imports of salt into African countries would depend on the competitiveness of the imported salt (including that of Cyprus), both in quality and price.

The possibility of export of chemical-grade industrial salt to African countries appears to be limited in view of the fact that these countries have no plans for the establishment of salt-based chemical industries. Cyprus salt would have markets in these countries for kitchen and table salt only.

Similar studies should be conducted in the countries of the Middle East where Cyprus salt could possibly find markets. Finally, a detailed market study for the export of Cyprus salt would be necessary when Cyprus salt is available for export.

The drafts of the required documents were submitted to the Government. Tenders were invited and evaluated. The Government may soon decide to appoint a contractor for project engineering.

Draft documents for inviting tenders, conditions of the contract for the construction of the plant and for its testing and trial run have also been submitted to the Government. The investigations carried out have led to the following tentative conclusions:

(a) The origin of salinity in the lake bed is owing to the existence of an underground saline aquifer from the adjacent Bay of Larnaca. The existence of subterranean brine in the lake has also been established, but its quantum should be further proved by drilling production bore-holes;

(b) The incidence of infiltration and dilution of brine by sweet water in the lake appears to be within reasonable limits and hence controllable by simple means. The rain water collected in the lake assumes salinity in a short time by the process of natural diffusion and could be utilized for manufacture of salt by proper harnessing;

(c) The soil of the bed of the crystallizers for the proposed solar salt plant should be consolidated and also made impermeable for the proper working of the harvesting and other equipment by a suitable blanket of clay or by providing a salt floor.

The measurements of sea-water density and of daily evaporation of water are being regularly recorded and should be continued for a period of one year at least.

Except for work on a preliminary market survey in the Middle East and the concluding portions of the technical investigations, the consultant completed the duties as per the job description. For the successful completion of the project, assistance will be needed during the execution/construction of the project. A detailed draft project proposal for the required assistance was prepared and submitted to the Government. The consultant recommends that assistance be made available to the Government at the proper time.

INTRODUCTION

This is the terminal report of the project "Preparatory Work for the Establishment of a Salt Plant" (IS/CYP/75/004). The report covers a return mission of the expert to Cyprus at the request of the Government for further assistance in the field of solar salt manufacture. The mission was split into two phases. The first phase was for three months, from 11 May to 31 July 1975; the second phase was for six weeks, from 19 November to 30 December 1975.

In October and November 1974 the expert carried out a preliminary investigation of the possibility of modernizing the existing salt industry of Cyprus at Larnaca with a view to meeting an increasing demand for good quality salt for human consumption and for industrial-grade salt for the proposed caustic chlorine plant and other industries in Cyprus. This study established that climatic and other factors at Larnaca were favourable for the manufacture of solar salt and that after taking into consideration the likely requirements for salt in Cyprus, including contemplated demand for caustic chlorine and other miscellaneous industries, the total requirements after 1980 might be about 16,000 tons per annum, out of which 7,000 tons would be consumed by the caustic chlorine plant, 3,500 tons by other industries and 5,500 tons by humans and agriculture.

Therefore, it was recommended that a modern and fully mechanized salt plant with a capacity of 20,000 tons per annum (which was considered to be the lowest economic unit) might be established from which industrial/chemical-grade salt in the required quantities might be set apart; the remaining production might be sold as kitchen salt and a small quantity as table salt. The balance stock might be exported to the neighbouring countries of the Middle East and Africa which depend on distant European countries for their supplies of kitchen and table salt. This plant would help to promote the growth of industries in Cyprus, save foreign exchange on the imports of salt into Cyprus and might also earn some foreign exchange by the export of kitchen salt.

The findings of the above study, when received by the Government, attracted their immediate attention. They carried out the required economic feasibility study, found the proposal economically viable and decided to establish the plant.

Since, however, the expert had recommended that certain technical investigations should be completed before going ahead with the detailed project engineering, the Government requested that UNIDO assign the same expert to Cyprus to carry out the required investigations and to assist them in drafting various tender and contract documents and in evaluating tenders. The Government also requested that the expert undertake a preliminary export market survey for the export of Cyprus salt to the countries of Africa and the Middle East. This request resulted in the present mission with effect from 1 May 1975.

The mission was initially to last four months, from May through August 1975. The expert had meanwhile been selected for a two-month assignment in Zambia to start at the latest in August and to be completed before the start of the rainy season in Zambia by the end of September 1975. Therefore, it was decided during briefing in Vienna that the Cyprus mission, which might have to be extended by four to six weeks to complete the various duties, might be split up into two phases - phase one to cover items I.1, I.3, II.5, II.6, II.7, II.8 and II.9 of the job description during May, June and July 1975 and phase two to cover items I.2 and I.4 of the job description to be completed during October 1975 and beyond if necessary. (The job description is given in the annex.)

On arrival in the field on 10 May 1975 the work of the mission was discussed with the Senior Officer (Industry) of the Ministry of Commerce and Industry, Nicosia, and the requirements of the Government for the mission were more precisely defined as follows:

(a) Technical investigations (see items I.1, II.5, II.6, II.7, II.8 and II.9 of the job description) to be undertaken immediately;

(b) Drafting of tenders for inviting tenders for project engineering, for execution of the project and for trial and test running of the plant to be undertaken soon after the technical investigations, i.e. after about a month or so (item I.3 (a), (b) and (c) of the job description) and to be completed by the end of June;

(c) Drafting contract documents for the appointment of contractors for the project engineering, execution and test runs of the plant to be completed by 15 July 1975;

(d) Drawing up terms of reference for the appointment of a consultant to carry out an export market study for Cyprus salt (item I.2 of the job description). The Government requested that as the expert was to go to Zambia on an assignment, he might carry out a preliminary export market study for Cyprus salt by visiting a few important centres in Africa on his way to and on return from Zambia, and some trade centres in the Middle East after debriefing at Vienna, and thereafter to return to Cyprus in October 1975;

(e) The Government had planned that the tenders for project engineering would be invited in early August and received in early October and it therefore wanted the expert to evaluate the tenders so that it could decide on the appointment of a contractor for this work by the end of October. In addition, the Government asked for a quick domestic market survey to determine the requirements for salt in Cyprus. These duties were entrusted to the expert over and above those set forth in the job description.

The duties listed in the preceding paragraph were completed on schedule. The expert left Cyprus on 24 July 1975 and carried out the necessary studies for the export of salt at Nairobi, Mombasa and Dar es Salaam during the period 24 July through 1 August and at Douala, Lagos and Accra during the period 1-6 October 1975. He attended debriefing at Vienna on 7-8 October and was to proceed to Kuwait, Teheran and Beirut for similar studies in the Middle East. Because of the situation in Beirut and the holidays of Ramadan, however, the visits to these centres had to be postponed. The Government of Cyprus meanwhile had extended the date of receiving the tenders to 22 November 1975 and requested that the expert postpone his return to Nicosia to that date to take up phase two of the split mission. The expert therefore remained engaged in other work until 18 November. As the situation in Beirut had not improved at that time, and as his presence was required at Nicosia urgently, he could not visit these centres on his return trip to Cyprus.

In the meantime, UNIDO in consultation with the UNDP Resident Representative at Nicosia and the Government decided to extend the time period by three weeks. Thus, the duration of phase two of the split mission was fixed at 6 weeks (19 November through 30 December 1975). The expert was to complete the work of evaluating tenders and other related work in 3 weeks, to finish the domestic market study in one week and to attend to miscellaneous duties including visits to site and discussions with the various departments in one week. The remaining

period of one week was spent in travel and debriefing at Vienna. Thus, the expert's mission was completed on 26 December 1975. He was debriefed on 28 and 29 December.

During the two phases of the mission a few difficulties were encountered that hampered the progress of investigations. These difficulties could not have been foreseen. Briefly, they involved the drilling operations, which were delayed owing to running into very difficult strata, and the situation in Beirut and other considerations which impeded the export market survey in the Middle East.

In the course of the mission, M. Michalides, a chemical engineer and an officer of the Ministry of Commerce and Industry, was attached as counterpart. He was associated with all the investigations and is conversant with the work of the mission.

I. INITIAL INVESTIGATIONS

Soon after arriving in the field, the expert contacted various departments of the Government and made arrangements for the following tests and studies:

(a) The Meteorological Department supplied the available records about the local weather system and also installed PAN and rainguage at Lake Larnaca to measure the daily evaporation and rainfall. A wind-speed meter and direction finder were also installed at the site;

(b) The Water Department at Larnaca agreed to depute its engineer to record the measurements of daily evaporation and also to record sea-water density with the help of a beaume hydrometer;

(c) The Land Survey Department was entrusted with preparing a detailed contour map of the lake area on a scale of 1:5,000 with contour intervals of 10 m^3;

(d) The Water Resources Directorate at Nicosia agreed to undertake drilling work, trial pitting and other experimental work in connexion with soil testing to determine permeability, plasticity, liquidity and soil strength of the strata in the lake;

(e) The Fisheries Department agreed to measure pH, density and temperature of sea water by the electric conductivity method;

(f) The Public Works Department agreed to supply a digger to dig trial wells for tapping subterranean brine in the lake, and to construct experimental crystallizers;

(g) The government analyst at Nicosia agreed to conduct chemical analysis of sea water, lake water, crude salt, subterranean brine etc. from time to time.

A variety of other useful data required in connexion with the preparation of offers in response to a Notice Inviting Tenders (NIT) was also collected. The data thus made available were collected and compiled into a background note to be made available to the prospective tenderers.

II. PRELIMINARY ESTIMATES OF DOMESTIC SALT MARKET IN CYPRUS

Domestic requirements for salt in Cyprus

The present requirements for salt in Cyprus are met mostly from indigenous production. Small quantities of high quality salt are also imported to meet the demand for table salt and of industries, especially food-processing industries, for high purity salt.

The indigenous production of salt in Cyprus varies from 3,000 to 5,000 tons per annum. The salt as produced is crude and of inferior quality. The production is dependent on the rainfall and its timing etc. Table 1 shows the production of salt during the period 1962-1974.

Table 1. Salt production, 1962-1974

Year	Production (tons)	Year	Production (tons)
1962	5,662	1968	4,740
1963	6,848	1969	5,776
1964	-	1970	6,688
1965	5,000	1971	6,487
1966	3,450	1972	5,674
1967	6,606	1973	-
		1974	3,495

The salt as produced is sold for the following purposes:

(a) Human and cattle consumption in its crude form;

(b) Crushing and purification for human consumption;

(c) Miscellaneous industries.

Table 2 gives the sales of salt made by the Customs Department of the Government (for different uses) during the period 1962-1973.

Table 2. Sales of salt made by Customs Department of the Government, 1962-1973

Year	Sales (tons)	Year	Sales (tons)
1962	3,413	1968	3,996
1963	2,602	1969	4,729
1964	3,404	1970	4,233
1965	3,966	1971	4,779
1966	3,755	1972	5,066
1967	4,032	1973	4,741

The main industries consuming salt in Cyprus in 1974 were:

Industry	Tons
Tanneries	447
Water softening	446
Canning	113
Animal feeds	520
Soap and detergents	92
Food processing	122
Seam bleaching	145
Hospital and veterinary services	190
Textile dying	181
Electrolysis	36
Cement factories	8
Total	2,300

The ex-factory selling price of indigenously manufactured salt for human and animal consumption (crude salt) is £C 20.00 per ton and for industries is £C 6.25 only. Table 3 gives the pattern of consumption of salt in Cyprus for different purposes during the years 1972-1975.

Table 3. Pattern of consumption of salt, 1972-1975

Year	Human consumption		Industry		Animal consumption		Total	
	(tons)	(£C)	(tons)	(£C)	(tons)	(£C)	(tons)	(£C)
1972	3,626	72,520	1,326	8,486	33	211	4,985	81,217
1973	3,355	67,100	1,225	7,840	47	301	4,627	75,241
1974	2,789	55,780	1,076	6,886	91	582	3,956	63,248
1975	2,541	55,850	891	5,653	5	32	3,437	56,500

Price indications of imported salt

Table 4 gives the f.o.b. and c.i.f. prices of salt as imported by the leading importer of salt in Cyprus, M/s. O.G. Shakarian.

Table 4. Salt imported by leading salt importer, 1972-1975

Year	Quantity imported (tons)	f.o.b. price (£C per ton)	c.i.f. price (£C per ton)
1972	100	10.00	24.48
1973	81	10.60	26.48
1974	127	13.50	39.66
1975	119	16.50	41.75

The salt was imported from the United Kingdom. It was pure dried vacuum salt, in 50 kg polypropylene/polyethylene-lined sacks. The c.i.f. price included surcharge, bunkering charges and war risk, amounting to £C 5 to £C 7 per ton. The import order was for 2.20 tons each. In addition to handling charges, warfage etc. which at Limassol are about £C 70.00 per ton, there is an £C 40.00 per ton import duty on salt in Cyprus.

Sales prices of salt in Cyprus

A quick market survey of the varieties of salt being marketed in Cyprus revealed the following prices for different packaging:

Package	Net weight (g)	Wholesale price (mils)[a]	Retail price (mils)	Remarks
Plastic jar	680	246	315	Cerebos (UK)
Tin	680	246	315	Imported table salt (iodized)
Plastic jar	680	246	315	Saxa (UK)
Paper pack	453	75	85	
Plastic jar	400	75-83	900-100	Locally packaged imported salt G. Charalmbais
Paper pack	420	50-55	65	
Polythene bag	510	100	115	
Polythene bag	600	40	45	Adonis Limmaso (indigenous) dull-coloured salt (indigenous)
Bulk polythene bag	620	35/1200 g	25	

a/ A mil is one thousandth of a Cyprus pound.

Future requirements for salt in Cyprus

Cyprus is in the process of industrial development. The Government is keen to identify industries that can be economically viable. The establishment of a caustic chlorine plant with a capacity of 5,000 tons of salt is under active consideration. When finished it would require about 7,000 tons of high quality salt as a raw material. Other industries like food-processing and water-softening plants for various industries would require increasing quantities of salt in the coming years. Thus, the industrial requirements of salt will continue to increase in the future.

The amount of salt required for human consumption in Cyprus is estimated as 5 kg per capita. When all these factors are taken into consideration, the projected demand for salt for domestic consumption is computed as follows:

Year	Kitchen salt (tons)	Table salt (tons)	Chemical-grade salt (tons)	Industrial salt (tons)	Total (tons)
1978	3,500	300	7,000	1,700	12,500
1979	4,400	400	7,000	1,700	13,500
1980	5,000	400	7,000	1,800	14,200
1981	5,400	500	7,000	2,000	14,900
1982	5,900	500	7,000	2,300	15,700
1983	6,500	500	7,000	2,600	16,800
1984	6,500	500	7,000	2,800	17,100
1985	6,600	500	7,000	3,000	17,100
1986	6,600	500	7,000	3,200	17,300
1987	6,700	500	7,000	3,500	17,700

Thus, neither the present production nor its quality will be sufficient to meet the anticipated needs for salt in Cyprus. It has therefore been decided that in view of the requirements for salt, the Government should take timely steps to organize the salt industry. It has been advised that subject to the above assumptions and projections, it would be justified to plan the installation of a modern salt plant with an annual capacity of 20,000 tons of high specifications to be able to meet the demand. As it takes about two to three years for a salt plant to come up to full production, the above-projected demand for salt has been computed for the decade 1978-1987.

III. PRELIMINARY EXPORT MARKET SURVEY FOR CYPRUS SALT IN AFRICA

According to the statistics compiled by the United Nations Economic Commission for Africa (ECA), a large number of countries especially in central and southern Africa would be deficit in salt even up to 1980 and beyond. The reason for this appears to be that in some countries there are no known occurrences of natural rock salt deposits nor do they have sea coast, and in others the climatic conditions are not suitable.

Briefly, the countries of North Africa by and large not only have sufficient salt but also have an exportable surplus. On the other hand, a large number of countries on the east and west coast of Africa have indigenous salt production but are not self sufficient so far and may not be able to achieve self-sufficiency in the foreseeable future.

Studies were therefore made in a few markets of east and west Africa which import salt, both for the requirements of the countries in which these ports are situated and also because salt moves into the hinterland of Africa through these ports. The places visited were Nairobi, Mombasa, Dar es Salaam, Lusaka Douala, Lagos and Accra.

As this was a preliminary survey and the time allotted for the studies was two weeks only, its scope had to be restricted to collecting statistics of imports and exports, quality of salt imported, prices in the market, packing, the status of the indigenous salt industry and its likely expansion and effect on imports of salt in future. The conclusions arrived at after evaluating the information collected are summarized in the following paragraphs.

Kenya

The requirements for salt are about 75,000 tons per annum. About 40,000 to 50,000 tons are available from indigenous production, 40,000 tons from Magadi salt and soda deposits and 5,000 to 7,000 tons from sea salt works. The imports therefore vary from 7,000 to 9,000 tons every year except in 1974 when imports were 28,250 tons. The imports are from Democratic Yemen, Ethiopia, Netherlands, Romania, the United Kingdom etc. The imported salt especially from European countries is pure, white and fine. It is generally imported in bags of 50 kg capacity each, and retail packings are made locally

in polythene bags ½, 1 and 2 kg each. Compared with this salt, the locally manufactured salt is dull white, wet and not finely crushed. The retail prices of salt are the same. Besides bagged salt, small quantities of table salt in original packings are also imported. Prices of imported salt are KSh 2 per 2 kg packing, and KSh 4 for 750 g of cerebos salt packed in a plastic jar. The retail price of indigenous salt is KSh 2 per kg in polythene bags. These prices appear to be high.

Kenya has launched a scheme of installing a salt refinery of 80,000-tons-per-annum capacity at Mombasa. Raw salt for this will be imported to start with and in due course the Government will develop a sea salt plant about 100 miles north of a place called Lindi.

United Republic of Tansania

The requirements for salt are about 75,000 tons per annum on the basis of a population of 14.75 million in 1972, calculating intake at the rate of 5 kg per capita. But in actual practice the per capita consumption, after taking into account indigenous production and imports minus exports, works out to 3.5 kg.

The indigenous production of salt in Tansania is derived from the Nyansa salt mines in the north (about 30,000 to 42,000 tons per annum) and from the sea salt works along its coast both north and south of Dar es Salaam (10,000 to 12,000 tons per annum). Thus Tansania is short of its requirements by about 20,000 tons. The imports range from 8,000 to 18,000 tons according to the status of indigenous production. The imports, however, have been showing a downward trend over the last several years, though indigenous production has not registered any appreciable or corresponding increase. In addition, Tansania is also an exporter of salt to neighbouring countries such as Zaire. Therefore, in the last analysis the local demand is not fully met and the per capita consumption is lower than the limit prescribed by nutritional standards.

Imports of salt into Tansania take place from Democratic Yemen, the Federal Republic of Germany, India, Kenya and the United Kingdom.

The locally manufactured salt is dull white in colour, wet and unorushed. Imported salt, by contrast, is whiter, finely orushed and dry. Table salt in original foreign packing is also imported into Tansania. The import of this variety has been declining, however, over the years (127 tons in 1962, 62 tons in 1969 and only 7 tons in 1972).

Prices of salt in wholesale and retail are high. Except for table salt, the other kitchen variety of crushed salt and coursely crushed and uncrushed salt are imported largely in 50 kg sacks, and salt is packed for local retail sale in ½, 1 and 2 kg bags. A 500-g retail pack of polythene containing imported salt sold at TSh 1.20. Loose salt uncrushed and wet was found selling at TSh 1 per kg. C.i.f. prices of imported salt vary widely - from 14 cents (US) per kg to 37.5 cents per kg depending on whether the salt is fine white, coarsely crushed or uncrushed crystal or table salt. The retail prices are 6 to 7 times higher than the c.i.f. prices. The indigenous salt is also available in retail polythene packs of 500 g at TSh 1.

The Government of Tanzania is keenly interested in developing its salt industry on modern lines and in producing high purity salt for its own requirements as well as for entering the export market. It plans to increase the capacity of the Nyanza salt mines to 80,000 tons and to increase sea-salt production to 25,000 tons per annum. For this purpose, it is reported to have had a techno-economic study made of Nyanza salt mines by M/s. Salin du Midi.

Zambia

The total requirements of Zambia at present appear to be about 32,500 tons per annum out of which 25,300 tons are required for a population of 4.9 million (5 kg per capita) 4,200 tons for agricultural needs and 3,000 tons for industries. The entire demand is met from imports which during the last four years were 19,500 tons in 1974, 32,100 tons in 1973, 22,700 tons in 1972 and 23,900 tons in 1971; the per capita consumption has been 2.7, 5.4, 3.5 and 3.8 kg respectively in these four years.

Zambia has a number of hot and saline springs on which the indigenous salt industry has thrived in the past. The mode of production has been by boiling water of very low salinity in open troughs over wood-fired furnaces or, after concentrating the saline water, by leaching the earth; in the latter case ash of the naturally growing grass fades away. In the few places where these practices are still in vogue, however, the salt so manufactured is dirty black in colour, contains a lot of impurities both soluble and insoluble and the production is not more than 50-60 tons per annum. The industry works for 2 to 3 dry months in the year. Thus indigenous production is not fulfilling the demand in any significant manner.

The Government of Zambia is however keen to tap its own natural rock-salt resources. All efforts made so far have failed to locate any deposits. Therefore, being a land-locked country and without known rock-salt deposits, Zambia will have to remain dependent for its requirements of salt on imports.

Zambia imports salt from a number of countries in Europe, Asia and Africa. The chief exporters are Angola, the Federal Republic of Germany, Mozambique, Netherlands and the United Kingdom.

The salt imported from the European countries comes mostly via Lobito seaport. The other port on the east coast is Beira in Mozambique. However, as a result of the closure of inland routes and the political situation, the movement of cargo for Zambia from these ports has been much affected; the scarcity of salt was felt especially during 1974 because of fewer and erratic deliveries. The situation is now expected to improve since the new Zambia/Tansania railway line connecting the Dar es Salaam seaport with destinations in Zambia has become operative so that salt should reach Zambia by the new route more quickly and perhaps cheaply.

It is also hoped that in time the conditions will become favourable to all countries of this region, and that other routes via Lobito and Beira will be open, transport will be easier and necessities like salt will be more readily available. The Government of Zambia is liberal in granting import licences for importing salt in sufficient quantity to ensure regular supplies. Neighbours such as Angola, Mozambique and Tanzania are all salt-producing countries and thus nearly all the supplies could be met from nearby scurces of Asia, Africa and the Mediterranean instead of from distant European countries from which the bulk of supplies now come. The distance plus difficult inland routes etc. result in salt being irregularly available and highly priced.

In the markets of Zambia three to four kinds of salt are available. There is white-coloured, finely crushed salt; dull white, coursely crushed salt; crystal, dull-white uncrushed salt and free-flowing table salt. The bulk of the salt supplied to Zambia for human consumption is imported by the National Milling Co. and Indeco Milling both of which are parastatal bodies. They undertake packing the salt in retail polythene bags of ½, 1 and 2 kg each and sell these at fixed rates. For example, the prive of a ½ kg bag in retail has been fixed at 8 kwacha (K) which means that the retail price is about

K 250.00 per ton. In actual practice, the retail prices of salt sold in the open market in the interior were more, owing possibly to the scarcity of salt. In other words, the prices of salt are high but it should be borne in mind that the expenses incurred to reach the salt are also high.

In Zambia there is a problem with acute goitre and the Government has decided to control it by introducing the use of iodized salt, so that in the future it will need only iodized salt.

United Republic of Cameroon

The climatic and topographical conditions in the United Republic of Cameroon do not appear to be favourable for the indigenous manufacture of salt. Therefore, this country also is principally dependent for its requirements of salt on imports.

Cameroon has a population of 6 million (1971) and therefore at the normal per capita consumption of 5 kg, its requirements for human consumption should be about 30,000 tons per annum. However, as food habits in this country tend to the use of tinned foods to which salt is already added, it may be that the actual per capita requirements to be met from the import of salt will be smaller.

Actual figures of imports of salt into Cameroon were unavailable. It is known, however, that supplies are received from Federal Republic of Germany, France, Portugal and Spain by the western sea route.

During visits to the supermarkets at Douala, the largest city and seaport of Cameroon, it was observed that the people prefer to buy high quality, dazzling white, free-flowing salt in attractive packings. Two varieties were available for sale: rounded crystalline salt, grain size 1/8 to 3/16 inch, iodized salt manufactured by M/s. Salin du Midi, France, in 1 kg packs costing 95 CFA francs (CFAF) and the other was German salt in plastic containers, fine, white, contents 850 g net and price CFAF 120.

Nigeria

Like Zambia, Nigeria is also dependent on imports of salt for its requirements. It imports substantial quantities from a number of countries of Europe and also small quantities from the United States. A country of 66 million

people (1972), it imports salt at the rate of 150,000 to 200,000 tons per annum. The countries which are exporting salt to Nigeria in substantial quantities are Federal Republic of Germany, Poland, Portugal, Romania, Spain, the United Kingdom, USSR and even India. Its neighbour Ghana also sends small quantities.

The c.i.f. price of salt in Nigeria is 50 naira (N) per ton. The retail price is much more.

Because of the humid climate, the indigenous salt industry has not developed significantly even though the sea coast and land are available. It was understood that the Government was contemplating the installation of a salt refinery by a German firm.

Ghana

On the basis of its population in 1970 (8.5 million), the requirement of Ghana for salt, at 5 kg per capita, should be 40,000 tons for human consumption. The consumption targets for 1970 and 1975 were estimated, however, at 48,000 tons and 66,000 tons respectively. The balance would be used to meet agricultural and industrial needs.

Ghana has its own salt industry and the Government has shown interest in developing the industry on sound lines in order to increase production and improve quality so that it would also meet the requirements of its neighbours which depend on imports of salt. According to statistics furnished by the ECA, the targets of production for 1970 and 1975 were fixed at 100,000 and 150,000 tons respectively. The actual production in 1970 was 42,000 tons, in 1971 it was 52,000 tons, and in 1973 it was 55,000 tons. In other words, the actual production is behind the targets. However, the country has reached its estimated consumption figures.

During a visit to Accra, the consultant learned that there are three salt works situated about 7 to 9 miles from Accra and their production in the near future is likely to increase significantly.

At present, Ghana is exporting small quantities of salt to Upper Volta and Nigeria. This appears to occur when its own needs are satisfied; exports are then permitted if there is salt to spare.

Requirements of countries in Africa

Other African countries in need of salt are: Burundi, Central African Republic, Chad, Malawi, Mali, Niger, Rwanda, Uganda and Zaire. These countries are likely to remain dependent on imports of salt either because they do not possess any natural salt sources or these cannot be exploited on a commerical scale for economic or other reasons. The population of these countries is estimated by 1980 to be 150 million. Their requirements on the basis of 5 kg per capita would thus be 750,000 tons or at least 500,000 tons, even if there were some indigenous production in countries like Zaire and Uganda (which are reported to be actively considering plans for the exploitation of their natural saline deposits). This demand can be met from Algeria, Egypt, Ethiopia, Kenya, Sudan, Tanzania, Tunisia etc., all of which have plans to produce salt of good quality and to enter the export markets. However, until the actual realization of these plans and the development of routes in the hinterland, salt from the countries of Europe, Asia and North Africa will continue to be imported.

Countries like Liberia, Mauritania, Senegal, Sierra Leone, Somalia, Togo etc. have the potential for the production of salt to meet their own requirements.

Conclusion

So far as Cyprus salt is concerned, the possibilities of its export should be examined along with the possibilities of exporting salt from other European countries. Because of the present tight situation in shipping, the shipping lines are not agreeable to offering a reduced tariff for cargo from Cyprus, which is nearer to the African markets than the Federal Republic of Germany, Netherlands, Norway, Romania, Spain, United Kingdom etc. Therefore, the Cyprus salt will have to be as good as the salt of other countries in quality and its f.o.b. price should be competitive. Packing in bags and in retail packs - cartons and plastic jars - would also have to be competitive in quality with those offered by other countries of Europe.

Further, as there are no prospects of any salt-based industries being set up in the African countries, the demand for chemical-grade salt will be limited. The markets of Africa may, however, absorb the imports of kitchen salt and

small quantities of table salt from Cyprus provided it is able to compete in quality, price, packing etc.

Similar studies were to have been made in the countries of the Middle East but had to be deferred as the expert's presence in Cyprus was required in connexion with the evaluation of tenders etc.

In conclusion, there appears to be no necessity to appoint a consultant to make a foreign market study for Cyprus salt at this time. However, when the Cyprus salt plant starts production a detailed study would be necessary.

IV. ACTION FOR INVITING TENDERS

Drafts of the following documents were prepared and submitted to the Government:

Notice Inviting Tenders (NIT)
Undertaking agreement
Appendix containing specifications of work
Background note for the guidance of the prospective tenderers

The Government invited tenders for the detailed project engineering of a 20,000-ton-capacity salt plant. The last date for receiving them was fixed at 15 October 1975, but it was later advanced to 22 November 1975.

In response to the NIT seven tenders were received from the following parties:

M/s. Salin du Midi, France
The Israel Salt Co., Haifa
M/s. Tecnosel, Freiburg, Switzerland
Saltec, Rome
Bureau of Economic and Market Research, Nicosia
ICI, Melbourne
White, Young and Partners, London

Action to invite tenders for the execution of the project was deferred as it was considered advisable to invite tenders for this work after receiving the project report. Likewise, no action to invite tenders for the test and trial running of the plant was considered necessary since the contractor for the construction of the plant would be made responsible for ensuring and guaranteeing the achievement of targets of production quality and cost of production.

V. DRAFTING THE CONTRACT DOCUMENTS

In accordance with item no. I.4 of the job description, the following drafts of contract documents were submitted to the Government:

(a) Annexures including specifications for the work required in connexion with:

(i) Project engineering;

(ii) Execution of the project;

(iii) Test and trial running of the plant;

(b) Draft agreement for item I.3 (b) and item I.3 (c) of the job description (see annex);

(c) Draft conditions of contract for items I.3 (b) and (c) of the job description.

The following points have been taken particularly into consideration in drafting the conditions of the contract:

(a) Definitions;

(b) Time allowed for the completion of the work;

(c) Procedure for measurement of the work and payment of contractor's bills;

(d) Power to make additions, alterations etc. in design drawings and rates payable for such additional work;

(e) Measures for ensuring sound workmanship;

(f) Compliance by the contractor with rules and regulations in respect of labour and other matters;

(g) Force majeure;

(h) Confidentiality clause;

(i) Procedure for arbitration in the event of a dispute;

(j) Training national personnel;

(k) Penalties for non-fulfilment of contract and for non-realization of the targets of production, quality and cost of production.

It was brought to the notice of the Government that the conditions of contract would require modifications in the light of the final terms and conditions agreed to between the Government and the contractor. Such modifications could not however be foreseen in advance.

The Government was also advised to have the draft tender and contract documents vetted by its law department before issuing tenders.

VI. INVESTIGATION OF THE CONDITIONS OF THE PROPOSED SITE FOR THE SOLAR SALT MANUFACTURING PLANT

According to the job description, detailed drilling and trial pitting was to be followed by laboratory work. It was agreed that this work would be executed by the Water Resources Directorate of the Government. A programme for drilling holes was drawn up in the first instance. Subsequently, the Geological Survey Department of the Government suggested that four more holes be drilled. However, during the course of actual drilling, very weak strata were encountered and the programme had to be substantially modified. Where drilling became difficult, trial pits were dug. Further, the sites of drill holes were changed to extend the scope of the operations. Two wells were dug side by side, to determine the existence of subterranean brine and its salinity. Experimental condensing and crystallizing pans were constructed to observe crystallization and percolation losses. A preliminary report of the work done up to the middle of July 1975 was made available by the Directorate of Water Resources. It has conducted further experiments and its final report is still awaited. In the meantime two notes on the tentative conclusions of the investigations made were submitted to the Government; they are summarized in the following paragraphs:

Origin and reserves of salinity in the Larnaca Lake

The origin of salinity in the Larnaca Lake mud (silty clay) and the existence of brine are attributable to the sea water of the Bay of Larnaca, which is supplying salinity and replenishing any loss by means of an underground aquifer (through a sandy strata). As a result, the salt content of the lake varies.

A very rough estimate of the quantum of brine in the lake mud up to depth may be about 300,000 tons (assuming the area of the lake containing the mud to be four square miles and the brine content to be 2% only). However, these conclusions require further confirmation by the drilling of one or two production bore-holes.

In the two wells dug in the size of 4m x 3m x 3.25m in the lake bed near the periphery on the western side, subterranean brine of 18 to 20 beaume concentration was encountered. From the observations made, there was brine

of different concentrations in the drill holes. Though no correct idea of the average salinity of subterranean brine could be made at this stage, the existence of subterranean brine in the lake bed has been established beyond doubt.

Elimination of the effects of infiltration and interference by the rain-water in the lake

During drilling operations, it was ascertained that the water-table in the lake is high and near the surface. At numerous places on the periphery of the lake, water was seen oozing out at the surface. This observation was conspicuous in the eastern part of the lake, while in other parts the mud immediately below the surface was wet, thus confirming the inference.

It is therefore inferred that by having ring channels around the salt plant, all such water could be collected and drained out regularly; thus its interference in the concentration cycle would not be likely to be significant. Besides, as the quantum of surface water is limited, and within normal limits, there would be no serious difficulty in dealing with it effectively.

As regards the rain-water collected in the lake, there is not much flow of water into the lake from the catchment area. There are two deep and long diversion channels on both sides of the lake which collect and drain this water to the sea. This was confirmed by a visit to the lake soon after heavy rainfall for a couple of days. It was noticed that some water flowed into the lake at a point near the mosque on the west side. Apart from that, all the accumulation of water in the lake was from direct rainfall.

It was noticed through careful observation that the water so collected in the lake gained salinity from the lake by a gradual but regular process of diffusion, as a result of which within a period of 60 days or so this water would contain as much salinity as sea water or more depending upon the depth of the accumulated water. The salinity so available could be harnessed for manufacturing salt and thus the necessity of channelling and draining this water would be obviated. At the same time the necessity of pumping sea water for the required salinity for the proposed salt plant would be eliminated or largely done away with. This would result in saving capital and recurring cost of the project. The rain-water so collected would gain the salinity in the

months of January and February, and, during March, this water could be collected in a reservoir and conserved for use for the operations of concentration and crystallization. The rain-water of the lake would prove to be a blessing in disguise. Only in the year of very small rainfall or no rain, would there be the necessity of procuring salinity and this need could be met either from tapping subterranean brine or by pumping sea water into the reservoir of the lake.

To obtain detailed information about the quantity of rain-water collected in the lake and to determine its salt content, the water contour was plotted on a large-scale map, depth was measured by an automatic depth recorder and salinity was measured. The data collected would provide valuable information.

Measures for making the bed-soil of salt crystallizers impervious

During drilling and digging of trial pits, frequent samples of the soil, the brine met with and the bed-rock as drilled through were drawn up regularly and tests to determine their permeability, plasticity and liquidity were carried out both in the field and in the laboratory. Also, the chemical and mechanical composition of the constituents of the soil was determined. These experiments have helped to establish that:

(a) The soil met with on the south-eastern side is more impermeable than that on the north-western side. The soil for a distance of 300 metres from the edge of the lake is soft and silty or silty clay;

(b) The soil on the north-eastern side of the lake is however permeable but stronger, consisting of intercalated bands of course semi-compact clay-like sandstone. This was also noticed for a width of about 200 metres from the edge of the lake;

(c) As one penetrates the lake further, the soil becomes very soft and is full of brine;

(d) Even on the north-eastern side of the lake, the bed at the outer fringes is not strong enough to bear the load of heavy machines.

As a result of the above observations, experiments both in the field and in the laboratory, it is considered necessary to take into consideration the following measures for consolidation and compacting the beds:

(a) A blanket of suitable earth material of sufficient thickness may be spread over the crystallizing area. Suitable plastic, impermeable clay-like earth with the required percentage of sand is reported to be available in the vicinity of the lake;

(b) A salt floor of sufficient thickness (6- to 12-inch layer) may be left intact to form the bed of the crystallizers over which subsequent years' crystallization may take place; only that crust may be harvested, thus leaving a permanent salt floor intact. Such a bed is strong enough to support the load of machinery and, at the same time, the harvested salt will be a clean product;

(c) Light-weight machinery for harvesting and transporting of salt or having predetermined load-bearing capacity (kg/cm^2) suitable for the beds may be used.

The logs of drilling, the results of field and laboratory tests and other observations have been as far as possible incorporated in the background note prepared for the use of the contractor to be appointed for project engineering of the work.

Measurement of the density of the sea water in the coast of Larnaca Bay

This work is being attended to by two separate departments of the Government independently. The local officer in the Water Department at Larnaca has been measuring the salinity of the sea water by beaume hydrometer twice daily in the open bay (at 0800 h and 1300 h).

The local officer of the Fisheries Department at Larnaca is also drawing samples of sea water from the open surface of the sea daily and these samples are being sent to the laboratory of the Fisheries Department at Nicosia to determine salinity by the electrical conductivity test method. The temperature of the sea water is also being regularly measured and recorded.

Thus, this work is receiving attention, and the data collected by these two departments are being regularly supplied to the Ministry of Commerce and Industry every fortnight. The recording of density and temperature in the above manner must be continued for a period of at least one year, i.e. up to the end of May 1976, so that one year's data may be available.

Measurement of the daily solar evaporation at Larnaca

The Meteorological Department of the Government, on request of the Ministry of Commerce and Industry which has sponsored the salt project, installed a PAN A Evaporimeter at Lake Larnaca in May 1975. Also, a rainguage, a maximum and minimum thermometer to measure the temperature of the water of the evapometer and a wind-speed meter and direction finder were installed at the same site. Thus, the measurement of water evaporated, the rainfall, the maximum and minimum temperatures of water, the speed and direction of winds at the lake are being measured and recorded daily. The data so collected are being supplied to the Ministry of Commerce and Industry. These measurements should also be recorded continuously for a minimum of one year and the data so available will be supplied to the contractor to be appointed for the engineering of the project.

Preparation of a large-scale contour map of the lake area

This work was entrusted to the Lands Survey Department of the Government. It has prepared a map on a scale of 1:5,000 with contour intervals of 10 m^3. The map, however, does not show contours in large parts of the lake, and in most of the area only spot levels have been given. The reason for this limited mapping was attributed to the inability of the survey staff to reach the inner part of the lake because of slush and soft ground on which the instruments could not be stationed.

It will be seen that the various departments of the Government have extended all possible co-operation in undertaking and completing the various investigations. The data available from this work are of great value and have helped to save a good deal of money and time.

VII. EVALUATION OF THE TENDERS

This chapter covers phase two of the mission from 19 November through 30 December 1975.

On the basis of tender documents submitted to the Government and NIT issued, seven tenders were received by the Government on 21 November 1975. These tenders were evaluated and a comparative statement showing particulars of each tender and a note containing detailed comments on its merits with regard to the considerations of cost, time required for completing work, and experience and competence of the tenderer was prepared and submitted to the Government.

The Tender Board of the Government considered the tenders and selected two tenderers, but before taking the final decision to accept any tender, the Board desired further information of a technical nature in clarification and elaboration of the offers made by these two. Also, it was thought, their relative experience in the field of project engineering for solar salt plants might be determined by discussions with them or their representatives and furnished to the Board for its further consideration.

Discussions were accordingly held with the two tenderers selected by the Board and the necessary clarification of their offers was obtained. A note was prepared to this effect and supplied to the Government.

Domestic market survey for salt in Cyprus

This work was also undertaken during the same period. The principal towns of Cyprus - Nicosia, Limmassol, Larnaca, Trudos, Paphos etc. - were visited for a study of the salt sold in the market. The refinery at Limmassol was visited and its working studied. Information regarding imports, prices, packings etc. was collected from several sources. Information regarding production and consumption of indigenous salt for human, agricultural and industrial uses was collected from the Customs Department. The findings have been incorporated in chapter II of this report.

VIII. RECOMMENDATIONS

For the successful completion of the project, action as outlined below should be undertaken.

The Government should:

1. Complete laboratory and other tests for the completion of work under items II.5, II.6 and II.7 of the job description (see annex);

2. Continue recording measurements of sea-water density in Larnaca Bay and of daily evaporation at the lake so as to make this data available for a period of one whole year;

3. Appoint a contractor for the project engineering work so that the project report is available and further action may be initiated;

4. Submit with the concurrence of the Resident Representative at Nicosia a revised proposal for undertaking a preliminary market survey for the export of Cyprus salt to the countries of the Middle East;

5. Submit a detailed project document for the required assistance during the execution of the project until its completion, testing, trial running etc., and a detailed export market survey after the completion of the project when the plant goes into production.

The services of an expert should be provided:

6. To complete the preliminary export market survey in the Middle East;

7. To evaluate the project report to be received from the contractor for project engineering and suggest any modifications;

8. To initiate action for the appointment of a contractor for the execution of the project by inviting tenders or by negotiation with the contractor who prepared the project report;

9. To ensure physical commencement of the project in the field;

10. To inspect and properly execute the project as per the time schedule and specifications during construction;

11. To supervise testing and trial-running of the plant under all sections for achieving the targets of production, quality and costs as per guarantee of the contractor;

12. To undertake a detailed export market survey for the export of Cyprus salt after the plant goes into production.

Annex

JOB DESCRIPTION
(IS/CYP/73/005/11-01/04)

Post title: Salt Production Expert

Duration: Four months, with possibility of extension

Date required: As soon as possible

Duty station: Nicosia, with travel within the country

Duties: The duties of the expert will be:

I. Preparatory work for setting up a solar salt manufacturing plant

1. To investigate, with the active co-operation of the government departments concerned, parameters essential to solar salt production from sea water, to be located at Larnaca Bay, and to collate the results with available data;

2. To make a preliminary estimate of the salt market and draw up terms of reference for a consultant to carry out an export market survey for Cyprus salt in prospective markets in the Middle East and Africa;

3. To initiate action for inviting tenders on a global basis for:

   (a) Carrying out detailed studies and submission of a complete engineering project report for the establishment of a modern, mechanized solar evaporation salt plant with an annual capacity of 20,000 tons, including detailed estimates, designs, drawings and specifications;

   (b) Executing the project within a stipulated time period;

   (c) Ensuring and guaranteeing achievement of the targets of production, quality, cost of production etc.;

4. To draft the required contract documents, including terms and conditions of the contract for the above-mentioned services of a contractor.

II. Investigation of conditions of the proposed site for solar salt manufacturing plant

5. To carry out research to establish the origin and reserves of salinity in the black mud of the main Larcana Lake and to explore the existence of subterranean brine, its density and quantum in the lake area by trial pits;

6. To suggest necessary measures to minimize or eliminate the effects of infiltration and interference (by rain water accumulation in the lake) of the brine concentration system in the crystallizing beds of the proposed salt plant;

7. To suggest measures for making the bed soil of salt crystallizers impervious and strong to take the load of heavy machines;

8. To measure the density of sea water in the coast of Larnaca Bay near the lake;

9. To measure daily solar evaporation at Larnaca with the assistance of the local weather bureau.

Qualifications: Chemical engineer with extensive experience in the salt industry.

Language: English

Background information: The Government of Cyprus has requested that an expert follow up the recommendations of a previous mission of a salt expert with the objective of setting up a 20,000 tons-per-year solar salt manufacturing plant.

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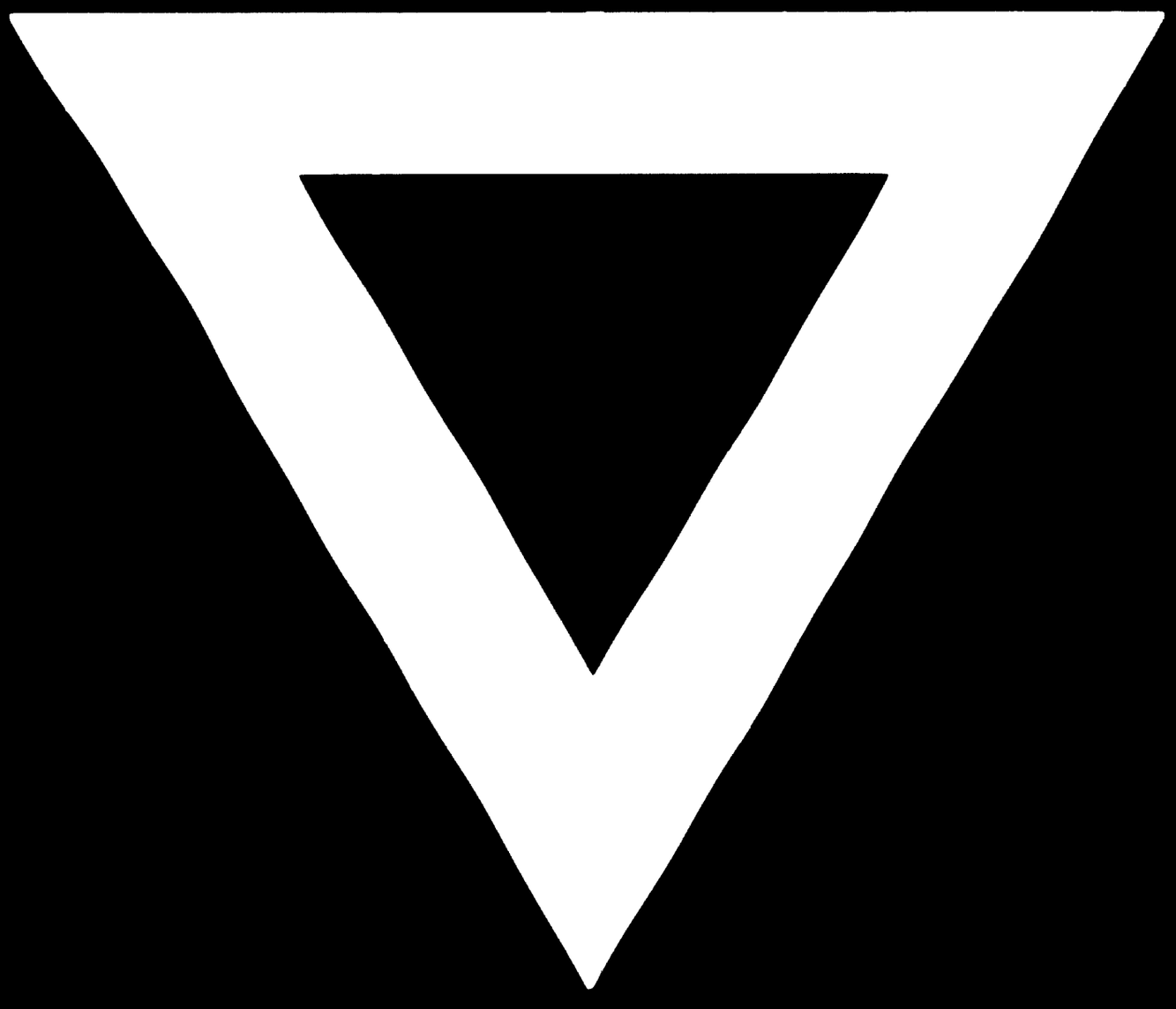

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