NML
Annual Report
1979-80

NATIONAL METALLURGICAL LABORATORY
JAMSHEDPUR, INDIA

ANNUAL REPORT

1979-80

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

Compiled, Edited & Produced by

P. K. Gupta

Design & Layout

P. K. Gupta

M. L. Sarkar

CONTENTS

INTRODUCTION

The National Metallurgical Laboratory has built up expertise and capabilities in various disciplines of metallurgy which is now well recognized resulting in a constant flow of sponsored projects and collaboration from national and international organizations.

For the establishment of an Iron & Steel Complex at Syria, based on their raw materials, M/S MECON was awarded the contract against global competition wherein the investigations on all raw materials were entrusted with NML. This challenging assignment of beneficiating two low grade oolitic iron ores with strict time schedule was undertaken. Bench Scale studies have revealed that good quality sinters and pellets could be produced with concentrates obtained through various routes of beneficiation. Large Scale pilot plant trials on tonnage quantities of the ore are in progress.

NML had also undertaken comprehensive pilot plant beneficiation studies on low grade ores received from both public sector and private undertakings and developed process flow sheets for the setting up of different ore-treatment plants many of which are coming up, while some of them are in the planning and design stages. Some of the projects which are coming up and presently in different stages are :

(i) Gandhamardan iron ores—Beneficiation and agglomeration plant for Orissa Mining Corporation.
(ii) Saladipura pyrite beneficiation plant for PPCL.
(iii) Coal flotation plants for the treatment of coal fines and middlings at Nandan, Damna, Bolanda and Jagannath collieries of CMPDI, Ranchi.
(iv) Fluorspar beneficiation plant (36 tpd) at Chandidungri, M.P. for M/s. Madhya Pradesh & Maharashtra Minerals & Chemicals (P) Ltd.
(v) Manganese ores beneficiation plant for TISCO.
(vi) Chromite beneficiation plant for FACOR.
(vii) Kyanite—Sillimanite beneficiation plant for M/s. Maharashtra State Mining Corporation.

With the National Research Institute for Metals, Tokyo, Japan; the Laboratory has taken up a collaborative project on the atmospheric corrosion of metals and alloys. NML has received 300 Japanese steel samples which have been exposed under different atmospheric conditions at Jamshedpur, Digha and Madras.

NML has accepted a package deal for setting up a one-tonne per day pilot plant for production of ferro-tungsten by alumino-thermic reaction, for the Central Research Organization, Rangoon. The assignment is through CSIR/NRDC under the Government of India assistance to Government of Burma under Indian Technical & Economic Co-operation Programme.

During the year, six process know-how have been translated to commercial production by the licencees. Under process technology and product development activities, further strides were made producing 350 carrier blade castings

Shri D. P. Kharia, Dy. Managing Director, Tata Iron & Steel Company Ltd. inaugurating the exposure of the metallic samples received from NRIM Japan, for atmospheric corrosion studies at NML

at TISCO works. These blades have been made out of the heat resistant alloy cast iron developed at NML, designated as NML-Pyroloy 1000. Industrial scale evaluation trials on element pins, made out of this alloy, used in electric arc furnaces has commenced with active co-operation of M/s General Electric Company, Calcutta.

The versatile electric grade aluminium alloy 'NML-PM2' was earlier well received by both the conductor manufacturers and users and that its production was established at three industrial units at Calcutta, Hyderabad and New Delhi. It is a matter of gratification that the application of M/s. Universal Cables Ltd., Satna ; for the transfer of technology of NML-PM2 was finally cleared by the Government of India and technology transfer effected during the month of November, 1979.

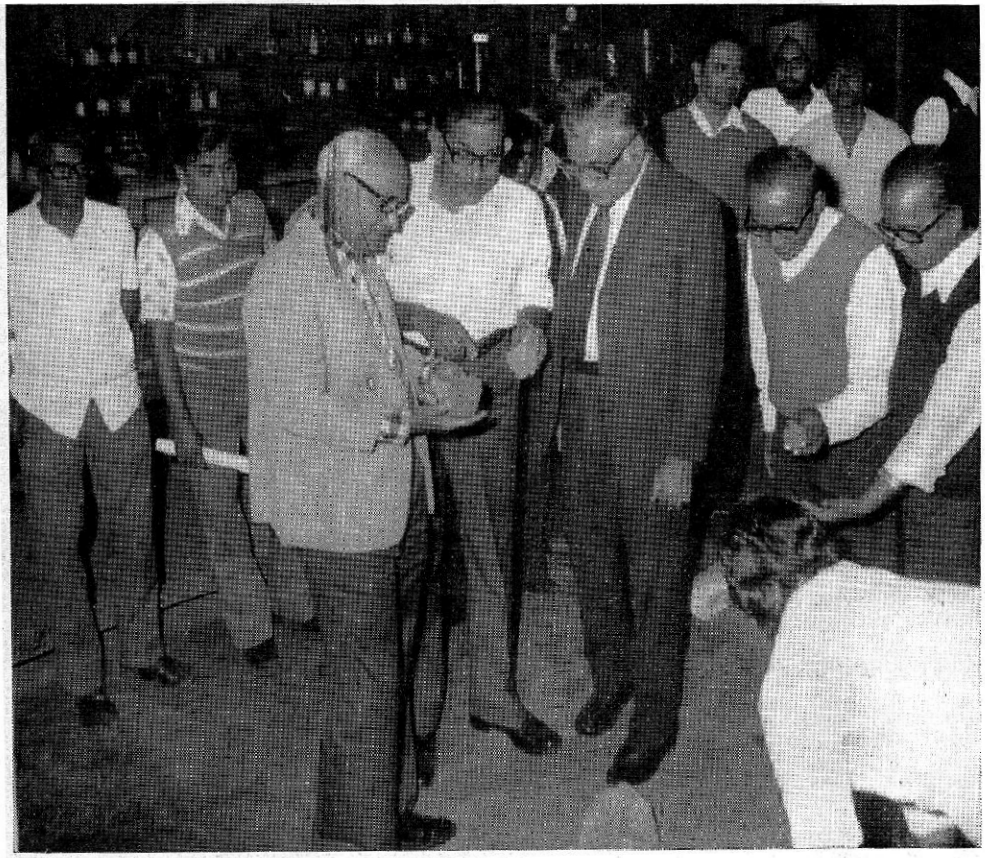
The concept of the use of annealed NML-PM2 steel reinforced conductors has been accepted by the Rural Electrification Corporation for field evaluation and 30 km of this type of conductor has been processed by our licencee M/s. Indian Aluminium Cables Ltd., New Delhi. The paper, incorporating these ideas, was published in the Journal of the Institution of Engineers (MM 1978 July) and it was awarded the 1979 Dr. Rajendra Prasad Memorial Gold Medal.

NML had collaborated with Bharat Heavy Electricals Ltd., Bhopal in the development of 16/20 MVA 132/33/11 KV aluminium transformer and one phase out of the three phases of the power transformer was wound with NML-PM2 DPC strips. It is understood that the power transformer has since been made by BHEL and passed the tests. It is now in the installation stages at the M.P. State Electricity Board.

Another important area of thrust of the aluminium technology group has been in establishing alloy melting and solidification technology. NML developed the concept of filtering the molten metal through a bed of refractory filter and towards the end developed "NML Reactive Filter". The NML Reactive Filter was initially evaluated at M/s. Hindustan Aluminium Corporation, Renukoot ; Electrical Manufacturing Company, Calcutta and the Ordnance Factory, Ambajhari ; Nagpur. The production technology of the filter was then transferred through NRDC to M/s. Bhaskar Stoneware Pipes (Pvt.) Ltd., Faridabad.

The Ministry of Defence referred some problems in KM Bridge Girders for investigations. It is heartening to state that the recommendations made by the NML after detailed Laboratory investigations have been accepted and adopted for shop practice. In this context, Director-General, Ordnance Factories has stated. "The NML has done very good work of national importance in the field of aluminium alloy technology".

The NML had also several interactions with the small scale industry manufacturers. One such interaction was with the utensil industries for improving the product quality and increase in productivity. After carrying out the investigations, including the field demonstration, the rejection of the finished utensils with respect to the circles was reduced from the existing figure of 32% to about 9%.



Samples of Syrian iron ore examined by Prof. V. A. Altekar, Director and Scientists of the Ore-Dressing Division of the Laboratory

Another important area is in the development of filler wires for aluminium and its alloys. The filler wires have undergone extensive evaluations for repair welding of aluminium alloys including aircraft components. The process is now ready for commercial exploitation.

Yet another area of substitution of copper is the development of aluminium alloy bearing metal corresponding to class iv type of bronze. The performance of these bearings have been evaluated at Research, Design & Standards Organisation, Lucknow. The RDSO have informed that NML aluminium alloy bearings (PM 401) conform to their specifications and the RDSO have asked to produce even larger bearings.

Industrial inplant trials for the technologies for the production of high strength low alloy steels, calcium-silicide and clad steels have been planned at Bhadravati works of M/s Visvesvaraya Iron & Steel Works. In plant trials are underway with the active co-operation of M/s JEMCO, Jamshedpur ; on the NML developed technology of desulphurization of iron & steel.

The Laboratory has continued to carry out sponsored investigations on creep resistant steels for M/s Bharat Heavy Electricals Ltd. & Reactor Research Centre, Kalpakkam. On behalf of M/s Guest, Keen & Williams ; nickel-iron alloys having properties similar to Rho-metal. radio metal and HCR alloy have been developed and report submitted to the firm. Besides, sponsored investigations on failure problems of metals in thermal power plants, chemical & other industries etc, development of beneficiation process of ores and minerals, development of refractory materials, extractive and chemical metallurgical problems, preparation and supply of standard reference materials were conducted and in progress.

The extension Centres at Batala, Ahmedabad, Howrah and NML unit at CSIR Madras Complex continued to cater to the regional requirement and rendered the assistance needed. The activities at NML unit at Madras have since been expanded to include industrial and chemical metallurgical disciplines, beside augmenting its ore-dressing and mineral beneficiation facilities.

Dr. Rajendra Kumar, Scientist (in the grade of Director) represented NML as a Member of the Patratu Thermal Power Enquiry Committee constituted by Bihar State Electricity Board to enquire into the causes of failure of superheater header and other pressure parts of unit No. 8.

The Volume 1 of the Monograph on "Ores & Minerals of India —Beneficiation & Agglomeration Techniques for Industrial & Economic Exploitation" is nearing completion and will be published soon. A special colourful brochure depicting the Laboratory's R & D achievements and a special folder depicting the various assistance the Laboratory can provide were published.

A brief resume of the progress of the various projects and other activities has been furnished in the chapters that follow.

RESEARCH, INVESTIGATION & DEVELOPMENT PROJECTS

A. ORE DRESSING & MINERAL BENEFICIATION

1.0 Batch & Pilot Plant Beneficiation and Agglomeration Studies with Low Grade Oolitic Iron Ore Samples from Syria. *Sponsored by M/s. MECON.*

Batch scale studies have revealed that good quality sinter and pellets could be produced with concentrates obtained through various routes of beneficiation.

After successfully completing bench scale beneficiation and agglomeration studies, comprehensive pilot plant studies have been taken up on large tonnage of iron ore from Syria, with a view to setting up an Iron & Steel Complex through the aegis of M/s. MECON, India. This Syrian assignment has been obtained by M/s. MECON against a global tender.

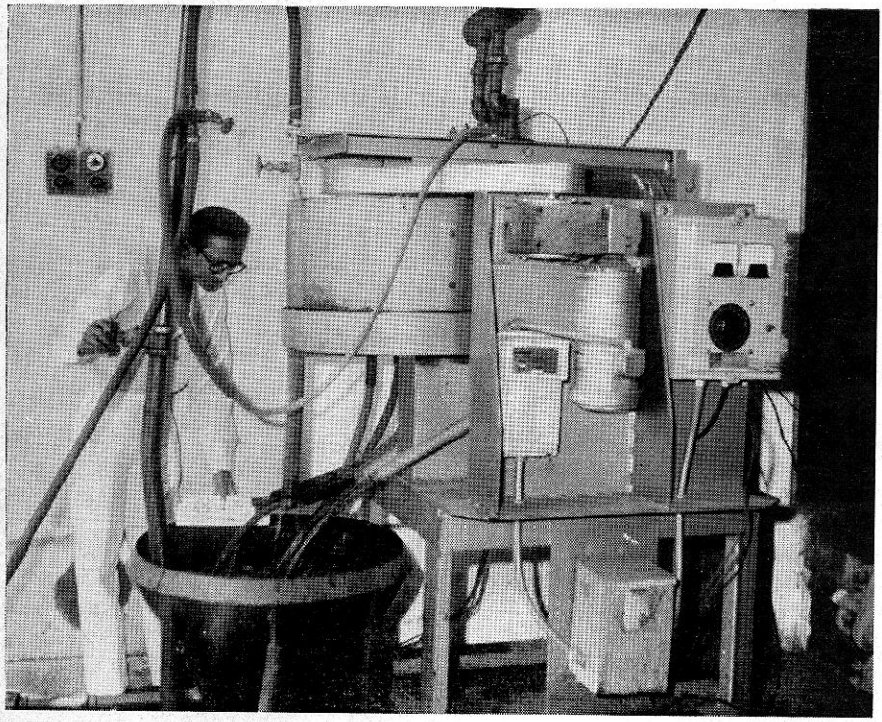
1.1 Beneficiation and Agglomeration Studies on Gandhamardan Iron Ores. Part I Beneficiation Studies. *Sponsored by M/s. MECON.*

M/s. Orissa Mining Corporation Ltd., Orissa ; have decided to develop Gandhamardan iron ore mines and setting up a pelletizing plant utilizing the iron ore deposits of Gandhamardan. M/s. MECON who were assigned by the firm to prepare the feasibility report have referred it to the laboratory for detailed studies on beneficiation and agglomeratlon with a view to obtain the various parameters needed for the purpose.

About 10 tonnes of lumpy iron ore of Gandhamardan mines were received for conducting beneficiation studies as per test schedules prepared by MECON. The samples as received consisted of 75 mm size lumps down to fines. The sample contained 64.0% Fe, 1.90% SiO_2, 3.52% Al_2O_3. MECON wanted a high grade lumpy product from the sample as well as high grade fines which would assay 66% Fe, 3.5% maximum silica plus alumina, to be used as pelletizing feed. The concentrates obtained were not upto the specifications laid down by the sponsors. Other data needed such as reducibility, thermal degradation, tumbling and abrasion indices, crushing strength, bulk densities of different products, etc. were determined.

1.2 Beneficiation and Agglomeration Studies on Gandhamardan Iron Ore Part II—Agglomeration Studies. *Sponsored by M/s. MECON.*

Agglomeration studies were undertaken for Gandhamardan iron ore fines obtained after scrubbing and washing lumpy material. For pelletizing studies, optimum parameters were determined with classified sand ground to different sizes. It was observed that in all the cases pellets of acceptable qualities could be produced, though the pellet characteristics were somewhat below the target stipulated by MECON.



High intensity wet magnetic separator in operation treating Syrian iron ore

Detailed sintering studies were also conducted with classifier sand with and without mixing the cyclone concentrate obtained after cycloning the slime. In both cases, sinters of acceptable grades could be produced. It was found that in the case of fluxed sinters, 1.5 basicity gave the optimum results.

2.0 Batch and Pilot Plant Beneficiation studies on Saladipura Pyrite Sample. *Sponsored by M/s. Pyrites, Phosphates & Chemicals Ltd.*

About 40 tonnes of pyrite sample from Saladipura, assaying 22.35% S were received for beneficiation studies.

Bench scale investigations indicated (i) tabling would produce a concentrate assaying 37.4% S with 61% S recovery, (ii) high tension separation followed by floatation would yield a concentrate analysing 35.7% S for a sulphur recovery of 93.8% in it (iii) straight froth flotation studies would yield a concentrate assaying 40.1% S with a recovery of 90.4% S in it.

Similar tests were conducted at M/s. Lurgi Laboratories at Germany and the results obtained were discussed at Germany between NML, Lurgi and M/s. PPCL and it was decided large scale pilot plant flotation studies following the optimum route would be conducted at NML. Work in this direction is in progress.

3.0 Bench Scale Beneficiation Studies on three Ferruginous Manganese Ore Samples. *Sponsored by M/s. Tata Iron & Steel Co. Ltd., Jamshedpur.*

Laboratory scale beneficiation studies were undertaken on three manganese ore samples, with a view to exploring the possibilities of upgrading the samples by ore-dressing methods, to yield concentrates suitable for ferro-manganese production. The samples as received analysed as follows :

		% Mn	% Fe	% SiO_2	% Al_2O_3
(i)	Low Grade Sample	18.15	31.64	9.22	8.50
(ii)	Low Grade Sample	26.9	27.67	3.20	5.09
(iii)	Medium grade	37.5	13.56	3.36	7.00

The first sample yielded a concentrate assaying 48.2% Mn with a manganese recovery of 53.5% and a Mn/Fe ratio of 6.34. Tests have been conducted on the other two samples and the assay results of the products are awaited.

3.1 Bench Scale Beneficiation Studies on a Sample of Manganese Ore. *Sponsored by M/s. Union Carbide Ltd.*

Bench scale beneficiation studies were carried out on a sample of manganese ore assaying 46.96% Mn, 74.32% MnO_2, 6.08% Fe, 3.46% SiO_2, etc. to explore the possibilities of upgrading the sample, by the physical beneficiation methods to yield a beneficiated product assaying 83.84% MnO_2, 2-3% Fe and 2-3% gangue, for use in dry battery manufacture.

A concentrate assaying 84.25% MnO_2, 2.9 Fe, 1.15% SiO_2 with a recovery of 53.5% MnO_2 in it was obtained. Further tests to improve the grade and recovery of MnO_2 did not improve the results.

4.0 Beneficiation Studies on a Chrome Ore Sample. *Sponsored by M/s. Ferro Alloy Corporation, Andhra Pradesh.*

The mixed run-of-mine chrome ore sample assaying 43.5% Cr_2O_3, 15.0% FeO, 19.73% SiO_2, 15.73% MgO, 7.45% Al_2O_3 and 0.68% CaO was subjected to bench scale beneficiation tests with a view to reducing the iron content to favourable limits so that the beneficiated product could be used for the manufacture of standard ferro-chrome.

Straight magnetic separation tests did not yield satisfactory results. Tabling after hydro classification followed by magnetic separation produced a chromite concentrate assaying 54.4% Cr_2O_3 and 17.94% FeO with a Cr_2O_3 recovery of 66.4% for a Cr/Fe ratio of 2.69.

4.1 Beneficiation Studies on Low Grade Chromite. *Sponsored by M/s. Hyderabad Asbestos Ltd.*

The chromite sample analysing about 10% Cr_2O_3 was subjected to a series of gravity concentration tests. The results are awaited.

5.0 Removal of Sand from South Bolanda and Jagannath Coal Samples. *Sponsored by M/s. Central Mine Planning & Design Institute, Ranchi.*

M/s. Central Mine Planning & Design Institute, Ranchi ; sent two coal samples, one from South Bolanda and the other from Jagannath coal mines to bring down the ash content to less than 26%, by conducting Humphery's Spiral tests in both the samples. Work is in progress.

5.1 Beneficiation of Coal Middling Samples from Nandan and Damua Colliery. *Sponsored by M/s. Central Mine Planning & Design Institute.*

Three coal middling samples from Nandan, Damua A & B inclines, Damua 5 & 6 inclines were received for bench scale beneficiation studies, for lowering their ash contents to less than 17% by employing flotation techniques so that the fines could be utilised for metallurgical purposes.

The samples as received were high in ash content, assaying between 32.57% and 38.0% ash. The results indicated that the ash content in the samples could be lowered to the specific limits 17% by forth flotation technique.

5.2 Recovery of Magnetite from the Dilute Medium contamined with Coal Fines and Shaly Matter from Kathara Colliery. *Sponsored by M/s. C.C.L., Ranchi.*

Laboratory scale studies were conducted for removing the contaminated coal and shaly material from the magnetic medium, from Kathara Washery. The sample assayed 50.8% Fe and over 10% fixed carbon.

Tabling with washed material yielded a table concentrate assaying 69.4% Fe with an Fe recovery of 87.7% in it. Flotation followed by a number of cleanings improved the grade of the concentrate to 69.89% Fe for an yield of 62.4% by weight. Washing followed by wet magnetic separation yielded a coal free concentrate of 69.8% by weight assaying 70.94% Fe. Semi-large scale trials with drum magnetic separation confirmed the above results.

6.0 Beneficiation of Low Grade Graphite Samples from Bhutan. *Sponsored by Royal Government of Bhutan.*

Three low grade graphite samples marked A, B & C were received for beneficiation studies. All the three samples had very low graphitic content assaying low in fixed carbon and high in ash content.

The sample A analysing 6-7% fixed carbon and approximately 84-85% ash content was taken up for bench scale beneficiation studies and it was observed that flotation followed by several cleanings would yield a product assaying 11-12% ash. Further work is in progress.

6.1 Beneficiation of a Low Grade Graphite Sample from Haryana. *Sponsored by Director of Industries, Govt. of Haryana.*

Beneficiation studies were carried out on a low grade graphite sample assaying 0.90% fixed carbon, 94.2% ash and 5.68% volatile matter. The sample was only a carbonaceous shale associated with quartz and mica with pratically no distinct graphite phase present in it. Tests conducted did not yield encouraging results.

7.0 Recovery of Barite from Calc-silicate Graphite Schist Sample Containing Cu-Pb-Zn Complex Sulphides from Dariba-Rajpura, Rajasthan. *Sponsored by M/s. Hindustan Zinc Ltd.*

A sample of calc-silicate graphite schist containing Cu-Pb-Zn complex sulphides from Hindustan Zinc Limited was received for barite recovery. The sample assayed 0.25% Cu, 1.20% Pb, 8.63% Zn, 4.03% Ba, 8.68% Fe, 13.75% S, 46.8% SiO_2 and 2.18% CaO-MgO.

Flotation studies at various grinds were conducted. The rougher barite float was refloated which after magnetic separation, assayed 42.1% Ba but with only 27.5% Ba recovery in it. In order to improve barite grade, the rougher concentrate was reground and refloated. Four cleanings followed by magnetic separation, yielded a cleaner concentrate with improved grade of 48% Ba but with only 26.6% Ba recovery in it.

8.0 Beneficiation Studies on a Low Grade Fluorspar Sample from Chandidungri Mines, Madhya Pradesh. *Sponsored by M/s. Madhya Pradesh & Maharashtra Minerals & Chemicals (P) Ltd.*

Studies were made on the beneficiation of a low grade fluorite sample from Chandidungri mines with a view to produce a concentrate assaying 96% CaF_2 for use in acid manufacture. The sample, as received, analysed 30.06% CaF_2, 66.1% insolubles.

Washing the r.o.m. ore followed by separate flotation under optimum conditions of the sand and slime, yielded a combined cleaner concentrate assaying 96.28% CaF_2, 1.52 insolubles for an overall recovery of 54.5% CaF_2 in it. Another concentrate of a lower grade, analysing 85% CaF_2 with an additional CaF_2 recovery of 12.5% was also obtained besides the acid grade concentrate. This could be suitable for metallurgical use.

Based on the bench scale results, a flow-sheet for upgrading the sample has been recommended. Specifications of equipments for the proposed fluorspar beneficiation plant of capacity 36 tpd to produce acid grade concentrate have also been separately furnished to the sponsors.

9.0 Further Flotation Studies (Bench Scale) on Low Grade Fluorspar Sample from Chandidungri, M.P. using Mines Water. *Sponsored by M/s. MPMMC.*

An desired by the sponsors, a few bench scale flotation tests under optimum conditions were conducted on the fluorite sample from Chandidungri mines employing mines water at site with a view to study its effect on beneficiation. The flotation results indicated that by suitably controlling the pH, a fluorite concentrate assaying 96% CaF_2 could be obtained with more than 50% CaF_2 recovery in it.

Most of the equipments for the proposed 36 tpd flourspar beneficiation plant have been ordered by M/s. MPMMC(P) Ltd., and it is expected that the plant would be commissioned as soon as all the equipments are received in site and installed.

10.0 Beneficiation of Low Grade Apatite from Beldih Mines, Purulia District. *Sponsored by West Bengal Mineral Development & Trading Corporation.*

The sample of apatite from Beldih mines assayed 31.0% P_2O_5 with 8.75% Fe. The investigation was conducted to lower the iron content to the specified limit for use in super phosphate manufacture. The beneficiation studies indicated that by a combination of forth flotation and high intensity magnetic separation, an apatite concentrate 38.0% P_2O_5 with less than 2% Fe could be obtained from the sample.

11.0 Bench and Pilot Beneficiation Studies on Kyanite-Sillimanite Sample from M/s. Maharashtra State Mining Corporation. *Sponsored by M/s. Development Consultants (P) Ltd.*

Bench scale beneficiation studies are in progress. Pilot plant trials would be started after completing the bench scale studies on the sample.

12.0 Bench Scale Beneficiation Studies on a Low Grade Run of Mine Wolframite Sample from Agargaon Deposit, Maharashtra for M/s. Maharashtra State Mining Corporation Ltd. *Sponsored by M/s. M. N. Dastur & Co. (P) Ltd., Calcutta.*

Bench scale beneficiation studies were carried out with a low grade run of mine wolframite sample from Agargaon deposit, Maharashtra. The

aim of the investigation was to explore the possibilities of upgrading the ore by ore-dressing methods to yield high concentrate consistent with high recovery.

The sample as received assayed 0.07% WO_3, 12.35% Fe_2O_3, 11.84% Al_2O_3, 56.49% SiO_2. Large scale tabling test followed by several cleanings produced a table concentrate assaying 29.01% WO_3 with a low recovery of 18.5% WO_3 in it. This table concentrate when subjected to magnetic separation yielded a magnetic fraction assaying 60.37% WO_3 with only 13.8% WO_3 recovery. Extensive studies employing various techniques to improve the recovery of WO_3 in the concentrates, did not yield encouraging results.

13.0 Physical Characteristics and Petrological Studies of Copper Ores from Khetri and Kolihan Mines of M/s. Hindustan Copper Ltd. *Sponsored by M/s. Engineers India Ltd., New Delhi.*

Petrological studies, crushing strength, Bond's Work Index and grindability studies on copper ores (lumps) of Kolihan and Khetri Mines of M/s. Khetri Copper Complex (HCL) were conducted.

Work indices for the copper ore samples from Kolihan and Khetri mines were determined in accordance with the test procedure developed by F. C. Bond of M/s. Allia-Chalmers. The indices were determined as 13.62 and 12.78 KWH/tonne respectively for the samples from Kolihan sample which was harder of the two.

Petrological studies indicated more or less similar lithological groups and mineral association in both the samples. Chalcopyrite, cubanite and valerite were the copper minerals, while pyrrhotite was the main metallic sulphide associate. Quartz and chlorite were the predominant non-metallic gangue constituents. The liberation size of the metallics from the silicate gangue would be about 100 mesh in both the cases. Kolihan sample was more enriched with chalcopyrite than Khetri sample.

14.0 Determination of Crushing Strength of Limestone Sample of M/s. Malabar Cements Ltd. *Sponsored by M/s. MacNally Bharat Engineering Co. Ltd.*

At the instance of M/s. MacNally Bharat Engineering Co. Ltd., Kumardhubi ; crushing strength on a limestone sample (lumps) was conducted. These data were needed by the firm for designing of crushing equipments for one of their cement projects in which the limestone is to be used as raw material. The crushing strength was found to be more or less uniform and ranged between 430 kg/sq. cm. and 470 kg/Sq. cm.

15.0 Petrological & DTA Studies on Ores and Minerals.

Detailed petrological, differential thermal analysis and physical characteristics studies were carried out on 20 samples of low grade ores and minerals received for beneficiation and other investigations.

B. REFRACTORY TECHNOLOGY

16.0 Development of High Alumina Refractories using Kyanite and Technical Alumina.

During the period under review, few quarter size bricks of 85% alumina content were made from thoroughly prepared mix of graded dense sintered alumina grog and calcined kyanite grains. These samples were fired at 1680°C for a soaking period of 4 hours and their sintering parameters studied. Certain physico-chemical and machanical properties of fired samples were determined and compared with similar imported products. It was found that the properties of NML developed 85% alumina samples compared well with that of imported ones. The values of apparent porosity varied from 18-20% and the bulk density varied from 2.75 gm/cc. The project was completed on laboratory scale. The know-how is ready for the transfer of technology.

17.0 Development of Synthetic Carbonaceous Product as Substitute for Petroleum Coke and Anthracite.

Experiments were made with raw materials such as a blended coke from CFRI, a coal from Bhowrah colliery, a coal from Assam and foundry coke. Several compositions were prepared and their properties in the green state were determined. Calcination studies of the properties of the clacined sample is in progress after which the evaluation will be made.

18.0 Development of Carbon Bricks for Chemical Industry.

From the study of the earlier experiments using different grades of dense carbon aggregate and different binder percentage, two specific compositions with optimum properties were chosen. Full size bricks of these compositions were formed by hydraulic pressing to study the reproducibility of the properties. These bricks were fired and the fired properties are being studied. Similar work on making the new body compositions based on calcined petroleum coke are also in progress.

19.0 Carbon Refractories—Testing of Binders.

The properties e.g. proximate analysis, solvent extraction, etc. of one sample of pitch obtained from Bhilai Steel Plant was studied. Arrangements for making different composition of carbon bricks using dense carbon aggregate as the base material and using the different varieties of tar and pitch as binder are in progress.

20.0 Studies on High Temperature Castables suitable for 1450°C to 1700°C.

In continuation of the previous work done, the specimen made by mixing high alumina cement and corundum aggregate fractions incorporating moisture, were fired at different temperature in globar furnace and down draft kiln. The physical properties like apparent porosity, bulk density, reheat shrinkage, etc. were studied. Further work is in progress

21.0 Development of Low Density and Low Iron Insulating Bricks.

A number of compositions were analysed and their green and fired properties were studied. A graphical representation of these properties against composition projects a suitable composition, which have excellent insulating bricks when fired at 1400°C and 1450°C.

22.0 Development of Graphite—Silicon Carbide Crucible.

The experiments for making large size clay bonded graphite-SiC crucible which Laboratory was making in collaboration with a manufacturer are now showing good results. Earlier experiments were not satisfactory as the crucibles were cracking. After suggesting certain modification, the crucibles are reported to be free from initial cracking. Further trial is in progress.

23.0 Development of Sub-merged Arc Welding Flux.

Based on weld metal analysis some compositions were further modified and are being prepared. Some of the compositions prepared earlier are being tested for bead-on-plate test.

24.0 Suitability of Indian Sea Water Magnesia for Refractory use (Inter-Laboratory Project)—NML & Central Salt & Marine Chemicals Research Institute, Bhavnagar.

Some preliminary exploratory work which was carried out on a supply of 50 kg of sea water magnesia supplied by CSMCRI show that dense dead burnt magnesia can be obtained by firing the sea water magnesia at 1700°C. The chemical analysis of the dead burnt product also showed a decreasing tendency of B_2O_3 content of the dead burnt product. As the sample was not sufficient to carry out further work more quantities are being obtained from Central Salt & Marine Chemicals Research Institute.

25.0 Utilization of Low Grade Magnesite from Salem.

A sample of about 100 kg of beneficiated concentrated magnesite from Salem was obtained to study the suitability of the concentrate for making dead burnt magnesia. The original magnesite contained about 6.7% SiO_2 and after beneficiation by flotation the sample contained 2.18% silica. The concentrate was in a finely ground condition. The material was made into small cylindrical briquettes and fired. The dead burnt material attained a bulk density of 3.15 gm/cc and 3.25 gm/cc at 1600°C and 1700°C respectively. The corresponding porosities are 6.8-8.3% and 4-6% respectively.

26.0 Investigation and Tests Conducted on behalf of Industries & Organisations.

Nature of Work	*Sponsor*
(*i*) Exploratory findings of (a) High alumina castable (b) Clay-graphite stopper head (RS 301) Morgan Norter.	SAIL (R & D) Ranchi.

(c) Permanent basic ramming wicks.

(*ii*)	Thermal conductivity test on acid resistant bricks	M/s. Engineers India.
(*iii*)	Reactivity of limestone	SAIL (R & D) Ranchi.
(*iv*)	Calcination reactivity and physical properties of limestone sample.	SAIL (R & D) Ranchi.
(*v*)	Studies on fireclay samples	M/s. Dr. V. S. Krishna Ceramic and Potteries, Rajahmundry.
(*vi*)	Utilization of high alumina slag for refractories.	M/s. Thermal Alloys (P) Ltd., Shimoga.
(*vii*)	Test report on acid proof bricks.	M/s. Kaycee Ceramics, Ranchi.

C. EXTRACTION & CHEMICAL METALLURGY

27.0 Extraction and Recovery of Nickel and Cobalt from Lateritic Nickel Ores—Large Seale Testing of NML Process (All India Co-ordinated Project).

This is an All India Coordinated Project where NML and RRL, Bhubaneswar ; are collaborating. During the year, about eight to nine tonnes of ore & coal were ground and mixed in proper proportion.

28.0 Treatment of Complex Ores for the Recovery of Copper, Lead, Zinc and Sulphur Values, (All India Co-ordinated Project).

This project is an All India Coordinated project in which the following participants are involved.

(*i*) Regional Research Laboratory, Bhubaneswar.
(*ii*) National Metallurgical Laboratory, Jamshedpur.
(*iii*) Indian Bureau of Mines, Nagpur.
(*iv*) Engineers India Ltd., New Delhi.
(*v*) Central Electrochemical Research Institute, Karaikudi.

During the period, static bed roasting experiments were completed on samples of concentrates from Ambamata and Deri. Based on these studies, work is in progress on a 5 cm dia. fluidised bed reactor.

29.0 Extraction and Recovery of Copper and Nickel from Bulk Copper-Nickel Sulphide Concentrates.

Laboratory scale experiments were completed on the electrothermal smelting of the concentrates to produce high grade copper-nickel matte and the leaching of the matte. Purification of the leach liquor and the recovery of nickel is in progress.

from Chukha, Bhutan. *Sponsored by Geological Survey of India, Bhutan.*

Leaching studies on 25% zinc containing ores were completed and further studies were made on recovery of zinc and lead. Report based on the above work was submitted to G.S.I., Bhutan circle. In the meanwhile fresh representative average grade samples were received on which extraction work is in progress.

31.0 Recovery of Vanadium from Sodium based Vanadium Sludge of Alumina Industry.

The two tonnes sludge treatment plant of M/s. Rare Metals & Chemicals, Ranchi ; which was designed by NML scientists was commissioned in November 1979, NML has provided advisory-cum-consultancy services for the establishment of the plant. Further studies are in progress for the recovery of chemicals from effluent of this plant.

32.0 Recovery of V_2O_5 from Vanadium bearing Slag of M/s. VISL, Bhadravati.

After completion of laboratory scale experiments on VISL slag, trials on 3 kg & 10 kg slag were conducted in details to obtain process & design data. Further trials on 10 & 50 kg basis are planned.

33.0 Purification of Molybdenite Concentrate Suitable for Making Ferro-Molybdenum.

Laboratory scale studies were completed and large scale trials on 1 kg, 2 kg, 3 kg & 5 kg basis on concentrates were completed during the year. 10 kg trials is in progress.

34.0 Setting a One Tonne per day Plant for Ferro-Tungsten at Central Research Organisation, Burma through NRDC.

This project has been taken up as a turnkey project with NRDC to be transfered to CRO, Rangoon, Burma. The layout design etc. has been completed and specifications of the equipment have been worked out. Quotations for the equipment are being invited through NRDC and the time bound programme for the establishment of the plant is maintained.

35.0 Electric Smelting of Dolomite for the Production of Magnesium.

This work was undertaken with a view to develop cheaper process for the production of magnesium metal by electric smelting route. The unit has been designed by NML scientists. Erection and assembly of the unit has been completed. Watercooling and vacuum connections are being given. The charging unit for charging raw materials under vacuum is yet to be received. After its receipt & installation and electrical connection given, the unit will be ready for commissioning.

36.0 Extraction of Tin from Bastar Concentrate.

Preliminary investigations were carried out on the extraction of tin from tin ore concentrate from Bastar district of Madhya Pradesh, with 98% recovery

of tin by a single stage direct smelting process. The metal after remelting was having a purity of 99.8%. Large scale studies are planned.

36.1 Improved Process for the Recovery of Tin from Tin Scruff.

A process for the recovery of tin from tin scruff obtained from M/s. Tin-Plate Co. of India Ltd., Jamshedpur, has been developed and is in the stage of transfer of technology to the Tinplate Co. through NRDC.

37.0 Recovery of Lead from Battery Scrap.

At the instance of Metals Preserving Committee of D.G.T.D., work has been taken up on this project with a view to establish a know-how for the benefit of the small smelters of battery scrap. Preliminary trials on half kg scale were conducted and optimum conditions were established for maximum recovery of lead.

38.0 Production of Aluminium-Silicon Alloys.

Preliminary bench scale experiments were conducted in a 50 KVA submerged arc furnace with a kyanite containing 48% Al_2O_3. An alloy containing 35% aluminium was produced.

39.0 Recovery of Metallic values by Bacterial Leaching (Inter-Laboratory Project).

The following Laboratories of CSIR are involved :

(*i*) National Chemical Laboratory, Pune.
(*ii*) National Metallurgical Laboratory. Jamshedpur.
(*iii*) Regional Research Laboratory, Bhubaneshwar.
(*iv*) Central Mining Research Station, Dhanbad.

The proposal of these CSIR Laboratories for conducting fields trials at Mosaboni, Hindustan Copper ; was not accepted by HCL and therefore there is no further work going on in this project.

40.0 Recovery of Copper, Nickel, Lead, Zinc and Elemental Sulphur from Complex Sulphide Mineral Concentrates.

Optimum conditions of leaching maximum recovery of the metallic values and elemental sulphur were determined with regard to (i) a low grade copper concentrate from Ghatsila, (ii) Sikkim complex copper concentrates (iii) copper-nickel concentrate from Uranium Corporation of India Ltd., (iv) Agnikundala lead concentrate.

Conditions of electrolysis in a double compartment cell with insoluble anodes for recovery of copper with simultaneous oxidation of ferrous to ferric iron in the anode chamber were systematically studied. Electrolysis of lead chloride in a solution of sodium chloride was studied with regard to optimum current density, temperature, concentration of electrolyte, etc.

Leaching of concentrate from Ambamata and Deri in a solution of ferric chloride has yielded good recoveries of the metallic values and elemental sulphur which indicates the preliminary feasibility of the leaching process. Electrolysis of the leached solution for recovery of metallic values under various conditions is in progress to evolve a suitable flow sheet and evaluation of its economic feasibility.

41.0 Studies on Processing of Sulphide Concentrates—Recovery of Metallic values directly from Complex Lean Concentrate / Ores.

Various types of additives at different temperatures were carried out using 160 gm/batch. The modification over the existing process for sulphation roasting successfully completed. The calcine was treated with water and the leach liquor obtained was purified and subsequent crystallisation yielded a copper sulphate product conforming to ISI specification. Specification of equipment for large scale operation were drawn up for treatment of 15-20 kg per batch.

On the basis of the sulphatisation know-how developed using copper concentrates from Chitradurga, exploratory work is under progress for utilising low and complex copper sulphide concentrates from Sikkim. Initial work indicated that for low temperature sulphatisation, certain impurities viz. Pb & Zn should be removed as much as possible so that these do not produce any trouble during sulphatisation or subsequent crystallisation. Further work is under progress.

Complex Cu-Ni sulphide concentrate under optimum sulphatisation conditions studied, gave a recovery of about 93% Cu and 56% Ni as water soluble products. The leach liquor is contaminated with high iron. Further work is under progress to increase the recovery of Ni and to reduce the iron content in the leach liquor.

42.0 Utilization of Ferrous Sulphate for Production of Pigment Grade Iron Oxide.

Optimum conditions for production of red ferric oxide by thermal decomposition were determined. An overall recovery of 95% with a ferric oxide content of over 99% was obtained. The product meets the ISI specification very closely. 2 kg samples of red ferric oxide produced has been sent to pigment and paint industries for evaluation of its pigment properties. Studies are under progress for production of yellow ferric oxide by precipitation technique.

43.0 Preparation of Fluorine Chemicals.

The fluoboric acid cryolite process developed on 100 kg/batch scale was evaluated and found to be technically sound and economically viable. The cryolite obtained by this process was tested in aluminium production cells by M/s. Indian Aluminium Company and was found suitable for use in aluminium industry.

In continuation of the work on the production of cryolite at 100 kg per batch scale ; experiments were carried out by recycling the process liquor. The over all fluorine recovery obtained was 86.2%. The objective of carrying out these experiments was to ascertain whether the process liquor can be recycled without hampering the fluorine recovery efficiency.

Work was also undertaken on tonnage scale on five tonnes sample of GMDC fluorspar. The fluorspar contained Fe_2O_3 -0.72% and P_2O_5 -0.20%. Half a tonne of this fluorspar was purified by subjecting the fluorspar to the selective leaching technique, thereby reducing the Fe_2O_3 and P_2O_5 contents of the fluorspar to 0.20% and 0.045% respectively. Further work is in progress.

44.0 Development of New Electrodes for Electrolytic Manganese Dioxide Process.

Lead content of electrolytic magnanese dioxide deposited on lead-antimony anodes will increase with repeated cycle of deposition and consequent roughness of the anodes. As such, the lead-antimony anodes have to be recast after 2-3 cycles of operation. It is intended to examine titanium and similar other anode materials to avoid lead contamination of the deposited MnO_2 . Surface preparation of such anodes also requires to be examined.

Titanium anodes with different surface conditions were examined for deposition of electrolytic manganese dioxide. Excellent deposits of electrolytic manganese dioxide were obtained on two differently processed surface with high current efficiancies. The electrolytic manganese dioxide contained 93-94% MnO_2 with a battery activity index of 71.6.

45.0 Production of Metal Powder.

Licencee M/s. Nalco Metal Products Ltd's plant for making aluminium and zinc powders was ready for commissioning and awaits power supply.

R & D work on coated aluminium powders for explosive slurries was planned while work on making aluminium pastes for pigments was continued.

46.0 Production of Distilled Zinc Dust.

Trials with an existing transformer to energize a resistor furnace designed in the laboratory for zinc distillation were conducted. Investigations proved the feasibility of the process but the transformer capacity was not adequate. It is planned to procure a suitable transformer. Fabrication of coke-bed resistance furnace was started for zinc vaporization.

47.0 Hydro-Electro Metallurgical Project

The construction of security gate lodge and other infrastructural facilities at the site continued to progress. Due to the high escalation of costs, it was not possible to start construction of the main process bays. Proposals are being drafted for covering escalated costs for approval by the Governing Body, CSIR.

D. IRON & STEEL TECHNOLOGY

48.0 Use of Sponge Iron as Steel Scrap in Steel Manufacture.

The studies on the mechanical properties of the wires drawn from the two high carbon industrial heats using 40 percent sponge iron in the charge, were completed and the report prepared.

49.0 High Strength Low Alloy Steel.

In continuation of the previous work on high tough vanadium-nitrogen steels, six 10 kg heats of steel were prepared containing C—0.06%, Mn—1.5%, V—0.12% with nickel in the range of 1% to 8%. These ingots are being forged into bars.

Negotiations have been made with Visveswaraya Iron & Steel Limited, Bhadravati ; for carrying out industrial scale trials on high strength low alloy steels at their plant.

50.0 Production of Martensitic Steel Grade AE-961 for Aircraft in Electric Arc Furnace. *Sponsored by M/s. Firth India (P) Ltd. for Hindustan Aircraft Ltd., Koraput.*

Martensitic stainless steel having rigid chemical specification with regard to ten constituent elements and conforming to aircraft quality grade was successfully melted in the 9.8T electric arc furnace and cast into 450 kg. cylindrical ingot for HAL (Koraput). The ingot is under going further processing at Firth India before being put in use for making aircraft engine components at HAL. Further heats are being planned to standardise the technology.

51.0 Development of Titanium bearing High Strength Low Alloy Steel.

The work on Ti-high strength low alloy steels indicated achievement of strength values considerably higher (by 20% to 40%) than hetherto obtained with HSLA steels commercially available in India. In spite of increased strength the material shows adequate ductility. In view of the encouraging results obtained, other relevant properties like toughness, weldability are also being looked into.

52.0 Development of Special Iron.

(*i*) Development of Briquetting Mix for Desulphurization of Hot Metal and Steel.

(*ii*) Development of Synthetic Compounds for Desulphurization of Hot metal.

Laboratory scale work on both are over. No. (i) is undergoing in-plant trials in M/s. JEMCO and feed back data are reviewed for suitable improvements and modifications for the process and the equipments. Regarding No. (ii) the process is awaiting in-plant trial.

53.0 Reduction of Oxide Concentrates for Alloying.

The possibility of reducing oxide concentrates of V & Mo directly in the molten bath, thus by-passing ferro-alloys additions, which is necessarily more expensive, was explored. Briquettes, exothermic in nature, consisting of oxide concentrates, reductants and fluxes were made and the extent of metal recovery when added to induction furnace melts was explored. Metal recovery to the extent of 85 to 95% and 90 to 97% was recorded for V and Mo respectively. Several possible chemistries for the briquettes were tried and the process parameters were standardized. Laboratory scale work is now completed and attempts are being made for industrial trial.

E. DEVELOPMENT & STUDY ON ALLOYS

54.0 Development of Aluminium Cables & Conductors—Electric Grade Aluminium Alloy NML-PM2.

The technology for the production of versalite electric grade aluminium alloy 'NML-PM2' was successfully transfered to M/s. Universal Cables, Satna—the fifth licencee in series through the NRDC in Nov. 1979. Even prior to this technology transfer, M/s. Universal Cables Ltd. Satna ; possessed considerable experience with the processing of NML-PM2 from the wire rods procured from other licencees and were manufacturing welding cables.

Based on the new concept of the "Steel supported annealed NML-PM2 conductor" the Rural Electrification Corporation, New Delhi ; has placed an order for 30 km of annealed NML-PM2 ACSR conductor (Squirrel) to M/s. Indian Aluminium Cable Ltd., Faridabad ; for evaluating the concept through field trials. Successful annealing and processing trials of the annealed NML-PM2 steel reinforced conductor were conducted at M/s. IACL works at Faridabad under the supervision of NML Scientists.

The Railway Board, after successful trials, on the use of NML-PM2 aluminium alloy conductor in railway signalling cables, have requested the various zonal railways i.e. Central, Eastern, South—Eastern and Western Railways to procure 3 kg of the signalling cables from NML-PM2 according to their specifications for further trials for a period of one year. These will be installed for operation of motor operated points, colour light signals etc. on one of the trunk/main lines routes in continuous stretches for proper monitoring. The procurement of the cables will be done by Railways with the involvement of NML to meet their rigid specifications.

54.1 Study on the Effect of Alloying Additions and Heat Treatment on the Mechanical Properties of Wrought Al-Si Alloys.

An aluminium alloy designated NML-PM215 has been developed to produce alloy aluminium conductor with compatible ductility. The alloy holds potential for making grooved contact wire in railway electrification. Studies were carried out to further improve the properties particularly electrical conductivity of NML-PM215 to meet the requirement of grooved contact wire. Electrical conductivity of 53% IACS has been achieved in the heat

treated conditions. In order to suit the design requirement of grooved contact wire, studies on welding characteristics of NML-PM215 extruded rods to get a continuous length of 1.6 km are in progress.

55.0 Development of Aluminium base Bearing Alloy.

Based on the results of preliminary field trials, modifications were made to the casting technology and a new set of floating bushes were made for further field trials using alloy of PM 401. Field trials were carried out at the Gonda shed of N.E. Railway by R.D.S.O. The performance of the bushes, used in place of conventional bronze bushes was found to be satisfactory. RDSO, Lucknow ; has requested the laboratory to supply more bushes for trials on different types of locos. Work is in progress.

56.0 Methods to Improve Mechanical and Physical Properties of Aluminium & its Alloys.

The process for the manufacture of reactive filter media was transfered to M/s. Bhaskar Stoneware Pipe Ltd., Delhi. Industrial trial with the reactive filter was carried out at Electrical Manufacturing Company, Calcutta and at HAL Koraput. Further quantity of filter media was prepared for firing.

57.0 Development of High Strength Aluminium Alloy for Aircraft Application. *Sponsored by M/s. Hindustan Aircraft Ltd., Koraput.*

Developmental work on the alloy AK4 for the HAL, Koraput ; was carried out on bench scale. After establishing the melting procedures, large scale heats of 200 kg were made. The ingots were machined in the laboratory and extruded at Ordnance Factory, Ambajhari and sections sent to HAL for evaluation. Whilst the mechanical properties conform to AK4 (imported), the chemical composition has been reported to be not in keeping with AK4 in so far as Cu & Ni are concerned. Further work is in progress.

58.0 Studies on High Strength Weldable Al-Zn-Mg Alloys.

As a part programme under this project, the following studies were carried out at Ordnance Factory, Ambajhari ; during the extrusion of C 21/51 alloy.

(i) Measurement of temperature rise of billets and container during extrusion, (ii) effect of cooling rate on the retention of fibrous structure in KM bridge girder (iii) welded samples (b) conventionally stress relieved samples (c) stress relieved by formula 62 at Ordnance Factory, Jabalpur.

The above studies were completed and the investigation reports prepared.

59.0 Development of Aluminium Alloy Electrode Wire.

(i) Large quantities of NML-PM6 welding filler wire as per BS 2901 and IS 1278-NG6 and NML-PM7 welding filler wire (16 SWG, 10 SWG) were made and supplied to M/s. HAL Bangalore to meet their requirement and for product evaluation.

(ii) Welding filler wires corresponding to NG 61 (Grilumin) were also made and sent to Ordnance Factory, Ambajhari ; for evaluation and field trials. The tensile strength achieved on the welded specimens ranged from 28 to 31 kg/mm^2.

(iii) The development of two grades of aluminium base welding filler wires and one grade of low carbon steel filler wire is under progress. Alloys were made and processing parameters are under study.

60.0 Grain Refinement of Wrought Aluminium Alloys.

Direct chill cast commercial Al-1.25% Mn alloy was subjected to different thermal treatments and their effect was studied using optical microscopy and electrical resistivity techniques. Hot and cold rolling of the alloy with and without thermal treatment was carried out and kinetics of recrystallization are being investigated. A modified electrolyte composition has been developed for electrolytic etching of the specimens and the operating parameters were optimised.

61.0 Fracture Studies on High Strength Aluminium Alloys.

Based on the literature survey, a review paper on fracture toughness was prepared.

62.0 Development of Thermostatic Bimetals.

A series of experiments were carried out to standardise the process of production of high sensitive thermostatic bimetals of invar/maganese alloy combination. The process was standardised and some samples of the bimetals were made and sent to various industries for evaluation of the properties. The test results obtained by the industries are quite satisfactory and satisfy the standard specification. Since the production technology has been developed and all the related parameters has been studied, the prjoect has been completed. Final report is under preparation.

63.0 Development of Clad Metals.

During the period, the technology of production of copper clad steel was developed and with this the phase development on the project on clad metals has been completed. The technical know how of the production of copper clad aluminium has been licenced to an industry for commercial exploitation. Negotiation is in progress for commercial exploitation of stainless steel clad mild steel.

63.1 Development of Stainless Steel Clad Aluminium Sheet.

Further work was carried out to roll-bond very thin sheets of stainless steel over a thicker aluminium sheet and to obtain a ductile clad sheet of stainless steel and aluminium. After making several experiments to control the deformation of stainless steel a solution was reached and by introducing a retainer, the deformation of stainless steel was controlled and finally a ductile product was obtained. The ductility of the roll-bonded stainless steel

aluminium clad sheet is suitable for various forming operations. Several samples were successfully bonded and tested for ductility. Further work is in progress.

63.2 Development of Duplex Shear Blade.

Few heats of Cr-V-Mo and high carbon steel were made. These were hot worked and hot roll-bonded with thicker mild steel backing plate to get the duplex shear blade. Other methods of getting the duplex properties at the two opposite surfaces was tried. Heat-treatment schedule and property evaluation of both the processes are being studied.

64.0 Production Technology of Contact Material.

(*i*) *Copper—Chromium Alloy.*

The copper-chromium alloy containing upto 1% chromium is widely used in electrical industries as electrical contacts owing to its good electrical conductivity, resistance to wear, hardness, etc.

Experiments were carried out to standardise the heat-treatment schedule for obtaining required properties. The hardness and conductivity after proper heat-treatment were found to be as per Indian Standard Specification. The Laboratory scale experiment is completed. Arrangements are being made for carrying out the service trials at TISCO.

(*ii*) *Pure Silver Contacts.*

Several heats were made to standardise the melting procedure. In order to get better surface finish of the cast metal, different techniques were adopted for mould dressing and subsequent treatments. From the study of the cold reduction and annealing treatment, the optimum percentage reduction was determined for obtaining a desired hardness of the contacts.

M/s. Vema Industries in Bhopal has shown their keen interest in this project. They are supplying pure silver contacts after brazing them with the carriers to M/s. Bharat Heavy Electricals Limited. M/s. Vema Industries are procuring these contacts from outside party. They are now interested to manufacture the contacts with NML technology.

F. DEVELOPMENT OF MAGNETIC MATERIALS ..

65.0 Development of High Permeability Nickel-Iron Alloys.

Sponsored by M/s. Guest, Keen & Williams Ltd.

Nickel-iron alloys having properties similar to Rho metal, Radio Metal and HCR alloy have been developed and the report pertaining to the development of these alloys has been submitted to M/s. GKW.

In order to get rectangular hysteresis loop and max. permeability in HCR alloys, cold rolling upto 97%, annealing and magnet annealing were carried out. Rectangularity of the order of 0.8 has been achieved. Further work to increase the Br/Bs ratio and maximum permeability in this alloy is in progress.

66.0 Development of Permanent Magnets based on High Crystal Anisotropy and Exchange Anisotropy.

Several misch metal-cobalt heats were made in argon arc melting furnace. The alloys after crushing, milling in petroleum ether & pressing under magnetic field were sintered in argon. The problem of getting well sintered products encountered earlier was overcome and alloy with a density of 90% of the theoretical density has been obtained. Further work on the sinterability of the alloy is being studied by the addition of small amounts of sintering additive.

The sintered alloys exhibited permanent magnet characteristics. Efforts are underway to improve the magnetic properties by giving heat treatment to the sintered alloy. The analysis of the alloy is also being done from x-ray diffraction and metallographic studies.

67.0 Structural, Magnetic and Deformation Characteristics of Mn-Al system.

About 12 heats of Mn-Al-C with varying amounts of Mn, Al and C and also with small additions of Ni were made in air induction furnace. The alloys after homogenisation were analysed by x-ray diffraction and metallographic studies. The alloy specimens were heat treated at 500°, 600°, 650° and 700°C for different durations to obtain optimum magnetic properties. The base properties obtained are Br=2800, G Hc=1220 Oe, and (BH) max=1.2 MG0e. The work on the preparation of anisotropic magnets by warm extrusion is being taken up.

68.0 Low Carbon Soft Magnetic Iron.

16 mm dia hot rolled rods of NML-low carbon soft magnetic iron manufactured at M/s. Telco and processed at Indian Ordnance Factory (Metal & Steel Factory, Ishapore) were further processed to 14 mm dia. by cold drawing at M/s. Steel Rolling Mills of Hindustan, Calcutta. The cold drawability of the material was established.

The programme of processing 65 mm sq. billets from the industrial heat of NML-low carbon soft magnetic iron to 10 mm dia. hot rolled rods and cold drawing to 9 mm dia. has been negotiated with the industry for the requirement of an performance evaluation at Indian Telephone Industries Bangalore.

G. TESTING OF MATERIALS

69.0 Central Creep Testing Facility.

During the period, work on the following projects was conducted.

(*i*) *Development and Testing of Creep-resistant Steels. Sponsored by M/s. Bharat Heavy Electricals Ltd.*

During the period, the long-term creep evaluation of the steels reported previously is in progress. Some additional grades of creep quality steels were also received for short-term and long-term evaluation of high temperature properties. The list of steel currently under evaluation are :

Steel Grade	*No. of Casts being tested*	*Total No. of Casts to be tested*
BOLTING STEEL		
(i) 1 1/4 Cr 1Mo 3/4V-TiB	3	3
(ii) 1 1/4 Cr 1/2Mo (En-20B)	3	3
(iii) 1 Cr 1Mo 1/4V DIN 17240 (21 Cr Mo V57)	2	4
TUBING STEEL		
(i) 2 1/4 Cr 1Mo	6	8
(ii) 1 1/4 Cr-1/2 Mo	1	3
(iii) 1 Cr-1/2 Mo (Forgings)	2	4
CASTING & FORGING STEEL		
(i) 1 Cr 1Mo 1/4V (FOV) (Castings)	8	8
(ii) 1/2 Cr 1/2 Mo (0.5 FO) (Casting)	3	3
(iii) 1.4 Cr-1 Mo 1/4V (1.4 FOV) (Forging)	1	—
(iv) 1 FO4/15XM (1 Cr 1/2 Mo) (Forging)	1	—

An assessment report on the above grades of steels has been submitted to BHEL. The long-term tests on the above grades of steel are under progress.

The test results available to-date in respect of each grade of steel have been compared to the available international data wherever possible. The comparison showed that the steel produced in India have properties as good as those produced abroad.

(*ii*) *Creep-rupture Testing of AISI-316 Grade Stainless Steel. Sponsored by Reactor Research Centre, Deptt. of Atomic Energy, Kalpakkam.*

Creep tests were conducted on 53 specimen of heat No. 21403/Plate No. 39,773 at 600°C and at various stresses. The creep test data generated from the above tests were submitted along with creep-curves to the sponsor. Few more tests under different test conditions are in progress and have completed a test duration of about 12,800 hours.

Stress-rupture tests at 550°C and 600°C temperature and various stresses are also under progress on steel plates of three heats and have completed upto 38,000 hours. The progress report on the above steels have been prepared and submitted to M/s. Reactor Research Centre, Kalpakkam.

(*iii*) *Development of Nickel Free Creep Resistant Austenitic Steel.*

The steel is being tried for its suitability for exhaust valve of automative engine at the premises of M/s. Engine Valves Ltd., Madras.

(*iv*) *Short-term Test Programmes.*

Materials were received for limited testing as given below to determine their specified properties.

Material	*Nature of investigation*	*Sponsoring Organisation*	*Present Status*
(a) 15 MO_3 Steel boiler tubes & DVP-9 Steel	Short-term accelerated stress-rupture tests for the estimation of residual creep life.	BHEL, R & D	Tests, Completed and report submitted.
(b) 12 Cr MOV Steel forgings for high temperature application other than steam turbine blading.	Short-term accelerated stress-rupture tests.	BHEL, R & D	-do-
(c) Samples of castings produced by Unabex, Alloy products. Thane.	Hot tensile and stress-rupture tests.	Uniabex, Alloy Products, Thane.	Test in Progress.
(d) 2¼ Cr 1 Mo forgings for seamless tubes.	Tensile and creep testing.	SAIL (R & D)	Progressing.

70.0 Mechanical Testing and Working Facilities.

Tensile, compression, Olsen ductility, torsion, load elongation, hardness, Charpy impact and calibration tests of Universal Testing Machines were carried out for the Laboratory. Hot tensile tests were done for H.E.C., Ranchi. Total number of samples tested during the year was 1164.

In mechanical working of metals and alloys ; a series of rolling, forging, wire-drawing, etc. were carried out. Studies were also made on the forgeability and rollability of various ferrous non-ferrous alloys developed in the laboratory.

70.1 Forging of Ferrous Powder Metallurgy Parts.

A series of green compacts of atomised iron powder were made under various compacting loads. Densities of the green compacts were measured. No increase in green compact density was observed on rising the compacting load beyond 20 TSI. Hence, experirments were conducted with compacts prepared under 20 TSI load. These green compacts were sintered at different sintering temperatures in a controlled atmosphere furnace. The sintered compacts were then forged. Densities and hardness of each specimen were measured. Best result was achieved with sintering at lower temperature ranges followed by forging. Another set of green compacts were sintered and forged at the same temperatures and it was observed that the best combination of density and hardness is obtained on sintering and forging at higher temperatures.

H. METALLURGICAL INVESTIGATION STUDIES ON METALS AND ALLOYS.

71.0 Failure of Air Compressor Motor. *Sponsored by M/s. National Insurance Co. Ltd., Calcutta.*

M/s. NICO Ltd. desired metallurgical investigation on the failure of shorud of 11 KV/45000 KW squirreal cage motor of the process air compressor to ascertain the cause. Metallurgical tests were carried out and the probable causes of failure were ascertained and furnished.

71.1 Metallurgical Examination of ERW Steel Tubes. *Sponsored by M/s. Walchand Nagar Industries Ltd., Pune.*

Nine numbers of ERW steel tube samples were metallurgically examined to assess the quality of the material and their weld joints. Metallurgical tests showed that the weld joints were sound but the materials were not very clean.

71.2 Failure of Ball Pin used in Porcelain Disc Insulator. *Sponsored by M/s. Jaya Shree Insulators, Calcutta.*

It was desired to determine the cause of frequent failures of the ball pins used in the high tension transmission line. Metallurgical tests showed that the material of the ball pins was plain carbon steel used for such purpose. The failure appeared to have taken place due to mechanical fibering at the critical section of the ball pins.

71.3 Hardness Measurement of Hammer Casting Samples. *Sponsored by R & D SAIL, Ranchi.*

Hardness (Rc) was determined on a number of samples after heat-treatment.

71.4 Metallographic Examination of an Axle of Skip Roller. *Sponsored by M/s. Uranium Corpn. of India, Ltd., Jadugoda.*

Metallurgical tests on the sample of an axle of skip roller showed that the material was plain carbon steel with hardness consistent to its chemical composition and heat-treatment.

71.5 Metallurgical Examination of Ferrous Casting. *Sponsored by M/s. Central Excise, Kalamassery, Cochin.*

A piece of ferrous casting was metallurgically examined and it was established that the sample was of gray cast iron.

71.6 Metallurgical Examination of Broken Ferrous Sample. *Sponsored by Bokaro Thermal Power Station, DVC, Bokaro.*

Metallurgical tests were carried out to determine the quality of the material.

71.7 Metallurgical Examination of Mild Steel/Stainless Steel Cald Plate. *Sponsored by R & D, SAIL, Ranchi.*

To evaluate the quality of the MS/SS clad plate ; mechanical, intergranular corrosion and optical metallography tests were carried out. The results were satisfactory.

71.8 Metallographic Examinatibn of S.G. Iron Sample. *Sponsored by R & D, SAIL, Ranchi.*

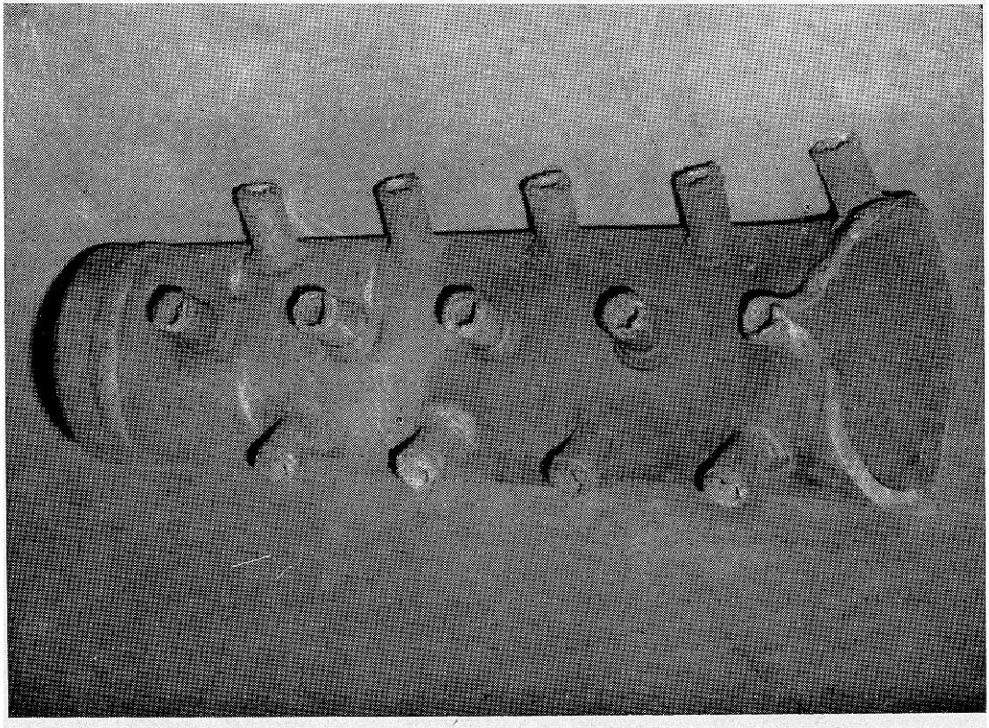
Metallographic examination of the S.G. iron samples showed that the distribution and morphology of graphite were uniform.

71.9 Failure Analysis of Primary Reformer Outlet Manifold. *Sponsored by M/s. Indian Farmers Fertilizer Co-operative Ltd., Kalol, Gujrat.*

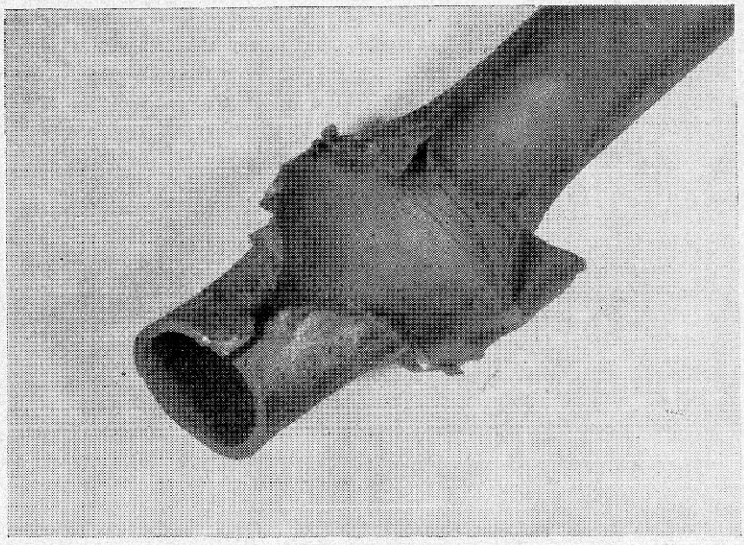
Metallurgical examinations were carried out to find out the cause of failure of the primary reformer outlet manifold in 910 STD ammonia plant designed by M/s. Kellogg at Kalol, operating at 820°C under 37 kg/cm^2 pressure. The material was found to conform to Incoloy-800 generally specified for high pressure reformer applications. The predominant mode of failure appeared to be creep rupture. Operation without insulation caused local overheating and salvaging by poor quality of weld overlay further impaired the creep strength eventually leading to its rupture.

71.10 Failure of Microwave Transmission Line. *Sponsored by P & T Department, Jabalpur.*

A microwave transmission line at Etawah collapsed during the stage of its erection. Metallurgical tests of the failed structural steel were carried out to find out the cause of failure. The material was found plain carbon steel meant for such purposes. The failure was attributed to welding defects and improper galvanising of the steel materials.



Failure of a platen super heater header



Premature failure of a super heater

71.11 Service Failure of Components in Thermal Power Station.

The following failed component were metallurgically examined.

	Failed Components	*Sponsor*
(i)	Platen super header	Patratu Thermal Power Station, Bihar State Electricity Board.
(ii)	Super heater	-do-
(iii)	Super heater	-do-
(iv)	Boiler Tube	Durgapur Thermal Power Station, D.V.C.

I. FOUNDRY TECHNOLOGY

72.0 Heat Resistant Cast Iron.

Signing of the agreement with M/s. Tata Iron & Steel Co. Ltd., Jamshedpur; for industrial scale production of carrier blade castings has been earlier reported. Fourteen large scale heats were carried out at TISCO Works and nearly 350 carrier blade castings were manufactured. Further heats are underway to manufacture a total of 550-600 castings.

Industrial scale evaluation trials on element pins used in electric resistance furnaces has commenced with the active cooperation of M/s. General Electric Co. Ltd., Calcutta. Twenty element pins have been installed in two different industrial furnaces at Field Gun factory, Kanpur and are giving satisfactory service.

Fingers of pipe annealing furnace were manufactured as per specification and have been despatched for industrial scale evaluation trials at Stanton Pipe and Foundry Co. Ltd., Ujjain. Grillage link castings for walking beam funace were manufactured and eight such castings have been supplied to Rourkela Steel Plant for evaluation trials. These castings have been installed in their walking beam furnace in different temperature zones for evaluation of their performance. These are working satisfactorily. Spacer castings for carburizing treatment of automobile parts are being manufactured for evaluation trials at M/s. TELCO, Poona.

73.0 Development of Self Setting and Fluid Sand Process.

Investigation on the use of esters as self setting agents for sodium silicate is in progress. Some fluidizing experiments have also been performed. Further work is underway.

74.0 Wear and Abrasion Resistant Cast Iron.

Three coal crushing hammers cast in NML-WEARNOT were sent to D.V.C., Chandrapura Thermal Power Station, Chandrapura; for industrial evaluation.

Three 6.5 mm thick plates cast in NML-WEARNOT were also sent for industrial evaluation in ash collecting plant of C.T.P.S. Chandrapura. The

performance report is awaited. Contacts were established with Mining & Allied Machinery Co. Ltd., Durgapur for industrial trial of NML-WEARNOT in their foundry ; and the subsequent evaluation of the product with respect to casting properties, mechanical properties and service performance in the mining industry.

J. CORROSION STUDIES ON METALS & ALLOYS

75.0 Studies on Atmospheric Corrosion of Metals and Alloys—International Collaborative Project with National Research Institute for Metals, Tokyo, Japan.

The Laboratory has undertaken a collaborative project on the subject with the National Research Institute for Metals, Tokyo, Japan. The main idea of NML's interaction with the NRIM is to approach the problem with the advantage of the scientific knowledge developed and facilities existed in both the organisations.

The first phase of the study will be confined to examine the extent of corrosion of different engineering materials and its correlation with the atmospheric variables. The second phase of study will include the development of protective schemes for the structural members which will be economically durable and require less maintenance.

Eleven varieties of metallic panels including mild, low and high alloy steels, hot dip and sprayed coatings of Al & Zn were received from Japan for the exposure test under the climatic conditions in India. These samples were exposed at three different sites namely, Jamshedpur, Digha and Madras representing industrial, marine and industrial-cum-marine atmosphere. The exposure test will continue for three years and periodical observations on performance of the sample will be made.

76.0 Development of Aluminium base Sacrificial Anode for Cathodic Protection.

An aluminium base sacrificial anode for the cathodic protection of ship hull and other submerged structures was earlier successfully developed and the performance trial was conducted for the protection of the hull surface of 'R.V. Gaveshani', the ocean going research vessel of National Institute of Oceanography, Goa. The anode material is designated as SUPERAL and has solution potential of —1.2 V and life of 4.2 kg per amp. year with current efficiency more than 80%. The know-how of the process has been released to M/s. Aluminium Manufacturing Co. Ltd., Calcutta; for commercial exploitation.

77.0 Evaluation of Inhibitors for Corrosion Control in Recirculating Cooling Water System.

Based on the earlier recommendation of Scientific Advisory Committee ; CECRI, Karaikudi was contacted and the literature of WACE, USA ; was also consulted. Based on above information a test rig was designed and blue print has been prepared for fabrication and commissioning.

78.0 Studies on Hydrogen Embrittlement of Steels in Aqueous system.

Based on the experiments conducted on some of xanthate compounds which are used as pickling inhibitor for steel, one compound was selected. The compatibility of this compund with a thio-compound was studied and it has shown increased inhibition efficiency at 83°C and in 2N, 5N H_2SO_4 prepared in tap water.

79.0 Development of High Temperature Oxidation Resistant Chromium Steel.

Low alloy steels containing chromium, aluminium, silicon and rare earth elements were prepared for high temperature oxidation studies. This study was taken up to develop material for thermocouple sheath to stand high temperature. Preliminary results have indicated some compositions to withstand temperature upto 1100°C.

80.0 Studies on Stress Corrosion Cracking of Metals.

Studies were taken up on stress corrosion cracking of mild steel and stainless steels in specific environmental conditions where these materials are susceptible to crack.

Effect of cold working, concentrations of the test media, pH, etc. on AISI 304 stainless steel employing stress relaxation technique was completed. Characteristic features of the crack initiation involve development of micro-pits on localised area of the surface. These pits, being interconnected to each other under the influence of stress acting on the metal, produce elongated cracks.

81.0 Industrial Corrosion Problems.

During the period under review, the following industrial corrosion problems have been investigated on sponsored basis.

	Nature of Work	*Sponsored by*
(i)	Examination of corrosion failure of underground pipelines.	M/s. Bongaigaon Petrochemical Ltd., Assam.
(ii)	High temperature oxidation of thermocouple sheath material used for the measurement of stove dome temperature.	Rourkela Steel Plant, SAIL.
(iii)	Evaluation of corrosion properties of austenitic stainless steel, developed by the SAIL.	M/s. SAIL (R&D), Ranchi.
(iv)	Anodic passivation of boiler steel in sodium carbonate and ammonia-hydrazine solution.	M/s. BHEL, Trichy.

K. SURFACE COATING ON METALS

82.0 Electroless Nickel Plating.

Experiments were completed using both the chloride and sulphate baths with the addition of various stabilizers, reducing agents, complexing agents, etc. The process developed using sodium hypophosphite as reducing agent is encouraging.

83.0 Hot-Dip Coatings.

Trial aluminizing of 800 stainless steel ferrules for Rashtriya Chemicals & Fertilizers, Bombay ; were carried out. A project profile on small scale production of hot-dip aluminized automotive and truck exhaust/silencer assemblies was prepared.

84.0 Development of Alkali Silicate-Zinc Dust Coatings.

Developmental work and laboratory tests on the performance of the coatings were completed. Coated panels of mild steel were exposed at NML, Marine Corrosion Research Station, Digha and NML Unit, CSIR Complex, Madras. The performance of these primers is excellent as evidenced from observation after 1½ years of exposure at NML and Digha. Exposure behaviour at Madras also shows excellent performance as reported.

Few top coats such as epoxy enamel and chlorinated rubber obtained from proprietory concerns were given on zinc rich primer and coated panels were exposed at the aforesaid three places. Data shows that zinc rich primer and epoxy combination is excellent in its performance. Chlorinated paint obtained from a proprietory concern has not shown good compatability with this primer. Coated panels of the primer were given to M/s. TISCO, Jamshedpur ; for exposure at different sites in the company and evaluation.

85.0 Chromizing and Calorizing of Low Alloy Steel for High Temperature Service.

The work on calorizing of tube saddle castings was completed and the results indicated good performance of coated samples both under continuous and cyclic heating conditions.

86.0 Electro-galvanizing of Steel Wires from Fluoborate Bath.

The conditions were optimized for producing a bright, smooth and adherent zinc deposits on steel wires on a laboratory scale. The brightener developed for the fluoborate bath is stable even at high current densities which makes it specifically suitable for electrogalvanizing of steel wires.

L. STANDARD REFERENCE MATERIALS & ANALYTICAL WORK.

87.0 Preparation of Chemical Standards.

Three samples of low alloy steels were prepared. These are going to be certified and released for sale. Replenishment of 0.4% carbon steel, nickel

steel and ferro-molybdenum samples was done. 110.3 kg. of different types of reference sample worth Rs. 1.43 lakhs were sold during the period.

88.0 Preparation of Spectrographic Standards.

Preparation of low alloy steel samples was completed. These are going to be certified for sale. Replenishment of plain carbon steel samples is in progress. Standard Samples worth Rs. 3000/- was sold during the period.

89.0 Analytical Work.

(*i*) *Chemical and Instrumental Analysis* —2815 samples for 7847 radicals were analysed.

(*ii*) *Analysis of Gases in Metals* —80 samples for 131 radicals were analysed.

(*iii*) *Spectrographic Analysis*

(a) X-ray fluorescence Analysis —1171 samples for 2262 radicals.

(b) Spectrography —56 Samples for 58 radicals.

M. APPLIED BASIC PROJECTS

90.0 Solidification from Two phase Field of Aluminium Alloys.

Precipitation kinetics through hardness measurement were investigated to study the influence of (i) stirring in the two phase field (ii) elements like Li and Mg. The studies were carried out on Al-Cu and Al-Zn-Mg systems. The results indicated that accelerated ageing behaviour is shown in alloys solidified after stirring the two phase region. The Mg and Li addition also influence the precipitation kinetics.

91.0 Study of the Physical and Mechanical Properties of Splat Cooled Aluminium Alloys.

Splat cooling of commercial Al has been carried out for further processing to make aluminium glass fibre composites. For the study of splat cooled Al-Cu alloys a master alloy has been prepared. High temperature mechanical testing of Al-Ni alloy has been carried out.

92.0 Structure Analysis of Intermetallics in Rapidly Solidifying Aluminium Alloys.

Structure analysis of extracted intermetallic constituents in some Al-Mn alloys is in progress. The phase constituents are extracted electrolytically. Besides these, few heats of Al-Mn containing Fe/Si as impurity ingredients were prepared to study the effect of super saturation in formability property in these alloys.

93.0 Fundamental Studies on Factors affecting Bentonite Properties.

Studies have been completed on this project. The studies included (i) effect of industrial gases on foundry properties of bentonites, (ii) studies on liquid limit values of bentonite (iii) activation studies (iv) effect of heat on bentonites and test on reusability of bentonites, (v) methylene blue, D.T.A. and electron diffraction studies.

LARGE SCALE FACILITIES

94.0 Mineral Beneficiation.

Large scale and comprehensive pilot plant beneficiation investigation studies conducted on tonnage samples of different low grade ores and minerals received from different agencies in India and abroad were undertaken and process flow sheets were developed for the setting up of different ore treatment plants as given below :

(*i*) Syrian oolitic iron ores—Beneficiation and agglomeration plants for Govt. of Syria received through M/s. MECON.

(*ii*) Gandhamardan iron ores—Beneficiation and agglomeration plant for Orissa Mining Corporation received through M/s. MECON.

(*iii*) Saladipura pyrite beneficiation plant for M/s. Pyrites, Phosphates & Chemicals Ltd.

(*iv*) Coal flotation plants for the treatment of coal fines and middlings for Bolanda, and Jagannath Collieries and Nandan and Damna coal mines for CMPDI.

(*v*) Fluorspar beneficiation Plant (36 tpd) at Chandidungri, M.P. for M/s. Madhya Pradesh and Maharashtra Minerals & Chemicals (P) Ltd., through M/s. Development Consultants.

(*vi*) Manganese ore beneficiation plant for M/s. TISCO.

(*vii*) Chromite beneficiation plant for M/s. FACOR.

(*viii*) Kyanite-Sillimanite beneficiation plant for M/s. Maharashtra State Mining Corporation.

95.0 Dense Carbon Aggregate & Soderberg Paste.

The industrial evaluation report carried out by M/s. Ferro Alloys Corpn., Shreeramangar, Garividi ; on 30 tons of soderberg paste was received. This paste was tried in two electrodes of the closed type furnace for making ferro-manganese. The report stated that the soderberg paste produced by NML is as good as the material at present manufactured indigenously in the country.

96.0 Characterization and Evaluation of Indian Fireclays—All India Coordinated Project on Fireclays.

Nine samples of fireclays from different sources have been received during the period and the preliminary studies of different tests are in progress.

97.0 Production of Electrolytic Manganese Metal and Electrolytic Manganese Dioxide.

The 50 kg. per day pilot plant for production of electrolytic manganese dioxide set up at Central Research Station, Rangoon, Burma ; under the Indian Technical and Economic Cooperation programme was commissioned in April 1979. The plant is successfully running at the rated capacity and it is informed that more than 3 tonnes of EMD has been produced during the year.

Steady progress is being made by Electro-Chem (Orissa) Ltd. a Joint Sector Company formed by Industrial Promotion & Investment Corporation of Orissa Ltd. & M/s. Rungta & Sons Pvt. Ltd. is setting up a 3000 tonnes per annum EMD plant at Remuli-Hoda Road, Keonjar Dt. based on NML Technology.

M/s Mysore Manganese Co. Pvt. Ltd. proposes to put up an EMD plant based on NML technology utilizing their own manganese ores. The ore samples of this company are expected shortly at NML for evaluation studies.

Studies on the soluble impurities in the manganese ore and its build up in the electrolyte for production of EMD are being continued.

NML UNIT IN CSIR COMPLEX, MADRAS

The NML Unit, during the period under review, has made steady progress in its scientific and technical activities in various disciplines. A number of public and private sector organisation have utilised the services and expertise available at the NML Unit. The construction of the Technological Bays is complete and equipment and machineries are being shifted to the bays and installed. The semi-automatic carbon analyser for rapid and efficent analysis of carbon, successfully developed at the NML Unit, has been assigned to NRDC for commercial exploitation and a firm in Madras has already taken the 'know-how' and have started manufacturing the same. The unit has taken up and completed several projects in the fields of industrial metallurgy, heat-treatment, foundry, mineral dressing, chemical metallurgy, etc. The unit has extended technical assistance in setting up an analytical laboratory at Mangalore. Several new items of equipment have been added to the laboratories of NML Unit. This unit earned a revenue of Rs. 119727/- through technical services, sponsored & testing work.

A resume of the progress of various projects and other activities in the Unit during the period is furnished below :—

1. Recovery of Mineral Values from Slimes and Flotation Toilings

(*a*) *Manganese Dust Sample from M/s. Maharashtra Electro-smelt Ltd., Chandrapur, Maharashtra.*

The sample of dust as received was found to be highly in weathered and decomposed form and was present mostly in the form of clusters, As received it analysed 33.6% Mn, 7.4% Fe, 9.4% SiO_2, 1.34% Al_2O_3 with 20.45% LOI.

Roasting trials conducted on the sample at varying temperatures indicated that roasting could yield a product analysing 42.1% Mn. On roasting, the material turned to brownish black, but was found to be non-magnetic.

(*b*) *Studies on the Fluorite Slime from GMDC Fluorite Beneficiation Plant at Kadipani.*

The flourspar beneficiation plant at Kadipani rejects about 50 tons of fluorite slime per day analysing about 20% CaF_2. This project was taken up with a view to recover the lost fluorite from the slimes by mineral dressing methods.

The sample of slime analysed 27.12% CaF_2, 2.95% $CaCO_3$, 39.68% SiO_2, 13.82% Al_2O_3, 10.98% Fe_2O_3, and 6.28% LOI. The tests conducted so far have yielded concentrates analysing 66-72% CaF_2 with around 65% CaF_2 recovery.

(*c*) *Studies on a Copper Tailing Sample from Mosabani, Hindustan Copper Complex.*

A representative sample on chemical analysis was found to analyse 0.06-0.065% copper. Particle size analysis of the sample indicated that there

is preferential enrichment of copper in —325 mesh fraction which constituted 45% by weight. Tabling and flotation tests on the sample have been initiated.

2. Development of a Fluo-Solid Reactor for the Calcination of Limestone.

Literature survey on the fluosolid calcination of limestone was completed. It is proposed to fabricate a 6" perspex model with five stages and all the materials required for the model have been procured. The model is likely to be ready in the next few months. In the meanwhile, a 75 mm laboratory fuild bed dryer to dry washed sands with 5% moisture to a level of 0.5% moisture and below has been designed and fabricated out of glass. Preheated air is used for fluidising the washed sand and trials with the reactor will start soon.

3. Development of Binders and Mould Materials for Foundry Moulding Purposes.

(*a*) *Latex as Core Binder.*

Trials were conducted to use rubber latex as a core binder in place of linseed oil as a cheaper substitute. Different sand mixtures were prepared using latex and dextrin and the properties were studied after baking at different temperatures for different lengths of time. The properties obtained were found to be inferior to that of linseed oil mixtures.

(*b*) *Testing of Collapsible Agents for Carbon Dioxide Process.*

Four different samples of collapsible agents developed by M/s. Texchemin Corporation, Madras, for steel and cast iron foundries were received for evaluation. The samples were mixed with 5% sodium silicate and gassed with carbon dioxide gas for 30 seconds. The samples were heated at different temperatures for a period of 30 minutes. The cooled samples were tested for compression strength.

The samples were found to have good collapsibility upto temperature of 700°C., but beyond this temperature they tended to harden very much.

(*c*) *Sand Testing.*

Twenty Sand Samples received from different foundry were tested for their physical properties.

(*d*) *Dry Scrubber for Sand Reclamation (Inter-Laboratory Project).*

Based on the work conducted by the Unit on the core scrap samples of M/s. Ennore Foundries Limited, Madras, an inter-laboratory project was started with MERADO for the design and manufacture of a dry scrubber. Accordingly, the design was made and raw materials for its fabrication have been procured.

4. Development of Specialised Analytical Equipment.

The semi-automatic carbon analyser developed at the NML Unit for rapid carbon analysis has been assigned to NRDC for commercial exploitation. One firm in Madras has been licensed to manufacture this equipment. The firm has already manufactured several units and marketted the project.

5. Pilot Trials of Heavy Media Separation of Magnesites from Various Mines from M/s. Burn Standard Company, Salem.

The HMS bench scale studies on a magnesite sample from M/s. Burn and Co., Salem ; conducted earlier gave indication that it could be possible to reduce the SiO_2 content in the magnesite to less than 3% by the HMS method. Tests were conducted at the site itself by taking samples from (*i*) Jagir mine (*ii*) Salem stack samples (*iii*) Karupur west mines (*iv*) Red hills mine.

The sink flotation from the above mines analysed on average of 2.54% insolubles in it, with a maximum of 3.11% and a minimum of 1.44% insolubles at a average specific gravity of 2.65. The yield was 60% average of HMS alone.

6. Benefication of a Molybdenite-Barite Sample from Geological Survey of India, Tamil Nadu Circle.

A sample of molybdenite-barite, from Alangayam area of North Arcot District, Tamil Nadu ; was received from the Director, G.S.I., Tamil Nadu Circle for beneficiation studies. The sample, as received, assayed 0.03% Mo, 5.6% Fe, 25.75% $BaSO_4$, 58% SiO_2, 5.59% Al_2O_3, 0.96% S and 3.31% LOI.

Exhaustive forth flotation studies conducted on the sample for recovering molybdenite mineral did not meet with success on account of the extremely poor recoveries in the rougher moly concentrate. The best moly recovery obtained in the rougher concentrate was less than 20%. The barite content of the sample was found to be amenable to flotation. Flotation yielded a concentrate analysing 93.1% $BaSO_4$ with recovery of 62.6% $BaSO_4$. This product fulfilled the grade requirements for its use in oil well drilling.

7. Beneficiation of High Silica Magnesite Dumps from Salem.

Samples from four different mines belonging to M/s. Burn Standard Co. were collected and work on these samples is in progress. Studies so far have given an indication of the amenability of these smaples to beneficiation by heavy media separation. Further studies such as hydrocyclone, heavy media jigging etc are being planned.

8. Beneficiation Studies on a Silica Sand from M/s. Arror Udyog Ltd, Bangalore.

About 200 kg of a silica sand sample was received fromM/s. Aroor Udyog, Bangalore ; with a view to beneficiate it to a level of over 98% SiO_2. Complete chemical analysis of the sample as received and mineralogical studies on the sample as well as its sieve fractions are in progress.

9. Treatment of Core Lumps for Ennore Foundries, Madras.

As a pilot test on reclamation of sand from rejected core-lumps, about 1 tonne of core lumps was crushed to about 1.5 mm size to study the suitability of these machines for crushing the core lumps and to evaluate the crushed product for reuse in foundry for moulding purposes.

10. Determination of Bond's Work Index, Grindability, Hardness etc. of a Vanadium Rich Slag from V.I.S.L.

This work is part of the NML-VISL project currently going on for the production of V_2O_5 rich slag by electric smelting of vanadium bearing titaniferous ores of Masanikere, Karnataka. VISL is interested in putting up suitable crushing and grinding equipments for further processing of the slag and this work is being carried out for collection of the basic data required for designing the equipments.

11. Production of Vanadium Rich Slag by Electric Smelting of Vanadium bearing Titaniferous Ores of Masanikere and Oxygen blowing in LD Converter at VISL, Bhadravati.

The first two campaigns of inplant trials of smelting in 1500 KVA furnace followed by oxidation in 2 ton ladles using consumable lances proved the feasibility of the NML process know-how released to M/s. VISL, Bhadravati. It was then felt necessary to scale up the trials further to a level of the targetted production (100/T/yr FeV) atleast for a shorter duration of a fortnight using the facilities available in VISL i.e. 100 tpd electric pig iron furnace and the 12/16 ton LD converter. The third campaign on the large scale smelting trials of vanadium bearing ores followed by oxidation of vanadium pig iron to produce V_2O_5 rich slag was successfully carried out for a fortnight. Nearly 1050 tonnes of vanadium ore were smelted to produce about 560 tonnes of vanadium pig iron analysing 4% C, O 2-0.40% Si, 0.18-0.2% Mn and 0.7-0.72% V in the metal with vanadium recoveries of about 75-80% in the metal. An energy consumption of around 2800 KWH/tonne of pig iron was achieved.

Vanadium rich slags analysing 17 to 27% V_2O_5 were produced by oxygen blowing of vanadium pig iron in LD coverter. The overall recovery of smelting and oxidation was around 70-72%.

12. Evaluation of Chromel/Alumel Thermocouples and Platinum Resistance Thermometers.

About 80 PRTs and 50Cr/Al thermocouples received from various parties were evaluated at different temperature ranges specified by them and test certificates were issued.

13. Recovery of Tin from Tin Dross.

Two samples of white metal and type metal drosses obtained from a local foundry were taken up for investigation for the recovery of metallics as well as tin both by pyrometallurgical and hydrometallurgical techniques.

Metallics were removed by melting and recovery of tin from the non-metallic part is being tried by caustic leaching fusion to recover it as sodium stannate. Further work is in progress.

14. Tests on Bauxite Samples.

Two samples of bauxite received from Hindalco. Renukoot ; are being investigated for their chemical composition and mineralogical make up both by microscopic and chemical methods.

15. Modernisation of Small Scale Industries.

At the instance of Small Scale Industries Service Institute, Madras, NML Unit is acting as consultant for the preparation of a scheme for modernisation of small scale industries in Tamil Nadu. Six foundries were selected in the above scheme, two from Madras and one each from Coimbatore, Erode, Tiruchirapalli and Villupuram. The concerned foundries were visited by a scientist of the Unit for collection of data and a scheme of modernisation was prepared for three foundries and submitted to the S.I.S.I.

16. Setting up of Chemical Laboratory for Analysis.

M/s. Aroor Udyog Limited at Bangalore has a sand washing plant of 10 tons/hour capacity. The washed and dried sand is supplied to leading foundries all over India. To control the quality of the product, the firm wanted to set up a chemical analysis laboratory for which NML Unit was approached. Accordingly, a layout was drawn up and the construction work is in progress. Chemicals and glass ware, equipment and furnaces have been procured by the firm for this purpose as per the advice tendered to the firm by the NML Unit.

17. Studies on Atmospheric Corrosion of Metals-International Collaborative Project with National Research Institute for Metals, Tokyo, Japan.

Exposure of 98 test samples consisting of different types of steels, aluminium, zinc coated iron sheets, aluminium coated iron sheets and various types of stainless steel sheets has been started simultaneously at Madras NML Unit (one of the three test centres in India) to study the behaviour of these materials exposed to atmospheric conditions over a period of 3 years.

18. Design & Fabrication.

The following design assignments were completed :

(i) Layout drawing was prepared for the new ore-dressing pilot plant.

(ii) Design and detailed drawing for ore storage bin.

(iii) Foundation drawings for various ore-dressing machineries.

The fabrication of PCE apparatus based on rotating furnace was completed with the rotating mechanism and furnace lines with zircon refractories. The furnace was put in operation.

19. Analysis, Heat-treatment of Metallographic Studies.

Analysis of 395 samples for 1365 radicals were conducted. Heat-treatment and metallographic studies were conducted on samples received from industrial organizations.

NML FIELD STATIONS

NML FIELD STATION, HOWRAH

Field Station at Howrah has rendered services to the industries situated in and around Calcutta by providing mechanical testing and chemical analysis of various metals and alloy products the results of which are used as a measure to check whether the product has the required specification as per standard. The Field Station has also contacted a number of metallurgical industries and gave spot assistance in the solution of various processing problems as well as attended technical enquiries relating to metal specifications, heat treatment, import substitution and other problems related to metallurgy. The station has set up a metallography wing which would facilitate in taking up job related to examination of microstructure of metals and alloys. In addition to the services offered to the industries, the Field Station, also actively participated in organising an Exhibition and Get together of National Laboratories sponsored by West Bengal R & D Committee held in April, 1979 at Birla Industrial & Technological Museum. The following gives an account of the work handled by the Field Station during the Period.

(*i*) Chemical Analysis—No. of radicals analysed 2689

(*ii*) Mechanical testing (Tensile, Transverse & Hardness)—No. of tests carried out 315

(*iii*) No. of technical enquiries attended 38

(*iv*) No. of technical assistance which have been provided for solution of problems 5

(*v*) No. of firms taken assistance regarding analysis and testing 125

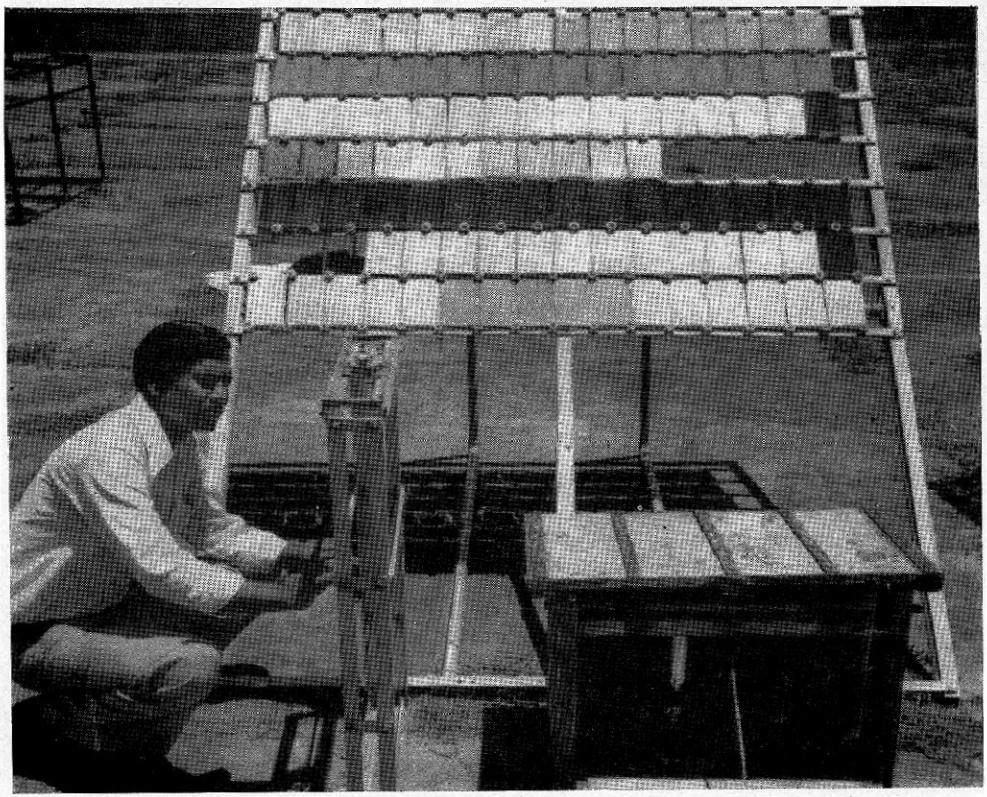
(*vi*) No. of Foundry/Works visited 17

(*vii*) Metallography :

(*a*) Microstructural information has been provided on three samples of cast iron sent by M/s Carterpillar Engineering Industries (P) Ltd.

(*b*) An evaluation of the microstructure has been carried out on 4 samples of weld deposits made from the electrodes manufactured by M/s P. D. Industries (Pvt.) Ltd. A report on the findings was submitted incorporating the micrographs with their interpretations signifying the performance for which the deposits were made.

(*viii*) Total Revenue earned during the period Rs. 54,043.00.



Metallic samples received from NRIM, Japan, exposed under marine atmosphere at Marine Corrosion Research Station, Digha

NML FIELD STATION, BATALA

The following services have been rendered by the Batala Field Station during the period.

(*i*)	Total No. of foundry visits	64
(*ii*)	Total No. of technical enquiries attended by post and by personal discussion	115
(*iii*)	Total No. of samples chemically analysed	91
(*iv*)	Total No. of sand samples investigated	4
(*v*)	Total No. of samples tested for hardness	11
(*vi*)	No. of cupola design released	6

The Station earned a revenue of Rs. 8,312/-.

NML FIELD STATION, AHMEDABAD

The Field Station did the following work during the period.

(*i*) Chemical analysis—1418 Samples for 4845 radicals
(*ii*) Sand testing—8 Samples for 34 tests
(*iii*) Revenue Collected—Rs. 1,01,117/-

MARINE CORROSION RESEARCH STATION, DIGHA

Under the international collaborative programme with the National Research Institute for Metals, Tokyo; for the studies on atmospheric corrosion of metals; systematic exposure tests in marine climatic conditions have been started with the different types of mild, low and high alloyed steels and metalic coatings.

Different alloys and the protective coatings under development at the NML have also been subjected to test for evaluation under marine conditions.

ENGINEERING ACTIVITIES

DESIGN ENGINEERING

Major work undertaken related to ferro-tungsten pilot plant to be set up in Rangoon for the Central Research Organisation, Burma. The process equipment has been designed for local fabrication and complete specifications drawn up for bought out items of equipment, tools and tackle and consumables.

Design office provides routine tracing and reprographic services for the laboratory. A large number of such jobs were undertaken and completed.

MECHANICAL ENGINEERING

The workshop, as a service section, caters to the requirements of the laboratory for fabrication and repair of equipment, instruments, etc. & preparation of test specimens of various types. During the year under review 316 jobs were completed. Nearly 500 test specimens were also prepared.

ELECTRONICS ENGINEERING

The following work was conducted during the period.

A. INSTRUMENTATION WORK

(*i*) *Mineral Processing*

Temperature recorders and flow meters were serviced and calibrated.

(*ii*) *Mechanical Metallurgy*

Steps were taken to replace existing thyratron control panel for Albert Mann rolling mill with thyristor type. Detailed specifications for the tender have been prepared.

(*iii*) *Instrumental Analysis*

Defects in the auto zero circuit of Pye Unicam Atomic Absorption Spectrophotometer have been rectified.

B. MAJOR MAINTENANCE, INSTALLATION & CALIBRATION JOBS COMPLETED

(i) X-ray fluorescence spectrometer
(ii) Derivatograph
(iii) Rolling mill controls
(iv) Scanning electron microscope
(v) Proportional counting system
(vi) Spectrophotometers
(vii) X-Y recorders
(viii) Temperature controllers (30 No.).

ELECTRICAL ENGINEERING

A. DEVELOPMENT WORK

(*i*) *Electrothermal smelting of Lead Concentrate.*

In continuation of the earlier work, the mode of electric smelting was established and various parameters of smelting were standardized in a 140 KVA electric furnace. The electrode consumption comes to about 1-5-1.8 kg of graphite per tonne of lead produced. The power consumption averages to around 2.5 KWH per tonne of lead. In the existing furnace without bag filter, the lead recovery is in excess of 90%.

(*ii*) *Extraction of Magnesium in a Single Electrode Electric Furnace*

Installation of auxiliaries and power supply bus bars of the furnace is under progress.

(*iii*) *Design and Development of Isothermal Electric Furnace for Multi-specimen Creep Testing Machines*

The prototype furnace gave the service to the full requirement of creep testing machines. The constant temperature zone is about 500 mm. The heatsink has shown no sign of oxidation even after continuous use of 18,000 hours.

B. DESIGN OF POWER DISTRIBUTION SYSTEMS, PREPARATION OF LAYOUTS, SCHEDULE OF QUANTITIES, SPECIFICATIONS & MANAGEMENT OF INSTALLATION & COMMISSIONING :

Following major jobs were carried out :

(i) Installation of main L.T. power cable from Tech. Block substation to main building distribution board.

(ii) Installation of power system for dry grinding ball mill with cyclones at M.B.P.P.

(iii) Supply, fabrication and installation of swival type hood of graphite rod resistor furnace.

(iv) Improvement of the power system and lighting of old analytical hall for the installation of special and sophisticated instruments.

(v) Installation of yard lighting system.

(vi) Permanent electrical installation of room coolers at different place in the laboratory.

(vii) Replacement of deteriorated cables and providing new power

(viii) Renovation of electric wiring of old H type quarters.

C. BREAKDOWN REPAIR AND PREVENTIVE MAINTENANCE

Break down repair and preventive maintenance were carried out for electrical equipments of the laboratory, its pilot plants and residential areas comprising high tension substations, electric arc furnaces, high frequency furnaces, resistance furnaces, rectifiers, motors and their control centres, temperature and humidity control equipment etc.

CIVIL ENGINEERING

WORK COMPLETED

1. Renovation of analytical section of Chemistry Division.
2. Construction of brick masonry tank at FPTD Area.
3. Periodical painting & white washing of residential quarters.
4. Providing unfiltered water supply to staff quarter at FPTD premises.
5. Modification in the old analytical hall for the installation of special and sophisticated instrument.
6. Water proofing treatment to Creep Building at NML.
7. Installation of Taco furnace and water system for high frequency furnace at NML.
8. Replacement of broken glass panes at FPTD and MBPP and carbon plant.
9. Replacement of gas pipe line in Pilot Plant in 0.8 ton arc furnace area.
10. RCC foundation and erection of machines in Refractories Pilot Plant Bay.
11. White washing, painting in raw materials stores at FPTD.
12. Providing wooden partition wall in the mechanical stores at NML.
13. Construction of link road at Agrico residential area.
14. Replacement of old corroded barbed wire fencing around the NML boundary wall.
15. Polishing and painting wooden furniture of Chemistry Division.
16. Construction of compound wall for Central School at Adityapur.
17. Making wooden cabins for electron microscope.

WORK IN PROGRESS

1. Tarfelt treatment on the terrace of NML Roofs of Eastern & Western wings of NML.
2. Barbed wire fencing for residential quarters.
3. Installation of Raymond Grinding Mill foundations at MBPP.
4. Periodical white washing, painting of old D type bungalows.
5. Periodical white washing, painting of bungalows at Agrico.
6. Periodical painting of old E type flats.
7. Construction of maintenance site office at Tuiladungri Colony.
8. Periodical painting, white washing of new E type flats at Agrico.

PLANNING OF RESEARCH & DEVELOPMENT PROJECTS

Annual Plan 1980-81

The Annual Plan for 1980-81 comprising Revised Budget Estimates for 1979-80 and Budget Estimates for 1980-81 was prepared on the basis of the requirements under on-going and new research projects, All India Coordinated projects, international collaborative projects, pilot plant studies, infrastructural facilities and institutional programmes, etc.

Sixth Five Year Plan Projection

Projectwise planning and programming of Research & Development work was continued on the Sixth Five Year Plan proposals covering the period of five years from 1978-79 to 1982-83 which included on-going and new R & D project proposals, institutional projects, infrastructural facilities, etc.

Efforts of the planning wing were continued on the proposals relating to the establishment/augmentation and modernisation of mineral processing facilities and the large scale multipurpose testing facility for extraction of non-ferrous metals.

Plans are also envisaged for expansion of the Central Creep Testing Facility to meet the increasing needs of the user industries and also to intensify R & D programmes.

Adequate plans have also been made to the development of instrumental analytical facilities, library, documentation and information services, infrastructural facilities, support to the field stations, social needs in the form of construction of staff quarters, club house, central school guest house, training hostels, co-operative stores, dispensaries, etc.

Research Appraisal Activities

The Second Meeting of the Scientific Advisory Committee was organised during Aug/Sept. 1979. Advisory panel meetings were held between 24th and 31st Aug '79 and the recommendations of the panels were discussed by the main committee on 1st Sept 1979. The final recommendations were brought out in the SAC proceedings.

Follow up actions on the SAC recommendations were taken up for implementation.

PUBLICATIONS

During the period under review, the following publications were prepared and edited.

NML Technical Journal

The issues of NML technical Journal Vol 21, 1979 ; were edited anp published.

Annual Report

The Annual Report of the Laboratory for the year 1978-79 was prepared, edited and published.

Monograph on Indian Ores & Minerals

The Vol 1 of the Monograph on "Ores and Minerals of India —Beneficiation & Agglomeration Techniques for Industrial & Economic Exploitation" comprising parts I & II is nearing completion. This volume contains distribution, production & demand of ores and minerals; beneficiation of iron ores from different parts of the country.

Special Brochure

A special colourful brochure depicting the laboratory's R & D Achievements has been prepared and published.

Special Folder

A special folder entitled 'Technology, Expertise, Consultancy and Services' depicting the various assistance the Laboratory can provide to the industries and industrial entrepreneurs as well as the technologies and processes that can be utilized has been prepared and published.

Special Report

A report covering the various activities and R & D achievements of the Laboratory during the last decade (1970-1979) has been prepared. Besides a number of other special reports covering plan proposals, R & D activities etc. were prepared as needed by Planning Commission, CSIR, Govt. Departments etc. from time to time.

Documented Survey on Metallurgical Development

The issues of this publication for the current year were brought out.

NML News Letter

The monthly issues of News Letter were published.

Publicity of Processes & Products

NML developed processes and products which are ready for commercialization were publicized through newspapers and other media.

Hand outs on NML developed products and processes were prepared and distributed in exhibition, Get-together etc.

Papers Published and Presented

Details furnished in Appendix I.

Research and Investigation Reports prepared

Details furnished in Appendix II.

LIBRARY & DOCUMENTATION SERVICE

The Library introduced some new features during the year. An evaluation form is now sent to all who reciprocates the Current Awareness Services, a daily bulletin of the Library. In this, they indicate the appropriateness or otherwise of the information furnished or the area and extent to which it should be supplemented. The excellent response to this innovation has strengthened the rapport between the Library and its users and improved the relevance and utility of the information supplied.

The Library maintained during the year, its service to its readers with a holding which was enlarged by 400 books, 600 journals and 600 other publications. The Library met requests for bibliographies in twelve areas, covering a wide cross section of the various disciplines in metallurgy and allied science.

Dissemination of research information to research staff of the NML is carried out through (i) bibliographic services to the research scientists as an aid and (ii) arranging translations from other foreign languages into English through INSDOC.

INDUSTRIAL LIAISON & RESEARCH CO-ORDINATION

Get-together & Exhibition

NML participated in the exhibition cum-get-together of national laboratories with small and medium entrepreneurs sponsored by State level Research & Development Committee, West Bengal ; in collaboration with National Research Development Corporation & National Council of Science Museums organised at B.I.T.M. Calcutta in April 1979. A number of processes/products developed such as reactive filter, aluminium alloy conductor NML-PM 53, NML pyroloy-1000, cast high speed steel cutting cools, wear and abrasion resistant cast iron were displayed and the prospective entrepreneurs were also explained in details regarding their feasibility.

In this Exhibition the NML stall was adjudged the best and won the first prize.

NML also displayed its processes and products by participating in the conference and exhibition on 'Aluminium metallurgy' organised by Indian Institute of Science, Bangalore from 5th to 7th October 1979. All R & D activities and processes developed on aluminium and its alloys and the expertise available were highlighted.

NML took part in the NRDC-CSIR get-together held on 3rd and 4th November, 1979, at Ahmedabad, where the State Industries and Govt. organisations and undertaking besides the entrepreneurs participated. This get-together generated interest in processes on PVC coatings on steel and aluminium, crucible production etc, the technologies of which were explained and data furnished to the entrepreneurs.

NML participated in the exhibition held during the 33rd Annual Technical Meeting of IIM, Hyderabad ; on the eve of National Metallurgists' Day celebrations, organised at the College of Engg. ; Osmania University, Hyderabad ; from 14th to 17th November 1979.

NML participated in the 'Indian International Trade fair-79' as a part of CSIR constituent unit in Science and Technology Pavilion held at Pragti Maidan, New Delhi, from 10th November to 9th December 1979.

NML also participated in the 'National Industries Fair-80' held at New Delhi from 21st January to 3rd February 1980 as a part of CSIR unit in the Science & Technology Pavilion to coincide with the UNIDO conference at New Delhi.

State Level R & D Committee for Bihar

During the period under review, two meetings (11th & 12th) of the State Level R & D Committee for Bihar were held under the Chairmanship of Prof. V. A. Altekar, Director, NML ; & Chairman of the State Level R & D Committee for Bihar.

The 11th meeting was held at Patna on 15th & 16th October, 1979 while the 12th Meeting was held at Bokaro on 10th and 11th March, 1980.

A view of the NML Stall at the Exhibition cum Get-Together of National Laboratories held at Birla Industrial & Technological Museum

As usual a get-together of small scale industrialists/entrepreneurs, officials of the Bihar Govt., representative from various institutions and agencies like SISI Patna, Ranchi, Muzaffarpur, and Dhanbad ; NRDC, Engineering Colleges of Bihar, CSIR PTC Patna, State Bank of India NML Jamshedpur, PPDC Ranchi, NIFFT Ranchi, ISM, CMRS & CFRI Dhanbad, BSL & BIADA Bokaro, BITCO Patna, DIC Nalanda and Patna, etc. was held both at Patna and Bokaro during each of the above meetings.

The get-togethers were preceded by visit by the members of the Committee to a few identified small scale units both at Patna and Bokaro to acquaint themselves with the technical problems of these SISI Units as also with their general working conditions. While on the spot solution/advice was also given to these units, many of their problems have since been taken up for thorough investigation at the concerned Laboratory/Institute.

Some highlights of these R & D Committee meetings are given below: —

Patna Meeting

At Patna meeting the first copy of the Brochure "Research and Development facilities available in Bihar" published under the guidance of Prof. V. A. Altekar Chairman R & D Committee was released by Sri Basudeo Prasad Singh the then Minister of State for Education, Govt., of Bihar.

Bokaro Meeting

An exibibition of products manufactured by SISI Units of the Bokaro Industrial Area for supply to Bokaro Steel Plant was inaugurated by Chairman Prof. V. A. Altekar with the view that enterpreneurs may indentify a few items for taking up their manufacture in the small scale sector.

Mr. S. S. Samarpungavan, Managing Director, Bokaro Steel Plant ; who was invited to attend the R & D Meeting assured the small scale Units of Bokaro Industrial Area Development Authority that all possible technical help and guidance would be extended by Bokaro Steel Plant for their full scale development keeping in view their own requirements and the capabilities of these Units.

Institutional Consultancy Services

The following institutional consultancy services were conducted.

	Name of Firm	*Scope of Consultancy*
1.	M/s. Durgapur Thermal Power Station, DVC, Durgapur.	Weld repair of IP Cylinder of 200 MW steam turbine.
2.	-Do-	Hydro-turbine blades failure at Panchet hydel Station and subsequent repairs by welding.
3.	M/s. Altanta Engg., Calcutta.	Scrutiny of the report on the manufacture of automobile bearings.

	Name of Firm	*Scope of Consultancy*
4.	M/s. Onkar Chand Deogar & Co., Raipur.	Manufacture of colled rolled and heat treated high carbon steel strips for application in metal wood & cutting saws involving process details of hardening, tempering of high carbon steel strips and process equipment specification.
5.	M/s. Bihar Aluminium Utensils Manufacturers Association, Patna.	Improving the quality and productivity of aluminium utensils.

Industrial Problems Referred by CSIR Polytechnology Transfer Centres

As many as 61 industrial and technical enquiries/problems were referred to NML by various CSIR Polytechnology Transfer Centres at Patna, Bangalore, Bhopal, Hyderabad, Ahmedabad, Trivandrum, Lucknow and Bombay.

Rural Development

Scientists from NML represented the get-together on "Gaon Ke Karigar Aur Science" organised at Bardoli by CSIR and Agricultural Tool Research Centre, Bardoli (Gujrat) from 28.10.1979 to 2.11.1979. NML successfully demonstrated heat treatment of agricultural tools before a good gathering of rural artisans, blacksmiths, carpenters and visitors.

Technical Aid to the Industries

Nearly three hundred enquiries were attended to on varying subjects such as processes/products, technical details, economic data, raw materials, equipment details, quality control, production etc. These enquiries were received from private/public sectors, government departments, universities and individuals.

Training

NML provided training facilities to various categories of candidates deputed from organisations such as State Government, Central Government, IIT and Universities etc. The training related mainly to fields such as corrosion and surface coating, ore dressing and mineral beneficiation, metallography, spectrometry etc.

Collaboration with Universities/Academic Institutions

Services were provided to

(*i*) Indian Institute of Technology, Kharagpur, in spectrographic analysis;
(*ii*) Regional Institute of Technology. Jamshedpur, in spectrographic and differential thermal analysis of samples;
(*iii*) National Institute of Foundry and Forge Technology, Ranchi; in microsceopy and determination of magnetic properties.

PATENTS AND PROCESSES

Patents Filed

	Title	*Inventors*
1.	A process for purification and enrichment of low grade molybdenum concentrate.	A. K. Saha, S. R. Sreenivasan, D D Akerkar & V. A. Altekar.
2.	An improved process for purification and enrichment of low grade molybdenite concentrates.	A. K. Saha, S. R. Sreenivasan, D. D. Akerkar & V. A. Altekar.
3.	A process relating to sulphation of copper sulphide concentrates.	V. A. Altekar, P. K. Som & S. K. Roy-chowdhury.
4.	An improved process for recovery of tin metal form tin scruff.	V. A. Altekar, Prem Chand & Diwakar Jha.

Transfer of Technology

a. Technical know-how released and commercialised through NRDC

	Process	*Parties*
1.	Production of electric grade alloy aluminium conductor—NML-PM 2	M/s Universal Cables Ltd., Satna.
2.	Production of carbon free ferro-alloys by alumino-thermic reactions.	M/s. Pratap Steel Rolling Mills (Amritsar) (P) Ltd.
3.	-Do- (Fe-V only)	M/s. Rare Metals & Chemicals Ranchi.
4.	Production of reactive ceramic filter for aluminium and its alloys.	M/s. Bhaskar Stonewars Pipes (P) Ltd., New Delhi.
5.	Production of vanadium pentoxide from alumina sludge.	M/s. Rare Metals & Chemicals Ranchi.
6.	Fabrication of semi automatic carbon analyser.	M/s. K. S. M. Laboratory Glass Works, Madras.

b. Technical Know-how Released Through NRDC

Process	*Parties*
1. Production of submerged arc welding flux. (Ind. Patent No. 14500)	M/s. Southern Electrodes, Hyderabad.
2. Production of aluminium based sacrificial anodes for cathodic protection, designated as 'SUPERAL' (Indian Pat. No. 119958)	M/s. The Aluminium Manufacturing Co. Ltd., Calcutta.
3. Production of nickel-magnesium alloy.	M/s. ABM and Metalloys, Shimoga.

c. Processes Ready for Release

Process

1. An improved process for the recovery of tin from tin scruff.
2. Production of welding filler wires/rods for welding aluminium alloys castings.
3. Inoculant for aluminium/aluminium alloys (in the wire form).

PHOTOGRAPHIC, REPROGRAPHIC & PRINTING SERVICES

Photographic & Reprographic Services

(*i*) *Technical Photography*

Photomicrography, macrophotography, fracture photography in colour, black and white of different types of minerals, metallographic work, were rendered regularly as an aid to R & D work. Proper documentation of various stages of the research projects was also done for illustration of the project reports.

Documentation in colour for the investigation & report relating to 'Beneficiation of Syrian Iron Ores' which include colour photographs of lump samples, photomicrographs of different specimen and various facilities used for beneficiation of ores, were done in record time for illustration in the report.

(*ii*) *Reprographic Services*

Photocopying, reflex printing etc of technical as well as slidemaking for presentation of papers for various technical conferences were also part of the regular jobs.

(*iii*) *Photographic Services for Publicity and Exhibition*

Exhibits for various R & D work with big size photographic blow-ups and translites were made for various exhibitions in India and abroad.

(*iv*) In addition to the technical assistance to the research projects, the general photographic needs for the laboratory such as a visits, seminars etc. were covered.

Printing & Binding Services

The printing section has conducted a large number of printing and binding jobs during the period. NML News letter, various types of brochure related to R & D activities of the laboratory, office forms, letter-heads, various cards, blocks for inclusion in reports, covers of reports and publicity display materials were printed. Binding jobs of investigation reports and 'Documented survey on Metallurgical Developments' have been done.

GENERAL

Receipient of Honours, Awards etc .

Dr. R. Kumar, Scientist in the grade of Director, received Dr. Rajendra Prasad Memorial Gold Medal for 1978-79 from Institution of Engineers, Calcutta ; for his paper "Steel supported annealed NML-PM2 conductor—a new concept for distribution lines" published in Institution of Engineers Journal, MM July 1978.

Shri G. P. Mathur, Scientist F, has received 'Indranil Award Gold Medal for Metallurgy' for the year 1978-79 from Mining, Geological & Metallurgical Institute of India for his contribution in the field of ore-dressing and mineral processing.

Shri K. K. Singh, Scientist, was awarded the degree of Doctor of Philosophy in ceramic engineering of Banaras Hindu University.

Foreign Deputation

Prof. V. A. Altekar Director	Visited Vienna as UN Consultant to attend the working Group Meeting on (*i*) Iron ore and (*ii*) Coking coal organised by UNIDO, Vienna. Visited U.S.A. Under the United States-India Exchange of Scientists Programme between CSIR and National Science Foundation, May 1979.
Dr. R. Kumar Scientist in the grade of Director	Served as Commonwealth Visiting Professor in Metallurgy at the University of Aston, Birmingham, U.K. for an academic year (Sept. 1979-July 1980) at the invitation of the Association of Commonwealth Universities, U.K.
Shri K. N. Srivastawa Scientist	Deputed to France under CSIR-CNRS Exchange Programme.
Shri M. J. Shahani Scientist	Visited Soviet Union as a Member of the Indian Powder Metallurgy Delegation.
Shri B. Chatterjee	Deputed to France under the Bilateral Exchange Programme between C.S.I.R. and C.N.R.S. France.

Training

Shri B. Banerjee S.S.A.	Attended short term course on 'Industrial Metallurgy' at Indian Institute of Technology, Bombay.
Shri K. Prasad Scientist	Attended short-term course on 'Modern Trends in Heat-treatment & Technology' at Indian Institute of Technology, Kanpur.

Shri M. N. Singh S.L.A.	Attended a one week advanced training course on 'Corrosion Control' organised by National Productivity Council, Bombay.
Shri K. R. K. Rao Scientist	Attended refresher course on 'Selection and Application of Refractories Iron & Steel Making' organised by Indian Ceramic Society, Jamshedpur.
Shri B. K. Mitra S.L.A.	Attended refresher course on 'Selection and Application of Refractories in 'Iron & Steel Making' organised by Indian Ceramic Society, Jamshedpur.
Shri S. K. Malaviya J.T.A.	Attended refresher course on 'Selection and Application of Refractories in 'Iron & Steel Making' organised by Indian Ceramic Society, Jamshedpur.

Directorship, Chairmanship, Fellowship, Membership etc. on Outside Bodies

Prof. V. A. Altekar Director	Director	U.P. State Mineral Development Corporation Ltd.
	Director	Maharashtra State Mining Corporation Ltd.
	Director	U.P. Carbide & Chemicals Ltd.
	Fellow	Indian Standards Institution.
	Member	Board of Governors of Regional Engineering College, Rourkela.
	Member	Board of Governors of National Institute of Foundry & Forge Technology, Ranchi.
	Member	Editorial Advisory Board of Journal of Indian Chemical Manufacturer.
	Member	Editorial Board of the Journal 'Tools & Alloy Steels'.
Dr. R. Kumar Scientist in the grade of Director	Member	Materials Process Panel of the Aeronautics R & D Board, Ministry of Defence.
	Member	SMDC 10 of Indian Standard Institution.
	Visiting Specialist	Creep studies for Bharat Heavy Electricals Ltd. Research & Product Development.

Shri G. P. Mathur Scientist	Member	SMDC 16 of Indian Standard Institution.
Dr. P. R. Khangaonkar Scientist	Chairman	SMDC-8 (Ferro-alloy Sectional Committee) of Indian Standards Institution.
Shri K. N. Srivastawa Scientist	Member	Indian Institute of Metals.
Shri A. Peravadhanulu Scientist	Member	Indian Institute of Mineral Engineers.
Shri S. Prasad STA	Member	Indian Institute of Mineral Engineers.
Shri A. K. P. Srivastava STA	Member	Indian Institute of Mineral Engineers.
Shri S. K. Sengupta STA	Member	Indian Institute of Mineral Engineers.
Shri D. M. Chakrabarti	Guest Professor	Regional Institute of Technology, Adityapur, Jamshedpur.
	Examiner	Ranchi University.
	Hony. Treasurer,	Indian Institute of Mineral Engineers.
Shri A. K. Bose Scientist	Member	Indian Institute of Metals.
Shri S. K. Malaviya JTA	Associate-Member	Indian Institute of Metals.
Dr. Inder Singh Scientist	Fellow	Electro-Chemical Society of India.
Dr. S. K. Narang Scientist	Fellow	Society for Advancement of Electro-chemical Science & Technology.
	Member	Indian Institute of Metals.
Shri B. M. Dutt Scientist	Member	Electro-Chemical Society of India.
Dr. S. C. Srivastava Scientist	Member	National Academy of Science.

Shri B. C. Mukherjee Scientist	Member	Indian Ceramic Society.
	Associate-Member	Indian Institute of Metals.
Shri S. K. Bera	Associate-Member	Indian Institute of Metals.
Shri S. K. Banerjee Scientist	Member	Indian Institute of Mineral Engineers.
	Member	Indian Institute of Metals.
	Member	I.S.I. SMDC 16/T-22.
Shri N. Chakravarty Scientist	Member	Indian Institute of Mineral Engineers.
	Member	I.S.I. EDC 57 : 4.
	Member	Standing Committee of Bureau of Public Enterprises for Mining Sector-Ore Handling & Beneficiation.
	Member	Non-ferrous Sub-committee of Central Geological Programming Board of G.S.I., Ministry of Steel & Mines.
Shri B. L. Sengupta Scientist	Member	Indian Institute of Mineral Engineers.
Shri M. V. Ranganathan Scientist	Member	Indian Institute of Mineral Engineers.
Shri T. C. De Scientist	Member	Indian Institute of Mineral Engineers.
	Member	Indian Institute of Chemical Engineers.
Shri S. C. Moulik Scientist	Member	Indian Institute of Mineral Engineers.
	Member	Indian Institute of Chemical Engineers.
Shri A. K. Mallik Scientist	Member	Indian Institute of Mineral Engineers.
	Member	Institute of Engineers, India.

Shri K. K. Bhatta-charya J.S.A.	Member	Indian Institute of Mineral Engineers.
B. K. Saxena Scientist	Member	Indian Institute of Metals.
	Secretary	I.I.M. Jamshedpur, Chapter.
	Member	I.S.I. SMDC-14.
Shri C. S. Sivaramakrishnan Scientist	Member	I.S.I. SMDC-11.
	Member	I.S.I. SMDC-12.
Shri Kishori Lal Scientist	Member	Indian Institute of Metals.
	Member	Indian Institute of Foundrymen.
	Member	I.S.I. SMDC-12.
Shri R. Singh Scientist	Member	Indian Institute of Metals.
	Member	Unfired Pressure vessels Material Sub-committee (I.S.I.).
	Member	Wrought Steel Products Sectional Committee SMDC-5 (I.S.I.).
Shri K. Prasad Scientist	Controller of Examination	Indian Institute of Metals.

Lectures

A number of lectures were delivered by eminent Indian & Foreign scientists, technologists, management personnel etc. during the period. Lectures were also delivered by NML Scientists in professional bodies, technical institution etc.

Activities of Societies, Club and Canteen

NML Staff Co-operative Credit Society handled with efficiency transaction over a million rupees. Savings accounts are maintained by the Society. Dvidends are given to the share holders, NML Canteen Catered to the staff members lunch, snacks, tea, coffee etc. at a reasonable rate.

NML Club maintained its sporting, cultural and social activities, The club participated at the Shanti Swrup Bhatnagar Memorial Tournament held between the CSIR laboratories. The Club won the championship in cards in the tournament and was runners in the volley ball. Sports were arranged amongst the NML staff and their families.

... Scientific Film shows and Get-together were also arranged.

Purchase & Stores

Purchase & Stores kept up their procurement of capital equipment, raw materials, consumable stores for various research and development projects, construction and maintenance work.

Administration & Accounts

Administration & Accounts sections handled the administration and budgetory affairs of the Laboratory with speed and efficiency.

First Aid Sections

The dispensaries and first aid sections at the staff colonies, pilotplant site and NML Main building attended minor injuries and ailments to NML staff members and their families. Medicines were given to the ailing persons. Safety measures are introduced in working of the plants, equipment, gas pipe line etc and inspection of safety measures was periodically carried out. There was no major casualty.

Budget Figures

Recurring (Non-Plan) — *Figures in lakhs of rupees (1 Lakh=10^5)*

P-1	Pay of Officers *	32.992
P-2	Pay of Establishment *	35.097
P-3	Allowances & Honorarium etc *	44.524
P-4	Contingencies	17.053
P-5	Maintenance	1.505
P-7	Chemicals & Apperatus etc.	12.354
	Total	143.525

* Include Plan

Capital (Non Plan)

P 5 (3)	Apparatus & Equipment (replacement)	5.671
P 5 (4)	Library books & journals	2.844
	Total	8.515

Capital (Plan)

P 5 (1)	Works	1.680
P 5 (2)	Services	1.200
P 5 (3)	Apparatus & Equipment (addition)	26.930
P 5 (4)	Furniture (addition)	0.450
	Total	30.260
	Grand Total	**182.300**

APPENDIX I

Papers Published, Communicated and Presented

1. Beneficiation of low grade graphites of Palamau District—M. V. Ranganathan, D. M. Chakravarty & N. Chakravarty; NML Technical Journal, Vol. 21(1 & 2) 1979.

2. Effect of additives of hot strength, retained strength and breakdown properties of sodium silicate bonded sands—T. A. Beck, G. N. Rao & V. A. Altekar; NML Technical Journal, Vol. 21 (1 & 2), 1979.

3. Super hard materials for erosion resistance-status of indigenous development—R. D. Gupta; NML Technical Journal, Vol. 21 (1 & 2), 1979.

4. Minerology and liquidus behaviour of Indian blast furnace slags—R. V. Hargave & M. R. K. Rao; NML Technical Journal, Vol. 21 (3 & 4), 1979.

5. Models for liquid metals—A metallurgical appreciation—C. S. Sivaramakrishnan & R. Kumar; NML Technical Journal, Vol. 21 (3 & 4), 1979.

6. Corrosion of steam header in the boiler plant—A case study—P. S. Nag & K. P. Mukherjee; NML Technical Journal, Vol. 21 (3 & 4), 1979.

7. Investigation of stress corrosion cracking in mild steel, stainless steel & brass by stress relaxation technique—S. B. Choudhary, Z. H. Khan & P. S. Nag; NML Technical Journal, Vol. 21 (3 & 4), 1979.

8. Studies on the hydration resistance of sintered dolomite—K. C. Ray, P. C. Sen & M. R. K. Roy; Trans. of Indian Ceramic Society, Vol. 38 (6)—Nov.-Dec., 1979.

9. Vanadium high strength low alloy steels for low temperature use—S. S. Bhatnagar, B. K. Guha & R. K. Sinha; Journal of Material Science, Vol. 14, 1979. (U.S.A.)

10. Advancement in the production of nodular cast iron—R. K. Dubey & S. P. Chakrabarty; Indian Journal of Engineers. Vol. XIX, No. 3 Sept., 1979.

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APPENDIX II

Research & Investigations Completed and Reports Prepared

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3. Chemical beneficiation of low grade bauxite ore from Gua.—A. K. Saha, S. R. Sreenivasan & D. D. Akerkar, (IR 1020/79).

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6. Beneficiation & agglomeration studies on Gandhamardan iron ore from Orissa Mining Corporation Pt I—Beneficiation studies. B. L. Sengupta, R. K. Kunwar, M. C. Das, N. Chakrabarty & G. P. Mathur, (IR 1023/79).

7. Recovery of barite from Calc-silicate graphite schist sample containing Cu-Pb-Zn complex sulphides from Dariba—Rajpur, Rajasthan, Hindustan Zinc Ltd.,—P. N. Pathak, S. Rafiuddin, N. Chakravorty, S. K. Banerjee, & G. P. Mathur, (IR 1024/79).

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13. Extraction and recovery of lead and zinc from mixed oxide and silicate ore from Chakula (Bhutan),—M. G. Bodas, M. S. Mahanty, M. Yaseema & D. D. Akerkar, (IR 1030/79).

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16. Beneficiation studies on a low grade fluorspar sample from Chandidungri mines (M.P.) for M/s. Madhya Pradesh & Maharashtra Minerals & Chemicals (P) Ltd.—K. K. Bhattacharya, M. V Ranganathan, N. Chakravorty, S. K. Banerjee & G. P. Mathur, (IR 1033/79).

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