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PRODUCT ADAPTATION AND UPGRADING OF QUALITY

DP/IND/72/045

INDIA

Technical report:
TANFAC ALKALIS AND CHEMICALS

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

4.10.6710

United Nations Development Programme

PRODUCT ADAPTATION AND UPGRADING OF QUALITY

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INDIA

Technical report: Tantalum capacitors

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

Based on the work of Jean C. Chielens,
expert in tantalum capacitors

United Nations Industrial Development Organization
Vienna, 1975

Explanatory Notes

A comma (,) is used to distinguish thousands and millions.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

During the period of the mission, the value of the Indian rupee in relation to the dollar was $ 1 = Rs 8.80.

Reference to "tons" is to metric tons.

The following forms are used in tables:

A dash (-) indicates that the amount is nil or negligible.

A full stop (.) is used to indicate decimals.

The following acronyms have been used

ECIL	Electronics Corporation of India
TDA	Trade Development Authority

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Tables

SUMMARY

The report discusses the main types of tantalum capacitors manufactured and relates the production of each to the world market. Manufacturing costs in Europe and the United States are compared with manufacturing costs in India. Since the world market will be saturated by existing production facilities in Europe, the United States and the Far East for the next four or five years, particular attention is given to the development of the Indian market, which should be the mainstay of an Indian tantalum capacitor industry.

The main types of tantalum capacitor to be manufactured in India are: hermetic and drop capacitors for the professional and consumer markets and, later, moulded capacitors. The production process should be highly flexible, so as to meet all the requirements of the Indian market and, to a lesser extent, the export market. The recommended annual volume of production is eight million capacitors, for which a schedule is given based on the capital budget and the domestic and export markets. The total cost is estimated to be about two million dollars, but this can be reduced by 30-40 per cent if use is made of the existing facilities of the Electronics Corporation of India (ECIL) in Hyderabad. The expert recommends, however, that the Electronics Corporation should acquire some additional know-how from overseas sources.

The report also discusses the possibility of collaboration for building a plant to produce exclusively for export, but it is unlikely that this can be arranged in the near future because of the present weakness of the market.

It is particularly interesting that India has its own resources of tantalum ore in the form of tantalite, pegmatites and the like. In view of the expected world shortage of tantalum, it might be possible to set up a favourable barter agreement with companies producing tantalum capacitors and metallic tantalum.

Since the production of tantalum capacitors is very limited and the Electronics Corporation is the only Indian producer, this report is more a feasibility study for the establishment of a tantalum capacitor industry in

India than a document giving technical advice on specific production steps. As the only line in operation is more a pilot line than a proper production line, small-scale laboratory production must be superseded by proper industrial production either by expanding the existing line or by setting up a brand new industry. The quality of the output must also be up to international standards, because the capacitors may be exported in equipment sold or as loose components.

INTRODUCTION

The Government of India, as outlined in the Export Policy Resolution of 1970, decided to attempt to increase exports and requested assistance from the United Nations Development Programme (UNDP). The present project "Assistance in Product Adaptation and Upgrading of Quality" (DP/IND/72/045) is part of this comprehensive plan.

Emphasis was placed on non-traditional goods such as engineering products, electronics equipment and components, etc. One of the fields of electronic equipment and components was selected by the Trade Development Authority (TDA) for intensive development. Certain manufacturers were selected, because of their technical competence, status of equipment and machinery, and financial viability, to manufacture these goods.

Long-range objectives were to increase export potential of certain industries, improve technological and technical development, and upgrade quality.

More immediate objectives were:

1. The development of products through improvements in production research, design, and presentation in order to improve their acceptance in potential export markets.

2. Reduction of unit cost.

3. The introduction of required modifications.

In order to achieve the above goals the assistance was requested of highly qualified technicians and product experts from developed countries to analyse problems, suggest improvements, and help carry out required modifications.

An expert in tantalum capacitors took part in this project from 29 September 1975 to 26 October 1975. In addition to this mission, experts on the following electronic products have been included in this project: power transistors, metal film resistors, solid state devices, and integrated circuits.

I. RECOMMENDATIONS

Types of tantalum capacitors to be produced in India

It is clear from the table of end users of tantalum capacitors (see section on the use of tantalum capacitors in industry) that the main users are in the professional and semi-professional markets. The ordinary consumer accounts for almost 25 per cent of the market.

Initially, the following types of capacitor should be manufactured:

(a) Hermetic solid tantalum capacitors in metallic cases with glass seals;

(b) Resin-coated drop tantalum capacitors for professional, semi-professional and consumer use;

(c) Moulded tantalum capacitors (cylindrical and rectangular) including DIL types.

Strategy for export

The main companies manufacturing tantalum capacitors built up considerable production capacity to meet the peak demand of 1973 and 1974. Some of the excess capacity planned is still being installed. The considerable depression of the market in 1975 has reduced sales to the 1972 level, and complete utilization of existing capacity is not expected before 1979. Manufacturers have been so disappointed by the turn events have taken that they are unlikely to commit themselves to any additional sales of products for which they do not have absolute control over manufacturing cost, quality, delivery and so forth. Moreover, the labour unions will be very reluctant to give their support to the creation of subsidiaries which will have a very direct effect on the level of employment in the partner's country. It is also inadvisable for an industry based in India to rely too heavily on a partner who may be unable at some point to meet his export obligations.

In view of the foregoing, the expert recommends that:

(a) The Engineering Export Promotion Council should continue its efforts to establish exporting offices to represent India component manufacturers in the countries of the European Economic Community and the Council for Mutual Economic Assistance, and the United States. Contracts should therefore contain no clauses that impose market restrictions;

(b) Where economically possible, production capacity should grow in step with the Indian and direct export markets;

(c) Complementary programmes should be discussed with the partner, using an accurate marketing study as a starting point;

(d) Equipment and products should be capable of easy and rapid modification (the electronics industry is an industry of rapid change).

Recommended schedule for the setting up of a plant in India

The tentative schedule submitted (see table 1) is for a plant to produce eight million capacitors a year. This would cover the needs of the domestic market and leave a surplus for export. Although it may not be the most economical scheme, the schedule makes allowances for the reality of the market, and is likely to be acceptable to a foreign partner. Production for export can of course be increased at any time by expanding the plant.

Table 1. Schedule for the installation in India of a line to produce eight million capacitors a year
(h = hermetic, d = drop, m = moulded)

Year	Action	Cost (thousand dollars)	Types of capacitor	Output (pcs)	Indian market (pcs)	Export market (pcs)	Status of international market
1975	-		hermetic	500,000 (ECIL)	h 550,000 d 200,000	-	Very poor
1976	Start project	375	hermetic	500,000 (ECIL)	h 700,000 d 200,000	-	Poor
1977	Building and facilities Installation of equipment	1,174	hermetic	500,000 (ECIL)	h 900,000 d 350,000	-	Poor
1978	Start production of hermetic caps		hermetic	h 2,000,000	h 1,000,000 d 500,000	h 1,000,000	Fair
1979	Install and start production drops	270	hermetic, drop	h 2,000,000 d 5,000,000	h 1,200,000 d 800,000	h 800,000 d 4,200,000	Good
1980	-	-	hermetic, drop	h 2,000,000 d 5,000,000	h 300,000 d 150,000	h 600,000 d 3,800,000	Good
1981	-	-	hermetic, drop	h 2,000,000 d 5,000,000	h 1,300,000 d 2,000,000	h 700,000 d 3,000,000	Good
1982	Install and start production of	50	Add moulded	h 2,000,000 d 5,000,000 m 1,000,000	h 1,350,000 d 2,100,000 m 200,000	h 650,000 d 2,600,000 m 800,000	Poor
1983	-	-	Add moulded	h 2,000,000 d 5,000,000 m 1,000,000	h 1,400,000 d 2,800,000 m 400,000	h 600,000 d 2,200,000 m 600,000	Poor
1984	-	-	-	h 2,000,000 d 5,000,000 m 1,000,000	h 1,500,000 d 3,000,000 m 500,000	h 500,000 d 2,000,000 m 500,000	Good
1985	Start new expansion		Hermetic, drops, moulded and possibly at other types	h 2,000,000 d 5,000,000 m 1,000,000	h 1,600,000 d 3,300,000 m 600,000	h 400,000 d 1,700,000 m 400,000	Good

II. FINDINGS

The market for tantalum capacitors

Only the basic type of solid tantalum capacitor will be considered. Solid tantalum capacitors account for 91 per cent of value and 97.5 per cent of volume on the world market. Research and development work is still going on to reduce manufacturing costs, improve characteristics, reduce size, and increase compatibility with modern packaging. There are four types of solid tantalum capacitor: hermetic (encapsulated in metal case), moulded (encapsulated transfer moulding), drops (encapsulated dipped), and chips (transfer moulding or glass).

The use of tantalum capacitors in industry

The tables below show how the industrial market for tantalum capacitors is divided up. The figures given are for the eastern European countries which are developing their component industries. The 1980 figures for India should be very similar. The tables indicate a shrinkage of the consumer market, and a rapid expansion of the markets for computers, industrial control equipment and scientific instrumentation.

Table 2. End users of tantalum capacitors (as percentage of output)

End users of tantalum capacitors	1975	1985
Consumer	25.6	22.4
Computer manufacture	19.3	35.0
Telecommunications	17.8	19.3
Industrial control equipment	8.5	14.1
Costing and measurement	5.5	5.8
Scientific instrumentation	3.9	6.7

Table 3. Breakdown (by type) of the professional market for tantalum capacitors, 1975-1985 (as a percentage)

Type	Europe			India		
	1975	1980	1985	1975	1980	1985
Foil	-	-	-	-	-	-
Wet	8.3	7.0	6.0	16.6	12	9
Solid						
Hermetic	34.8	35.0	37.0	53.2	50	40.5
Drop	35.1	36.0	37.0	30.2		
Moulded	18.0	15.0	10.0	-	38	40.5
Chip	3.8	5.0	6.0			
DIL	-	2.0	4.0			
Total value (million $)	70.1	96.0[a/]	134.0[b/]	0.53 0.265[e/]	1.07[c/] 0.61[e/]	2.35[d/] 1.47[e/]

a/ Yearly growth 6.5%.

b/ Yearly growth 7.0%.

c/ Yearly growth 15.0%.

d/ Yearly growth 17.0%.

e/ Value reduced to international market price, the Indian market value being currently twice the international market price.

Production: an economic study

In considering whether to set up a plant to manufacture tantalum capacitors in India the following factors, which are peculiar to India, must be taken into account:

(a) The availability of raw materials (tantalum powder or wire, metal tubing, silver paste and the like);

(b) The relatively high duties on imported equipment and raw materials.

It will be seen from table 7 that costs in India are substantially lower than those in Europe. It must be remembered, however, that the major manufacturers of tantalum capacitors are building large plants to produce low- and medium-priced capacitors in areas where labour is cheap (Malaysia, Taiwan, South America). The result of this may be aggressive competition because of the surplus of production capacity in the world.

An evaluation of the Indian market

Most of the users of tantalum capacitors in India are to be found in the professional sector. It is therefore expected that there will be a growing need for low-cost consumer types in the next few years, amounting to perhaps one third of the predicted demand figure of 2.35 million. The following table shows a tentative estimate of the total Indian market:

Table 4. Estimated total Indian market

Type of capacitor	1975		1980		1985	
	Quantity (thousands)	Value (million dollars)	Quantity (thousands)	Value (million dollars)	Quantity (thousands)	Value (million dollars)
Hermetics	350	0.141	680	0.305	1 190	0.595
Drops (professional or imported hermetics)	348	0.080	860	0.232	1 860	0.595
Drops (consumer)	-	-	1 200	0.204	2 450	0.490
Wet	55	0.044	81	0.073	100	0.106
Total	753	0.265	2 821	0.814	5 600	1.785

Prices

International market prices

The table below shows the estimated average price of tantalum capacitors.

Table 5. Estimated average international market price of tantalum capacitors

Type of capacitor	International market price ($) 1975	1980	1985
Hermetic	0.40	0.45	0.50
Drop (professional)	0.23	0.27	0.32
Drop (consumer)	0.15	0.17	0.20
Wet	0.80	0.90	1.00

Note: These prices are based on actual shipments and the following mix:

Case size	
1	25%
2	30%
3	30%
4	10%
5 (or equivalent)	5%

Table 6. Price structure for tantalum capacitors (Prices for capacitors sold in lots of 10,000, tolerance ± 20%)

Case size	Dollars			
	Hermetics	Drops		Moulded rectangular/ cylindrical
		Professional	Consumer	
1	0.22	0.13	0.08	0.18
2	0.27	0.15	0.10	0.22
3	0.35	0.17	0.12	0.31
4	0.75	0.42	0.25	0.65
5	1.20 or 1.50	0.77 or 0.90	0.50 or 0.72	1.00 or 1.20

Note: Mark-up for tolerance:

Tolerance	Mark-up
± 10%	10%
± 5%	100%

Mark-up for smaller quantities:

Quantity (pcs)	Mark-up
1,000	10%
500	30%
100	60%

Estimating the optimum ratio between the domestic and export markets

Owing to the surplus of production capacity in the world and the economic depression, which is expected to last for another two years (it is predicted that the volume of goods shipped from factories will not reach the 1974 levels again before 1978), it will be difficult for India to find a partner willing to participate in a joint venture. Indeed, most of the new investment projects launched in 1973 and 1974 still have to be made final, and some have even been stopped as a consequence of the dramatic decline in markets up to the end of 1974. Nor is it likely that any major manufacturer would accept an export commitment for 75 per cent of a large output.

A compromise must be found to balance the development of the Indian market, the optimum or minimum size of the venture, and export potential. There are three ways of doing this:

(a) By making the development of the domestic market the main objective, in which case export would be only a secondary consideration. The production of hermetic capacitors (by ECIL) should first be expanded and improved; the production of drops should be introduced during the following phase. The main investment would be in a finishing line for drops;

(b) By making the target balance between the domestic and export markets, in which case an integrated production line should be set up. It is generally accepted that any capacity below six million pieces a year is only marginally efficient. The manufacture of good-quality products requires not only production machinery, but also such general services as power distribution, cooling water, vacuum lines, air conditioning of working areas, exhaust and drainage systems, and effluent treatment. The price of such services is not proportional to the size of the plant. Since the quantities to be exported are relatively small, it is likely that a market can be found, provided the price and quality are right;

(c) By making exports the main target, in which case plant must be installed in competitive conditions. The main requirements would be: low investment cost, cheap utilities, easy access, and tax and export incentives where necessary. Minimum capacity would be 15-20 million pieces a year. The figures given in table 7 show that such an enterprise is workable, but it is unlikely that a partner could be found, at least for the time being, to handle the export of such large quantities of tantalum capcitors. Technical assistance could be found, however (see annex IV).

Growth of the market for tantalum capacitors over the next ten years

The world market for tantalum capacitors is expected to grow at an average rate of seven to eight per cent a year. The application of tantalum capacitors will become more and more specific as their characteristics improve. Because of a potential shortage of tantalum in the world, prices are likely to rise with the cost of the raw material.

There will be competition from time to time from three other types of capacitor:

(a) Multi-layer ceramic capacitors, for high reliability and low rating applications, up to three to four microfarads;

(b) Improved aluminium electrolytic capacitors, for high rating and cheap drop applications;

(c) Niobium capacitors, for low voltage and capacity applications.

Any capacitors manufactured in India must therefore have excellent characteristics.

Manufacturing costs

Table 7 shows the manufacturing costs for professional (1,3,5) and low cost (2,4,6) drops: rating 10μ F$\pm$ 25 %, yield 65 %, in batches of 10,000.

Table 7. Manufacturing costs ($US per mil)

Item	Type of capacitor[a/]					
	1	2	3	4	5	6
Direct raw material	2.5	1.2	4.25	2.04	2.75	1.35
Direct labour including fringes (Europe 4.10 $US/h India 0.23 $US/h)	4.8	2.4	0.27	0.15	0.27	0.15
Total direct cost (A)	7.3	3.6	4.52	2.19	3.02	1.50

Table 7 (continued)

Item	Type of capacitor[a]					
	1	2	3	4	5	6
Indirect raw material	0.5	0.4	0.85	0.70	0.55	0.45
Indirect labour including fringes (Europe 6.80 $US/h India 0.35 $US/h)	1.2	1.0	0.06	0.05	0.06	0.05
Supplies and utilities	0.6	0.6	0.6	0.6	0.6	0.6
Depreciation and financial costs (interest 15 %)	1.8	1.8	2.4	2.4	2.4	2.4
Engineering costs (Europe 12.0 $US/H India 0.7 $US/h)	0.6	0.4	0.04	0.04	0.04	0.03
Administrative sales costs (Europe 15 $US/h India 1 $US/h)	1.3	1.3	0.09	0.09	0.09	0.09
Total indirect costs (B)	6.0	5.5	4.04	3.87	3.74	3.62
Grand total (A and B)	13.3	9.1	8.56	6.06	6.76	5.12
Selling prices	15.0	10.0	30.0	20.0	12.0	8.0

Note: Various export incentives such as cash incentive and replenishment licences have not been taken into account, and the possible royalty to be paid to the foreign partner has not been considered. It seems reasonable to add to the cost a maximum of 5 % of the selling price.

a/Type of capacitor:

1. Professional drop manufactured in Europe
2. Consumer drop manufactured in Europe
3. Professional drop manufactured in India for domestic market (70 % duty on raw material)
4. Consumer drop manufactured in India for domestic market
5. Professional drop manufactured in India for export (duty draw back included)
6. Consumer drop manufactured in India for export

The manufacturing process and quality control

Table 8 shows a typical series of operations for the manufacture of tantalum capacitors. Quality control should be provided, by spot check or routine inspection, at the stages indicated.

Table 8. Typical stages in the manufacture of tantalum capacitors

Operation	Notes	Quality control
Tantalum powder preparation		Inspection of pellet production
Tantalum powder pressing		
Binder removal		
First sintering		
Lead wire welding		
Second sintering	(a)	
Tests for sintered pellets	(b)	
Welding of tantalum pellets to stainless steel bars		
Forming of dielectric film		
Removal of forming electrolyte	(c)	
Deposition of solid MnO_2 electrolyte	(c)	
Sand blasting		
Reforming of dielectric film		
Removal of forming electrolyte		
Epoxy resin application		
Epoxy resin gauging		
Sandblasting		
Reforming of dielectric film		
Reforming of electrolyte		
Application of colloidal graphite		
Application of silver		
Tests of silvered capacitors		
Anode lead attachment	(d)	Assembly inspection
Cathode lead attachment	(d)	

Table 8 (continued)

Operation	Notes	Quality control
Degreasing		
Encapsulation		
Ageing of capacitors		
Application colour coding		Ageing and testing inspection
Testing of capacitors		
		Outgoing control check
Stamping		Inspection for finishing
Application colour coding	(e)	
Testing of capacitors	(e)	
Cut-off		Outgoing control check
Visual inspection		
Shipment		

Notes: (a), (b): At these steps the anodes may be transferred to other locations if necessary for further processing. This is important, because it makes for considerable flexibility in the volume of output and a better schedule of operations. Output can be increased rapidly and cheaply, for example, by importing silvered anodes that can be finished cheaply.

(c): These operations will be repeated for certain production batches.

(d), (e): For dipped transfer mouldings.

Estimated costs of a production line

Prices in the schedule (see annex I) are given ex-works (supplier) in dollars for equipment suited to the size of the venture, except in the case of ECIL, which already has the general utilities and premises required. Where equipment is provided by a local supplier, 20-30 per cent should be added to the prices given. About five per cent should be added to cover the costs of material consumed by the equipment each year, and a further six per cent a year for spares used for equipment maintenance. The estimate is based on a working year of 4,500 hours.

Three possibilities have been considered:

(a) An expansion of the existing line at ECIL's works in Hyderabad. The first phase (expansion of drop production) would require $US 566,800; phase two (expansion to produce five million capacitors a year, and the introduction of moulded capcitors) would require a further $US 696,800;

(b) The installation of an integrated production line with a capacity of about eight million capcitors a year, made up as follows: two million hermetic, five million drop, and one million moulded capacitors. Investment required would amount to $US 1,499,000, to which a know-how fee would probably have to added (20-25 per cent of the value of the equipment). It has been assumed that the fee would be in the form of royalties and would therefore be part of the manufacturing costs;

(c) The installation of plant producing 15-20 million capacitors a year for expert.

Annex I

ESTIMATED COSTS OF A PRODUCTION LINE

(a) Expansion of the existing line at the Electric Corporation of India, Hyderabad

Phase I	$US
Additional sintering equipment Brew Abar of NRC 7" x 14"	100,000
Additional forming and reforming equipment	13,000
Power supply for above	44,300
Rinsing unit	2,500
Pyrolysis unit	240,000
After-pyrolysis treatment	11,000
Mechanized welding equipment including templates and clamp for the leads	75,000
Cooling equipment for drops including soldering	51,000
Other sundry equipment	30,000
Total	566,800

Phase II	$US
Equipment listed for phase I	566,800
Additional sintering facilities	100,000
Moulding facilities	30,000
Total	696,800

The sintering facilities of phase I should be studied so as to avoid the installation of sintering ovens of various sizes and types. The best equipment available must be purchased.

(b) Installation of an integrated production line with a capacity of approximately eight million pieces a year

(i) Equipment for:	$US
Anode pressing	100,000
Anode sintering	365,000
Anode welding	60,000

(i)	Equipment for:	$US
	Bar welding	64,000
	Forming and reforming	270,000
	Pyrolysis	125,000
	Aquadag treatment	75,000
	Assembly, ageing and testing drops	270,000
	Additional equipment for hermetic capacitors	70,000
	Additional equipment for moulded capacitors	50,000
	Intermediate and final inspection laboratory	50,000
	Sub-total	1,499,000
(ii)	Facilities available locally (buildings, general facilities)	375,000
(iii)	Consumption parts for one year (5 %)	75,000
(iv)	Spare parts for one year (6 %)	90,000
	Total	2,039,000

(c) Installation of an export oriented plant producing 15-20 million capacitors a year

(i)	Equipment for:	$US
	Anode pressing	200,000
	Anode sintering	535,000
	Anode welding	110,000
	Bar welding	130,000
	Forming and reforming	520,000
	Pyrolysis	250,000
	Aquadag treatment	100,000
	Assembly, ageing and testing of drops	520,000
	For hermetic capacitors optional	120,000
	Intermediate and final inspection	50,000
	Sub-total	2,425,000
(ii)	Facilities available locally (buildings, general facilites)	500,000
(iii)	Consumption parts for one year (5 %)	120,000
(iv)	Spare parts for one year (6%)	140,000
	Total	3,185,000

Annex II

TYPICAL EQUIPMENT AND PRINCIPAL RAW MATERIALS REQUIRED TO PRODUCE EIGHT MILLION CAPACITORS A YEAR

Equipment

Description	Available in India?	Could be manufactured in India using drawings supplied? a/	Foreign suppliers (see list)
Powder preparation:			
Complete installation including:			
Blender			
Granulator manual			
Table scale (30 kg)			
Analytic balance			
Explosion proof drying oven	No		
Crucibles	No		Kaecki Fansteel Norton Reframet Starck
Pelletizing:			
Four ton press	No		)Stokes
Half ton press	No		)Dorst)Courtoy
Tools for pelletizing		Yes	
Binder removal:			
Single retort oven	No		)Abar)Brew
Dewar flasks for liquid nitrogen	No		)Variant
First and second sintering:			
Sintering kiln	No		)
Mass spectrometer	Yes		)Abar
Optical pyrometer	Yes		)Brew
Water chiller	Yes		)Variant

a/ This possibility must be discussed with foreign partner. A very good machine shop should be used.

Description	Available in India?	Could be manufactured in India using drawings supplied?	Foreign suppliers (see list)
Pellet welders:			
Semiautomatic pellet welder		Yes	
Manual pellet welder		Yes	
Wet check:			
Capacitance bridge		Yes	
Leakage meter		Yes	
Drying oven		Yes	
Test cells	No		
Hand welder			Hughes
Bar welder:			
Semi-automatic bar welder		Yes	
Forming and reforming:			
Forming tanks			
First forming			
Reforming		Yes	
Reforming power supply, programmer and rack assembly			
Power supply 400 V/10 A	No		Sprague
Power supply 400 V/10 A			Sprague
Rinsing tanks		Yes	
Drying oven		Yes	
Heat exchanger		Yes	
Bar cleaner		Yes	
Rack cleaning station		Yes	
Racks		Yes	
Conductivity for pelletizing	Yes		
Air conditioning for pelletizing room		?	
Air conditioning for testing room		?	
Air conditioning for pyrolysis room		?	
Pyrolysis:			
Pyrolysis oven and panel control	No		Blue M AEM
Dual dip tank		Yes	
Preheating oven 250 °C - 288 dm^3		Yes	
Preparation of electrolyte		Yes	
Oven (100 °C)		Yes	
Sandblasting:			
Cabinet for sandblasting			
Cleaning of leads	No		Sprague
Dust collector			

Description	Available in India?	Could be manufactured in India using drawings supplied?	Foreign suppliers (see list)
Epoxy tower:			
Station for epoxy		Yes	
Preparation of epoxy:		Yes	
Balance			
Mixer			
Curing oven			
Aquadag:			
Dipping station		Yes	
Oven		Yes	
Silvering:			
Silvering station		Yes	
Oven		Yes	
Silver preparation rollmill		Yes	
Viscometer		Yes	
Silver check and inspection:			
Capacitance bridge		Yes	
Leakage test and jig		Yes	
FINISHING:			
Preparation of leads:			
Crimping and forming of leads			Sprague
Lead attachment for size 1 2 - 4 - 5 cases			Sprague
Soldering:			
Soldering for dipped capacitors	No		Sprague
Soldering for hermetic and moulded capacitors	No		Sprague
Epoxy coating (capacitors):			
Tricholorethylene degreaser		Yes	
Dipping station		Yes	
Epoxy preparation		Yes	
Curing oven		Yes	
Moulding:			
20 or 50 ton press	No		)Hull
Moulds for all types			)Stokes

Description	Available in India?	Could be manufactured in India using drawings supplied?	Foreign suppliers (see list)
Ageing:			
Boards for size 1 - 2 - 3 - 4 - 5 cases		Yes	
Short check station		Yes	
Ovens			Damuzeaux
Power supplies			
Tests:			
Leakage tester for size 1 - 2 - 3 cases			)Boonton
Leakage tester for size 4 and 5 cases			) or)Teradyne
Manual capacity test for size 1 - 2 - 3 - 4 - 5 cases			)Boonton)Teradyne
Printing:			
Stamping machine			)Markem
Oven stamp curing			)Grauel
Lead cutting:			
Lead cutter		Yes	
Visual inspection:			
Magnifier with light		Yes	

Materials

Description	Typical quantities	Available in India?	Foreign supplier
Manganous nitrate	1,800 kg	Yes	)Kawecki
Tantalum powder	2,165 kg	Yes, up to 25 V	)Fansteel)Norton)Reframet)Starck
Tantalum wire ∅ 0,014	95 kg)	No	
Tantalum wire ∅ 0,018	157.5 kg)		
Epoxy resin	60 kg	No	Ciba
White silica powder	40 kg	?	
Red pigment	40 kg	No	Ciba
Diethylene triamine	12 kg	Yes	
Colloidal graphite	30 kg	Yes	
Conductive silver paste	150 kg	Yes	Ciba or DuPont

Description	Typical quantities	Available in India?	Foreign supplier
Nickel wire	1,375 kg	No	
Tin/lead solder bar	250 kg	Yes	
Solder alloy	560 kg	Yes	
Epoxy resin	2,600 kg	No	
Hardener	520 kg	No	Ciba
Stamping ink	40 tubes	No	Markem
Stainless steel bar	200,000 pces	Yes	
Chipbcards	290,000 pces	Yes	
Stearic acid	1 kg	Yes	
Binder	36 kg	No	Pechiney
Acetone	400 l	Yes	
Phosphoric acid	80 kg	Yes	
Ethylene glycol	840 kg	Yes	
Nitric acid	350 kg	Yes	
Ammonium chloride	30 kg	Yes	
Oxalic acid	40 kg	Yes	
Hydrogen peroxide	50 l	Yes	
Aluminum oxide	400 kg	Yes	
Boric acid	900 kg	Yes	
Butyl acetate	47,5 l	?	
Silica powder (extremely fine)	16 kg	No	Pechiney
Salicylic acid	50 kg	Yes	
Thinner	270 l	Yes	
Rosin flux 115	135 l	Yes	
Zip-lip polyethylene bags	2,000 pces	Yes	
Polytethylene bag	2,000 pces	Yes	
Stain-resistant pressure sensitive tape	600 rolls	No	Rollem
Metal cases		?	
Glass seals		No	
Solder preforms		?	
Moulding compound		No	Ciba

Possible suppliers

Abar	United States
AEW	United Kingdom
Blue M	United States
Boonton	United States
Brew	United States
Ciba	Switzerland
Courtoy	Belgium
Damuzeaux	Belgium
Dorst	Federal Republic of Germany
DuPont	United States
Fansteel	United States
Granel	Federal Republic of Germany
Hughes	United States
Hull	United States
Kawcki	United States
Markem	United States
Norton (Metal division)	United States
Pechiney	France
Reframet	Belgium
Starck	Federal Republic of Germany
Stokes	United States
Teradyne	United States
Variant	Switzerland

Annex III

EVALUATION OF POTENTIAL MANUFACTURERS IN INDIA

1. Electronic Component Industries Association, Delhi

President: Gurpreet Singh, CDIL. Representatives of Belton Industrial Corp. and Ushba Electronics also attended.

With their background in electronics and experience in marketing of components, one of these companies can be entrusted in setting a factory for the production of tantalum capacitors.

Their main concerns were (a) the present market situation; (b) the fact that this is a capital intensive industry; and (c) the difficulty of securing foreign collaboration.

They were to explore the possibilities and agreed that such an industry should be supported by an Indian market.

2. Orissa Cements Limited

C.P. Sharma, Project Manager.

This company is not involved for the time being in production of electronic components. They wish to enter this market and are looking mainly for collaboration in setting up a totally export-oriented industry in the Santa Cruz area. The main problem is finding foreign collaboration. They were advised that:

Further fluctuations of the market being likely to occur, they should carefully study their relationship with the collaborator, in order to avoid any heavy impact of a depressed market on their industry;

The manufacture of tantalum capacitors being a delicate operation they should look for highly comptent engineering staff.

3. Electronics Corporation of India Limited

Head, (Mr. Raju), Components Group; S. Srinivasa, Technical Manager; P.A. Narasayya, Technical Officer.

Those attending the meeting, requested that certain technical information be sent to them, exclusive of proprietary manufacturing processes and patents. This company is completely involved in the production of tantalum capacitors, having built up reliable technology and a programme of expansion. Their immediate target is to supply the Indian market; they may consider some export also.

It will be necessary for them to acquire additional technology skills in order to keep under closer control the steps of production and to introduce processes allowing the handling of a number of capacitors at a time, reducing operator dependence and improving the quality. Some practical suggestions have been made.

This company may be considered as excellent candidates for the implementation of a full-size industrial facility.

4. Andhra Pradesh Industrial Development Corporation Ltd.

N.R. Mantena, Project Officer. Electronics: advice given was similar to that offered to Orissa Cements Ltd.

5. Associated Distributors

S.K. Bhasin, Partner. See under Orissa Cements Ltd.

6. Keltron Electronic Components Ltd.

K.P.P. Nambiar, Chairman; E.S. Ramamurthy, Technical Manager.

This company is exclusively involved in the production of components of good reliability. They are likely to acquire experience in manufacture and quality control. They wish to enter both the Indian and export markets. As they are in the process of organizing their export market, they may more easily find export channels for tantalum capacitors.

7. Kirloskar Consultants Ltd.

S.R. Mirashi.

This company has undertaken a survey of the electronic industry in India and a feasibility report on the tantalum capacitor industry. Their opinions coincide closely with the conclusions of this report. It is recommended that some use be made by Indian industries of the work elaborated by this company.

8. SEEPZ - Bombay

Mr. Rajkopal.

The conditions found (see Orissa Cements Ltd. above) for the implementation of manufacturing facilities in Santa Cruz, Bombay, have been compared with the conditions found in other low-cost areas in Asia. The main advantages are:

(a) Availability of workers having an efficiency equivalent to those in industrialized countries;

(b) Availability of excellent engineering staff;

(c) Availability of raw materials and components in India. In this case, the indigenous manufacturers can supply at very favourable prices, as they receive export incentives;

(d) The zone has full authority to give the clearance to any import of raw material, components and equipment when necessary.

The main disadvantages are:

(a) Unfavourable tax holiday compared to those offered in other countries;

(b) Taxation of income, which may not exist in other countries;

(c) No bonus in cash, or reduced rate of interest.

It is generally admitted that the present situation of the international electronic market is detrimental to the progress of the zone.

Conclusion

Several requests for licenses have been filed by the Government of India. An Indian partnership is available, together with engineering forces and skilled workers. The reluctance of foreign collaboration to undertake export from India is the main obstacle to any progress for the time being.

The collaborator could eventually be limited to the supply of technology and equipment. In this case, marketing and sales should be undertaken by the Indian partner with the support of the Government of India.

Annex IV

COMPANIES FROM WHICH COLLABORATION MAY BE REQUESTED

I.T.T. Standard Elektrik Lorenz AG
Hellmuth Hirth Strasse 42
7000 Stuttgart 40
Federal Republic of Germany

Union Carbide Company (KEMET)
100 W. Clarendon Avenue
Phoenix, Arizona, United States

The Plessey Company Ltd.
Illford, Essex, United Kingdom

Sprague Electric Company
North Adams, Mass. 01247, United States

Thomson CSF
173 Boulevard Haussmann
Paris 8e, France

Tekelek Airtronic
Voie Romaine
Parc Industriel Bersol
Pessac, France

Nippon Electric Company
5 Shiba Hamamatsucho 3-chome
Minato-ku
Tokyo, Japan

Siemens Aktiengesellschaft
Balanstrasse 73
8000 Munich 80
Federal Republic of Germany

Leclanche S.A.
Avenue de Grandson 48
Yverdon, Switzerland

It is recommended that the approach be made as follows:

1. Two programmes should be presented, for example, with $US 8 million oriented partly to the Indian market and $US 15-20 million exclusively for export; an accurate schedule of implementation, preferably by phase, should be defined.

2. Types of capacitors should be discussed, taking into account that the Indian production should to some extent be complementary.

3. An exact breakdown of costs of equipment installation, production, sales, etc. should be made, showing the cost in India including all types of taxes, duties, etc.

4. The collaborator should be advised of all particularities of Indian law for such ventures, such as (a) duties on equipment and raw materials; (b) taxation of know-how fee, royalties, salaries; (c) rules concerning imports of equipment and raw materials, limitations, tenders, availability in India; and (d) incentives, if any.

   All this information should preferably be confirmed by the TDA or other officials.

5. The possibility of a barter deal on tantalum should be discussed.

6. When possible, comparisons should be made with the competitive conditions of other sites in Asia.

Annex V

TANTALUM PRODUCTION IN INDIA

Some shortages of tantalum are expected in the next years, and many large companies producing either tantalum and or tantalum capacitors are in search of new sources.

India has on its territory deposits of tantalite in diverse forms and already has undertaken concentration of the ore; and on a small scale, the production of tantalum powders. An evaluation of this potential should be made, as it is likely to be of importance in future negotiations with foreign collaborators.

The following programme of study has been discussed with TDA, for which it is suggested that UNDP may be asked to give support.

Sources of information

A. United States Department of the Interior
Bureau of Mines 8120
by William R., Barton

Sources of ores have been identified in India. Production of concentrates in several thousands of pounds has been implemented.

Questions

1. What is the present production of columbite? tantalite?
2. Any production of concentrate?
3. Any production of tantalum metal?

B. Electronics IPAI, vol. 2, No. 2 (November 1974). A schedule of production in the special material plant indicated for 1973-1975 of 1,000 kg.

Questions

1. What is the quality, purity, other characteristics?
2. What process: electro-beam, sodo zeductum or other?
3. Are samples availble of powder sheet, wire etc.?

C. Ros Kill Information Services Ltd.
14 Great College Street
London SW 1

This service does not indicate India as an exporter of tantalite.

Questions

1. Is any export made for the time being and in what quantities?
2. Are contracts or places for contracts considered now?
3. Has approach been made to manufacturers of tantalum such as:

Austria	Me Lullwerke Plausee Ag., Reutte
Belgium	Reframet Hoboken, Hoboken
Federal Republic of Germany	Starek, Neu Isenburg
United States of America	Kawecki - Berg Company Boyertown Fansteel - Muskogee (Oklahoma) Metal Decersion Norton - Newton (Mass.)
United Kingdom	Special Metal, Romford, Essex
Japan	Schowa Denko

Concluding note

I. Considering the present state of production of tantalum:

1. Is there any plan to increase this production with the help of a foreign collaborator?
2. This collaboration can eventually be set up with a manufacturer of tantalum capacitors, associated with producers of tantalum, to install in India an integrated industry, from ore to finished product.
3. In view of the importance of the project, some study can eventually be undertaken by TDA possibly with the assistance of UNDP.

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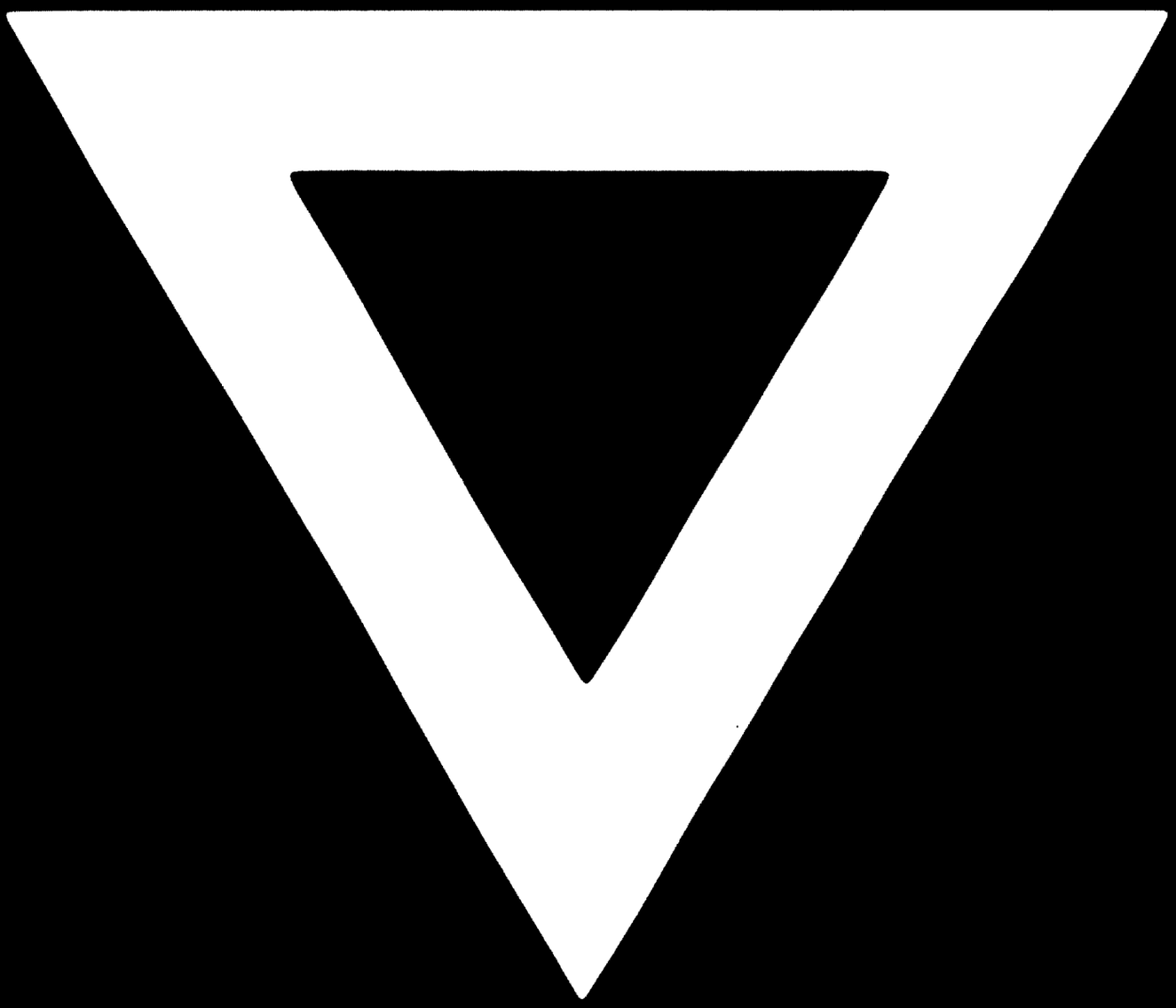

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