OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

D00957

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.60/3
5 June 1970

ORIGINAL:ENGLISH

UNIDO/DECHEMA Seminar on Operation,
Maintenance, Design and Manufacturing of
Chemical Plants and Equipment in
Developing Countries

Königstein (Taunus) near Frankfurt/Main
Federal Republic of Germany
25 -26 June 1970

PROBLEMS AND PROGRESS OF INSTRUMENTATION IN CHEMICAL INDUSTRIES IN DEVELOPING COUNTRIES 1/

by

S.D. Bhasin
M.Sc. (Tech), M.S.E. Chem. Engg.
ICI (India) Private Limited
Calcutta, India

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

id.70-3445

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.60/3 SUMMARY
10 March 1970
ORIGINAL: ENGLISH

UNIDO - DECHEMA - Seminar on Operation, Maintenance, Design and Manufacturing of Chemical Plants and Equipment in Developing Countries

Königstein (Taunus) near Frankfurt/Main
Federal Republic of Germany
25 - 26 June 1970

SUMMARY

PROBLEMS AND PROGRESS OF INSTRUMENTATION IN CHEMICAL INDUSTRIES IN DEVELOPING COUNTRIES 1/

by

S.D. Bhasin
I.C.I. (India) Private Limited
Calcutta, India

Sophistication in Chemical Industries in India and other developing countries is a more recent phenomenon. The growth of Petro Chemicals, Fertilizers, Fibres and Plastics and the trend towards application of latest technology has made development of instrumentation at a much faster pace a necessity.

The paper reviews the growth of instrumentation in ICI(I) and its associated companies, surveys development of progressive manufacture of instruments in India, problems of standards and quality control and facilities for training of technicians.

The problems of availability from indigenous sources of components and parts conforming to the desired quality standards are highlighted.

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

Relying essentially on the experience of the ICI Companies in India an attempt has been made in this paper to project a broad picture of the progress and problems of instrumentation in the chemical industry in India.

Although some basic chemical manufacturing units were set up in India immediately after World War II, real development of this industry has taken place during the last 15 years. The petrochemical industry is still in its infancy with only one medium size cracker and down-stream units in operation. While sophistication has, as was to be expected, given rise to demands for establishment of higher skills in operating and maintenance personnel, far greater has been the impact of import restrictions imposed by the Government during the last decade. The instrument manufacturer as well as the maintenance engineer has had to work with his back to the wall to cope with the problems. The price paid by the manufacturer of instruments and of chemicals has been heavy but very large strides have been made in this short period towards attaining self-sufficiency.

1. History of Development

In the early stages of development of the chemical industry in the country, plants were imported as package units of which instruments formed an integral component. While this circumvented any restriction on imports, the maintenance and replacement of these instruments became a serious problem. Sometimes instruments were discarded or replaced by manual control. It is also true that at this stage in the design emphasis was placed on greater use of manual labour obviously to provide increased employment.

By virtue of their process and the attitudes of the operating personnel the earlier plants in India seldom employed instruments as an aid to efficient and economic operation. Today, with the higher pressures and temperatures at which plants have to operate and the dangerous fluids that have to be handled, precise measurement and control by instruments is inescapable and has been so accepted by the designer and the operators. There is, no doubt, a serious unemployment problem and, although automation is violently opposed and computerisation has not been as wide as would be expected, instrumentation in

chemical industry is accepted and has progressed well.

Today process design groups have been established in all major organisations and they are supported by instruments design engineers. In the last decade in the ICI Group of Companies in India the handling capacity of instruments designers has trebled.

In Graph I is indicated the growth of demand of all instruments and process control instruments from 1968 to 1974. Also given for comparison is the growth of investment in the instruments manufacturing industry during the same period.

Graph I

Graph II gives the growth of process control instruments as a percentage of total instruments and shows clearly the more rapid development of the requirements of the chemical industry.

Graph II

Graph III is another presentation of the annual rate of growth of process control instruments when compared with demand for all instruments and the investment in the instruments manufacturing industry.

Graph III

Graph IV is a representation of the investment in instruments against the total investment in chemical plant in one Group of Companies in India in the last decade or so.

Graph IV

2. <u>Progress of Manufacture of Instruments</u>

The Instruments Manufacturers and Dealers Association in India has projected the demand for instruments in the coming years, based on an assessment of instruments requirements as a percentage of physical plant cost for major groups of industries.

	Instrumentation Cost as % of Physical Plant Cost
Heavy Metallurgical Industries	
Steel and Machine Tools	3 to 4
Aluminium	2 to 3
Petroleum and Chemicals	
Fertilisers, Petroleum Refining and Petrochemicals	8 to 10
Heavy Chemicals	5 to 6
Drugs and Pharmaceuticals	3 to 4
Plastics	3 to 4
Synthetic Fibres	2 to 3
Paint and Pigments	2 to 4
Other Industries	
Power Plants - Thermal and Hydro	3 to 4
Paper	2 to 3
Rubber	3 to 4
Sugar	4 to 5
Other Industries	
Cement and Textiles	1.5 to 2
Electronics	3 to 4
Food and Dairy Beverages	1.5
Glass	3 to 4

A small beginning in the manufacture of simple, indicative and recording instruments was made in 1955. The total value of instruments manufactured in that year was about Rs 500,000 ($65,000). Considerable progress has since been made in the manufacture of pneumatic and electronic process instruments - more in pneumatic than in electronic - and the output in 1969 rose to Rs 30 million ($400,000). A high rate of growth is expected to continue and one important manufacturer expects an increase of 18% per annum over the next 4 years. Miniaturisation has begun and manufacture of still more compact instruments is planned to be taken up soon.

In Graph V are presented the estimates of demand, manufacturing capacity and the shortfall of instruments in the period 1969 to 1974.

Graph V

Currently in India there are 30 to 40 medium to large size instruments manufacturing units and about 650 small units. There are 5 large units, 4 in the private sector and 1 in the public sector (owned by the Government) manufacturing process control instruments. Only 2 or 3 units are manufacturing control valves. The manufacturing capacity falls considerably short of the demand.

The manufacture of process control instruments has started only recently and more attention needs to be paid to quality control to turn out equipment conforming to international standards. Today the user of instruments is required to undertake much more detailed inspection at various stages of manufacture than should be necessary (in the ICI Group of Companies the progress and inspection overheads are 3 to 6% of the material cost).

3. The Present and the Problems

(i) The range of instruments now available and those that are still not manufactured are given in the table below :-

Process Variable	Type of Instrument	Available in India	Not Available in India
Temperature	a) Indicators & Recorders	Filled system. Galvanometric & Potentiometric types for range 200°C to 1600°C.	Radiation and Optical Pyrometer type and Thermistor type.
	b) Transmitters	Filled system-	Electro-pneumatic type.
	c) Controllers	Pneumatic & Electric type with switches for ON/OFF control.	Electric 3-mode Controllers and FLP Thermostats.
Pressure	a) Indicators & Recorders	Non-ferrous & S.S. sensing element for range - 76cm. Hg.Vac. to 650 Kg/cm^2	Special alloy sensing elements like Monel, Inconel etc. and also for range above 650 Kg/cm^2.
	b) Transmitters	Pneumatic	Strain gauge and other electrical transducers. Gauges and transducers in FLP enclosures.
	c) Controllers	Pressure switches for limited applications.	Pressure switches for absolute, diff. pressure, etc. with various materials for the sensing elements. Also flameproof switches.

Process Variable	Type of Instrument	Available in India	Not Available in India
Vacuum	Indicating Gauges	Diaphragm & Bellows type.	McLeod Gauges, ionization gauges etc.
Flow	a) Indicators & Recorders	Glass tube Rotameters and Hg filled diff. pressure recorders.	Dry type differential recorders.
	b) Transmitters	Pneumatic diff. pressure type in C.S. and S.S. bodies.	Magnetic flow transmitters, D.P. cells with various body materials to withstand corrosion.
Level	a) Indicators & Recorders	Gauge glasses & diff. pressure type gauges for limited application.	Gauge glasses & indicators for high pressure and temp. with materials to withstand corrosion. Ultrasonic and neuclonic gauges.
	b) Transmitters	(Pneumatic) diff. pressure type.	Float operated type D.P. cells with body materials to withstand different corrosive conditions.
	c) Controllers	Float switches for general applications.	Float switches for critical duty. Buoyancy type controllers.
Analysis	a) pH Indicators & Redox Indicators	Laboratory & industrial type with limited electrode holders.	Industrial type with various electrode holders.
	b) Conductivity Indicators	Laboratory & industrial type for general use.	Industrial type for a variety of duty conditions.
	c) Gas Analysis	-	Infra-red type thermal conductivity type and others.
	d) Chemical Composition Measurement	-	Spectro-photometers, Chromatographs.
Density or weight	a) Indicators & Recorders	Weighing machine upto 100,000 kg.	Accurate weigh scales for low range. Density Indicators & Recorders.

Process Variable	Type of Instrument	Available in India	Not Available in India
	Control Valves	Air operated valves for general duty. Solenoid valves.	Air & Electric operated valves for critical duties covering a range of applications to suit Pressure, Temp. Corrosion, etc. FLP Solenoids.

(ii) The situation is aggravated by the virtual non-existence of standard laboratories for evaluating, testing and calibrating process control instruments. Most large users have had to develop their own facilities at considerable cost for carrying out these tasks.

(iii) There is a big shortage of trained instruments engineers. Today there are only 3 or 4 Institutes in India giving courses in instrumentation. The instruments design overhead is considerable and is now of the order of 1% of the physical plant cost.

(iv) Due to the limitations of instruments availability and shortage of technicians the chemical plant designers tend to restrict the degree of complexity in instrumentation to that absolutely essential. This inevitably increases the demand on efficiency and performance of the process operator. Greater number of visual and audible alarms are provided to compensate the human element and the control instruments are designed "fail safe."

(v) The yawning gap between production and demand has resulted in long and uncertain delivery periods for instruments and spares. Also the instruments manufacturers, restricted to production, have not enlarged their activities into other fields, e.g. contract designing, servicing etc. The effect of these on the design and maintenance is -

(a) The designer is obliged to aim for a "minimum adequate" concept rather than one of "optimum design."

(b) Tried and trusted equipment which will have easier spares availability is preferred.

(c) The spare parts inventory increases. A typical figure of spares for instruments in a factory is 17% of the installed instruments cost.

(d) A larger maintenance force is required. A typical figure is one man per $20,000 worth of instruments.

(e) Extensive training of craftsmen.

(f) Larger investment on repair shops i.e. a greater variety of testing and calibrating equipment.

4. Future Trends

It is expected that in the coming years -

(i) More and more total design will be handled by the engineers in India.

(ii) Methods aimed at increasing the design handling capacity and efficiency will be employed.

(iii) The instruments engineer will play an increasingly important role in the design of more complex high through-put continuous stream plants and would progress towards the role of systems design engineer.

(iv) Computers will establish their usefulness in the industry. Although the rate of growth may not follow the trends in the developed countries more and more computers will be installed for selective use.

(v) The range of activities of the instruments manufacturers will expand and so will the approach to design and maintenance.

(vi) Contractual design and comprehensive servicing facilities are likely to develop which will bring about a corresponding change in the approach to manning, training and spare parts inventory control.

(vii) National standards will be evolved for instruments which will help in rationalising manufacture. The Indian Standards Institute has already taken up formulation of standards for instruments.

5. Development of Technical Skills

Only two decades back electricians and watch makers were the only instruments mechanics. There were no institutions or any other form of training facilities for instruments technology. Repairs and calibration were carried out with the aid of manufacturers' hand-books and by trial

and error methods. Lack of theoretical and practical background rendered maintenance personnel incapable of analysing instruments problems on operating plants.

It was soon recognized that the success of sophisticated and increasingly complex plants depended very much on the capabilities of instruments maintenance personnel. Large manufacturing organisations took up, in earnest, training programmes and set up training schools to cater for their own requirements.

In all the ICI Companies in India training courses are now run for high-school educated boys in the age group 17 to 20. The training programme extends over 3 years and covers classroom, laboratory and in-plant training. Refresher courses for plant instruments technicians are specially designed to give theoretical background with emphasis on development and application of new instruments. Special courses of 12 - 15 months duration are organised to cater for the requirements of specific plants having a high degree of sophisticated instrumentation.

A number of institutions for training craftsmen, most of them sponsored by the Government, have also come up. Some of the training institutes established by the Government have received assistance from international organisations both by way of equipment and instructors.

Special Graduate level courses leading to a diploma are now being run by 3 or 4 technical institutes in the country.

There nevertheless continues to be a shortage of instrument engineers and technicians in the country and good trained men are at a premium. Their turnover is high and greater than that of any other category of craftsmen.

6. Import Substitution

The adverse balance of trade in India makes import restrictions necessary. Substitution is thus forced upon the manufacturers by Government regulations. The manufacturing and maintenance engineer has to exercise considerable ingenuity to keep the plants running.

Sophisticated materials of construction are virtually non-existent and the critical tolerance levels for some of the components difficult to achieve. Nevertheless much progress has been made in import substitution

and while a few years ago a large modern fertiliser plant would have imported almost all instruments, an indigenous content of 40% is now possible. It is also possible to equip less sophisticated and smaller plants with instruments entirely manufactured in India. However, as mentioned earlier in the text, a very close liaison with the manufacturer is necessary and frequent inspections are unavoidable.

The manufacturer of instruments has his own problems. He cannot possibly undertake manufacture/fabrication of all components himself and, therefore, spends considerable time and money in sub-contracting and guiding small fabricators to make individual components. He is often forced to instal special and expensive machinery to make some components himself.

The maintenance engineer has to face similar problems in procurement of parts to ensure that his instruments remain in useful service. Import substitution cells are set up in all ICI manufacturing units in India to coordinate procurement and fabrication of sophisticated parts. This is an expensive operation.

A list of some important components of instruments that are and are still not available in India is given below :-

	Available in India	Not Available in India
Mechanical	Fittings for copper tubes, M.S. pipes (low pressure) isolation valves (low pressure), control panels, copper tubes (single core).	High Pressure Pipes, fittings, valves for corrosive conditions, special composition valves, multicore pneumatic tubes, special gaskets, special thermo-pockets.
Electrical Accessories	Relays, Annunciators, Heaters, fittings, alarm indicating lights, a few workshop testing equipment Micro-switches.	FLP Heaters, special type of relays, FLP alarm indicating workshop test equipment, Thermo-couples, Resistance Thermometers, Special switches.
Other Components	Resistors, Capacitors, Potentiometers (limited accuracies), Electronic valves, transistors of limited range, mechanical spares of the general hardware type.	High quality resistors, capacitors, valves, transistors, printed and integrated circuits, electrical, electronic spares of special nature for proprietory items, mechanical spares for proprietory instruments, special recorder inks.

While the larger instruments manufacturer set up his own standards of production and aims at improving them in accord with international developments, the large mass of small manufacturers do not or cannot afford to produce to high quality standards. The result is a variety of sub-standard products which the sophisticated chemical manufacturer cannot risk installing in [illegible] plants. This problem exists in almost all the manufacturing industries and the development of small scale industry - a national objective - brings this problem in its wake. Therefore, some of the items listed above as available may not in fact be upto required standards.

Summary

(1) Production of and use in chemical plants of modern sophisticated instruments is making good progress in India.

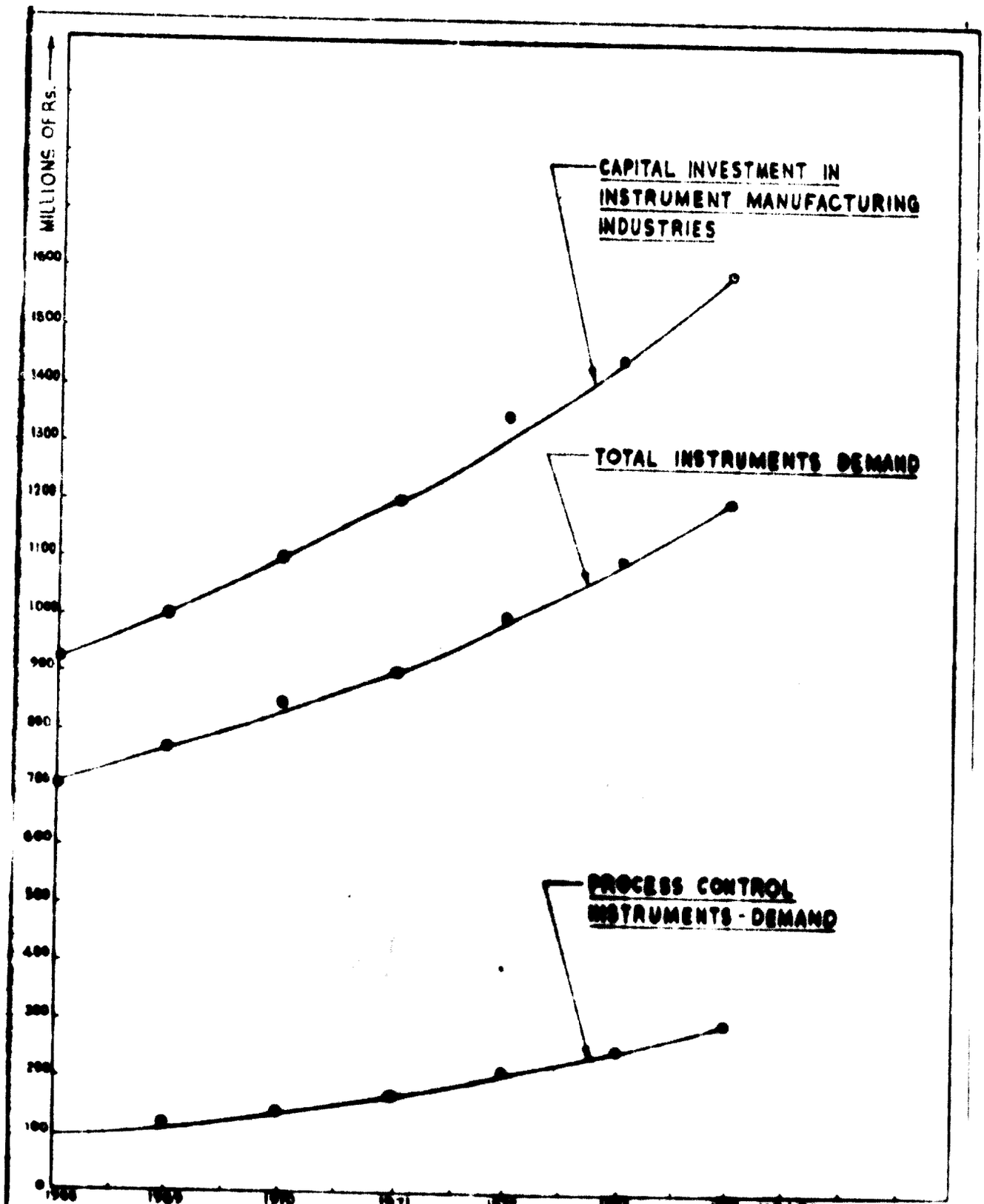
(2) There is a large unfilled gap between demand and production capacity of instruments including process control instruments which will take many years to fill.

(3) There is a shortage of trained instruments engineers and technicians but a number of institutions have been set up in recent years which are turning out acceptable quality of engineers and technicians.

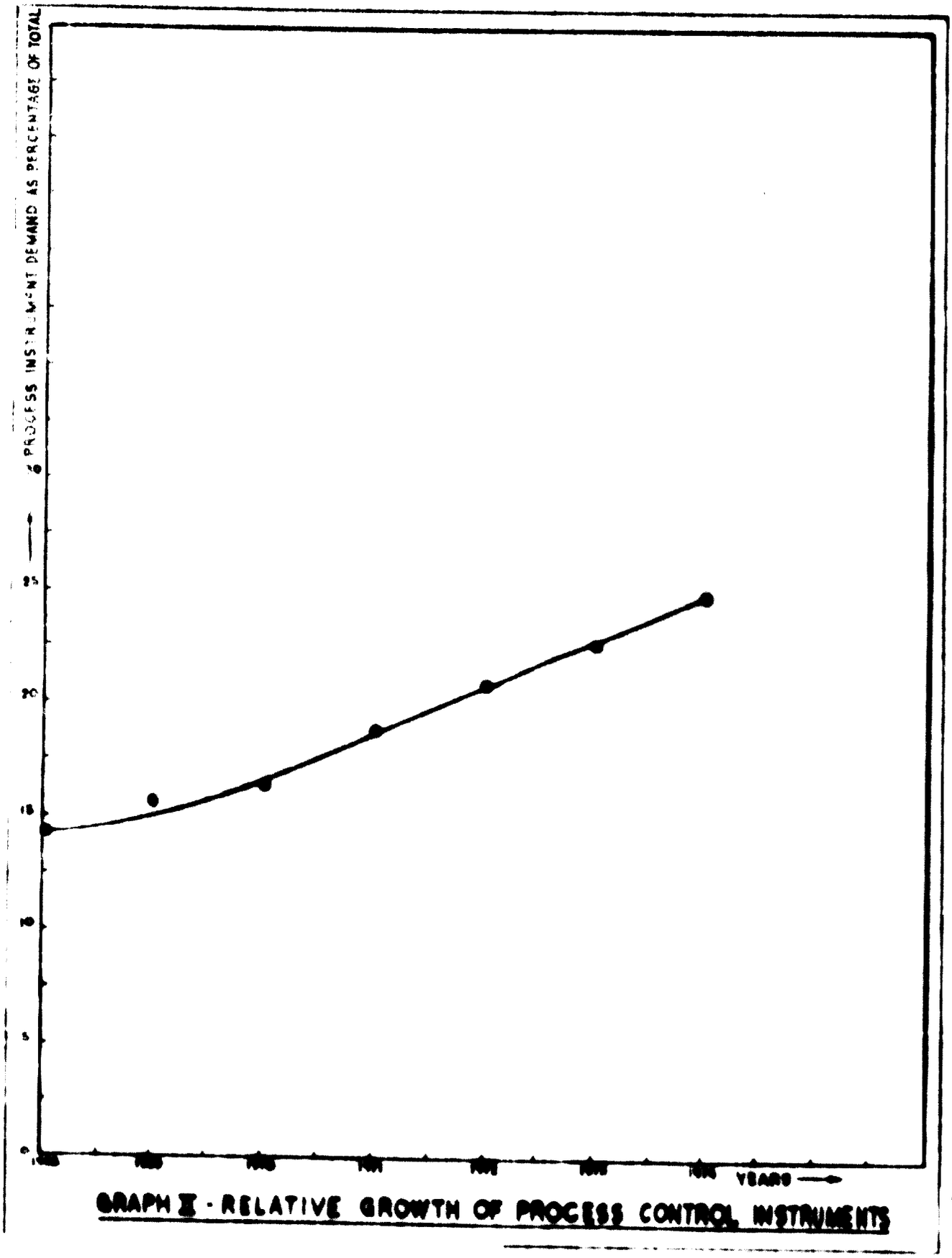
(4) There is emphasis on more and more design work for chemical plants being carried out in India but due to the limitations in supply of instruments and technicians the trend is to design for "minimum adequate" requirements.

(5) Facilities for servicing, testing and calibrating instruments are not available from the instruments manufacturers.

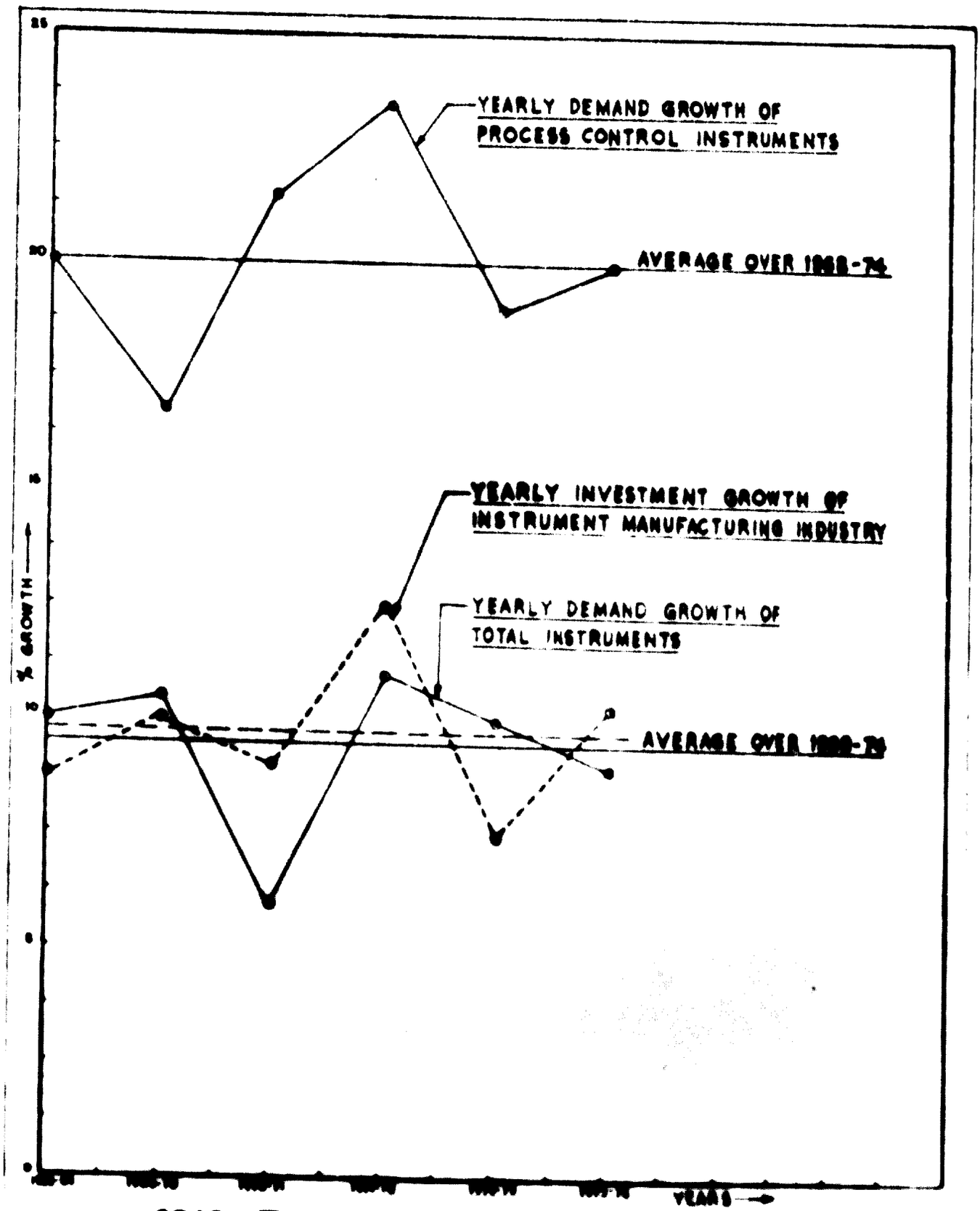
(6) Import restrictions make import substitution essential and both the manufacturing and maintenance engineer are required to spend considerable time and money in fabricating components and spare parts.



GRAPH I - INSTRUMENTS DEMAND & MANUFACTURING INVESTMENT

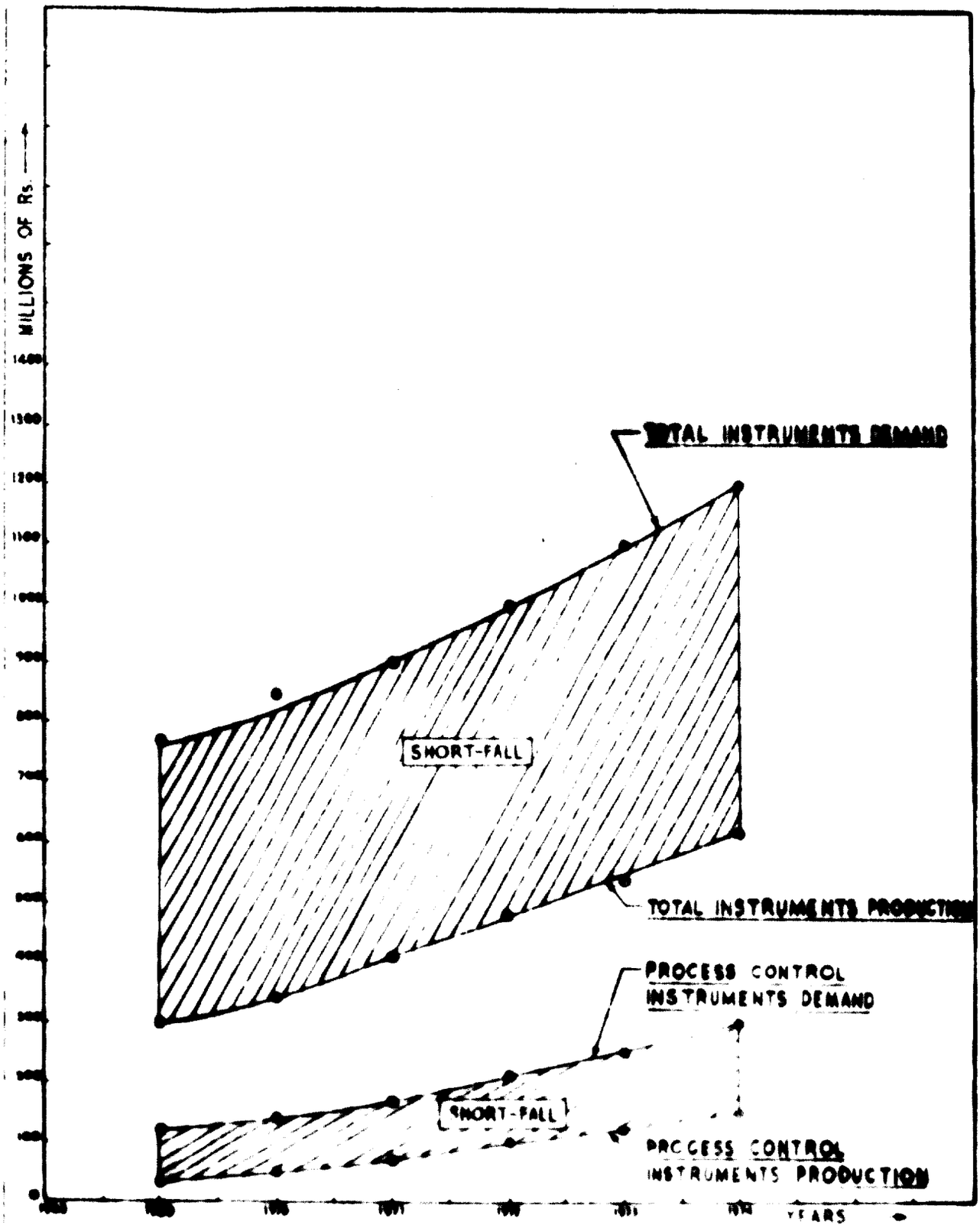


GRAPH II - RELATIVE GROWTH OF PROCESS CONTROL INSTRUMENTS

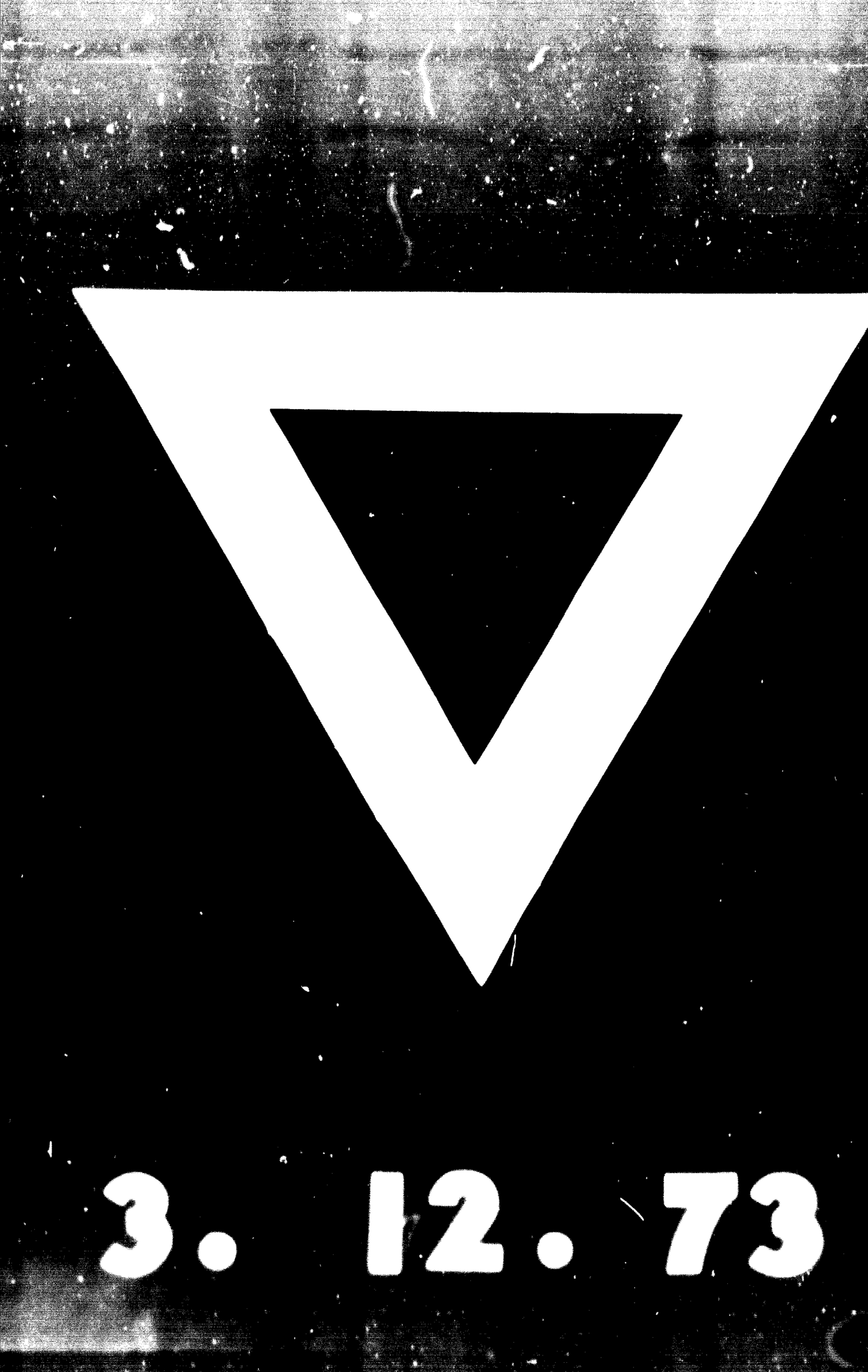


GRAPH III - DEMAND GROWTH OF INSTRUMENTS

GRAPH IX - INSTRUMENTATION COST Vs PLANT COST



GRAPH I - PRODUCTION AND DEMAND OF INSTRUMENTS


3. 12. 73