

1984-85

ANNUAL
REPORT



NATIONAL METALLURGICAL LABORATORY

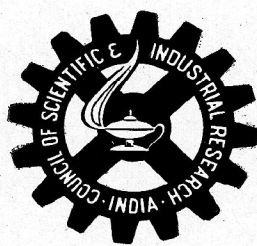
JAMSHEDPUR-831007, INDIA

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ANNUAL REPORT

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NML ARCHIVE
No.....
Date.....



NATIONAL METALLURGICAL LABORATORY
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
JAMSHEDPUR, 831 007
INDIA

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FOREWORD

I have great pleasure in presenting the annual report of the National Metallurgical Laboratory for the year 1984-85.

As usual this year witnessed a considerable rise in the recognition and utilisation of NML developed technology and expertise.

For the proposed Daitary Steel Project, detailed evaluation studies of the raw materials particularly beneficiation and sintering characteristics of iron ores were completed.

Investigations conducted on five different types of Magnesite of Salem area indicated that a general improvement in recovery could be attained from prevalent 8% to 16.0% to 18.2% of parent rock magnesite and respective flowsheet recommended to M/s. Mineral Development Board, New Delhi for adoption.

Successful investigations were carried out on pelletization of Tiruvannamali magnetite ore and the pellets were sent back to Dept. of Geology, Govt. of Tamilnadu for trials at the plant of M/s. Sponge Iron (India) Ltd., Kothagudam, A.P.

A suitable economic process for the extraction and recovery of Metallic values viz. Nickel, Cobalt, Copper and Manganese from sea nodules was perfected.

Sustained work on development, testing and evaluation studies on indigenously produced steels in collaboration with BHEL (R and D) has contributed to the indigenisation of two boiler grade super heater quality steels with chromium and molybdenum contents for acceptance of these steels for indigenous production thereby leading to Import substitution. For ascertaining the state of health, evaluation and prediction of life of thermal power plant components such as super heater tubes for taking a decision for their continued use or replacement on time to avoid unscheduled outages, a detailed survey and analysis was conducted thereby creating a consciousness in the thermal power plant sector. This evaluation has led to the development of quicker and more reliable methods for arriving at residual life of boiler tubes and their initiation throughout the country. Simultaneously about 25 metallurgical investigations were carried out on the failure of components of thermal power plants and refineries in the country successfully and remedial measures and methodology of reduction of downtime due to outages were suggested.

The first commercial distilled grade zinc dust plant set up by M/s. Zinc Products and Co. P. Ltd., Patna, based on the NML technological know-how and consultancy services provided by NML was formally inaugurated by the Honourable Minister of State for Science and Technology, Shri Shivraj Patil on 30th March, 1985. The plant was commissioned in Nov. 1984. The first lot of 20 tonnes against export orders had been supplied by the firm in Jan. 1985 and a second lot of 40 tonnes is scheduled for export in Mar./April 1985. The present capacity is over 600 tonnes per annum worth over Rs. 24 crores and the second phase currently being taken up will raise the capacity to 1000 tonnes per annum, the product worth being over Rs. 40 crores.

Nickel free creep resistant austenitic steel for automotive exhaust valves application has been developed. The performance of two valves conforming to DLW-WDM 2 loco engine which are under service trails at Eastern Railway, Calcutta in the air side since August 1984 are reported to give satisfactory performance and are still in good shape. On completion of the trial in air side four valves will be subjected to the exhaust side of the loco engine also.

A new concept of filtering molten aluminium culminated in the development of 'NML reactive filter' for aluminium and its alloys, the use of which reduces the level of dispersed solid particles, inclusion of oxides and dross etc., and improve the grain structure of the cast product. Dr. Rajendra Kumar, Scientist Director Sri C. S. Sivaramakrishnan and Sri R. K. Mohanti have jointly been the recipients of a certificate of merit of the NRDC Republic Day award for this invention.

Based on very encouraging performance results of the aluminium base bearing alloys in the field of evaluation trials by RDSO Lucknow some more bushes of different sizes have been made and supplied for a second series of evaluation studies.

Work on the preparation of clay-graphite stopper heads of pin type with improved properties and surface finish for use in ladles of 50 tonnes capacity under CSIR-SAIL collaborative project was undertaken and completed. The Inplant trials at Alloy Steel Plant, Durgapur are planned in April 1985.

A memorandum of understanding was arrived at for a joint collaborative venture between NML-CSIR, MECON, and Bhilai Engineering Corporation, Bhilai, for setting up of the first commercial plant of 4000 tonnes per annum capacity of sponge iron utilising the vertical retort direct reduction process know-how developed by NML. This know-how was a modular approach and the commercial plant will have a number of retorts producing 3-5 tonnes of sponge per day.

The technology of diffusion treated steels for utilisation in fertilizer and chemical industries have been extensively evaluated in laboratory and under actual plant conditions, for over a period of 2 years at PDL Sindri, a Government of India undertaking under a joint collaborative programme and the know-how so developed is in the final stages of implementation.

The technology for the production of NML-PM215 high strength aluminium conductor has been released to M/s. Electrical Manufacturing Co. Ltd., Calcutta and the transfer is in progress. The alloy holds potential for use as catenary wire and grooved contact wire for Railway electric traction.

The technology of production of electrolytic copper powder has been transferred to M/s. Tapadia & Co., Jamshedpur who are establishing a 100 kg per day production plant.

The process know-how for the production of filler wires NML-PM6 for MIG welding of high strength aluminium alloys has been released through NRDC to M/s. Karnataka Aluminium Ltd., Mysore and is under the process of transfer.

The technology for production of high purity magnesia and magnesium carbonate from low grade magnesite of the type occurring in Salem for use in cosmetics, pharmaceutical and rubber industries is under assignment to NRDC for its release to industries.

The process know-how for the preparation and use of an inhibitor suitable for continuous pickling of steels in hot sulphuric acid solution is under progress for release to the parties.

The NML has provided the necessary technical data on batch and pilot scale trials of different Manganese ores from various parts of India to M/s. Engineers India Ltd. with a view to enabling them to prepare basic engineering package for the technology on production of electrolytic Manganese metal and Manganese dioxide developed at NML.

During the year, recovery of valuable Tin metal from the sludge of electrolytic tinning plant of M/s. Tinplate Company of India was undertaken and about 2 tonnes of sludge was processed.

Director

SPONSORED INVESTIGATIONS (1984-85) CONDUCTED/UNDERWAY

<i>Sl. No.</i>	<i>Title</i>	<i>Sponsor</i>
1.	Beneficiation and agglomeration studies on iron ore samples from Daitari and Gandhamardhan Mines—Part I & II	M/s. Nilachal Ispat Nigam Ltd. (SAIL)
2.	Studies on a sample of Coal fine (Lalmatia, Rajmahal area)	CEMPDIL, Ranchi
3.	Bench and pilot plant beneficiation studies on a tourmaline rich kyanite sample from Pardi Mines and development of a technical flow sheet for treatment and setting up of a commercial plant	Maharashtra Minerals Corporation Limited, Bombay
4.	Report on the beneficiation of Gua iron ore and its slime together with Kiriburu slime	M/s. Mineral Development Board, New Delhi
5.	Investigations on the corroded water pipes	Tamilnadu State Electricity Board
6.	Failure of Superheater Tubes	Obra Thermal Power Station, Obra
7.	Determination of abrasive particles in coal samples of CTPS	D.V.C., Chandrapura
8.	Determination of alpha quartz in coal sample	D.V.C., Chandrapura
9.	Metallurgical investigation on the failure of reheater tubes	D.V.C., Chandrapura
10.	Failure of Boiler tubes	Ennore Thermal Power Station, Ennore
11.	Failure of primary super heater tube unit No. 5 (CBIP/18)	Ennore Thermal Power Station, Ennore
12.	Failure of economiser tube (CBIP/21)	Ennore Thermal Power Station, Ennore
13.	Failure of water pipe	Tamilnadu Electricity Board, Madras
14.	Non-destructive metallographic examination of coke chamber R1A & R1B.	Indian Oil Corporation, Guwahati
15.	Fatigue tests on connecting links	M/s. MAMC, Durgapur
16.	Investigation on residual life of Platen super heater tube of unit No. 3 of Badarpur Thermal power station.	The Executive Engineer, Dam Construction Division, Chuka Hydel Project, Tsimalakha, Bhutan
17.	Development and testing of creep resistant steel for the period from 1.4.84 to 31.3.85	Corporate R & D Unit, BHEL, Hyderabad
18.	Investigation on imported tube of 2½ Cr-1MO Steel	SAIL, R & D, Ranchi
19.	Determination of reduction degradation indices of iron ore sinters	Bhilai Steel Plant, SAIL, Bhilai

COLLABORATIVE PROJECTS

<i>Sl. No.</i>	<i>Title</i>	<i>Collaborator</i>
1.	Characterisation of high quality boiler plates for creep properties	NML/SAIL
2.	Processing of polymetallic sea nodules for recovery of metallic values	NIO, IBM, ICC, RRL (B), NGRI, HZL etc)
3.	Evaluation of pre-reduced iron in L.D. converter	CSIR/SAIL
4.	Improvement in the manufacturing techniques for tar bonded basic refractories	CSIR/SAIL
5.	Evaluation of clay graphite stopper heads developed by NML (Improvement of clay graphite stopper heads)	CSIR/SAIL
6.	Development of refractory using beneficiated kyanite and beach sand silimanite	CSIR/SAIL
7.	Development and Performance evaluation of diffusion treated steels in fertilizer and chemical industries	NML—PDIL, Sindri

CONSULTANCY SERVICES RENDERED

The NML has provided the following consultancy services:

- (i) lowering and continuous production of low iron containing calcaerous sand for production of white cement to M/s. Associated Cement Co. Ltd.
- (ii) vetting of technical feasibility reports prepared by M/s. Bihar Industrial Technical Consultancy service on establishment of graphite beneficiation plant and magnetite grinding unit on behalf of Bihar State Mineral Development Corpn.
- (iii) assessment of present status of L.D. converter refractories lining practice in the light of modern developments and suggestions thereof for SAIL.
- (iv) analysis of the problem of rusting of tin mill back plate during transit and remedial measures thereof for M/s. Kothari & Co., Calcutta.
- (v) improvement in the wear life of coal crushing hammers for Hindustan Fertiliser Corpn. Ltd., Barauni.
- (vi) development of beneficiation flow-sheet for kyanite ore utilization and advice on the same.

UTILISATION OF TECHNOLOGY

Process released to Industries

(a) Processes released for the first time in 1984-85 and technology transferred

<i>Process</i>	<i>Party</i>
(1) Production of copper Powder by electrolyte process (Released direct by NML)	M/s. Tapadia & Co., Jamshedpur
(2) Production of high strength aluminium alloy NML PM215 (Released direct by NML)	M/s. Electrical Mfg. Co. Ltd., Calcutta

(b) Processes approved by CSIR for release (for first time)

- (1) Production of high purity magnesia from low grade magnesite for the requirement of pharmaceutical, rubber and cosmetic industries.
(to be released through NRDC)
- (2) Production of Inhibitor suitable for continuous pickling of steels in hot-sulphuric acid.
(to be released direct by NML)

(c) Processes to be assigned to NRDC through CSIR

- (1) Vertical Retort direct reduction process for production of direct reduced iron (sponge iron)
(under joint collaborative venture of NML, CSIR, NRDC, MECON and M/s. Bhilai Engg. Corpn., Bhilai)

The joint commercial plant will be set up by M/s. Bhilai Engg. Corpn. and for which commercial terms have been mutually agreed upon by all the above collaborative agencies.

R & D HIGHLIGHTS

A. ORE DRESSING & MINERAL BENEFICIATION

1. Reduction of Silica content in a manganese sample from M/s. Aditya Minerals Ltd., Nagpur

Exploratory studies indicated that the Silica content in the sample could be reduced from 19.79% to 11.82% by gravity concentration methods. The investigation report is being prepared.

2. Beneficiation of wolframite sample from Gauripur, Bankura area, West Bengal

The sample assaying 0.6% WO_3 , 7.02% Fe and 85.12% SiO_2 was subjected to gravity concentration tests and a table concentrate assaying 30% WO_3 with a recovery of 42.0% could be obtained. The grade could be further increased to 41% WO_3 at a recovery of 30.0%. The investigation results are being reported.

3. Exploratory studies on Scheelite samples from Uttar Pradesh Mineral Development Corporation

The investigation is completed.

4. Exploratory studies on low grade phosphate sample from Purulia district for M/s. West Bengal Mineral Development Corporation, Calcutta

The sample assaying 18.69% P_2O_5 , 9.86% SiO_2 and 20.01% Fe was subjected to preliminary concentration as desired by the sponsor.

(a) Scrubbing the sample with water followed by disliming indicated that the P_2O_5 content could be improved to 23% for a weight yield of about 70%.

(b) West magnetic separation at -100 mesh size, has yielded a non-magnetic product assaying 27% P_2O_5 with 10% Fe and 11% SiO_2 for a weight recovery of over 50%.

The investigation is completed and the report is under preparation.

5. Pilot plant studies on beneficiation of four iron ore slimes for M/s. Mineral Development Board Ltd., New Delhi

The studies have been completed and the investigation reports have been submitted to the sponsors.

6. Bench Scale beneficiation studies on three graphite samples from SEWADIH, MANASOTI and BISHRAMPUR mines of M/s. Bihar State Mineral Development Corporation, Ranchi

The graphite samples assaying 8-10% fixed carbon and 86-88% ash were upgraded by flotation to yield graphite concentrates assaying between 75 and 90% F.C. with yield recoveries varying between 8 to and percent by weight. The fixed carbon recoveries were also higher. In the case of Bishrampur sample, 7 to 8% by weight of +80 mesh size flaky graphite concentrate suitable for crucible making could also be obtained by gravity treatment at -28 mesh size.

The investigation is completed and the report is being compiled.

7. Bench scale beneficiation studies on two magnetite sample from SEMRA AND SALATHUA mines of M/s. BSMDC Ltd., Ranchi

Bench scale studies indicated that by wet magnetic separation at suitable sizes, concentrates assaying high in Fe and low in SiO_2 , for use in medium preparation could be produced.

The report is under preparation.

8. Assembly of sub-sieve sizer for particle size determination

An elutriator type of sub-sieve sizer made of glass has been assembled, which is capable of separating fine mineral powders (in the range of 5 to 50 microns) into five fractions, using water as medium. A few

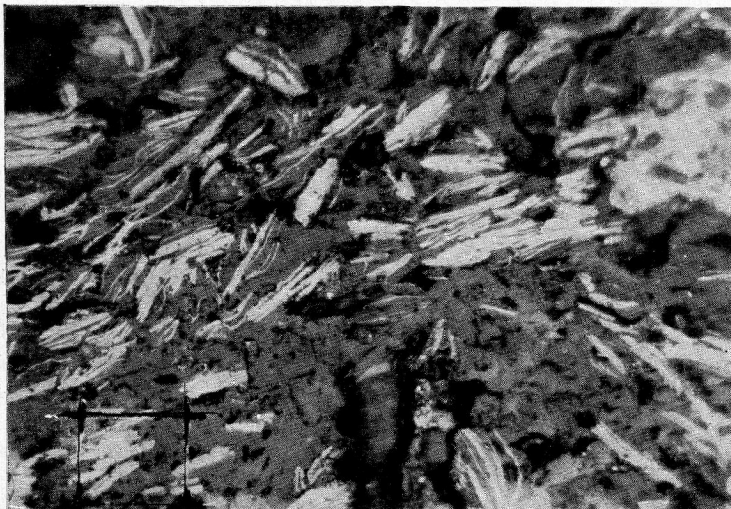


Photo-micrograph of a graphite sample from Bihar showing the texture and inter relationship of graphite flakes and gangue materials × 60



Photo-micrograph showing brachioid nature of chromite (white) from Orissa. Note highly fractured nature of chromite — (Black criss cross network). Refl illum $\times 80$ nicol not crossed

samples of mineral powders of different specific gravity are being studied to check up the performance of the unit.

9. Bench scale flotation studies on two coal samples from Bargolai mines, NBC, Assam for M/s. CEMPDIL, Ranchi

The samples of coal from 60' seam and 20' seam from Bargolai mines, Assam were received for lowering the sulphur content by froth flotation. The 60' seam sample was taken up first for investigation.

Flotation tests were conducted on (-0.5 mm) sample of coal fines obtained by crushing the coal sample to 16 mm size. The results just indicated that the sulphur content could not be reduced to any appreciable content. As major part of the sulphur is present in the form of combined sulphur which is also corroborated by analysis of the head and feed product samples. But there was significant reduction in the ash content from 20.0 to 3.02%.

The second sample from 20' seam is also taken up for studies as a matter of academic interest.

10. Reduction of silica content in Bhawanathpur limestone sample received from M/s. Bokaro Steel Plant

The sample of limestone (-25 mm $+6$ mm) as received contained lot of clay admixed and assayed high in SiO_2 content (roughly 20%).

The object of the investigation was to reduce the SiO_2 content to 8 to 10% if possible by scrubbing and screening methods, so that the -3 mm size material could be used for sintering. Bench scale studies have indicated that the SiO_2 content could be lowered to about 10.8% only. Further studies are in progress.

11. Bench scale flotation studies on two samples of partially oxidised copper ore from Malankhand Copper Project (HCL)

Detailed mineralogical studies have been completed on both the samples. Flotation tests have also been carried out with one of the samples are found to be encouraging. Further work is in progress.

12. Sintering studies with Blue Dust sample from Bailadila mines for M/s. NMDC, Hyderabad

The studies carried out at NML so far indicated that Blue Dust to the extent of 22-25% could be successfully used for producing quality fluxed sinters. Further studies are in progress.

13. Beneficiation of Chromite samples from Saruabil mines, Orissa

The samples of chromite have been received and the results of exhaustive bench scale studies carried out on one of the samples have indicated that the Cr_2O_3 content could be upgraded to about 43-55% for a Cr/Fe ratio of 3 : 4. Further studies are underway.

14. Pilot plant studies on a sample of magnetite received from M/s. BSMDC Ltd., Ranchi

Work on this sample is taken up.

15. Multi Agency Projects (MAP)

Beneficiation of high silica magnesite. The status report is being updated.

B. REFRACTORY TECHNOLOGY

1. Improvement in manufacturing technique for Tar bonded basic refractories

With four varieties of modified tar supplied by CFRI, sintered dolomite obtained from Bokaro Steel Plant (SAIL) was utilized in the Bench scale study of physical properties for establishing the manufacturing process/technique.

2. Suitability of sea water Magnesia for refractory use

The sea water magnesia received from CSMCRI was fully studied for its suitability. The project has been completed.

3. High Alumina refractories based on beneficiated Kyanite concentrates and Beach sand Sillimanite

Under this multigency project, various physical properties of the beach sand e.g. Sieve analysis, Chemical Analysis PCE, Sp. gravity and X-ray diffraction have been done to evaluate the material for its refractory properties.

4. Studies on the development of high temperature castables for 1500-1700°C using fused alumina as aggregate and NML made Cement

The properties studied indicate that the castables using fused Alumina aggregate were comparable with imported ones.

5. Utilisation of concentrates from low grade magnesites for refractory purposes

Study of physical and refractory properties on concentrates from Salem indicate good results.

6. Studies on the development and production of carbon bricks & blocks

Bench scale studies have been completed.

7. Evaluation of clay Graphite stopper heads developed by NML

The first batch of stopper heads were subjected to trial service in a ladle of a 10 tonne Electric arc furnace at Durgapur. The results indicated the necessity of further improvement in surface finish & properties and a second batch was made with the properties and sent for in plant trials.

8. Development of dense high purity alumina grains from technical alumina

Physico chemical properties on 1" dia buttons made under high pressures in a hydraulic press are being studied after firing at higher temperatures in the range of 1650-1850°C.

9. Development of Magnesite Carbon refractories

Different batch positions with 12, 16 & 20% graphite mixes and various resins as bonds are taken up for the study of properties like bulk density, porosity, cold crushing strength and are being compared with data on industrially available samples.

C. EXTRACTION & CHEMICAL METALLURGY

1. Production of Calcium Silicide in 500 KVA sub-merged arc furnace

An interim report was prepared and given to M/s. Ispat Project Pvt. Ltd., Calcutta, the sponsors who are now setting up a commercial unit for production of calcium silicide in Orissa.

2. Treatment of Sludge for Recovery of Tin

A further 2 tonnes of sludge received from M/s. T.C.I. Ltd., was processed and recovered tin was given back. Negotiations were going on for the transfer of know-how for setting up a commercial unit in Jamshedpur.

3. Production of Low Aluminium Ferro Silicon

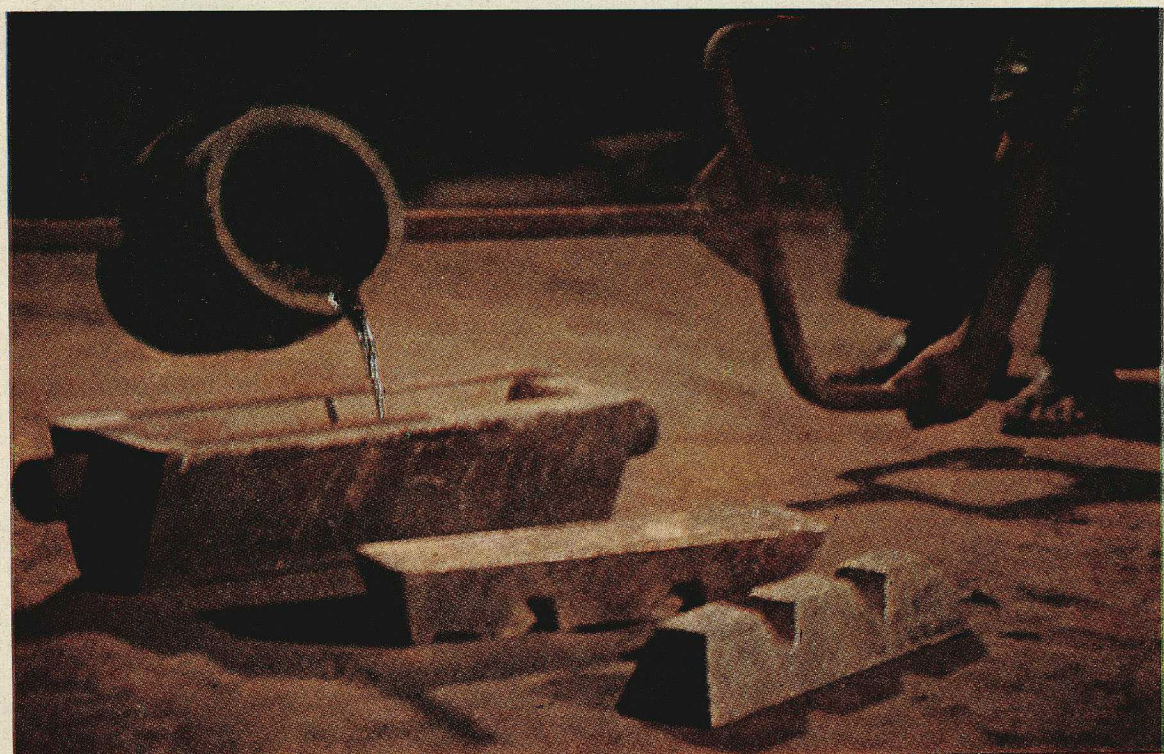
After the completion of successful bench scale trials, negotiations are being made with M/s. VISL for conducting large scale trials.

4. Processing of Polymetallic seandules for extraction and recovery of metallic values

Two processes have been developed on bench scale based on ammonical leaching.

(i) Reduction roast with fuel oil as reductant followed by Ammonium carbonate leaching and subsequent solvent extraction, electro winning of the metallic value. The process has been fully tested for recovery of Ni, Co and Cu.

(ii) Direct ammonical leaching in presence of cuprous ion.



Tin recovered from Electrolytic Tin Plating sludge is being cast into ingot



NML developed clay graphite stopper head for teeming steel

The process has been intensively studied on the bench scale. Recovery of Ni, Co and Cu has been done using solvent extraction and electro winning. Preliminary experiments on recovery of Mn from residue has also been carried out. Based on the bench scale data a continuous set up consisting of leaching reactors, CCD Unit, has been fabricated and installed to treat up to 1 kg of nodules/hr. A similar set up for solvent extraction electro winning has also been designed and is being installed to recover Ni, Co and Cu from the leach solution. Studies on characterisation of sea nodules were carried out using TEM, DTA/TG, and X-ray diffraction.

5. Production of Magnesium by Electric Smelting

Fabrication and testing of various units are being done. Assembly of necessary equipment is also under progress.

6. Electrolytic Manganese Dioxide

Engineers India Ltd. (EIL) have evinced keen interest in giving engineering package to the technologies for production of Electrolytic Manganese Metal & Dioxide developed at NML. Senior Engineers of EIL visited NML and saw the Pilot Plant. The data collected on bench and pilot plant on different manganese ores from various parts of India were handed over to them with a view to preparing basic engineering package for the above two technologies.

7. Chemical Beneficiation of Magnesite

Based on the extensive work carried out at NML on the production of pure magnesium carbonate from magnesite by carbonation and calcium chloride leaching processes, a novel improved process on the chloride route has been evolved and a patent has been filed. The process parameters of this new process are actively under study together with the quality of product obtained.

8. Production of Microfine Silver Powder

A novel method for production of Silver Powder of spherical shape of 0.1-1.0 dia with appropriate sintering characteristics has been developed. The powder so obtained has been found quite suitable for electrical contacts and brazing alloys and could also be used as catalysts for conductive coatings and manufacture of pseudo alloys.

9. Bench scale studies on production of Electrolytic Manganese Dioxide from the ore supplied by Manganese Ore (I) Ltd.

The ore is found to be essentially suitable for production of EMD—only that an additional pressure leaching step has to be introduced to remove the potassium contained in the ore to obtain EMD meeting the international specifications.

10. Production of Metal Powders

(a) Distilled Zinc Dust

The NML process know-how was released to M/s. Zinc Products of Patna under a consultancy agreement with this licensee services were rendered for implementation of the project at Patna. The equipment is in place with (an investment of over Rs. 30 lakhs) and the plant was successfully commissioned in November 1984. The first lot of 10 tonnes was supplied for export in January 1985 and the second order for 40 tonnes is scheduled for despatch by March 1985. The unit is now producing an average of 2 tonnes per day.

(b) Air-Atomized Metal Powders

The NML process know-how was licensed to M/s. Jagganath Pyrotechnics Pvt Limited to Hyderabad to produce up to 2,000 tonnes of aluminium powder. The formal technology transfer was completed in the first week of March, 1984. A consultancy services agreement is being negotiated with this party for assisting them in implementing the project at Hyderabad.

Three other licensing agreements have been signed, one for a unit at Kharagpur, the other two at Calcutta and Giridih respectively.

(c) Water-Atomized Metal Powders

Work continued on the development of water-atomized metal powders. Optimal process parameters were determined for the production of water-atomized aluminium powders. Work on this has now being concluded and the process will be released for commercial exploitation in due course.

Work continues on other water-atomized metal powders such as brass and copper. Other non-ferrous metal powders will follow in due course to include such as solder powders, hard-facing powders, dental alloys etc.

Iron and ferrous alloy powders will be taken up as and when the required ferrous induction melting furnace is procured, installed and commissioned.

(d) Microbiohydrometallurgical Metal Powders

Further exploratory work on producing P/M grade and other metal powders directly from microbial leachates, such as of copper, was continued. Cemented powders were produced from microbial leachate supplied by the MACS Research Institute, Pune. These were tested and further work planned.

11. Hot Dip Coating

A consultancy was completed with M/s. Modern Malleable Casting Works of Calcutta for development of Alcoat aluminized wires for producing wire-forms. Another sponsored trial for Pressure Cookers and Appliances of Bombay is being undertaken.

D. IRON AND STEEL TECHNOLOGY

1. Evaluation of the use of pre-reduced iron in LD. Converter (CSIR—SAIL MAP)

A technical know-how is being developed to replace mild steel scrap with pre-reduced iron in L.D. converter to overcome the anticipated shortage of scrap in near future due to advent of continuous casting of steel in iron and steel plants. Large scale trials in the 100/130 tonne LD converter at Bokaro Steel Plant have been conducted successfully. It has been found possible to replace up to 35% of scrap without any operational problems.

Further laboratory scale trials have indicated that more than 35% scrap replacement with DRI up to about 80% is also easily possible due to the good dissolution characteristics at temperatures around 1550°C. It also does not pose any operational problems. Same is being tried out in Bokaro LD Converter.

2. Evaluation of coal gasification based direct reduction processes

A survey of the commercially proven coal gasification and direct reduction processes to match the production of DRI appropriate under Indian conditions, has been submitted to the working group on SAIL-CSIR for expert comments and to approve the future work indicated therein at NML.

3. Development of direct reduction process using iron ore coal agglomerates

A process using stoichiometric quantities of coal in iron ore coal agglomerates is being developed for use in the production of direct Reduced Iron. Laboratory and Pilot Plant scale experiments have shown production of DRI but problems of excessive breakage still needs solution.

4. To use the non-isothermal, model developed for correlating the actual operating parameters of a vertical retort for DRI production incorporating geometrical, similarity criteria

Second phase has been taken up to evaluate a mathematical model aiming at correlating productivity as dependent variable on residence time, temperature rise, size, or coal ratio, with a view to obtaining data on actual operating vertical retort process for DRI production.

Requisite modifications have been made in the experimental set up to include studies under simulated conditions, close to those prevailing in actual reactors and to study the effect of recirculation outgoing gases heating as well as for reduction when injected into the system. Experimentation is on to obtain relevant data for the aforesaid studies.

5. Commercialising the NML's VRDR technology

The VRDR process developed at NML pilot plant scale is being commercialised by installing a plant of 4,000 tonnes/annum capacity at Urla Raipur, Madhya Pradesh, under the joint collaboration of NML-CSIR, Mecon, Ranchi, NRDC, and Bhilai Engineering Corporation, Bhilai. Mecon & NRDC have agreed to put 25% each of the equity capital in the plant.

6. Sponsored investigations

(i) Investigation on sponge iron samples.

Sponsor: M/s. Mehta and Padamsey Surveyors Pvt. Ltd., Calcutta.

(ii) Determination of reduction degradation indices of six iron ore sinters from Bhilai.

Sponsor: Bhilai Steel Plant.

(iii) Thermal degradation studies on samples received from Charge Chrome Plant, Orissa in rotary tube at high temperature.

Sponsor: M/s. OMC Alloys Ltd., Keonjhar, Orissa.

(iv) Determination of crushing strength, density, shatter strength and tumbler strength of sponge iron briquettes from Orissa Sponge Iron Ltd.

Sponsor: Orissa Sponge Iron Ltd.

(v) Physico-chemical testing of iron ore sinters produced at O.D. Division of NML from samples of beneficiated Daitary Iron Ores.

Sponsor: MECON.

(vi) Reduction behaviour of Bailadila Iron Ore sinter produced at O.D. Division, NML.

Sponsor: NMDC.

(vii) Cold bonded pellets.

Sponsor: SAIL-CSIR Project.

7. NML Wearnot; Wear & abrasion resistant cast iron

In order to have performance evaluation of 'NML-Wearnot' a wear and abrasion resistant cast iron developed at NML for handling abrasive slurries, joint discussions were held and 14 inch main washery pump of DSP Coal Washery was identified for trial. In the same context contacts were made with ONGC Bombay and Super Thermal Power Project, NTPC, Mirzapur, for evaluation purposes.

The wear plate of Hi flow valve of disc filter which was identified for trial for study of various wear and abrasion problems at Malanjkhand Copper Project of Hindustan Copper Ltd., was also selected. The present plate wears after handling 0.6-0.7 million tonnes of concentrates.

It is expected to handle 20 million tonnes (capacity of the 2 million tonnes year) in its life of 10 years. Work is in progress with the specified objectives.

8. Wear and Abrasion Resistant Alloy Steel (14% Manganese)

BEML, Bangalore & CLW Varanasi were identified as the users of rolled 14% manganese steel plate in their Bharat Earth Moving Equipment and Diesel locomotives respectively. The specifications and drawings of different parts were obtained for making the components at NML for subsequent service performance at these plants.

In order to have industrial plant rolling trials at RSP, Rourkela, preparations for generation of hot hardness data were made.

E. ALUMINIUM TECHNOLOGY

1. Studies on corrosion behaviour of Aluminium alloy conductor (NML-PM 215)

Salt spray tests of individual strands of prototype aluminium alloy NML-PM 215 and conventional aluminium alloy conductors have been carried out as per Indian specification. It has been observed that NML-PM 215 conductor has superior corrosion resistance, electrical conductivity and tensile strength to the conventional alloy conductor under otherwise identical condition of exposure.

Polarization behaviour of NML-PM 215 alloy catenary conductor and conventional alloy conductor in neutral salt solutions (3% NaCl, 3% Na₂SO₄) and acidic medium (0.1 N HCl) has been carried out by Galvanostatic and potentiostatic methods. This study indicates that NML-PM 215 strand is more cathodic to conventional alloy strand and therefore more corrosion resistant with respect to the conventional one in neutral solution. In case of acidic medium, both the conductors have exhibited more or less equal properties from corrosion point of view.

2. Product development from high strength Aluminium alloy conductor designated NML-PM 215

Fatigue tests of NML-PM 215 rod in heat treated condition were carried out on rotary bending cantilever type machine. It was observed that the above samples have a fatigue strength of 12 kg/mm² for 100×10⁶ cycles.

The Technology of production of NML-PM 215 is under process of transfer to M/s Bindawala Electrical Industries (Pvt.) Ltd., Lucknow for the production of catenary wire (19/2.79 mm) for use in Railway electric traction. And a trial has been conducted to demonstrate the processing sequence successfully at their Lucknow works and properties were evaluated which were found satisfactory.

3. Non-corrosive, non-polluting degassing of liquid Aluminium

The project is completed and the report submitted.

4. Development of Filfer Wires for Mig welding of high strength Aluminium alloys

The project is completed. The technology for the development of NML-PM 6 developed at the NML has been assigned to NRDC and also been licenced to M/s. Karnataka Aluminium Ltd., Mysore. The Technology is under process of transfer.

5. Mitigation of pollution caused by Agra Foundries

The scrubbing unit was installed at M/s UASL, Agra. The unit was commissioned and trial runs were made for its efficient before the entry of the gas into the scrubber and as the gas emerged out.

6. Fracture studies in Mg-Zn-Al alloys

The studies on the fracture morphology through SEM of Mg-Zn-Al alloys containing up to 6% Al and small additions of Li were carried out, and evaluated using standard equations. These were compared with high strength alloy as a function of grain size also. The observed inter-spacing of micro voids ahead of the crack tip in Mg alloys agrees with theoretical values calculated from equation. The project is completed and the report prepared.

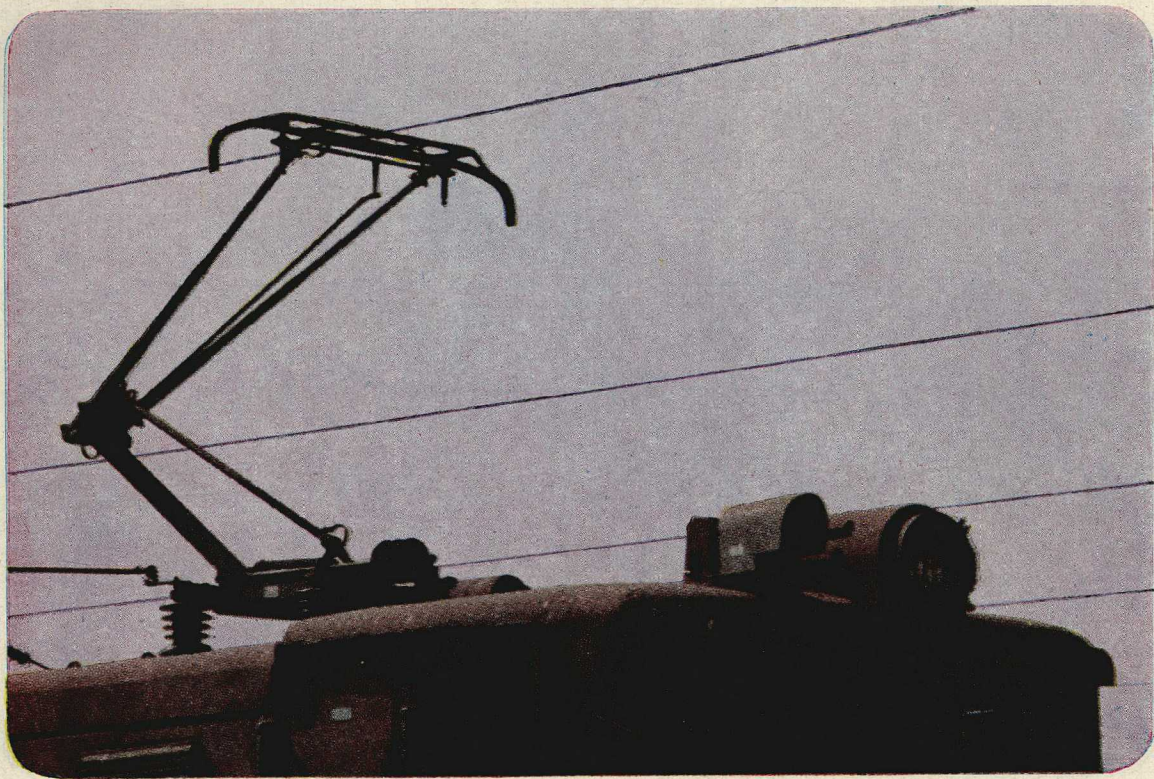
7. Study on the effect of chlorine and nitrogen bubbling on the solidification behaviour and properties of Al-Si and Al-Zn-Mg alloys

Nitrogen bubbling in ordinary atmospheric pressure and under partial vacuum was carried out for specified period of time in moten Al-Si alloys and the morphological features were studied.

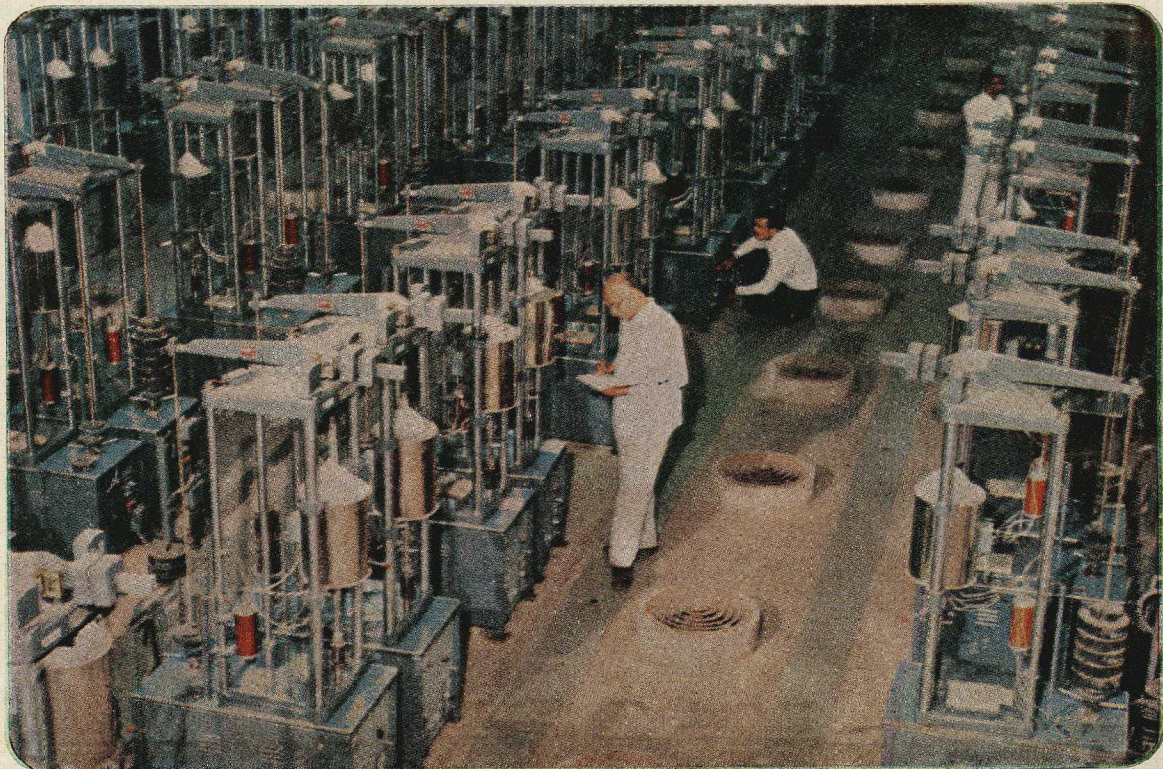
Purging nitrogen through porous refractory plugs is being tried out in order to improve degassing efficiency.

8. Solidification behaviour of Al alloys composites

It is possible to bring about improvements in wear properties in certain Al base alloys containing immiscible phases and a set up for carrying out the experiments for the study of such composites is being fabricated.



NML PM215 Aluminium alloy conductor has potential for use as catenary conductor for railway electric traction



Creep evaluation of boiler quality creep resisting steel in progress

9. Preparation of Li bearing Al alloys and evaluation of their physical and mechanical properties

Li bearing alloys have a good potential as light weight tough materials and are emerging materials of future. Viable techniques of alloying will be found out in the first stage followed by property evaluation. A few alloys containing up to 2% Li have been prepared and the studies are in progress.

10. Aluminium base bearing alloys for RDSO

20 aluminium base alloy bushes of three different sizes were cast, machined and stress relieved and despatched to RDSO, Lucknow for a second series of evaluations. The alloy has been developed at NML and earlier trials had shown very encouraging results.

F. MAGNETIC MATERIALS

1. Low cobalt magnetic alloys

Various compositions of Fe-Cr-Co alloys containing 12-16 wt% Co, 28-33 wt% Cr, Bal. Fe have been made. The cast alloys were forged, hot rolled solution treated, and subjected to spinodal decomposition by slow cooling from 700°-620°C and then given cold deformation by rolling/drawing. The evaluation of the structural and magnetic properties of the alloys is in progress.

2. Materials for portable generators

Due to high rotational velocity, portable generators encounter high stresses in their rotors and also temperatures of the order of 300°-400°C. Hence materials having high yield strengths and reasonably good magnetic properties up to 400°C are required for the purpose. As a prelude to developing materials for portable generators, a set up for the determination of magnetic properties from room temperature to 700°C has been fabricated. Measurements have been made on high carbon steel and some HSLA steels from room temperature to 600°C. The results are being interpreted in light of the phase changes taking place.

3. Evaluation of d.c. magnetic properties of (a) soft iron (b) silicon steel

The specimens in the form of rings were given suitable heat treatment and their magnetic properties determined. The specimens were also evaluated after aging at 100°C for 600 hrs. The investigation has been completed and the report submitted to sponsor.

4. Effect of alloying additions on the stability and mag. properties of Mn-Al alloys

Stable isotropic Mn-Al permanent magnets with a remanence=3000 gauss, Hc=2200 Oe and max. energy product=1.65 MGOe have been made by additions of about 1 wt% C and 1.5 wt% Fe. The project has been completed and the report is being prepared.

G. HIGH TEMPERATURE CREEP RESISTANT STEELS

1. Studies on high temperature creep resistant steels

(i) Super heater tubing steels

Steel grades of 2½ Cr1Mo (ASTM-213-T22 and 1¼ Cr½Mo (ASTM-213-T11) were cast and being tested for super heater tubing application as per Central Boiler Board Regulations. The creep evaluation tests for 33,000 and 40,000 hrs. are being completed.

(ii) Casting and forging steels

Creep properties on the following grades of steels produced by CFFP. Hardwar have been evaluated and the data have been communicated to the sponsor:

1. ½Cr-½Mo (0.5 FO) Steel
2. GS 22 Mo Steel
3. 18 Cr-Mo 910 Steel
4. Ti-B Bolting Steel

Creep evaluation on the following grades of steels are in progress and some of the tests have completed more than 30,000 hrs. duration :

1. 15× M Grade
2. DVP-9 Steel
3. FOV Steel
4. 17 Cr-Mo-V 511 Steel
5. Cr-Mo-V Steel

2. Characterisation of boiler quality plates for creep properties (MAP-NML/SAIL)

Creep properties on the various casts of boiler quality plates conforming to IS: 2002/62 have been generated for a test duration of 1000 and 10000 hrs. at 400°, 450° and 500°C. Interim report has been prepared and submitted to SAIL (R&D), Ranchi.

3. Development of nickel-free creep resistant austenitic steel for automotive exhaust valve application

Two numbers of exhaust valves conforming to DLW-WDM2 loco engine are under service trial at Eastern Railway, Calcutta since August, 1984 in the Air side. The performance of these valves are satisfactory and are still functioning alright. The details are as follows:

Loco No.: 1·8779 WDM2
Engine No.: 1359
Location 2L
Cylinder Head No. 30331 (Air side)

Generally the cylinder heads of the Locomotive engines are opened for a periodical check-up at an interval of one year. On completion of the above trial, it is proposed that the exhaust valves of the above specification shall be subject to the service trial on an exhaust side of the locomotive engine.

4. Estimation of residual creep life of Thermal Power Plant components

The estimation of residual life on the sample of 70,000 hrs. sponsored by IOC, Haldia was completed and the investigation report submitted.

The estimation of residual life of convective super heater tubes of Boiler No. 3 sponsored by Korba Thermal Power Station were completed, and investigation report submitted.

The residual life determination on the following samples is in progress:

- (i) Super heater tubes of Badarpur Thermal Power Station sponsored by NTPC, New Delhi.
- (ii) Boiler tube of Neyveli Lignite Corporation, Neyveli, Tamil Nadu.

5. Steels for short-term evaluation

During the above period the following materials received from different organisations for investigation/ determining specific properties.

H. METALLURGICAL INVESTIGATION STUDIES ON FAILURE OF METALS & ALLOYS

Investigations completed

- | | |
|---|---------------------------|
| 1. Failure on water wall tube of Chandrapura Plant | D.V.C., Chandrapura |
| 2. Failure of Main Steam Load drum of Chandrapura Plant | " |
| 3. Failure of H.P. Governor valve spindles of Chandrapura Plant | " |
| 4. Failure of Reheater tube of Chandrapura Plant | " |
| 5. Failure of Economiser Tubes coil Nos. 42 & 43 of United of Dhuvarnan Thermal Power Station | Gujarat Electricity Board |

6. Failure of Platen super heater tubes of Unit No. 5 of Ennore Thermal Power Station	Ennore Thermal Power Station
7. Failure of platen super heater technology of Unit No. 5 of Chandrapura	DVC, Chandrapura
8. Failure on Economiser Tube of Unit No. 5 supplied by Ennore Thermal Power Station (Date of failure 19.6.83)	Ennore Thermal Power Station
9. Failure of platen super heater Tubes (Date of failure 12.5.83, 29.5.83 and 15.6.83) of Unit No. 5 of Ennore Thermal Power Station	"
10. Failure of Boiler Tubes of Korba Thermal Power Station	Korba Thermal Power Station
11. Study on Failure and life estimation of convective super heater tubes (date of failure 20.10.84 and 2.2.85) of Boiler No. 3 of Korba Thermal Power Station	"

I. MECHANICAL WORKING & TESTING

1. Stainless steel clad aluminium sheet

Technology for the production of ductile stainless steel clad aluminium sheet by hot roll-bonding has been developed.

Utilising the process it has been made possible to clad a very thin layer of stainless steel to aluminium and the clad sheet has produced is sufficiently ductile for various forming operations.

The study of the process includes:

- (i) Effect of temperature of roll-bondings,
- (ii) Manipulation of the geometrical/frictional parameters during roll-bonding,
- (iii) Adequate thickness and surface finish of the backing plate to restrict the deformation of stainless steel to eliminate the tensile failure of stainless steel,
- (iv) Effect of surface preparation of stainless steel and aluminium before roll-bonding.

The novel technique of achieving the differential deformation during roll-cladding of harder and softer metal such as stainless steel and aluminium for obtaining ductile stainless steel clad aluminium steel has been patented.

Some of the findings of the process has been published (1983) in Tran of Ind. Inst. of Metal Journal.

2. Aluminium-mild steel-aluminium sandwich sheet

Aluminium-mild steel-aluminium sandwich sheets find application in various structuralness.

Technology for the economic production of such claded sheet has been developed. Hot roll-bonded sheets obtained from different temperature of roll-bonding were given diffusitonal annealing heat treatment for assessing the bond quality and formability of the sheet.

Satisfactory results obtained at about 500°C for 30 minutes. The work is in progress.

3. Development of silver cadmium alloy contact

Development work of contact materials containing 15% cadmium oxide have been completed. In the low cadmium range 2.5, 5 and 8% cadmium oxide contact materials have been developed after standardising the process parameters. Internal oxidation schedule was also worked out.

4. Development of silver brazing alloy

Silver brazing alloys IS BAG 6 have been completed. The alloy is used for joining electrical components. Developmental work attained in melting, casting, heat treatment and cold rolling, of the alloy in required thickness range.

Silver brazing alloys: IS BAG 10 and BAG 8 have been completed and used for joining contacts to the backing material.

5. Development of Nichrome alloy

Development work on 35 Ni-20Cr and balance iron has been completed. Melting, casting and working characteristics of the alloy finally in the form of wire has been standardised. The alloy has been successfully produced and physical and mechanical properties of the alloys, including the life test at the specified temperature have been found as per standard.

6. Development of W-Ag contact material by P/M techniques

Work for the development of 6SW-35 Ag contact material by conventional sinter infiltration technique has been completed. A different approach which utilise a combined of the layer powder processing with the conventional infiltration technique has also been made to show greater advantage over the conventional technique.

Besides the formation of contact material by processing silver and tungsten simultaneously in the same die with a single thermal treatment, an overdoze of infiltration on the revise side of the contact provided the faultless joining without coating extra procedure.

7. Fatigue testing HSL-45-connecting links, from M/s. MAMC Ltd., Durgapur, West Bengal

Fatigue testing of the HSL-45, connecting links nearly hundred samples were done during this period and Rs. 78,000/- has been earned towards testing charges.

8. After successful development of silver cadmium oxide contact (10%)

Samples were supplied to Bokaro and Bhilai for service performance. In an interim report they have conveyed that the service performance of NML developed contacts are satisfactory and are still in service.

J. FOUNDRY TECHNOLOGY

1. Development of compacted graphite iron-structure property correlation

The production of compacted graphite iron requires low sulphur and low phosphorus. Such an iron as the starting material is very difficult to be made available. In view of this for the production of compacted graphite iron, sponge iron was chosen as the starting material. Sponge iron could be melted in the arc furnace successfully which was then inoculated with Fe-Mg-Si and Fe-Ti in the specially designed ladle whereby compacted graphite iron was produced successfully. The inoculation method used was an improvised sandwich method. By such a process, CG iron was made successfully and repeatedly.

2. Aluminium cast iron

Cast iron containing aluminium in the range of 9 to 16 percent exhibits a white structure and is hard. Our main objective was to achieve graphitization in this range of Al and to produce a cast iron having machinable grey structure with good oxidation resistance.

The work was planned and carried out by adjustment of the composition of the melt, minor alloy additions and inoculation of the melt.

3. Development of humidity resistance chemical compounds for sodium silicate bonded sands system

Sodium silicate bonded moulds/cores are generally regarded as not suitable for long term storage due to deterioration under high humidity conditions. To reduce the adverse affect of high humidity addition of

some inorganic chemical compounds (like lithium and zinc) were made to study the strength properties of sodium silicate bonded sand mix, experiments were carried out at different constant relative humidity. The preliminary results obtained were found to be encouraging.

4. Development of rural oils as foundry core binders

With RRL, Hyderabad, a collaborative project has been taken-up to identify the locally available oils the rural areas as foundry core oils. So far 14 Nos. of rural oils have been collected and their physical properties have been studied, without any treatment to the oil. It has also been planned to upgrade the oils by suitable treatments so as to make these oils acceptable to foundrymen.

5. Foundry service

Moulds, cores and heats were made to meet the requirements of other divisions of the laboratory as and when requisitioned.

For instance during the current year the following work was taken up :

50 heats were made for heat resistant cast iron
3 heats were made in magnetic steel
10 heats were made for Al base alloy
Moulds prepared — 70 Nos.
Cores prepared — 50 Nos.

K. CORROSION

1. Preparation and use of a stabilizer for autocatalytic decomposition of H_2O_2 in acid pickling batches in the presence of metal ions produced during the pickling of copper and copper alloys

A process has been developed to prepare a stabilizer to control the autocatalytic decomposition of H_2O_2 in acid solutions containing a wide range of concentration of metal ions produced during pickling of copper and copper alloys at elevated temperatures. The stabilizer inhibits the decomposition of H_2O_2 to a tune of over 90% as compared to the blank solution.

2. Studies on corrosion of metal in non-aqueous solvents

To investigate the corrosion behaviour of some metals and alloys in non-aqueous solvents, a study has been made for the corrosion of Nickel and 304 stainless steel in Methanol, Dimethyl sulphoxide and Dimethyl formamide. In some protic solvents like Methanol, the addition of water strengthens the passivity of metals. In other solvents like Dimethyl formamide and Dimethyl sulphoxide, the passivity is lost even if a trace amount of water is added. In addition to this effect of chloride, pH, temperature and other parameters have also been investigated and compared with the corresponding values in aqueous media.

3. Stress corrosion cracking and Hydrogen embrittlement of carbon and stainless steel

Investigations were made to study the stress corrosion susceptibility of a low carbon steel, cold worked up to 70%, and 304 stainless steel under conditions of sustained and tensile loading with simultaneous measurement of shift of potential of specimens. Discontinuous potential changes, with special feature, immediately preceding fracture were observed and were related to the various stages of crack initiation and growth depending upon particular stressed state of the specimen.

L. COATING—ELECTRO PLATING

1. Development and performance evaluation of diffusion treated steels in Fertiliser and Chemical Industry

The project has been completed as per schedule and final joint report has been prepared for submission. In view of the magnitude of the corrosion problems in heat exchanger tubes of sulphuric acid plants, the high annual consumption of carbon steel used in such application and the growing awareness of utilisation of improved ALON tubes which are considered to have better life by sulphuric acid manufacturers, Calorized tubes and samples were prepared under different conditions and evaluated along with improved ALON materials used in heat exchangers. The laboratory and in plant evaluation data revealed that calorized carbon steel developed as per NML know-how is extremely resistant to gases encountered in sulphuric acid heat exchangers

at the operating temperatures and is even better than imported ALON material used in heat exchangers. Having established the credibility of the material for such applications, PDIL and NML have evinced keen interest in making joint efforts for the transfer of technology to an interested party.

2. Metal pigmented primers for corrosion protection of steel

Even though the zinc rich paint based on hydrolysed ethyl silicate had shown good corrosion resistance over steel as evaluated by potential measurements under immersion in 3% NaCl, it was found that the stability of the hydrolysed ethyl silicate and the pot life of mixed zinc paint are not satisfactorily high. Hence a number of experiments were carried to increase the stability of hydrolysed and pot life of mixed paint and some process has been achieved. Work is in progress.

3. (a) Conserving energy in nickel deposition by A.C. potential

It has been possible to conserve energy in electroless nickel plating by the application of low AC Potential to the conventional baths. By the use of AC to the bath, it is possible to get uniform, coherent and bright deposit at room temperature whereas the optimum temperature for the conventional bath is from 80° to 100°C. Various parameters like voltages, temperatures pH, change in composition of the bath, concentration of the sodium hypophosphite (reducing agent), metal ion concentration etc. have been varied and optimised. Various metals like copper, phosphorous bronze, brass and mild steel have thus been nickel coated successfully.

With this new process, it is possible to conserve energy as well as imported chemical (sodium hypophosphite) since nickel deposits are obtained at room temperature and lower concentration of the reducing agent.

Further work is under progress concerning microstructure, corrosion resistance (accelerated tests), micro-hardness etc.

(b) Exploratory Projects

(i) Electrolytic Nickel Powder

Through survey of the literature on the electrolytic nickel powder shows its promise for industrial applications and further, it is not manufactured in India. Preliminary experiments have been conducted to obtain electrolytic nickel powder from ammonical and acid baths on bench scale. Although the powder obtained is not so pure, it has a spiky and dendritic structure. Further work is under progress.

(ii) Continuous Plating for strips and wires

Different metal coatings like nickel, tin, silver, copper and zinc were done on mild steel wires and strips on a laboratory scale and samples made for evaluation. A pre-design feasibility report has been prepared for electrogalvanizing of strips and silver plating on copper wires.

M. STANDARD REFERENCE MATERIALS

- 1. Certification of Fe-vanadium has been completed and it is being sold to R-D organisations etc.**
- 2. Reference material of Mn. ore is ready for certification.**
- 3. Preparation, sampling of reference materials of low carbon steel and cast iron have been completed and already sent for chemical analysis to different organisation.**
- 4. Preparation of Standard reference materials of medium carbon steel (0.4% app) are being undertaken.**
- 5. 47.9 Kg of Std ref. material was sold during the year worth Rs. 1.44 Lakhs.**

N. APPLIED BASIC PROJECTS

- 1. Study on the effect of chlorine and nitrogen bubbling on the solidification behaviour and properties of Al-Si and Al-Zn-Mg alloys**

With a view to achieving optimum level of properties through uniform dispersion of microheterogenetics like second phases, porosities and non-metallic inclusions and to study the influence of size of bubbles and

rate of bubbling on the solidified structure, experiments have been initiated with nitrogen as flushing gas under atmospheric partial vacuum (work is in progress).

2. High temperature oxidation study of boiler super heater tubing materials $\frac{1}{4}$ Cr, $\frac{1}{2}$ Mo and $2\frac{1}{4}$ Cr-1 Mo steels

Oxidation of super heater tube is a complex phenomenon due to different environments prevailing inside and outside. It involves simultaneous formation of magnetite, hematite, worstite and other complex oxides. Studies on oxidation phenomenon on samples from both the above compositions in the temperature range of 500° to 800°C for extensively long time duration is under initiation (work is in progress).

3. Development of a non-isothermal thermoanalytical model developed at NML for correlating the actual operating parameters of a vertical retort for Direct Reduced Iron (DRI) production with the model incorporating geometrical, mechanical dynamic similarity criteria

A bench scale experimental set up using a marring capsule has been developed with a view to obtaining more useful results from the technique already developed at NML and IIT Kharagpur, plans are underway to study the various parameters simulating some essential features of the vertical retort process for DRI production (work is in progress).

4. Super plastic deformation of alloys

Deformation processes involving lower energy are industrially very attractive and their importance has gone up in the present day context with acute energy crisis. Plans have been formulated for studies on optimisation of microstructure and treatment for super plastic deformation of various grades of brasses and stainless steels. Work will be initiated shortly.

5. Conserving energy in nickel deposition by A C potential

Experiments were conducted on the application of AC in the deposition of nickel from conventional electroless nickel plating bath some distinct advantage such as deposition of nickel at much lower temperatures than is possible from conventional electroless nickel plating. Studies of various parameters on various substrates have revealed that it was possible to get satisfactory deposits of nickel at lower temperatures with superimposition of AC with the deposits being harder, brighter and uniform.

EXTENSION UNITS

NML UNIT IN CSIR COMPLEX, MADRAS

The National Metallurgical Laboratory Madras Centre has been engaged in applied and fundamental R&D projects in various disciplines, apart from rendering technical services by way of sponsored investigations to various public and private sector organisations. Several important sponsored investigations have been successfully completed or are in various stages of completion viz. studies on Salem Magnesite sponsored by the Mineral Development Board, New Delhi to evolve a flow sheet for improved recovery of magnesite; pelletisation and heat hardening studies of Tiruvannamalai Iron Ore Concentrates and supply of heat hardened pellets sponsored by the Department of Geology and Mining, Tamil Nadu for sponge iron production trials at Sponge Iron (India) Ltd., Kothagudam, Andhra Pradesh; testing and evaluation of limestone sponsored by Tamil Nadu Newsprint and Paper Ltd. etc. NML Madras Centre has undertaken chemical analysis, metallographic and mineralographic studies on various samples received from outside parties as well as for its own R&D programmes.

NML-NRIM collaboration project on atmospheric corrosion studies have been completed and the results are being evaluated.

I. MINERAL DRESSING AND CHEMICAL METALLURGY

A. SPONSORED INVESTIGATIONS

1. Studies on Magnesite from Salem

NML Madras Centre was requested by the Mineral Development Board, New Delhi to carry out detailed investigations and evolve a suitable flow sheet for improving and optimising the mining recovery of magnesite of Salem area from the present level of recovery of 8% by weight. About 55 tonnes of ROM ore of five different types and 5 tonnes of magnesite dumps from Salem were obtained. The magnesite samples were found to contain around 25% magnesite. Mineral beneficiation studies involving optical sorting, gravity and heavy media separation methods were adopted and a flow sheet drawn up for the recovery of 16-18% of the parent rock magnesite has been recommended to the Mineral Development Board. Further pilot plant studies are under progress for the recovery of magnesite from the above samples and from magnesite dumps.

2. Determination of Bonds' Work Index and cold crushing strength of limestone samples from M/s. Sayaji Iron and Engineering Co., Madras

Two crystalline limestone samples were received from M/s. Sayaji Iron and Engineering Co., Madras for determination of their bonds' work indices and cold crushing strength. The test results indicated work index values of 11.95 KWH/Tonne and 10.8 KWH/Tonne for the two samples respectively. Cold crushing strength values were found to be in the range 237-317 kg/cm² and 238-458 kg/cm² respectively after carrying out the test on 6 specimens from each sample. The test data and results have been reported vide NML IR No. 1187/85.

3. Pelletisation and heat hardening studies on Tiruvannamalai Iron Ore concentrate sponsored by Dept. of Geology and Mining, Tamil Nadu

Department of Geology and Mining, Tamil Nadu Govt. desired detailed investigations and testing work to be taken up on Tiruvannamalai iron ore for production of D/R quality pellets for sponge iron production trials at M/s. Sponge Iron (India) Ltd., Kothagudam, Andhra Pradesh. Investigations were conducted using hydrated lime as binder-cum-flux. The iron ore concentrate constituted mainly magnetite and analysed 70.56% Total Fe, 2.14% SiO₂, 1.43% Al₂O₃ and trace CaO+MgO. Bench scale studies were carried out on pellets of 0.3, 0.6 and 0.8 basicities with 1300, 1600 and 1800 blains using hydrated lime as binder/flux and heat hardened at 1250°-1330°C. The heat hardened pellets were subjected to Gakushin reducibility test and other properties viz. swelling index, porosity, strength etc. The optimum parameters were found to be 0.8 basicity and 1800 blains grind and the pellets were found to be D/R quality.

Based on the above investigation, 500 kgs of heat hardened pellets were made available and supplied to the party for sponge iron production trials.

4. Testing of limestone for M/s. Tamil Nadu Newsprint and Paper Limited

At the instance of M/s. TNPL, a sample of limestone was collected from Sendurai near Ariyalur, Trichy District to study its suitability for use in paper industry. The samples analysed 49.10% CaO, 7.9% SiO₂, 1.0% Fe₂O₃, 2.2% Al₂O₃, 0.45% MgO, 0.07% P, 39.01% LOI and traces of S. The cold crushing strength was found to be 385-400 kg/cm². Six calcination tests were carried out on -150+100 mm samples at temperatures between 900°-1200°C and the product lime wet screened to find out the extent of disintegration. Reactivity tests revealed that the lime samples were medium reactive. Further tests on samples in sieve range of -100+50 mm is under progress.

B. BASIC RESEARCH SCHEME

1. Electrofloatation Cell

A laboratory column floatation cell 7 cm dia and 80 cm height has been fabricated. In order to obtain uniform and small sized bubbles, a special feature of this cell, the column has been provided with two electrodes to enable electrolytic oxygen and hydrogen bubbles to ascend the column. Preliminary trials using the cell are in progress.

2. Beneficiation studies on scheelite

Trial experiments and investigations on scheelite sample from Jaurasi Area of Uttar Pradesh, containing 0.15% calcium wolframite (CaWO₄) are under progress for beneficiation to commercially acceptable level. A series of bench scale tabling experiments carried out proved ineffective. Floatation experiments using various phosphate modifiers such as Na₃PO₄, Na₄P₂O₃, Na(Po₄)₃ Na-obate as collector are under progress.

C. MINERALOGICAL STUDIES

Mineralogical studies were conducted for all the mineral processing investigations undertaken at the Unit.

II. ENGINEERING METALLURGY

A. FOUNDRY

1. Technical guidance was provided to M/s St. Vincents Industrials, Calicut to overcome cracking of chilled rolls cast in their foundry and in general to improve the quality and productivity and modernise the foundry.

2. Reclamation of used foundry moulding sand (Inter Lab. Project): Reclamation trials were conducted in the prototype sand reclamation unit developed by MERADO on core sand lumps procured from M/s. Ennore Foundries, Madras. The results were evaluated by sieve analysis.

3. About 10 foundry sand samples received from M/s. Binny Engineering Co., Meenambakkam, Aruna Castings, Guindy; Brakes India Limited, Padi, Chemical and Metallurgical Services, Madras were tested for strength, permeability, sintering point etc.

4. Pull out tests were conducted on 25 water pump body samples received from M/s. Carburettore Limited, Madras.

B. METALLOGRAPHY AND HEAT TREATMENT

During the year under review, a total of 164 testing cases were carried out, 90 involving metallographic studies including failure analysis. 73 for hardness and other mechanical tests and one case of heat treatment to attain desired properties. These investigations were carried out on behalf of power stations of Tamil Nadu Electricity Board; Indian Standards Institution, Madras; South Central Railway, Hyderabad; Institute of Road Transport, Madras; Kunal Engineering Co., Madras; India Radiators, Madras; Cockweld Electrodes, Madras etc. Some of the investigations included failure of water wall tubes and super heater tubes of Ennore Thermal Power Station. Correlation of structure and toughness properties of test weld impact specimen for Rockweld Electrodes and structure evaluation of 63/37 brass strip for radiator production by India Radiators. Metallographic work was carried out on a variety of samples like steel and alloy steels, copper alloys, aluminium alloys, ST Irons etc. Heat treatment work was carried out on a batch of high Mu-Metal to relieve the stress at controlled atmosphere and restore magnetic permeability.

C. CALIBRATION OF THERMOCOUPLES

50 thermocouples were tested for their accuracy and test certificates issued to various outside parties.

D. REFRACTORY TESTING

Testing of refractory materials was carried out on a total of about 12 samples received from various outside agencies like M/s. Vispro Foundries, Madras; M/s. Aluka Refractories, Kerala; Vadapalani Refractories, Madras; Dugar Vermiculites Products, Madras etc. The refractory samples were tested for physical properties such as sieve analysis, apparent porosity, bulk density, Cold Crushing Strength, PCE and Thermal conductivities at various hot face and mean temperatures. Some iron ore powder samples (departmental) were tested for specific surface area using Lea-Nurse apparatus.

E. DESIGN/DRAWING

Detailed drawing for slurry tank, rotary drum and trunnion arrangements has been completed. Drawings for the drive mechanism, stirrer arrangement etc. for the rotary vacuum drum filter is in progress.

III. METALLURGICAL ANALYSIS

The analysis division handled a total of 829 samples involving analysis of 2821 radicals. Of these 524 samples were from outside parties and 305 from projects taken up by different division of the Unit.

IV. CORROSION

After completing the exposure studies on samples received from Japan under the project of NML-NRIM collaboration on atmospheric corrosion, exposure tests on Indian samples were taken up and completed and the results are being evaluated.

FIELD STATIONS

During the period, the field had rendered the necessary technical services to the engineering and foundry industries particularly the small scale industries. These services comprised of chemical analysis (both qualitative and quantitative) of various metals and minerals, mechanical testing of metals and alloys, testing of foundry moulding sands and bonding clays etc., on the spot study of foundry problems and their remedial measures, improvement in quality according to the stringent specifications and export purposes.

Work done by the three field stations during the period is furnished below.

	<i>Howrah</i>	<i>Batala</i>	<i>Ahmedabad</i>
<i>I.</i> Chem. Analysis :			
(a) No. of samples	650	220	996
(b) No. of radicals	2983	761	3941
<i>II.</i> Mech. Testing :			
(a) No. of samples	428	71	—
(b) No. of tests	428	71	—
<i>III.</i> Metallography Test :			
(a) No. of samples	15	63	—
(b) No. of tests	15	63	—
<i>IV.</i> Total No. of tech. enquiries	28	194	83
<i>V.</i> Total No. of foundry visits	3	162	—

The Howrah field station had also conducted tests on fifteen metallography samples and the Batala field station had conducted tests on sixty-three metallography samples.

ADDITIONAL ACTIVITIES AT THE FIELD STATIONS

HOWRAH

The field station personnel helped in organising a seminar on "Appropriate technologies for rural development" held in Calcutta in February 1985 in which the Scientist-in-Charge acted as co-ordinator of the technical sessions.

BATALA

During 10.2.85 to 22.2.85, the Scientist-in-Charge had visited various foundries at Gujarat State and H.M.T. Ajmer along with the industrialists of Punjab as a member of the Co-ordinating Committee formed by the Department of Industries, Government of Punjab.

ENGINEERING SERVICES

ELECTRONICS ENGINEERING

A. INSTRUMENTATION OF PROJECTS

(i) Corrosion

Corrosion meter designed earlier is under fabrication. The heart of the instrument is MOS FET Operational amplifier.

(ii) One HIL 2962 Microprocessor Lab, has been installed

Training of staff is under progress so that they can undertake servicing of microprocessor-based instruments as and when required. Pye-Unicam Atomic absorption spectrophotometer SP 2900 (microprocessor-based) was already received.

(iii) Mechanical metallurgy

Major repair of vibrophone (Fatigue testing machine) has been completed. As the electronic panel of the machine is more than 20 years' old, steps have been taken to replace it with a modern (solid state) panel.

B. GENERAL MAINTENANCE, CALIBRATION, TESTING JOBS COMPLETED (MAJOR JOBS ONLY)

1. Philips X-ray Fluorescence Spectrometer
2. Philips X-ray Diffractometer
3. Pye-Unicam Atomic Absorption Spectrophotometer SP-1900
4. Digital Electronics X-Y Recorder
5. H&B Magnet Tester
6. Temperature Controllers & recorders (about 50 Nos)

ELECTRICAL ENGINEERING SECTION

1. Development work

(i) Development of Arc Plasma Furnace for use in Metallurgical Processes

During the operation of Arc Plasma Furnace developed in the laboratory, it was observed that the refractory lining had very short life. To increase the life of refractory, the shell was water cooled and sea water magnesia ramming mass of purity over 98% MgO with less than 0.05% B₂O₃ was planned to procure.

(ii) Design and building of 3-Zone isothermal electric resistance furnaces for creep testing machines

After proving the prototype design of the furnace for long service, ten furnaces of normal zone design and five furnaces of expanded zone design for single specimen creep testing machines were built. Expanded zone furnaces can accommodate three specimens and thus increase the capacity of test points.

2. Design of power distribution system, and temperature and humidity control system, installation and commissioning

Design of power distribution system, and temperature and humidity control systems in respect of following major jobs were carried out. Their detailed specifications and layouts were prepared. Installation and commissioning of engineering projects were planned and executed.

- (i) Installation of power supply system and control units in various new projects of the laboratory.
- (ii) Replacement of unserviceable power supply system in the Main Building, Tech. Block and Plant area.

- (iii) Electrical services for the modification of old Auditorium for Library accommodation.
- (iv) Electrical installation of water cooling tower 200 TR for creep testing laboratory.
- (v) Corrosion prevention of H.T. & L.T. panels in the main sub-station of the laboratory.
- (vi) Complete overhauling, repairing, painting of exhaust fans, ceiling fans, regulators etc. in the main laboratory.
- (vii) Replacement of old damaged internal wiring of residential areas.
- (viii) Replacement of old damaged electrical cables, and overhead wirings of residential areas.
- (ix) Scrutiny and selection of 80 TR chilling unit for creep testing laboratory.
- (x) Installation of one—500 KVA transformer, 6,600 volts/415 volts in the plant area.

3. Preventive maintenance and break-down repairs

Scheduled preventive maintenance and replacements, planning and execution of proper inspection and monitoring of various critical components while in service and fault shooting and repairing were carried out for the electrical equipment of the laboratory, its pilot plants and residential areas, comprising of high tension sub-stations, electric arc furnaces, high frequency furnaces, resistance furnaces, rectifiers, electric motors and their control centres, temperature and humidity control equipment etc.

4. Forecasting and procurement of spare parts

Forecasting and procurement of spare parts for power distribution system, temperature and humidity control system, melting facilities, metal testing facilities, pilot plants etc. were carried out.

CIVIL SECTION

JOBS COMPLETED

1. Painting white washing of old E-type blocks at Agrico NML Flats.
2. Periodical painting, white washing to residential quarters at NML Tuiladungri Colony, FPTD and NML premises.
3. Cleaning of overhead and ground water reservoirs at CH Area and Pipe Line Road, Agrico NML Flats.
4. Renovation of community development centre at Agrico and Tuiladungri NML Colony.

JOBS IN PROGRESS

1. Periodical painting, white washing for FGH-type quarters.
2. Periodical painting, white washing to B-type bungalows at CH Area and Pipe Line Road.
3. Periodical painting, white washing to old D-type blocks at Agrico NML Flats.

JOBS COMPLETED UNDER SUB-HEAD P/6 MAINTENANCE

1. Repair and replacement of broken ACC sheets and general maintenance work in sub stores at FPTD NML.
2. Modification of RLC Calcutta and rearrangement of exhibits.
3. Repair and replacement of damaged doors and windows at FPTD Pilot Plants and office building, NML.
4. Making passage at 2nd floor eastern wing for connecting to roof terrace over Chemistry Divn., NML.

RESEARCH PLANNING

Annual plan for 1984-85 and the budget estimates for 1985-86 were formulated keeping in view the ongoing projects as well as areas of major thrust proposed during the successive years.

SEVENTH FIVE-YEAR PLAN PROJECTIONS

The seventh Five-Year Plan document covering the period 85-86 to 89-90 was formulated yearwise and presented before the RAC for their comments and approval. The area on metallurgy was co-ordinated by Scientist (Director), Dr. Rajendra Kumar taking into consideration the important areas at various CSIR Laboratories such as RRL, Bhopal, RRL, Bhubaneswar; RRL, Jorhat; RRL, Trivandrum; CECRI, Karaikudi. The Seventh Five-Year Plan proposals have included priority areas on mineral beneficiation, extractive metallurgy, iron and steel, metal powders, mechanical metallurgy, high temperature steels, Al-alloys, alloy steels, foundry, failure analysis, standard reference samples and pollution control in metallurgical processes.

The laboratory had taken up collaborative projects with SAIL R&D and have completed two projects. Two projects were closed during the period.

At a workshop held at SAIL, Ranchi between 19th and 20th Feb. 1985 about 15 proposals of NML were discussed and seven projects were identified for taking up during the Seventh Five-year plan.

RURAL DEVELOPMENT

A team of scientists from NISTADS (CSIR) New Delhi led by the Project Co-ordinator, Bankura Project (W. Bengal) during their visit to NML in May '84, suggested to phase out the activities along the following lines:

- Phase I : To standardize the casting techniques for bell and brass metal products, establish demonstration facilities at Bankura (W. Bengal), train the artisans in batches to adopt the improved techniques thereby saving in fuel consumption and increasing their productivity.
- Phase II : To develop appropriate technologies at NML and transfer the same through training.
- Phase III : To introduce diversification in product development with better skills and relatively better sophistication and establish a training centre with necessary infrastructural facilities at Bankura.

In connection with the above programme the NML has already prepared a proposal for implementation during the Seventh Plan Period.

The following five projects have also been included in the NML's Seventh Plan Document.

1. Reducing the rejections in the manufacture of aluminium utensils thereby improving the productivity.
2. Solving the problems of Sari industries.
3. Improvement in wear resistance properties of harvesting and tillage tools.
4. Development of duplex shear blades for agricultural purposes.
5. Mini Cupola for use in rural areas.

The RAC (Research Appraisal Committee) of NML at its meeting held on 22nd and 23rd March 1984 has also suggested to include in the programme, the development of Kanchanpur knives as also rendering assistance to blacksmithy.

PATENTS

The following patents were filed:

<i>Title</i>	<i>Inventors</i>
1. A process for the preparation and use of an inhibitor suitable for batch and continuous pickling of steels in sulphuric acid solutions at high temperature.	Dr. V. A. Aitekar Dr. Inder Singh Dr. D. D. N. Singh Mr. M. K. Banerjee
2. A process for the preparation of a non-corrosive flux for soft soldering of copper and copper-based alloys.	Dr. Inder Singh Dr. D. D. N. Singh Mr. M. K. Banerjee
3. Improvements in or relating to production of pure magnesium carbonate from magnesite.	Dr. V. A. Altekar Mr. Gurdial Singh Mr. M. L. Dey Dr. N. Dhananjayan

TECHNICAL CONFERENCE

SYMPOSIA/SEMINARS

1. The Eleventh National Powder Metallurgy (P/M) Conference 1985

NML played host to the Eleventh National P/M Conference held jointly with the Powder Metallurgy Association of India on 08-09 Feb. 1985.

Attended by over 150 delegates, this Annual National Conference highlighted the status of Powder Metallurgy in India as well as worldwide.

The two-day conference included a key-note address session, five Technical sessions and a Poster session. The pioneering role of the National Metallurgical Laboratory in the area of metal powders production technology particularly by air and water-atomization as well as by distillation and shock-cooling was pin-pointed and substantiated by the two key-note addresses by NML on 'Powder Metallurgy comes of Age in India' by Dr. V. A. Altekhar, Director, NML and on 'Value-Engineering Aspects of Powder Metallurgy' by M. J. Shahani, Scientist. Eight other papers were also presented by NML scientists.

Other notable contributions included those by scientists from BARC, Bombay; IIT, Kanpur; IIT, Kharagpur; IIT, Madras and many others.

Generous assistance was given by local industrial giants such as M/s. Tata Steel as well as Powder Metallurgy Units from all over India, including NML's licensee in Patna—M/s. ZIPGO for distilled zinc dust.

2. Symposium on Magnesium—Its status and prospects in India.

A Symposium on 'Magnesium—Its status and Prospects in India' was organised by the Magnesium Project, National Metallurgical Laboratory, Jamshedpur on 15th and 16th Feb. 1985 with a view to making a realistic assessment of the present and future demands and the need to set up production of primary magnesium metal in the country, since the country has to be self-reliant in this strategic metal.

12 technical papers covering development of magnesium alloys and their casting characteristics, production techniques of magnesium and uses of magnesium and magnesium residue in foundries and prospects of commercial production of high purity magnesium were presented during the technical sessions and invoked lively discussions.

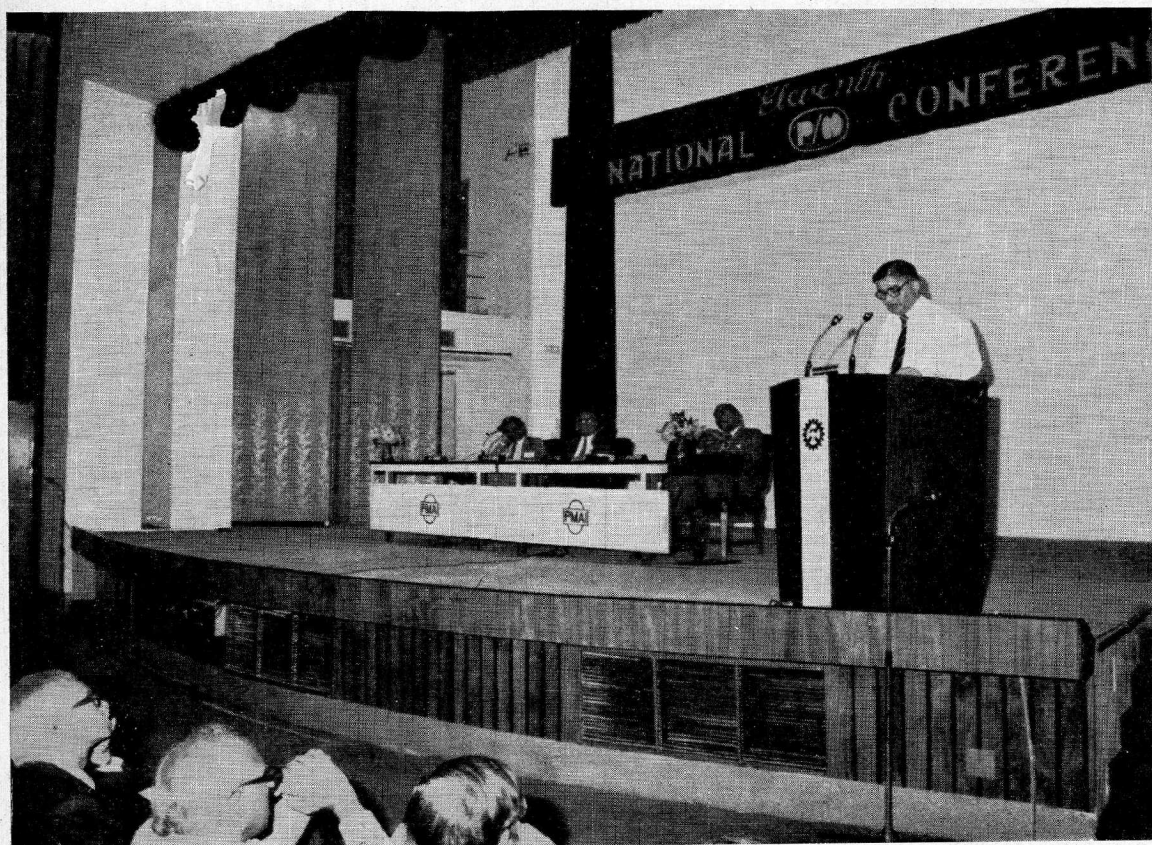
The Symposium was inaugurated by Shri M. K. Batra, Chairman and Managing Director, Uranium Corporation of India Ltd., Deptt. of Atomic Energy at an august function attended by eminent metallurgists and dignitaries.

He emphasized the importance of indigenous production to make the country self-reliant in this strategic metal, and congratulated CSIR and NML for taking the initiative in setting up the demonstration-cum-development plant for the production of magnesium metal by the silico-thermal process and CECRI for developing the know-how by the electrolysis route.

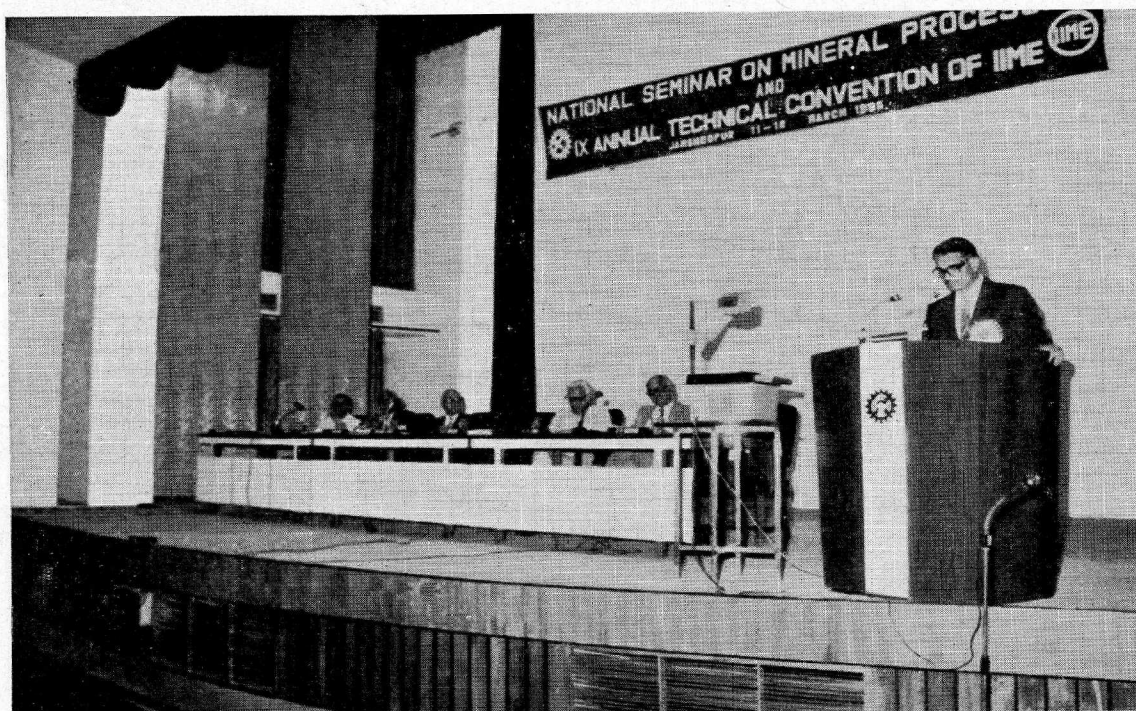
Prof. V. A. Altekhar, Director, NML, in his Presidential Address stressed the strategic role of magnesium metal in the area of defence, space and nuclear energy and the importance of the adoption of indigenous technologies already available under the aegis of CSIR for establishing commercial production in the country.

Dr. B. R. Nijhawan, Senior Adviser, Inter Regional UNIDO, Vienna, in his brief address, appreciated the role of NML Scientists in establishing the production technology on a proving scale to enable indigenisation of the technology on a commercial scale to meet the country's demands. He also mentioned the role played by the scientists of the country specially of NML, in assisting the developing countries, which is being recognized by the world over.

The consensus of the Symposium was that there is every prospect for the enhancement of the indigenous demand of magnesium metal and there is a need for establishing commercial production of magnesium metal in the country.



Dr. J. J. Irani, President, Tata Iron and Steel Company, delivering the inaugural address at the Eleventh National Powder Metallurgy Conference held at NML on 8th & 9th February, 1985



Hon'ble Sri Shivraj Patil, Minister of State for Science & Technology, Vice-President, CSIR delivering the inaugural speech of the Seminar on "Mineral Processing and the Annual Technical Convention of Indian Institute of Mineral Engineers" held at NML from 11th to 13th March, 1985

3. National Seminar on Mineral Processing

A three-day Seminar, on 'Mineral Processing' and the annual technical convention of India Institute of Mineral Engineers (IIME) jointly organized by NML and IIME were held at NML from 11th to 13th March 1985.

The Seminar was inaugurated on 11th March, 1985, by the Chief Guest, Hon'ble Shri Shivraj Patil, Minister of State for Science and Technology, Ocean Development, Atomic Energy, Space and Electronics and also Vice-President CSIR. Shri Patil emphasized the need for economy in the use of minerals and metals so that these could last longer. Care should be taken to economize their use as also to avoid environmental pollution. At the same time, he said, the country should not lag behind in obtaining advanced technology for exploitation, processing and grading of minerals. He said that the need of the hour is to modernize the mineral industry to cope up with the rising demand for which scientific and managerial inputs must go side by side.

Prof. V. A. Altekar, Director, NML and President, IIME, presided over the inaugural session, Prof. Altekar, stressing planned utilization of minerals said that economy could be achieved by recycling the waste minerals.

About 180 delegates from all over the country including foreign delegates from Canada and Japan participated in the Seminar. In all 56 papers (out of which NML contributed 8 papers including 4 invited lectures were presented during the Seminar). Works visits on 13th March, 1985 to Moshabani and Rakha Plant of M/s. UCIL were also arranged.

An Honorary Membership of the IIME was conferred on Shri R. H. Mody, Chairman and Managing Director, Tata Iron & Steel Co. Ltd. in recognition of his outstanding contribution to the cause of mineral industry in India.

LIBRARY SERVICES

The Library added 950 new books and subscribed nearly 250 periodicals on metallurgy and its allied subjects covering a total grant of Rs. 5,75,000/-. In addition to this nearly 100 publications and 180 periodicals were received on exchange and complementary basis. The 3rd batch containing 23 publications under Overseas Development Administration (ODA) programme of British Council, have been received.

The Library continued the project oriented documentation service and weekly current awareness service. Five selected bibliographies and specific subjects were furnished to the scientists of NML

The scheme for Institutional Membership of NML Library for academic institute and R&D units of industries continued to be in operation. During the period under review three more organisations have become member.

The modernisation work of Library for acquiring more space is in progress. Efforts are being made for procuring and 'Automatic plain paper copier' for the Library.

HONOURS & AWARDS

Dr. R. Kumar—Member of the Inter Advisory Board of the Journal "High Temp. Technology" (England).

Dr. R. Kumar, C. S. Siva Ramakrishnan and R. K. Mohanty—Certificate of Merit by NRDC for development of reactive filter medium for Al.

Dr. P. R. Khangaokar and Mr. R. Krishnamurty—Certificate of merit by Institute of Engineers, India, for extractive metallurgy on non-ferrous metals and alloys.

Mr. D. D. Akerkar—Indranil Award for extraction of non-ferrous metals and alloys.

Dr. M. R. K. Rao—Unido Assignment as Refractory Expert to Mexico.

Dr. S. S. Bhatnagar—Unido Assignment on high strength low alloy steel to Mexico.

Prof. V. A. Altekar, M. J. Shahani and A. K. Saha—Ganga Ram Memorial Gold Medal by Institute of Engineers, India.

Shri H. Singh and V. A. Altekar—Certificate of Merit by Institution of Engineers, India.

Mr. G. P. Mathur—Unido Assignment as an expert on mineral processing to Nigeria.

DEPUTATION TO TRAINING COURSES IN INDIA

Sl. No.	Name & Designation	Course	Organised by	Period	Place
1.	Shri A. P. Chowdhuri, Sct. E-I	Course on Instrument Technology	—	12-13 Sept. '84	Calcutta
2.	" D. M. Chakraborty, Sct. E-I				
3.	Shri M. L. Sharma, Sr. Doc. Officer	Workshop on Computer Applications Information Science	—	4-6 Sept. '84	N.M.L., Jamshedpur
4.	" B. V. S. Yedavalli, Sct. B				
5.	Mrs. N. Chakravorty, Sr. Lib. Officer				
6.	" V. Kher, Sr. Librarian				
7.	Shri P. R. Sastri, Sct. A-1				
8.	" V. Muthukrishnan, Sct. E-I	Workshop on Sintering Technology	—	4-5 Feb. '85	N.M.L., Jamshedpur
9.	" G. S. Minhas, Sct. C				
10.	" P. K. Sinha, Sct. C	Workshop on Extractive Metallurgy of Base Metal Sulphides	—	7-8 Feb. '85	Udaipur
11.	" S. C. Moulik, Sct. C				
12.	" J. P. Srivastava, Sct. C				
13.	" R. K. Kunwar, Sct. A-1				
14.	" M. C. Goswami, Sct. A				
15.	" A. K. Sinhamahapatra, SSA				
16.	" Premchand, Sct. E-I	Workshop on alloy steel castings	—	12.1.85	Calcutta
17.	" D. Jha, Sct. B				
18.	" S. K. Sinha, Sct. A	Workshop cum Colloquium on Modern Information Technology for Industry	SAIL & British Council, Calcutta	17-19 Jan. '85	Ranchi
19.	" M. L. Sharma, Sr. Doc. O				
20.	Mrs. N. Chakraborty, Sr. Lib. O				
21.	Shri A. Kumar, SSA	Course on Principles & Applications of Digital Electronics	—	28.1.85-2.2.85	Jamshedpur
22.	Shri L. N. Das, Sct. C				
23.	" P. K. Bagchi, Sct. B-I	Workshop on Relevance of X-ray diffraction and X-ray Fluorescence Techniques in Iron & Steel Industry	SAIL & Philips	19.3.85	Ranchi
24.	Shri S. K. Bose, Sct. E-I				
25.	" N. K. Das, Sct. C				
26.	Dr. S. C. Srivastava, Sct. C				
27.	Shri S. K. Roy, A.O. (S.G.)	Ninth course on New dimensions in the management of human resources	Indian Institute of Public Administration	11-16 Feb. '85	New Delhi
28.	Mrs. Saroja Rajagopal, S.O. (Gen.)	Course on Administrative Management in R&D	NISTAD	1-9 Feb. '85	Hyderabad
29.	Shri G. N. Rao, Sct. E-II	National Workshop on new ideas, new Horizons in Technology, productivity and cost reduction in Foundry	—	7-8 April '84	Ranchi
30.	" S. K. Sinhababu, JSA				
31.	Shri D. M. Chakraborty, Sct. E-I	Summer School on Business and Technological Fore-casting	—	25.4.84 to 5.5.84	I.I.T., Kharagpur
32.	" S. Prakash, Sct. B				
33.	Shri Ashimesh Dutt, Sct. C	Training programme in Patents	—	25.4.84 to 27.4.84	Calcutta
34.	" G. S. Minhas				
35.	" Arun Kumar, SSA				
36.	" Gurucharan Singh, Sct. B	2 Day Workshop on Chemical Analysis of Aluminium and its alloys	—	22-23 June '84	Bangalore
37.	Shri Raghubir Singh, Sct. E-I	Appreciation course on Welding	—	15-16 June '84	Jamshedpur
38.	" B. N. Halder, Sct. E-I				
39.	" N. N. Mathur, Sct. A				
40.	Shri T. A. Beck, Sct. C	Workshop on Sodium Silicate based sand systems	—	14.7.84	NML, Jamshedpur
41.	" S. K. Sinha, Sct. A				
42.	" R. R. Dash, Sct. A				
43.	" S. K. Sinhababu, JSA				

Sl. No.	Name & Designation	Course	Organised by	Period	Place
44.	Shri S. Ghosh, Sct. C	Course on Concepts of Computer systems and programming	I.I.T., Kanpur	14.5.84 to 13.7.84	Kanpur
45.	„ S. Prakash, Sct. B	Summar course on Process Engineerind Fundamentals of Iron & Steel manufacture	-do-	2-18 July '84	Kanpur
46.	„ P. R. Shastri, Sct. A-1	Executive development & orientation course for young engineers	—	18-30 June '84	Hyderabad
47.	„ S. K. Malaviya, Sct. A	Course on Process and Quality control in the manufacture of new and special ceramics	Cement Research Institute of India	2-4 July '84	Ballabgarh (Haryana)
48.	„ L. N. Das Sct. C	Microprocessors : Fundamentals and Programming Techniques	I.I.T., New Delhi	18-25 July '84	New Delhi
49.	„ P. Basak, Sct. C	Refresher course on Recent trends in Forge Technology	NIFT	16-27 July '84	Ranchi
50.	„ S. P. Chakraborty, Sct. A }				
51.	Mrs. Saroja Rajagopal, SPA	Training programme for Administrative and Finance staff	CSIR	2-9 Feb '85	Hyderabad

DEPUTATIONS TO CONFERENCE/SYMPOSIA/SEMINAR, ETC. IN INDIA

Sl.No.	Name & Designation	Symposia/Conference, etc.	Organised by	Period	Place
1.	Shri M. L. Blaggan, Security Officer	Seminar on Security Management	Indian Institute of Security Management	21.7.84	Calcutta
2.	Dr. Inder Singh, Sct. 'C'	} Seminar on Indigenisation of oil field equipment, chemicals and projected requirements	ONGC	24.7.84	Bombay
3.	Prof. V. A. Altekar, Director				
4.	Shri A. Dutta, Sct. 'C'				
5.	Dr. O. N. Mohanty, Sct. F	National Seminar on Management of R & D in Public Enterprises	—	27th & 28th July '84	Hyderabad
6.	Prof. V. A. Altekar, Director	12th World mining congress	—	19-23 Nov '84	New Delhi
7.	Dr. R. N. Ghosh, Sct, EI	Prof Brahm Prakash Memorial Seminar	—	21-22 Aug '84	Hyderabad
8.	Dr. R. Kumar, Sct (Director)	} Sixth International Conve Conference on Fracture	—	4-10 Dec '84	New Delhi
9.	Dr. R. N. Ghosh, Sct. EI				
10.	Dr. M. R. K. Rao, Sct. EII	} National Seminar on High energy materials and Advanced Workshop on thermal Analysis	—	19-23 Nov '84	Poona
11.	Shri B. Banerjee, Sct. B				
12.	Dr. D. D. N. Singh, Sct. B	Symposia on Corrosion and its prevention	B.H.U.	12-13 Oct '84	Varanasi
13.	Shri B. K. Saxena, Sct. EI	Workshop on Status of Welding in Research and Production	—	12-14 Sept '84	Roorkee
14.	Prof. V. A. Altekar, Director	} 22nd NMD, 38th ATM of IIM and Symposium on "Advances in Metal Processing"	IIM	14-18 Nov '84	Bangalore
15.	Dr. O. N. Mohanty, Sct. F				
16.	Shri K. N. Srivastava, Sct. EII				
17.	„ D. D. Akerkar, Sct. E. II				
18.	„ K. N. Gupta, Sct. E II				
19.	„ S. K. Bose, Sct. E I				
20.	„ C. S. Sivaramakrishnan, Sct. EI				
21.	„ A. K. Vaish, Sct. C				
22.	„ D. Jha, Sct. B				
23.	„ S. Prakash, Sct. B				
24.	„ A. K. Bhattamishra, JSA				
25.	Prof. V. A. Altekar, Director	} Third Indo-Soviet Bilateral Symposium on "Improvements in Technology and Quality of finished products in Iron & Steel Industry— Problems and Prospects"	—	26-28 Nov '84	Ranchi
26.	Dr. R. Kumar, Sct. (Director)				
27.	Dr. O. N. Mohanty, Sct. F				
28.	Dr. S. S. Bhatnagar, Sct. EII				
29.	Shri K. N. Gupta, Sct. EII	} Seminar on Finishing and coating of Copper and Copper alloys	—	29-30 Nov '84	New Delhi
30.	Shri A. N. Mukherjee, Sct. B				
31.	Dr. S. K. Narang, Sct. C				

Sl.No.	Name & Designation	Symposia/Conference, etc.	Organised by	Period	Place				
32.	Shri P. L. Sengupta, Sct. C	Workshop on quality circles	—	20.10.84	Calcutta				
33.	Shri K. N. Gupta, Sct. EII	National Symposium on "Role and Application of innovations in Indian Steel Industry"	—	15.12.84	Durgapur				
34.	Dr. S. K. Narang, Sct. C	} ATM of the E.C.S. of India	—	19th & 20th July '84	Bangalore				
35.	Shri T. L. Sharma, Sct. B								
36.	Dr. O. N. Mohanty, Sct. F	National Symposium on Computer modelling and Applications in Metallurgical Research and Industry (COMARI)	—	7th & 8th March, 1985	Bombay				
37.	Prof. V. A. Altekar, Director	} 34th A.T.M. of I.I.F.	I.I.F.	1st to 4th Feb '85	Bombay				
38.	Shri S. Ghosh, Sct. C								
39.	Shri R. R. Dash, Sct. A								
40.	Dr. O. N. Mohanty, Sct. F	}	—	19.1.85	Ranchi				
41.	Shri K. N. Srivastava, Sct. EII								
42.	Dr. M. R. K. Rao, Sct. EII	} Seminar on Ceramic Firing & Energy Savings— Current trends	—	24-25 Jan '85	Bangalore				
43.	Mr. A. K. Bose, Sct. B								
44.	Prof. V. A. Altekar, Director	}	P.W.I.	8-9 Feb '85	Jamshedpur				
45.	Shri M. J. Shahani, Sct. EII								
46.	„ D. D. Akerkar, Sct. EII								
47.	„ Upkar Singh, Sct. EI								
48.	„ G. Basak, Sct. C								
49.	„ R. G. Ganguli, Sct. C								
50.	„ S. Prasad, Sct. B								
51.	„ J. P. Tiwari, Sct. B								
52.	„ R. N. Lahiri, Sct. BI								
53.	„ S. K. Singh, Sct. A								
54.	„ A. Nag, JSA								
55.	Dr. N. Dhananjayan, Sct. EII	} Eleventh National Powder Metallurgy Conference	—	11-15 Feb '85	Kanpur				
56.	Shri B. N. Singh, Sct. C								
57.	Dr. Inder Singh, Sct.								
58.	Shri Swatantra Prakash, Sct. B								
59.	Dr. O. N. Mohanty, Sct. F								
60.	Dr. Inder Singh, Sct. C					} International Conference on Corrosion Science & Technology	—	20-23 Feb '85	Calcutta
61.	Shri K. P. Mukherjee, Sct. EI								
62.	Shri T. A. Beck, Sct. C					} Symposium on Magnesium —Its status and prospects in India	—	15-17 Feb '85	NML, Jamshedpur
63.	„ R. R. Dash, Sct. A								
64.	„ S. K. Sinha, Sct. A								

Sl.No.	Name & Designation	Symposia/Conference, etc.	Organised by	Period	Place
65.	Dr. N. Dhananjayan, Sct. EII	}	IIME	11-12 March '85	NML, Jamshedpur
66.	Mr. R. D. Gupta, Sct. EI				
67.	„ A. K. Mallik, Sct. EI				
68.	„ J. S. Padan, Sct. C				
69.	„ S. Rafiuddin, Sct. C				
70.	„ M. V. Ranganathan, Sct. C				
71.	„ T. C. Dey, Sct. C				
72.	„ J. P. Srivastava, Sct. C				
73.	„ H. Patnaik, Sct. C				
74.	„ P. K. Sinha, Sct. C				
75.	„ S. R. Joti, Sct. C				
76.	„ S. R. Ghosh, Sct. C				
77.	„ B. Banerjee, Sct. B				
78.	„ N. N. Mathur, Sct. B				
79.	Dr. K. V. Rao, Sct. B				
80.	Shri S. Mohan Rao, Sct. A				
81.	„ S. N. Prasad, Sct. A				
82.	„ S. K. Sengupta, Sct. A				
83.	Dr. S. Siviah, Sct. A				
84.	Shri. P. N. Pathak, Sct. A				
85.	„ N. K. Chaturvedi, Sct. AI				
86.	„ R. K. Kunwar, Sct. AI				
87.	„ S. K. Sil, JTA				
88.	„ U. S. Chattoraj, SLA				
89.	„ S. K. Biswas, JTA				
90.	„ Gurdial Singh, Sct. C				
91.	„ P. L. Sengupta, Sct. C				
92.	Shri S. Sanyal, Asstt.	Seminar on Pollution Control and Environmental Management	—	16-18 March '85	Nagpur
93.	Shri S. K. Bose, Sct. EI	}	—	25-26 April '84	RRL., Bhopal
94.	„ C. S. S. Krishnan				
95.	Shri J. S. Padan, Sct. C				
96.	„ S. R. Ghosh Sct. C	}	—	26.5.84	Kiriburu
97.	„ A. K. Sinha Mahapatra, Sct.				
98.	„ M. C. Goswami, SSA				
99.	„ S. K. Biswas, Sct. C	}	IIM Cal. Chapter	27.7.84	Calcutta
100.	„ Ashimesh Dutta, Sct. C				
101.	„ B. K. Saxena, Sct. EI				
102.	„ S. R. Srinivasan, Sct. EI	}	—	17-19 June '84	Jamshedpur
103.	Dr. A. Shyam, Research Associate				
104.	Prof. V. A. Altekar, Director				
105.	Shri K. N. Gupta, Sct. EII	International Symposium on use of sponge iron in Electric and Arc melting units	—	6-7 July '84	Hyderabad

CHAIRMANSHIP, MEMBERSHIP ETC., ON OUTSIDE BODIES

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	Director	Bihar Industrial & Technical Consultancy Organisation, Patna.
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Mr. K. N. Srivastava	Member	State Council of S & T, Bihar.
	Member	State R & D and Design Committee, Bihar.
	Member	Advisory Committee to SISI, Bihar.

APPENDIX I

Research Papers Published/Communicated

1. "Permanent Black Finishes on Alluminium"—By T. L. Sharma, Y. N. Trehan and S. K. Narang, J. Electro-Chemical Soc. of India, vol. 32, No. 3, July 1983, p. 268.
2. "Corrosion—An Introduction"—By S. K. Narang, Publication No. 172, Central Board of Irrigation and Power, New Delhi, 1984.
3. "Electron Diffraction Analysis of Gas treated Indian Bentonite Clays"—By G. N. Rao, M. Ram and T. L. Sharma, NML Tech. J. 25 No. 3 & 4, August and November, 1983.
4. "Development of Integral colours of Alluminium and its alloys"—By T. L. Sharma, and Y. N. Trehan, J. Electrochem. Soc. of India. vol. 32, No. 4, 389 (1983).
5. Performance evaluation of zinc rich primer based on soluble silicates by P. Prabhakaran, A. K. Dey, S. Rao Addanki, D. K. Khan. NML Tech. J. No. 25 Feb.-May 1983.
6. Water side Corrosion in Boilers—By Inder Singh. Proceeding on "workshop on metallurgy in thermal power stations", July '84 pp. 46-52.
7. Properties and Application of Stainless Steel Powders produced at NML—By Inder Singh, V. A. Altekar. 11th National P/M Conference & Exhibition Feb. 8th, 9th, 1985, NML, Jamshedpur.
8. Rusting of Cold rolled sheet coils during transit and storage—a case study—By Inder Singh, K. P. Mukherjee and V. A. Altekar. J. Electro-chemical Society of India, Bangalore, April '85.
9. Passivation Behaviour of Titanium-6Al-4V alloy in Phosphoric acid solution—By D. D. N. Singh, J. Electro-chem. Soc. (USA) Feb. 1985, p. 378.
10. Vapour Phase corrosion inhibitors—A. Review, D. D. N. Singh & M. K. Banerjee. Anti-Corrosion Methods & Materials 31, 6 (1984) 4-8.
11. Repassivation Kinetics of 304 stainless steel under loaded conditions—D. D. N. Singh & M. K. Banerjee. All India Symposium on Corrosion and its prevention. Applied Chemistry Section. BHU, Varanasi, 14-15 Oct. 1984, paper No. 31.
12. Protection of Mg. from atmospheric Corrosion—An effective surface treatment for the metal—D. D. N. Singh, Symposium on "Magnesium, its Status & Prospects in India", NML, Jamshedpur Feb. 85.
13. On some aspects of creep deformation of low alloy Cr-Mo-V Creep resistant steels—R. Singh & R. Kumar. Published in the Transaction of the Indian Institute of Metals, Vol. 37, No. 5, October, 1984 (T.P. 1227).
14. Sizing a mill—statistical approach by H. Patnaik Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
15. A sub-sieve sizer employing elutriation with water by Dr. S. Sivaiah and S. Rafiuddin. Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
16. Studies on beneficiation of ferruginous manganese ores using solid reductants by S. Rafiuddin *et al.* Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
17. A computer oriented algorithm to determine the raw mixture composition for sintering by S. C. Maulic and N. Chakravorty. Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
18. A review of the beneficiation prospects of some of the graphite deposits of Palamau district in Bihar by P. N. Pathak, M. V. Ranganathan and D. M. Chakrabarti, Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.

19. Mineral characterisation of some Indian phosphatic deposits and its influence on their processing problems by S. Mohana Rao, B. Banerjee and A. Peravadhanulu. Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
20. Some observations on the beneficiation of lean phosphate rock from indigenous resources by T. C. De and N. Chakravorty. Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
21. Experimental processing of some of the Indian clays for commercial purposes—By M. V. Ranganathan and N. Chakravorty. Presented at the National Seminar on Mineral Processing held at NML, March 11-13, 1985.
22. Beneficiation of industrial minerals for basic refractories—by P. D. Prasada Rao, A. Peravadhanulu and G. P. Mathur presented in Ceramic Society, Jamshedpur Chapter.
23. Monograph on ores and minerals of India (Vol. II)—Developments and processing techniques for industrial utilisation—By P. D. Prasada Rao, A. Peravadhanulu, G. P. Mathur and V. A. Altekar. This volume was released on 11th March '85 during the Mineral Processing Seminar at NML.
24. A bench scale experiment for simulating the vertical retort process for production of Direct Reduced Iron (DRI) Communicated to "Iron making and Steel making", U.K.—By S. Prakash, K. N. Gupta and H. S. Ray.
25. Momentum Transfer to Newtonian and non-newtonian fluids flow past a sphere communicated to—By S. Prakash, K. N. Gupta and V. A. Altekar. Indian Chemical Engineer.
26. Lithium chemical from Indian lithium bearing minerals lepidolite—techno-economic examination. Communicated to chemical Age of India. S. Prakash, K. N. Gupta, V. A. Altekar.
27. A moving bed experiment for simulation of Iron ore reduction by coal in a continuous vertical reactor. "Proceedings of International Conference on Progress in Metallurgical Research—Fundamental and Applied aspects, held on Feb. 11-15, 1983 at IIT, Kanpur by S. Prakash, K. N. Gupta, H. S. Ray and V. A. Altekar.
28. Commercial Feasibility of lithium chemicals production exploiting lithium resources in India. Presented at 38th ATM of IIM held on Nov. 14-17 1984, at IISc, Bangalore—S. Prakash, K. N. Gupta and V. A. Altekar.
29. Mathematical modelling in Flue Gas desulfurisation—A State of Art at 37th Annual Session of IICHe with AIChE—By S. Prakash and A. P. Bhattacharya, held at IIT New Delhi on Dec. 17-29, 1984.
30. "Role of Raw Materials in optimising productivity in Steel Plants"—Silver Jubilee Seminar, at Kiriburu Mines of Bokaro Steel Plant was attended by A.K. Sinha Mahapatra and M.C. Goswami
31. Possibility of coal Gas based direct reduction" A Ganguly, B.R. Chowdhury and K.N. Gupta—MIP Coal gassification Seminar '84, KHD/SMI—at New Delhi Dec. '84
32. "Recent Trends in Energy Conservation Associated with Steelmaking"—R.D. Gupta & V.A. Altekar. Presented at the 8th ASPA International Seminar at New Delhi 11-12 Dec. '84 organised by Alloy Steel Producers Association of India
33. "Hot processing of 14 per cent Austenitic manganese steel"—R.D. Gupta, S.K. Palit & V.A. Altekar. Presented at the International Conference on Progress in Metallurgical Research, Fundamental & Applied Aspects, at IIT, Kanpur, 11-15 Feb. 1985
34. Status of L-D Refractories Practice. By P.C. Sen, M.R.K. Rao, K.C. Ray and N.N. Mathur. Submitted to the 49th Annual Technical Meeting of Indian Ceramic Society held at Hyderabad during 9-12 March, 1985
35. Beneficiation and utilisation of low grade Refractory Materials. By N.N. Mathur, P.C. Sen & M.R.K. Rao. Presented in the National Seminar on Mineral Processing & Ninth Annual Technical Convention organised by Indian Institute of Minerals Engineers and NML on March 11-12, 1985 at Jamshedpur

36. Development of high alumina refractories from technical alumina and Kyanite. By K. K. Singh, A. V. Subramanyam and M. R. K. Rao. Trans Indian Ceramic Society, Vol. 43(I), Jan-Feb 1984, pp. 25-27.
37. Foam Insulation Refractories. By A. K. Bose & M. R. K. Rao, NML RR 420/84, Feb 1984. Presented at the REFCHEM Seminar, New Delhi, March 20, 1984
38. Prospects of commercialisation of direct ammonia leaching process versus reduction roast ammoniacal leaching of manganese sea nodules by D. D. Akerkar. Presented at the National Seminar on "Processing Manganese Sea Nodules" held at R.R.L., Bhubaneswar on 28th Feb-1st March 1985
39. Processing of polymetallic sea nodules by reduction-roast-ammonia leaching for recovery of nickel, cobalt and copper—A. K. Saha, M. S. Mahanty, D. Bagchi and D. D. Akerkar, Presented at the National Seminar on "Processing of Manganese Sea Nodules" held at R.R.L., Bhubaneswar on 28th Feb-1st March 1985.
40. Development of direct ammonia leaching process for treatment of polymetallic sea nodules by B. D. Pandey, R. K. Jana, V. Kumar, M. G. Bodas, D. D. Akerkar and V. A. Altekar. Presented at the National Seminar on "Processing of Manganese Sea nodules" held at R.R.L., Bhubaneswar on 28th Feb-1st March 1985.
41. Recovery of metallic values from the ammoniacal leach solutions obtained by leaching of polymetallic sea nodules in reduction roast ammonia leaching and direct ammonia leaching processes by R. K. Jana, B. D. Pandey, V. Kumar, M. Yaseen, A. K. Saha and D. D. Akerkar. Presented at the National Seminar on "Processing of Mn-Sea nodules" held at R.R.L., Bhubaneswar on 28th Feb-1st March 1985.
42. Design and scaling up of the direct ammonia leaching process for treatment of polymetallic sea nodules for recovery of multi-metals by A. P. Bhattacharya, S. K. Tiwary, M. G. Bodas, M. S. Mahanty and D. D. Akerkar, Presented at the National Seminar on "Processing of Mn-Sea nodules" held at R.R.L. Bhubaneswar 28th Feb-1st March 1985.
43. Studies of characterisation of different samples of polymetallic sea nodules by electron-optical instruments by B. Banerjee, S. K. Bose, S. R. Singh, A. K. Nayak and D. D. Akerkar. Presented at the National Seminar on "Processing of Mn-Sea nodules" held at R.R.L., Bhubaneswar on 28th Feb-1st March 1985.
44. X-ray diffractometric studies of Mn-Fe sea nodules by S. K. Bose, N. K. Das and A. K. Nayak. Presented at the National Seminar on "Processing of Mn-Sea nodules" held at R.R.L., Bhubaneswar 28th Feb-1st March 1985.
45. Production of Microfine Silver Powder by B. N. Singh, N. Dhananjayan and V. A. Altekar. Presented at the 11th National Powder Metallurgy Conference held on February 8-9, 1985, at NML, Jamshedpur
46. Chemical Beneficiation of magnesite by Gurdial Singh, M. L. Dey, N. Dhananjayan and V. A. Altekar. Presented at the National Seminar on Mineral Processing and IX Annual Technical Convention of IIME held at NML, Jamshedpur March 11-12, 1985
47. Crushing and Grinding of Electrodeposited Manganese Dioxide by P L. Sengupta and N. Dhananjayan. Presented at the National Seminar on Mineral Processing and IX Annual Technical Convention of IIME held at NML, Jamshedpur, March 11-12, 1985.
48. "Powder Metallurgy comes of Age", Altekar V.A.: Keynote Address, Eleventh National Powder Metallurgy Conference (Jamshedpur), February 1985
49. "Value-Engineering Aspects of Powder Metallurgy", Shahani M.J.: Keynote Address, Eleventh National Powder Metallurgy Conference (Jamshedpur) February 1985
50. "Impressions of the P/M Industry in the United States and Canada", Tewari J.P.: Eleventh National P/M Conference (Jamshedpur), February 1985
51. "Production Parameters of Air-Atomized Non-ferrous Metal Powders", Ganguly R.G.; Singh U.; Shahani M.J.: Eleventh National P/M Conference (Jamshedpur) February 1985.
52. "Technology Aspects of Water-Atomized Metal Powders Production in India", Ganguly R.G.; Singh U.; Shahani M.J.: Eleventh National P/M Conference (Jamshedpur) February 1985

53. "Microbiohydro Copper Powders" Prasad S; Nag A; Shahani M.J.: Eleventh National P/M Conference (Jamshedpur) February 1985
54. "The Production Technology of super fine distilled grade metal powders", Basak G.; Lahiri R.N.; Shahani M.J.: Eleventh National P/M Conference (Jamshedpur) February 1985
55. "Metal Powders..... to Decade of R & D at the National Metallurgical Laboratory", Shahani M.J.: P/M Conference Souvenir, February 1985, pp 4-15
56. Al-5% Mg alloy extruded tube as support member of overhead electric traction—A case study by G. G. Nair, A. K. Bhattamishra, Kishori Lal, B. K. Saxena and R. Kumar, accepted for publication in Jr. Institution of Engineers, Aug. 1984
57. Solidification and mechanical behaviour of metals, Kishori Lal. Published in "workshop on metallurgy in Thermal Power Station", CBIP, New Delhi (Sept. 1984)
58. Studies on corrosion behaviour of aluminium alloy conductors in NaCl and Na₂ SO₄ solutions by A. K. Bhattamishra, Kishori Lal and R. Kumar. Presented at 38th ATM of IIM, Bangalore, Nov. 1984.
59. A peep into remelting of aluminium by Kishori Lal, C. S. Shivaramakrishnan and R. Kumar. Proc. Industry Workshop on modernisation of aluminium casting industries, SISI, Trichur, Nov. 1984.
60. Metallurgy of welding of steel by B. K. Saxena—Workshop on metallurgy in Thermal Power Station publication No. 172, CBIP, New Delhi, July 1984.
61. Standardization of melting technology of Aircraft Grade Aluminium alloy by C. S. Shivaramakrishnan, B. K. Saxena, Rajendra Kumar—ISI Bulletin Vol. 36, No. 4 pp. 127-32 (1984)
62. An experience with Al-5% Mg alloy steady arm component in the cantilever assembly supporting overhead electrical conductors by G. G. Nair, A. K. Bhattamishra, K. Lal, B. K. Saxena and Rajendra Kumar. Paper accepted for publication in the Bulletin of Institution of Engineers (India)
63. Non-polluting non-corrosive treatment of aluminium melts. Paper presented at the Annual Tech. Meeting of IIM at Banaras Hindu University, Varanasi 1—17 Nov. 1983.
64. The dispersion of lead and graphite in aluminium alloys for bearing applications by C. S. Sivaramakrishnan, R. K. Mahanti and R. Kumar. Wear (U. K.) 96. No. 21984, 121-134; also presented in Nov. 84 at IIM.
65. Stability in metallic alloys in liquid phase by C. S. Sivaramakrishnan and R. Kumar. Presented at the Seminar on phase stability and phase transformation at BARC, Bombay, Feb. 6-8, 1984.
66. Development in Al and its alloy solidification technology by C. S. Sivaramakrishnan and R. Kumar. Presented at the Seminar on Solidification of Metals—Future Trends, held at Bhopal RRL, April 25-26, 1984.
67. Morphology of Fracture in Al and Mg alloys by C. S. Sivaramakrihnan, N. K. Das, R. K. Mahanti and R. Kumar. Aluminium 60, 1984, pp. 467-471.
68. The use of NML reactive ceramic filter in the production of Al alloys by C. S; Sivaramakrishnan, R. K. Mahanti and R. Kumar. Proc. Seminar on High strength Al alloys in defence and Industry, 24-25 Feb. 1984.
69. Trends in grain refinement of Al melts by C. S. Sivaramakrishnan and R. Kumar. Proc. 34th Annual Convention, 1-3 Feb. 1985, pp. 156-159.
70. Studies on the fracture toughness in light alloys by C. S. Sivaramakrishnan, N. K. Das, R. K. Mahanti and R. Kumar. Proc. Poster session papers of 6th Int. Conf. on Fracture ICF6, 4-10 Dec. 1984, New Delhi, pp. 96-98.
71. Statistical evaluation of indigenous foundry moulding sands from Northern region by R. R. Dash, S. K. Sinhababu and G. N. Rao, presented at 33rd IIF Annual Convention at Delhi, March 1984.

72. Effect of additives on moulding properties of sodium silicate bonded sand containing ferrochrome slag as hardener by S. K. Sinhababu, T. A. Bech and G. N. Rao (RR No. 423/84, March '84) presented at National Workshop, HEC, Ranchi, April, 1984.
73. Some fundamental aspects in quality assessment of foundry clays by R. R. Dash, S. K. Sinhababu, S. Ghosh, and G. N. Rao Presented at 34th Annual Convnetion, IIF at Bombay, Feb. 1985.
74. Pidgeon Process—Magnesium residue finds foundry application by R. R. Dash, T. A. Bech, S. K. Sinha, S. K. Sinhababu, S. K. Biswas and G. N. Rao, Presented at the Seminar on Magnesium at NML, February, 1985.

APPENDIX II

Research Reports

1. Foam Insulation Refractories by A. K. Bose, M. R. K. Rao (RR 420/84).
2. Studies on the development of high temperature refractory castables at the NML by M. C. Kundra, S. K. Malaviya, M. R. K. Rao (RR 421/84).
3. Some observations and results of atmospheric corrosion tests carried at Madras on test specimens received from NRIM—Japan by S. Rao Addanki, P. R. Khangaonkar (RR 422/84).
4. Effect of additions on the moulding properties of sodium silicate bonded sand containing ferro-chrome slag as hardner by S. K. Sinhababu, T. A. Beck and G. N. Rao (RR 423/84).
5. Corrosion problems and combating research activities in India by K. P. Mukherjee (RR 424/84).
6. Development of Indian solvent extraction Reagents in collaboration with National Chemical Laboratory, Pune by D. D. Akerkar, R. K. Jena, B. D. Pandey, M. G. Bodas, M. Yaseen and V. A. Altekar (RR 425/84).
7. Corrosion behaviour of Nickel in Methanol by D. D. N. Singh and M. K. Banerjee (RR 426/84).
8. Repassivation of 304 stainless steel under applied tensile load by D. D. N. Singh and M. K. Banerjee (RR 427/84).
9. Flow properties of granular solids by S. Sivaiah, S. Raffiuddin and N. Chakravarty (RR 429/84).
10. Statistical and structural analysis of Indian Foundry clays—a new approach by R. R. Dash, S. K. Sinhababu, G. N. Rao and V. A. Altekar (RR 430/84).

Investigation Reports

1. Investigation report on the failure of Part-I Connection Super Heater Tube. Part-II Economiser Tube. Part-III Screen Tube of Unit No. 4, supplied by Badarpur Thermal Power Station (IR No. 1163/84).
2. Determination of reduction degradation index of iron ore/iron ore sinter samples received from Bhilai Steel Plant by M. C. Goswami, A. K. S. Mahapatra, K. N. Gupta (IR No. 1164/84).
3. Metallurgical investigation on the failure of hard drawn grooved Copper contact wire by R. Kumar, Kishorilal, G. G. Nair, A. K. Bhattamisra (IR No. 1165/84).
4. Investigation on failure Raiser tube of Boiler No. 1 from M/s. Indian Oil Corporation, Barauni by R. Kumar (IR No. 1166/84).
5. Assessment of residual life of main streamline pipe in the Thermal Power Station of Neveli lignite Corporation by Rajendra Kumar, R. Singh, Y. N. Tewary (IR No. 1167/84).
6. Bench scale beneficiation studies on Coal samples from Tuticorin thermal power station—Tamil Nadu by A. Raja Kumar, K. Vijayaraghavan, V. Mohan, C. Satyanarayana, P. R. Khangaonkar (IR No. 1168/84).
7. Testing of samples of Sponge iron supplied by M/s. Mehta & Padansay Surveyors (P) Ltd. with a view to assessing the damage due to fire on stock of sponge iron (IR 1169/84).
8. Residual life of furnace tube of crude distillate unit including metallographic examination and mechanical testing by R. Kumar, R. Singh, B. K. Chowdhury (IR No. 1170/84).
9. Failure of Tie Bar at Chukha Hydel Project, Bhutan by R. Kumar, R. Singh, B. K. Choudhury (IR No. 1171/84).
10. Report on mineralogical studies on tar/pitch impregnated sea water magnesia and permanent volume change after reheating of Silica bricks from Belpahar Refractories Ltd. by N. N. Mathur, M. R. K. Rao (IR No. 1172/84).

11. Investigation on PAIMKEY failure at Chandrapura Thermal Power Station, Chandrapura (D.V.C.) by G. G. Nair, R. Singh, R. N. Ghosh, R. Kumar (IR No. 1173/84).
12. Beneficiation studies and agglomeration studies on Iron ore samples from Daitari and Gandhamardan mines from M/s. Paradip Steel Project (Nilachal Ispat Nigam) SAIL-Part I (IR No. 1174/84).
13. Investigation on the failure of Reeconomiser tubes of Unit No. 5, of Dhuvaran Thermal Power Station Gujarat Electricity Board by R. Kumar, S. Choudhury (IR No. 1175/84).
14. Investigation on the failure of Platen super heater tube of Unit No. V, Ennore Thermal Power Station by R. Kumar, S. Choudhuri (IR No. 1176/84).
15. Investigation on failed inlet plate super heater of Unit V by R. Kumar, S. Chaudhury (IR No. 1177/84).
16. Beneficiation and agglomeration studies on iron ore samples from Daitari and Gandhamardan mines for M/s. Paradip Steel Project (SAIL), Part II (Nilachal Ispat Nigam) (IR No. 1178/84).
17. Failure of connective super heater State II Boiler No. 3 of Patratu Thermal Power Station by R. Kumar, R. Singh, B. K. Choudhury (IR No. 1179/84).
18. Metallurgical examination of stainless steel wire ropes for automatic tensioning of 25 KV overhead Catenary line of Indian Railways by R. Kumar, B. N. Haldar, G. G. Nair, S. P. Mukherjee, and A. K. Bhattamisra (IR No. 1180/84).
19. Rusting of TMBP (mill back plate) coils during transit and storage by Inder Singh, K. P. Mukherjee (IR No. 1181/84).
20. Metallurgical Investigation on the cracking during extrusion of lead-alloy sheathing telecommunication cables and recommendations to avoid the problem by R. Kumar, Kishorilal, G. G. Nair, B. N. Haldar, A. K. Bhattamisra (IR No. 1182/83).
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