

**MINISTRY OF MINES
INDIAN BUREAU OF MINES**



**PROPOSAL FOR
PROCUREMENT OF LABORATORY SCALE MINERAL
PROCESSING EQUIPMENTS, CHARACTERISATION AND
ANALYSIS INSTRUMENTS
AT
MODERN MINERAL PROCESSING LABORATORY, NAGPUR
OF
INDIAN BUREAU OF MINES
THROUGH ASSISTANCE FROM
NATIONAL MINERAL EXPLORATION TRUST (NMET)**

AUGUST, 2022

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I. Introduction

To exploit India's mineral potential for sustainable development, systematic exploration in the mineral bearing areas using state-of-the-art techniques are vital. It is not only essential to explore the new mineral deposits but also to utilize the low grade ores by adopting beneficiation techniques for their upgradation and value addition. Modern facilities are extremely essential for efficient and effective R&D in mineral processing.

Indian Bureau of Mines is the principal agency for undertaking ore beneficiation studies. The Modern Mineral Processing Laboratory situated at Nagpur is the principal laboratory and caters to the need of vast mineral bearing areas of the country viz. Northern, Central, Eastern and North Eastern Regions of India. Studies on all types of ores & minerals viz. ferrous, non-ferrous, base metal, precious metal, industrial & fertilizer minerals are carried out at IBM's Nagpur Laboratory. Ore beneficiation, mineralogical characterization studies and chemical analysis of ores are vital in assessing economic feasibility of mineral deposits. As many of the ores of our country are of low grade in nature, modernization of Mineral Processing facility through improved technology is utmost essential for upgradation of low grade ores such as iron, manganese, chromite, bauxite, rock phosphate, Copper-Lead-Zinc and recovery of valuable minerals viz. Rare Earth Elements (REEs), Platinum Group of Elements (PGEs), Gold, Silver, Nickel, Cobalt, Lithium, Molybdenum, Vanadium etc.

The National Mineral Policy, 2019 emphasizes the need for conservation of mineral resources through beneficiation keeping in view the present needs and future requirements. To overhaul the development of mineral resources in the country, major enhancement in mineral exploration and expansion of R&D activities in mineral beneficiation are vital aspects. In the NMP, 2019 IBM laboratories have been identified as the principal agency for undertaking beneficiation studies.

II. Importance of Beneficiation Study for Exploration Samples

Mineral exploration indicates the geological aspect, whereas beneficiation study shows the viability of the block for commercial operations i.e. feasibility and economic aspects. Beneficiation study is essential to assess the auction potential of mineral blocks. IBM conducts beneficiation studies on G2 & G1 level exploration samples to assess the amenability of the ore for upgradation for their industrial applications/utilization and to assess recovery of associated valuable minerals.

To meet the growing demand of Indian industry and to fulfill the objective of Atma Nirbhar Bharat, enhancement of mineral production and utilization of low and lean grade ores are need of the hour. Decrease in grade of the ores with change in the characteristics and ores having complex mineral assemblages requires thorough characterization and beneficiation studies for assessing their upgradability for utilization by different user industries. These need to be addressed in multifaceted way to find case-specific solution, e.g. processing of ores to maintain metal value production, recovery of valuable associated minerals as co-product and by product for conservation of minerals. All the above necessitate the development of new and modern facilities to diagnose the problems in processing of such ores. Hence, beneficiation study has paramount and crucial role for the development of mineral deposits in India.

III. Beneficiation Studies carried out by IBM on Exploration Samples

IBM has been carrying out laboratory scale beneficiation studies on exploration samples of GSI, MECL and State DGMs. Since 2016, IBM is conducting beneficiation studies on exploration samples of GSI on free of charge (notional) basis. As per the recent policy decision taken in May 2022, Union Ministry of Mines has allowed IBM to exempt charges for beneficiation studies of State Government Department samples. Accordingly, IBM has started taking up beneficiation studies of State Government samples on free of charge (notional) basis.

IBM has conducted beneficiation studies on a large number of exploration samples comprising different ores and minerals received from various parts of the country. Till date beneficiation studies on total **138** mineral blocks have been completed and report were submitted by IBM to the respective organizations for auctioning. Out of these, more than a dozen of the mineral blocks comprising of Gold ore, Graphite ore, Copper-Lead-Zinc ores, Iron ore, Bauxite ore, Rock Phosphate etc have already been auctioned successfully and remaining blocks are under process of auction. For the current year, beneficiation studies on **13** mineral

blocks are in progress. The year wise figure on beneficiation studies carried out by IBM on exploration samples is given in table 1.

Table – 1

Beneficiation Studies by IBM on Exploration Samples

Year	Number of Mineral Blocks			Total
	GSI	MECL	State DGMs	
No. of Completed Projects				
2016-17	18	01	02	21
2017-18	28	06	--	34
2018-19	22	--	01	23
2019-20	17	03	--	20
2020-21	15	--	02	17
2021-22	17	03	01	21
2022-23 (till July, 2022)	02	--	--	02
Total	119	13	06	138
No. of Ongoing Projects				
2022-23 (till date)	10	02	01	13
Grand Total	129	15	07	151

IV. Beneficiation study carried out at MMPL, IBM, Nagpur

The Mineral Processing Laboratory at Nagpur is a unique R&D base in the country and has larger facilities to carry out different varieties of ores and minerals. Out of the 138 completed projects on exploration samples, majority of the beneficiation work (>50%) were carried out at MMPL, IBM, Nagpur. The year wise figure on beneficiation studies carried out on exploration samples at MMPL, IBM, Nagpur is furnished in table 2.

Table - 2

**Beneficiation Studies carried out on Exploration Samples
at MMPL, IBM, Nagpur**

Year	Number of Mineral Blocks			Total
	GSI	MECL	DGMs	
No. of Completed Projects				
2016-17	10	--	02	12
2017-18	16	01	--	17
2018-19	10	--	--	10
2019-20	05	01	--	06
2020-21	06	--	02	08
2021-22	12	03	01	16
2022-23 (till July, 2022)	02	--	--	02
Total	61	05	05	71
No. of Ongoing Projects				
2022-23 (till date)	03	02	01	06
Grand Total	64	07	06	77

**V. Projection of Number of Samples for Beneficiation Study on
Exploration Mineral Blocks**

The recent reforms in the mineral sector has paved the way for boosting exploration activities in the country and a large number of mineral blocks are going to be auctioned in coming years. There would be significant increase in samples for beneficiation study by IBM.

Future projections and challenges for Mineral Processing are vast. The thrust on focused R&D is the need of hour to give impetus to “Make in India” initiatives for “Atmanirbhar Bharat”. In the new regime, auctioning of blocks for PL-cum-ML and participation of private exploration agencies would enhance exploration activities,

which in turn would increase in number of projects for mineral beneficiation. It requires expanded and robust R&D facility for their assessment for further utilisation.

The central, eastern and north eastern India states are endowed with wide spectrum of ores and minerals viz. Iron ore, Manganese ore, Copper ore, Chromite ore, Bauxite ore, REE, Gold ore, PGE ore, Graphite ore, Copper ore, Lead & Zinc Ore, Rock Phosphate, Limestone etc. Extensive exploration activities are being undertaken in these states by GSI, MECL, State DGMs, Central & State PSUs and by Private entities. There will be generation of a large number of samples for beneficiation studies for MMPL, IBM, Nagpur.

Projection on number of exploration samples likely to be taken up during coming 03 years is shown in table 3.

Table - 3

Projection of No. of Exploration Samples for coming 3 years

Year	Total No. of Mineral Blocks projected	Likely to be taken up by MMPL, Nagpur
2023-24	30	15-20
2024-25	35	20-25
2025-26	40	25-30

To meet the requirements of various exploration agencies for auctioning of mineral blocks and for effective R&D on different low grade & complex ores, replacement of existing equipments and addition of new facility for processing of precious, strategic and critical minerals are utmost essential.

VI. Status of Existing Facilities of IBM at MMPL, Nagpur

The existing facilities of Mineral Processing at Nagpur are 20-25 years old. Majority of the instruments and equipments are old and unserviceable. Due to the maximum use of the existing instruments and equipments in processing and analyzing a large number of different ores and by natural wear and tear, their efficiency have reduced, demand frequent repairs, they are less energy efficient and inadequate to meet the present demands of the mineral industry.

Most of the equipments and instruments belong to the old technology and need replacement in order to cater to the present requirements for mineral beneficiation at a high level both qualitatively and quantitatively. Due to drastic

reduction in efficiency of the equipments and instruments, there is delay in completion of projects in time. Most of the existing equipments have become obsolete and non-repairable. The manufacturers are unable to provide service maintenance due to non-availability of spares and accessories. Therefore, maintaining such equipments and carrying out experiments has become a difficult task.

VII. Requirement of New Facility and replacement of Existing Facility

- (A) **New and Comprehensive Facility at MMPL, Nagpur** is required for characterization and processing of different ores. At present facilities for extraction of Ni, Co, PGE, REE, strategic minerals and technology metals are not available.
- a) To conduct study of rocks/ores containing
 - Rare Earth Elements (REE),
 - Platinum Group of Elements(PGE),
 - Cobalt, Gold, Silver, Molybdenum, Nickel
 - Lithium &
 - Other Technology metals.
 - b) Recovery of metals values such Au, Ag, Li, Co, Mo, Ni, PGE etc. using hydro-metallurgical route. Facilities for recovery of gold from refractory ores are becoming economically attractive to treat. Example: Lithium from Lepidolite and Spodumine, Vanadium from other Mica and other minerals.
 - c) Development of optimal process for recovery of valuable minerals as by-product and co-product for minimizing waste and maximizing value & to augment the national mineral resources. Example: REE and Vanadium from graphite ore, Ni, Co from base metal ores, carbonate from copper ore.
 - d) Processing of fines and ultrafine sized particles and recovery of metal value from different ores and agglomeration. Example: PGE and Gold from different rocks/ores.
 - e) Treating of lean grade & complex ferrous ore using pyrometallurgical route.
Ex: Reduction roasting of lean grade ore
 - f) Cost effective, energy saving and dry separation processes.
Example: Dry separation of iron ore (pre concentration) at coarser sizes

- (B) **Replacement of Existing Facility at MMPL, Nagpur** with advance equipment and instrument is essential to study the low & lean grade and complex ores and to develop suitable techniques/process flowsheets for their utilization.
- i) Due to high demand of iron ores in the iron and steel sector and depleting resources of high grade ore, expeditious and wide spread exploration for iron ore have been taken up in various states of the country. As a result, low and lean grade iron ore deposits such as high aluminous and complex iron ores and siliceous iron ores (iron ores fine, BHQ, BHJ, BMQ) have been explored and beneficiation studies on those iron ores are undertaken by IBM. The existing gravity and magnetic separation equipments are very old, their efficiency and magnetic intensity have reduced. They need to be replaced with new & advance equipments for obtaining best results.
 - ii) Bulk utilization of bauxite ore is made in aluminum refinery for metallurgical use. Owing to depletion of high grade bauxite ore and its demand in refractory industry, dependence on low grade bauxite ore has become essential. Besides, low grade bauxite and laterite also contain different valuable strategic and critical minerals. Therefore, various dry gravity, dry magnetic, electrostatic and wet processing equipments are essential to carry out studies on low grade bauxite and laterite samples to upgrade and to recover associated valuable minerals.
 - iii) India is mainly an agriculture based country and augmentation in agricultural production depends on use of fertilizer. Rock Phosphate is the principal fertilizer mineral and 80% of the requirement is met through import. There are many low grade and complex rock phosphate viz. siliceous, carbonaceous and ferruginous deposits are available in the country. Beneficiation by flotation is the most important process adopted for upgradation. Replacement of existing laboratory flotation cells with new and advance units is essential.
 - iv) Beach Sand minerals such as Monazite, Zircon, Rutile, Ilmenite, Sillimanite, Garnet are some of the important strategic and critical minerals and vital for development of the country. They also occur in association with other ores and rocks. Separations of these minerals can be done employing Electrostatic Separators through dry process. The existing instrument is more than 25 years old and its efficiency is very low. Replacement with a new and advance model of Electrostatic Separators is required.

Equipment and instrument wise detailed justification is given in section VIII. List of new facility required and replacement of existing facility is furnished in table 4.

VIII. Procurement of Equipments and Instruments for Mineral Processing Facility at MMPL, IBM, Nagpur through assistance from NMET

To cater to the above requirements, new facilities to be created and existing facilities to be replaced with advance models in the Mineral Processing Plant, Mineralogy and Chemical laboratories. Mineral beneficiation study includes detailed mineralogical characterization studies and chemical analysis of original bulk sample as well as study of process products generated in each stage/batch of experiments/beneficiation test work. The products of each test work are studied by mineralogical methods and further input is given to optimize the process parameters and improve the grade as well as recovery.

- (A) **Mineral Processing Laboratory** to be modernize and upgraded with procurement of new machineries and equipments. Laboratory/Batch Scale beneficiation equipments viz. WHIMS, Column Flotation, Air Jig, Electrostatic Separator, HIDMS(dry), Leach Column, Flotation Cell, Zeta Potential, Slurry Rheometer and BET Surface Area Analyser to be added for gravity, magnetic, flotation, electrostatic separation and for determination of various process parameter in beneficiation study.
- (B) **Mineralogy Laboratory** to be equipped with procurement of FE-SEM with EDS, Digital XRD with 2D Detector instruments to develop a proper strategy for mineral characterization and processing.
- (C) **Chemical Laboratory** to be strengthened with Fire Assay facility for Gold and PGE ore analysis and Proximate Analyzer for analysis of graphite samples.

Item wise justification and approximate cost

(A) LABORATORY SCALE MINERAL PROCESSING EQUIPMENTS

Beneficiation study on exploration sample is carried out to ascertain the amenability of the ores towards upgradation. Bench/laboratory scale investigation is done to develop the process flowsheet to upgrade the ores and obtain concentrates suitable for user industry specification. To develop the process flowsheet on laboratory scale, initially, characteristic of the feed ore is studied and based on observations the material are crushed and ground to liberate desired valuable minerals. These mineral particles then separated employing various beneficiation techniques to recover valuable minerals by remove contaminating minerals. The separation is based on differences in the

physico-chemical properties of the mineral particles, density, magnetic susceptibility, surface chemistry, particle size, mechanical strength, electrical conductivity etc. All these unit operations either work separately or combined to achieve maximum grade and recovery. The following major equipments need to be procured urgently to meet the requirement for exploration samples.

1. Wet High Intensity Magnetic Separator (WHIMS)

Wet High Intensity Magnetic Separator (WHIMS) is important magnetic separation equipment used for beneficiation study of ferrous Minerals (Iron, manganese, Chromite) and separation of iron oxide minerals from non-ferrous ores and silicate rocks. WHIMS removes fine magnetic and para-magnetic particles from mineral slurries. Handling of minerals in a slurry or suspension form is preferred for many processes, especially when beneficiation involves wet processing. Majority of the exploration samples received at MMPL, Nagpur are Ferrous ores i.e Iron and Manganese ores and they are studied employing WHIMS. The existing laboratory scale batch WHIMS (Capacity 10 kg/ hr) is very old and giving magnetic field upto 1.2 Tesla only. The proposed WHIMS would give magnetic intensity 1.8 to 2 Tesla as well as higher capacity range 2 to 50 kg/hr for efficient separation of minerals.

Approximate Cost: Rs. 140 Lakhs

2. Air Jig for Dry Separation

Nowadays, due to water scarcity dry beneficiation technologies is the need of the hour. Air jig is equipment useful for pre concentration of minerals at coarser sizes. Dry processing is the answer for those minerals mined from the regions. It is very much useful for processing of Iron Ore, Chromite, Manganese and other minerals which are used in coarser sizes. This is a new facility to be added in the IBM laboratory. The proposed jig will be able to process minerals like iron ore at coarser sizes and with a capacity range of 20 to 50 kg per batch. It will help to map the dry beneficiation potential of exploration samples like iron ore, chromite ore and manganese ore etc.

Approximate Cost: Rs. 100 Lakhs

3. Flotation Column

Column Flotation is an important Surface Chemical Separation equipment used for beneficiation study of different minerals starting from Copper, Lead, Zinc to

Iron ore, Gold, PGE, REE and other ores which are finely ground to recover metal value. Currently due to exploration of such low tenor Minerals viz. Cu, Pb, Zn, REE, Au, PGE and other strategic and critical minerals are going on, the column flotation study is very much essential. The existing Column Flotation Cell is of larger capacity (100 kg/hr & 4 inch diameter) and not in working condition. Small capacity (50 kg/hr & 2 inch diameter) Column Flotation cell is essential for flotation of ultrafine particles (PGE, REE, Co, Ni, Mo etc).

Approximate Cost: Rs. 50 Lakhs

4. Air Pulsated Batac Jig (for wet separation)

An air-pulsated jig is primarily used for gravity separation of minerals at coarser sizes. The existing laboratory mineral jig is very old, stroke of the jig is not functioning properly, particle size from 1 mm to 10 mm can only be processed. With the proposed Jig, coarser size up to 40 mm can be processed, useful for Iron, Manganese, Chromiter, Bauxite ores etc. Currently 50% of the exploration samples are of ferrous ores (iron and manganese). Therefore it is very much essential to have an Air Pulsated Batac Jig in the laboratory.

Approximate Cost: Rs. 50 Lakhs

5. Leach Column

Laboratory leach testing procedures include the studies of dissolving metal ions with an acid, base, cyanide or other chemicals. The leach column simulates the effects of heap leaching of an ore in a controlled lab environment making data collection simple. Leaching operation is very much essential for study through hydrometallurgical route for extraction of low and lean grade precious metal ores, REE, PGE, Gold, Lithium, Nickel, Potassium from Glauconite and other strategic minerals with low tenor. Currently there is no such facility available in the laboratory. Therefore, it is very much essential to have a leach column in the laboratory.

Approximate Cost: Rs. 30 Lakhs

6. Electrostatic Separator

Electrostatic separator is used for dry separation of minerals according to their electrical conductivity. The existing Electrostatic separator is very old and not performing accurately. It is essential for dry processing of Beach Sand Minerals,

Nb-Ta and REE minerals etc. Therefore, it is very much essential to replace the existing electrostatic separator with a new one.

Approximate Cost: Rs. 60 Lakhs

7. High Intensity Disc Magnetic Separator (Dry)

High intensity dry disc magnetic separator is used for dry separation of minerals according to their magnetic intensity. It is very much essential for processing of ferrous minerals like Iron, Chromite, Manganese ores etc. The existing dry disc magnetic separator (Capacity 2 kg/hr) is very old and not performing accurately. The magnetic intensity of existing dry disc magnetic separator is 3000 gauss (maximum). The new proposed dry disc magnetic separator would give wide range of magnetic intensity from 0.1 Tesla to 4 Tesla for efficient separation of minerals.

Approximate Cost: Rs. 30 Lakhs

8. Electrophoretic Cell for Zeta Potential

Zeta Potential Measurement is used for surface chemical characterization of minerals. Surface chemical characterization is very much essential for determining the parameters for froth flotation. The equipment is very much needed for study of flotation of ultrafine particles (sulphide ores, PGE, REE etc). The existing Zeta Potential is very old, damaged and not serviceable. It needs to be replaced with a new one.

Approximate Cost: Rs. 50 Lakhs

9. Slurry Rheometer

Slurry Rheometer is very much essential for flow behavior study of mineral slurry. Now a days the concentrated mineral (iron, manganese and chromite in particular) needs to be transported through slurry pipelines. Rheometric studies are very much essential for designing of slurry pipelines in mineral processing plants. The existing laboratory Rheometer is not in working condition and it needs to be replaced with a new one.

Approximate Cost: Rs. 30 Lakhs

10. BET Surface Area Analyzer

It is essential for particle characterization for deciding the process parameters of froth flotation process. There are approximately 10 to 15 exploration samples coming each year for froth flotation. The existing laboratory BET surface area analyzer is not in working condition and it needs to be replaced with a new one.

Approximate Cost: Rs. 40 Lakhs

11. LAARMANN Flotation Cell with External Air Supply (for Roughing and Cleaning)

The existing flotation cells are self aerated and did not have monitoring facility for amount of air supply. Air supply is an important parameter for mapping the flotation performance for processing of ores viz. gold, PGE, REE, Lithium.

Approximate Cost: Rs. 40 Lakhs

(B) MINERALOGY – CHARACTERISATION INSTRUMENT

Mineral Characterization study is carried out on numerous samples generated during ore dressing investigation. The study is important in mineral processing for identification of the valuable and gangue minerals, their textural relationship, quantification of ore and gangue minerals which decides the grade of ore. Grain size of the minerals and their textural relationship helps in deciding the size reduction and liberation in mineral processing. An effective liberation of gangue minerals and ore minerals influences the optimum separation efficiency. Application of advance research tools and interceptive techniques such as Field Emission Scanning Electron Microscopy (FE-SEM) with EDS and digital X-ray Diffractometer (XRD) are vital instruments and study carried out by using these techniques are highly precise and confirmative in nature. The following two major instruments are urgently required for ore characterization.

1. Field Emission Scanning Electron Microscope with Energy Dispersive Spectrometer (FE-SEM with EDS) along with Carbon Coating Machine and ancillary units

FE-SEM with EDS would be a new facility, which would be extremely essential for characterization of complex ores as well as lean grade ores of iron, chromite, manganese, bauxite, rock phosphate, glauconite, study of fines & ultrafine particles, Gold, REE, PGE, Cu-Pb-Zn, Co, Li, Ni & Molybdenum ores and their process products. Nomenclature of minerals occurring in solid solution phases,

elemental substitution in minerals and isomorphous minerals can be studied accurately. Rapid semi-quantitative point analysis of different mineral phases, Back Scattered Electron imaging, Elemental dot mapping and qualitative analysis can be done in different ore samples. Identification of micron & submicron sized particles in ores and processed products, study of intermixed & intergrowth minerals and their liberation characteristics can be studied, which are essential for mineral beneficiation study. All these aspects of mineral characterization are not possible by conventional microscope. Hence, FE-SEM with EDS is extremely essential to fulfill the above important attributes of mineral characterization. This facility is Alongwith FE-SEM, carbon coating machine, water chiller and UPS as ancillary units are required.

Approximate Cost: Rs. 300 Lakhs

2. Digital X-Ray Diffractometer with Solid State Detector, Search Match Software, PDF-4 Mineral Data and ancillary units

XRD study is a rapid, accurate and confirmative technique. This instrument is essential for ores which contain microcrystalline as well as cryptocrystalline minerals viz. iron ore, manganese ore, limestone, bauxite, rock phosphate, clay etc. and for nomenclature of polymorphous mineral phases viz. kyanite, andalusite, sillimanite. The main advantage of X-Ray Diffraction is for rapid identification of unknown minerals with high level of accuracy. The existing X-Ray Diffractometer (XRD) is 18 years old and is giving frequent problems. The company has stopped manufacturing of spares which are required to run the instruments. The company has informed to stop the maintenance service support after one year. Hence, a new digital XRD with solid state detector, software, PDF-4 mineral data alongwith water chiller & UPS as ancillary units are required.

Approximate Cost: Rs. 200 Lakhs

(C) CHEMICAL LABORATORY – ANALYSIS INSTRUMENTS

The chemistry of ores is the key to understand the concentration of different elements. Chemical assay is important for the beneficiation engineers to plan their test work to enhance the grade during the beneficiation process. Ores and minerals have variety of elements and radicals, which offer interference with one another during analysis. The choice of any analytical procedure or instrumental analytical techniques depends on the concentration of elements and also the nature of ore samples. Thus each procedure of chemical analysis has its own

merits and demerits and selection of method is based on desired accuracy. The analyst needs to develop techniques very carefully for obtaining the accurate results and reproducibility also.

1. Fire Assay Assembly along with accessories

It would be a new facility for pre-concentration of various elements in trace level presence especially Gold, Silver and Platinum Group Elements (PGE). This technique required for pre-concentration of the various Precious elements like Au, Ag and Platinum Group of Elements like Pt, Pd, Ru, Rh & Os present traces in ores for further analysis.

Approximate Cost: Rs. 40 Lakhs

2. Proximate Analyzer along with accessories

It would be a new facility for proximate analysis of Graphite, Coal and carbonaceous material content in other ores in reliable and cost effective manner. It is more useful for quick analysis of various original Graphite and its products generated during beneficiation investigations. The required parameters can be analyzed rapidly with high accuracy in short span of time without any additional chemicals in cost effective way.

Approximate Cost: Rs. 35 Lakhs

Table-4

List of requirement of New Facility and Replacement of existing facility

Sl. No.	Name of Equipments/Instruments	Remarks
(A) Laboratory Scale Process Equipments		
NEW FACILITY		
1	Air Jig for Dry Separation	Useful for pre concentration/ dry separation of ferrous Minerals (Iron, chromite and manganese) at coarser sizes.
2	Air Pulsated Batac Jig	Useful for wet concentration and processing of ferrous minerals at a wide size range 5 mm to 40 mm
3	Leach Column	Useful for hydrometallurgical processing of low and lean grade precious metal ores, REE, PGE, Gold, Lithium, Nickel, Potassium from Glauconite and other

		strategic minerals with low tenor.
4	High Intensity Disc Magnetic Separator (Dry)	Useful for dry processing of ferrous minerals like Iron, Chromite etc with a wide range of magnetic intensities (0.1 Tesla to 4 Tesla)
5	LAARMANN Flotation Cell with external air supply	Useful for mapping the flotation performance for processing of ores viz. gold, PGE, REE, Lithium.
REPLACEMENT OF EXISTING FACILITY		
6	Wet High Intensity Magnetic Separator (WHIMS)	Beneficiation study of ferrous Minerals (Iron, manganese, Chromite) and separation of iron oxide minerals from non-ferrous ores and silicate rocks at high intensities and ultrafine sizes (0.5 tesla to 2 tesla @100,150 & 200 mesh sizes)
7	Flotation Column	Wide range of application includes different minerals starting from Copper, Lead, Zinc to Iron ore, Gold, PGE, REE and other ores which are finely ground to recover metal value.
8	Electrostatic Separator	Useful for dry processing of Beach Sand Minerals, Nb-Ta and REE minerals etc.
9	Electrophoretic Cell for Zeta Potential	Useful for mapping the surface chemical characterization of minerals. Required for study of flotation of ultrafine particles (sulphide ores, PGE, REE etc).
10	Slurry Rheometer	Rheometer is very much essential for flow behavior study of mineral slurry. Essential for designing of slurry pipelines in mineral processing plants.
11	BET Surface Area Analyser	It is essential for particle characterization for deciding the reagent dosage of froth flotation process. Useful for determining the surface area of Iron concentrate useful for pelletization
(B) Mineralogy – Characterisation Instruments		
NEW FACILITY		
12	Field Emission Scanning Electron Microscope with Energy Dispersive Spectrometer (FE-SEM with EDS) along with Carbon Coating machine and ancillary units.	Extremely essential for characterization of complex ores as well as lean grade ores of iron, chromite, manganese, bauxite, rock phosphate, glauconite, study of fine & ultrafine particles, Gold, REE, PGE, Cu-Pb-Zn, Co, Li, Ni & Molybdenum ores and their process products. Nomenclature of solid solution phases, elemental substitution in minerals and isomorphous minerals. Rapid semi-quantitative point analysis of different mineral phases.

REPLACEMENT OF EXISTING FACILITY		
13	Digital X-Ray Diffractometer with Solid State Detector, Search Match Software, PDF-4 Mineral Data and ancillary units	Required for rapid identification of unknown minerals, microcrystalline/cryptocrystalline minerals viz. iron ore, manganese ore, limestone, bauxite, rock phosphate, clay etc. and for nomenclature of polymorphous mineral phases viz. kyanite, andalusite, sillimanite.
(C) Chemical – Analysis Instruments		
NEW FACILITY		
14	Fire Assay Assembly along with accessories	It is useful used for chemical analysis of various elements in trace level presence especially Gold, Silver and Platinum Group Elements (PGE)
15	Proximate Analyzer along with accessories	Essential for quick analysis of graphite, coal and various carbonaceous samples.

IX. SUMMARY

To meet the requirement of exploration activities, expanded and robust beneficiation facility are essential for their assessment for utilisation. The new and upgraded facilities for MMPL, IBM, Nagpur envisaged by this proposal is vital for auctioning of mineral blocks so that several low grade mineral deposits can be brought into production efficiently and economically, which in turn would promote India's self-reliance in the minerals sector including strategic minerals. This would add to the value of country's mineral production and create viable alternative for import substitution. The proposed R&D facilities will thus form a strong base for mineral beneficiation study on exploration samples for present need and future requirements for country's development. The list of equipments, instruments, quantity and approximate cost is given in table 5.

Table-5**LIST OF EQUIPMENTS & INSTRUMENTS REQUIRED FOR MMPL, IBM, NAGPUR**

Sl. No.	Name of Equipment/Instruments	Quantity	Approximate Cost in Rs. (Lakhs)
(D) LABORATORY SCALE PROCESS EQUIPMENT			
New Facility			
1	Air Jig for Dry Separation	1	100
2	Air Pulsated Batac Jig	1	50
3	Leach Column	1	30
4	High Intensity Disc Magnetic Separator (Dry)	1	30
5	LAARMANN Flotation Cell with external air supply	2	40
Replacement of Existing Facility			
6	Wet High Intensity Magnetic Separator (WHIMS)	1	140
7	Flotation Column	1	50
8	Electrostatic Separator	1	60
9	Electrophoretic Cell for Zeta Potential	1	50
10	Slurry Rheometer	1	30
11	BET Surface Area Analyser	1	40
(E) MINERALOGY - CHARACTERISATION INSTRUMENT			
New Facility			
12	Field Emission Scanning Electron Microscope with Energy Dispersive Spectrometer (FE-SEM with EDS) alongwith Carbon Coating machine and ancillary units.	1	300
Replacement of Existing Facility			
13	Digital X-Ray Diffractometer with Solid State Detector, Search Match Software, PDF-4 Mineral Data and ancillary units	1	200
(F) CHEMICAL - ANALYSIS INSTRUMENTS			
New Facility			
14	Fire Assay Assembly alongwith accessories	1	40
15	Proximate Analyzer alongwith accessories	1	35
	Total		1195

Mode of Procurement: The above mentioned 15 numbers of equipments, instruments and their ancillary units will be procured through GeM bidding.

Time Line for Procurement: Procurement of the above equipment and instruments will be completed within 18 months after approval and allotment of fund.

Sl. No.	Laboratory wise no. of instruments	Approx. Cost in Rs.(Crore)
A	Laboratory Scale Processing Equipment (11 nos)	6.2
B	Mineral Characterization Instruments (2 nos)	5.0
C	Chemical Analysis Instruments (2 nos)	0.75
	Total	11.95

It is earnestly requested that the required funds may be made available through NMET for procurements of the above mentioned laboratory scale mineral processing equipment, characterization and analysis instruments for mineral beneficiation studies on exploration samples at MMPL, IBM, Nagpur.
