NML
Annual Report

1982-83

NATIONAL METALLURGICAL LABORATORY
JAMSHEDPUR, INDIA

ANNUAL REPORT

1982-83

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

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FOREWORD

I have great pleasure in presenting the annual report of the National Metallurgical Laboratory for the year 1982-83.

National Metallurgical Laboratory went through another year of considerable R & D activity. It is a matter of satisfaction that R and D work of the Laboratory during the past few years have resulted in commercialization of many of its products and technologies. The 6000 tonnes per day copper concentrating plant of M/s Hindustan Copper Ltd. at Malanjkhand, which the Prime Minister dedicated to the Nation, has been set up based on the process flowsheet developed at NML following the findings of batch and tonnage scale pilot plant work done. Utilizing NML's expertise, fluorspar and graphite beneficiation plants have made considerable progress by M/s Madhya Pradesh and Maharashtra Minerals and Chemicals Ltd. and M/s Tamilnadu Minerals Ltd. Another electrolytic manganese dioxide plant having a capacity to produce 2500 tonnes annually is under negotiation with M/s Electro-Chem, Orissa Ltd. based on NML technology.

M/s Tin Plate Co. of India is utilizing the technology developed in the laboratory in recovering tin from their tin sludge. Tonnage quantities of refined tin have been produced by the laboratory and returned to the firm. NML developed aluminium base bearing alloy is undergoing service trial in locomotives in place of conventional bronze bushes. Highly satisfactory service report of this bearing alloy has been received from Research, Design and Standards Organization, Ministry of Railways, who are greatly interested in it. In the area of high temperature steels, long term creep, stress rupture and stress relaxation properties of steam turbine bolting steels have been evaluated on behalf of M/s Bharat Heavy Electricals Ltd.

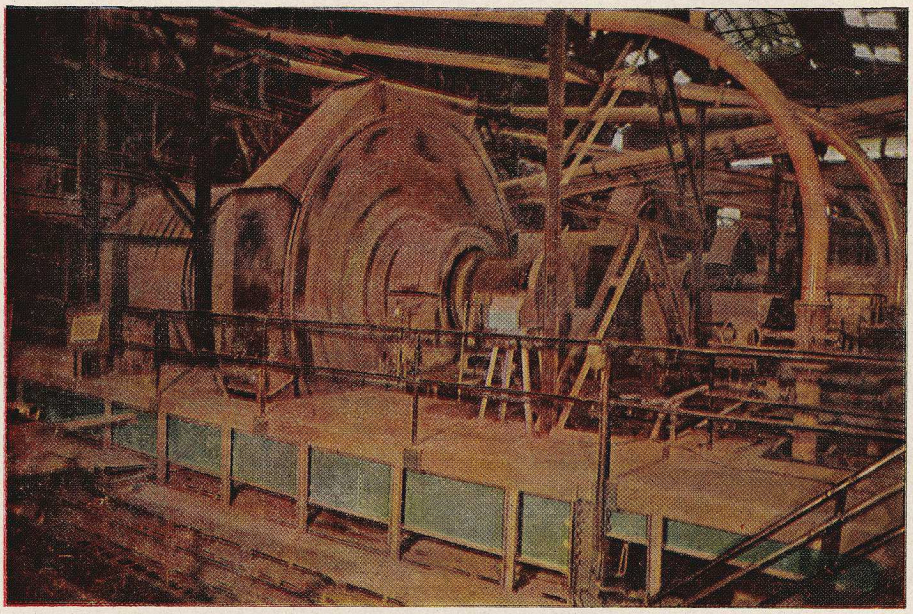
NML is actively associated with Rural Development Programme of CSIR and assisting the rural artisans of Bankura district, W. Bengal, in melting and casting techniques of brass and bronze metals. The laboratory is inter-acting with small scale aluminium utensil manufacturers of Bihar and has helped them in improving the quality and productivity of their product and minimising rejection rates.

With National Research Institute for Metals, Japan; NML is continuing the joint study on the exposure of different metals and alloys under industrial and marine atmosphere in two countries. NML has established a rapport with Steel Authority of India Ltd. and identified seven projects, work on which has been initiated.

In collaboration with INSDOC, NISTAD and PID of CSIR and Society for Documentation and Information Service, Jamshedpur, a Seminar on "Co-operation in Information Management" was held.

The report furnishes a brief review of the activities and achievements of NML during the period. The tempo of R and D which the laboratory is maintaining will no doubt help in commercial utilization of many of its products and technologies in years to come.

V. A. Altekar
Director



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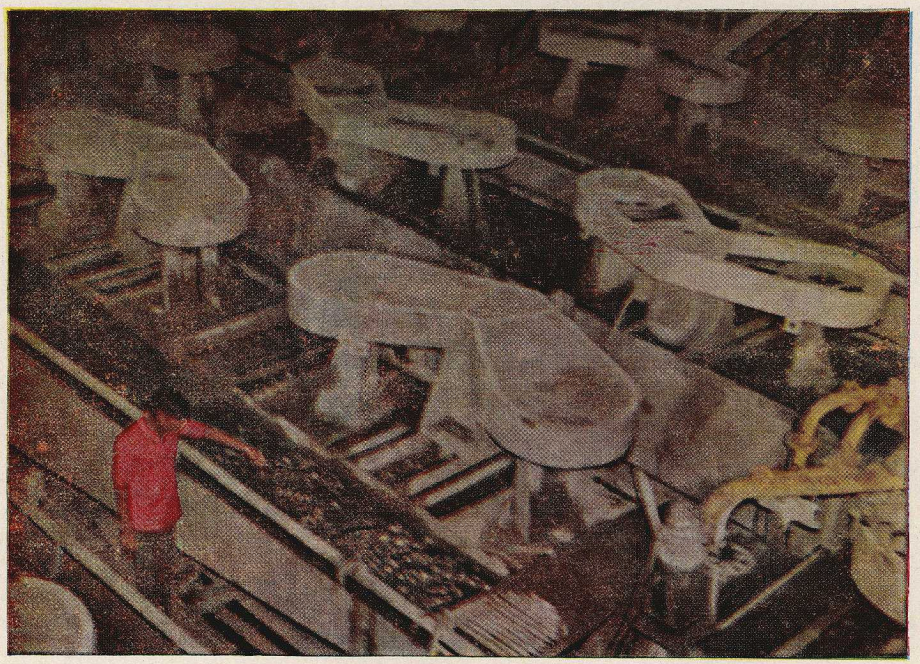

(b)

6000 tonnes/day Copper Concentrator at Malanjkhand of M/s. Hindustan Copper Ltd. showing (a) Ball Mill (b) Flotation Unit. The plant has been set up on the basis of the investigations conducted and flow-sheet developed at NML.

INTRODUCTION

The expertise and capabilities of National Metallurgical Laboratory in various disciplines of metallurgy have made great impact on the industrial development and adaptation of technologies during the period.

The Prime Minister dedicated to the nation on 12th November, 1982, the 6000 tonnes per day copper concentrator at Malanjkhand which is based on the process flowsheet developed at NML after comprehensive bench and pilot plant scale beneficiation studies on tonnage quantities of the ore sample. The studies at NML indicated that copper concentrates assaying around 25 p.c. copper with a copper recoveries of 96-98 p.c. from the run-of-mine ore assaying 1 p.c. copper could be produced in continuous runs. Similar findings were also reported by M/s. Mechanober Laboratories of USSR and the NML recommendations were accept in toto.

The Laboratory's expertise is being utilized in setting up the proposed fluorspar beneficiation plant at Chandidungri by M/s. Madhya Pradesh and Maharashtra Minerals and Chemical Ltd. M/s. Tamilnadu Mineral Ltd. is proposing to set up a 100 tonnes per day beneficiation plant for processing their graphite deposits at Shivganga, Ramnad dist based on the work done at NML Unit at CSIR Complex, Madras. The NML unit is also acting as a Consultant to this project.

Based on NML technology, a 2500 tonnes per annum electrolytic manganese dioxide plant is being set up at Baripada, Orissa, by M/s. Electro-Chem, Orissa Ltd., Continuous inplant trials for the commercial production of vanadium rich slag and low silicon low phosphorus pig iron were successfully undertaken at M/s. Visvesvaraya Iron and Steel Ltd., Bhadravati, where the NML Scientists took active part during the production campaign covering a few months.

Long term creep, stress rupture and stress relaxation properties of steam turbine bolting steels have been evaluated as per the programme of Indian Creep Panel and the report has been submitted to M/s. Bharat Heavy Electrical Ltd., (R and D), who sponsored the project.

NML developed aluminium base bearing alloy (NML-PM401) is undergoing field trials for uses as floating bushes in locomotives in place of conventional bronze bushes. The Research, Design and Standards Organization, Ministry of Railway, Lucknow, have reported that some bushes have given satisfactory service for over 29000 km. run. RDSO is interested in utilizing the NML developed know how.

Service failures of vital engineering components such as boiler tubes, rotors, turbine blades, condenser tube etc. relating to Power Plants of Energy Sectors e.g. DVC, Electricity Boards of State Governments, National Thermal Power Corporation etc. were diagonised for the cause of failures. Remedial measures for preventing recurrence of such failures have been recommended.

Prof. V. A. Altekar, Director, NML, briefing a group of I.A.S. Officers and probationers during their visit.

A process has been developed for recovery of tin from tin sludge. An agreement has been made with M/s. Tinplate Co. of India, for treating their tin sludge to produce tin metal. Tonnage quantities of tin have been produced and supplied to M/s. Tin Plate Co. Process has also been developed to recover tin from tin slag. Consultancy service has been provided to M/s. Detinners (P) Ltd., Calcutta, for the recovery of tin from tin sponge and tin slag.

With a view to minimise the extent of atmospheric pollution due to emission of sulphurous fumes, by foundry/re-rolling mills at Agra so as to protect the beauty and life of historical and archaeological monuments, NML expertise is being utilized.

NML in collaboration with SAIL has identified seven projects, work on which has been taken up. NML has assisted the rural artisans at Bankura district in West Bengal towards the improvement and modification of conventional castings and heat-treatment of metals and alloys.

A National Seminar on "Co-operation in Information Management" was organised by NML on 14-15 February 1983, in collaboration with INSDOC, NISTAD, PID all of CSIR and Society for Documentation and Information Science, Jamshedpur.

Two Metallurgical Orientation courses, and a Short Term course on 'Basic Metallurgy' were organised. A Refresher course on 'Ceramic Science in Engineering' was also conducted in collaboration with Indian Ceramic Society, Jamshedpur Chapter and Indian Institute of Ceramics, Calcutta.

A brief resume of the various R and D Projects and other activities are furnished in the various Chapters of the Report.

PROJECT HIGHLIGHTS

A. ORE DRESSING & MINERAL BENEFICIATION

1. Evaluation of Daitari and Gandhamardan Iron Ore Samples for Paradeep Steel Plant. *Sponsored by M/s. Mecon.*

Evaluation of iron ore samples from Daitari and Gandhamardan (10 type samples), have been undertaken and the pilot scale investigation work is in progress.

2. Studies on Limestone and Dolomite Samples for Vizag Steel Project. *Sponsored by M/s. Vizag Steel Project.*

Specified physical tests like crushing strength, grindability tests sieve and chemical analyses, DTA studies etc. are being conducted with the limestone and dolomite samples received from M/s. Vizag Steel Project.

3. Studies on Coal from Talcher Area. *Sponsored by M/s. C.M.P.D.I. Ranchi.*

Heavy media separation tests with the size fractions of the coal sample, using a suspension of zinc chloride in water and at varying specific densities have been performed and the sink and float products are being chemically analysed. The aim of the investigation is to determine the percentage of alpha quartz in the sample.

4. Beneficiation Studies on Two Large Tonnage Ferruginous Manganese Ore Lumps and Fine Samples from Joda West Manganese Mines of M/s. Tisco.

Two ferruginous low grade manganese ores were received for up-grading them to produce a manganese concentrate suitable for ferro-manganese production. The two samples designated as lumps and fines contained pyrolusite, psilomelane and cryptomelane and the associated gangue minerals were goethite, limonite, clay minerals and quartz. Liberation studies indicated about 48 mesh grind.

Lumps assayed 27% Mn, 24.64% Fe, 6.76%SiO_2, 4.5% Al_2O_3 and fines analysed 28.7% Mn, 24.64% Fe, 5.2% SiO_2, & 3.85% Al_2O_3. The lumps gave a manganese concentrate analysing 49.6% Mn, giving a Mn/Fe ratio of 5.9. The fines yielded a manganese concentrate assaying 51.6% Mn, 7.9% Fe with 72.7% Mn in it giving Mn/Fe ratio of 6.53.

5. Beneficiation of Manganese Ore. *Sponsored by M/s. Aditya Minerals Limited, Nagpur.*

Detailed mineralogical studies have been completed on a sample of manganese ore received from the above firm. Bench scale beneficiation

studies by gravity concentration methods have also been completed and the products are being chemically analysed.

6. Beneficiation of Tourmaline rich Kyanite from PARDI Mines of M/s. Maharashtra Minerals Corporation Limited.

Exploratory studies on samples of tourmaline rich kyanite from Pardi mines, were undertaken for producing tourmaline free kyanite concentrate (also free from other deleterios gangue) and supply the sized concentrates to the sponsors for evaluation studies. The sized concentrates were found to assay between 59 to 63% Al_2O_3 mostly free from tourmaline with PCE value of 35 to 37 approx. Recently, concentrates produced from a 4 tonnes lot of the sample have been also supplied in bulk to the sponsors for onward transmission to M/s. Belpahar Refractories, M/s. Maithan Industries etc. for evaluation/trials and a suitable feed-back to NML.

7. Beneficiation of Four Kyanite Samples. *Sponsored by M/s. Maharashtra State Mining Corporation Ltd.*

Bench scales beneficiation tests by gravity method as well as flotation are in progress with the individual samples.

8. Beneficiation Studies on Iron Ore Slime Samples. *Sponsored by M/s. Mineral Development Board.*

Detailed beneficiation studies on four different iron ore slimes from Bolani, Gua, Kiriburu and Barsua mines and the same were completed.

9. Beneficiation Studies on Lead-Zinc Ore Containing Barium from Bhutan. *Sponsored by Geological Survey of India.*

A partially oxidized lead-zinc ore rich in mineral barite, weighing five tonnes was received for beneficiation studies. The sample received was from Rome Gangri mines of Genekha, Bhutan.

The sample consisted of four types—red lumpy, red fines, black lumpy and black fines. A composite sample was prepared by mixing equal proportion of each. The composite sample analysed 4.77% Pb, 6.2% Zn. 29.5% Ba and 33.64% SiO_2 etc. Further work is in progress.

10. Beneficiation Studies of a Low Grade Rock Phosphate from Mussoorie. *Sponsored by M/s. Pyrites, Phosphates & Chemicals Limited.*

Bench scale beneficiation studies on a low grade rock phosphate from Mussoorie, U.P. were carried out. The sample as received assayed as 18.96% P_2O_5 and 10.47% SiO_2.

The optimum result showed 22.0% P_2O_5 with a recovery of 77.8% in —28 mesh sample. Further work on 88% —100 mesh with initial roasting and subsequent leaching in HCl gave a sand weighing 62.6% which on flotation test, gave 28.08% P_2O_5 with 50.8% P_2O_5 recovery in it.

11. Exploratory Studies on a Pyrite Sample from Amjhore. *Sponsored by M/s. Pyrites, Phosphates and Chemicals Limited.*

Exploratory studies on a sample of pyrite from Amjhore assaying 36.06% S, were conducted with a view to upgrading the sulphur content to about 44% S, for meeting F.C.I. Sindri requirements for their use.

Flotation studies carried out with the sample, indicated that only marginal improvement in the grade up to 37.4% S, could be obtained. The first float itself was assaying only 41% S.

12. Beneficiation of Low Grade Sillimanite Samples. *Sponsored by Maharashtra State Mining Corporation.*

Samples of sillimanite from four different mines were received from Maharashtra State Mining Corporation Limited (Nagpur). Bench scale operation on two samples were taken up which assayed 36.78% and 41.69% Al_2O_3.

Gravity separation method was resorted to for elimination of gangue but it did not work satisfactorily. Flotation tests carried on one sample gave 46.1% Al_2O_3 with 26.6% Al_2O_3 recovery in it. While the other one gave 51.5% Al_2O_3 with 23.3% Al_2O_3 recovery in it.

13. Beneficiation of Two Low Grade Kyanite Samples. *Sponsored by Director of Mines and Geology, Government of Rajasthan.*

Bench scale beneficiation studies were undertaken at NML on two low grade kyanite samples. The samples designated as UDK-1 and UDK-2 had the following composition.

Sample UDK-1 41.81% Al_2O_3, 48.92% SiO_3, 2.1% Fe_2O_3.

Sample UDK-2 41.94% Al_2O_3, 48.08% SiO_2, 1.6% Fe_2O_3.

The object of the investigation was to find out their amenability to beneficiation for producing high grade Kyanite concentrates suitable for refractory purposes.

Hydroclassification followed by tabling yielded concentrates assaying between 55.4% to 56.6% Al_2O_3 with about 30 to 33% Al_2O_3 recovery in them. Flotation tests conducted with the sample ground to suitable fineness followed by reflotation produced concentrates assaying between 58.6 to 59.2% Al_2O_3 with Al_2O_3 recoveries of over 25% in them. However, the actual kyanite recoveries in these concentrates would be much higher, a part of the Al_2O_3 being contributed by non kyanite minerals.

14. Beneficiation of Limestone Sample from Chopan, Uttar Pradesh. *Sponsored by M/s. Cement Corporation of India.*

A limestone sample from Chopan, U.P. sent by the Cement Corporation of India, was received to study the possibility of beneficiation of the sample

by dry methods only to a grade suitable for cement production. The sample as received was —100 mm in size and assayed 43.8% CaO, 2.6% MgO, 12.8% SiO_2, 2.7% Al_2O_3, 2.3% Fe_2O_5 and 34.8% LOI. The acceptable quality of the beneficiated product, as specified by the sponsors of the investigation was: 43 to 46% CaO, and not more than 14% SiO_2.

Screening of the —100 mm as received ore yielded a +9.5 mm concentrate fraction weighing 96.7% and assaying 43.9% CaO.

B. REFRACTORY TECHNOLOGY

1. Evaluation and Characterization of Indian Fireclays. *All India Co-Ordinated Project.*

Studies were completed on the evaluation and characterization of the fireclay samples sent by G.S.I. In general the fireclay samples under investigation are low in Al_2O_3 content and all samples are non slaking. Plasticity indices are low except for two samples which are moderately plastic. Only four samples out of the fourteen samples studied have P.C.E. near about 32 Orton cone (1717°C); all other samples have low P.C.E out of which one sample has very low P.C.E about 1550°C which vitrified on firing at 1400°C. Linear shrinkage on drying and firing are moderate. The samples fired to different temperatures from 1200-1400°C produced good sinter. The bulk density generally increases with higher firing temperatures, while porosity and water absorption decreases significantly. Some samples show very low porosity at a firing temperature of 1350-1400°C. Only one sample showed signs of vitrification. The strength of fired clay bar samples as determined by M.O.R are quite good excepting those samples which are badly cracked on firing.

2. Development of Graphite-Silicon Carbide Crucible.

The project has been completed and report is being prepared.

3. Suitability of Indian Sea-Water Magnesia for Refractory use.

One tonne of material was received from CSMCRI, Bhavnagar, for further evaluation. The material was sampled and chemical analysis, mineralogical studies and dead burning properties of fired magnesia at temperatures were carried out.

The dead burning and sintering studies were carried out on as received sample of filter cake and on those briquetted into 30 mm dia, 50 mm dia cylindrical specimen. Sample specimens were also prepared with raw sea water magnesia with the addition of 20,30 and 50% of calcined magnesia. The bulk density, porosity were studied.

4. Development of Dense High Purity Alumina Grains from Technical Alumina.

Physical properties such as bulk density, percent apparent porosity, percent water absorption and percent linear shrinkage of sintered samples

were determined. It was noted that some samples and very high density and low porosity. The dense sintered samples were further crushed, ground and sieved for carrying out chemical analysis.

5. Utilisation of Concentrates from Low Grade Salem Magnesite for Refractory Purpose.

The experiment was carried out in two stages. In the first stage raw magnesite concentrate was mixed with water and 50 mm. dia $\times$50 mm. cylindrical specimens were made. The samples were fired at 1600 and 1700 °C with 2 hours soaking and their physical properties were studied.

In the second batch the magnesite concentrate was calcined cylindrical specimens and almond type briquetts were made. These samples were fired at 1800 °C with 1 hour soaking, and their physical properties were determined.

6. Development of Low Density, Low Iron Insulation Bricks from Alumina-Silicate Aggregate.

Foam insulation bricks were made successfully from the raw materials e.g. fire clay, chinaclay, kyanite, bauxite and technical alumina. The properties of the alumina, kyanite and fireclay foam insulation bricks were evaluated.

7. Studies on the Development of High Temperature Castables for 1500-1700 °C Using Fused Alumina on Aggregate and NML CA Cement.

Six different batch compositions with varying cement content from 6-20% and fused alumina aggregate were pressed and fired in the form of 2" dia buttons. Physical properties of the fired batches were studied. Further firing of such buttons and determination of physical properties e.g. apparent porosity, bulk density, cold crushing strength, volume shrinkage and % wt. loss on firing is under progress.

8. Studies on the Development and Production of Carbon Bricks and Blocks.

Procurement of raw material is still under progress. A C/H ratio apparatus for evaluating the binder materials i.e. tar/pitch has been set up.

9. Studies on Petroleum Coke. *Sponsored by M/s. Engineers India Ltd, New Delhi.*

The work has been completed and report submitted to the party.

10. Development of Improved Clay-Graphite Stopper Heads. *NML-SAIL Project.*

During the period under review, 25 numbers of clay-graphite stopper heads of both screw and pin types (Similar to RS 23 and RS 301) were

made with improved compositions and their properties were studied. Further work regarding their in-plant trials at Alloy Steel Plant, Durgapur is in progress.

C. EXTRACTION AND CHEMICAL METALLURGY

1. Treatment of Sludge for Recovery of Tin. *Sponsored by M/s. Tinplate Co. of India Ltd.*

About 6 tonnes of sludge have been treated out of 14 tonnes received.

2. Production of Calcium/Silicide in 500 KVA submerged Arc Furnace. *Sponsored by M/s. A. S. C. Engineers, Calcutta.*

Few heats were made in 50 KVA Arc Furnace. Renovation of 500 KVA submerged arc furnace is being done for final trial smelting.

3. Development of Indigenous Solvent Extraction Reagent (NX-12). *Inter-laboratory Project between NML and NCL, Pune.*

Fresh samples of the reagent were received from NCL and were evaluated.

4. Processing of Polymetallic Sea Nodules for Recovery of Metallic Values.

26 Kg. of sea module samples have been received. Bench scale experiments on reduction roast by ammonia leaching has been undertaken.

5. Recovery of Lead from Battery Scrap.

Preliminary experiments have been completed. Control of pollution arising out of the processing is yet to be tackled. For this purpose a rotary furnace along with dust catching system is necessary. Such a system is to be designed, fabricated and installed and subsequently smelting of battery scrap can be performed.

6. Treatment of Complex Sulphide Ore for the Recovery of Copper, Zinc and Lead and Sulphur Values.

Detailed studies were conducted on solvent extraction of copper and zinc from synthetic solutions of $CuSo_4$ and $ZnSO_4$ by Lix-64 N. Electrowinning of copper and zinc from the solution was satisfactorily conducted.

7. Electric Smelting of Dolomite for Extraction of Magnesium.

Water cooling system for the entire unit was fabricated and installed. The electrode drive unit complete with variable speed motor and electromagnetic brake has been fabricated and the pump is being connected to the furnace unit. Electric heating arrangements of the condensing system are under progress.

8. Recovery of Vanadium Pentoxide from Vanadium Bearing Slags.

Experiments for recovery of vanadium pentoxide from the vanadium rich slag of M/s. VISL produced recently are almost in completion stage. Studies to improve the recovery have also been carried out. The project report for processing 2 tonnes of slag per day is under preparation.

9. Development of New Electrodes for Electrolytic Manganese Dioxide Process.

Titanium anodes with copper and aluminium bus bars were fabricated from titanium sheets. The surface of the anodes were also prepared according to the process developed and a 50 kg. EMD cell was operated with 21 anodes of size 1 metre $\times$ 0.5 metre under the optimum conditions established. Excellent deposits of EMD were obtained with titanium anodes with voltage lower than that usually obtained with lead-antimony anodes.

10. Large Scale Electro-Metallurgical Facility—Production of Electrolytic Manganese Metal and Dioxide.

M/s. Electrochem (Orissa) Ltd. (ECOL) sponsored an investigation for production of electrolytic manganese dioxide with titanium anodes using the manganese ore from Siljora-Kalimati Mines supplied by them. The operation of the EMD plant with their ore was demonstrated successfully to the technical team from the various financial organisations. The financial organizations expressed their satisfaction with the titanium anode technology as developed at NML for production of EMD. They are considering the grant of financial assistance to ECOL for setting up of their 3000 TPY EMD Plant at Beleipada in Orissa based on NML technology.

D. IRON AND STEEL TECHNOLOGY

1. Design and Engineering of a Vertical Retort Furnace for Sponge Iron Production using Solid Reductant.

The technical know-how developed in 1-1.5 tpd sponge iron plant at NML needs complete design and engineering data for commercial plant. In collaboration with MECON, complete design and engineering will be worked out, MECON engineers have suggested cretain modifications and additions in the vertical retort furnace. Some of the modifications have been carried out. The other modifications are in progress.

2. Development of a Mini Cupola.

A mini cupola with a capacity of 250 kg molten iron/hour has been developed at NML suitable for rural artisans in rural areas. With a small investment it can be easily installed in villages to meet the demands of local people.

3. External Dephosphorization of Hot Metal.

Dephosphorisation trials carried out on a laboratory scale have yielded so far 40-75 p.c. silicon removal (initial silicon content ~ 0.65-1.4 p.c.) and 20-50 p.c. phosphorus removal (initial phosphorus content ~ 0.18-0.30 p.c.) without any appreciable loss of carbon. Significantly even the iron losses in the slag were very nominal. These trials were done without the use of gaseous oxygen and the reaction time was always less than 2 min. Subsequent trials with oxygen injection resulted in heavy loss of carbon and iron but practically no removal of phosphorus within the aforesaid time.

4. Development of Cryogenic Steel. *NML-SAIL (R and D) and MECON Collaborative Project.*

A project has been started on cryogenic steels with a view to develop steels suitable for low temperature use. Three heats of this steel were made with nickel and vanadium as the principal alloying elements. These steels are being forged and would be tested for low temperature properties.

5. Martensitic Transformation in Cr-Mn-N Stainless Steels.

This project pertains to the fundamental study on martensitic reactions in Cr-Mn-N stainless steels by transmission electron microscopy. The process for obtaining thin foils by mechanical, chemical and electrolytic polishing has been standardized. The work is in progress.

E. ALUMINIUM TECHNOLOGY

1. Product Development from High Strength Aluminium Alloy Conductor Designated NML-PM 215.

A high strength, medium conductivity aluminium alloy conductor designated NML-PM215 has been developed. Scaling of the production of this alloy in the form of wire rod was successfully carried out at Bharat Aluminium Co., Korba by extrusion of semi-continuous D.C. cast billets. Manufacture of over I km length of catenary wire (19/2.79 mm) from NML-PM 215 for railway has been completed at M/s. Indian Cable Co., Jamshedpur; as per Railway specification. A prototype multistrand over head conductor (61/4.25 mm) from NML-PM 215 has been made for evaluation.

2. Studies on Corrosion Behaviour of Aluminium Alloy Conductors—NML-PM215.

Salt spray chamber as per Indian Specification for salt spray test of aluminium/alloy conductors has been fabricated. The test has been carried out for NML developed catenary conductor (19/2.79 mm) made from NML-PM215 and comparison has been made with conventional D50S aluminium alloy. The report has been submitted to RDSO, Railway Board & Ministry of Defence.

3. Development of Filler Wire Rod for Welding Aluminium and Castings.

The NML has developed the production technology of aluminium alloy filler wire containing aluminium-5% magnesium providing strengths upto 28 Kg/mm^2.

The technology covers the melting, solidification and processing and the filler wires have been designated as NML-PM6. After extensive and rigorous physical and mechanical testing of the welded zones, M/s. Hindustan Aeronautics Limited, Bangalore, have accepted the filler wires NML-PM6 towards their import substitution efforts.

M/s. HAL have advised the leading Indian manufacturers of welding consumables to opt for the NML technology. The production technology of NML-PM6 has since been assigned to NRDC.

Current work is in progress for the development of filler wires suitable to attain the strength of the weld metal upto 32 Kg/mm^2.

4. Studies on Overhead Aluminium Conductor Installed in the Vicinity of Paper Plant.

Studies on the two samples of overhead conductors (30/3+7/3 mm) and (6/4.09+1/4.09 mm) installed in the vicinity of carbon-di-sulphide plant in a paper mill in Nagda near Jabalpur (M.P.) have been completed. It has been observed that sulphur bearing gases of the plant atmosphere have caused severe pitting of the conductor deteriorating its normal properties, and an investigation report entitled "Metallurgical investigation of Aluminium Over-Head Conductors in the Vicinity of CS_2 Plant in a Paper Mill" has been sent to M.P. Electricity Board.

5. Non-Corrosive, Non-Polluting, Degassing of Aluminium.

An experimental set up has been fabricated for fumeless degassing and cleaning of aluminium melt on an in-line basis. The set up includes a filtration chamber and facilities for gas lancing. The metal first enters the degassing chamber continuously where it is treated with nitrogen or a combination of gases, then it passess through the reactive filter bed to complete the cleaning operation. The experiments on this set up are in progress.

6. Productivity and Quality Improvement in Aluminium Utensils.

The interaction with small scale industries producing aluminium utensils with a view to improve the quality and productivity is being continued. The NML recommendations have since been implemented at M/s. Suresh Aluminium Works, Patna and at M/s. Mahadeva Aluminium & Metal Works, Kishanganj, Purnea and the rejection rates of the finished utensils have been considerably reduced.

M/s. Aluminium Udyog, Raipur sponsored an investigation to go into the details of their existing production/process and support methods to improve quality and reduce rejection rate. The report has been submitted.

M/s. Udyog Kendra, Jayanagar (Madhubani) also sponsored a similar investigation on "Defects in Aluminium Utensils". NML Scientists visited the plant and collected the typical samples and details of the processing. The work is in progress.

7. Development of Aluminium base Bearing Alloy.

Some results of the ongoing field trails of floating bushes made of NML developed Al bearing alloy PM 401 have been received from Research, Design & Standards Organisation, Ministry of Railways. Some of the bushes have earned over 29,000 km service. R.D.S.O., Lucknow, has evinced interest in taking the know how for making the bushes. R & D work in the project has been completed and the know how is ready for transfer.

8. Friction and Wear Properties of Aluminium Alloys Containing Lead.

A simple pin and disc wear testing apparatus is being fabricated. A few alloys have been prepared for studying the wear properties.

F. MAGNETIC MATERIALS

1. Effect of Alloying Additions on the Stability and Magnetic Properties of Hard Mn-Al-C Alloys.

Several alloys in the composition range of 70-73 Wt % Mn, 30-27 Wt % Al, 0.8-1.0 Wt % C and 0-1.5 Wt % Fe were been made and given suitable heat treatments in order to get the ferromagnetic T phase responsible for the permanent magnet properties. From X-ray diffraction micro-structures and magnetic studies, it was found that good isotropic permanent magnets could be obtained by tempering quenched alloy. Studies have also been made to understand the reason, for the physical instability e.g. crumbling of the cast alloy into powder. It has been shown that the crumbling into powder occurs due to the formation of equilibrium phases. An inflection in the coercive force vs tempering time has also been observed in this system which is ascribed to the presence of two ferro-magnetic phases—one ordered and the other disordered.

2. Low Cobalt Magnetic Alloys.

A few cylindrical and rectangular castings of Fe-Cr-Co with varying amounts of Nb, Al and Cu were made after melting in air induction furnace. Work on hot rolling, cold rolling, cold shaping, solution annealing and deformation ageing treatments are in progress.

G. HIGH TEMPERATURE CREEP RESISTANT STEELS

1. Development and Testing of Creep Resistant Steels Produced Indigenously for Thermal Power Plant Applications. *Sponsored by M/s Bharat Heavy Electricals Ltd.*

The long term creep behaviour of three grades of bolting steels viz.—

(i) $1\frac{1}{4}$Cr-1Mo-$\frac{3}{4}$ Ti-B

(ii) $1\frac{1}{4}$Cr-$\frac{3}{4}$ Mo (En-20B)

(iii) 1Cr-1Mo-$\frac{1}{4}$V (DIN-17240)

were completed. The creep data were collected up 33,00 hours. A final report has been submitted.

Creep evaluation on the following steels is in progress.

Superheater Tubing Steel

	Steel Grade	*No. of casts*	*Producer*
1.	$2\frac{1}{4}$Cr-1Mo Steel	7	MUSCO and ASP
2.	$1\frac{1}{4}$Cr-1Mo Steel	5	MUSCO and ASP
3.	1Cr-$\frac{1}{2}$Mo Steel	2	VISL

Casting and Forging Steel

1.	$\frac{1}{2}$Cr-$\frac{1}{2}$Mo (0.5 FO) Steel	1	CFFP
2.	GS 22 Mo Steel	1	,,
3.	18Cr-Mo 910 Steel	1	,,
4.	Ti-B Bolting Steel	1	,,
5.	15×M Grade	1	,,

2. Characterization of Boiler Quality Plate for Creep Properties. *NML/SAIL Co-ordinated Project.*

Samples of one heat was received from SAIL and short-term properties viz. impact, hot tensile tests as well as creep tests upto 1000 hrs. at three temperature-400°, 450° and 500°C were completed.

3. Development of Nickel Free Creep Resistant Austenitic Steels.

Two semi-commercial heat weighing 100 kg each were made at M/s Automotive Enterprises, New Delhi. The ingots subsequently were

forged and rolled into bars of different sizes for the production of exhaust valves to suit to Tata D-1 engines as well as diesel locomotive engines. Arrangements for the production of such valves have been made.

4. Estimation of Residual Creep Life of Thermal Power Plant Components.

Residual creep life of the following components received from various thermal power plants is in progress.

(i) Steam pipe line which has already undergone a service life of 100,000 hr sample from Boiler No. 3 of Thermal Power Station, Neyveli Lignite Corporation.

(ii) Superheater tubes which has rendered service life for 100,000 hr Indian Oil Corporation, Gauhati.

(iii) Superheater tubes of Unit No. 5 (50MW) from Barauni Thermal Power Station, Bihar State Electricity Board, BSEB.

(iv) Furnace tube received from Indian Oil Corporation Haldia.

5. Steels for Short-term Evaluation.

During the period the following samples were received from different organisations for determining the specific properties :—

	Material	*Nature of investigation*	*Sponsor*	*Status*
(a)	Boiler tubes	Metallurgical study as per Indian Boiler Regulation.	M/s Steel Tubes of India Ltd., Dewas.	Test completed and the report submitted.
(b)	Boiler tubes	-do-	M/s Bharat Steel Tubes, Calcutta	-do-
(c)	Boiler quality steel	0.2 p.c. proof stress at elevated temperatures	M/s ABL, Durgapur	-do-
(d)	P.C. Wire	Stress relaxation and other tests as per IS: 6003: 1970	M/s Aluminium Industries, Kundara, Trivandrum.	-do-
(e)	Contact grooved wires and catenary wires.	Creep test for 1000 hours.	R.D.S.O., Lucknow.	-do-

H. METALLURGICAL INVESTIGATION STUDIES ON FAILURE OF METALS AND ALLOYS

The main object of the failure investigations at the NML is not only to study the basic causes responsible for the premature failures but to advise about the remedial measures which could lead to material conservation and smooth/reliable service particularly for the Government sector of technological services. For example, a complete examination of Stainless Steel Wire Rope for Automatic Tensioning of 25 KV Over-head Catenary line of Indian Railways was carried out because the Indian Railways are experiencing frequent failures of stainless steel wire ropes processed from imported wire rod or already drawn wires within short span of their installation. The problem is so acute that some stocks have failed even in storage. On the contrary the imported wire ropes, have given trouble free service for 8-10 years.

Metallurgical evaluation of the imported and indigeneous wire ropes showed that the short span of life of the indigenous wire ropes is on account of their stress corrosion cracking in presence of moist air; due to residual stress derived from the manufacturing sequence. The investigation has helped the Research Design & Standards Organization of Ministry of Railways to revise the acceptance standards of the material.

Another investigation conducted on behalf of Railways relates to "Failure of 25 KV AC Traction Overhead Aluminium Alloy Steady Arm Components". The examination revealed that the alloy selection was not to the specification and the lack of proper heat-treatment has resulted in the failure. The correct composition of the alloy for this component and the heat-treatment procedure has been suggested.

Support to Thermal Power Plants

NML continues to render service to various thermal power plants by way of :

(i) Investigation on the failed components to establish the reasons of the failure and the remedial measures.

(ii) Estimation of residual life of the high temperature components like boiler tubes, superheater tubes etc.

(iii) Development of suitable material to withstand heavy erosion due to the corroding nature of ashes.

Service failures of vital engineering components such as boiler tubes, rotors, turbine blades, condenser tubes etc. relating to power plants of Energy Sectors e.g. DVC, Electricity Boards of Gujarat, Bihar, Haryana, UP, M.P., Maharastra, National Thermal Power Corporation and so on were diagnosed for the cause of failures, Remedial measures for preventing recurrence of such failures have been recommended. These investigations have been acclaimed by the sponsors to be of immense help to them in understanding the scope of premature failure of high temperature materials

in the correct perspective based on principles of physical metallurgy corelated with mechanical properties, welding characteristics and behaviour under environmental conditions and to make them aware of the significance of design short comings, residual stresses, service abuses, improper-selection of materials, defective fabrication, faulty maintenance and repair, and environmentally assisted corrosion. Expertise of NML in high temperature metal technology has been sought by the power plant engineers at the time of expansion of existing thermal power plants. Recently, there has been a growing realisation on their part to have more and more interaction with NML. This is evidenced from the fact that DVC and the Central Board of Irrigation and Power have come forward with their problems to seek metallurgical advice from NML.

Some examples where NML has made significant contribution to the power sector include :—

1. As Expert Member on the enquiry commission on the explosion of 32 MW Turbogenerator, Panki Thermal Power Station, Kanpur, wherein the cause of the explosion was attributed to the grid fluctuation leading to torsional fatigue of the rotor which had inherent microstructural deficiency originating from faulty heat-treatment.

2. Recommendation to M/s. Nagaland Pulp and Paper Mills Ltd., to immediately retire the boiler tubes in service which had shown symptoms of microstructural decay.

Following are some of the investigations completed during the period.

Investigation	*Sponsor*
1. Failure of the Shaft of a Motor of Nitrogen Compressor.	F.C.I., Ramagundam, A.P.
2. Metallurgical Investigation on the failure of Stainless Steel Wire Ropes.	R.D.S.O., Lucknow.
3. Metallurgical Examination of Boiler Plate.	Sharda Plywood Industries Ltd., Assam.
4. Metallurgical Investigation on the failure of Boiler Tube.	Renusagar Power Co. Ltd., Repukoot, U.P.

5.	Metallurgical Examination of Pin and Spacer.	Uranium Corpn. of India, Jadugoda.
6.	Development of Coal Crushing Hammers.	Haryana State Electricity Board.
7.	Metallurgical Examination of Hammer Bits for Crushing Coal.	Barauni Thermal Power Station.
8.	Failure of Steam Pipe.	Tata Chemicals Ltd., Mithapur, Gujarat.
9.	Failure of Boiler Tubes.	Nagaland Pulp & Paper Co. Ltd., Nagaland.
10.	Hardness Measurement of Copper Conductor.	I.C.C. Ltd., Jamshedpur.
11.	Failure of Water Wall Tube.	N.T.P.C., Singrauli Super Thermal Power Station.
12.	Hammer Arms and Tips.	Cement Corporation of India Ltd., Adilabad (A.P.).
13.	Failure of Condenser Tubes.	Renusagar Power Co. Ltd., Renukoot.
14.	Failure of Boiler Tubes.	Badarpur Thermal Power Station.
15.	Failure of Secondary Super-Heater Tube.	Chandrapura Thermal Power Station.
16.	Failure of Super-Heater Tube.	Obra Thermal Power Station.
17.	Failure of Economiser Weld Tube.	Ennore Thermal Power Station.
18.	Failure of Water Wall Tube.	Ukkai Thermal Power Station.
19.	Failure of Boiler Tubes.	Chandrapura Thermal Power Station.
20.	Failure of Nozzle.	-do-
21.	Failure of Screen Super-Heater Tube.	Obra Thermal Power Station.
22.	Failure of Boilers Tubes.	Kothagudem Thermal Power Station, (A.P.).
23.	Failure of ID Fan Blade.	Singrauli Super Thermal Power Station (NTPC).

I. MECHANICAL WORKING AND TESTING

1. Stainless Steel Clad Aluminium Sheet

A novel technique has been developed in which a thin stainless steel sheet could be roll-bonded to aluminium sheet with very little deformation in stainless steel compared to aluminium sheet. The necessary parameters of the process have been studied and standardised.

2. Development of Duplex Shear Blade.

Different parameters regarding roll-bonding, quench hardening and tempering were standardised. The project is complete.

3. Development of Silver base Contact Materials.

Production of silver-base contact materials containing 3 p.c. CdO was completed through internal oxidation route.

4. Development of Ni-Cr and Ni-Cr-Fe Alloys.

Development work on Ni-Cr-Fe alloys has been completed. Initial work has been started with Ni-Cr alloy. Few heats were made. Further work is in progress.

5. Development of Silver base Contact Materials by Powder Metallurgy Technique.

Work on silver-nickel contact (two compositions) by powder metallurgy technique has been completed. Initial work on Ag-W contact materials is in progress.

6. Development of Silver-Cadmium Oxide Contact Materials.

Contact material containing 12 p.c. cadmium oxide in silver were completed. Several heats were made to standardise the melting, castings and heat-treatment schedules. Service trials of the materials are being conducted by Indian Railway. Further work on other 15 p.c. CdO is in progress.

7. Development of Silver Brazing Alloy.

Several heats of brazing alloy containing silver, copper and zinc were made. They were further processed to the finished size and thickness for use in practice. This group of alloys are used for joining vacuum tubes. Work on other compositions are in progress.

8. Mechanical Testing and Working Facilities.

Mechanical testing such as tensile, compression, ductility, torsion, hardness, impact, wear etc. were carried out regularly for projects of the laboratory as well as for other industries for their developmental work.

Hot/cold working such as hot/cold rolling, hot/cold forging, extrusion and wire drawing etc. were carried out for the laboratory projects and for the industries who have purchased Laboratory's technical knowhow.

J. FOUNDRY TECHNOLOGY

1. Product Substitution with NML-Pyroloy 1000.

Twelve heat of 9 percent aluminium cast iron were made in 25 kg. arc furnace by varying carbon and silicon percentage. The melts were cast into standard tensile test specimen and bar moulds for subsequent tests. The tensile specimens were finished to size by grinding. The specimens for oxidation, growth and hardness tests are under preparation.

Work on low aluminium cast iron was carried out and its properties along with high aluminium heat resistant cast iron were studied.

2. Coke-less Cupola.

Encouraged by the successful laboratory scale trials, efforts are under way to take up inplant trials in a commercial sized cupola in a production unit on sponsored basis.

3. Development of Know-how regarding Special Casting Methods.

The sillimanite obtained from indigeneous source was heat treated, crushed, ground and sized. The thermal expansion characteristic was measured at different temperatures to study the suitability and for selecting the appropriate heat-treating cycle. Preparation of raw materials for large scale inplant trial is in progress.

4. Rural Development Programme at Bankura.

NML Scientists have assisted the rural artisan in improvement for the production of brass and bronze castings practiced by them. The method based on modern technology has resulted in increased efficiency, and cut down cost of production. They have also been assisted in improving furnace design for better performance and efficient operation resulting in saving of fuel. Improved methods of production including use of more appropriate raw-materials for obtaining better finishing of artistic castings have also been demonstrated.

K. CORROSION STUDIES ON METALS AND ALLOYS

1. Studies on Atmospheric Corrosion of Metals and Alloys. : *International Project between National Metallurgical Laboratory & N.R.I.M. Tokyo.*

A collaborative programme for conducting exposure tests with different metals and alloys and metallic coating at different places representing industrial and marine atmospheric conditions of the two countries, namely

India and Japan was started in 1980. Results of three years exposure tests including corrosion rate and correlation with pollution data and atmospheric variations, growth morphology of rust formed on different samples etc. have been obtained.

2. Mitigation of Pollution of Agra Foundries.

To minimise the extent of atmospheric pollution due to emission of sulphurous fumes by Foundries at Agra so as to protect the beauty and life of historical and archaeological monuments, the Laboratory is experimenting on the following concepts simultaneously.

(i) Demonstration of NML designed thermally more efficient cupola for reducing the total amount of pollution through reduction in the coke consumption for the same tonnage production of castings, which also helps in energy conservation.

(ii) A cheaper chemical gas scrubbing system to fix the SO_2 of the cupola effluent gases as solid particulate matter.

(iii) To cause reduction in the amount of SO_2 emissions by incorporating suitable chemical additive in the coke.

One of the two NML designed cupolas has already been installed and commissioned. The installation of the other unit is under way. Installation of scrubbing tower is in progress and trials are expected to be carried out soon.

3. Development of Sintered Magnetite Anode for Cathodic Protection.

Parameters for making sintered magnetite anode from synthetic magnetite are being studied. Sintered samples tested in acid solutions under anodic charging of high current density have shown total insolubility.

4. Studies on Stress Corrosion Cracking of Metals.

Susceptibility of AISI-304 stainless steels under tensile loading conditions and subjected to different electrode potentials, potentio statically controlled in boiling magnesium chloride solutions have been studied. Hysteresis loops produced on retracing of the polarisation curve in reverse direction were indicative of pitting corrosion and stress corrosion cracking of steels.

L. SURFACE COATING ON METALS

1. Development and Performance Evaluation of Diffusion Treated Steels in Fertiliser and Chemical Industries. *Collaborative Project between NML and Fertilizer (P & D) India Ltd., Sindri.*

The first batch of calorized specimens supplied by NML were tested by PDIL in their plant at Sindri and the calorized specimens were found to be ten times more resistant than mild steel specimens.

Calorized specimens supplied by NML were found to be twice more resistant than specimens supplied by ALON, USA which is the main supplier of heat exchanger tubes. Work on exposure trials in different plants is in progress.

2. Development of Zinc rich Primer.

Alkali silicate-zinc dust primer was developed and tested widely both in the Laboratory and under atmospheric conditions at Jamshedpur, Digha and Madras with a view to evaluate its efficacy in protecting steel. Observations over three years of exposure revealed that the primer developed is excellent in protecting steel.

The primer was evaluated under industrial conditions of TISCO works, Jamshedpur for a period of $1\frac{1}{2}$ years, and the report revealed that its performance is extremely satisfactory under highly corrosive conditions. Efforts are being made for utilisation of the above primer by interested parties.

3. Electrolytic Colouring of Aluminium and its Alloys.

A process was developed for electrolytically colouring aluminium and its alloys and very fast coloured anodic coatings were produced by first D.C anodizing and subsequently A.C colouring. Some of the black coatings produced find an application in solar panels and the coloured coatings in general find application in different types of consumer market.

4. Development of Metal Pigmented Primers.

Work is being carried out on "Metal Pigmented Primers for corrosion Protection of Steel" using organic and inorganic vehicles on an exploratory basis since such primers are very much in use in many countries for protection of offshore structures, structurals, bridges, petroleum drilling rigs etc.

M. STANDARD REFERENCE MATERIALS AND ANALYTICAL WORK.

1. Preparation of Standard Reference Materials.

Standard samples of sea-bed polymetallic nodules were prepared and given to N.I.O., Goa. Standard Samples of ferro-vanadium and manganese ore were prepared. Replacement of 0.4% carbon steel and nickel steel was carried out.

2. Analytical Work.

(*i*) *Chemical Analysis*—2393 samples were analysed for 7728 radicals.

(*ii*) *Spectrographic Analysis*—91 samples were completely analysed.

(*iii*) *X-ray Fluorescence Spectrometry*—1118 samples were analysed for 1993 radicals.

(*iv*) *Gases in metals*—75 samples were analysed for 192 radicals.

N. APPLIED BASIC PROJECTS.

1. Grain Refinement of Wrought Aluminium Alloys.

Studies on the effect of different thermal pretreatment schedules and effect of heating rates and recrystallization temperature on the recrystallization kinetics and recrystallized grain size of Al-1.25% Mn alloy were completed. On the basis of the studies heat treatment schedules were identified for achieving fine recrystallized grain size in Al-1.25% Mn alloy sheets produced from D.C. Cast ingots.

Based on the earlier results on the grain size of Al-Cu-Zr alloys, a modified alloy was prepared and processed for further investigation for achieving fine recrystallized grain size.

2. Solidification Structures of Al-Cu Alloys.

Study on the solidification morphology of Al-Cu alloys has led to the following observations.

(a) Upto eutectic composition the dendrite arm spacing (DAS) decreases and thereafter increases at all freezing rates. The freezing rates were varied by varying the pouring and mould temperature. The freezing rates employed were in this range of a fraction of a degree to about 25°C/sec.

(b) For each composition a linear relationship between DAS and square root of inverse freezing rate exists.

(c) The alloys near the terminal solid solubility showed that their grain size is a function of dendrite size.

3. Fracture Studies in Mg-Al-Zn Alloys.

Specimen for fracture tests were prepared from the alloys, and tested by three point bend method in a transmeter with modified arrangement. The specimens were also precracked by applying fluctuating loads. The data for precipitation hardened specimen is also being collected. Studies on ageing behaviour of these alloys are also being carried out simultaneously.

4. Solidification from Two Phase Field of Aluminium Alloys.

Fracture studies on high strength Aluminium alloys were completed.

5. Effect of Super Saturation on Structure and Properties of Aluminium Alloys Containing Mn, Mg, Zn etc.

Metallography and structure of the super saturated solid solution in Al-Mn alloys are being studied. Applying a rapid rate of solidification, super-saturated solution in Al-Mn system was retained at room temperature.

On studying its decomposition kinetics it has been inferred that some sort of short range ordering clustering is formed in samples that are highly supersaturated with Mn in primary solid solution, whereas such clustering is formed in alloys with lower degree of supersaturation.

6. Splat Cooling of Aluminium Alloys Containing Pb, Bi, Cd.

A modifield splat cooling technique has been developed to study the impact of splat cooling on the properties of Al alloys and other alloys prone to oxidation during melting. Some experiments with Al-Pb alloy have been carried out. Further work is in progress.

NML UNIT IN CSIR COMPLEX, MADRAS

The NML Madras Centre, during the period under review, was engaged in applied and fundamental R and D projects in various disciplines, apart from rendering technical services to various public and private sector organisations. Several important sponsored investigations have been successfully completed such as pelletisation and heat hardening of Kudremukh iron ore concentrate for Sponge Iron India Limited, studies on Iron Ore samples from Karnataka for SAIL and MECON, bench scale beneficiation studies on coal samples from Ennore Thermal Power Station, bench and Pilot Plant scale beneficiation of low grade graphite sample from Sivaganga, acid pressure leaching of Chitradurga Copper concentrates, corrosion studies on condenser tubes for Ennore Thermal Power Station etc. NML Madras Centre has undertaken chemical analysis, metallographic and mineralogical studies on various samples received from outside parties as also for its own R and D Programmes.

Exposure studies of samples received from Japan under the project of NML-NRIM Collaboration on atmospheric corrosion are still continuing.

A brief resume of various projects and activities is furnished below :

1. Pelletization and Heat-hardening Studies on Kudremukh Iron Ore Concentrate. *Sponsored by M/s. Sponge Iron India Ltd.*

Detailed pelletisation and heat hardening studies as per the guidelines given by M/s Sponge Iron India Limited and Kudremukh Iron Ore Company Limited were conducted on Kudremukh iron ore concentrates. The work involved pilot scale pelletisation and supply of 500 kg. of heat endurated iron ore pellets at basicity levels of 0.3 and 0.6 (250 kg. each). The iron ore concentrate as received had a surface area of 1700 cm^2/gm. The pellets were heat hardened in batches of 40-50 kg. in pot grate furnace. All the parameters viz., temperature, timecycle pressure drop rate of heating etc. were standardised to obtain good quality heat hardened pellets having the desired properties of porosity, swelling index and reducibility. The pellets (500 kg.) have been sent for sponge iron production trials at Sponge Iron India's plant at Kothagudam A.P.

2. Studies on Iron Ore Samples. *Sponsored by SAIL AND MECON.*

SAIL and MECON sponsored the investigation on seven samples of iron ore and a composite sample from Karnataka. The samples were subjected to chemical and screen analysis, specific gravity, cold crushing strength, angle of repose etc. The composite sample was also investigated both as in the received condition as well as at every stage of its treatment on the products. The composite sample was subjected to crushing and (a) dry screening over 6 mm sieve (b) wet screening over 6 mm sieve and classification of 6 mm fines (c) scrubbing and wet screening over 6 mm

sieve and classitication of 6 mm fines. The test products were subjected to physical and chemical properties. The investigation report has been prepared and sent to the party.

3. Graphite Beneficiation Project. *Sponsored by M/s Tamil Nadu Minerals.*

Consequent to the successful conclusions of the bench scale beneficiation studies on a 300 kg. graphite sample, TAMIN had sponsored pilot plant investigation on 50 tonnes sample. After completion of pilot plant tests, a detailed Project Report for the setting up of a 100 tpd beneficiation plant at Sivaganga has also been submitted to TAMIN.

4. Studies on Magnesite Fines

Pelletisation studies on magnesite flotation concentrates using various binders like dextrine, molasses, starch and hydrated magnesia revealed that the pellets produced using 1.5 p.c. Mg $(OH)_2$ and 1 p.c. dextrine as binders had good strength and burnability. Small additions of sodium silicate in combination with magnesia and dextrine resulted in pellets of 30 kg./pellet strength.

5. Studies on GMDC Fluorite Samples.

The use of hot flotation technique employing oleic acid emulsion after gently desliming the slime, improved the speed of rougher fluorite flotation when compared to flotation under cold conditions. Nearly 50 p.c. of the slime by weight was floated leaving a tailing, very low in CaF_2. Tests were continued using fresh sample from kadipani which confirmed that flotation is faster under hot conditions.

6. Extraction of Copper from Chitradurga Copper Concentrate. *Sponsored by M/s Chitradurga Copper Corporation, Karnataka.*

Acid pressure leaching of copper concentrates with oxygen for the production of agricultural grade copper sulphate was investigated. Various process parameters such as oxygen pressure, temperature, time, excess concentrate over stoichiometric acid requirement etc. were studied and optimised. A shorter leaching cycle was found to be optimum for maximum copper dissolution. The excess concentrate was recovered by flotation for reuse in the process. The copper sulphate produced contained more than 0.2 p.c. Fe stipulated for agricultural grade. The copper sulphate solution has to be purified and crystallised.

7. NML-NRIM, Japan Atmospheric Corrosion Collaboration Project.

All the NRIM samples due to be assessed after two year period were removed, and assessment made. Indian samples sent from NML Jamshedpur were also prepared and exposed at Madras.

8. Studies on the Effect of Ferrous Sulphate additions on the Corrosion Behaviours of Al-Brass Condenser Tubes. *Sponsored by Ennore Thermal Power Station, Madras.*

Studies carried out revealed that the normal dosage of ferrous sulphate addition (1 ppm, $\frac{1}{2}$ hr.) failed to produce a satisfactory film under the prevailing conditions at ETPS. At lower concentrations, a well formed film was obtained when the immersion time was more than two hours. Continous exposure of tubes at a concentration of 100 to 200 parts per billion proved more effective in lowering the rate of attack under laboratory condition of immersion for a minimum period of 24 hours. Contamination of sea water with H_2S and the cathodic protection system at ETPS were also found to be some reasons for the poorly formed protective films on Al brass tubes.

9. Chelating Agents as Collectors in Mineral Flotation.

The feasibility of using 8-hydroxy quinoline as a collector in the flotation of Salem Magnesite was investigated. Flotation tests were carried in Hallimond tube for various sieve fractions. The variables studied include concentration of the reagent, pH etc. Maximum flotability was obtained in basic medium of the system i.e. pH around 10 where the oxime can complex magnesium ion effectively in aqueous solutions.

10. Zeta Potential Studies on Chalcopyrite Flotation.

Zeta potential and adsorption data for chalcopyrite fines-sodiumdiethyldithio carbamate system was examined to evaluate the nature of adsorption at $CuFeS_2/H_2O$/DTC interface. Modi-fuerstenau and Stern Grahame's models showed that the Vanderwaal's and electrostatic forces play a very minor role in adsorption of DTC on $CuFeS_2$ A method proposed for the interpretation of chemisorption from the I.E.P. and P.Z.C. measurements showed the chemisorption characteristics. It was further confirmed by spectral analysis. Technical problems for the smooth functioning of large scale electro flotation cell was worked out and its construction is in progress.

11. Sand testing, Heat-treatment, Metallographic Studies, Mineralogical Studies, Analysis, Calibration of Thermocouples, Refractory Testing etc.

The unit conducted the above work on behalf of various industrial units and organizations. Six sand samples from HMT Bangalore and four asbestos samples from M/s Tamilnadu Electricity Board and tested. 26 samples were tested for tensile strength and elongation for various parties Mineralogical studies were carried out on all mineral processing investigations conducted.

During the period 243 testing and investigations were conducted in the field of metallography, failure studies, heat treatment and hardness measurements on behalf of various organization. About 100 Thermocouples were tested for their accuracy and certificates issued to various parties. Refractory testing were done on behalf of six organization. 563 samples were analysed for 2190 radicals for various industries and the unit's own R and D work.

NML FIELD STATIONS AT HOWRAH, BATALA AND AHMEDABAD

During the period under review, the Field Stations had rendered technical services to the engineering and foundry industries in and around their respective locations.

These sorvices comprised of mechanical testing and chemical analysis (both qualitative and quantitative) of various metals and alloys as well as minerals, testing of foundry moulding sands and bonding clays, etc. on the spot study of foundry shop floor problems on various types of products and their remedial measures, improvement in quality according to the stringent specifications and export purposes etc.

A comprehensive statement of work done by the field stations during the period is furnished below:

	Howrah	*Batala*	*Ahmedabad*
i. *Chemical Analysis*			
(a) No. of Samples	6117	85	787
(b) No. of Rradicals	2105	272	2725
ii. *Mechanical Testing*			
(a) No. of Samples	530	1	1
(b) No. of Tests	530	1	1
iii. *Metallographic Tests*	16	—	—
iv. *Sand Samples investigated and tested*	4	4	3
v. *Cupola design issued*	—	2	—
vi. *No. of foundry visited*	8	221	10
vii. *No. of Technical Enquiries*	35	250	119
viii. *Number of Units served*	166	64	500
ix. *Small scale unit served*	117	44	332

DESIGN ENGINEERING

The following work was undertaken during the period

(i) Design of a coal gasification unit.

(ii) Design drawing of a CaO slurry atomizer.

(iii) Design of atomizer for atomizing molten metals with high pressure water.

(iv) A large number tracings, prints, etc. were prepared for compilation of research and investigation reports.

MECHANICAL ENGINEERING

Work done relates to :

(i) Fabrication of stainless steel apparatus with arrangements to drive a boat at the rate 3 to 10 mm per hour for transcient reduction studies on various iron ores-by the moving boat techniques.

(ii) Fabrication and installation of cooling tower for 500 KVA Ferro-Alloy Furnace.

(iii) Major mechanical maintenance and repair of the Ferro-Alloy Furnace in connection with calcium silicide project.

(iv) In addition, a large number of jobs for different test specimens, repair and maintenance work, fabrication of apparatus and attachments, special purpose tools, etc. were also undertaken.

ELECTRONICS ENGINEERING

A. Instrumentation of Projects

(*i*) *Mineral Processing*

Several flow recorders, temperature controllers, pH meters, oxygen analyser and gas chromatograph were serviced and re-commissioned.

(*ii*) *Corrosion*

Literature study for various corrosion measurement techniques and instrumentation such as Tafel extrapolation, linear polarisation technique, Faraday rectification etc. were made. Development of some of these instruments are planned for in house requirement.

(*iii*) *Refractories*

The following sophisitcated instruments were installed and commissioned.

(i) High temperature bending strength tester model 422 (mfd by Netz-Geratbau GmbH, FRG).

(ii) Hot load testing furnace (RUL) (mfd by Netz).

(iii) Micromeritics (USA) make Sedigraph model 5000D (Particle size analyser).

B. General Maintenance, Installation, Calibration and Testing Jobs Completed (Major Jobs):

1. Philips X-ray Fluorescence Spectrometer
2. Pye-Unicam Atomic Absorption Spectrophotometer
3. Philips X-ray Diffractometer
4. Vibrophore (fatigue testing apparatus)
5. X-ray Recorders
6. Gamma Ray Spectrometer
7. Potentiometric Recorders (20 Nos.)
8. Temperature Controller (50 Nos.)
9. Potentiostats
10. H and B Magnet Tester

ELECTRICAL ENGINEERING

A. Development Work

(*i*) *Development of Plasma Arc Technique for Use in Various Metallurgical Processes.*

Initial operation and study of characteristics of Plasma arc in a 50 KVA furnace was carried out. With the data so obtained the design of a 100 KVA furnace with improved features was undertaken.

(*ii*) *Electrothermal smelting of magnesium.*

Central control panel for the operation of electric furnace for smelting of magnesium was designed, fabricated and installed.

(*iii*) *Design and building of 3-Zone isothermal electric resistance furnace for Creep testing machines.*

Materials as per NML design were procured and tested. Fabrication of various parts of the furnaces were under taken.

(*iv*) *Development of modification in speed control system of a 50 H.P. rolling mill with Ward-Leomerd drive.*

As the existing speed control system of the imported rolling mill had become unserviceable due to obsolescence of certain parts, modification in existing speed control system was developed.

B. Design of Power Distribution Systems, Temperature and Humidity Control Systems, Preparation of Detailed Specifications, Layout, Installation and Commissioning.

Design of power distribution system and temperature and humidity control systems in respect of the following major jobs were carried out. Their detailed specifications and layouts were prepared. Execution of installation and commissioning were planned and implemented.

(i) Power supply system for Jigger Jolley Machine, automatic compressor and hot mixer at Dense Carbon Plant.
(ii) Installation of distribution boards, cables etc. and their termination at various places in the main building and technological block.
(iii) Providing earthing stations for Sub-station equipment in F.P.T.D. and M.B.P.P.
(v) Power supply system of water pumps, blowers, grinders, split furnace, ball mill, roll crusher, jaw crusher etc.
(vi) Replacement of unserviciable temperature and humidity control systems at various places in the laboratory.

C. Establishment of Special Facility for R and D Work.

(i) Provision of 80-TR Chiller unit for Creep Testing Laboratory.

Planning for the provision of one 80-TR Chiller unit to meet the increasing load of temperature and humity control system of the creep laboratory was carried out.

(ii) Design and Planning of Double Protected Panel System of 300 KVA Capacity were carried out to meet the strignent requirement of continuous power supply of the creep testing lab.

D. Preventive, Maintenance and Breakdown Repairs.

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

E. 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 plant etc. were carried out.

CIVIL ENGINEERING

Other than the normal maintenance of gas, water and other services lines, modification at various places installation of equipments the following jobs were completed/in progress during the year.

Work Completed

1. Tarfelt treatment over the electron microscope building.
2. Periodical painting, white washing of staff quarters at MCRS Digha.
3. Extension of sub-station building at Ist. floor of Creep Building.
4. Rebuilding of damaged compound wall at Pilot Plants,
5. Maintenance and Repairing work of Sukinda Nickel Pilot Plant.
6. Providing false ceiling to sub-station in the NML Building.
7. White washing, painting and polishing of NML Canteen, Dark room etc.
8. Providing wooden partition in M.M.T. Division.
9. Modification of existing accommodation/foundation for instailation of new equipments at Ref. Divn.
10. Providing steam and water pipe lines for electro boiler manganese dioxide pilot plant.
11. Supplying and fixing in position M.S. Grills for microscopes.
12. Covering the front varandah of NML Club House.
13. White washing, painting of M.S. Flats at Agrico Type II.
14. Providing motor cycle garage for Security Officer at FPTD.
15. Repairing and replacement of sanitary fittings at Staff Quarters Djgha.

Works in Progress

1. Extension of eastern wing of NML Building at 2nd floor.
2. Modification of old auditorium at 1st floor of NML Building.
3. Re-roofing of the stores shed at FPTD.

RESEARCH PLANNING

Annual Plan 1983-84

The Annual Plan for 1983-84 inclusive of Revised Budget Estimates for 1982-83 and Budget Estimates for 1983-84 was formulated on the basis of the requirements under on-going and new research project, international collaborative projects, SAIL-NML collaborative project programmes, infra-structural facilities, augmentation and modernisation of existing critical areas, etc.

The document further includes major achievements and contribution of NML during 1981-82 and areas of major thrust planned in 1983-84, etc.

Sixth Five Year Plan Projection

Projectwise planning and programming of Research and Development work was continued on the Sixth Five Year Plan proposals covering the period of five years from 1980-81 to 1984-85. This projection includes on going projects and new R and D project proposals, institutional projects, infrastructural facilities, extension centres, etc.

The major thrust in the Sixth Five Year Plan Projection has been provided to the SAIL-NML collaborative project programmes in the areas of mineral beneficiation, creep, cryogenic steels, iron and steel and refractories.

Augmentation and modernisation of the existing facilities in the vital areas having national importance have been planned with special emphasis. The fields include (1) mineral beneficiation (ii) development testing and evaluation of high temperature creep resistance minerals (iii) extraction of non-ferrous metals and minerals (iv) development and testing of refractories (v) development of aluninium and light alloys technology, etc. The proposals envisage foreign/UNDP and bilateral assistance in some of the areas.

Efforts are being made to improve service facilities like instrumental analysis, library, information and other R and D infrastructural activities besides support to extension centres and social ameneties.

Research Appraisal Activities

Ten Multi Agency Projects have been identified for coordinated pursuit between SAIL and NML/CSIR with short and long term objectives. A high level working group has been set up to periodically review the progress of these priority projects and to provide necessary guidance. At the project level, task forces meet at regular intervals and discuss the progress. The following projects are being pursued actively.

(1) Characterisation of boiler quality plates for creep properties.

(2) Development of steels for cryogenic application.

(3) Evaluation of coal gasification based on direct reduction processes.

(4) Evaluation of the use of pre-reduced iron in the LD converter.

(5) Evaluation and development of direct reduction processes using iron ores, coal agglomerates.

(6) Improvement in the manufacturing techniques for tar bonded basic refractories.

(7) Evaluation of clay-graphite stopper heads developed by NML (Improvement of clay-graphite stopper heads).

The following three are awaiting sponsorship from the Mineral Development Board.

(1) High alumina refractories based on beneficiated kyanite concentrates and beach sand sillimanite.

(2) Beneficiation of magnesite.

(3) Beneficiation of high silica lime stone and dolomite.

TECHNOLOGY UTILIZATION

A. Technology Transfer.

The following technologies have been released and transfer of technologies were effected.

	Title	*Name of the Licencee*
1.	Production of aluminium base sacrificial anode for cathodic protection 'SUPERAL' (PATENTED)	(i) M/s. Electro-protection services, Karaikddi—Production commenced. (ii) M/s. Dum Dum Valves and Bearings (P) Ltd, Calcutta.
2.	Production of air-atomised extra fine non-ferrous metal powders	M/s. Fort William Co. Calcutta.
3.	Production of refractory aluminous cement (Cement foundu type) by sintering technique.	M/s. Vijay Magnesites Ltd., Ghaziabad.
4.	Production of distilled zinc dust.	M/s. Zinc Products and Co. P. Ltd., Patna.
5.	Production of electrical resistance alloys for heating elements.	M/s. G. K. Enterprises, Adityapur —under transferring stage.
6.	Design of equi-blast-cum balance blast cupola (Blue print)	1. M/s. Kamani Foundry, Rajkot. 2. M/s. Pranav Casting, Rajkot. 3. M/s. Metallic Enterprises, Rajkot. 4. Ashok Engg. and Foundry Works, Rajkot.

B. Technology assigned to NRDC

(i) Production of aluminium filler-wire (NML-PM6) corresponding to BS 290 NG6.

C. Assistance to Licencee

Assistance was rendered in finalising the equipment and lay-out drawings to M/s. Micro-Metal Sen and Co. (P) Ltd., Giridih who have been granted the licence through NRDC for the production of extra-fine atomised non-ferrous metal powders.

D. Consultancy Services Completed

The following consultancy assignments were completed :

	Title	*Sponsor*
1.	Advice on switching over from bentonite bonded system to resin bonded sand system.	M/s. Hindustan Machines Tool Ltd., Foundry, Bangalore.
2.	Advice and opinion on the product sample of skelp mill.	Durgapur Steel Plant, Durgapur.
3.	Production of tin metal from sponge tin and tin slag.	M/s. Detinners Pvt. Ltd., Calcutta.
4.	Advice and assistance relating to Rhodium plating of silver articles.	Mr. Vijay Kumar Soni, Calcutta.
5.	Advice on Bright Nickel Plating.	India Automobiles Ltd., Adityapur.

E. Rural Development Programme

The rural development programme sponsored by the Centre for Management Development, CSIR, is being actively persued. Field work was taken up in Bankura District of West Bengal. After preliminary survey, attention was concentrated on the implementation of melting and casting technique for brass and bronze metal in place of the conventional practice followed by the artisans.

Practical demonstration for the melting technique has been given at Bishnupur. The usefulness of the NML development melting technique has been appreciated by artisans and trainees of the locality. At present the work on the production of export grade fish hooks, is in progress.

CSIR has established at Bankura an S and T field Station for artisans in which the NML will be participating relating to metallurgical based areas.

F. Patents

The following complete specifications of patent applications have been filed.

	Title	*Inventors*
1.	Improved process for casting of aluminium alloys to obtain fine grain refining thereof.	Rajendra Kumar C. S. Sivaramakrishanan and R. K. Mahanti
2.	Process for liquid state treatment of aluminium for aluminium alloys.	Rajendra Kumar C. S. Sivaramakrishnan N. K. Das and R. K. Mahanti

Under the Rural Development Programme, NML scientists are guiding and working with rural artisans of Bankura district, West Bengal.

G. Exhibitions

The Laboratory participated in the following Exhibitions :

1. Indian International Trade Fair 1982 CSIR Science and Technology pavilion at Pragati Maidan, New Delhi from 1st to 14th November, 1982.

2. "Festival of India" Exhibition 1982 held at London.

3. CSIR Parliament Science Exhibition at Parliament House Annexe— 23rd February to 1st March 1983.

Dr. J. J. Irani, Dy. Managing Director, Tata Iron and Steel Co. Ltd., delivering the inaugural address at the Seminar on 'Co-operation in Information Management.'

National Seminar on Co-operation in Information Management

A National Seminar on "Co-operation in Information Management" was organised by NML on 14th and 15th February 1983, in collaboration with Indian National Scientific Documentation Centre, Publication and Information Directorate, National Institute of Science and Technology Development Studies (all belonging to CSIR) and Society for Information and Documentation Science, Jamshedpur.

The seminar was inaugurated by Dr. J. J. Irani, Dy. Managing Director, Tata Iron and Steel Co. Ltd., Jamshedpur and presided over by Prof. V. A. Altekar, Director, National Metallurgical Laboratory. Shri T. S. Rajagopalan, Scientist-in-Charge INSDOC, welcomed the participating delegates. Shri R. Thiagarajan, Director, Information and Documentation, Dept. of Science and Technology Govt. of India delivered the invited lecture 'Information Science and Technology-Quo Vadis' as well as the key-note address "Planning an Integrated Information system—the NISSAT Experience" at first technical session.

The key-note address at the second technical session was delivered by Shri S. Ranga Raja Rao of RRL, Hyderabad. He spoke on "Design & Organization of Integrated Information System." Shri T. S. Rajagopalan of INSDOC, New Delhi; delivered key-note address on "Framework for Co-operation in Developing Integrated Information System "at the third technical session. Dr. N. Vijayaditya of Electronics Commission, New Delhi; delivered key-note address on "Prospects for Application of Modern Technologies in Developing Integrated Information System" at the fourth and concluding technical session.

Thirty Papers were presented in four technical sessions. At the conclusion session a number of recommendations were drawn up based on the deliberations of the seminar. The seminar was attended by over hundred delegates drawn from various cross sections of the country's industrial complexes, Research Laboratories, Universities, Technical Institutions and Information & Documentation Centres.

DISSEMINATION OF INFORMATION

Training Courses

Two Metallurgical Orientation Courses, were conducted for trainees sponsored by Power Engineers Training Society, Nagpur. A series of lectures were delivered by the NML Scientists covering the subject course.

A short term course on 'Basic Metallurgy' for the Asst. Inspecting Engineers of Indian Railways was conducted. A series of lectures were delivered by NML scientists covering the course.

A refresher courses on 'Ceramic Science in Engineering was conducted in collaboration with Indian Ceramic Society, Jamshedpur Chapter and Indian Institute of Ceramics, Calcutta. A series of lectures by NML Scientists and other experts were delivered during the course.

Visit of Foreign Scientists under Science and Technology and other Exchange Programme.

Dr H. Buhl of Institute of Aeronautical Materials, Lohman, West Germany, visited under Indo-FRG Technical Co-operation Agreement on Short-term Expert Pool, for period of 4 weeks. Dr. Buhl is an expert in the field of Stress-Corrosion Cracking and delivered the following lectures to NML Scientists.

1. Stress corrosion test methods.
2. The constant strain rate testing technique.
3. Phenomenological aspects of stress corrosion cracking.
4. Mechanism of stress corrosion cracking.
5. Stress corrosion cracking of ferrous materials.
6. Stress corrosion cracking of aluminium alloys.
7. Repassivation kinetics and its effect on the stress corrosion cracking behaviour.
8. Corrosion fatigue.

Three Bulgarian experts in the field of corrosion visited under Indo-Bulgarian Science and Technology Exchange Programme and discussed with the NML Scientists the various aspects of R and D work in the field of corrosion.

Lectures Delivered by Visiting Experts During the Period

	Speaker	*Subject*
1.	Shri S. K. Mitra Tata Iron Steel Company, Jamshedpur.	Present and future problems in L.D. Refractories.
2.	Shri P. C. Varshnai President, Indian Ceramic Society Mg. Director Saraikela Glass Works.	Glass Industry in India with Special reference to Recent Developments.

3.	Shri H. R. Thilakan Chief Chemist (R and D) Tube Products of India, Madras.	R and D in Industry.
4.	Prof. R. V. Tamhankar Chairman RAC, NML	Some Aspects of Powder Metallurgy.
5.	Dr. B. P. Verma Director of Engineering and Research, EL Power Corporation Santa Ana, CA. U.S.A.	Recent Development in lead acid batteries with lead-calcium alloys.
6.	Dr. S. K. Saxena SINTEF NORWAY	Potential of Magnesium as a refining agent in steel making.
7.	Dr. Sharif Ahmed Research Associate, A.M.U., Aligarh.	High temperature oxidation and hot corrosion behaviour of some inorganic coatings on AISI 303 Steel.
8.	Prof. G. B. Pant Ex-Professor, MESRA, Ranchi, Birla Inst. of Technology.	Satellite Technology and Space shuttle.

Broadcast Talks

The following talks were broadcasted from All India Radio, Ranchi, by NML Scientist.

Speaker	*Subject*
Prof. V. A. Altekar Director	R and D activities of NML in the field of copper (in Hindi).
Prof. V. A. Altekar Director	Achievement of NML (under National Programme on the eve of Republic Day).
Dr. L. P. Pandey Scientist	Contribution of Science (in Hindi).

Training of Foreign Personnel

Mr. Innocent Nnaekizie from Nigeria under UNIDO sponsored Scheme, was imparted training for 4 months in the area of metallography, X-ray diffraction, magnetic materials, creep study of high temperature steels and corrosion.

NML Technical Journal

The issues of Vol. 24, 1982, were edited and published. Leading abstracting services like Metal Abstracts, Chemical Abstract etc. report the abstracts of the papers published in the journal.

Documented Survey on Metallurgical Development

The issue of the publication were brought out.

Annual Report

Annual Report for 1981-82 was prepared, published and circulated.

Monograph on Ores and Minerals of India

The Vol. 2 of the Monograph was edited and is under publication.

NML News Letter

The issues of NML News letter were brought out and circulated.

News Paper Clipping Service

Daily newspapers including commercial and business papers were scanned and items of importance covering news on metallurgical and allied industries R and D work, Govt. Industrial policy, new and Scientific and industrial innovations etc. were classified and depart mentally circulated.

Publicity of Processes and Products

Periodic publicity was given about NML activities, processes and technologies ready for commercial utilization through brochures, articles, newspapers, broadcast talk etc.

Papers Published

61 papers are published, presented and communicated. Details furnished in Appendix I.

Investigation and Research Reports Prepared

Details furnished in Appendix II.

LIBRARY SERVICE

The Library continued the 'Project Oriented Documentation Service' and weekly Current Awareness Service'. Eight select bibliographics on specific subjects were furnished to the scientists of the NML.

A scheme for 'Institutional Membership of NML Library' for academic institutions and R and D units of industries has been introduced during this period. The aim of this scheme is to make available, on charge basis, the vast resources of NML Library which include books, periodicals and other relevant information to the research workers of those organizations.

The British Council proposed to present British books worth of 3,000 pound under their 'Overseas Development Administration' (ODA) book presentation programme. The negotiations were completed during the year.

CHAIRMANSHIP, MEMBERSHIP ETC. OF NML STAFF ON OUTSIDE BODIES

Pro f. V. A. Altekar Director	Member	Court of the Banaras Hindu University.
	Member	State Industrial Development Panel, Mines and Minerals based Industries, State Advisory Council, Govt. of Gujarat.
Dr. R. Kumar Scientist in the grade of Director.	Member	Board of Governors of National Institute of Foundry and Forge Technology, Ranchi.
	Member	Materials and Power Panel of the Aeronautical R and D Board.
	Member	On behalf of the Central Boiler Board on the Adhoc Panel to consider the draft IS specification for bolts, studs and nuts for flanges and pressure containing purposes DOC : EDC : 27(2786).
Dr. M. R. K. Rao Scientist	Vice-Chairman	Indian Ceramic Society Jamshedpur Chapter.
	Fellow	Indian Institute of Ceramics, Calcutta.
Shri P. C. Sen Scientist.	Secretary	Indian Ceramic Society, Jamshedpur Chapter.
Shri M. C. Kundra Scientist	Member	Carbon Panel for Carbon Blocks and Carbon Refractories Committee —DGTD.
Shri B. K. Saxena Scientist	Jt. Hony Secretary	Jamshedpur Centre of Institution of Engineers (India).
Shri G. N. Rao Scientist	Vice-President	Indian Institute of Foundryman, Jamshedpur, Chapter.
	Secretary	Technical Services Co-ordination Committee, Indian Institute of Foundrymen.

Shri T. A. Beck Scientist	Member	ISI (Sub-Committee) SMDC 17:1 for Silica sand and SMDC 17/p-5 for binders.
Shri S. Ghosh Scientist	Member	Foundry Materials Panel, Technical Services Co-ordination Committee of IIF.

DEPUTATION AND TRAINING

Shri L. N. Das Scientist	Attended a 2 weeks course on Micro/mini computer concepts organized by Computer Maintenance Corporation Ltd., Calcutta.
Dr. S. C. Srivastava Scientist	Deputed to France under Indo-French Co-operation Programme.
Shri M. J. Shahani Scientist	Attended the UNESCO Regional Advanced Winter Institute on Basic Principles of Geo-microbiology with special reference to Microbial culture used in Biohydrometallurgy on invitation as a teacher and delivered two lectures. The course was held at MACS Research Institute at Poona under joint auspices of UNESCO, UNEP and ICRO.

HONOURS AND AWARDS

Shri K. K. Padhi, Scientist, was awarded Ph.D degree from Patna University.

APPENDIX I

Papers Published, Communicated and Presented

1. Studies on iron reduction of stibnite by X-ray diffraction and scanning electron microscopy—S. K. Bose & V. A. Altekar. NML Technical Journal, 24 (1 & 2), 1982.

2. Recovery of metal values from industrial wastes—P. K. Som & S. K. Roy Choudhury, Same as Sl. No. 1.

3. Some experiences on X-ray fluorescence analysis of ores and minerals—A. Peravadhanulu, G. P. Mathur & V. A. Altekar, same as Sl. No. 1.

4. Relations between the theoritical hydrogen and observed hydrogen in the presence of inhibitors—V. A. Altekar, Inder Singh, M. K. Banerjee & M. N. Singh, NML Technical Journal, 24 (3 & 4), 1982.

5. The effect of solute and melt treatment on precipitation behaviour of Al-Cu & Al-Zn-Mg alloys—C. S. Sivaramakrishnan & R. K. Mahanti, same as Sl. No. 4.

6. Using lattice parameter to estimate activation energy—(Miss) R. Sharma & S. K. Bose, same as Sl. No. 4.

7. Inhibition and polarization studies of titanium on sulphuric and hydrochloric acid solution—D. D. N. Singh, M. N. Banerjee & P.S. Nag, same as Sl. No. 4.

8. Effect of some organic inhibitors on corrosion and hydrogen absorption by high carbon steel—Inder Singh, A. K. Dey & V. A. Altekar; same as Sl. No. 4.

9. Effect of sulphur in synthetic slags for the studies of sulphur partition between pig iron and slags using radioactive tracer—K. D. Maji, same as Sl. No. 4.

10. From bench scale to industrial concentrator—the story of 500 tonnes per day fluorspar project—M. V. Ranganathan, G. P. Mathur & V. A. Altekar, presented at the XIV International Mineral Processing Congress, Toronto, Canada, Sept.-Oct., 1982.

11. Studies on liquid phase sintering of Mgo-china clay compacts—K. K. Singh, V. A. Altekar & M. D. Narsimham, presented at the 46th Annual General Meeting of Indian Ceramic Society held at Morvi, Gujarat, April, 1982.

12. Development and production of blast furnace refractories in India—K. K. Singh & M. R. K. Rao, presented at the seminar on 'Refractories for Iron Making' held at Bokaro, January, 1982.

13. Raw materials for refractories for iron making—P. C. Sen & M. R. K. Rao; same as Sl. No. 12.

14. Studies on liquid phase sintering of Mgo-talc compacts K. K. Singh, V. A. Altekar & M. D. Narsimham; presented at the 47th Annual General Meeting of Indian Ceramic Society, held at Madras, Feb., 1983.

15. Natural graphite—a raw material for refractories and other industries; P. C. Sen & M. R. K. Rao; presented at the Carbon Conference held at NPL, New Delhi.

16. R&D work on refractory minerals undertaken at NML—P.C. Sen and M. R. K. Rao for presentation at RRL, Bhubaneswar.

17. Major ceramic raw materials—P. C. Sen; presented at the refresher course on 'Ceramic Science & Engineering' held at NML, October, 1982.

18. Mineral statistics and planning of ceramics materials—P. C. Sen, same as Sl. No. 17.

19. Dolomite refractories for electric arc furnaces—P. C. Sen and M. R. K. Rao; presented at the seminar on 'Refractories for electric arc funrace' held at Calcutta, December, 1982.

20. Refractories for vacuum processing of steels—N. N. Mathur and M. R. K. Rao; same as Sl. No. 19.

21. Extraction of nickel and cobalt from the nickeliferous oxide ore of India—B. N. Singh, M. S. Mohanty, D. D. Akerkar & V. A. Altekar; Trans of Indian Institute of Metals 35(4), August, 1982.

22. Studies on lime roast leach technique for treating chalcopyrite concentrates—P. K. Som, & S. K. Roy Chowdhury—Trans. Indian Institute of Metals 35(6), December, 1982.

23. Studies on sulphation roasting & copper sulphide concentrates—P. K. Som & S. K. Roy Chowdhury, communicated to Trans. Ind. Inst. of Metals.

24. Geomicrobio-hydrometallurgy—emergent technology for the eighties—M. J. Shahani presented at the seminar on 'Utilization of Mineral Resources' Indian National Science Academy, New Delhi, October, 1982.

25. An indigenous filler wire for welding aircraft components—R. Kumar, B. N. Saxena & G. D. Sani; proceedings of the Symposium on "Aerospace alloys and fabrication technology", Bangalore, December, 1981 (published in 1982).

26. Study of grain refinement of Al by PM 122—C. S. Sivaramakrishnan, R. K. Mahanty, & R. Kumar; Indian Jr. of technology. 20(10), 1982.

27. Development of a melting and solidification technology for the production of aircraft grade Al alloys—C. S. Sivaramakrishnan, R. K. Mahanti & R. Kumar; Light Metal Age 49 (5 & 6), June, 1982.

28. Development of a melting and solidification technology for the production of light alloys—C. S. Sivaramakrishnan R. K. Mahanti & R. Kumar; Proc. of Symp. "Aerospace alloys and fabrication technology," December, 1981.

29. Studies on the grain refining efficiency of an inoculant for Al melt—C. S. Sivaramakrishnan, R. K. Mahanti & R. Kumar accepted for publication in Aluminium (W. Germany).

30. Effect of two phase solidification on dispersion of lead and graphite on Al alloys—C. S. Sivaramakrishnan, R. K. Mahanti & R. Kumar; sent for publication in "Wear".

31. Structural and magnetic studies of pure and substituted gamma iron oxide—V. Prakash, V. Rao & S. Pramanik; Trans. Ind. Inst. Metals 35(5), October, 1982.

32. Effects of alloying additions on the stability and magnetic properties of Mn-Al-C alloys—C. R. Tiwari, V. Rao, S. Pramanik & R. Kumar; Communicated to Trans. Magnetic Society of India.

33. Structural and magnetic studies of Mn-Al-C alloys—V. Rao, S. Pramanik C. R. Tiwari & R. Kumar; presented at the seminar on "Recent trends in materials research", IIT, Bombay, December, 1982.

34. Preparation and properties of barium-lead and barium-strontium-lead ferrities—V. Rao, S. P. Narayan & V. Prakash Same as Sl. No. 33.

35. Indigenous development of creep resistant steels—R. Singh & R. Kumar; presented at the Symp. on "Creep resistant steels in thermal power plants" BHEL, Hyderabad, January, 1983.

36. Long term behaviour of 20 Cr 5 Mo 9V 8 TiB for studs and bolts at elevated temperatures; same as Sl. No. 35.

37. Some aspects of Cr-Mo-V steels—R. Singh & R. Kumar; presented at the Int. Conference on "Deformation—all aspects", Ranchi, March, 1983.

38. Design/development of load cell—G. Jaura; presented at the Symp. on "Instrumentation" held at Indian Inst. Sciencie, Bangalore, July, 1982.

39. Differential deformation during roll-bonding of dissimilar metals—J. Bhattacharya, B. N. Ghose & S. K. Banerjee; presented at the

International Conference on "Deformation—all aspects"; Ranchi, March, 1983.

40. Development of silver-nickel contact—V. A. Altekar, R. K. Dubey, S. K. Chowdhury, S. P. Chakraborty & P. K. De—Communicated for publication to PMAI journal.

41. Heat resistance properties and structure of aluminium alloyed cast iron—G. N. Rao, S. S. Dhanjal, C. A. N. Rao & V. A. Altekar; presented at the seminar on "Recent advances in materials research", I.I.T., Bombay, December, 1982.

42. Indian foundry sands—availability and quality—S. Ghosh, G. N. Rao & V. A. Altekar; presented at the seminar on "Foundry raw materials", New Delhi, August, 1982.

43. Manufacture of investment casting refractory materials from Indian sillimanite—S. K. Sinha, G. N. Rao & S. Ghosh; presented at the 32nd Annual Convention of Ind. Inst. of Foundrymen, Madras, February, 1983.

44. Production of non-ferrous artefacts through investment casting—G. N. Rao, S. Ghosh, B. Dutta & S. K. Sinhababu; presented at the seminar on "Casting and forging of non-ferrous metals and alloys" Madras, November, 1982.

45. Manufacture of investment casting refractory raw materials from Indian sillimanite—S. K. Sinha, G. N. Rao & S. Ghosh—souvenir volume, 32nd Annual Convention of I.I.F., February, 1983.

46. Recent developments in continuous casting—R. D. Gupta & V. A. Altekar; presented at the Symp. on "Continuous casting of steel"; Alloy Steel Plant & I.I.M. Durgapur Chapter, Durgapur, October, 1982.

47. Metal surgical implants—availability—R. D. Gupta & V. A. Altekar; Tool & Alloy Steels, 17(1), January, 1983.

48. Hydrogen absorption index and input hydrogen fugacity—V. A. Altekar, Inder Singh & M. K. Banerjee; Communicated to 3rd International Congress on "Hydrogen in metals and materials", Paris, June, 1982.

49. Effect of cold work on hydrogen absorption in inhibitor acid—M. K. Banerjee, D. D. N. Singh, Inder Singh and V. A. Altekar; same as Sl. No. 48.

50. Studies on the effect of zinc ions on passivation of mild steel in chromate solution using radio tracer—V. A. Altekar, K. D. Maji & Inder Singh; communicated to seminar on "Corrosion prevention and control".

51. Zeta potential and flotation studies of chalcopyrite fines with 8 hydroxy quinoline—V. Mangalam & P. R. Khangaonkar; Colloids & Surface.

52. Electro flotation—A review—G. Bhaskar Raju & P. R. Khangaonkar; Trans. I.I.M.

53. Spectro-photometric determination of vanadium in steels with chromotropic acid—B. R. U. Narasimham & P. R. Khangaonkar; Trans. I.I.M.

54. Electro-flotation of chalcopyrite fines with sodium diethyl-dithio carbonate as collector—G. Bhaskar Raju and P. R. Khangaonkar; International Journal of Mineral Processing.

55. Zeta potential and adsorption studies of chalcopyrite-sodium diethyl-dithio-carbonate system—G. Bhaskar Raju, V. Mangalam & P. R. Khangaonkar; Journal of Colloids & Interface Science.

56. Flotation and adsorption studies of chalcopyrite with 8-hydroxy-quinoline—S. Prabhakar & P. R. Khangaonkar, Trans. I.I.M.

57. Zeta potential and flotation studies of chalcopyrite fines with cupferrous—V. Mangalam & P. R. Khangaonkar; Trans. I.I.M.

58. Flotation behaviour of magnetite with carboxylic acid collectors and a chelating agent—V. Mangalam & P. R. Khangaonkar; Trans. I.I.M.

59. Zeta potential and flotation studies of magnesite fine particles with sodium lauryl sulphate—V. Mangalam & P. R. Khangaonkar; presented at the Symp. on "Recent advances in particulate science and technology", I.I.T., Madras, December, 1982.

60. Beneficiation of magnesite dumps on Tamil Nadu—an industrial approach—V. Mohan, D. Jayakumar & P. R. Khangaonkar; 125th Madras University Souvenir.

61. Design & organisation of integrated information system for metallurgy—M. L. Sharma & P. K. Gupta; presented at the seminar on "Co-operation in Information Management" at NML, February, 1983.

APPENDIX II

Research and Investigations Completed and Reports Prepared

1. Contamination of control and instrument air at DTPS, Durgapur and investigation thereof—R. Kumar & Inder Singh (IR 1112/82).

2. Bench scale beneficiation studies on coal samples from M/s. Ennore Thermal Power Plant, Madras—K. Vijaya Raghavan, V. Mohan & P. R. Khangaonkar (IR 1113/82).

3. Beneficiation studies on two large tonnage ferruginous manganese ore lump and fine samples from Joda West manganese plant of M/s. TISCO—P. N. Pathak, S. Sivaiah, S. Rafiuddin & N. Chakraborty (IR 1114/82).

4. Investigation report of the samples of steel shovellings and turnings, received from M/s. Modi Steel, Modinagar, A. N. Pandey & K. N. Gupta (IR 1115/82).

5. Exploratory studies on pelletization of chilled iron oxide from M/s. FPTDL, Sindri—J. P. Srivastava, N. Chakraborty & S. K. Banerjee (IR 1116/82).

6. Investigation of failed reheater tube of boiler no. 4 and estimation of residual stress in gas welded super-heater tubes from Maharashtra State Electricity Board-R. Singh & R. Kumar (IR 1117/82).

7. Failure of aluminium-brass condenser tubes from unit no. 5 of E.T.R.S., Madras—R. Srinivasan, C. Satyanarayan, S. Rao Addanki & P. R. Khangaonkar (IR 1118/82).

8. Metallurgical investigation of aluminium overhead conductors in the vicinity of carbon disulphide plant in a paper mill—R. Kumar (IR 1119/82).

9. Defects in aluminium utensils—R. Kumar, B. K. Saxena, L. Lal & R. K. Mahanti (IR 1120/82).

10. Testing on seven sets of samples of screen super heater tubes of boiler no. 4 & 5—R. Kumar, R. Singh ; R. K. Sinha (IR 1121/82).

11. Extraction and recovery of zinc from zinc silicate ore from Chakula, Bhutan—M. G. Bodas, M. Yaseen, M. S. Mohanty, & D. D. Akerkar (IR 1122/82).

12. Further bench scale beneficiation studies on two low grade graphite samples from Khepchishi hills, Bhutan; from M/s. Industrial Development Corporation—P. N. Pathak, M. V. Ranganathan & N. Chakraborty (IR 1123/82).

13. Exploratory bench scale beneficiation studies for producing bulk quantities of tourmaline free kyanite concentrate from kyanite samples from Pardi mines, Bhandra for M/s. Maharashtra Mineral Corporation—S. N. Prasad, M. V. Ranganathan, N. Chakraborty & S. K. Banerjee (IR 1124/82).

14. Beneficiation of low grade sillimanite samples from Maharashtra State Mining Corporation—T. C. De, S. K. Sengupta, N. Chakraborty & S. K. Banerjee (IR 1125/82).

15. Beneficiation studies on rock salt sample of M/s. Hindustan Salts Ltd, Mandi (H. P.)—S. C. Maulik, S. K. Sil & Chakraborty (IR 1126/82).

16. Studies on the effect of frerrous sulphate additions on the corrosion behaviour of aluminium brass condenser tube for Ennor Thermal Power Station, Madras—S. Rao addanki & P. R. Khangaonkar (IR 1127/82).

17. Beneficiation of limestone sample for Chopan, U.P.—S. Biswas, P. K. Sinha, S. R. Ghosh, D. M. Chakraborty (IR 1128/82).

18. Studies on the freduction of iron content of silica sand sample received from U.P. State Mineral Development Corporation, Lucknow—S. Sivaiah, K. K. Bhattacharya, S. K. Sengupta, D. M. Chakraborty & N. Chakraborty (IR 1130/82).

19. Beneficiation of low grade kyanite sample marked UDR-1 and UDK-2, received from Director of Mines & Geology, Udaipur, Rajasthan—S. N. Prasad, S. K. Sengupta, M. V. Renganathan, D. M. Chakraborty, N. Chakraborty & S. K. Banerjee (IR 1131/82).

20. Beneficiation of low grade sillimanite samples from M/s. Maharashtra State Mining Corp. Part I, Corrundum and Sillimanite rejects—T. C. De, S. K. Sil, K. V. Rao, N. Chakraborty & S. K. Banerjee (IR 1132/82).

21. Studies on petroleum coke from Bombay High Crude—B. Charrerjee, M. C. Kundra & M. R. K. Rao (IR 1133/82).

22. Beneficiation studies of a low grade rock phosphate from Mussorie, U.P.—T. C. De, S. C. Moulik, S. K. Sengupta, N. Chakraborty & S. K. Banerjee (IR 1134/82).

23. Reduction of ash content in a sample of coal dust received for M/s. TELCO—S. N. Prasad, M. V. Ranganathan & N. Chakraborty (IR 1135/82).

24. Beneficiation studies on lead-zinc ore containing barite from Bhutan—P. N. Pathak, S. Rafiuddin, N. Chakraborty & S. K. Banerjee (IR 1136/82).

25. Moulding characteristics of natural moulding sand deposit received from M/s. A. R. Shining Foundry & Engineering Works, Batla—H. P. Singh & R. N. P. Gupta (IR 1137/82).

26. Evaluation of physical and refractory properties of fire clays—B. K. Mitra, P. C. Sen & M. R. K. Rao (IR 1138/83).

27. Determination of work index and crushing strength of an ore sample from M/s. UCIL, Jadugoda—S. Sivaiah, S. Mohan Rao, B. Banerjee, M. V. Ranganathan & N. Chakraborty (IR 1139/83).

28. Report on beneficiation of Gua iron ore and its slime together with Kiriburu slime; prepared for M/s. Mineral Development Board, New Delhi—U. S. Chattoraj, R. K. Kunwar, J. S. Padan & N. Chakraborty (IR 1140/83).

29. Pressure leaching of Chitradurga copper concentrate with sulphuric acid—P. V. Viswanathan, C. Sankaran & P. R. Khangaonkar (IR 1141/83).

30. Indian foundry sands—availability and quality—S. Ghosh, G. N. Rao & V. A. Altekar (RR 408/82).

31. Manufacture of investment casting refractory materials from Indian sillimanite—S. K. Sinha, G. N. Rao & S. Ghosh (RR 409/82).

32. Treatment of complex copper nickel sulphide concentrate—P. K. Som & S. K. Roy choudhury (RR 410/82).

33. Production of non-ferrous artefacts through investment casting—G. N. Rao, S. Ghosh, B. Dutta, S. K. Singha & S. K. Sinhababu (RR 411/82).

34. Heat resistance properties and structure of aluminium alloyed cast iron—G. N. Rao, S. S. Dhanjal, C. A. Naresh Rao & V. A. Altekar (RR 412/83).

35. Corrosion behaviour of high strength, medium conductivity NML—PM215 aluminium alloy conductor—A. K. Bhattamishra, K. Lal & R. Kumar (RR 413/83).

36. Pilot plant trial on roast reduction ammonia-ammonium carbonate leaching of Sukinda nickel lateritic ores from Kansa in vertical reduction furnace—D. D. Akerkar, Z. M. Khan, M. S. Mohanty, B. N. Singh, B. V. S. Yadavalli & S. K. Singh (RR 414/83).