No. 16/86/2021-Mines VI
Government of India
Ministry of Mines
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Shastri Bhawan, New Delhi
Dated: 03rd October, 2023

To
Secretary / Principal Secretary,
In-charge of Mining Department,
Major mineral rich State Governments (as per list)

Subject: Guidelines for prevention of misclassification of different grades of iron ore and other minerals.

Sir,

It is informed that the Average Sale Price (ASP) of any specific grade of a mineral is published based on the ex-mine price of that particular mineral grade as declared by the respective lease holders in their monthly returns. The ASP so published is used for payment of various statutory levies to the State Governments such as auction premium and also royalty & contribution to District Mineral Foundation where royalty is fixed on *ad-valorem* basis.

2. Therefore, any misreporting in the grades of the minerals produced to lower the ex-mine prices can lower the ASP of the minerals leading to loss of revenue to the State exchequer. As per Rule 23C of the MMDR Act, 1957, the State Governments are empowered to make rules for preventing illegal mining, transportation and storage of minerals and for the purposes connected therewith.

3. However, considering the significance of the issue and its implications for the mineral rich States, a committee was constituted by Ministry of Mines to *inter-alia* examine the issue of misclassification of different grades of iron ore and other minerals and to suggest measures to prevent misclassification of grades of minerals. The committee had representation from major iron ore producing States and submitted its report on 11.11.2022 and the same is accepted by the Ministry of Mines. .

4. Based on the recommendations of the committee the guidelines to prevent mis-classifiaction of grades of iron ore and other minerals by using technology are enclosed herewith. The implementation of these guidelines will help in ensuring that the State Governments obtain their due share of revenue from mining activities.

5. It is requested that these guidelines may be implemented by the State Governments by suitably incorporating them in the rules framed under Section 23C of the MMDR Act, 1957.

6. This issues with the approval of the competent authority.

Encl: As above

Yours faithfully,

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Enclosure

Guidelines for prevention of misclassification of different grades of iron ore and other minerals

Background

As per Rule 42(3) of the Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016 [M(OAHCEM)CR, 2016] the Average Sale Price (ASP) of any mineral grade / concentrate in respect of a month is the weighted average of the ex-mine prices of the non-captive mines and any merchant sale done by the captive mines, computed in accordance with the provisions of Rule 42(2) of the said rules, the weight being the quantity dispatched from the mining lease area of mineral grade / concentrate relevant to each ex-mine price.

As per Rule 43 of the said rules, the Indian Bureau of Mines (IBM) publishes the ASP of each mineral grade / concentrate removed from the mining leases in a month in a State within 45 days from the due date for filing the monthly returns as required under the Mineral Conservation and Development Rules. The ASP so published is used for payment of various statutory levies to the State Governments such auction premium and also royalty & contribution to District Mineral Foundation where royalty is fixed on *ad-valorem* basis. Any misreporting of the grade of minerals, misrepresentation in production data and illegality in transportation directly affects the revenue accruing to the State Governments.

Under the statutory scheme provided in the MMDR Act, the legislative and administrative powers relating to transportation and storage of minerals have entirely been given to the State Governments. Thus, the State Governments are required to implement robust mechanisms for sampling of minerals, determination of grade and monitoring of transportation to reduce any chances of leakage in its revenues. The rules made under Section 23C of the MMDR Act should be robust enough to check any misreporting in grades of mineral and transportation of non-reported or misreported mineral.

Considering the importance of the matter, the Ministry of Mines had constituted a committee to *inter-alia* examine the issue of misclassification of different grades of iron ore and other minerals and to suggest measures to prevent misclassification of grades of minerals.

Pursuant to the acceptance of the recommendations of the committee, the following guidelines have been framed for implementation by suitably incorporating the same in the rules framed by the State Governments under Section 23C of the MMDR Act, 1957.

Part A: The system of mineral sampling and analysis should have the following essential features

(a) An IT enabled system with no or minimal human intervention should be adopted by all the States.
(b) The system should cover all processes involved, right from mining of mineral, stacking, sampling, issuing of transportation challans, dispatch and transportation of mineral up to the factory/port.
(c) The system should reduce the time taken in sampling, analysis and declaration of grade and the process should take minimum time and space.
(d) Provision should be made for integration of internal system of the lease holder with monitoring system of the State Government at all points of interaction, allowing auto generation and transfer of data to the Government.
(e) As far as possible the system so developed should have the scalability to integrate with Internet of Things (IoT) based equipment, devices and applications.
(f) Technologies used for large and small mines can vary depending on ground situation.
(g) Random physical inspections and regular audit should be integral part of the system.
(h) System must be interoperable, scalable and technology-agnostic.
(i) States may give incentives to the miners to adopt new technologies which will in turn lead to proper monitoring and increase in revenue of the States.

Part B: System developed by the State Governments should have the following technologies

B. (I): IT-based grade information system: State Governments can develop their own IT based grade information system, for unbiased sampling. This also makes the process more secure, efficient and fast. Grade information system developed should have backward and forward integration toward sample analysis and issuing of transport permit. The system should be able to generate alert when there is significant variance in the grade beyond the prescribed tolerance limit. Any manual interventions are to be avoided in the system. IT enabled systems should also have facility of tracing and tracking of transportation of mineral from mine to factory/ port.

B. (II): On the spot sampling and analysis of working seam(s): State Government to conduct on the spot sampling and analysis of grade of iron ore for working seam(s) in a mine. On the spot analysis and result generation can be done by analyzers such as Pulsed Fast Thermal Neutron Activation (PFTNA) analyzers.

B. (III): Automated sampling and analysis: Current system of preparation of stacks and sample analysis through labs is cumbersome, time taking and prone to human interventions. Instead, automatic sample collection system and automated analysis through continuous online analyzers, as explained below, may be considered. This will reduce the chances of misclassification or misreporting of grades. The States should mandate automated sampling and analysis in large mines in a phased manner. The process of automated sampling can be achieved through following options:

a. Continuous online analyzers mounted on cross belt conveyer: The continuous analyzer may be based on technologies such as Laser Induced Breakdown Spectroscopy (LIBS), Pulsed Fast Thermal Neutron Activation (PFTNA), Prompt gamma neutron activation analysis (PGNAA), X-Ray Fluorescence (XRF) or any such suitable advanced technology. In case of mechanized loading systems such as through belt conveyors and loading chute, high frequency laser based online analyser installed above cross-belt system can do away with the need for manual sampling and

analysis. The high frequency data generation will give better chemical composition with superior accuracy. As the initial investment in this type of analysers is higher than other methods and they can only be installed in mechanized loading system, these will be suitable for large mechanized mines. Presently this is being practiced in agglomeration in steel plants for process optimization, and in Limestone mines associated with the Cement Plants. This system will be integrated with the data storage system of the State Governments.

b. Augur based auto-samplers integrated with continuous online analyzers mounted on cross belt conveyer: These types of samplers utilize augur to automatically collect samples from augmented realty (AR) based randomly generated locations from the trucks or other transport systems. The samples get collected into a hopper attached at the top of the augur. These samples are transferred into a chute installed above the conveyer belt. The continuous online analyzers mounted on cross belt conveyer analyze the samples and generates analysis report instantaneously. The mechanism ensures sample integrity and reduces the time of analysis.

Continuous online elemental analyzers reduce sampling time by providing real-time online analysis and provide qualitative analysis of the ore. Another benefit of continuous online elemental analyzers is that they can detect other minerals/ elements present in the ore that were not known earlier to be present in the area such as rare earth elements (REE) or other valuable minerals. In case of sizable presence of such minerals/ elements, the State Government can take measures for securing the recovery of the same.

Cost: The cost of above technology/ systems is as below:

- Cross-belt conveyer sampling system – Rs. 1.5 crore (approx.).
- Auger Sampler System – Rs. 1.5 crore to 2 crore (approx.).
- Initial cost for laser based continuous online analyzers - Rs. 6 crore (approx.) and total operation costs for 10 years - Rs. 7 crore (approx.).

Availability of technology: All these technologies, as discussed above, are currently available in India, except Auger Based Sampler System. The committee had discussed with a technology and equipment supplier of Auger Based Sampler System who have informed that this system can be supplied in India.

B. (IV): Videography of sampling process: Videography of the sampling process should be mandatory and live feed of the process should be available to the State Government officers and lease holders.

B. (V): Random sampling and audit: Surprise sample inspections to be made in a block of 15 days where samples analysed by the continuous analyzer to be collected and analyzed in Government laboratories. For this, random sampling process must be inbuilt in the system by installing auto samplers in the extended conveyer belts after continuous online analyzers installed. Labs conducting verification of samples should be equipped with Inductively Coupled Plasma (ICP) Spectrometers for quick analysis.

Part C: Process for mineral sampling and grade analysis

C. (I): Monthly on the spot sampling and analysis of working seam(s)

At the beginning of each month, the State Government officials to conduct on the spot sampling and analysis of grade of iron ore for working seam(s) in a mine. The lessee shall extract ore/ mineral only from the seam(s) which have been analyzed. In case of change of working seam or any geological interference in the analyzed seam, the lessee shall request fresh grade analysis of the proposed seam to be conducted by the State Government. Seam analysis shall become the basis for fixing the tolerance limit. If the analysis from continuous analyzers (as described below) detects the grade below this tolerance limit, then the State Government can take corrective action such as increasing the number of samples for analysis by continuous analyzers in each batch or recalibration of analysers, etc.

C. (II): Analysis of extracted mineral by online continuous analyzers

Case 1: For mines that are large and having longer operational period:

Applicability: The following process is applicable for mines with (i) dispatch capacity of 10,000 tonnes per day (TPD) or above and (ii) having remaining lease period for 10 years or more, or having remaining resources for 10 years or more as per approved mining plan.

(i)(a) Mines with mechanized loading system-

The lease holder should be mandated to install **cross belt online continuous analyzers** at the dispatch conveyer with auto samplers in the extended conveyer belts after continuous online analyzers for audit sampling. Auto samplers will take samples for audit purposes and for calibration of the analyzer. The real-time analysis data generated would be linked with a centralized data storage and processing system of the State Government. Accordingly, dispatch/ transport permit would be automatically generated through centralized system. Continuous online analyzers should be recalibrated as per the SOP provided by the technology supplier or a Standard can be generated by a Government agency.

(i)(b) Mines with non-mechanized loading system-

The lease holder should be mandated to install **augur-based auto-samplers with cross belt online continuous analyzers**. In this process, dispatch truck or railway wagon would pass through the facility where RFID scanner will scan the RFID tag and create the signature specific to the truck/ wagon. Then, the augur would automatically collect samples from augmented realty (AR) based randomly generated locations from the trucks. The samples would get collected into a hopper attached at the top of the augur. These samples would be transferred into a chute installed above the conveyer belt. The continuous online analyzers mounted on cross belt conveyer will analyze the samples and generate analysis report instantaneously which will be imparted in the RFID tag of the truck/ wagon.

Further, as mentioned in point (a) above, the real-time analysis

data generated would be linked with a centralized data storage and processing system of the State Government. Accordingly, dispatch/ transport permit would be automatically generated through centralized system. Continuous online analyzers should be recalibrated as per the SOP provided by the technology supplier or a Standard can be generated by a Government agency.

These augur auto-samplers should be installed at the mine exit point. If dispatch is done through both truck and railways, the lease holder may install separate augur auto samplers for truck and wagons or an integrated augur auto sampler may be installed for both type of transport.

(ii) Analysis as provided by the cross-belt analyzers, as above, can be monitored by the Government in the similar lines as it is being done for monitoring of environmental parameters by State Pollution Control Boards.
(iii) The cross belt online continuous analyzers should be continually monitored by CCTV cameras sending real-time feed to centralized data storage system of the State Government. CCTV video to be stored for the prescribed period.
(iv) Artificial Intelligence based cameras for differentiating between fines and lumps may be installed.
(v) Surprise sample inspections to be made in a block of 30 days where samples analysed by the continuous analyzer to be collected and analyzed in Government laboratories.
(vi) This method would increase the accuracy in sampling and analysis of mineral before dispatch and increase transparency and trust in the process.
(vii) This method will help in automation of mining activities in large mines. As such many lease holders are already in the process of automating various activities in the mine, this method will integrate in their system.
(viii) The turn-around time from mining of ore till dispatch would drastically reduce from at least 7 days to 2-3 hours, thereby improving their productivity and efficiency.
(ix) The centralized system which collect and process the data for its analysis from each mine, can also be integrated with IBM’s reporting system.

Case 2: For mines that are small and having shorter operational period:

Applicability: The following process is applicable for mines with dispatch capacity of less than 10,000 tonnes per day (TPD) and (ii) having remaining lease period for less than 10 years, or having remaining resources for less than 10 years as per approved mining plan.

(i) These lease holders may also be encouraged by the State Government to implement the same process as suggested for large mines having dispatch capacity of 10,000 TPD or above. However, installation of dispatch conveyer or augur auto samplers and cross belt analyzers may not be viable for small mines due to high cost of installing it.

(ii) Thus, as an alternative for such mines, the State Government should establish common facility having **augur based auto-samplers with cross belt online continuous analyzers for cluster of mines** to analyse samples directly from the dispatch trucks. This facility may be installed at the **common point for cluster of mines**. The State Government already have such common facility for weighment of the dispatch trucks, where this facility of augur auto-samplers with cross belt online continuous analyzers may be installed. Each truck should also be integrated with RFID tagging system.

(iii) Every dispatch truck shall be mandated to pass through the common facility. However, sampling and analysis shall be done randomly of only 10% of the trucks dispatched from a mine in a batch of up to 20,000 tonnes or of such percentage as per the ISO norms of sampling, in the following manner. Random analysis is being recommended to avoid traffic jams and delays due to sampling of each truck.

(iv) Before entering the common facility, the RFID tag scanner/ reader based on Artificial Intelligence (AI) software shall read the information and decide to either allow to the truck further proceed on its journey or direct it to take detour to sampler and analysis facility where auto sampling and analysis shall be done before the

truck is allowed to further proceed on its journey. The AI software shall randomly select only 10% of the trucks dispatched from a mine in a batch of 20,000 tonnes or such percentage as per the ISO norms of sampling, for auto sampling and analysis.

(v) Continuous online analyzers should be recalibrated as per the SOP provided by the technology supplier or a Standard can be generated by a Government agency.

(vi) The process of augur auto-sampling and online continuous analysis should be continuously monitored by CCTV cameras sending real-time feed to centralized data storage system of the State Government. CCTV video to be stored for the prescribed period.

(vii) Artificial Intelligence based cameras for differentiating between fines and lumps may be installed.

(viii) Regular audit samples should also be collected and analyzed separately at government laboratories. Labs should be equipped with Inductively Coupled Plasma (ICP) Spectrometers for quick analysis. Robust Quality assurance and quality control (QA&QC) protocol should be developed by each State Government to ensure that the sample actually being sent to the laboratory being analyzed accurately. For this, certain percentage of the audit samples should be tested and verified from third party laboratory.

C. (III): Payment of royalty and other statutory payments

The royalty and other statutory payments shall be charged on the analysis done by continuous analyzers as given in point (II) above for a batch of 20000 tonnes of mineral dispatched. Seam analysis shall become the basis for fixing the tolerance limit. If the analysis from continuous analyzers detects the grade below this tolerance limit, then the State Government can take corrective action such as increasing the number of samples for analysis by continuous analyzers in each batch or recalibration of analysers, etc.

Part D: Transportation of mineral

D. (I) GPS enabled vehicles coupled with RFID tagging: In mines, outbound loaded GPS enabled trucks can be issued with RFID tags (unique identification) along with records of vehicle No., time, destination, tonnage, grade, etc. All these information can be checked

online at any point of time and at any location such as Govt. weighbridges, common augur auto-sampler facilities, plant location etc. RFID provides automated solutions that monitor trips made by vehicles. RFID enabled weighbridges automate calculation of vehicle bare weight and laden weight, update databases at remote servers and transmit this data to the destination weighbridge for verification of trip made and delivered mineral quantity. RFID based automatic boom barriers may be installed at all the entry and exit points of Mines and Railway Sidings so that only authorized vehicles/ tippers can enter/exit into the mine premises which eliminate the possibility of any pilferage, illegal transportation and helps to regulate vehicle traffic and transportation routes.

D. (II): Pre-registration of mineral carrying vehicles with DMG, Govt. Portals: This enables States to collect details of mineral-carrying trucks and maintain a database of such pre-approved trucks, which can be tracked via GPS at any point of time.

D. (III): Mine Monitoring System and Geo-fencing: Live feed CCTV system may be established at the stacks, weighbridges and entry-exit points. All mine boundaries, unloading points like sidings, stocks, feeder breakers, crusher and bunker, internal transportation routes should be geo-fenced. System checks a defined region to search for any unusual activity. This will enable detection of intrusion of vehicles or transportation of mineral through unauthorized routes. For example, if any truck takes a detour from the pre-defined geo-fenced route it will cause breach of the geo-fence which will generate auto alert to the miners and authorities.

Part E: Use of Block Chain for Accounting from Mine to Factory / Port

There are lot of manual processes and complexity involved in mineral and mining industry right from extraction to end utilization of mineral, whether it is traceability of minerals and ores, grade determination or regulatory compliances. Once ore is extracted from the mine, it changes hands between multiple parties. It creates multiple opportunities for misreporting, because of lack of data transparency resulting in significant revenue loss to the State exchequer. Proper tracking of

value chain and supply chain is required to ensure that minerals are mined responsibly and sustainably and reach its end use destination.

Block-chain is essentially a type of database. Transactions entered into the database are copied and distributed to all participating stakeholders on a network that have to approve the transaction, rather than held by a centralized hub that acts as the regulator. This happens in real time and so increases transparency, efficiency and security among network participants. Entries to the database are secured by encryption and agreed through consensus mechanisms so the network flags up false entries, which 'break the chain'. The longer the chain of entries (chain), the more complex the encryption sequence becomes and the harder it is to corrupt, or hack. This cements the integrity of the data.

Block-chain can be used for self declaration of grades, where the base data generated in the initial period can be compiled to standardize the output grades from a mine. The same standard data can be utilized for continuous self declaration of the grades thereafter. In case of any variation from the standard grades, more than a tolerable limit, an audit request can be generated automatically for any possible re-standardization of the grades.

Block-chain can be also used to track materials in the mining value chain from the ROM to the concentrate and upto metal production. This block-chain technology along with RFID and GPS tracking of transport vehicles can be utilized for better monitoring of mines and transportation operations to address malpractices with regards to gradation of ore and ensuring the right grade ore gets domestically utilized or exported. Block-chain may be utilized to generate colour coded QR tags.

Use of block-chain will not only ensure proper regulatory monitoring but also be helpful to the miners. Block-chain would lead to the automation of invoice reconciliation. Block-chain would improve traceability of reserve estimation for stock exchange reporting and the traceability of inventory into the ERP for inventory management of the resource/reserves. Block-chain can be used to validate the workflow/audit of activities and outputs used in the resource/reserve calculations. If all the mines are brought on to a single platform, it will

help in minimizing the delay in compilation of ASP and a quick reconciliation of payments will be possible.

Accordingly, the block-chain technology may be adopted in mining sector. In the initial stage a pilot project can be undertaken in respect of a high value mineral having less number of mines and end-users, such as gold, copper, zinc, etc. Learning on the outcomes of the pilot project, the model may be replicated in other mines/ minerals.

Part F: Applicability on other ores

The above guidelines, given mainly in the context of iron ore, may be made applicable for all other ores where royalty, auction premium and other payments to the Government are dependent of grade of the ore.

Part G: Additional recommendations

i. Adequate redressal mechanism in case of variation between physical inspection and system-enabled results: State Governments may set up a redressal mechanism and fix a suitable tolerance limit for deviation from the face sample based on available geological data and previous reporting of grades.
ii. Provision to allow dispatch in case of non-functionality of any equipment in the entire system: States may keep a provision to allow dispatch on the basis of grade as per seam/face analysis or the last determined grade, whichever is higher.
iii. The guidelines are of recommendatory in nature and the adoption of the same may be done by the State Government.
iv. The system may initially be implemented on pilot basis, through a PSU and the level of accuracy and detection limits may be cross-verified before full implementation of such system.

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