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PRODUCT ADAPTATION AND UPGRADING OF QUALITY

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INDIA

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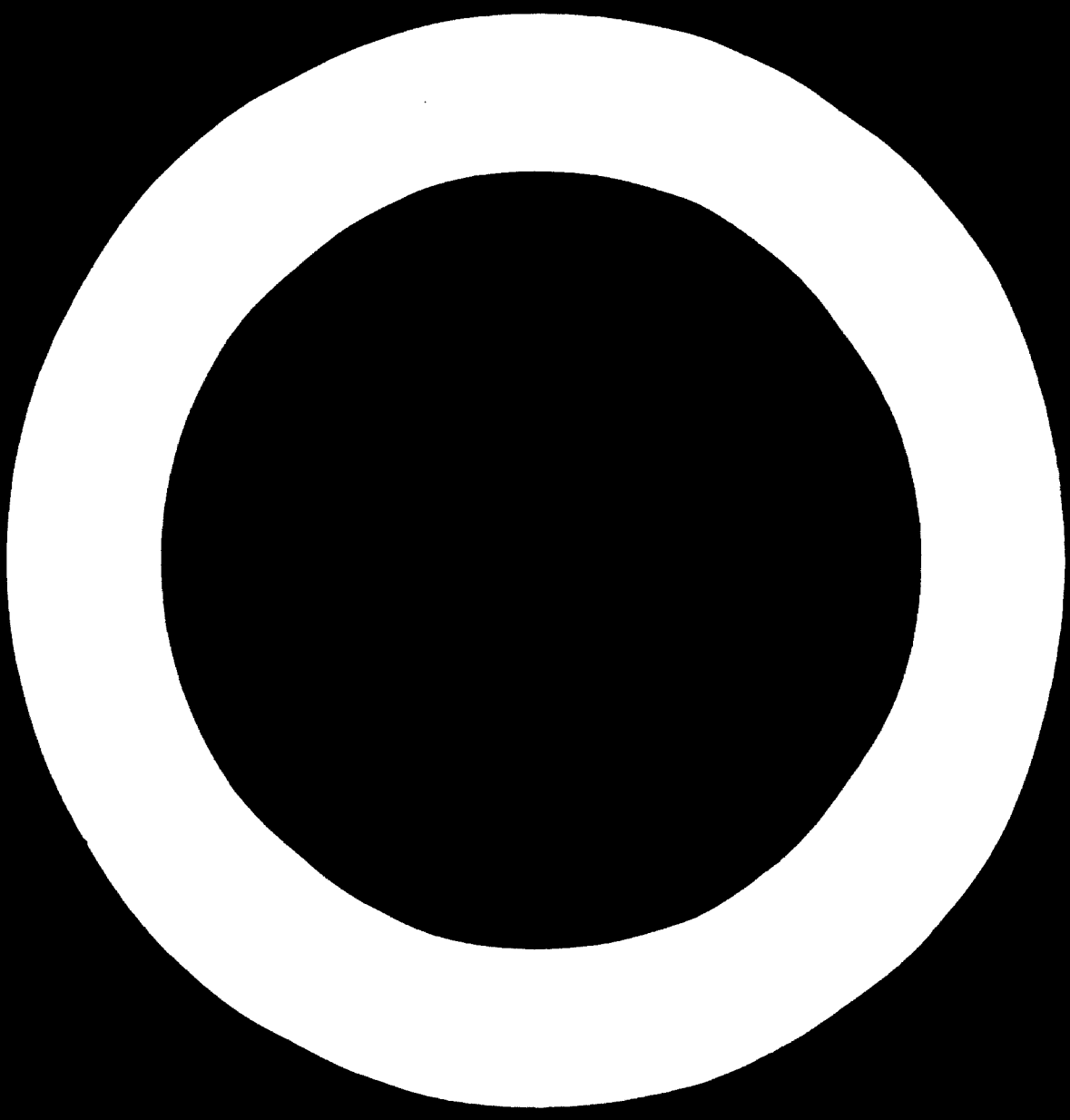

United Nations Development Programme

PRODUCT ADAPTATION AND UPGRADING OF QUALITY

DP/IND/72/045

INDIA

Technical report: Metal-film resistors

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 Hans Dieter Liess, expert in the production of metal-film resistors

United Nations Industrial Development Organization
Vienna, 1975

Explanatory notes

Reference to "dollars" ($) indicates United States dollars.

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

A comma (,) is used to separate thousands.

The following abbreviations are used:

IC	integrated circuit
STEPZ	Santa Cruz Electronic Export Processing Zone
TDA	Trade Development Authority

The monetary unit of India is the rupee (Rs). A piso is a hundredth of a rupee. During the period of the project, the value of the rupee in relation to the United States dollar was $US 1 = Rs 8.80.

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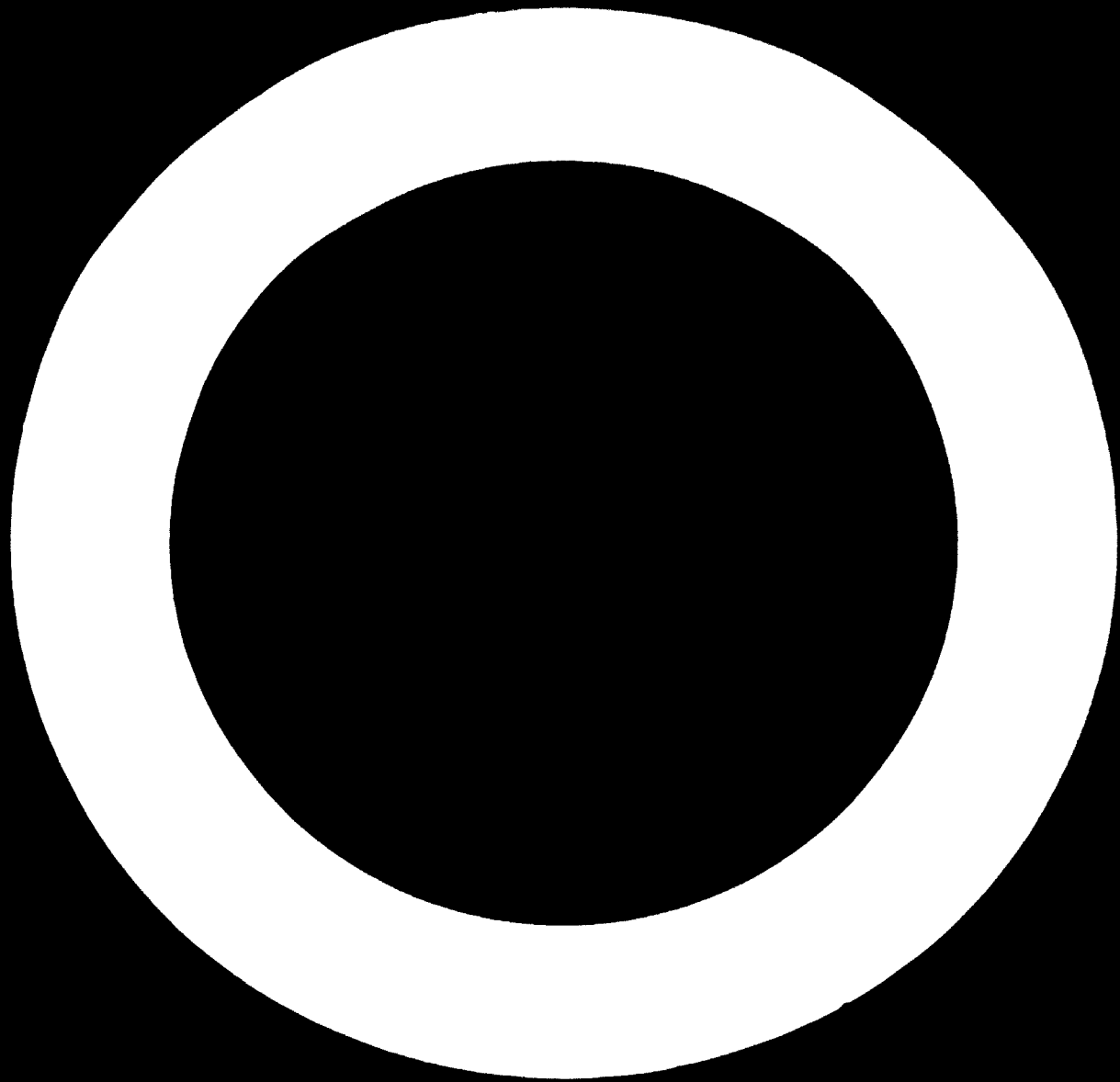


SUMMARY

The metal-film resistors currently being produced in India are in general not entirely suitable for export in quantity nor do they meet the high quality requirements of the internal market for military and industrial application. Furthermore, the uneven quality of the raw material available will create new problems if foreign supplies are to be restricted. Manufacturers are not in a position to reduce the technological gap in a sufficiently short time, and the market in India is not yet able to absorb sufficient quantities to make production economic and to justify a more intense development effort.

It would therefore be advisable to search for non-Indian partners to contribute the necessary know-how and to distribute the components in their countries. This contribution might require certain financial terms. The Indian authorities should improve the competitiveness of Indian components by setting up a test result documentation scheme and making the results of the tests available to any user at the government laboratories.

INTRODUCTION

The developing production of industrial electronic equipment in India and the demand for equipment for military applications require an increasing number of high-quality electronic components. For resistors this requirement could mainly be covered by using metal-film resistors. For industrial equipment "non-insulated" (varnished) resistors would be sufficient in most cases, while for military uses "insulated" (moulded) components are required.

Metal-film resistors have been produced in at least three factories in India for some time. However, according to the findings of the potential users of Indian metal-film resistors, quality and delivery terms are not sufficiently good yet to meet market requirements. The Trade Development Authority (TDA) therefore asked the United Nations Development Programme (UNDP) to provide an expert on product adaptation, and it prepared a mission to introduce manufacturers of metal-film resistors to potential entrepreneurs.

The project entitled "Product Adaptation and Upgrading of Quality" was sponsored by UNDP and is part of a comprehensive plan of export development of the Government of India. In addition to the mission by an expert on metal-film resistors, missions by experts on the following electronic components were included in the project: IC technology, tantalum capacitors, power transistors and solid-state devices.

The mission by the expert on metal-film resistors lasted from 20 October to 12 November 1979. The purpose of the mission was to advise Indian manufacturers on product adaptation measures needed to improve the export competitiveness and market acceptability of their products.

During detailed discussions on technical and commercial questions with metal- and carbon-film resistor manufacturers and entrepreneurs interested in the field, it was possible to define specifically the lay-out of the production processes required and the marketing arrangements necessary to export components.

It was found that India was a potential producer not only of metal-film resistors but also of all electronic components whose manufacture is labour-intensive. It is understood that in the beginning, particularly, much of the output would have to be produced for export to the so-called hard-currency countries, but as a long-term objective this undertaking might also encourage Indian component users to improve the export competitiveness of their products.

FINDINGS

General

In principle, India has everything that is necessary for the manufacture of the resistors required within and outside the country. However, Indian users stressed, and that seemed to be in accordance with the expert's observations, that the present quality, quantity and speed of delivery will not even cover domestic demand. High quality insulated resistors for military applications, in particular, have to be bought entirely from abroad. The expert was able to answer all the questions put to him, but the short time available was insufficient to complete the product adaptation phase or to deal with the problems of upgrading quality. The recommendations made would have to be carried out after the mission.

Materials required

Ceramic base. It was generally observed that the quality of Indian ceramic base material is not good enough yet. The main complaints turned out to be that dimension tolerances were too high and that surface quality and alumina content should also be improved. Some manufacturers are therefore still using imported ceramic material and are going to apply for further import licences.

One manufacturing company produces the ceramic base to its own requirements. The quality seems to be sufficiently good and it would have the capacity to meet total current requirements. Although the ceramic material is available locally, prices are too high and delivery schedules are sometimes unfavourable.

Caps. It was generally felt that Indian resistor caps (mainly of small dimensions) seem to be too uneven for the automatic machines to run continuously. Manufacturers with such equipment still have to purchase caps from abroad. The quality, however, seems sufficiently good for the larger sizes and manual operation.

Wire. It was generally said that Indian resistor connexion wires give problems with the automatic machines because the solder film is too uneven. The solderability of the wire was generally also found to be too close to the limits of acceptability.

Varnish. The only varnish which has been accepted generally by the manufacturers is delivered by the Indian subsidiary of a European manufacturer of resist r-varnish. The varnish is fairly expensive, however, and is difficult to obtain. Indian suppliers have not been approached properly.

Epoxy moulding materials. Resins for covering insulated (moulded) metal-film resistors are not being produced in India yet. Since the material has a short shelf life and requires cool storage, it is uneconomical to obtain supplies from abroad for small-scale production.

Production equipment

Some companies work fairly successfully with completely manual operation. Automation will be required increasingly in the future for the production of smaller sizes and bigger batches and to ensure consistent quality. Complete automatic lines are available from the Soviet Union, Japan and Western Europe. Since the lines are produced by machine manufacturers, the know-how for resistor film deposition and production experience can be acquired only by collaborating with a resistor manufacturer.

Production process

Preparation of the ceramic. There is a lack of the facilities necessary for the treatment of the ceramic base. Dust-free clean rooms with air conditioning are absolutely essential.

Film deposition. The processes currently employed for film evaporation are deficient. They should include ion bombardment cleaning before evaporation and a protective coating after it. For smaller sizes and larger output the present "individual" deposition method may be uneconomic. The technical details of a batch process for larger quantities were therefore discussed in detail. Initially, one outfit for batch evaporation should be bought from abroad, together with drawings for later duplication.

The sputtering production units appeared to be satisfactory. Owing to the electrical characteristics involved(lower sheet resistivity, higher temperature coefficient), however, these processes will not be able to replace the evaporation process for the whole range of resistances required.

Further treatment. Further treatment, with the exception of spiralling, seemed to be satisfactory. The only drawback was that the [illegible] were too small to run any automatic unit economically.

Spiralling. Owing to excessive variations in mechanical dimensions and basic resistance value, the effective spiralling length was found to be insufficient in all cases. Closer tolerances for both have to be applied.

Production instructions. The lack of precise production instructions leaves the operators too much margin for individual variations. As research and development work is introduced, this production margin must be narrowed down so as to reach a more uniform quality.

Research and Development

No manufacturer was able to show a separate unit for product research and development. All the development work was done on the production line. Potential manufacturers normally maintain a laboratory which is able to repeat all the production processes under controlled conditions. The budget for such research and development normally accounts for about four to seven per cent of turnover. A similar approach is necessary where an Indian manufacturer is willing to improve his product quality and to become independent of foreign know-how.

Quality Control

The lack of any acceptance tests for incoming goods and the as yet insufficient controls during production were leading in some cases to repeated interruptions of the production flow and to a low yield. Only the final inspection seemed to be generally sufficient.

Working conditions

The standard of basic education and the general interest of the workers and technical staff were found to be extremely high. Only the frequent power cuts and the sometimes difficult working conditions seem to be a damper on their enthusiasm.

Market size

Indian market. According to ETTDC the following figures (million pieces) were estimated for the Indian resistor market:

	1974	1975	1978/79
arbon-composition and carbon-film resistors	115	135	300
Metal- and oxide-film resistors	3.5	4.5	10

Since the demand for oxides-film resistors could be covered by metal-film resistors the figures may be taken as referring to metal film only.

At present the figures for precision film would be much lower than those mentioned above.

Even using the estimated figures the future market in India would not justify the presence of many manufacturers in the field.

European market. According to Electronics International (26 November 1974), the European market is estimated to be (million dollars):

	1974	1975	1978/79
Fixed resistors	245	890	300

If an annual growth of five per cent and a proportion of ten per cent metal- and metal-oxide resistors are assumed, the expected market share in 1978 79 is estimated to be 1,000 million pieces.

If the world market is twice the European market and India is able to supply five per cent of the metal-film resistors, exports would amount to 100 million pieces. This justifies production by no more than five manufacturers.

RECOMMENDATIONS

1. Metal-film resistors should be produced only by manufacturers who may already successfully launched production lines for carbon- or oxide-film resistors. The reason for this is that, with the exception of the film deposition, the production of metal-film resistors is generally similar to the production of carbon-film resistors but requires more care and control. It would be easier to meet these requirements and acquire the necessary production know-how by producing carbon-film resistors and there would be less risk of endangering the company's image. Furthermore, the markets for the two types partly overlap and the consumer might value products coming from the same source and having the same appearance.

The foreseeable domestic demand for metal-film resistors in the near future does not of itself allow the production of economic quantities. At least part of the production facilities envisaged should be shared with a line for the manufacture of carbon-film resistors, which is more likely to produce economic quantities because of the larger market for its products.

The foreign market requires a high degree of confidence in the quality of a metal-film resistor. The user's confidence in the product and the product reliability as designed by the manufacturer could more easily be established initially with carbon-film resistors.

This recommendation does not cover the production of metal-film resistors manufactured by completely different techniques (e.g. on flat substrates) or of metal-film resistors of extremely high quality and performance, where the disadvantages of small-scale production and the impossibility of combining production with an existing line are of less importance.

2. Insulated metal-film resistors should be produced only by manufacturers who have already successfully launched the production of non-insulated metal-film devices. The most commonly required power dissipation is normally less than one watt. The most popular size would be the smallest (about 1 mm diameter x 3 mm length). The most economical dimensions, however, are about 2.5 mm diameter x 6.5 mm length.

The reason for this is that the production of insulated metal-film resistors is identical to that of non-insulated metal-film resistors with the sole exception of the final coating. Insulated resistors require a rather expensive epoxy resin moulding press, the purchase of which is justifiable only for certain production quantities. As the advantages of a moulded resistor become apparent only if the general production standard is already high, this improvement should not be considered before the production of non-insulated (e.g. varnished) resistors has been established properly, when it would be an additional advantage to combine both lines. The insulated resistor would benefit from the higher efficiency of the line for non-insulated resistors which are generally required in much larger quantities.

3. Resistors should be tested and certified by an independent Indian (if possible governmental) standards institute according to the national and international standards. For export to Western Europe and the United States the appropriate standard (MIL, DIN, CCTU or DEP) should be applied. After the Indian test has been passed successfully, bodies concerned should apply to the appropriate standards institute of the countries to which the components will be exported for recognition of their test results. If this is not possible the test should at least be repeated with FOA-FTL, Stockholm, for the European market.

A component test by an independent standards institute gives the user an unbiased picture of the quality level available and is excellent publicity for those components which pass the test. Especially in countries that have no experience of Indian workmanship yet, even a test result with some restrictions would facilitate sales greatly. The manufacturer would also have the advantage of learning about the quality of its own components. It seems that so far no manufacturer in India has the necessary equipment, particularly heat and humidity chambers, for the tests required.

An exception can be made for manufacturers of consumer equipment, who purchase components in very large quantities and might rely on their own limited tests and be prepared to offset quality by financial advantages. This exception is possible only for non-insulated resistors and certainly does not apply for insulated resistors.

4. The results of all tests of electronic components should be published with a regular updating service and should be available to any user on request. All Indian standards institutes should make this a common effort and should not hesitate to publish test failures and insufficiencies.

Such a service would be a challenge to manufacturers to achieve the required quality, and an excellent guide for users, especially the small- and medium-size industries, to choose the required components without expensive acceptance tests. It would allow the user to strike a balance between available quality and required cost price for less critical applications. It would be to the advantage of the users to spend some money in getting the test results of the components they are going to use in their circuit designs, and this would enable them to avoid the failure of resistors in their equipment.

5. The next step after the test results are received should be for the resistor manufacturers to establish a distribution network in suitable customer countries. There should be at least one distributor in each country who also keeps a stock of all frequently required components for immediate dispatch. It would be advisable for all interested component manufacturers to start a common effort in one or a few "test countries".

A national distributor is preferable, because the distribution of electronic components requires (at least in Europe) close contact between user and supplier. Orders are normally placed in the language of the country. Telephone calls beyond national boundaries are not usually acceptable.

It would be advisable to try, initially at least, a common distribution network for the following reasons:

(a) The costs of penetrating an already saturated market are fairly high;

(b) Indian manufacturers do not have sufficient experience in selling abroad and might not find enough suitable distributors;

(c) Too strong competition between Indian manufacturers in a new foreign market might damage their image;

(d) Production quantities are often too small as yet for western European and American users.

It might even be advisable to establish only one brand name and restrict competition to size, style and technical parameters.

6. The distributor would be a work on a commission or for a fixed price. The possibility should also be considered, however, of allowing a financial participation of the manufacturer and the distributor in some cases.

A financial tie would give the distributor more confidence in a continuing supply and would assure the manufacturer of a more permanent distribution effort which he could control better. A financial limit would ease the transfer-price question and would help to share any profits and losses on either side.

7. Where the Indian manufacturer is not prepared to fulfil the requirements of the foreign market in the desired period, the following approaches should be considered:

(a) The Indian manufacturer applies for a licence from a non-Indian manufacturer which has already shown its ability to produce to a recognized standard. It has been shown that this approach is cheaper than continued development. It might be difficult to find such a partner, however, since established manufacturers are careful not to spoil their own markets;

(b) The Indian manufacturer sets up a second company, together with a partner, to produce components for export. Alternatively, a non-Indian distribution company could be set up and shared by both sides. To ease the start the export-production company could be situated in the Santa Cruz Electronic Export Processing Zone (SCEEPZ) in Bombay. After a successful start, further plants could be also established inside the country.

A company which has been set-up with an established foreign resistor manufacturer would have the advantage of access to a proven technology and a working distribution network. Both the technology and the distribution network would then also be more easily available for the Indian mother company.

The SCEEPZ in Bombay is a particularly good place to start a factory with the complete technological know-how and equipment of a non-Indian mother company, provided the foreign partner takes care of distribution abroad. By making a research and development effort of its own, the Bombay manufacturer can then gradually substitute Indian raw materials for imported items and can supplement imported equipment with its own developments if required.

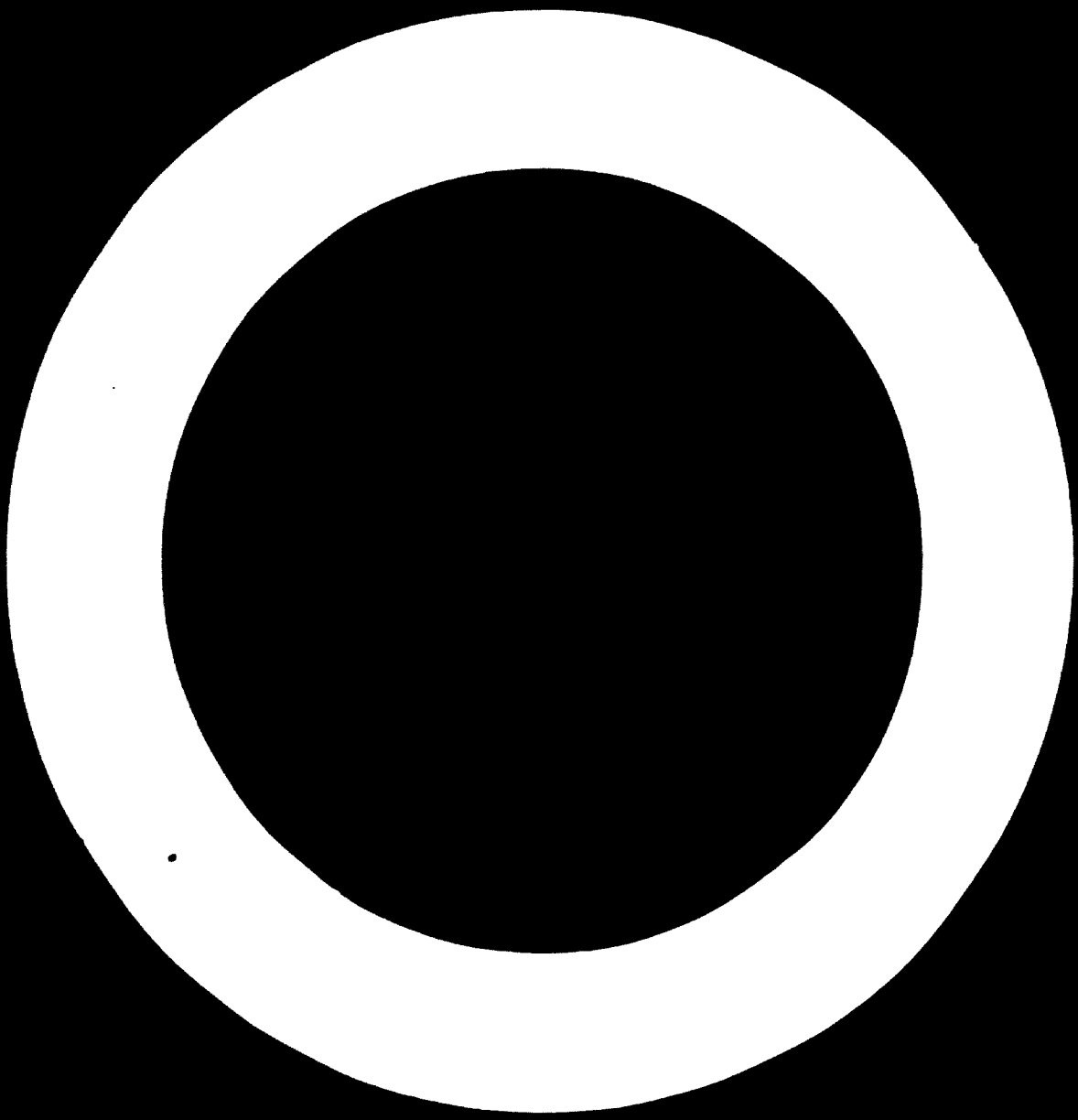
8. The Trade Development Authority (TDA) should contact all non-Indian potential resistor manufacturers (see annex I) in order to discover whether they are interested in licensing (see 7(a) above) or joint production in India (see 7(b) above). UNDP might offer a second short time assignment for a resistor expert to ascertain whether possible offers meet the needs of the Indian industries and to advise TDA accordingly. The TDA could then choose the appropriate partners to arrange the necessary contacts.

9. UNDP should assign some scholarships for Indian engineers to be trained by a resistor manufacturer abroad. TDA could also use its contact letter (see 8 above) to search for manufacturers willing to accept such assistance. The final selection could be made by TDA during the second assignment of a resistor expert.

Almost all Indian manufacturers would derive an advantage from the knowledge of metal-film high quality depositions and economic large-scale resistor production of the type established in recent years. A formal application for a scholarship has already been expressed by the Electronics Corporation of India and Tamil Nadu Electronics.

10. Potential suppliers of caps, wires and ceramic rods should also be approached to improve quality. Short term scholarships for engineers from the companies concerned should be sufficient. The best formula for varnish has to be found by close collaboration between resistor and varnish manufacturers, and by continuous optimization tests.

If Indian manufacturers see the standards reached abroad they might be able to produce the same quality immediately since the variations are only minor. Resistor manufacturers also have to claim the required quality and to inspect incoming goods accordingly. The varnish supply in particular requires a tight control since there are almost no rules yet which define a suitable resistor varnish. Formulas which have been found to fulfil the requirements properly should be exactly repeatable.



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Piher International GmbH
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Resista GmbH
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Ludmillastr. 23-25
8300 Landshut (Bay.)

Rheinisch-Westf. Isolatoren-Werke GmbH
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Siegert Widerstandsbau KG
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8501 Cadolzburg

Siemens AG
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8000 Munich

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Visegrádi u.47/a-b
H-Budapest XIII

Japan

Japan Electronics Co., Ltd.
2-3-80, Nakamachi
I - Machida
Tokyo

Netherlands

Philips Gloeilampen fabrieken
Eindhoven

United Kingdom

Allen-Bradley Electronics Ltd.
Bede Industrial Estate
Jarrow

Electrosil
P.O. Box No.37
Pallion Sunderland
Co. Durham

Erie Electronics Ltd.
South Denes
Great Yarmouth
Norfolk

The Plessey Company Ltd. Components Group
Cheney Manor
Swindon
Wiltshire

Vitramon Europe
Wycombe Lane, Wooburn Green
Buckinghamshire

Welwyn Electric Ltd.
Bedlington
Northumberland

Yugoslavia

Iskra ZP
Kotnikova 6
61000 Ljubljana

Annex II

FLOWCHART OF RESISTOR PRODUCTION

(Deviations possible)

CARBON FILM		METAL FILM
Etching of ceramic rods		-
Cleaning of rods		Ultrasonic cleaning of rods
-		Glow discharge cleaning -
Pyrolytic film deposition		Vacuum deposition of resistive film and protective film sputtering
-		-
Value control		TC and value control
-		Surface oxydising
-	CAPPING	
-		pre-varnishing
-		aging
	PRE-SORTING	
	SPIRALLING	
	WELDING	
	VARNISHING	
	FINAL TESTING	
	CODING	

Annex III

INVESTMENT AND PROFIT ESTIMATE

Investment

The minimum economic unit for automatic resistor production consists of one full operating line requiring the following major items:

Deposition unit
Pre-sorting machine
Capping machines
About four spiralling machines
Welding machine
Varnishing, testing and coding line

The investment costs (including outlay for 100 m^2 production space, vary between 500,000 and 1,000,000 rupees, depending on quality and the degree of automation.

Production volume

One line can produce about one resistor a second. There are already faster machines available, but they have not been considered here. Capacity with two shifts should be at least 10,000,000 resistors a year.

Production costs per resistor

Invertment (with a depreciation of the equipment of 5 years)	1-2 pice
Material	4-5 pice
Labour	1-2 pice

(These estimates are based on carbon-film resistor production since no manufacturer has experience in large quantity production as far.

Selling price (outside limits for large quantities)

Carbon-film resistors		6-9 pice
Metal-film resistors	(expected)	18 pice

Summary

This comparison shows that even for carbon-film resistors the profit margin is very small. The advantage of the higher prices of metal-film resistors can be maintained at present only if at least one line is sufficiently [illegible]. It is not advisable, therefore, for too many manufacturers to try to penetrate the present metal-film resistor market.

The calculations have been restricted to the low-price varnished metal-film resistors. The much higher selling prices for precision moulded types give a [illegible] different picture. It may be assumed, however, that this price level will not be maintained in the near future.

Annex IV

RESISTOR MANUFACTURERS AND POTENTIAL ENTREPRENEURS

Manufacturers visited or contacted	Types of resistors produced 1/	Officials met
Arkon Electronics Limited (Bombay, Nasik, Thana)	C M W	Managing director, technical executive
Clarostat, Bombay	M	Manager
Electronics Corporation of India, Hyderabad	C M	Head of components division Head of resistor section
Jaipur Electronic Components, Jaipur	-	Director
L.P. Electronics Pvt Ltd, Thana	C	Director
Micro Electronics Laboratory, Thana	M(f)	Director
Philips India Limited, Bombay	C	Marketing director Technical manager Technical and commercial managers
Rescon Manufacturing Co Pvt Ltd, Poona	C	Director
Sonnen Shine, Nasik	C	Proprietor
Tamil Nadu Electronic Components (Adyar, Chinglepet District, Madras)	C M O	Chairman and managing director
Other Indian manufacturers of resistors		
Baroda Electronic, Baroda	C	
Mahendra and Mahendra, Bombay	M	
Standard Electric, Baroda	C	

1/ C - Carbon-film
M - Metal-film
O - Oxide-film
W - Wirewound
(f)- On flat substrates

Potential enterpreneurs

Six enterpreneurs showed an interest in investing in electronic components. Only one had experience with electronics.

Annex V

ASSESSMENT OF INDIAN MANUFACTURERS OF METAL-FILM RESISTORS

Asian Electronics

This company produces:

Carbon-film and soldered resistors (Iskra) in Thana
Carbon-film and capped metal-film resistors in Nasik
Oxide-film (experimental) and wire-wound resistors in Thana

The production of soldered and capped carbon-film resistors is highly automated. Metal-film resistors are produced manually in small batches; the film is deposited individually by evaporation on radial axes. This type of production is justified only for high-stability and low tolerance resistors, but the types produced did not seem to fulfil these requirements. Support is recommended for film deposition.

Electronics Corporation of India Limited

The Corporation produces carbon- and metal-film resistors in Hyderabad, using manual and semi-automatic processes. The comments made about Asian Electronics also apply. A complete new fully-automatic line for the production of carbon-film resistors is being installed. Support is recommended for film deposition.

Micro-electronics Laboratory

Microelectronics produces flat metal-film resistors by sputtering on plastic board. The completely manual operation seems to be very efficient and requires little space. The rather modest-looking resistor is comparatively cheap (about 10 pice). No support is required.

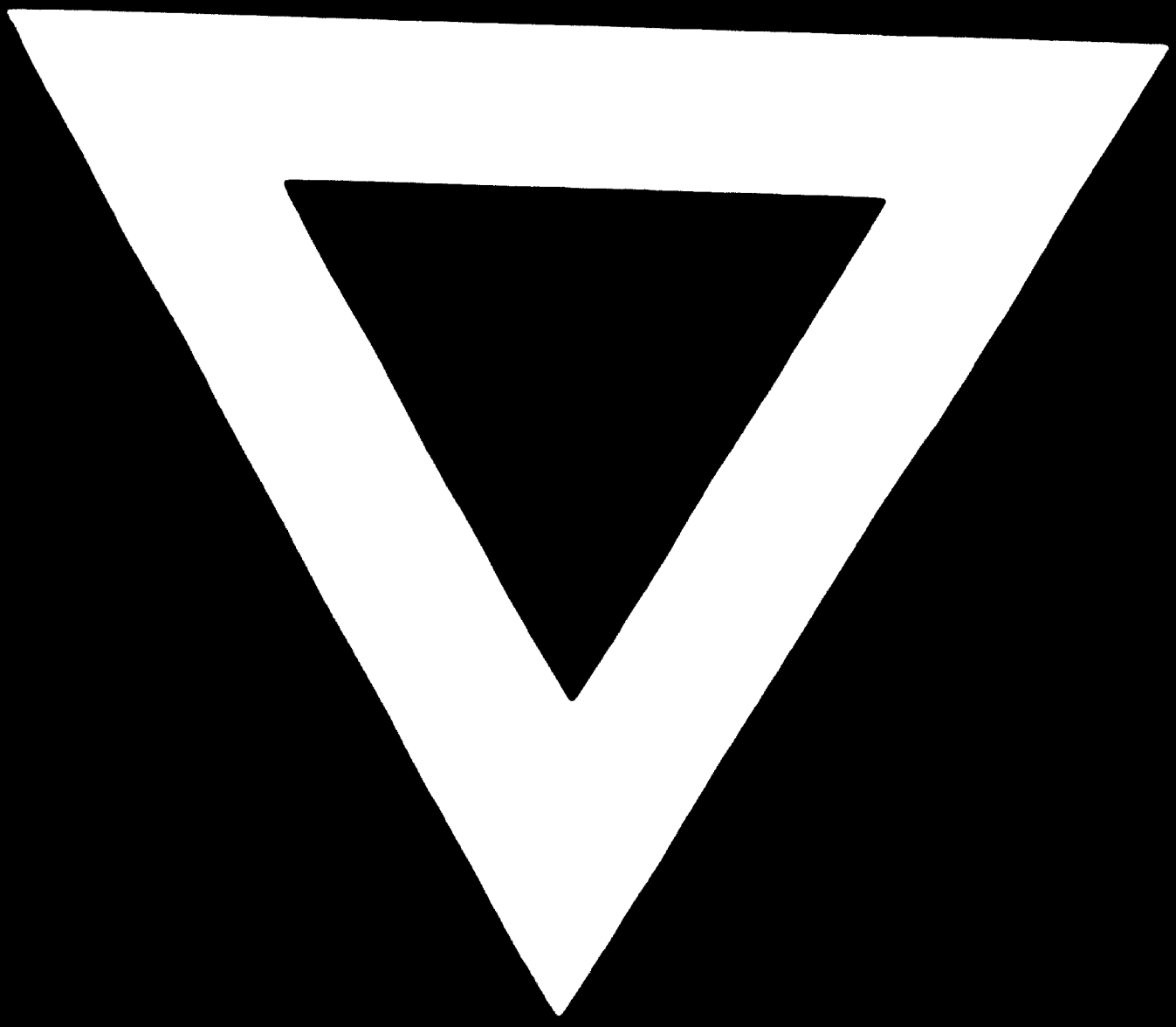
Tamil Nadu Electronic Components

The company is preparing to start production of carbon-, metal- and oxide-film resistors. The film will be deposited by sputtering. Automatic capping, spiralling and welding equipment is available, but the whole set-up is still very modest. Support is required for film deposition and to start up production.

Annex VI

ORGANIZATIONS CONNECTED WITH THE MISSION

Organization	Officials met
Department of Electronics, Government of India, New Delhi	Director
Electronics Trade and Technology Development Corporation Limited (ETTDC), New Delhi	Chief export manager
Electronics Export Promotion Council:	
Bombay	Regional officer
Madras	Regional officer
New Delhi	Executive director
Office of the Director of Industries and Commerce, Madras	Director, joint director
Santa Cruz Electronics Export Processing Zone, Bombay	Development commissioner
State Industrial Development Corporations: Chandigarh Small Industries Development Corporation, Haryana State Industrial Development Corporation, Chandigarh	Director
Rajasthan State Industrial and Mineral Development Corporation, Jaipur	Development engineer
West Bengal Electronics Industrial Development Corporation, Calcutta	Development engineer
Trade Development Authority (TDA):	
Bombay	Regional manager
New Delhi	Executive director senior economist, mechanizing executive
United Nations Development Programme (UNDP), New Delhi	Resident Representative, UNIDO senior industrial development field adviser, programme assistant



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