ANNUAL REPORT

1968-69

NATIONAL PHYSICAL LABORATORY

NEW DELHI-12

REPORT OF THE DIRECTOR FOR THE YEAR 1968-69

To the Executive Council of the National Physical Laboratory, New Delhi-12

During the period under review two meetings of the Executive Council were held—one on 26th October, 1968 and the other on the 3rd March, 1969. These were preceded by meetings of Scientific Sub Committee, Building and Finance Sub Committee, G.T.U. Sub Committee, DPEC Sub Committee.

Panel of Consultants for the various Divisions of the Laboratory

During the year under review, a meeting of the panel of consultants of Optics Division was convened. The panel recommended that all the

Fig. 1. Dr. Triguna Sen visiting the laboratory

projects in hand in the Optics Division may be continued and testing facilities should be expanded to include other items such as mercury vapour lamps, fittings, flourescent lamps, etc. Efforts should be made in collaboration with lamp manufacturers for the manufacture of standard lamps. The panel also recommended that a get-together of the manufacturers of lamps and lamp fittings should be arranged.

Open Day

Open day was organised on 10th and 12th August 1968 on the occasion of Silver Jubilee Celebrations of CSIR. The Open Day was inaugurated by Dr. Triguna Sen, Union Education Minister and Vice-President of CSIR. A large number of distinguished persons visited the laboratory. Since the work of NPL is not commodity oriented no single industry can claim a special association with it. Therefore, open days provide a valuable opportunity to contact those in industry and elsewhere who have interest in our programmes.

Krishnan Memorial Lecture—10th January, 1969

Professor Dame Kathleen Lonsdale, Professor Emeritus, University of London, delivered the 5th Krishnan Memorial Lecture on 'Geometrical changes occurring in the structures of single crystals' before a selected gathering of scientists from educational, scientific and research organisations in Delhi. The lecture aroused considerable interest of scientists and in view of its popular demand, it has been published in the form of a booklet.

Fig. 2. Prof. Lonsdale delivering the Krishnan Memorial Lecture

Brochure

To publicise scientific activities of the laboratory, a brochure 'NPL 1968' was published highlighting aims and objectives and work done under the categories, Standards and Testing, Applied Research, Basic Research and Pilot Plants.

Get-Together

Get-Together on Weights and Balances, jointly sponsored by National Physical Laboratory, New Delhi, the Directorate of Weights and Measures (Ministry of Commerce) and the Indian Standards Institution was held at NPL on 19th and 20th December 1968 with a view to provide a forum to the representatives of the industry and research scientists to discuss problems of mutual interest. It was a unique opportunity to exhibit facilities available and the vital role played by Weights and Measures Division of the laboratory. About a hundred delegates from all over the country as well as delegates from Germany and Russia participated. Seven papers on the subject were presented and discussed. During the discussions, a plea was made by the manufacturers for the establishment of branch laboratories of NPL at all important centres, for the testing of precision balances and weights, in view of the risks involved in the transportation of such delicate items.

Scientific activities

As in the past, the scientific work of the laboratory progressed under six separate categories. The progress of work falling under different categories is given separately. In this report some selected projects have been given.

Testing and Calibration

The Testing and Calibration facilities were extended to industry, Government agencies and Defence establishments as in the previous years by way of performance and life evaluation of various instruments, appliances and industrial products. About 2800 items were tested/calibrated as compared to last year's figure of 2000 and a sum of Rs. 1,59,476·40 was realised as test fees as compared to Rs. 1,02,389·00 realised last year. The above figures indicate rapid increase in number of requests received for calibration and testing work.

Standards

During the year efforts on the maintenance of standards were intensified to improve the accuracy of existing standards and to formulate some new standards for which need was felt. The accuracy of standards maintained at the NPL compare fairly well with the accuracy of International Standards.

Electrical Standards

The standard for resistance has an accuracy of one part in a million. Eight sets of readings of one ohm standard comprising ten manganin resistances, were taken under controlled condition of temperature at 20°C. Two 0·01 ohm and two 1000 ohm standard type resistances were also fabricated

and supplied to interested organisations. Ten sets of readings of the EMF standard were taken under controlled conditions ensuring the accuracy of standard to one part in a million. A standard is being established for DC/AC Transfer.

Microwave and r.f. Voltage Standards

Bolometer-mounts calibrated by the National Bureau of Standards were received. These mounts could be used with the existing circuits for r.f. power measurement. The Heterodyne frequency meter has been calibrated to cater internal as well as external requirements. Development of r.f. voltage standard is progressing.

Optical Standards

To establish photometric standard of light inter-comparison of existing secondary incandescent standards is being continued as a regular programme. Tests for the measurement of efficiency factors of fluorescent luminaires were carried out. The results were communicated to ISI for incorporation in the standard. Work on colorimetric standardisation was done. Chromaticity measurements were carried out on samples sent by ISI and results compared with British Standards.

Acoustic Standards

Standard for Auditory Threshold measurement has been established. An internationally recognised standard ear-phone has been used in a coupler cavity fabricated according to the internationally recommended specifications, in conjunction with a standard microphone. Similarly, standards for measurement of sound pressure have been established by calibration of standard microphones using reciprocity method. An anechoic chamber is under construction which would further facilitate work on acoustic standards in a better way.

Time and Frequency

Standards of time and frequency are maintained and time signals are broadcast on all working days for 4 hours a day from the 'ATA' stations at Kalkaji, a suburb of Delhi. The accuracy of frequency is one part in 10^8 and that of time signals is also one part in 10^8. It is the only station between Turin (Italy) in the West and Tokyo in the East. The facility is being utilised by Overseas Communication Services, Atomic Energy, P and T Deptt., Defence Services etc.

Applied Research

During the year laboratory successfully developed the know-how for several processes. The processes were tested on pilot plant or batch production scale and were handed over to industry.

Cathode Ray Tubes for Oscilloscopes

The project on fabrication of Cathode-ray tube was initiated during the year with the object of developing know-how for its indigenous manufacture. The C.R. tubes, now being used in oscilloscopes, are imported. A

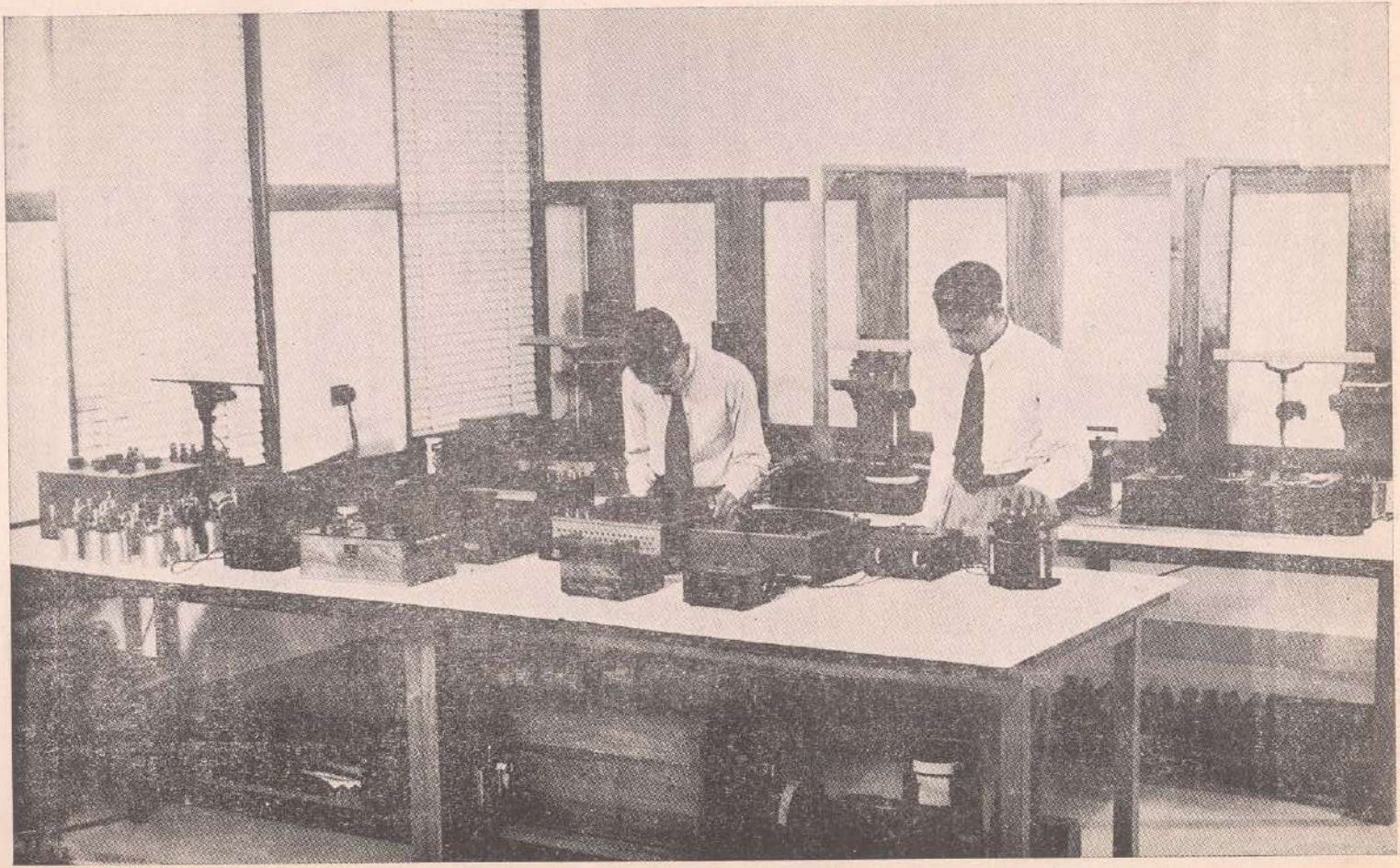


Fig. 3. Calibration of Electrical Instruments

training programme on the design, development and fabrication of these tubes was organised at NPL. Fabrication process using following techniques has been perfected.

1. Deposition of phosphor in glass bulb.
2. Aquadag coating inside the bulb.
3. Gun-assembly on glass stems.
4. Sealing of the stem to the glass bulb.
5. Evacuation, break down and activation of cathode, processing of the tube, seal off, aging etc.
6. Testing of the complete bulb.

Two types of cathode ray tubes viz. 5UP1 and 5AQP31 with accelerating voltages of 1500 and 3000 V respectively have been fabricated. Some of the tubes have been coated with a greenish blue phosphor developed at NPL. Using this cathode-ray tube complete kit for a general purpose oscilloscope has been designed at the laboratory.

Silicon

The know-how for the manufacture of semi-conductor grade silicon in the polycrystalline and single crystal form has been further improved. Low resistivity crystals of 20 mm diameter have been grown. The production capacity of the plant has been enhanced to produce 100 gms of polycrystalline silicon per unit per day. Methods of preparation of silicon are shown in Figs. 4 & 5.

Batch Production of Microweve Components

Microwave components find intensive applications in radar, microwave communications, navigational systems, scientific research and teaching. To attain self-reliance and to achieve saving in foreign exchange in this field of technology design, development and fabrication of waveguide type microwave components for 3-cm band (frequency ranging from 8·2 to 12·4 kilo mega cycles/sec) like waveguides, slotted lines, probes, attenuators, bends, T-junction directional couplers, tuners etc. was undertaken. 20 complete microwave test benches comprising 27 components each have been batch produced and supplied to research and educational organisations, thereby conserving foreign exchange to the tune of Rs. 7 lakhs. The process has now been handed over to M/s. K.L Bhakri, New Delhi through National Research Development Corporation of India, New Delhi. Batch-production of 5 cm components for frequency range 5·8—8·2 kilomegacycles would be taken up.

A drawing machine was designed for drawing about 2 meter long waveguides. The machine has been fabricated by M/s. K.L.B. electronics and the waveguides have been successfully drawn

Phosphors

Zinc sulphide of high purity has been prepared from completely indigenous raw material. The overall impurity content is less than 40 parts per

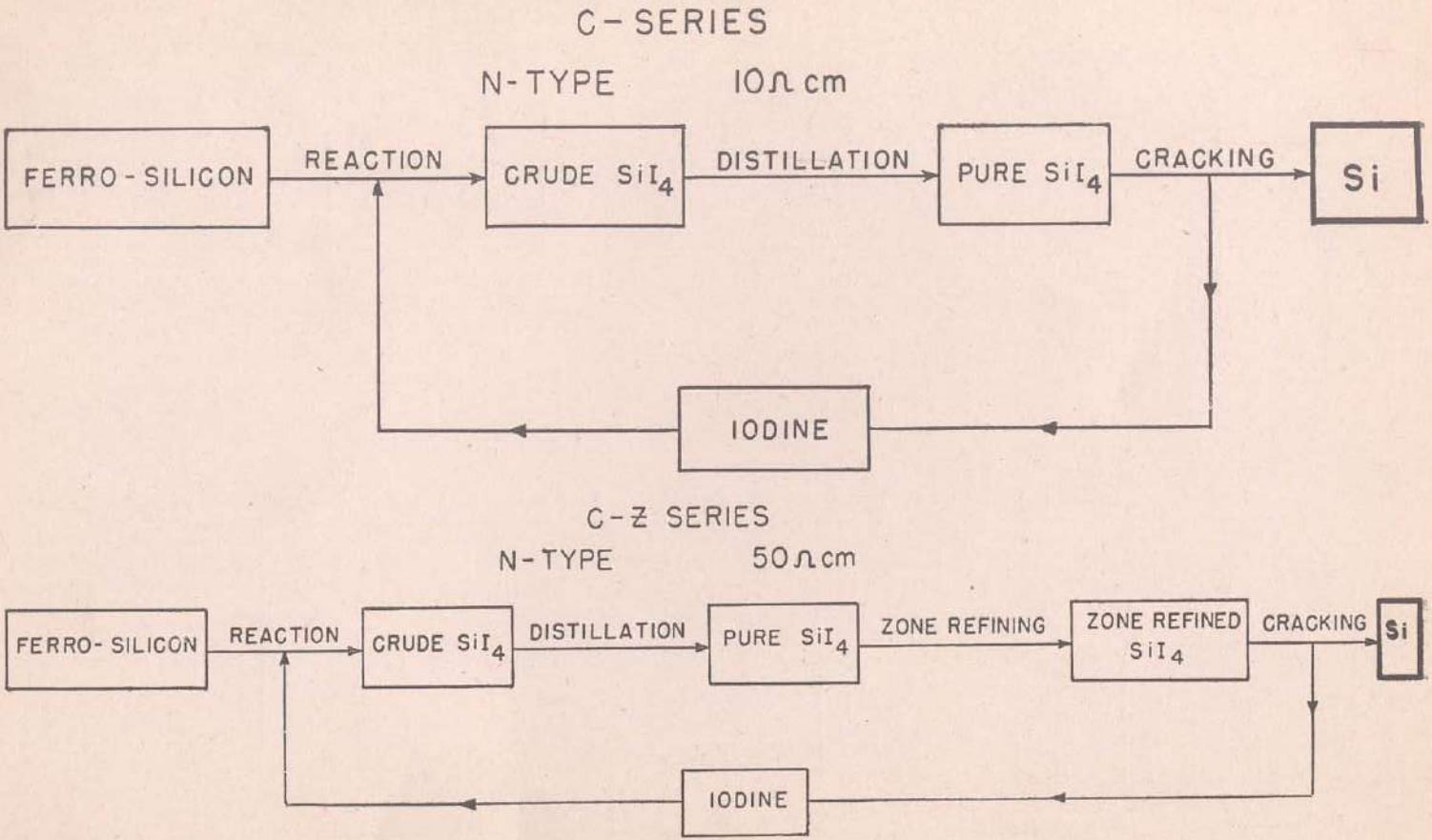
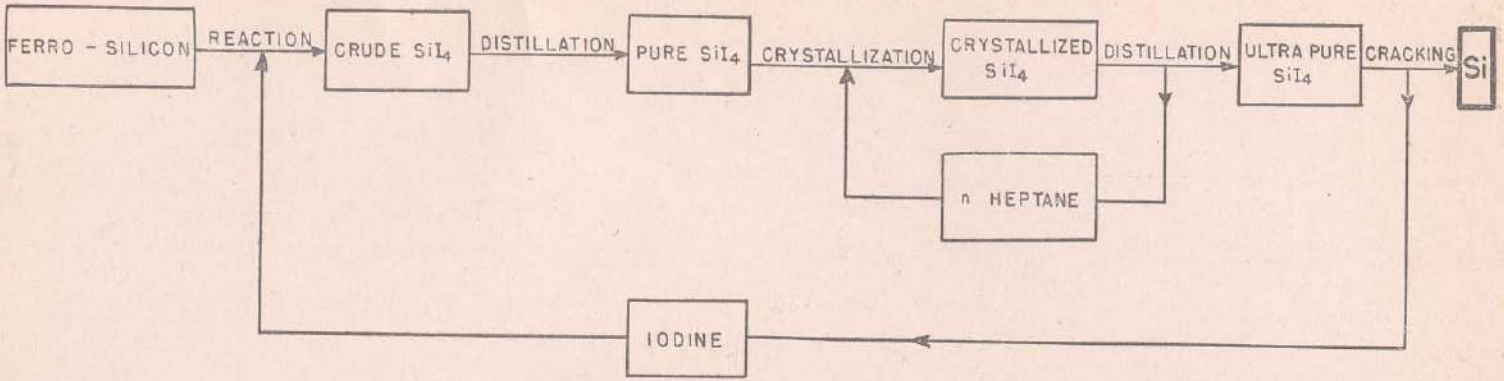


Fig. 4. Preparation of Polycrystalline Silicon, C-Series, C-Z, Series

T- SERIES

N-TYPE >100Ω cm



TRICHLOROSILANE PROCESS

N- TYPE 1 TO 10Ω cm

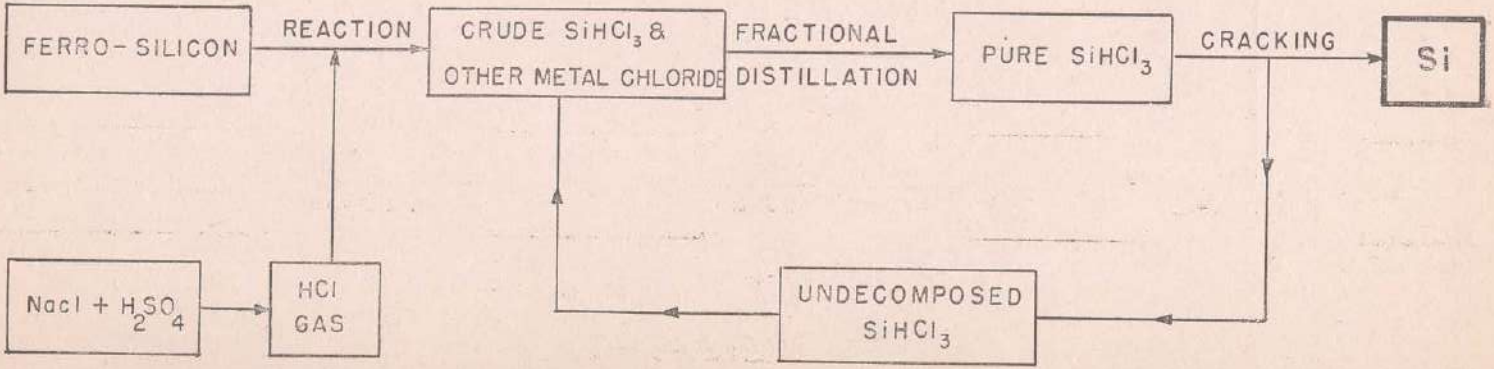


Fig. 5. Preparation of Polycrystalline Silicon, T-Series, N-Type

million, with the killer impurity less than few parts per million. Techniques have been developed to suitably activate zinc sulphide to give a phosphor having possible use in cathode ray tubes. This phosphor was tried in the cathode ray tubes made in the NPL and was found quite successful.

Ferrite and Memory Cores

Advance in the manufacture of memory cores has been made by fabricating suitable dies and using indigenously available presses, to produce memory cores in quantity. It has been possible to achieve a production rate of thirty to forty thousand pieces per shift of eight hours.

A break-through has been achieved in the technology of fabrication of complicated small-sized cup cores by using calcined ferrite powder as a filler with a thermoplastic resin and moulding them to shape using the conventional plastic moulding technology. The characteristics of such products have been found to be similar to those of ferrite components made by using high pressure pressing and firing.

A very important achievement in the manufacture of short-cum-medium wave ferrite rods which cover frequencies both in the medium and shortwave bands has been possible by suitably modifying the compositions and controlling the sintering cycle. In fact, it has been found that the antenna rods made by this process are superior in many respects to the imported ones.

Sponsored Research

The know-how for the fabrication of thin film thickness monitor and controller has been handed over to the NRDC for commercial exploitation. The technique for coating of sun-glasses is being evolved on behalf of a sponsor. A 25 ton universal testing machine has been developed as a sponsored research project.

During the period four patents have been accepted, six patents have been sealed and three patents have been filed.

Oriented basic research

The staff of this laboratory has published 44 research papers based on the work carried out at this laboratory. Five members of the staff were awarded the degree of Ph.D. on the basis of work done here.

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CONTENTS

APPENDIX I

STANDARDS

Code No. and Standards	*Progress*	*Project Team*
1	2	3
	HEAT	
Precision platinum resistance thermometry	(*a*) An attempt to work all glass Zn melting point apparatus was not successful.	*Baveja K. D., Ram Krishan*
	(*b*) Some pure graphite rods have been obtained from the Atomic Energy Establishment suitable for the graphite apparatus. Various other component parts for assembling the zinc and Indium point apparatus have been constructed.	
	(*c*) Sulphur point apparatus was assembled. Resistance measurements of the several platinum resistance thermometers were made at the sulphur point. The measurements along with the data at the triple point of water, steam point and liquid oxygen point is being utilized to evaluate the constants of the platinum resistance thermometers for comparison with previously determined values.	
	(*d*) A new furnace for the temperature upto 450°C has been constructed for the inter-comparison of platinum resistance thermometers. In this furnace uniform temperature is achieved around the sensors of the platinum resistance thermometers to be compared.	
	(*e*) One Capsule type platinum resistance thermometer—out of the spec-pure platinum wire from P.T.B. (Germany) has been fabricated.	

1	2	3
H/ST/1 Temperature Unit (Realisation and Utilisation)	Arrangements are in hand for setting up equipment for Copper Point which in the next few years is likely to replace the Gold Point. Equipment for other Defining Points is being assembled. The TPW equipment has been improved to keep the temperature constant, round the clock.	*Wasan, V.P.*

ELECTRICITY

	(i) Resistance Standard	
ECY/ST/1 Setting up, maintenance and improvement of the Electrical Standards.	Eight sets of readings of the one ohm standard comprising ten manganin resistances, were taken under controlled condition of temperature at 20°C by the method of substitution for intercomparison and ensuring that the values of the standard are accurate to one part in a million. The record of the values is being maintained.	*Batra V.K.* *Sircar B.* *Tandon R.K.*
	(ii) E.M.F. Standard	
	Ten sets of readings of the E.M.F. Standard comprising seventeen cadmium cells, were taken under controlled condition of temperature at 20°C for intercomparison and ensuring that the values of the standard are accurate to one part in a million. The record of the values is maintained.	*Batra V.K.* *Sircar B.* *Tandan R.K.*
	(iii) DC/AC Transfer Standard	
	Having concluded that the mechanical perfection and symmetry are the limiting factors to the accuracy that can be attained, the needle was removed for dismantling and reassembly after reannealing some parts. A careful scrutiny of the apparatus is being made to avoid the high percentage error that was prevalent. It is expected that the careful study of all possible sources of error and special efforts being made to eliminate them will yield results when the apparatus is re-assembled for final evaluation and testing.	*Vashisth S.C.*

The power amplifier (for 400 cycles power source) is also expected to be completed well in time for the readings.

(*iv*) *Fabrication of Standard Type Resistances*

Two 0·01 ohm and two 1000 ohm standard type resistances were fabricated and one each of these in addition a one ohm resistance fabricated earlier, have been given on loan to C.M.E.R.I., Durgapur at their request.

Two each of 0·1 ohm, 10 ohm and 100 ohm resistances have been fabricated for leasing out, on request, to the Jammu and Kahsmir University, Srinagar.

ELECTRONICS

(*a*) *Microwave Standards*

Elec/ST/3 Development and maintenance of Microwave and r.f. Voltage Standards.

Chandra K.
Parshad R.
Agarwala V.K.
Kataria B.K.

1. Bolometer-mounts calibrated by the National Bureau of Standards have been received from M/s Hewlett Packard Co., U.S.A. These mounts would be used with the existing bridge circuits for r.f. power measurement.
2. The Heterodyne frequency meter has been calibrated against the crystal oscillator of the Time and Frequency Section. It is now being used for the calibration of frequency meters fabricated by the laboratory and signal generators received from outside organizations.
3. Radar test sets, power meters, attenuators etc. are being calibrated using the power standards set-up here.

(*b*) *R.F. Voltage Standards*

The work on a new method of use of diodes and transistors for r.f. voltage standards was continued. Instrumentation required for this work has been completed. In order to extend the frequency limit for voltage standards, silicon diodes were tried which did not

show satisfactory results. Using microwave transistors, operating in the normal way beyond 3000 megacycles, the frequency range for the r.f. standards was extended to about 3 megacycles.

Thermal convertors are useful for obtaining r.f. voltage standards upto 100 MHz. Efforts are being made to procure these for our work on r.f. voltage standards.

OPTICS

OPT/ST/1 Photometric Standardization & measurements.

Inter-comparison of existing secondary incandescent standards is continued as regular programme. Further tests for the measurement of efficiency factors of fluorescent luminaires is done. The major manufacturers co-operated to supply different designs of the fittings in this programme. The results are communicated for incorporation in an Indian Standard Specification.

Sarma K S.
Dandawate V.D.

Life test racks for various types of lamps are being set up. A 3-hour-ON and 15 minute-OFF switch circuit device has been designed and made. This has enabled us to undertake long life tests for Fluorescent lamps also. Routine testing and product testing for framing relevant Indian Standard Specifications is a continuous feature of this project and the number of test reports and test fees collected show the regular increase in this work.

OPT/ST/2 Calorimetric measurement and Standardization.

Chromaticity measurement of more surfaces sent by ISI was continued. Thirteen surfaces meant to serve as standards for ready mixed paints, were measured very accurately and the difference of their chromaticities from corresponding British Standards were reported.

Das S.R.
Manamohanan S.B.

APPENDIX II

CALIBRATION & TESTING

One of the prime objectives of the National Physical Laboratory is to undertake Developmental testing with a view to help Indian Industry in the import substitution problems and to create export potential for industrial electrical and electronic products. In view of large demand of developmental testing services Government of India has decided to set up a Test & Evaluation Centre at National Physical Laboratory to cater electronic industry in Northern Region. In addition to performance and life evaluation of materials/products advice is also rendered to improve them. There is no end to the facilities available at the laboratory. The facilities are being constantly expanded to meet varied requirements of industry.

The laboratory undertakes a wide variety of industrial products such as radio & TV receivers, weights and balances, capacity measures, slip gauges, proving rings, dynamometers, electric motors, fans, cables, refrigerators, lamps and lamp fittings, chemical analysis etc.

The number and variety of testing and calibration jobs undertaken during the year in the various divisions of this laboratory are given in following table. The laboratory has realised Rs. 1,59,476.40 compared to last year's figure of Rs. 1,02,664.31.

The laboratory discourages routine testing but in some cases it also undertakes routine tests for which test facilities are not available elsewhere in the country.

TESTING & CALIBRATION

(List of items tested)

Year 1968-69

Code No.	*Materials*	*No. of items*
1	2	3
	ACOUSTICS	
A/T/I	Vibrating Machines	16
	Loudspeakers, Amplifiers	3
	Sirens	3
	Sound Absorption Material	3
	Audiometer, Sound Level Meter	9
	Horns	10
	Microphone Megaphone	2
	Transistor Oscillator	1
	Warbling Relays	1
	Screened Cable	1
	Alloy Steel Piece	1
	ANALYTICAL CHEMISTRY	
AC/T/I	Composition analysis of various metals, alloys, compounds and industrial products	104
	Water	17
	Acid	7
	Indelible Ink	7
	Bitumin	2
	Mesonary	6
	Petridish	1
	Oils, Glycerine, Gums & Spirit etc.	18
	CARBON PLANT	
CP/T/I	Carbon discs, brushes & Blocks	3
	Graphite blocks & electrodes	3
	Pin insulator	2
	Wagner Turbidimeter	1

1	2	3
	APPLIED MECHANICS	
AM/T/I	Universal Testing Machine	6
	Compression Testing Machine	3
	Tensile Testing Machines	4
	Pulling & Lifting Machines	3
	Impact Testing Machine	2
	Vibrating Machine	1
	Hydraulic Jacks and Compression Tester	10
	Proving Rings	219
	Standardising Box	5
	Dynamometers	5
	Strainmeters	17
	Torque Meters	3
	Ratchet Hoists	24
	Pipe Wrenches	4
	Tension & Suspension Clamps, deadend assemblies and compression joints	25
	Mild Steel Rods, Plates, Wires, Welded joints, steel balls and glass moulds etc.	136
	D.P.E.C. UNIT	
DPEC/T/I	Capacitors	6
	Carbon Composition Resistors	3
	Flash Light	10
	Fuse Units	1
	Insulators (Porcelain)	5
	Starter for Tubes	2
	ELECTRICITY	
ECY/T/I	Calibration of DC & AC Substandard and Precision measuring instruments *viz.* Voltmeters, Wattmeters, Ohmmeters, Potentiometers, Ammeters	62
	Bridges	8
	Standard Cell	10
	Standard Resistances	50

1	2	3
	Resistance Box	7
	Developmental testing of Industrial Products *viz.*	
	Electric Motors	5
	Chokes	4
	Electric Horns	10
	Cables of various types	16
	Transformers	2
	Wires, Conductors	24
	Insulators	19
	Fuse Units, Switches, Voltage Stabiliser	15
	Transformer Oil	2
	Fibre Glass Material	4
	Pliers	4
	Ceiling Fan	1
	Bitumin Sample	5
	Induction coil & Polythene T Box	2
	ELECTRONICS	
ELEC/T/I	Radio Receivers and Community Receivers	18
	Frequency Meter	1
	Radome Window	2
	U.H.F. Connector	1
	Microwave Attenuator	1
	HEAT DIVISION	
HD/T/I	Thermometers and Pyrometers	107
	Glass Plate, Boards & Fuse Units etc.	8
	Mineral Wool	4
	Thermocouple	7
	Spintex sample	2
	OPTICS DIVISION	
OD/T/I	Photometers	4
	Lamps	70

1	2	3
	Lenses, Roundels & Glass Sheets etc.	82
	X-ray Films, Microscope Objectives, Microscopes etc.	14
	Taxiway light	6
	Fluorescent Tubes	3
	Tracing Cloth and Gauge Cloth	3
	Filters	7
	Coke ash, candle, graphite sample	3
	Tin Metal	1
	Salt solutions	6
	Infra Red Spectra	3
	MISCELLANEOUS TESTS	
MT/T/1	Abel's Flash Point Apparatus	6
	Viscometers	10
	Oils	3
	Diffusion Pump	1
	WEIGHTS & MEASURES	
WM/T/1	Length accuracy for the following items :	
	Micrometers, Length bars, scales, setting rods, slip gauges, steel tapes, length gauges etc.	95
	Dimensional measurements of the following industrial products :	
	Flash point apparatus, valves, flush doors, nozzles, air flow measurements, ring gauges, weight per gallon cup, sieves, orifice plate, spanners, surface plates, microscopes, needles and jets, penctrometer, flash lights and flow cup viscometers etc.	357
	Mass Section	
	Sets of weights for scientific purposes	181
	Horology Section	
	Stop watches	7
	Wall Clock	1

1	2	3
	Volumetry Section	
	Capacity measures, pipettes, burettes, measuring flasks, measuring cylinders, lactometers and butyrometers etc.	245
	Hydrometry Section	
	Hydrometers	59
	General Testing Section	
	Balances of various capacities, pressure gauges, taxi meters, electrical appliances, coking bulbs & furnace, master gauges, drills, welded steel pieces, polythene box, gas guns, horns, soil pipes, pistons, stone, ink, plug gauge, ring gauge, petridish etc.	491
X-ray/T/I	**X-RAY**	
	Diamond Powder	7
	Fly ash	2
	Precious Stone	7

TESTING FEES REALISED

1968-69

	Name of Division	*Amounts in Rs.*
1.	Acoustics	5,322.00
2.	Basic Physics Low Temperature	2,700.00
3.	Electricity	18,070.35
4.	Electronics	2,879.00
5.	Heat & Power	6,876.67
6.	Materials	25.00
7.	Material Analysis :	
	(*a*) Analytical Chemistry	13,301.02
	(*b*) Infra-red	400.00
	(*c*) X-ray	1,100.00
8.	Mechanics	27,595.00
9.	Optics	22,934.68
10.	Weights & Measures	55,211.00
11.	Carbon Plant	1,049.00
12.	DPEC Unit	2,012.68
	TOTAL :	1,59,476.40

MISCELLANEOUS RECEIPTS

1968-69

Particulars	*Amount in Rupees*
Sales of Carbon Products	45,863.24
Sales of Electronic Equipment	5,000.00
*Supply of M.W. Test Benches	1,97,220.00
Supply of liquid air	2,344.00
Supply of Distilled Water	765.64
Supply of Liquid Nitrogen	423.75
Jobs done in the Workshop	2,921.55
Repairs of Traffic Control Units & Metal Detectors	3,274.85
Instruments Services & Repairs (Instrumentation & Servicing Section)	3,225.00
Coating of Mirrors	1,566.66
Supply of Ice Point equipment, Optical assessories, crystals & electron micrographs etc.	2,789.56
TOTAL :	2,65,394.25

* Supply made during 1967-63 but Bills issued during 1968-69.

APPENDIX III

DEVELOPMENTAL PROJECTS

Code No and Project	*Progress*	*Project Team*
1	2	3
	ACOUSTICS	
AC/D/1 Ultrasonic Sensing & Control Devices	A small unit consisting of a transmitter and receiver, along with transistorised circuitry, capable of working in the range 30-60 kHz has been developed for use in air as remote control device in situations when photo-electric cells are ineffective. A patent on ultrasonic transducer for remote control devices has also been filed. A request has been received from a photo films manufacturing company for supply of these units and these are being produced for them.	
	APPLIED MECHANICS	
AM/D/3 Design and fabrication of photoelastic bench	The design and fabrication of the photoelastic bench has been completed. Efforts are being made to release the know-how to the industry.	*Agarwala, B.K. Das Gupta, M.K. & Agarwal, A.K.*
AM/D/S Hydrostatic extrusion of metals & alloys	The double cylinder extrusion press (both the shrink-fit and the force-fit presses) has been fabricated and the extrusion of metals and alloys is being taken up.	*Agarwala, B.K. Agarwal, A K.*
AM/D/6 Design of a 25 Tons-Universal Testing Machine	The Division has designed a 25-ton Universal Testing Machine. The project was sponsored by the Associated Instruments Manufacturers (P) Ltd. who are interested in producing the machine indigenously. The detailed designs have been passed on to the firm.	

1	2	3
AM/D/7 High Pressure Technology (Metal Forming)	The work on the extrusion of metals and alloys will be continued. In the double cylinder extrusion press the pressure generated is about 8800 kg. per square cm. and it is possible only to extrude brass, copper and aluminium alloys Attempts are now being made to build a small extrusion press in which the extrusion ratio will be kept small. It will be able to extrude small billets of steel also in this press. We are also trying to build an augmented extrusion press on a laboratory scale. In this press one will be able to control the extrusion process which we are not able to do in the single cylinder and double cylinder extrusion presses that we have built.	*Agarwala, B.K. & Agarwal, A.K.*
AM/D/8 The design and fabrication of linear & circular machines for making large size grids for moire work	These machines are being designed so that one is able to make large size linear and circular grids for strain analysis by moire technique in two and three dimensions. The designs have been completed and the fabrication work has been taken in hand. It is expected that the machine will be ready for trial runs by March 1970.	*Agarwala, B.K. Agarwal, A.K. Bindal, M.M. Kumar, Rakesh*
AM/D/9 Ruling Engine Project	A wooden model of the Mark Iruling engine according to the NPL (Teddington) design has been completed with a view to study the working of a ruling engine and gain experience for the design of a larger machine. The final design of the ruling engine that we want to build now have been completed and the drawings has been sent to Dr. Franks for his approval. Work on the construction of the engine will be taken up after the design has been approved.	*Agarwala, B.K. Agarwal, A.K. Bindal, M.M. Nayar, R.K.*
	ELECTRONICS	
Elec/D/1 Design, development and fabrication of prototype of 10 cm. reflex klystrons.	In continuation with the work on the fabrication of cathodes for the 10 cm reflex klystrons Ni-matrix cathode in the form of discs were pressed, but cracks developed after sintering. The process is being further perfected. For immediate	*Chandra K. Joginder Singh Arora T.R.*

1	2	3

use in the 10 cm reflex klystrons, oxide coated cathodes have been successfully fabricated. These cathodes would be used until matrix type are perfected. Disc-sealing has been achieved by sealing one disc after the other.

All other components of the 10 cm klystron are ready and very soon prototypes would be aasembled and tested.

Elec/D/2 Design, development and fabrication of microwave components, materials and systems

Chandra K.
Parshad R.
Agarwal V.K.
Bhatnagar H.M.
Kataria B.K.

1. Batch production of microwave test benches for X-band was continued. Twenty banches were supplied last year to several universities and colleges and ten more benches are being fabricated now. The know-how has been released to M/s. K.L.B. Electronics, New Delhi.

2. A drawing machine was designed for drawing 1.8 meters long waveguides. The machine has been fabricated by M/s. K.L.B. Electronics for the manufacture of microwave components and these waveguides have been successfully drawn.

3. Precision variable attenuator and an improved version of slotted section forX-band have been designed and fabricated.

4. T-circulator has been perfected. Work on low insertion loss isolator is still in progress. The dielectric slab supplied by CGCRI is being used in this isolator.

5. A prototype of Bragg's diffraction apparatus to study Bragg's diffraction at microwave frequencies has been fabricated. The apparatus would also be used to study polar diagram of horn antennas, their gain etc. There is demand from universities for the supply of this apparatus.

6. Microwave system to study Electron Paramagnetic Resonance has been assembled and tested.

1	2	3
	7. Using a combination of slotted section and directional couplers, a method for accurate measurement of impedances has been developed. In this method, the three factors, *i.e.* reaction of generator on V.S W.R., probe-loading and dependence of crystal characteristics are eliminated. The use of directional coupler yields the V.S.W.R , the slotted section and the phase for the impedance to be measured.	
Elec/D/4 & 5 Electronic Circuits and Instrumentation	1. A three-stage decade counter, employing the techniques developed already and having a direct ten-light readout is being assembled and is nearing completion.	*Parshad R.* *Suri S.P.* *Singh S.K.* *Parbhakar A.C.* *Taneja K.C.*
	2. A number of thin film monitors and controllers were fabricated during the year.	
	3. Oscilloscope circuitry kits for providing oscilloscope kits, including CR tubes to universities are being developed.	
	4. Services were rendered to two industrial concerns in regard to the design of a motor-starter and the design of an I.F. transformer for transistor radios.	
	5. Three papers were published regarding the application of transistors and reversible counters.	
Elec/D/7 Effect of Magnetic Field on Diode and Transistor operation	1. An instrument has been made on the use of the p-n junction for measuring the magnetic field. A paper was published on the work in the March 1969 issue of Indian Journal of Pure and Applied Physics.	*Parshad R.* *Mehta S.C.* *Bansal S K.*
	2. The observations on depletion layer capacitance under magnetic field of different p-n junctions were completed and a report on this has been written. It has been found that in germanium diodes there is a slight	

decrease of the capacitance with the use of the magnetic field, while on silicon diodes no effect could be observed.

3. Effect of magnetic field on the breakdown behaviour of Zener Diodes has been investigated. It has been found that in the low voltage Zener Diodes, in which the breakdown is caused by the high field tunnelling mechanism, there is no effect of the magnetic field on the breakdown voltage of the diodes. However, once the diode breaks down, the backward current increases under the magnetic field. In contrast, the diodes breaking down under higher voltage by avalanche process, exhibited increase of breakdown potential under the magnetic field. Also, after the diodes had broken down, the breakdown current increased under the magnetic field.

4. The effect of magnetic field on the forward and backward currents of silicon diodes was investigated again by using a standard d.c. potentiometer for investigating the small effects of change of diode currents, which could not be detected by the technique used earlier. It has now been found that like germanium diodes, some silicon diodes also exhibit the decrease of forward current, though to a much lesser degree, but there is no decrease of the backward current. The measurements on silicon diodes have been extended to high magnetic fields (of the order of 30 Koe) by using the Arthur D. Little Magnet.

In order that investigations could be done on diodes having known concentration of impurity in the p and n parts of the diodes, the doping has been carried out in the laboratory.

HEAT

H/D/2 Clinical Thermometers

1. The graduation and calibration of accelerometer has been completed. *Bansal, T.D.*

2. Performance Tests have been carried out on the baths, particularly with a view to find out optimum working conditions.

3. Output obtainable from the Accuracy and Time Rating Test Equipment has been tested with the help of 100 thermometers, which were used repeatedly. A conservative estimate shows that under certain conditions, the equipment can be safely used to test 7,000 thermometers per shift of 8 hours, with the staff stipulated originally.

4. The ISI had requested NPL to shift the test equipment to ISI during Ist week of October, 1968. Accordingly a number of improvisations were introduced in the equipment to facilitate the transfer of complicated network of electrical circuits.

5. The Engineering Economics of a separate equipment for testing pigment, in use at present, was studied and a simple device has been made which could totally eliminate the separate equipment.

6. The Swastik Thermometer Co. was eager to improve their manufacture of Clinical Thermometers. Their products were being rejected 100%. As a result of our advice, their products have now improved in following ways—

(*a*) alignment of bulb and stem,
(*b*) shape of bulb,
(*c*) conical connection of capillary with bulb, and
(*d*) time rating reduced to 4 sec. instead of 7.5 sec. prescribed by ISI.

HEAT POWER

HP/D/1
Drying of coal fines obtainable during coal washings by the utilisation of Solar Energy

Khanna, M L.

The question as to how efficiently solar heat could be utilised for heating air and thereby drying wet coal fines from the coal washeries was thoroughly considered. It has been concluded that quantity of heat withdrawn from the heat exchanger may be regained by exposure to solar radiation during the day.

A preliminary study of heat transfer from the heat exchanger to air used for drying of coal fines from the coal washeries has been made. Heat required for a working unit handling 200 kg. of coal fines (on dry basis) with moisture content reduced from 30 to 5% of the finished product has been estimated.

The paper entitled "The design data for heating air under free or natural convection conditions utilizing solar energy" was presented at the Annual Meeting of Solar Energy Society, held at Menlo Park, Calif., U.S.A. on 26th October, 1968, and it has been accepted for publication.

The Indian Patent No. 99523 has been sealed.

As in earlier years, the performance test of Abel's Flash Point Apparatus, Pensky Martin's flash point apparatus, the calibration of U-tube and suspend level viscometers, the testing of petroleum fuels and lubricants according to different IS/BS specifications were under taken and the test reports were issued.

MATERIALS

(*i*) *Preparation by tetra-iodide process*:

M/D/1
Silicon and semiconductor devices

Jain G.C.
Gautam Soni
Menon M.V.G.
Gupta P.K.
Amar V.K.
Iyengar T.R.G.

Last year silicon tetra-iodide was successfully cracked to yield semiconductor grade silicon. The cracked material was cast into rods and single crystal will be grown from it. However, to make it usable for rectifier industry material of higher resistivity and therefore of greater purity is needed.

In order to improve the resistivity, the material produced as above was processed with one more additional step namely crystallisation of silicon tetra-iodide in n-heptane. Indications of higher resistivity (100 ohm-cm) have already been obtained. Experiments are being repeated to obtain consistency in results.

To increase the resistivity further, attempts are being made to zone refine silicon tetra-iodide.

(*ii*) *Preparation by trichlorosilane method* :

From cost considerations it seems that high purity silicon produced by the trichlorosilane method will be more suitable and it has now been developed in this laboratory. Experiments are being repeated to confirm the results.

(*iii*) *Casting, fusing and zone-refining of silicon rods* :

All these processes have now been standardised. It is now possible for the NPL to grow single crystals of silicon of all possible diameters upto 23 mm.

M/D/2 Development and Physical Study of Phosphors

Agarwal J.P.
Ghosh P.K.

A completely indigenous Zns-Cu phosphor material for C.R. tubes has been successfully developed, during the year under report. The Spectral Energy Distribution under U.V. excitation shows a strong peak at 5370A° and a weaker peak at 4550A°. The Decay Characteristics were also measured under U.V. excitation.

A few coatings of our phosphor material, on to the C.R. tubes, have given excellent results. The ZnS-Cu phosphor could be used for a general purpose C.R. Tube.

A good deal of literature has been collected for a Black and White Television phosphor material. We will concentrate our attention towards an early development of a completely Indian phosphor material for T.V. tubes.

M/D/4 Instrumentation for measuring consistency of butter

1. Instrumentation for butter

Chari, S S. Awasthy B.R.

It is a joint project taken in collaboration with National Dairy Research Institute, Karnal. NPL Part of project is completed. An instrument called 'Constant Stress Viscometer' was designed and fabricated in the N.P.L. This instrument was thoroughly tested with different kinds of butter purchased from the market. Both yield stress and viscosity were determined. The instrument was patented. This instrument will now be sent to Karnal where the rheological properties like yield stress and viscosity, as determined by this instrument under standard conditions, will be correlated with functional properties.

2. Rheology of bulk solids :

As related to the design of hoppers and bins : Interested party : Sindri Fertilizers :

A prototype of Jenike's apparatus for the measurement of flow function, flow factor, effective angle of deformation for bulk solids has been fabricated by the associated instruments according to our specification. The instrument was used for determining the flow factor studies of fertilizers. Exhaustive studies were made especially on gypsum for the flow of which in hoppers vibrators have to be used at Sindri. These studies will help to make a better design of hoppers which can transport gypsum without the aid of Vibrators.

A study is underway for the correlation of cone penetrometer and plunger viscometer as given by I.S.I. for the measurement of consistency of lubricating greases. The interested party is I.S.I. The likely beneficiaries from this project are Burma Shell, Esso and Indian Oil who are the bulk manufacturers of Lubricating greases in India.

1	2	3
Synthetic Optical Crystals	The primary aim of the project is to develop a process for the production of single crystals for special optical uses. The fluorides (especially CaF_2 and LiF) are extensively used in visible as well as in ultraviolet (down to 1100 A°) and in infra-red (upto 12 micron) region of spectrum. CaF_2 is of special use in lens combinations. All good quality lenses such as apochromates and superchromates for use in microscopes, telescopes, aerial and high speed photography use CaF_2 lenses. The material is of strategic defence use since the special lenses for naval periscopes and gun sights etc. need CaF_2 as one of the components. The process for the production of such crystals is Stockbarger technique. The technique has been successfully used in National Physical Laboratory for producing optical grade CaF_2 single crystals in the laboratory from 100 per cent indigenous material, equipment and technical know-how. The process developed is suitable for all the other fluorides (BaF_2, SrF_2, LiF etc.) and many other optical crystals.	*Ved Prakash*
Growth of single crystals of InSb.	Apparatus has been fabricated and set up to synthesize Indium and Antimony of 99.99% purity to yield high purity InSb (Indium Antimonide). Volatile impurities like Zn and Cd, which cannot be removed by zone refining, can be removed by volatilization under vacuum. InSb can be zone refined to yield semiconductor grade material. Single crystals of InSb of size 1 cm 1 cm 8 cm can be prepared in the same apparatus. By using a seed, crystals oriented in any specific crystallographic direction can be grown.	*Dahake, S.L.*
	OPTICS	
TF/D/1 Thin film devices	An improved substrate holder incorporating planetary rotation of the samples was designed and fitted to the evaporation unit. This has removed the	*Sen D. & Puntambekar P.N.*

defects and interference filters are now showing the required uniformity and reproducibility. However the band width of the filters made recently is larger than those made earlier. The cause of this is being investigated. Synthetic cryolite of Indian make was tried as a substitute for imported magnesium fluoride being used in interference filters. However, the keeping property of the cryolite filter was found unsatisfactory.

Some work was done on the development of achromatic multilayer mirrors and on using such coating for making blocking filters to eliminate unwanted transmission of interference filters. Very good blocking was achieved by this method but such blocking filters are rather expensive.

Thin Film Interference Filters

Shah V.V.
Sharma D.C.

1. Metal-dielectric-metal type interference filters have been prepared for different peak transmission wavelengths in the visible region and the same were supplied to universities, colleges, and private firms for field trials.

2. During the preparation of filters it was felt that with the existing system it is not possible to control the uniformity and thickness of the dielectric spacer layer very precisely. In view of this, a planetary gear system alogwith an optical monitoring device has been designed and fabricated. The planetary gear system can accommodate four glass plates of 5×5 cm. or 5 cm. diameter plates. As regards optical monitoring device, it has been observed experimentally that the set up becomes insensitive after depositing four dielectric layers of $\lambda/4$ thickness in succession. Keeping this in mind suitable alterations have been made in the old set up so that successive monitoring of a few layers can be carried out more accurately.

1	2	3
Determination of optical constants of metal and dielectric films by ellipsometer	This project was undertaken as a supplement to the work already in progress on thin film interference filters. The ellipsometer was fabricated using an old spectrometer. The collimator is replaced by a polariser and the telescope arm now carries a quarter wave plate and an analyser. The eyepiece of the telescope is substituted by a photomultiplier. Preliminary work on the determination of optical constants of silver and bismuth films was carried out and results obtained were quite satisfactory.	*Shah V.V.* *Dayal D.*
Film Thickness Monitor and Controller	The work on the project has been completed. Four patents have been filed. The process can now be released to industry for commercial exploitation.	*Shah V.V.* *Suri S.P.*
Development of Colour Coatings on Sunglasses	(*a*) This project was sponsored by M/s. Vacuum Coating Laboratories, Karol Bagh, New Delhi-5. In this project some of the colour shades in current use are successfully developed. A major difficulty of giving hard and abrasion resistant coating on the colour coating has also been solved. (*b*) Advice was rendered to Messrs Vacuum Coating Laboratories, Karol Bagh, New Delhi-5. for the purchase and installation of material and equipment useful in the preparation of colour coating on sunglass blanks.	*Shah V.V.*
OPT/D/3 Optical test methods based on interferometry	Work has been taken up for the Hindustan Photo Films Manufacturing Co., to develop an interferometer with reduced sensitivity for measuring the optical thickness variation in the film base. Attempt was first made to reduce the sensitivity by the known method of using the beat effect between sets of fringes obtained by illuminating an interferometer with two or more spectral bands of different wavelengths. A double focus interferometer was set up and a fifth order interference filter was fabri-	*Sen, D. Puntambekar P.N.* *Grover C P.*

cated for this purpose But this method was not found satisfactory for the required application. Later, a new method was devised for reducing the sensitivity of a Twyman-Green type interferometer by any desired amount. Here, both the beams pass through the sample but at different angles of incidence and the interference pattern shows the difference in the error seen in the sample by the two beams. A simple compensator has been devised to correct for the difference in the projected areas of the sample as seen by the two beams. An interferometer based on this principle has been set up and very good results have been obtained. Quantitative measurements are in progress.

A scatter Fringe interferometer was set up for testing concave mirrors. Several enquiries have been received from other research institutes for supply of this interferometer. A prototype of the instrument is being designed.

OPT/D/6 Development of infrared spectrometers

1. *Development of infrared spectrometer :*

Fabrication of the prototype of the near infrared spectrophotometer was started but some parts needed alteration. These are under fabrication. The optical design of the far-infrared spectrophotometer was modified to incorporate additional wire mesh reflection filters and sample changing mechanism. The development of this spectrophotometer has been completed and a report has been published.

(Late) B.D. Saksena, Pahwa, D.R. Pradhan M.M. & Lal K.

2. *Performance evaluation of infrared spectrophotometer :*

A mathematical theory of convolution and deconvolution of Lorentzian bands with a triangular function was worked out and a new and convenient method of deconvolution has been derived. This

method enables the band shape to be obtained from the recorded spectrum, even when the apparent band width and the spectral slit widths are nearly equal. It has been shown that if two bands are of equal width, the limit of resolution is reached when the distance between their centres is 0.8 times the band width.

The contribution of diffraction to the limit of resolution at various slit widths has been worked out.

The reflection and transmission characteristics of wire meshes used in far-infrared spectrophotometers, have been obtained on the theory of micro-wave propagation. The transmission and reflection values have been compared with the available experimental data.

OPT/D/7 Precision Optical component development

The following optical components were fabricated during the year : *Sen D. Grover C.P.*

	Type of components	*Number*	*Precision*	*For whom made*
1.	Test plates for laser	4	$\lambda/8$	Laser project
2.	Resonator mirrors	4	$\lambda/8$	,,
3.	18 cm. dia tools and test plate for Fizeau interferometer lens	4	$2/\lambda$	Interferometric test project
4.	90° prisms	5	—	Interferometric test project
5.	5 cm. dia optical flats.	4	$\lambda/8$	Hindustan Photo Films Mfg. Co.
6.	10 cm. dia beam dividers	4	$\lambda/4$	,,
7.	2.5 cm. dia concave mirrors	4	$\lambda/8$	Bhabha Atomic Research Centre
8.	2.5 cm dia optical windows	4	$\lambda/8$	,,
9.	15 cm. dia concave mirrors for long path absorption cell	3	$\lambda/4$	I.I.T., Kanpur
10.	5 × 5 cm. optical flats	2	$\lambda/4$	Uptodate Optical Works

Approximate value of the above items is Rs. 5000.

1	2	3
OPT/D/9 Spectrochemical Analysis	Some components and appliances required in the routine spectrochemical analysis have been fabricated in the workshop. After a detailed study of the various designs of controlled atmospheric arc, a blueprint of the same suitable to our work and the ancillary equipment available with us has been prepared. Efforts have also been made to develop a simpler device for an arc burning in controlled atmosphere and a few of them have been made and tried. One of them has been found to give the required performance in the preliminary trials. A number of ratios of graphite powder buffer to silicon have been tried and the one which gives maximum intensity for the impurities has been determined and is being used in the routine analysis. The experiments about the separation of zones of emission in arc for SiO_2 and B have not yielded any positive results. During the period 74 samples were analysed.	*Sastri V.D.P.* *Parthasarathi S.*
OPT/D/10 Design & Development of Optical Systems	During the year consultancy services were rendered as follows : (*i*) Development of level optics ; (*ii*) Development of enlarger lenses ; (*iii*) Development of box camera, mini-project and mini-microscope ; (*iv*) Development of diavision display unit ; (*v*) Development of low power microscope objectives condensers and eye pieces. The manufacturers are being assisted to set up their own testing facilities for the instruments/components manufactured according to our designs. The recommendations of ISI Specification are being incorporated into the designs. A few technical articles and research papers have also been published.	*Ram Prasad* *Manrai Mrs. S.*

1	2	3
OPT/D/11 **Gas lasers**	The laser tube was tried out by filling it at several different partial pressures of helium and neon. Electrodeless, RF discharge was used. Different resonator mirrors having 13 to 17 layers were tried but lasing action could not be obtained. Investigations showed the presence of oxygen impurity in the discharge tube. The gas purifying and outgassing arrangements have been improved and the oxygen contamination has been eliminated. Improved resonator mirror mounts have been designed and are being fabricated. Two new discharge tubes have been made with internal electrodes for AC excitation. These will be tried out as soon as the assembly is completed.	*Das S R.* *Sen D.* *Puntambekar P.N.* *Grover C P.* *Dandawate V.D.*
	CARBON PRODUCTS	
IP/D/1 **Development of manufacturing process for silver graphite relay contacts**	The compositions with lamp black incorporations gave slightly improved performance with successful life tests extending over 100 hrs with 20 makes and breaks a minute. A new relay was obtained. This has been commissioned and should help in eliminating errors due to already corroded contact dimples. New formulations, using slightly modified technique were processed and a few were tested successfully. Cohesiveness, hardness and electro-erosion are being hoped to be improved by using incorporations of different materials.	*Sen, D.* *Awasthy, B.R.* *Joglekar, G.D.*
IP/D/2 **Developments of Process Carbons**	Some improvements on the quality of light emitted by process carbons by changing core compositions has been done. Processing capacity of raw materials has been increased. The baking capacity has been doubled by doubling the charge with modifications of baking containers. Studies on the time of baking, cooling and their effect on the characteristics of the products are being carried out.	*Kapur, S.K.* *Verma, C.L. &* *Joglekar, G.D.*

1	2	3
IP/D/3 Structural Carbons	A split die was designed. With this new die, it has become possible to extrude sections of different anode carbons.	*Joglekar, G.D. Verma, C.L.*
IP/D/4 Development of pressure sensitive discs	Experiments to improve upon the performance of the pressure sensitive carbon discs are being continued. The improvement in the surface is expected to minimise voltage fluctuations. The discs made in the laboratory have been sent to proper places for tests under actual working conditions.	*Dutta, K.K. and Joglekar, G.D.*
	Development-cum-Production of Electronic Components :	
DPEC/D/1 Permanent Magnet Ferrites	A special die for pressing magnets (hard ferrites) in an oriented magnetic field has been completed. The necessary equipment such as high current, low voltage power supply, water cooling arrangements, etc., have also been set up. Experiments have been started for pressing oriented magnets.	
DPEC/D/2 Soft Ferrites	(*a*) The process on short-cum-medium wave ferrites has been stabilised after supplying some quantity to the industry and getting their reports. The process and compositions were suitably modified to meet the needs of the industry. One of our licencees has evinced interest in the process and the details have been furnished to him. They are expected to commence manufacture of MW-cum-SW ferrites shortly. Another of our licencees is also to commence production in a few months' time. (*b*) *Manganese Ferrites* The study of the variables of the process for MnZn Ferrites for the entertainment industry has been stabilised. The details have now been furnished to our licencees. The Government have also been informed that in the case of MW ferrites nickel can be completely	

substituted with Mn, thereby making the production of MW antenna rods fully indigenous.

(*c*) *Microwave Ferrites*

Some samples of microwave ferrites were supplied to a few organisations for their tests.

(*d*) *Square Loop Ferrites*

An automatic tester for the square loop ferrites is being built. A new set of dies has also been fabricated.

DPEC/D/3 Piezoelectric Ceramics

Further studies on standardization of the composition of PZT ceramics have been undertaken. Samples are being supplied regularly to many universities and research laboratories.

(*a*) *Machinable Ceramics* :

DPEC/D/4 Technical Ceramics

The process of machinable ceramics has been passed on to two of our licencees. Meanwhile, the manufacture of coil formers for the Home Ministry is continuing.

(*b*) *Pyrolytic Carbon Film Resistors* :

Some firms have evinced interest in taking over the process for Pyrolytic Carbon Film Resistors. Negotiations are in progress.

DPEC/D/5 Professional Ferrites

Latest experiments on development of professional ferrites for I.T I. have yielded very encouraging results. It has been possible to achieve the specifications for the High Permeability Ferrites required by the I.T.I., practically in all respects except permeability. The value of the permeability is about 10% below the requirements. It is expected that this problem will also be solved.

Meanwhile, in order to standardise the process, automatic control devices for the temperature and firing schedule have been evolved. The complicated dies required for E-cores, pot cores, etc., are continuing to be made.

DPEC/D/7 Thermistors

The Research, Designs and Standards Organisation Lucknow have taken samples of the high temperature thermistors for tests in their laboratory.

DPEC/D/9 Silver Paint (Conducting Cement)

Demand for silver paint and ceramic-to-metal seal paint have been growing and the requirements are being met from our production.

APPENDIX IV

RESEARCH INVESTIGATIONS

Code No. and Investigations	*Progress*	*Project Team*
1	2	3
	ACOUSTICS	
AR/4 Sound Absorption by Wedges made out of Indigenous Materials for use in Anechoic Chamber	For making wedge the selected material is available in slabs of 50 mm. thickness and since the ultimate thickness of the wedge is 20 cm, it is necessary to use four slabs in each wedge. Experiments were, therefore, undertaken to study the effect of bonding the slabs together. Several bonding materials recommended by the manufacturers such as sodium silicate, 'Mowicole', 'Fevicole' were tried out. The fibreglass material of the wedge slabs had to be put in sheaths. Muslin cloth, nylon and polythene were tried out as sheath material and cloth and nylon mesh were found to be satisfactory. Air gap at the back of the wedge was found to increase the absorption only marginally.	*Pancholy, M. Chhapgar A.F. & Bansal S.C.*
AR/8 Efficiency of Sirens	(*a*) An attempt to increase the sound output by using optimum dimensions of the stator and rotor ports was made. Preliminary measurements made in the open indicate a slight increase but the results are not conclusive due to the effect of wind and ambient noise. The measurements may be repeated when the anechoic chamber of the Acoustics Block is ready. (*b*) In order to measure the effort required to start and turn a hand-operated siren, a torque measuring device	*Pancholy, M. Bindal V.N. & Singh Davinder*

was designed. A paper describing the instrument was published. Enquiries have been received from manufacturers of sirens for making the instruments for their use.

AR/9 Sonoluminescence

Pancholy M. & Sidkey M.A. (Guest Worker from U.A.R.)

The relation between the phase of the exciting sound wave and the intensity of the emitted light was studied in a single layer of liquid in a standing wave pattern. For this purpose, a magneto-strictive transducer with a tapered velocity transformer was set up to operate at about 20 kHz. The results indicate that the light is emitted in flashes near the sound pressure maxima but the flashes do not repeat with every phase cycle of the sound wave.

The spectral distribution of the emitted light was also measured. It was found to be a continuous spectrum with a peak at about 4250 A°.

The comprehensive data collected has been analysed and an explanation of the origin of sonoluminescence has been put forward. A thesis comprising the experimental work and discussions has been prepared and submitted to Cairo University for the award of the Ph.D. degree.

BASIC PHYSICS DIVISION

BP/R/4 Thermal, magnetic and transport properties of metals and alloys at low temperatures

(*a*) *Study of torsional and young's modulli of thin metallic rods at low temperatures* :

Baveja, K.D,

(*a*) The cryostate was reassembled after repairing the leak that had developed into it. A capsule type (uncalibrated) platinum resistance thermometer has been incorporated in the cryostat.

(*b*) Measurements on the torsional modulus of elasticity have been made on an un-annealed spec-pure gold wire specimen from room temperature to liquid air temperature. Measurements are being repeated after annealing the wire.

(*b*) *Specific heat measurements at low temperatures* :

(*i*) Specific heat apparatus already perfected was used first to evaluate the heat capacity of new specimen holder which had two carbon resistance thermometers attached to it to cover different ranges of temperatures. For this, two specimen of copper of different masses were taken and their heat capacities measured. This also enabled one to compare the heat capacity of copper measured with this apparatus to that measured previously by other research workers elsewhere. Measurements on dilute Bi-Sn alloys were made. Efforts are being made to prepare other alloy systems i.e. Bi-Pb, Bi-Se, Bi-Te, etc.

Dhillon, J.S.
Sharma, R.G.
Reddy, Y.S.
Jakhwal. B D.

BP/R/6
Fabrication of Linde Type Air liquefier

Two oxygen compressors purchased from disposal were put into operation with electric drive by providing all the necessary accessories. These compressors are used to deliver air at a pressure of 150 kg/cm^2. A conical heat exchanger more or less similar in design to that developed by Collins was designed and fabricated. This was housed in a rectangular insulated metallic shell having a brass flange at the top. Both these flanges matched against each other with a 'O' ring seal in between. The heat exchanger assembly alongwith J.T. valve, siphon transfer tube and pressure gauges was completed. The compressors, electric motors, drying cylinders and the heat exchanger unit are installed in the liquid air plant room and the necessary fittings made. This unit is under test at present.

Dhillon J.S.
Sharma R.G.
Reddy Y.S.
Jakhwal B.D.

In addition to fabrication of liquid air container of 5 litre capacity, it was decided to make a small liquid helium container. Efforts are being made to get the copper hemispheres spun in the workshop. A wooden die and a few hemispheres have already been made. This work is in progress.

1	2	3
LT/R/8 Topology of bands in transition metals including s-d interaction	The s-d mixing, treated as a resonance interaction (given in the earlier reports) has important application in the problem of localized magnetic states in metals. In this connection, the Anderson Hamiltonian was studied in detail. This Calculation using Green's function technique enables us to predict localized magnetic states in a dilute alloy. Kondo effect which is related to this problem was also studied by the Green's function technique. A new truncation procedure effectively decoupling the impurity d-electron from the s-band electrons is being worked out. This study would help in explaining the anomalous conductance observed in some tunnel junctions.	*Sundram, R.*
LT/R/4 Theoretical Study of formal surface of Metals and Alloys	The effects of a l-dependent potential were compared with those of Hartree-Fock-Slater potential on band structure. It was found that the choice of a l-dependent potential does yield energy eigen states in some of the 3d transition series like Chromium and Nickel different from those obtained by taking a H.F.S. potential.	*Sundram, R,*
LT/R/5 Transport Properties	The heat conductivity of Cu-0.013, 0.1, 0.2 and 0.4 atomic % Mn and Ag-0.02 atomic % Mn have been measured in zero field and three different magnetic fields in the liquid helium temperatures. Also the electrical resistivity of these rods has been measured at liquid helium temperatures in zero and three different magnetic fields. Wire specimen of the copper-manganese and silver manganese rods have been prepared from the existing thick rods by hot-drawing a small portion of each of the rods through a wire-drawing die. The concentration (atomic % Manganese) was determined for each of the wires The electrical resistivity of these wires has been determined in the	*Chari, M.S.R.* *Natarajan, N.S.*

liquid helium temperature range and from liquid helium temperature upto the steam point.

Using Gold-Iron-Chromel thermocouple the gap between 4°K and 60°K (with a liquid helium bath) and from there up to room temperature(with a liquid nitrogen bath) has now been bridged.

The magnetic susceptibility of the following Cu-Mn and Ag-Mn rods was determined in the temperature range 80° to 300°K ; Cu-0.13, 0.1, 0 3, 0.4 and 0.5% Mn., Ag-0.02, 0.2, 0.3, 0.5 and 0.6% Mn. For these, the effective magneton number p_{eff} and θ were determined.

The thermal conductivity of Rhodium wire (obtained from Johnson and Matthey and of 99.995 per cent purity) has been measured in the liquid helium and liquid nitrogen temperature range in zero field and in four different magnetic fields. The electrical conductivity of the same specimen was also measured in zero field and in various magnetic fields. These data have enabled us to separate out the lattice thermal conductivity at liquid helium temperatures which seems to be limited by the scattering by the conduction electrons. Earlier workers have always ignored the lattice thermal conductivity in the transition metals since it is difficult to derive.

BP/R/5 Mossbauer Spectrometer

Jain, A.P.
Shringi, S.N.
Sharma, M.L.

During the initial part of this year, the first Mossbauer spectrometer was completed, installed and tested. Linewidths were measured for standard absorbers like stainless steel enriched in Fe^{57} and Ferrous Oxalate using $Cu-Co^{57}$ source and Pd-Sn absorber and the expected line widths were obtained. Another mercury cup and an electromagnetic digital counter was added to the system to enable automatic recording of the number of revolutions which is needed for calculating the velocity with which the source or absorber

moves. With this modification, it has been possible even for an untrained laboratory assistant to take measurements which had been quite a strenuous and tiring job earlier.

With a view to further improve the Mossbauer spectrometer, few other items were also studied, One of the items needed was the constant velocity monitor so that the velocity could be directly read from a dial gauge. After several investigations, a dynamo system was tried and found successful. A device, using a standard dynamo, will be shortly put on the apparatus for automatic recording of velocities.

In order to avoid the changing of belts from any pulley a gearbox using about 20 helical gears (to reduce noise still further down from the present one) has been completed and is being tested. Also, a Cam has been prepared and its profile measured with an accurate dial gauge. This Cam has given satisfactory results.

Attempt has been made to replace the governor controlled gramophone motor with a D.C. motor system where speed could be varied by varying the D.C. voltage. This is also ready and will be tried shortly when the new spectrometer is ready. In addition, the work on glass Dewar which entails glass to metal seals at several places was also attempted to replace the metal Dewar. This Dewar is ready.

Research: The technique for making a $PdSn^{119*}$ source was developed and a reasonably strong source and a Pd-Sn absorber containing 10 per cent atomic Sn was prepared. During this year, major efforts have been made on the study of $PbZrO_3$ doped with Sn^{119} in the source and absorber state. The Mossbauer spectrum was taken as a function of temparature in a specially designed furnace from 77°K to 280°C, the transi-

tion temperature being 236°C. The temperature dependent optical mode was observed. A paper is being prepared for publication. In addition, studies on Fe_2O_3, Cr_2O_3, NiO, CoO doped with Sn^{119*} have also been carried out at 300°K and 77°K. Further work in this direction is in progress.

ELECTRICITY

ECY/R/1 Survey and investigation of Electrical insulating materials

Dhar, R.N

The following measurements have been made during this year under this project :

(*a*) Effect of thermal aging at 75°C and 100°C for 0.25, 0.5, 1, 2 and 4 hours on dissipation factor of 9 grades of Formica samples.

(*b*) Determination of dielectric constant and dissipation factor at 1 and 1000 KC of 3 varieties of fibreglass reinforced plastics.

(*c*) Determination of volume and surface resistivities of 3 varieties of fibreglass reinforced plastics (FRP).

(*d*) Effect of moisture on dissipation factor and resistivities of 3 varieties of fibreglass reinforced plastics.

(*e*) Study of the surface resistivity of different grades of mica.

(*f*) Determination of dissipation factor and dielectric constant at 1 KC of FRP sheets.

(*g*) Determination of volume and surface resistivities of FRP sheets.

(*h*) Preliminary study regarding thermal life of paper based resin laminates

A three terminal cell for the measurement of the electrical properties of liquids has been designed and fabricated,

ELECTRONICS

Elec/R/1

Dielectric Behaviour of Solid and Liquid Mixtures

Parshad R.
Dube D.C.
Yadav R.S.

Solid Powders :

New correlation formulae based on the concept of propagation of radio waves through powders have been proposed for determining the dielectric data of solids from the corresponding data of its powder. The formulae proposed by us are accurate to 2 per cent for measuring dielectric constant and to 5 per cent for measuring loss. This represent higher accuracy than that obtained by the existing formulae. A number of different samples, whose dielectric constants fall under a wide range have been used for testing the formulae. A wide range of packing fractions and particle sizes have also been investigated.

The investingations have two applications,

(*i*) the possibility of elimination of use of large single crystals for determination of dielectric behaviour under different physical conditions, and

(*ii*) the technical application of designing materials of required dielectric constant and loss by use of sintered material, injection of high dielectric constant powders in paraffin, plastics etc. The latter materials are needed for assorted applications in Electronic Engineering.

Liquid Mixtures :

The correlation formula of Bottcher originally evolved for solid powders has been used for non-polar in non-polar and polar in non-polar liquid solutions. Bottcher's formula is found to be applicable to the solutions As a result of this work, an apparent dielectric constant of pure polar liquids has been introduced, which by the application of Clausius-Mosotti equation leads to a new method of determining dipole moment in solution.

The dipole moments so determined are linearly related to the real vapour values and so the latter can be determined with sufficient accuracy. A Ph.D. thesis on the above and allied subject entitled "Dielectric Investigation on Solid and Liquid Mixtures" has been submitted.

Experimental investigations have started on the study of solvent effect in solutions. The dielectric data of different polar liquids in a series of non-polar solvents are being collected. The data would yield apparent polarisation of polar liquids in non-polar solvents, dipole moments, and relaxation times. The relative values of these quantities would be compared for studying the intermolecular action in the mixtures.

A new method of accurate determination of impedances at microwave frequencies has been developed for these investigations.

ANALYTICAL CHEMISTRY

AC/R/1 Spectrophotometric methods of chemical analysis

(*a*) *Rapid determination of Chromium and Manganese in steels* : *Bhuchar, V.M. Kukreja, V.P.*

This method has been reported at the 21st Annual Session of Indian Institute of Chemical Engineers. In future, it is proposed to develop rapid method of complete analysis of steel. Silicon can be determined during the course of above method. Determination of other ingredients would be undertaken.

(*b*) *β-Thiol-propionic Acid complexes of Molybdenum* : *Bhuchar, V.M. Kukreja V.P.*

In pursuance of the work with Thiol-acetic/benzoic acid, β-thiol propionic acid was used for determination of Group VI elements. Mo gives a solution chelate with β-Thiol propionic acid. Optimum conditions for the formation are pH 4-5. It shows a λ max at 355 nm with A_m= 5000. Beer's Law is obeyed between 10-100 ug Mo/ml.

(c) *α-Thioglycerol complexes of Molybdenum :* — *Bhuchar, V.M. Kukreja, V.P.*

Another Thio-oxy ligand of similar nature is α-thioglycerol which forms a colourless chelate with Mo. Optimum conditions for its formation are pH 3 — 3.5, temp. 70°. The chelate shows a λ max at 390 nm and A_m = 5000. Amongst the cations and anions tested, the most interfering are tungstate, vanadate, chromate, uranyl, tartarates and citrates.

(d) *Use of α-Thioglycrol for the determination of Selenium and Tellurium* : — *Bhuchar, V.M. Kukreja, V.P.*

The behaviour of α-thioglycerol towards those two elements of group VI has been under investigation.

Individually, selenium precipitates with this reagent in the element state between pH 4-6.3 and can be accurately determined. Similarly, tellurium precipitates with this reagent at pHs' and above 3 and can be accurately determined. One could thus expect to determine Te and Se in presence of each other by first determining Te at pH 11 and subsequently determining Se by lowering the pH to pH 1.

It was found that when Se and Te are present in equimolar concentration *viz.* 25 mg of Se and 40 mg of Te in about 100 ml solution these could be accurately determined by the above procedure. But the method was not applicable if the concentration of either of them is reduced appreciably, due to some co-precipitation of Se and Te in the first precipitation.

(d) *Spectrophotometric determination of Selenium and Tellurium with α-Thioglycerol* : — *Bhuchar, V.M. Kukreja, V.P.*

Se^{+4} forms a complex with α-thioglycerol in molar ratio of 1 : 3 which shows a λ max. at 260 nm and A_m = 1800 at a pH of 3. The absorption falls on either

side of this pH. This complex is also stable for 48 hours.

Te^{+4} also forms a complex with the same reagent in a molar ratio of 1 : 4 which shows a λ max of 242 nm and $A_m = 6450$ between pH 1—2. This complex is also stable for 48 hours.

In this method again the absorption spectra of the two complexes fairly overlap and one is handicapped in the determination of one in presence of other because of ;

(*i*) the lack of a common pH of maximum absorption, and

(*ii*) the non-availability of suitable solvent of extraction.

AC/R/2 Thin Layer Chromatographic Methods of analysis

(*a*) *Separation of Metal ions as Acetylacetonates* : *Trehan, J.C.*

Acetyl acetone is useful as a ligand and a solvent. Its complexes are extractable by organic solvents Cobalt, nickel and copper could be separated on a silica gel thin layer by elution with cyclohexane : butanol : acetyl acetone (84 : 14 : 2), or ammoniacal benzoyl acetone. The spots after separation could be detected by rubeanic acid. Rf values of these are in the order of 4 : 5 : 10.

(*b*) *Separation of Metal ions as PAN complexes* : *Trehan, J C.*

1-(2-pyridyl azo) 2-naphthol forms coloured chelates with many metal ions and are extractable with organic solvents. Taking advantage of these two characteristics, cobalt, copper and nickel could be separated on silica gel thin layer with a mixture of $C Cl_4$: MeOH (75:25). The method is rapid. The colour of the complexes is green, red and pink respectively and the Rf values are in the order of 1 : 3 : 8. A paper has been published in Current Science on this work.

(c) *Thin layer chromatograhpic method of separation of selenium and telurium. (Selenium as selenite and Tellurium as tellurite)* : — *J. Rai. Kukreja, V.P.*

Selenium as selenite and tellurium as tellurite could be separated by the TLC technique on silica gel by an eluent prepared by saturing amyl acetate with hydrochloric acid for about 15-20 mts at 30°C. The spots could be detected as elements by reducing with stannuous Chloride solution. Rf value for Selenite and tellurite was in the ratio of about 2 : 1.

(d) *Thin layer chromatography of inorganic ions* :

Using various eluents based on alkyl esters saturated with hydrochloric acid, the following groups of cations have been separated on silica gel. The details are under publication in 'Chromatographia'.

The cationic groups separated are :

(*i*) Au : Pt : Rh : Hg

(*ii*) As : Sb : Sn : Pb

(*iii*) Cu : Ni : Co

(*iv*) Cu : V and Ti

(*v*) Mo : W : Rh

(*vi*) Se : Te.

(e) *Thin layer chromatography of diethyl dithiocarbamates of some inorganic ions :* — *Rai J Kukreja V.P.*

Diethyl-dithiocarbamate of inorganic ions, Ag, Hg, Cu, Pb, Pd, Bi and Ti are extractable with chloroform at pH 11 and of Co, Ni, Cu and U are extractable of lower pHs' of 6-8. Members of each of these groups could be separated by TLC on silica. They could be identified by the colour of their sulphide in the first group and intrinsic colour in the second group.

(f) *Separation and identification of water soluble and fat soluble food dyes :* — *Rai J.*

Rf values of 25 water soluble and 21 fat soluble dyes, marked for use in food

stuffs, have been determined in five different eluents by thin layer chromatography on silica. This gives rapid and inexpensive method of their identification.

(g) *Thin layer chromatographic studies of Phthalein indicators* : *Rai J. Kukreja V.P.*

Rf values of five phthalein indicators have been determined on silica gel layers in three different eluents. From this study, it could be ascertained that phenol-thymol-phthalein marketed by B. D. H. consist of a mixture of two indicators viz. phenolphthalein and thymol phthalein.

X-RAY

X/R/1
X-ray Studies of Solid Solutions and Phase-transformations in Semi-Conductor Materials

(*i*) *X-ray study of bismuth selenio- and sulpho-tellurides.* *Ali S.Z. Kundra K.D. Nagpal K.C.*

In order to obtain accurate powder intensity data, diffractometer alignment and calibration procedures were carefully done on the newly received Philips X-ray diffractometer, using both the G.M. and the scintillation counters. A difference synthesis based on the amplitudes ($F_{obs.} - F_{bi}$) for the basal orders has been calculated. This has given a more accurate position for Bi, with little intensity in the relative heights and positions of the peaks due to the other atoms. A two or three-dimensional Fourier projection cannot be obtained due to the disorder in the structure, specially of the stacking faults type.

Heating of Bi_2Te_3 and Bi_2 Se Te_2 in air at various temperatures has been carried out and the results are being interpreted in terms of phase changes leading to the observed bismuth oxide phase in both compositions.

(*ii*) *X-ray Study of InSe*

On the basis of Weissenberg and single crystal oscillation photographs for

annealed crystals, the space group has been determined as $P 6_3 mc$. One dimensional Patterson and Fourier projections have also been obtained. The sequence of atoms in the layer packet appears to be (In-Se-Se-In). The structural disorder in the stacking of the layer packets has prevented intensity estimation for okl and hkl reflections. Prolonged annealing for varying periods has been undertaken to remove the stacking disorder as far as possible. Diffractometer runs using the various counters for the powder patterns have heen obtained.

OPTICS

OPT/R/4 Studies on Daylight

V.D.P. Sastri, S.R. Das, Manamohanan, S.B.

The parts required for the modification of the output-tapping device of the sky scanner have been made in the workshop and fitted to the scanner. The sky scanner with the new spun gears, new tapping device and new reversing mechanism has been found to give quite satisfactory performance.

In spite of the differences in the behaviour of the characteristic vectors for Delhi and Bombay data, individual measured distributions for Bombay have been found to agree satisfactorily with the typical distributions derived from Delhi data. Some other aspects of Bombay data have also been studied and a paper is being prepared on all aspects of the Bombay data.

Some literature has been collected for the work on the Brightness contrast distribution in natural scenes. After a study of the literature a suitable design of apparatus has been thought and the details are being worked out.

RADIO SCIENCE

RSD/4 Satellite Radio Beacon Studies

Tyagi Tuhi Ram Somayajulu Y.V. Bakshi S.R. Gupta J.K.

1. Satellite transmissions of Explorer-22 were recorded regularly on 20, 40 and 41 MHz.

2. Electron content values were calculated for the period July, 1967 to March, 1968 from Explorer-22 record and for the period January, 1967 to July, 1967 from Explorer-27 records.

3. The theoretical explanation of time lag in the occurrence of Q-T points at widely spaced frequencies has been revised. A paper based on this has been accepted for publication.

4. A thesis entitled "Satellite Radio Beacon Studies of the Ionosphere" has been submitted to the Delhi University. The work reported in this thesis is essentially based on the studies made under this project.

5. Collaboration with the Kurukshetra University :

   Active collaboration between the Radio Science Division and Kurukshetra University is being pursued to get a wider coverage of the satellite beacon radio reception. The receiving equipment was given to Kurukshetra University. Faraday fadings rccorded at Delhi and Kurukshetra simultaneously are being anlysed. A staff member of the Kurukshetra University is writing another thesis for Ph.D. based on these results.

RSD/5
Rocket Studies of Lower Ionosphere

Somayajulu Y.V.
Avadhanulu M.B
Kane N.N.
Bakshi S.R.
Gupta J.K.

1. The d.c. probe data from the rocket flight 14.256 II has been analyzed. An electron density profile and an electron temperature profile have been derived for the altitude range of 70-140 km. Some of these results were presented at the Equatorial Aeronomy Conference in Ahmedabad as well as at the International COSPAR meeting in Prague, Czechoslovakia.

2. A second rocket flight from the Thumba equatorial rocket range is scheduled for September, 1969.

Assembly, calibration and integration of the various payloads will be carried out as soon as possible.

3. Meetings were held with the Thumba rocket range personnel to discuss the flight plan, the integration and telemetry requirements.
4. The various details of the ground support experiments and facilities were worked out and the rocket range engineers were informed about these.

RSD/R/6 Riometers — *Sharma, S.B.S.S. Sharma M.C.*

Routine observations of Cosmic radio noise were carried out to study the normal ionospheric absorption and to make use of the observations as a solar flare patrol. The following are some of the important results :

1. During low sunspot years the F region contribution towards total absorption is more than the lower regions ;
2. for the same foF_2 value the absorption shows a seasonal variation (minimum during summer);
3. there is a strong correlation between total electron content and total absorption during the low sunspot period;
4. the absorption values obtained are consistent with an inverse square law frequency dependence of absorption confirming the conclusion drawn from rocket experiments that the high frequency absorption must be above about 80 km.

Final values of the normal ionospheric absorption at 20 and 30 MHz for the year 1968 have been sent to World Data Centres for exchange of the Data.

RSDR/8 Rocket and Satellite Studies of the Ionosphere — *Mitra A.P. Saha A.K. Chakrabarty, D.K.*

Detailed computation of height distribution of ion production function in the upper atmosphere that were made with a computer programme (RPU Scientific Report No. 40, Feb., 1968) have been utilized to investigate D-region electron density variations as well

1	2	3
	as recombination processes. Particular emphasis was given to the diurnal variation aspect. A draft report has been prepared and titled "Some conclusions from a study of gross features in diurnal variation of electron density profiles in the D-region".	
RSD/R/9 Study of F-layer effects with frequency Deviation and Phase Anomalies (PL-480 Project)	The dopplometer equipment which has been running at Calcutta very satisfactorily for the last four years, had to be brought for overhaul to Delhi in May 1968 and in November 1968. Otherwise it has been running satisfactorily and flare records obtained have been referred to RSD/S/2 for publication. The VLF phase equipment has been put into operation but the running has not been very satisfactory due to non-availability of a suitable station. Since December, 1968 it is put on a strong station (1000 KW) at Western Australia radiating at 22.3 kc/s A detailed study has been made into the ways of obtaining flare time increase in electron density distribution in the D-region from SID data A detailed statistical study of solar X-ray flares and associated SID effects has been made, and a paper based on the above is under preparation.	*Saha A.K.* *Subrahmanyam, C.V.* *Vashisht, A R.S.*
RSD/R/10 LF and VLF Radio Wave Propagation	A study of the propagation of radio waves of frequency 164 KHz transmitted from Radio Tashkent and received at Delhi is undertaken. Theoretical calculation of the ionospheric reflection coefficients is made and the results discussed in a paper to be presented at the Symposium on Electro-magnetic Probing of the ionosphere due to be held in July 1969 at Calcutta. The response of noon-time signal amplitude to solar and geomagnetic activities is being studied. The effect of flare in the X-ray source Sco X-1 on LF propagation is also being studied.	*Ramanamurty, Y.V.* *Hamid, A.*

SOLID STATE PHYSICS

SSP/R/3
Study of Colour Centres in Ionic Crystals

Jain, S.C.
Mahendru, P.C.
Parashar, D.C.
Sootha, G.D.
Narendra Kumar

Detailed optical and ESR absorption and electrical conductivity measurements with additively coloured KCl crystals of different purities have shown that the nature of the colour centres in these crystals and their effects on the above mentioned properties of the crystal depends upon (1) the purity of the crystals, (2) exposure of the coloured crystals to visible or F light and (3) thermal treatment given to the coloured crystals. Highly pure crystals quenched from the colouring temperature show only the F band at 560 nm. Exposure of these crystals to visible light near room temperature produces M, R and N centres. The M centres produced in this manner are of two types, i.e., the soft M centres, M_s and the hard M centres, Mn. On heating, the F centres are converted into colloids at ~300°C, The colloids are always in heterogeneous equilibrium with the F centres in the temperature range 300–450°C.

Crystals of ordinary purity also behave in the same manner at about room temperature. However, the formation of colloids is suppressed in these crystals. The impurity effects are enhanced if heating is done in light. Impurities like Cd suppress the formation of alkali metal colloids completely.

The coloured crystals quenched from the colouring temperature in dark, show only one ESR line due to F centres.

Crystals containing alkali metal colloids show a sharp ESR line of half width 2.5 gauss at room temperature, superimposed over the broad ESR line due to F centres. The half width of ESR line due to colloids remains constant in pure crystals heated in dark. Impurities like cadmium do not show any additional line after colouration. The Cadmium

colloids disappear when the crystals are heated to 700°C.

The conductivity of the highly pure coloured crystals in dark, remains unchanged upto ~300°C. Above 300°C, it starts increasing and the ratio $\sigma C/\sigma N$ (σC is the conductivity of the coloured crystal and σN that of an identical uncoloured crystal) shows a maximum near 400 – 450°C. Detailed experiments have shown that the enhanced conductivity is electronic and the electrons are emitted by the alkali metal colloids by the process of thermionic emission. In cadmium doped crystals, the ratio $\sigma C/\sigma N$ remains less than unity upto ~550°C.

Ionic conductivity of pure and doped KI has been measured in the temperature range 200 to 700°C. A large contribution to conductivity by the anion vacancies is observed in pure KI at high temperatures.

The solubility of CO_3^{2-} in KI is also good. KI crystals doped with CO_3^{2-} show an increase in conductivity at high temperatures due to the increase in anion vacancy concentration. At lower temperatures the conductivity of KI is suppressed with CO_3^{2-} impurity. All these results have been explained satisfactorily and published.

SSP/R/4
Study of Optical, Electrical and other Properties of Thin Films

Jain, S.C.
Ramesh Chander
Davendra Singh

The measurements of temperature coefficient of resistance (TCR) of the evaporated vanadium films in the thickness range 60-900A° have been made. The TCR of the films is zero in the range 150-450 A°, positive for film >450 A° thick and negative for films <150 A° thick. These results have been explained in terms of the size effects and the structure of the films.

Studies have been carried out on the electrical resistivity, the TCR and the Hall effect in evaporated palladium films. The results show a strong thickness dependence for films below

300 A° thick. Similar observations have been made on the vanadium and titanium films also.

SSP/R/5
Physical properties of and irradiation effect on ionic crystals and semi conductors

Jain, S.C.
Mahendru, P.C.
Sootha, G.D.
Krishan Lal
Narendra Kumar
Ved Mitra

(*a*) EPR, optical absorption and electrical conduction studies of X-irradiated Co doped NaCl crystals were carried out. X-irradiation produced new centres, designated as S centres, in these crystals. The S centers showed an EPR line with g-value 2.049 $\pm$0.002 and half width 62$\pm$3 gauss. An optical band was observed at 210 nm due to S centres. These and earlier results of dielectric loss studies could be explained on the basis of the model $Co^{+}+-$. Thermal bleaching of heavily X-irradiated Co doped crystals produced another type of centres, designated as centers. The C centres showed a Lorentzian EPR line with a g value 2.14$\pm$0.01, and an optical absorption band at 200 nm. The conductivity of crystals decreases due to C centres. The observed results could be explained by assuming C centres to be loose clusters of Co^{+} centres.

(*b*) Effect of optical and thermal bleaching on the UV bands in highly pure and Mn doped KCl crystals have been studied. In highly pure KCl crystals, X-irradiated at room temperature, the usual UV bands at 212 and 230 nm are observed. The peak position of the 212 nm band when bleached with UV light shifts gradually to 195 nm, without any appreciable change in the intensity of the band. When bleached thermally or optically with UV light the peak position of the 230 nm band remains unaltered whereas its intensity decreases.

In uncoloured KCl : Mn crystals, Mn introduces two U / absorption bands at 201 and 273 nm. having half widths 0.36 and 0.15 eV, respectively. On X-irradiation, the positions, intensities and half widths of these bands remain

unaltered and a new absorption band at 223 nm appears. Although thermally unstable, the centres responsible for the 223 nm are fairly resistant to UV light bleaching. An activatioq energy E=0.54 ±0.02 eV is obtained for the thermal bleaching of the centres that absorb in the 223 nm band.

(*c*) Alkali halide Thermoluminescent Dosimeters :

Calcium activated KCl crystals have been developed as dosimeters, suitable for measuring radiation dosages from 10 mR to 50,000 R. These dosimeters are easy to prepare, easy to handle and are sensitive for small dosages. These can be used repeatedly without any loss in the sensitivity.

SSP/R/6
Ultrasonic attenuation, elastic constants and internal friction in Metal and alloy single crystals

Dayal C.R.

But for the contributions arising from the distortion of the Fermi-surface, the work on the following has been completed :

1. Electronic contributions to the elastic constants of the divalent metals in the normal and the super-conducting state.

2. Electronic contributions to the thermal expansion coefficient of divalent metals with hexagonal crystal symmetry.

CARBON PROJECTS

IP/R/1
Micromeritics of indigenous industrial material like carbon powders

John, P.T. & Vohra, J.N.

Changes are being made in the adsorption apparatus with different parts obtained during the period. A complete review of methods of measurements of particle size has been made. Some modification in the ISI draft for particle size distribution in the subsieve range by methods other than sieving were incorporated. Modifications in the Andreasen pipette method also have been made for incorporation in ISI draft.

Two turbidimeters for AIMIL and one for DPEC were tested. Tests have

1	2	3
	been made on porosity for two insulators supplied by outside firms, and on permeability coefficients for a number of fibre glass and foamed rubber from Acoustical Division, a filter by another division, and particle size determination on alumina supplied by an outside firm were done. One hygrometer was tested for its performance.	
IP/R/2 Studies on Battery Separators	Studies on the structural parameters of slab separators of miners' cap lamp batteries have been completed.	*John, P.T. Bohra, J.N. & Joglekar, G.D.*
IP/R/3 Development of porosimeter	Preliminary investigations for the development of mercury porosimeter are in progress.	*John, P.T. Bohra, J.N. & Joglekar, G.D.*

Code No. and Projects	Progress	Project Team
1	2	3
	1. Carbon	
IP/PP/1 Development of Projector, Process and other carbons	Quantities of process carbons and projector carbons were processed and baked in improved capacity formers packed in modified containers. Graphite rejected from mercury cells supplied by Dhrangadhara Chemical Works were tried ; these graphites were successfully extruded and baked in two sizes. Large diameter electrodes extruded earlier were also baked. Projector carbons of different foreign makes were tested along with those made at NPL and results sent to Messrs. India Carbon Co. Process carbons sold during the period amount to over Rs. 45,000. The two hundred ton press was recommissioned and some 45 mm dia. rods of different sections of anode carbons were extruded. The new boiler was installed and will be commissioned after certification by the Boiler Inspector.	*Kapur, S.K. Verma, C.L. & Joglekar, G.D.*
	2. D.P.E.C. Unit	
DPEC/PP/1 Sft Ferrites	Since the licencees for the process of Soft Ferrites have commenced production of antenna rods, etc., required by the radio receiver industry, the production of antenna rods was brought down to one tonne per month. This too is in the newly developed MnZn ferrites in place of NiZn ferrites which was completely stopped. Since the process	

for the MnZn ferrites has been stabilised by large scale experiments in pilot plant trials, the pilot plant has gradually changed over to making MW-cum-SW ferrites.

DPEC/PP/3 Professional Ferrites

The refractories for the tunnel kiln have been ordered and the refractories are expected to be shipped in October, 1969. The automatic presses that have been ordered from West Germany for making memory cores as well as TV Yokes are also expected to be shipped at the same time.

DPEC/PP/5 Hard Ferrites

It has been possible to improve the quality of the hard ferrites by careful process control. Suitable compositions and dies have been developed for making cycle dynamo magnets and a few other components. As reported under development projects, the presses, tools and power supply for oriented magnets have been installed.

The production figures of the electronic components in the DPEC unit are given in the following table :—

Name of the Product	*Quantity*	*Value (Rs.)*
1. Ferrite Rods	1,70,404	2,38,017.15
2. I. F. Cores & Tubes	6,30,124	72,666.48
3. Oscillator Cores	22,458	4,003.32
4. Hard Ferrites	7,430	7,423.65
5. Toroids	216	630.70
6. PZT bodies	944	2,347.98
7. Professional Ferrites	7,342	3,092.80
8. Silver Paint	4,320 kg	2,592.00

3. GLASS TECHNOLOGY UNIT

This unit continued to play a very active part in the various fields of Scientific Glass Instrumentation and vacuum technique. The momentum of the manifold activities has been accelerated for the benefit of Industry, Research, Medical Colleges and Educational Institutes. During the year under review the unit has achieved a few outstanding achievements which will have a major effect on the development of complicated glass apparatus in the country.

A few apparatus have been designed and patents for the following two processes are being finalised.

1. An automatic all glass distillation unit type heater inside the flask covered with a glass tube 1,000 w in which capacity of flask can be supplied upto 20 litres. This unit can be used as single, double or triple as per requirement of the indentor.
2. Cracking unit for silicon tetraiodide crystals.

A few of the important apparatuses being made in Glass Technology Unit are listed hereunder :—

1. Sedimentation test apparatus.
2. Particle Separator.
3. Pen Recorder.
4. Low Temperature Cryostat.
5. All Glass 20 litre extraction assembly.
6. All Glass 20 litre fractionating assembly.
7. Kerr cell for High Velocity Cameras.
8. Dewar flasks for liquid helium and liquid oxygen.
9. Corad Head.
10. Different types of High Vacuum System.
11. Vacuum gauges like McLeod Gauges, Vacuostats etc.
12. Mercury Diffusion Pump.
13. Reaction Kettles.
14. Micro pipettes and Micro burettes.
15. Special Glass Cylinders with ground stoppers.
16. Pipette Washers.
17. Multineck flasks with standard ground glass joints—capacity upto 20 litres.
18. Specific Gravity bottles.

19. Standard Quartz Joints.
20. Glass Electrodes
21. Conductivity Cells.
22. Glass Atomizers.
23. Glass Sprayers.
24. Pear-shape separating funnels.
25. High Vacuum stop corks upto 20 mm base.
26. Triple Distillation apparatus.
27. Glass to Metal Seals.
28. Graded Seals.
29. Vanslyke apparatus.
30. Gas Respirometer.
31. Oldershaw columns.
32. Mercury Purification Columns.
33. Mercury Distillation apparatus.
34. Particle size determination apparatus.
35. Typinizing flasks.
36. Crooks discharge tubes.
37. Vacuum unit for crystal growing (semi-conductors).
38. BET apparatus for moisture determination.

Important Achievements

New techniques have now been developed to use teflon and PTFE in the fabrication of Scientific Glass Apparatus. Teflon sheets, Flat rings, O rings, washers and stoppers etc. are provided by this department in the apparatus in which no greases are to be used or where greases are to be avoided. This has been adopted by the National Physical Laboratory in this country for the first time and it will have a far reaching impact on the development of Scientific Research, Chemical Industry and Technology.

Developmental work on the Ignitrons is in hand and certain definite results have been obtained. Further work in the project is being done and it is hoped, the full know-how will be ready soon.

Developmental work on spherical joints is also being taken up.

During the year under review a large number of Mercury Arc Glass Rectifier Bulbs have been reconditioned for

1. M/s. Andrew Yule & Co., Calcutta.
2. M/s. Standard Batteries Ltd., Madras.
3. M/s. Oldhem & Sons, Madras.
4. M/s. Speciality Papers Ltd , Vapi.
5. M/s. Kanpur Electricity Supply Administration, Kanpur and many others.

A few High Power water-cooled Oscillating valves were received and reconditioned for M/s. Usha Forgings & Stampings Ltd., Faridabad and M/s. Dewidutt Tools Ltd., Faridabad.

A large number of requests have also been received for the reconditioning of Steel Tank Type Rectifiers (Big capacity) but due to the lack of facilities and equipment this project could not be taken up. Efforts are being taken to procure necessary equipment for this work.

Following firms have been advised by the Department :—

M/s. Indian Tube Company, Jamshedpur.

M/s. DCM, New Delhi.

M/s. Link Electronics, New Delhi-15.

M/s. A Paul Instruments, Jind.

M/s. Tata Tube Company.

M/s. Bhilai Steel Plant.

M/s. Chopra Electricals, New Delhi and many other firms have been advised for their manufacturing problems.

The unit have turned out equipment worth approximately Rs. 2,450 lakhs during the year.

WORKSHOP

During the year under review, the workshop received 2,128 work orders and executed 2,312 work orders out of which some of the major jobs are listed below :—

(*a*) XYZ movement apparatus for Materials Division.

(*b*) Groving machine for Electron-Microscope.

(*c*) High pressure assembly for DNPL Division.

(*d*) Two loop antennae frames for RPU.

(*e*) One book holder for micro-film camera AHS for Insdoc.

(*f*) Aluminium lamp housing and three beams for Mechanics Division.

(*g*) Steel cabinet for the U.H.F. assembly for Electronics.

(*h*) Integrating sphere 250 cm dia for Optics.

(*i*) Two cryostats for Materials Division.

(*j*) Two jets for high vacuum pump for G.T.U.

(*k*) Batch production of micro-wave component parts for Electronics.

A number of design works were carried out by the Drawing and Design Section. The following are the important one :—

(*a*) Design of variable speed gear box, reduction 1 RPM in 24 hours.

(*b*) Design of gear box reduction 1 : 144 for DNPL Division.

(*c*) Design of rolling reversible canvas black board for DNPL Division.

(*d*) Design of die for Carbon Pilot Plant.

(*e*) Design of anti-vibrating device for Infrared Division.

(*f*) Design of horn for Acoustics Division.

(*g*) Design for Terrestrial eye piece mount box for Optics Division.

(*h*) Design of Twyman green interferometer mirror mount for Optics Division.

(*i*) Design of testing mount for microscope objective for Optics Division.

(*j*) Design of variable Attenuator for Electronics Division.

(*k*) Design of Planetary gear system for Optics Division.

(*l*) Design of an Apparatus for recording kinetic energy for Basic Physics Division.

(*m*) Design of variable gear box for Basic Physics Division.

The following jobs were carried out for outside organisations :—

Sr. No.	*Details of jobs*	*Organisation*
(*i*)	Fabrication of iron and brass male and female cones.	C..D.R.I, Lucknow.
(*ii*)	Engraving names of the members of Parliament.	Asst. Eng. Elect. Divn., CPWD, New Delhi.
(*iii*)	Machining of Aluminium casting.	Patel Chest Institute, New Delhi.
(*iv*)	Silver soldering of various components of brass cylinderical chamber.	Atomic Mineral Dept., New Delhi.
(*v*)	Fabricate gears as per drawing.	University of Delhi.
(*vi*)	Machine for pieces of mild steel girders.	C.R.R.I., New Delhi.
(*vii*)	Machining of a 3 m long shaft for girder.	Dy. Director, Research and Development, Civil Aviation, New Delhi.

SERVICE TO INSTITUTIONS/INDUSTRY

Radio Science Division

Code No. & Problem	*Service/Advice*	*Team*
1	2	3
RSD/S/1 Regular Ionospheric Soundings and True Heights	Routine round the clock soundings of the ionosphere at 15 min. interval continued satisfactorily. Routine hourly scaled data were provided for radio propagation services (RPU/S/2). Weekly summary data were sent (on request) to interested people in India and abroad. Selected records were specially scaled and reduced to true heights with an electronic computer programme and given to other laboratories on request and for the project RPU/R/4 on satellite radio beacon studies. A study on the feasibility of measuring electron temperature through measurement of ionospheric absorption and ionosonde records had been made. The results were reported at the International Symposium on Equatorial Aeronomy held at Ahmedabad in February 1969.	*Saha A.K.* *Subrahmanyam C.V.* *Jain V.C.* *Venkatachari, R.*
RSD/S/2 Solar Geophysical and Propagation Data Services	Being in-charge of the ARWC, this project was responsible for the dissemination of warnings about solar and geophysical events (being received in the form of geoalerts and URSIGRAMS to all the scientific and research organisations in India. Several attempts were made during last year to broadcast the Geoalert and Ursigram messages along with Time and Frequency transmissions from ATA. A survey of the reaction of the various	*Reddy B.M.* *Mrs. Agarwal S.* *Jain V.C.* *Malhotra P.L.* *Mendiratta R.L.* *Chandrasekharan V.A.*

users of these transmissions revealed that the voice broadcasts from the ATA transmitter were very unsatisfactory and now it has been ascertained that poor voice modulation is the reason for bad reception. Hence the All India Radio has been approached to continue these transmissions until independent arrangements could be made. This service is realised to be of immense use to workers in geophysical and allied sciences in the current year of International Year of Active Sun (IASY).

Radio propagation data services were provided, on a regular basis, to the radio traffic organizations in India (e.g. AIR, OCS, Defence, P & T) and abroad in the following form :—

(*i*) through regular dissemination of basic ionospheric data (RRC—A Series, Part I).

(*ii*) through regular dissemination of solar and geophysical data (RRC—A Series, Part II).

(*iii*) through prediction of solar index, sunspot number (six months in advance).

(*iv*) through predictions (6 months in advance) of radio propagation conditions over Asia and parts of Europe.

(*v*) through special predictions of radio propagation conditions for the border area (NEFA and LADAKH).

(*vi*) On the request of OCS the problem of bad receiving conditions at their receiving station Calcutta is being investigated.

1	2	3
RSD/S/3 Development of Radio Forecasting and Service Techniques	Preliminary studies of day-to-day variations of f_0F_2 and M(3,000)F2 are in progress. The study has been initiated with a view to formulate a procedure for starting a suitable short-term prediction service. The basic data used in routine long-term prediction have been updated and several new stations' data have been included. At the request of P and T Department a survey of the coverage of the Meteorological Transmissions given by them on behalf of India Meteorological Department has been undertaken. The study revealed that the frequency coverage was sufficient to give the coverage expected.	*Saha A.K.* *Mrs. Agarwal S.*

INSTRUMENTATION AND SERVICING
1968-69

During the period under review, 81 Instrument Service jobs were carried out. These included lakhs worth of out-of-order imported apparatus from a variety of Educational, Research, Medical and Industrial Institutes from all over the country. The variety and complexity of the sceintific apparatus serviced at NPL is increasing every year and more and more institutions are making use of this facility which has by now an established reputation in this line.

Some special types of instruments received for service/modifications were :—

Petrol Analysis apparatus, Audiometer, Microtome, Photocolorimeter, Surgical Diathermy, Digital Wheatstone Bridge, Research Camera, Fumigant Gas Analyser, Electro-cardiograph, Plating Thickness Monitor, Automatic Titrator, Muscle Stimulator, Decade Scaler, Polarograph, Electro-surgical Apparatus, Flaw Detector, Ether Inhaler etc.

Besides Instrument Servicing, 59 Inquiries concerning instrument application, instrument operation, Instrument specifications and sources for purchases of specific apparatus were dealt with from a variety of Institutions and individual users of instruments.

During this period, services of Mr. S. K. Suri, Scientist Incharge, were loaned to UNESCO for six months to impart teaching and training in Instrumentation at the UNESCO Project in South Korea.

The activities of this Department were taken note of by the Press in the form of a feature article in the Hindustan Times when an illustrated article entitled "NPL Service Centre Helps Hospitals and Factories" appeared.

An article "Medical Instrumentation and the NPL" appeared in the Journal of the Institution of Engineers (India).

NPL LIBRARY

The total number of additions to the library during the period 1st April, 1968 to 31st March, 1969 was 5514

The toral number of accessioned publications in the library upto 31st March, 1969 was 65,870.

APPOINTMENTS AND PROMOTIONS

Dr. Kailash Chandra Scientist 'C' promoted to Scientist 'E' w.e.f. 10.1.1969.

SPONSORED SCHEMES

A PL-480 aided project "Study of Flare effects with freuqency deviations & phase anomalies" was carried out during the year. A number of additional equipment were set up. These include observation of Radio transmission from Alina Ata (182 KHZ) Leningrad (224 KHZ) & NWC (22.3 KHZ) Australia. Recording of transmission from Leningrad and Australia was commenced.

HONOURS AND AWARDS

1. Shri G.D. Joglekar and Shri C.L. Verma were awarded by Invention Promotion Board for their patent "The Simultaneous Extrusion of Core & Shell Materials."

2. Dr. A.R. Verma, Directer, National Physial Laboratory, was awarded degree of D.Sc. by London University.

3. Shri H. C. Bhasin was awarded degree of Ph.D. by Bombay University on his thesis "Resonance & absorption of X-rays for Fe^{57} in Sr Tco_3 Lattice."

4. Sh. Tuhi Ram was awarded degree of Ph D. by Delhi University on his thesis "satellite radio beacon studies."

5. Shri Jagdish Sharan was awarded degree of Ph.D. by Delhi University on his thesis "Some investigations on Algebra of currents & dispersion theoretic approches to particle physics."

6. Shri Darshan Lal Katyal was awarded Ph. D. by Delhi University on his thesis "Massers & Decay widths of Baryons & Resonances in Quark Model."

7. Shri D.C. Parashar was awarded degree of Ph.D. by Delhi University on his thesis "Cation diffusion, electrical conduction and optical absorption in KCL, KI & Nacl Crystals."

FOREIGN DEPUTATIONS

DIRECTOR

Dr. A. R. Verma

U.K. : Deputed to attend the International Conference on Crystal Growth held at Birmingham (UK) and also visited NPL, Teddington from 15th to 24th July, 1968.

France : Represented Govt. of India at the 57th session of the International Ccmmittee of Weights and Measures and General Conference of Weights and Measures held in Paris from 14th to 18th Oct., 1968.

U.S.A. : From Paris Dr. Verma went to Pennsylvania to attend the International Conference on Silicon Carbide from 20th to 23rd October, 1968.

SCIENTISTS

1. **Dr. A. P. Mitra**

U.K. : To participate in Planning Assembly of Inter-union Commission on Solar Terristrial Physics held in London from 27.1.1969 to 31.1.1969.

2. **Dr. V. G. Bhide**

U.S.A. : *U.K.* & *Japan* : As nominee of National Science Foundation to get acquainted with Science projects that have been launched by the National Science Foundation, U S.A. and other agencies for improvement of science education in India, under the agreement between the Government of India and U.S. Agency for International Development during October to December, 1968.

I. Colombo Plan

3. **Sh. S. P. Suri**

Japan : For training in the field of Electronics under Colombo Plan from 15th May to 30th Nov., 1968.

4. **Sh. V. K. Batra**

Canada : For training in the field of Maintenance and Derivation of Electrical Standards (Electricity) under the Colombo Plan for a period of one year from 26.3.1968 (A.N.).

5. Sh. V. P. Wasan

Canada : For training in the field of Heat and Solid State Physics under Colombo Plan for a period of one year (from 17th October, 1967 to 1.10.1968).

6. Sh. P. K. Mittal

Canada : For training in the field of calculable unit capacitance for a period of 2 years – from 4.2.1967 to 13.11.1968.

II. Indo-French Technical Cooperation Agreement

7. Sh. M. M. Bindal

Under Indo-French Technical Cooperation Agreement specialisation in Stress Analysis by Moire Technique for 10 months from 1st June, 1967 to 22nd April, 1968.

III. Exchange of Scientists Programme between CSIR and British Council

8. Dr. D. Sen

U.K. : For training in the field of Optical Interferometry under the exchange of scientists programme between CSIR and British Council for a period of 3 months w.e.f. 4.11.1968.

9. Dr. Kailash Chandra

U.S.A. : To acquaint with Microwave Standardisation Technique under Exchange Agreement with U. S. National Science Foundation—for 158 days w.e.f. 22.2.1969.

1	2	3
16. Prof. Harry Meiners, (U.S.A.)	Electron Diffraction	15.11.68
17. -do-	Optical Multiplexing and Computer Generated Satellite Orbits	20.11.68
18. Prof. J. M. Ziman, F.R.S., University of Bristol	Localization of Electrons in Ordered and Disordered Systems	3.12.68
19. Dr. A. Engstrom, Karolinsk Institute, Sweden	Low Angle Scattering and Diffraction in the study of Biological Macromolecules	7.12.68
20. Prof. F.C. Brown, University of Illinois	Magneto-optical properties of Defect Centres in Alkali Halides	18.1.69
21. Dr. W.A. Runciman, AEE, Harwell (UK)	Spectroscopic Studies of Zero Phonon Lines	20.1.69
22. Dr. A. Franks, N.P.L. Teddington (UK)	Applied X-rays, Electrons and Ions	22.1.69
23. Dr. I.S. Szanto, Hungary	X-ray Topographic Methods for making visible the Lattice Defects of Solids	23.1.69
24. Prof. A. B. Scott, Oregaon State University (USA)	Recent Experiments on Processes in Ionic Crystals	24.1.69
25. Dr. A. Franks, N.P.L., Teddington (UK)	Electron Microprobe Analysis & Scanning Electron Microscopy	29.1.69
26. Dr. A. Jayaraman, Bell Telephone Lab., (USA)	Solids under Pressure	30.1.69
27. Dr. A. Franks, N.P.L., Teddington (UK)	NPL Ruling Engine and X-ray Diffraction Gratings	18.2.69
28. Prof. Fred Hoyle, F.R.S., Cambridge University	Pulsars	25.2.69
29. Dr. Alladi Ramakrishnan, Institute of Mathematical Sciences, Madras	New Generalizations of Pauli Matrices	3.3.69
30. Prof. Bernhard, Physikalisches Institute, Regensburg	X-ray Interference Patterns of Spherical Surfaces	7.3.69
31. Prof. Rustom Roy, Penn. State University (USA)	Non-crystalline Materials as Solid State Hosts	12.3.69

GUEST WORKERS

Sl No	Institution	No.	Placement Division
	1	2	3
1.	Deccan College-Post Graduate & Research Institute, Poona.	1	Acoustics
2.	Delhi College of Engg., Delhi.	5 7 4	App. Mech. Electronics Workshop
3.	CEERI, Pilani.	1	Electronics
4.	Directorate of Scientific Research, Naval Head Qtrs., New Delhi.	1	Optics
5.	Govt. Science College, Gwalior.	1	Microwave
6.	B.H.U., Varanasi.	9 1	Electronics Basic Physics
7.	Madhav Engg. College, Gwalior.	1	Rheology
8.	Thapar Institute of Engg. & Technology, Patiala.	4	Electronics
9.	Birla Institute of Science & Technology, Pilani.	10 1	Electronics Electricity
10	Indian Institute of Technology, Kanpur.	1 2 1	Low-Temperature Workshop Materials
11.	Punjab Engg. College, Chandigarh.	14	Electronics
12.	Madras Institute of Technology, Madras.	2	Electronics
13.	Motilal Nehru Regional Engg. College, Allahabad.		
14.	Jadavpur University, Jadavpur, Calcutta.	2	Workshop
15.	College of Engg., Kakinada (A.P.)	2	Electronics

1		2	3
16.	J.K. Institute of App. Physics, University of Allahabad.	4	Electronics
17.	N.R.E.C. College, Khurja.	1	Microwave Components
18.	Govt. Science College, Gwalior.	1	Electronics
19.	Kashmere Gate Polytechnique, Delhi-6.	4 1	Electronics DPEC
20.	Regional Engg. College, Kurukshetra.	1 2	Radio Science Electronics
21.	Jodhpur University, Jodhpur.	1	Solid State Physics
22.	I.I.T., Delhi.	2 12	Acoustics Electronics
23.	Wireless Station, Mehrauli, New Delhi	1	Electronics
24.	College of Engg. & Technology, Aligarh.	1	X-Ray
25.	Delhi University	1	Analytical Chemistry

PAPERS PUBLISHED

(A) In Indian Journals

1. A modified equation for pore vol. and area distribution in finely divided and porous materials by Dr. P.T. John and J.N. Bohra, J. Physical Chemistry 71,4041, 1967.
2. Electrical properties of Thin Titanium Films by Dr. S.C. Jain, R. Chander, R. Howard. Ind.J.P. & A.P., 5 (1967). 397-400.
3. Electrical and magneto-resistances of Carbon resistors at low temperature by Dr. M.S.R. Chari, J PAP, Vol. **5**, No. 10, p. 482, 1967.
4. Properties of Ferrite Antenna rods made from iron ore and its effect on receiver performance by T.V. Ramamurthi, C.V. Ganpathy and V.N. Sharma. J of Inst. of Tele. Com. Engrs., 1967, Vol. **13**, No. 8, pp. 310-315.
5. Soft ferrite manufacture from mineral iron ore by C.V. Ganpathy, S.C. Gupta, G. Govindaswamy, T.V. Ramamurthi, J. of Institution of Telecomm. Engrs., 1967, Vol. **13**, No. 8, pp 306-9.
6. Primary aberrations of two lens systems of Ramsden type by Sh. Ram Parshad IJPAP, 1967 Vol. **5**, No. 9, pp. 405-9.
7. Water Desalination by Dr. M.L. Khanna, Chemical Age of India, Vol. **19**, No. 4, April, 1968.
8. Paper chromatographic method for the separation and identification of Titanium, Uranium, Thorium and Zirconium as their thiocyanate complexes by M.R. Verma and P.K. Gupta, Curr. Sci. 5-4-68, 37, No. **7**, 194-5.
9. Chromatographic methods developed at NPL—A Review by Sh. M.R. Verma, P.K. Gupta, J. Rai, Research and Industry, 1967, 12, 233.
10. Rheology in Industry by Dr. S.S. Chari, Research and Industry, 1967, 12, 149.
11. Volumetric method for the assay of ferrous oxalate by M.R. Verma, V.K. Amar and N. Gangopadhyaya, Ind. J. Chem., 1967, 5, 58.

12. Investigations on Dielectric Behaviours of Acetone Chloroform and Diethyl ether-Chloroform mixtures at Microwave frequencies by R.S. Yadav, D.C. Dube and Ram Parshad, Ind. J. Pure and Appl. Phys., 1968, 6, 101.

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14. Rapid Spectrophotometric determination of minor quantities of iron in nickel, aluminium, zinc, copper and their salts by V.M. Bhuchar, Ind. J. of Chemistry, 1967, **6**, 562.

15. Studies on atmospheric particulate matter at Delhi by R.S. Sekhon and Bh. V. Ramana Murty Ind. J. of Meteorology and Geophysics, Vol. **16**, No. 2 April 65.

16. Synchronous operation of ther eflex klystrons in parallel under pulse squate wave and frequency modulation by Drs. R. Parshad, Kailash Chandra and R.C. Kumar, J. of Inst. of Tele-comm. Engrs., 1968, Vol. **14**, No. 3 pp. 138-140.

17. Methods of Measuring vapour pressure of water and other liquids by Dr. P.T. John, J.S.I.R. 1968, Vol. **27**, No. 2, pp. 50-57.

18. Negative Effect of Magnetic field on the lifetime of Minority carriers in Solid State Diodes by Sarvashri Ram Parshad, S.C. Mehta and G. Singh. Ind. J. Pure & Appl. Phys. 1967, **10**, pp. 490-91.

19. Physical bases of a mechanism of hysteresis in phase transformations by Dr. Ram Parshad and Dr. S.K. Sharma, Ind. J. of Pure & Appl. Phys. 1968, Vol. **6**, No. 4.

20. Conference on water desalination by Dr. M.L. Khanna, J.S.I.R. 1968, Vol. **27**, No. 4, p. 131.

21. Spectrophotometric and chromatographic studies of Henna Leaf and powder extracts by Sh. M.R. Verma and J. Rai, ISI Bulletin, Vol. **20**, No. 12, pp. 495-97 (1968).

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(B) In Foreign Journals

1. Deviative absorption in F_2 layers by Dr. A.K. Saha J. of Atmospheric and Terrestrial Physics, 1967, Vol. **29**, 1261.
2. On the determination of mean field height from the Faraday fading of satellite transmissions by Sh. T.R. Tyagi, J. of Atmospheric and Terrestrial Physics, 1967, Vol. **29**, 1947.
3. Cloud seeding experiment using common salt by K.R. Biswas, R.K. Kapoor, K.K. Kanuga, J. of Applied Meteorology, Vol. **6**, No. 5, Oct., **67**, pp. 914-923.
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5. Current Algebra—unsubtracted dispersion relation and radio-active decays of strange mesons by J.S. Vaishya and K.C. Gupta, the Physical Review, Vol. **165**, No. 5. 1696-1699.
6. S. Wave Quarks and Baryon Resonances by D.L. Katyal and A.N. Mitra, Nuclear Physics, B5, 1968, 308-316.
7. Typical spectral distributions and colour for tropical daylight by Dr. S.R. Das and V.D.P. Sastry, J. Opt. Soc. Am., 1968, **58**, 391.
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11. The phonon electron scattering coefficients in dilute silver manganese alloys by Sh. N.S. Natrajan and Dr. M.S.R. Chari, Phy. Stat. Sol. **29**, K69 (1968).
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17. Optical, ESR and Electrical studies of colloidal and F. Aggregate Centres by Drs. S.C. Jain and G.D. Sootha, The Physical Review, Vol. **171**, No. 3, 1075-1082, 15-7-1968.

18. Direct Readout for reversible counter by S.P. Suri and Dr. Ram Parshad, Elect. Engg., Nov. 1968.

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Expenditure-Receipts Analysis for 1968-69

Expenditure Head	*Actual expenditure in lakhs*
Pay of Officers	9.907
Pay of Establishment	14.815
Allowances and Honoraria	14.160
Contingencies	9.098
Maintenance	0.377
Chemicals & Apparatus	6.943
Testing & Evaluation Centre	10.080
Pilot Plants	22.140
	87.520
Receipts	
Sale proceeds of NPL pilot plant products	7.274
Developmental Testing	1.560
Royalties	1.015
Miscellaneous Receipts	.254
	10.103

Slaries & allowances are for 13 months.

STAFF

S. No.	Category	No.
1.	Director	1
2.	Scientists	98
3.	Scientific Staff (JLA/SLA, JSA/SSA)	88
4.	Auxiliary Technical	221
5.	Administrative	107
6.	Class IV	227

Glass Technology Unit

1.	Glass Technologist	1
2.	Scientific/Technical Officer	1
3.	Scientific/Technical Assistants	6
4.	Auxiliary Technical	25
5.	Cost Accountant	1
6.	Apprentices	9
7.	Administrative	1

D.P.E.C. Unit

1.	Scientific/Technical Officer	10
2.	Scientific/Technical Assistants	16
3.	Auxlliary Technical	83
4.	Administrative	8
5.	Class IV	1

MEMBERS OF THE EXECUTIVES COUNCIL

Chairman

Prof. S.N. Bose, F.R.S.
National Professor
22, Iswar Mill Lane
Calcutta-6

Members

1. Dr. S Chandrashekhar
Professor of Physics
University of Mysore
Mysore-2

2. Dr. A.K. Saha
Saha Institute of Nuclear Physics
92, Acharya Prafulla Chandra Road
Calcutta-9

3. Dr. D.S. Kothari
Chairman
University Grants Commission
Bahadur Shah Zafar Marg
New Delhi-1

4. Prof. B.D. Nag Chaudhuri
Member (Science)
Planning Commission
Yojana Bhavan
Parliament Street
New Delhi-1

5. Prof. P.K. Kelkar
Director
Indian Institute of Technology
Kanpur

6. Dr. A.N. Ghosh
Director-General
Indian Standards Institution
Manak Bhavan
9, Bahadur Shah Zafar Marg
New Delhi-1

7. Dr. Kartar Singh
Director
Defence Science Laboratory
Ministry of Defence
Metcalfe House
Delhi-6

8. Dr. R.K. Asundi
Spectroscopy Division
Bhabha Atomic Research Centre
Trombay
Bombay

9. Dr. A. Ramakrishnan
Director
Institute of Mathematical Sciences
Central Polytechnic Buildings
Madras-20

Ex-Officio-Members

10. Director-General
Scientific & Industrial Research
New Delhi

11. Financial Adviser
Council of Scientific & Industrial Research
New Delhi

12. Director
National Physical Laboratory
New Delhi

Non-member Secretary

Shri Lalit Mohan
Administrative Officer
National Physical Laboratory
New Delhi-12

MEMBERS OF THE SCIENTIFIC SUB-COMMITTEE

Chairman

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7. Shri S.C. Israni
Waco Radio Electronic industries
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   JG Glass Industries Pvt. Ltd.
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   16-A, Wellesley Road
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1. Dr. D. Srinivasan
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2. Prof. Dr. Ignacy Malecki
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1. Prof. S. Ramaseshan
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2. Dr. J. Gupta
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3. Dr. V. T. Athavale
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4. Shri G. V. L. N. Murthy
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National Physical Laboratory
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3. Dr. R. Ulrich
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5. Dr. G. K. Mehta
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6. Prof. Dr. L. Genzel
Physikalisches

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1. Prof. S. N. Ghosh
Prof. & Head of the Deptt. of Applied Physics
Allahabad University
Allahabad

2. Shri S. N. Mukerjee
Director, National Test House
Calcutta

3. Shri T. R. Vachha
Director, Research, Research Designs & Standards Organisation
Lucknow

Optics

1. Dr. S. N. Mukerjee
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2. Dr. P. Hariharan
Joint Director (Research), Hindustan Photo Film Co. Ltd.
Ootacamund

3. Gr. Capt. Jones
Officer-in-Command, Air Force Hospital
Secunderabad

4. Mr. P. J. Veger
M/s. Philips India Ltd., Kalwa
Bombay

Radio Science

1. Prof. K. R. Ramanathan
Chairman
Radio Research Committee and Director
Physical Research Laboratory
Ahmedabad

2. Prof. Vikram A. Sarabhai
Chairman
Indian National Committee for Space Research
Ahmedabad

3. Prof. J. N. Bhar
Director
Institute of Radiophysics & Electronics
Calcutta

4. Prof. B. Ramachandra Rao
Andhra University
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5. Mr. Chaman Lal
Wireless Adviser
Wireless Planning & Coordination Wing
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Solid State Physics

1. Prof. Putcha Venkataswarulu
Indian Institute of Technology
Kanpur

2. Prof. B. Dayal
Physics Department
Banaras Hindu University
Varanasi

3. Prof. L. S. Kothari
Prof. of Physics
University of Delhi
Delhi-7

4. Dr. K. P. Sinha
Assistant Director
National Chemical Laboratory
Poona

Weights & Measures
(Standards)

1. Dr. K. N. Mathur
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2. Prof. Dr. R. Vieweg
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3. Dr. E. Engelherd
Head, Length Section
Physikalisch Technische Bundersenstalt
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Bundesallee-100
West Germany

4. Dr. E. Hess
Head, Mass Section
Physikalisch Technische Bundersanstalt
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Bundesallee-100
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5. Dr. H. Barrell
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Teddington, Middlesex
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(Testing)

1. Mr. H C. Verma
Managing Director
Messrs. Associated Instrument Manufacturers
(India) Pvt. Ltd.
New Delhi

2. Mr. B. R. Dhurandhar
Managing Director
Messrs Saple's Scales Mfg. Co (Pvt.) Ltd.
Bombay

3. Dr. S.R. Lele
Managing Director
Borosil Glass Works
Bombay

4. Mr. V. J. Joshi
Master of the Mint
India Govt. Mint
Fort, Bombay

5. Mr. M. V. Patankar
Director (Mech. Engineering)
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6. Mr. V. B. Mainkar
Director
Weights & Measures
Ministry of Commerce
New Delhi

7. Dr. K. N. Mathur
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N.P.L., New Delhi

1. Prof. K. Bannerji
   Indian Association for the Cultivation of Science
   Calcutta

2. Prof. S. Chandrashekhar
   Professor of Physics
   Mysore University
   Mysore

3. Prof. G. B. Mitra
   Indian Institute for Technology
   Kharagpur

4. Prof. G. N. Ramachandran
   Prof. of Physics
   University of Madras
   Madras

I.S.I. MEETINGS

Dr. Ram Prashad	:	Composition of Semiconductor Devices Sectional Committee, ETDC 40 Helmets Subcommittee, BDC 22 : 5 Semi-Conductor Device Sectional Committee, ETDC 40
Sh. T.D. Bansal	:	Thermal Insulation Materials Sectional Committee, CDC-17 International Standards Organisation Technical Committee, TC-48 Industrial Instruments Sectional Committee, EDC-60 Glassware Sampling of Labourer Glassware Subcommittee, CDC-33 : 5
Sh. G.D. Joglekar	:	Primary Cells & Batteries Sectional Committee, ETDC-10
Sh. M.K. Das Gupta	:	Sluice Valves Subcommittee, EDC-3 : 5 Bicyl. Sectional Committee, EDC-26
Sh. N.N. Singh	:	Air Compressors Sectional Committee, EDC-62
Sh. Prem Prakash	:	Laboratory Glassware Committee, CDC-33 Engineering Metrology Committee, EDC-43 Medical Glass Apparatus & Instruments Committee, CPDC-12 Dairy Laboratory Apparatus Committee, AFDC-34 : 2 Machine Tools Committee, EDC-11 Engineering Division Council, EDC Research Panel On Bearings, EDC-39 PI Taximeters Sub-Committee, KDC-41 : 3 Dairy Products & Laboratory Apparatus Committee, AFDC-34
Dr. P.C. Jain	:	Commercial Weights & Capacity Measure Subcommittee, EDC-41 : 1 Screw Threads, Sectional Committee Practices Subcommittee, EDC-27
Dr. S.R. Das	:	Protective Glasses Sub-Committee, CDC-10 : 13

Sh. K.S. Sharma	(*i*)	Electronic Lamps & Accessories Sectional Committee, ETDC-23
	(*ii*)	Illumination Engg. Sectional Committee, ETDC-47
	(*iii*)	Lighting & Ventilation Committee, BDC-64 : P-12
Sh. R.K. Tandon	(*i*)	Electrical Appliances Sectional Committee, ETDC-43 & ETDC-43/P1
	(*ii*)	Automobile Equipment Electrical Sectional Committee, ETDC-14
	(*iii*)	Transformers Sectional Committee, ETDC-34
Dr. A.F. Chhapgar & Sh. Ram Prasad	:	Fifth Meeting of the Cinematographic Equipment Subcommittee, ETDC-47.
Sh. Mohinder Nath	:	Hydrometers & Laboratory Glassware & Related Apparatus Subcommittee.