



SOP for Ore & OB Measurement System

Odisha Mining Corporation Limited

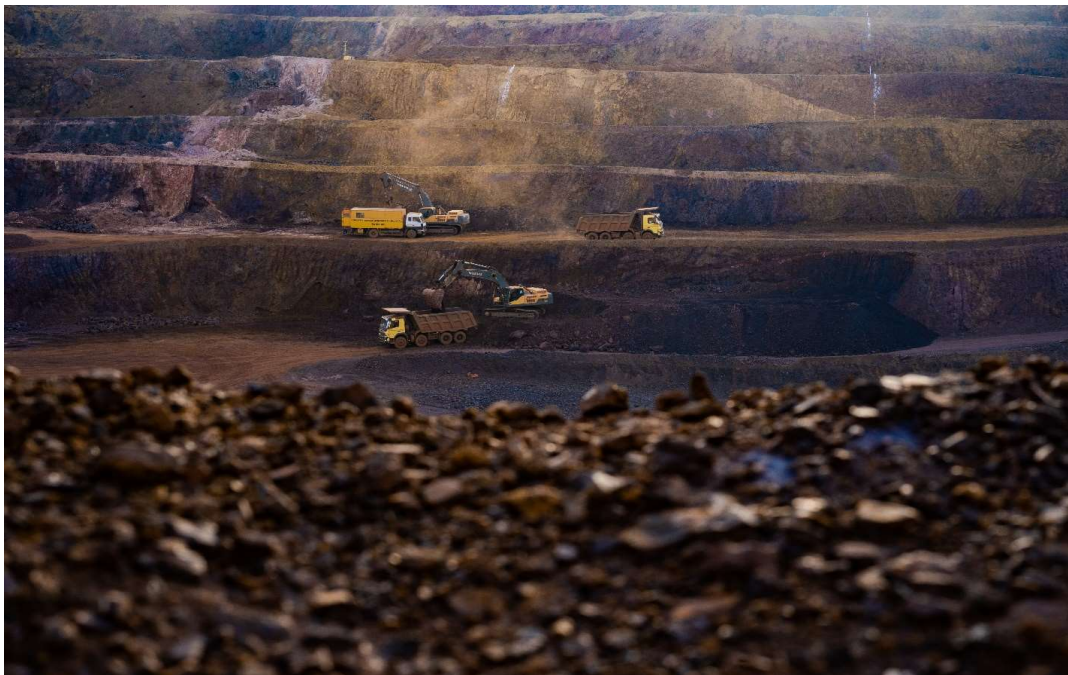


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Glossary of Terms

Abbreviation	Expansion
HO	Head-Office
RA Bills	Running Account
GNSS	Global Navigation Satellite System
LIDAR	Light Detection and Ranging
DTM	Digital Terrain Model
OGL	Original Ground Level
MDO/MO	Mine Developer Cum Operator/Mine Operator
BD	Bulk Density
MIS	Management Information System
RA Bills	RA bills means Running Account (RA) bills issued by the contractor upon completion of part of work
Stock Survey/Stock Verification/Physical Verification	It refers to the process of volumetric assessment of stacks/ore stocks leading to assessment of quantity/ore inventories present
GNSS/GPS	A standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage (GPS)
LIDAR	Lidar is a method for measuring distances by illuminating the target with laser light and measuring the reflection with a sensor
DTM	A digital terrain model is a 3D computer graphics representation of elevation data to represent terrain
OGL	Original Ground level is the true ground level where natural ground can be exposed
Process Coordinator	Process Coordinator is the person immediately accountable for creating, sustaining, and improving a particular process, as well as, being responsible for the outcomes of the process.
Carpet Stock	Carpet stock are the compressed material build up over the original ground above Original Ground Level

1. Introduction

Odisha Mining Corporation (OMC) is the largest State Public Sector Undertaking in mining industry having presence in Iron ore, Chromite, Bauxite, Manganese and Limestone and its foray into Coal Mining is in the offing. Owing to its presence across numerous commodities and large-scale production, OMC has inducted several Mine Operators/MDOs to manage its mining operations. To evaluate the performance of these MDO/MOs, and monitor its own mining performance, it is imperative for the company to conduct regular surveys in order to—

- ✓ Provide initial ground profile for the proposed excavation for handing over to the agencies
- ✓ Certify excavation of Ore and OB for payment of RA bills
- ✓ Conduct annual survey to measure excavation made by Mine Operator/MDO
- ✓ Stock Verification and reconciliation

In absence of standardized SOP for all the above-mentioned activities, OMC faces significant challenge in achieving the above objective and maintain a standard process all across the organization. Therefore, OMC intends to develop a standard operating procedure for measurement of ore and OB across the value chain to achieve the objective in a transparent and time bound manner.

2. Applicability

The provisions of this SOP are applicable to all OMC establishments including but not limited to

- ✓ Head Office & Regional Offices
- ✓ Exploration Establishments
- ✓ Mines (Opencast/Underground)
- ✓ Stockyard
- ✓ Railway Siding
- ✓ Ore Handling Plants (OHP), Silos, Weighbridges and likewise, within OMC establishment
- ✓ Any other premises owned or operated by OMC

3. Type & frequency of Survey

Following types of survey shall be carried out in various establishments of OMC to ensure smooth and transparent operations –

#	Type of Survey	Frequency
1.	Provide initial ground profile before commencement of excavation by MO/MDO	As and when required
2.	Measurement of excavation for reconciliation -	Quarterly

#	Type of Survey	Frequency
	Iron Ore, Bauxite, Manganese and Limestone	
3.	Measurement of excavation for RA Bill Payment	Fortnightly/Monthly
4.	Conduct annual survey to measure excavation made by Mine Operator/MDO at the end of contractual year	Annually
5.	Stock verification by Internal team	Half yearly
6.	Stock verification by External team	Annually

Table 1 Frequency of Survey

4. Safety Precautions to be taken during the Survey

All the rules, regulations, stipulations, and guidelines as per statute and OHSE manual is to be followed during Survey.

5. General Guidelines for carrying out Survey

- ✓ Process Co-Ordinator is the Asst. Manager (Mining) nominated by the Mines Manager. He is responsible to cordon off the area to be surveyed. Operations in the designated area shall either be stopped or managed in such a way that it doesn't hinder the survey process.
- ✓ Survey shall not be started unless all the authorized representatives i.e. members from Mining, Survey, Geology, Mine Operator's/MDO representative (If required) are present at the site and in case of any exigencies, if somebody can't attend due to unavoidable circumstances, the 2nd In command shall be present at the site for survey
- ✓ Every mine shall have a pre-defined geo reference point connected to national grid and survey shall always be started with reference to the permanently fixed benchmark / reference point having known Reduced Level and Northing, Easting with respect to a standard datum
- ✓ Stock Reconciliation exercise shall be carried out by all the mines to maintain uniformity of data provided to IBM, Directorate of Mines, and SAP system and on ground stock. Necessary adjustment and consideration of handling loss may be taken up in this regard as per revised Robust Policy of OMC dated April 15, 2017. (Enclosed as Annexure X)
- ✓ In case of stock verification, the Stock Register/Book (Enclosed as Annexure III) is mandatory, and survey shall not be started unless duly signed Stock Register/Book is provided to the survey team by the Mines Manager.
- ✓ All the SAP entries shall be completed before the stock verification process and such stock entries must be reflected in the stock register/book.

- ✓ In case there is stacking of material in the immediate shift or within 24 hours which has not been booked in SAP, such quantity of material shall be reflected in the stock register/book under category “Quantities not booked”
- ✓ In case of stock verification, the stacking operation and dispatch from the same stack shall be stopped during the survey and separate stack shall be prepared for stacking the ore during aforesaid period

6. Survey Instruments and Accessories

Primarily, Electronic Total Station shall be used for the survey. In such cases, where geographical constraint or accessibility issue restricts the use of Electronic Total Station, emerging technologies such as LiDAR based scanners or drones can be used. These alternate technologies shall be used only after due approval from designated Authority i.e., Director Technical (Operations).

Following are the features of survey instruments which can be used based on their feasibility—

- a. **Electronic Total Station** —Key capabilities of the instrument are laser-based distance measurement, vertical and horizontal angle measurements, and inbuilt memory with basic trigonometric computing. With such instrument, reflector less measurement can be done for distance of at most 100-1000 m. The required accuracy is minimum 1” with the least count of 1”/10”/20” based on the instrument used. The instrument shall be in permanent adjustment, calibrated by authorized service center
- b. **LiDAR based scanners** — Long range laser scanning and integrated high resolution panoramic digital imaging can be done using LiDAR (Light Detection and Ranging) technology. Required accuracy is minimum 6 mm for a maximum range of 2000 meter
- c. **Drones**¹¹ — It is an unmanned aerial vehicle (UAV) used to capture aerial data and is equipped with a downward-facing sensor like RGB or multi-spectral cameras, and GPS. Required accuracy of equipment is 99.8%² and it shall have the capability of generating point cloud maps (Annexure IX)

Apart from the above-mentioned survey accessories, following accessories shall be used in the survey as per the applicability of the survey –

- ✓ Stand
- ✓ Prism
- ✓ PrismPole
- ✓ MagneticNeedle
- ✓ Digital weighing scale
- ✓ Laser distance meter

1. Drones vs Total station for volumetric survey: <https://pdfs.semanticscholar.org/ee62/119a38991c3c492408c2a482d3260c0948e8.pdf>
 2. Accuracy of drones: <https://dudek.com/uav-based-construction-monitoring-delivers-accurate-daily-counts/#:~:text=Throughout%202019%2C%20Dudek%20flew%20daily,is%20prone%20to%20human%20error>

7. Determination of Bulk Density and In-Situ Density

For physical verification/stock verification by internal cross functional team, bulk density measurement shall be done in every 6 months i.e. (November and April).

Following guidelines are laid down for measurement of bulk density—

- ✓ Bulk density shall not be measured in monsoon season
- ✓ Bulk density shall not be measured in the event of cyclonic storm
- ✓ Bulk density of the previous month i.e. bulk density of May shall be used for the entire monsoon period
- ✓ Bulk density determination must be initiated only after the volumetric survey has been completed
- ✓ Mines Manager will nominate Process Coordinator to assist and co-ordinate the entire process of sampling and bulk density test
- ✓ Process Coordinator, survey team members and internal cross-functional team shall be present during the bulk density test

The bulk density & in-situ density measurement data shall be duly signed by Mines Manager & Regional Manager and submitted to Director Technical (Operations) for approval. Once approved, the copy of the same shall be kept at MD's Office, Director Technical (Operations)'s office and the Mines/RO. No changes shall be made in data without approval of Director Technical (Operations).

7.1. Procedure for In-situ Density measurement for stock survey

In-situ density measurement is required in case of conducting annual survey to measure excavation made by Mine Operator/MDO at the end of each contractual year.

Mines Manager of the concerned mines shall make arrangement for in-situ density test through an Internal Cross Functional Team in the presence of authorized representative of Mine Operator/MDO and nominated process coordinator. Once the in-situ density determination is done, the results shall be duly signed by all the witnesses including Process Coordinator and Mine Operator's authorized representative. It shall be countersigned by Mines Manager and such record shall be maintained at Mines Manager's office and a copy shall be submitted to Director Technical (Operations) & Managing Director's Office.

Process – The process involves 4 steps – pit excavation & material collection, plastic sheet spread & water pouring and calculation. Firstly, a square area of dimensions 305mm x 305mm is marked on ground surface, cordoned off by laying plastic sheets or gunny bags and then manually excavated to a depth of 305mm using chisel and hammer while maintaining regular geometrical shape. All the material excavated from the pit is collected in a plastic bag and weighed. Secondly, the pit is laminated with a thin plastic sheet of size 1500mm x1500mm and filled with water completely. Total volume of water used for filling the laminated pit is determined either by pouring premeasured quantity of water into the pit or weighing water vessel before and after pouring water into pit. Finally, in-situ density is calculated by dividing weight of material recovered from pit by the volume of pit i.e., combined volume of water poured and thin plastic. **(All the measurement shall be recorded in format given in Annexure II(A)).** Volume of the pit should not be determined by measuring pit dimensions using tape as this involves significant amount of measurement error. Survey Team shall decide on the number of samples to be drawn after observing the area having compacted material. In case of any doubt, the opinion of the Survey Team shall be final.

7.2. Procedure for Bulk Density measurements for stock survey

The procedure, as prescribed in IS 5842² (Re affirmed 1986) (Enclosed as Annexure VIII) shall be followed for measurement of bulk density by calculation of tonnage of measured material for Internal/External stock verification.

A cubic box of internal dimensions (305mmx305 mmx305 mm) constructed of solid wooden planks, 16mm thick waterproof ply or steel plate with stiffeners, and electronic measurement scale of 100kg capacity (0.50kg least count) and a shovel are required to be used. The survey team shall inspect the instruments at the start of the activity to ascertain their suitability.

Bulk density shall be measured on-site. The box must be inspected by the survey team from OMC and the Length, Width & Height should be measured with a measuring tape before starting the stock verification exercise. At least three readings should be taken for each Length, Width and Height, and average of these readings should be used to calculate box volume. The sample required for test shall be drawn from the stack in such a way that grain size distribution in actual stack is closely replicated.

It is usually observed that coarser particles roll down and settle towards bottom of the heap while smaller particles remain on top and that the moisture content on surface is lower than down.

For each instance of Physical Verification, the weight of empty box must be measured at the beginning and at the end. The average of both reading should be considered as the weight of the empty box. Material from top crust of heap is removed with shovel for at least 500mm or till moist material is encountered. This material is used for filling the cubical box. Moreover, material is collected from near bottom, middle and top of the heap. The box is filled using material collected from different heights in two layers. When half box is filled; the box is tilted sideways by lifting about 25 mm above the floor and tamping forcefully down. The procedure is repeated 25 times. The box is lifted by about 50mm and dropped down to ensure that material fills into cavities of the box. Also, this ensures that material particles settle under their own weight and get interlocked like when they are poured in stockpile. Material is then filled till top of the box with additional material. Compaction effort as applied earlier is again repeated. Any extra material projecting above the top edge of box is removed with a straight edge rod. The material is weighed along with the box using electronic measurement scale. Weight of empty box shall be determined and recorded.

Net weight of material gives bulk density in Kg/Cu mm. It shall be converted to Kg/Cum. or Mt/Cum. by using appropriate multiplication factor.

The number of sample points taken for each stockpile depends on the volume of the heap. The table "Data points to be taken" prepared by survey team provides the minimum number of sample points. The survey team will however be deciding on the sample points based on practical aspects on-site. Average of these readings shall be used for quantity determination.

8. Verification and Declaration of Original Ground Level

Reference of Original Ground Level (OGL) is required in the following type of surveys—

- a. Stock Verification by Internal Team
- b. Stock Verification by External Team (Cross Functional Team from other Mines)

Once the stack is lifted, total ground clearance shall be done to expose OGL. OGL shall be recorded by the Surveyor. Maintenance of OGL data is mandatory.

² Reference: <https://archive.org/details/gov.in.is5842.1986>

9. Procedure for Survey of Ore/OB

9.1. Provide initial ground profile for the proposed excavation for handing over

Before starting of Mining Operations by Mine Operator/MDO, Joint survey shall be carried out by the authorized representatives of OMC and Mine Operator/MDO. Joint determination of initial ground level is essential to decide quantum of excavation done by raising contractor i.e., MO/MDO for payment of RA Bill and to assess annual performance. Following activities shall be carried out before handing over site to the Mine Operator/MDO—

- a. Deputation of site observer by Production Section
- b. Formation of site survey team
- c. Intimation to the Mine Operator/MDO
- d. Conducting Site Survey
- e. Joint Signoff

9.1.1. Deputation of site observer by Production Section

- ✓ Upon the request from Mine Operator/MDO for handing over the operations at site, Mines Manager shall request Regional Manager for conducting site survey.
- ✓ Regional Manager shall request Production Section in OMC Head Office for deputation of site observer for the site handover survey through Email/E-office or any other suitable means.
- ✓ On request of Regional Manager, Head-Production section shall depute at least one site observer from Head-Office or from other regions having requisite experience in Survey with respect to the above-mentioned process.
- ✓ Head-Production section shall provide the final confirmation along with date of survey and site observer details.
- ✓ Upon receipt of confirmation from Head-Production section, Regional Manager shall communicate Mines Manager to intimate the Mine Operator/MDO regarding the date and time of survey.

9.1.2. Formation of Site Survey Team

- ✓ Once the survey date is finalized, Mines Manager shall form a team consisting members from Mining, Geology, Survey & Finance or any other member(s) required from the concerned region out of which at least two persons shall have requisite knowledge/ experience in measurement through Total Station/Drone/LiDAR based scanner and use of Mine Planning Software.
- ✓ In case adequate number of officials are not available, concerned Regional Manager shall request Director Technical (Operations) for deputation of required personnel through formal Email/E-office as the case may be.
- ✓ In case required personnel is available at other regions, Director Technical (Operations) will instruct concerned Regional Manager to relieve the personnel for above stated job
- ✓ Survey team to be headed by RM/ Mines Manager.

9.1.3. Intimation to the Mine Operator/MDO

- ✓ Mine Manager shall intimate the Mine Operator/MDO regarding date of the Joint Survey
- ✓ The Mine Operator/MDO shall be informed at least 3 working days in advance to depute its representative/(s) during the period of initial measurement to check and witness the quarry survey

9.1.4. Conducting Site Survey

- ✓ Site survey is conducted as per the approved date and time communicated by the Head-Production section in the presence of Site Observer from HO or other RO, Site Survey Team, and representative from Mine Operator/MDO
- ✓ Site survey team shall carry out the surveying operations only with the help of Total Station
- ✓ Initial ground level of the mines shall be taken w.r.t the permanently fixed benchmark having known elevation and Northing, Easting with respect to a standard datum and collecting the data of the ground level at regular interval as per ground position and not more than 5 m apart
- ✓ In case 5m interval is not feasible then suitable interval may be taken with the approval of Regional Manager & Observer.
- ✓ No change in reference benchmark shall be allowed, in case of exceptional circumstances new baseline survey to be done to establish the Reference Benchmark point after approval for Director Technical (Operations)
- ✓ At places such as at a spot close to the crest of the bench, if maintaining a 5 m distance is not possible then reading at lesser interval may be taken
- ✓ The survey data shall be downloaded to PC using software provided by the instrument manufacturer. The data shall be imported in processing software. The software uses the Northing, Easting and Reduced Level data for readings to build a DTM
- ✓ The above recorded initial level (in .str/.csv/point cloud format/.sdr) shall be used as base line data for volume computation using suitable Mine Planning software

9.1.5. Joint Signoff

- ✓ The RM shall approve the recorded initial level taken by the survey team in hard copy duly signed by the site observer, members of the site survey committee, Mine Operator's/MDO representative/(s), and Mines Manager
- ✓ Authenticated hard copy along with soft copy shall be retained at Mines Manager's Office, RM office and Production section at HO for future records
- ✓ After the joint sign off and authentication by Regional Manager, Mine shall be handed over to the Mine Operator/MDO.

9.2. Certify Excavation of Ore and OB for Payment of RA bills

This type of survey is used to assess the quantity of excavation done by the Mine Operator/MDO for RA Bill payment. Though frequency of the survey is different for Iron Ore,

Bauxite and Chromite but procedure of the survey remains the same. The following activities to be carried out in this regard —

- a. Formation of Site Survey Team
- b. Intimation to the Mine Operator/MDO
- c. Conducting Site Survey
- d. Joint Signoff
- e. Calculation of Volumes
- f. Calculation of Ore and OB
- g. Reporting in the MIS sheet

9.2.1. Formation of Site Survey Team

Procedure laid down in clause 9.1.2 shall be followed

9.2.2. Intimation to the Mine Operator/MDO

Procedure laid down in clause 9.1.3 shall be followed

9.2.3. Conducting Site Survey

- ✓ Site survey team shall carry out the surveying operations only with the help of Total Station or LiDAR based scanners/Drones (as the case may be), as per the specification furnished above
- ✓ The survey shall be done based on pre-established reference survey stations with known values of Northing, Easting and RL. No change in reference survey stations shall be allowed without a prior written approval from the survey team. In case of any doubts, the decision taken by survey team would be final and binding for all
- ✓ Individual readings shall be recorded and position of the reading point in Northing, Easting and Reduced Level shall be fixed. All readings shall be taken with reference to same datum coordinate system (Local/Universal). Care shall be taken to see that no blank areas are left without readings

9.2.4. Joint Signoff

The Mines Manager shall countersign the recorded measurement duly signed by the members of the Site Survey Team & Mine Operator's/MDO representative/(s). A copy of the above measurement in soft and hard copy shall be kept at Mines & Regional office for record.

9.2.5. Calculation of Volumes

- ✓ The survey data shall be downloaded to PC using software provided by the instrument manufacturer in .str/. dtm/point cloud/.sdr file format.
- ✓ The data shall be imported in processing software. The software uses the Northing, Easting, Reduced Level data for readings to build a 3D model preferably a DTM / String model
- ✓ The volume calculated shall be reported to nearest 2 decimal place
- ✓ The volume derived from this shall be processed at Regional level and record shall be kept at Regional Office & Mines

9.2.6. Calculation of Ore and OB

Following formulas shall be used for calculation of volume as per applicability

Type of Mineral	Type of material	Formula
Iron	CLO	Volume of CLO = Tonnage of CLO delivered at Stockyard after weighment/ Bulk Density of CLO
	Lumps	Volume of Lumps = Tonnage of Lumps delivered at Stockyard/ Bulk Density of Lumps
	Fines	Volume of fines =Tonnage of fines delivered at Stockyard after weighment/ Bulk density of Fines
	Subgrade	Volume of subgrade =Tonnage of subgrade delivered at Stockyard after weighment/ Bulk density of subgrade
	OB	Volume of OB = Total Volume measured – (Volume of CLO+ Volume of Lumps + Volume of fines+ Volume of subgrade)
Chromite	Lumps	Volume of Lumps = Tonnage of Lumps delivered at Stockyard/ Bulk density of Lumps
	Fines	Volume of Fines = Tonnage of Fines delivered at Stockyard/ Bulk density of Fines
	Subgrade	Volume of subgrade =Tonnage of subgrade delivered at Stockyard after weighment/ Bulk density of subgrade
	OB	Volume of OB = Total Volume measured – (Volume of lumps+ Volume of fines+ Volume of subgrade)
Bauxite	Ore	Volume of Ore= Tonnage of Ore delivered at Stockyard/ Bulk density of Ore
	OB	Volume of OB = Total Volume measured – Volume of ore

Table 2Formula for Calculation of Ore & OB

9.2.7. Reporting in the MIS sheet

- ✓ The calculated volume shall be maintained in the MIS as per [Annexure-I](#) maintained in Mines and Regional Offices
- ✓ Such MIS shall also be circulated to Production section through Email
- ✓ Data from this MIS shall be used to certify the quantity of Mine Operator/MDO once the RA Bill is raised

9.3. Conduct Annual Survey to Measure Excavation made by Mine Operator/MDO

Annual survey shall be carried out by the OMC to assess the performance of Mine Operator/MDO after end of a contractual year. The quantity is used for adjustment in the RA Bills. It will be also used for imposing penalty, if any and as an input for decision on renewal of the

contract. Following process shall be carried out to ascertain the volume excavated by the Mine Operator/MDO in the contractual year—

- a. Deputation of site observer by Production Section
- b. Intimation to the Mine Operator/MDO
- c. Conducting Site Survey
- d. Joint Signoff
- e. Calculation of Volumes
- f. Calculation of Ore and OB
- g. Reporting in the MIS sheet

9.3.1. Deputation of Site Observer by Production Section

- ✓ Upon the expiry of the contractual period, concerned Regional Manager shall request Head-Production section to carry out Annual survey to measure the performance of Mine Operator

Procedure laid down in clause 9.1.1 shall be followed for deputation of site observer

9.3.2. Intimation to the Mine Operator/MDO

- ✓ Mine Manager shall intimate the Mine Operator/MDO regarding date of the Joint Survey
- ✓ The Mine Operator/MDO shall be informed in advance to depute its representative/(s) during the period of initial measurement to check and witness the quarry survey

9.3.3. Conducting Site Survey

- ✓ Internal cross-functional team shall carry out the surveying operations only with the help of Total Station or LiDAR based scanners/Drones (as the case may be), as per the specification furnished above.
- ✓ The survey shall be done based on pre-established reference survey stations with known values. No change in reference survey stations would be allowed, without a prior written approval from the survey team. In case of any doubts, the decision taken by survey team would be final and binding for all.
- ✓ Individual readings shall be recorded and position of the reading point in Northing, Easting and Reduced Level shall be fixed. All readings are taken with reference to same datum coordinate system (Local/Universal). Care shall be taken to see that no blank areas are left without readings.

9.3.4. Joint Signoff

- ✓ The Mines Manager shall countersign the recorded measurement duly signed by internal cross-functional team, site observers & Mine Operator's/MDO representative/(s). A copy of the above measurement in soft and hard copy shall be kept at Mines & Regional office for record.

9.3.5. Calculation of Volumes

- ✓ The survey data shall be downloaded to PC using software provided by the instrument manufacturer in .str/. dtm/point cloud/.sdr file format.

- ✓ The data shall be imported in processing software. The software uses the Northing, Easting, Reduced Level data for readings to build a 3D model preferably a DTM /String model.
- ✓ The volume calculated shall be reported to nearest 2 decimal places.
- ✓ The volume derived from this shall be processed at SURPAC Cell-HO and record shall be kept at Regional Office, mines, and HO.

9.3.6. Calculation of Ore and OB

Formulas mentioned in clause 9.2.6 shall be used for calculation of Ore and OB

9.3.7. Reporting in the MIS sheet

- ✓ The calculated volume shall be maintained in the MIS as per [Annexure-II](#) maintained in Mines and Regional Offices
- ✓ Such MIS shall also be circulated to Production section through Email
- ✓ Data from this MIS shall be used to certify the quantity of Mine Operator/MDO for renewal of contract/penalty calculation/RA bill adjustment

9.4. Stock Verification by Internal/Accredited External Team

Stock verification is a process of checking the ore/finished product retained in the stockpile at any point of time after accounting production, sales, and material loss. In OMC there are two types of physical verification -

- a. Stock verification by internal team
- b. Stock verification by accredited external team

Though frequency of both type of verifications are different but the modalities of both processes are exactly same. The frequency of the stock verification is mentioned in the **section 3**. Following steps shall be taken during the survey—

- a. Site preparedness before the survey
- b. Formation of Surveillance Team
- c. Formation of Site Survey Team
- d. Accredited survey agency onboarding
- e. Declaration of pre-requisites before the survey
- f. Stock Verification and Bulk density measurement
- g. Determination of volume and tonnage
- h. Sign off the survey
- i. Submission of the deliverables by accredited external team
- j. Reporting with production section in the MIS

9.4.1. Site Preparedness Before the Survey

- ✓ The stockpiles should be prepared such that their top surfaces are smooth and have geometrically uniform shape
- ✓ Once the survey starts, no movement of material in or out of stackyard takes place and Mines Manager will be responsible for the cut off procedure
- ✓ Required number of workforces shall be arranged by the Mines Manager

- ✓ Unit representative before closure of the survey shall confirm that all the necessary stockpiles have been covered by the survey team

9.4.2. Formation of Surveillance Team and intimation to Regional Manager

- ✓ Production section at HO shall prepare the schedule for Internal/External stock verification for all the mines as per defined frequency
- ✓ Head-Production section shall form a surveillance team with the approval of MD consisting of—
 - At least two surveyors out of which at least one surveyor should have adequate knowledge in use of prescribed survey instruments and software
 - One Geologist
 - One Mining Engineer/Manager (Mining)
 - One Executive from Account Section
- ✓ The above committee shall be headed by a senior official of Mining/Geology discipline of rank E-4 or above and these officials shall not belong to the same mine.
- ✓ Head-Production section shall inform the Regional Manager of the concerned mines regarding the surveillance team and probable date of carrying out Internal/External stock survey.
- ✓ Based on the ground situation, RM shall inform Head-Production section regarding the date of survey. The date of survey shall be finalized through mutual agreement.

9.4.3. Formation of Site Survey Team in case of Internal Stock Verification

- ✓ Site survey team shall carry out Internal Stock verification as per defined frequency in Section 3
- ✓ Once the survey date is finalized, MinesManager shall form a team consisting members from Mining, Geology, Survey & Finance section from the concerned region out of which at least 2 persons having knowledge/ experience in measurement through Total Station/Drone/LIDAR based scanner and use of Mine Planning Software
- ✓ In case of adequate number of officials are not available, concerned Regional Manager shall request Director Technical (Operations) for deputation of required personnel through formal Email/E-office as the case may be
- ✓ In case required personnel is available at other regions, Director Technical (Operations) will instruct concerned Regional Manager to relieve the personnel for above stated job

9.4.4. Accredited Survey Agency Onboarding in case of Stock Verification by recognized external team

For the stock verification, any Government or Government recognized or institute of national repute having experience in physical verification of stocks in the mines shall be onboarded to carry out the survey. Head-Production section shall co-ordinate with the accredited external team and arrange for survey on the agreed date. On arrival of the accredited external team at the site of survey, they shall be provided with following input by the OMC survey team-

- a. Initial ground level of the stacks
- b. Pit profile/stockpile (Northing, Easting, Reduced Level)
- c. Co-ordinate of reference point and location

9.4.5. Pre-requisites before the commencement of survey

The following are the pre-requisites before the start of Internal/External stock verification-

- a. Appointment of Process Coordinator
- b. Declaration of OGL
- c. Handing over the duly signed stockregister/book

9.4.5.1. Presence of Process Coordinator

Before starting Internal/External stock verification, Mines Manager shall appoint a Process Coordinator for the entire process. A process coordinator is—

- ✓ A person having experience in Mining Operation and understanding of stack position, survey etc. and appointed by the Mines Manager
- ✓ He is responsible for coordinating end-to end process of Internal/External stock verification
- ✓ He shall arrange for transportation of the survey team, accredited external team (if any), and surveillance team to mines
- ✓ He is responsible for showing the stack which is to be surveyed to the surveying team
- ✓ It is the responsibility of process coordinator to get the bulk density or in-situ density determined
- ✓ He is also responsible to suspend operations from stacks to be surveyed

9.4.5.2. Declaration of OGL

Original ground level of each stack shall be declared as per section 8.

9.4.5.3. Handing over the signed off stock statement

Before the start of survey, Process Coordinator shall handover the duly signed stock register/book to the surveying team which is, the site survey team in case of internal stock verification and accredited external team in case of external stock verification. The stock register/book shall contain the following information

- a. Name of the Process Coordinator for the survey
- b. Stack wise stock present in the mines
- c. Quantity of material stacked but not booked in SAP
- d. Quantity of material dispatched but not booked in SAP

All the material which has been added in the stack and the material which has been dispatched but not booked in SAP, shall be mentioned in the stock register/book.

All the quantity of production and dispatch shall be booked in SAP within 24 hours. Only those quantity which has been done within 24 hours and not booked in SAP shall be reflected in the stock statement.

The stock register/book shall be duly signed by Mines Manager before it is handed over to the survey team. The stock register/book shall be prepared as per [Annexure-III.](#)

9.4.6. Stock Verification and Bulk Density measurement

- ✓ Before start of the survey, it should be ensured that the operation has been suspended in the concerned stack.

- ✓ It is the responsibility of the Process Coordinator to ensure that no addition and/or sale of material from the stack happens during the period of the measurement.
- ✓ Survey to be conducted by the site survey team in case of Internal Stock Verification and by the accredited external team in case of External Stock Verification
- ✓ In case of any quantity supposed to be stacked during the survey period, it shall be stacked separately
- ✓ In case of any dispatch scheduled from the stack, it shall be taken from some other stack in a staggered manner.
- ✓ Survey shall be done with appropriate equipment as mentioned in Survey Instruments as per section 6.
- ✓ The survey shall be done based on pre-established reference survey stations with known values. No change in reference survey stations would be allowed, without a prior written approval from the Survey Team. In case of any doubts, the decision taken by Survey Team would be final and binding for all
- ✓ The stacks having regular shape with a quantity of 500 tones or less shall be surveyed by conventional tape measurement and volume to be calculated by the geometrical shape of the stack
- ✓ The stacks with a quantity of more than 500 tones shall be surveyed using the prescribed survey instruments and accessories
- ✓ Samples for bulk density shall be taken by external agency parallelly while stacks are being surveyed but Bulk Density Test shall be performed once the stack survey has been completed in the presence of Process Coordinator, survey team (Internal/external as the case may be), and surveillance team
- ✓ Bulk Density Test shall be carried out as per section 7.2.

9.4.7. Sign off the Survey

The Mines Manager and Regional Manager shall countersign the recorded (Northing, Easting, Reduced Level) co-ordinates taken by survey team (Internal/External). A copy of the above signed document shall be kept in soft and hard copy at Mines & Regional Office for record. The following data shall be provided by the accredited external team which shall be duly signed post survey

- a. Nomenclature of survey points (Spot, Crest, Toe etc.)
- b. Northing, Easting and Reduced level of the survey points

9.4.8. Determination of Volume and Tonnage

- ✓ The survey data shall be downloaded to PC using software provided by the instrument manufacturer in .str/. dtm/point cloud/.sdr file format
- ✓ The data shall be imported in processing software. The software uses the Northing, Easting and Reduced Level for readings to build a 3D model preferably a DTM model
- ✓ In case, when 5m interval is not feasible, then the surveyor may decide the interval of cross section. However, it shall not exceed 15 meters.
- ✓ The volume calculated shall be reported to nearest 2 decimal places

- ✓ The volume derived from this shall be processed at Regional level and record shall be kept at Regional Office & Mines
- ✓ The tonnage will be derived as per the formula= $\sum (\text{Total Volume of the Stack} \times \text{Bulk Density of Material})$

9.4.9. Submission of the Deliverables by Accredited External Team

In case of External Stock Survey, the accredited external team shall submit the report within 15 working days. The team shall submit the stock survey report in a standard format. The contents of the report would be detailed out by the survey team.

The survey report should necessarily contain (but not limited to) the following —

- ✓ Final report with yard wise stack wise material volume, area, density, tonnage in the prescribed format.
- ✓ Schematic layout of stack in prescribed format created before cut-off
- ✓ Data points recorded for bulk density measurement by different methods in the prescribed format.
- ✓ Downloaded raw data containing Northing, Easting, Reduced Levels of all surveyed points with necessary coding for all stockpiles, carpet stock area for volumetric survey.
- ✓ The detailed models of stockpiles in .strand .dtm format in both hard and soft copies.
- ✓ The external agency may be asked to provide videos (captured using standard electronic gadgets such as cell phones, cameras, etc.) of each bulk density measurement process and sample collected for quality testing.

9.4.10. Reporting with Production Section in the MIS

- ✓ The calculated volume shall be maintained in the MIS as per [Annexure-IV \(A&B\)](#) maintained in Mines and Regional Offices along with the variance
- ✓ Such MIS shall also be circulated to Production section through Email

10. Capacity Building

OMC shall put utmost focus on capacity building to implement physical verification practices efficiently and sustain those practices in the long run. Training and development will play vital role in achieving the overall objectives. Following trainings shall be imparted to the Surveyors and Mining Engineers preferably at the age of below 35 years

- a. Microsoft Office
- b. Drone Surveying and interpretation of point cloud maps
- c. SAP PP

All the attendees shall be nominated by the Mines Manager of concerned mines and upon recommendation to GM (P&A), such trainings shall be organized at OMC level.

Annexures

11. Annexure

11.1. Annexure I: Format for Monthly / Fortnightly / Quarterly Survey

Outcome of Fortnightly/Monthly/Quarterly Survey			
Date	__/__/__		Mine Name
Period of Survey	From	To	Name of the MO/MDO
	__-__	__-__	
Calculation of Volume of Ore			
Material type (as applicable) (1)	Tonnage of Material (2)	Bulk Density of Material (3)	Volume of Material (2÷3)
CLO			
Lumps			
Fines			
Sub grade			
Total			
Total Volume Measured (In Cu.M.)(A)	Total Volume of Ore (in Cu.M.) (as calculated above) (B)		Volume of Waste (in Cu. M.) (C=A-B)

To be duly signed by-

Name & Signature of team members with date

11.2. Annexure II: Format for Annual survey

<i>Outcome of Annual Survey</i>			
Date	__/__/__		Mine Name
Period of Survey	From	To	Name of the MO/MDO
<i>Calculation of Volume of Ore</i>			
Material type (as applicable) (1)	Tonnage of Material (2)	Bulk Density of Material (3)	Volume of Material (2÷3)
CLO			
Lumps			
Fines			
Sub grade			
Total			
<i>Total Volume Measured (In Cu.M.)(A)</i>		<i>Total Volume of Ore (in Cu.M.) (as calculated above)(B)</i>	<i>Volume of Waste (in Cu. M.) (C=A-B)</i>

To be duly signed by-

Name & Signature of team members with date

11.3. Annexure II (A): Format for In-situ Density Measurement

Format for In-situ Density Measurement							
S. No.	Name of Region	Name of Mines	Date of Measurement	Time of measurement	Weight of material recovered from pit	Volume of pit	In-situ density (col. 6/ col. 7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

To be duly signed by-

Name & Signature of team members with date

11.4. Annexure III: Format for Stock Register / Book

<i>Stock Register/ Book for the year 20__ - __</i>								
Name of Mines	Material type	Opening balance as on 1 st April of financial year	Production (in MT)	Received from other locations	Total (3+4+5)	Sales/ Transport to other locations	Closing Balance (6-7)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

To be duly signed by-

Name & Signature of team members with date

11.5. Annexure IV (A): Format for Stock Verification Report

Stock and Grade-wise difference calculation sheet of _____ for the year 20__ - __									
(As per Annual Physical Ore Verification Statement)									
S. No.	Name of Region	Name of Mines	Size & Grade ³	Closing Balance in MT as of 30 th Sept/31 st March	Calculated verified balance in MT as of 30 th Sept/ 31 st March	Difference in quantity in MT	Shortage (S)/ Excess (E) in MT	% of difference (Col 7)/(Col5) * 100	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

To be duly signed by-

Name & Signature of team members with date

³Individual entries shall be made for each product (Grade and size wise)

11.6. Annexure IV (B): Format for Stock Verification Statement

Stock Verification Statement for the year 20__-__											
Name of Mines	Material type	Opening balance as on 1 st April of financial year	Production (in MT)	Received from previous year	Total (3+4+5)	Sales/ Transport	Closing Balance (6-7)	Verified closing balance as on 30 th Sept/ 31 st March of financial year	Difference (8-9)	Total (6+7)	Handling Loss % (Col 10)/ (Col 11) *100
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)

To be duly signed by-

Name & Signature of team members with date

11.7. Annexure V: Our Approach and Methodology

We have undertaken following initiatives to prepare this SOP.



Figure 1: Our Approach

11.8. Annexure VI: As Is Process for Ore & OB Measurement

11.8.1. Provide initial ground profile for the proposed excavation for handing over

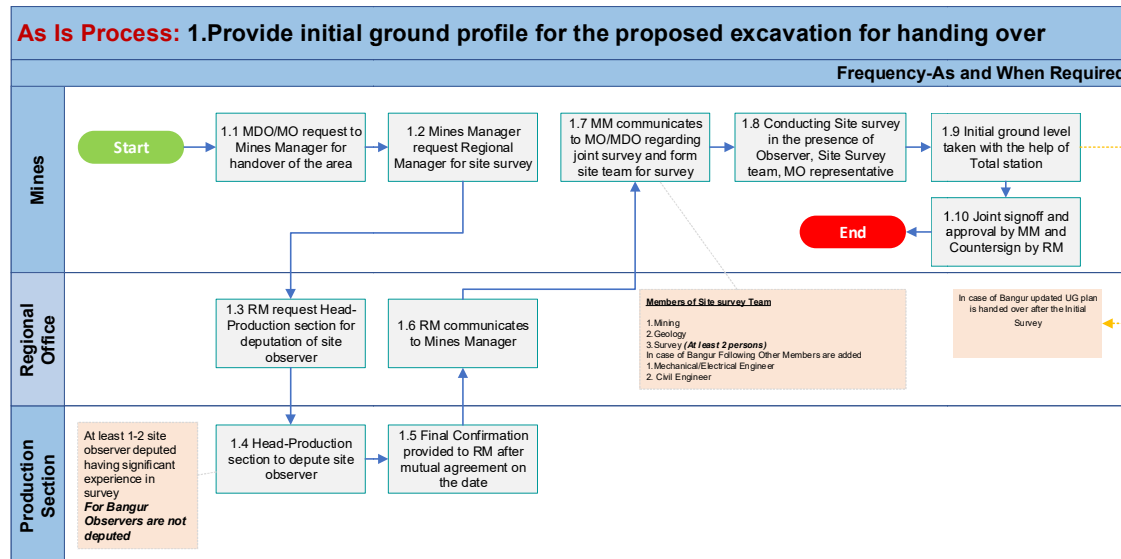


Figure 2: As Is Process-Initial hand over

11.8.2. Certify excavation of Ore and OB for payment of RA bills

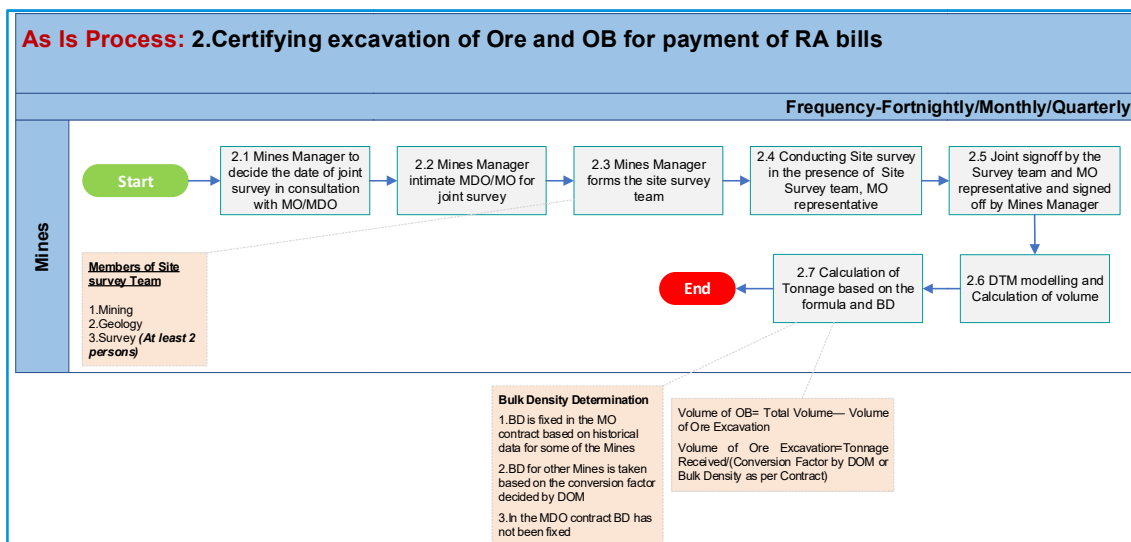


Figure 3: As Is Process-JMC for RA Bill⁴

⁴ Modification in Model Tender Document with respect to Bulk Density determination shall be done as per the revised guidelines, in line with the SOP

11.8.3. Conduct annual survey to measure excavation made by Mine Operator/MDO

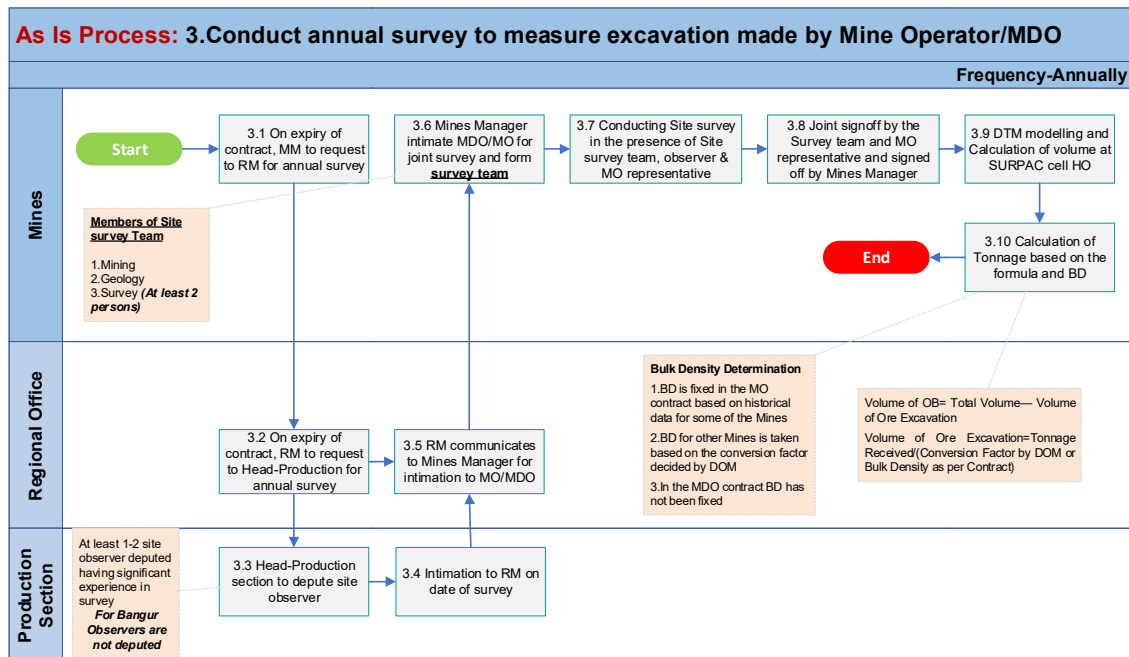


Figure 4: As Is Process-Annual Survey

11.8.4. Physical Verification of Stocks

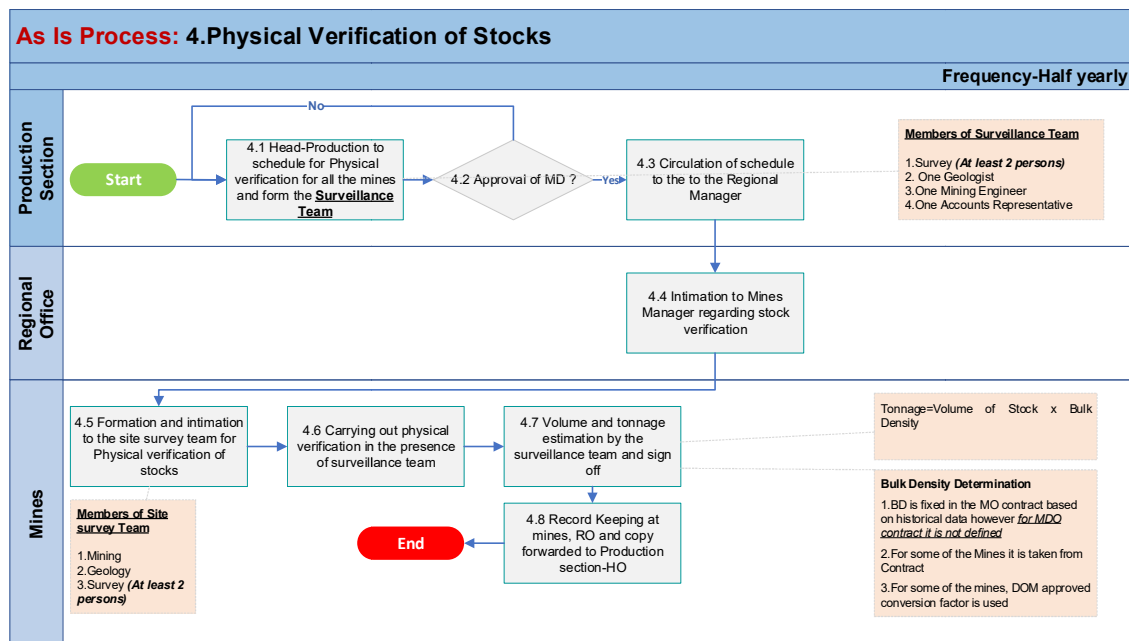


Figure 5: As Is Process-Physical Verification

11.8.5. Overall Snapshot of As Is Process of OMC

Area	Sub Area	Daitari	KIOM	GIOM	Rayagada
Survey for Initial Handover	Deputation of Site observer by HO	✓	✓	✓	✓
Annual survey to certify for Mine Operator's excavation	Deputation of Site observer by HO	✓	✓	✓	✓
Survey for Certification of excavation of ore and OB for payment of RA bills	Frequency	☒ ⁵	Quarterly	Quarterly	Quarterly
RA Bill Payment to Mine Operator	Volume/Tonnage	Tonnage on Transport	Tonnage at Stack through WB	Tonnage at Stack through WB	Tonnage at Stack through WB
Conversion from Tonnage of Ore to Volume of Ore	Conversion Factor/BD as per Contract	On tonnage basis	As per Contract ⁶	As per Contract	As per Contract
Bulk Density for Physical Verification	Conversion Factor/BD as per Contract	Previous DOM data	Previous DOM data	DOM data/ 3 rd Party Analysis Report	Previous DOM data

Area	Sub Area	South Kaliapani	Sukrangi	Bangur
Survey for Initial Handover	Deputation of Site observer by HO	✓	✓	☒
Annual survey to certify for Mine Operator's excavation	Deputation of Site observer by HO	✓	✓	☒
Survey for Certification of excavation of ore and OB for payment of RA bills	Frequency	Fortnightly/ Monthly	Fortnightly/ Monthly	Half Yearly
RA Bill Payment to Mine Operator	Volume/Tonnage	Volume= Tonnage at WB/Conversion factor (DOM)	Volume= Tonnage at WB/Conversion factor (DOM)	Tonnage at Stack through WB
Conversion from Tonnage of Ore to Volume of Ore	Conversion Factor/BD as per Contract	As per Contract	No conversion done ⁷	As per contract
Bulk Density for Physical Verification	Conversion Factor/BD as per Contract	Previous DOM data	Previous DOM data	Previous DOM data

Figure 6: Snapshot of As Is Process

⁵ Payment is based on weightment as there is no OB in the mine

⁶ Varies from time to time on sole discretion of OMC

⁷ Volume of OB is ascertained by subtracting Volume of Ore from Total Volume

11.9. Annexure VII: To Be Process for Ore & OB Measurement

11.9.1. Provide initial ground profile for the proposed excavation for handing over

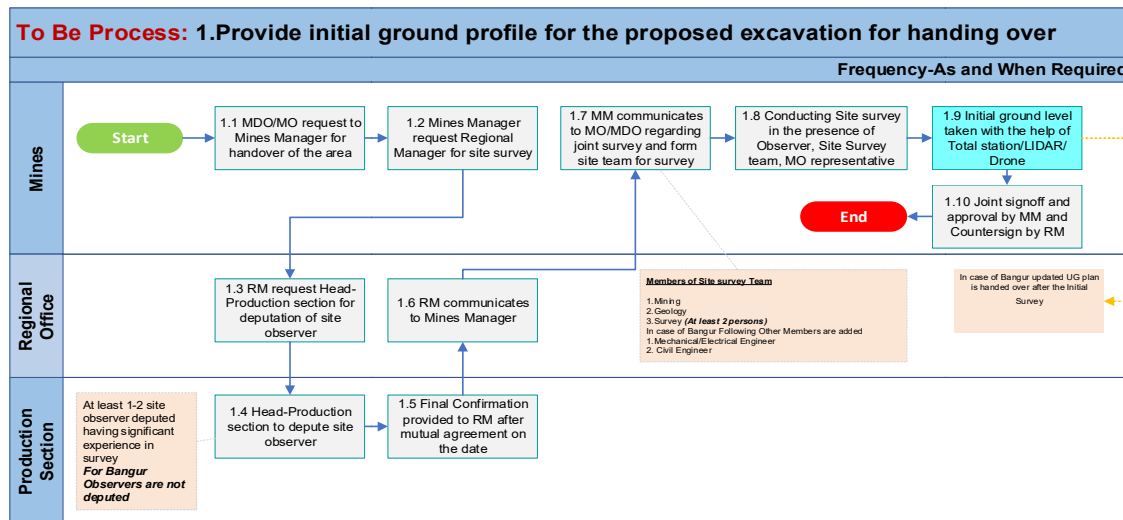


Figure 7: To Be Process-Initial hand over

11.9.2. Certify excavation of ore and OB for payment of RA bills

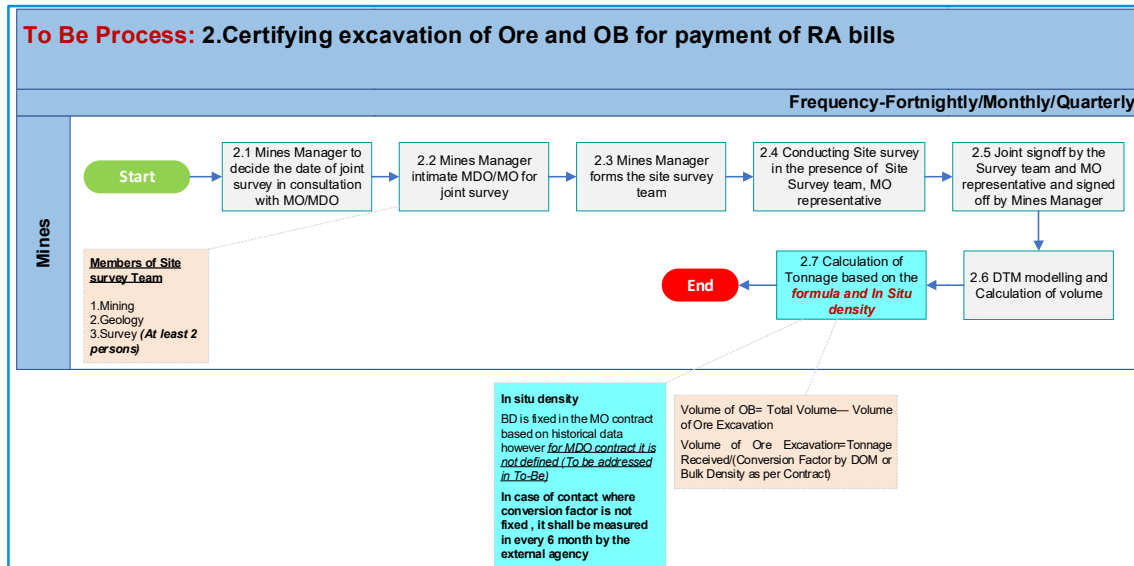


Figure 8: To Be Process-JMC for RA Bill

11.9.3. Conduct annual survey to measure excavation made by Mine Operator/MDO

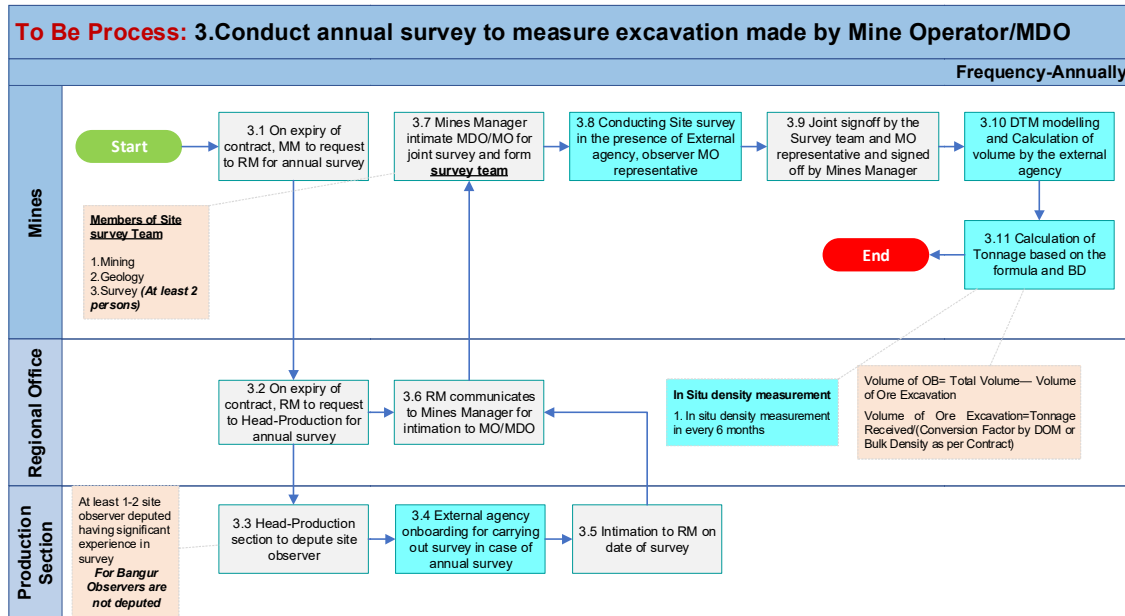


Figure 9: To Be Process-Annual Survey

11.9.4. Physical Verification of Stocks

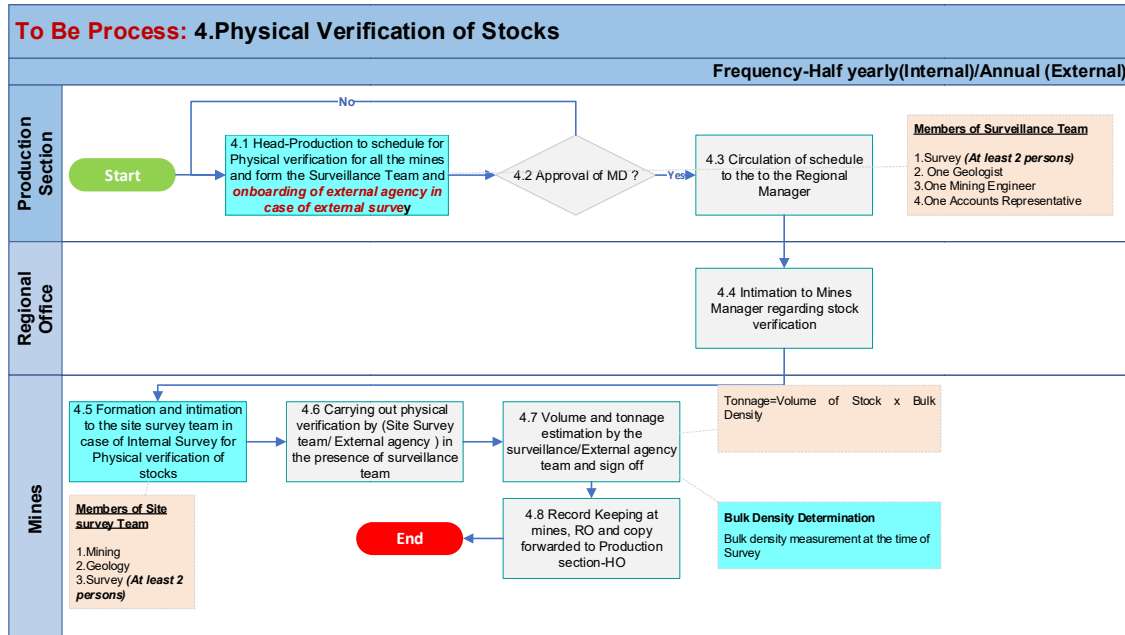


Figure 10: To Be Process Physical Verification

11.10. Annexure VIII: IS 5842 – Method for measuring bulk density

REAFFIRMED

2008

IS : 5842 - 1986
(Superseding IS : 5843)

Indian Standard

REAFFIRMED

METHOD FOR
MEASURING BULK DENSITY OF IRON OXIDES:
LUMP ORES, SINTER AND PELLETS

(First Revision)

UDC 622.341.1'188.5 : 531.755.22

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 2

May 1987

IS : 5842 - 1986
(Superseding IS : 5843)

Indian Standard

METHOD FOR MEASURING BULK DENSITY OF IRON OXIDES: LUMP ORES, SINTER AND PELLETS

(*First Revision*)

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(Continued on page 8)

I

IS : 5842 - 1986
(Superseding IS : 5843)

Indian Standard

**METHOD FOR
MEASURING BULK DENSITY OF IRON OXIDES:
LUMP ORES, SINTER AND PELLETS**

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 1 December 1986, after the draft finalized by the Ores and Raw Materials Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1970. In this revision the contents of IS : 5843-1970 ' Method for measuring the bulk density of iron ore and iron ore agglomerates including sinters in a large container (applicable for size over 40 mm) ' have been suitably merged for the convenience of the user for measuring bulk density of iron ores, pellets and sinter, irrespective of the sizes.

0.3 Knowledge of bulk density of ores and agglomerates is often required during transportation, calculation of masses of stockpiled material *in situ*, designing of plants related to ore handling and in ore dressing.

0.4 The method prescribed in this standard is equally valid for other minerals and may be applied when need arises.

0.5 In the preparation of this revision, assistance has been derived from ISO/DP 3852 'Iron Ores — Method of bulk density test', formulated by the International Organization for Standardization (ISO).

0.6 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard prescribes the method for determining the bulk density (in tonnes/m³) of iron ores (lumps, sized ores, fines, concentrates) and agglomerates including sinter and pellets.

*Rules for rounding off numerical values (*revised*).

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2. TERMINOLOGY

2.0 For the purpose of this standard, the following definition shall apply.

2.1 Bulk Density — The mass in air, at a stated temperature of a unit volume of the material in question including the voids within and between particles.

NOTE — Moisture content and size distribution are two main factors which affect bulk density. The moisture content and the size distribution shall be reported alongwith the bulk density value to ensure proper interpretation.

3. SAMPLING

3.1 The sampling of iron oxides : lump ores, sinter and pellets for the purpose of conducting the test shall be as per IS : 1405-1982*, IS : 11607-1986† and IS : 9101-1979‡.

3.2 The sample shall be of sufficient quantity to fill the container, used for the measurement, three times, with a small overflow and also to provide for the determination of size distribution, moisture content and chemical analysis.

3.3 The bulk density test may be carried out on natural air-dried material. If the test is to be made on oven dried material using a small container, the sample shall be dried at $105 \pm 5^{\circ}\text{C}$.

4. TEST APPARATUS

4.1 Measure for Sample — Any large container such as a truck or a railway wagon of regular geometrical shape with smooth inner surfaces of walls and bottom and in good condition shall be taken. The container shall have sufficient capacity to holds when filled a minimum of 10 tonnes of sample to a minimum height of sample bed of 500 mm.

NOTE — For iron ore lumps, sinter and pellets of sizes less than 40 mm, a cylindrical metal container, having an internal diameter of 400 ± 2 mm and internal height of 400 ± 2 mm (volume : 0.05 m^3) may be used. The container shall be constructed of metal of sufficient thickness to ensure the rigidity of the walls and base of the container under the conditions of the test. The container shall be reinforced by a steel band around the top and shall have four handles, separated by 90° , attached to the outer surface by welding.

4.2 Scales — A weighing apparatus, preferably of the platform type having a capacity commensurate with the masses to be determined and a sensitivity of around 1/100 of full deflection.

*Methods of sampling iron ore (first revision).

†Methods of sampling iron ore sinters.

‡Methods of sampling iron ore pellets.§

5. PROCEDURE

5.1 For Large Container

5.1.1 Weigh the empty container. Measure the length, width and height of the container within an error of 0.1 percent and calculate its volume.

5.1.2 With the container on a level surface, carefully discharge the sample into it in such a manner as to minimize breakage. Level the upper surface by sliding a straight edge across the top of the container and removing the pieces which obstruct the passage of the straight edge. In filling the container care should be taken to avoid obvious segregation of lumps and fines.

5.1.3 Reweigh the filled container.

5.1.4 Calculate the bulk density according to the formula given in 7.1.

5.1.5 Repeat the test using the same or a second container of similar capacity.

5.2 For Small Cylindrical Container

5.2.1 *Loose Mass Determination*

5.2.1.1 The dry container shall be weighed and the mass recorded to the nearest 0.1 kg. Calculate the volume of the container within an error of 0.1 litre.

NOTE — The volume of the container may be calculated by first recording the mass in g of water required to fill the container. The mass of the water so obtained shall be expressed in litres.

5.2.1.2 The container shall be filled to overflowing by means of a shovel or a scoop, the material being discharged from a height not exceeding 50 mm from the surface of the material inside the container. Care shall be taken to prevent obvious segregation of the particle sizes of which the sample is composed. The surface of the sample shall then be levelled off with a straight edge in such a way that any slight projections of the sample above the top edge of the container shall approximately balance the voids in the surface below the top of the container.

5.2.1.3 The filled container shall be transported to the weighing scale without loss of material from the container. The net mass of the sample shall be determined by weighing the filled container to the nearest 0.1 kg and subtracting from this, the mass of the empty container.

5.2.2 *Compact Mass Determination*

5.2.2.1 The container shall be filled in three approximately equal layers. When the mass of the sample permits manual handling each

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layer shall be compacted by placing the measure on a firm foundation such as a concrete floor and raising alternate sides of the container about 25 mm above the floor and allowing it to drop in such a manner as to hit the floor with sharp, slapping blow. By this procedure, the sample particles will arrange themselves in a closely compacted mass. Each layer shall be compacted by raising and dropping the container 25 times. When the mass of the sample requires mechanical handling this raising and dropping of the container may be done by use of a small crane pulley set up. If a vibrator is to be used, the empty container shall first be firmly attached to the vibrator platform and filled in three approximately equal layers while in this position, each layer being compacted by vibration. The surface of the compacted sample shall then be levelled off with a straight edge as in 5.2.1.2 and weighed as in 5.2.1.3 and the bulk density calculated as in 7.1.

6. NUMBER OF TESTS

6.1 The test shall be made in duplicate. If the results of the two tests do not meet the permissible tolerance specified in 8, a third test shall be carried out. If any two results of the three tests meet the tolerance requirement, the respective two values, together with their mean value shall be reported. If any two results do not comply with the tolerance limits, all the three values together with their mean value shall be reported. The mean value shall be reported to the first decimal place.

7. CALCULATION

7.1 The bulk density of the sample, as measured, expressed in tonnes per cubic metre, shall be calculated to the second decimal place by means of the following formula:

$$\text{Bulk density} = \frac{M_1 - M_0}{V}$$

where

M_1 = is the mass, in tonnes, of the container plus the sample (or in kilograms when smaller container is used *see 5.2*);

M_0 = is the mass, in tonnes, of the empty container (or in kilograms when smaller container is used, *see 5.2*); and

V = is the volume, in cubic metres of the container (or in litres when smaller container is used *see 5.2*).

7.2 The final bulk density shall be obtained as indicated in 6.

PERMISSIBLE TOLERANCE

.1 The results of duplicate determinations carried out by the same operator, with the same apparatus on the samples from the same consignment and taken in succession shall not differ by more than 0.1 tonne/m³.

.2 The permissible tolerance as specified in 8.1 applies only to samples taken at one point only that is at point of loading or at point of discharge. No tolerance is stated for samples taken at these two different locations, as transport of the sample involves the risk of size degradation and consequent variation in bulk density.

9. TEST REPORT

.1 The test report shall include the following:

- a) Identification of the test sample (that is lumps, fines, concentrate, pellets and sinter);
- b) A statement of the condition of the sample as tested. That is natural, air dried (or oven dried);
- c) Identification of the measured values whether determined as loose or compact mass;
- d) Measured values of all tests and their mean value;
- e) Date and method of calibration of the container;
- f) Statement of the capacity and sensitivity of the weighing device;
- g) Percent moisture content of the sample;
- h) Size distribution of the sample showing percent on each sieve;
- j) Total iron content of the sample; and
- k) Reference of this Indian Standard.

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11.11. Annexure IX: Comparison of survey results during Drones' trial at OMC

STOCK ID	Volume in Cubic Meters(Aerial Survey)	Volume in Cubic Meters(TS Survey)	Volume in Cubic Meters(Laser Scanner)	% Deviation between both Drone and LS survey	% Deviation Between LS and TS Survey
Heap 1	35819.747	35571.502	35559.48	0.73	0.03
Heap 2	102.07	104.172	100.877	1.18	3.27
Heap 3	149.714	150.435	145.029	3.23	3.73
Heap 4	53.036	55.719	51.783	2.42	7.60

Table [5]: Stockpile volume generated by all three different modes of survey.

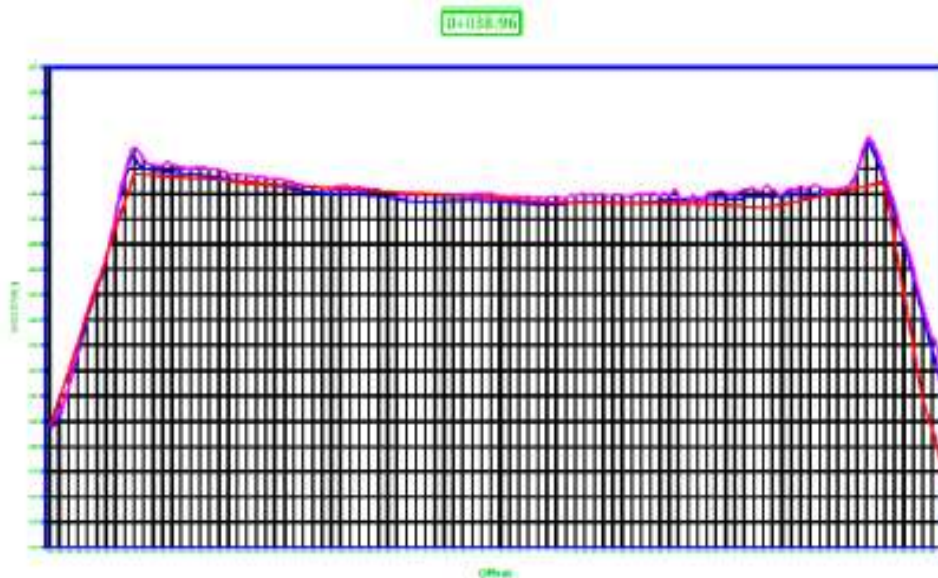


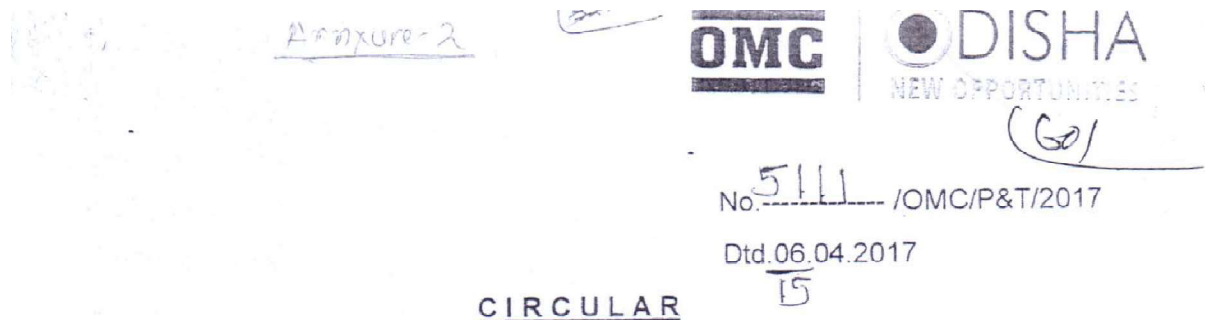
Fig [11]: View of CS of Heap-1 where red line depicts TS surface, blue line shows the LS surface and the magenta line shows the drone surface.

Cross-Sections of the stockpiles are available in annexure 1 of this report for your perusal.

Technology	Survey Timespan	Manpower	Instruments used
TS	2 Hours	3	1 TS and 2 Prisms
LS	3 Hours	1	1 LS
Drone	1 Hours	1	1 Drone

Table [6]: Comparison of Manpower and Survey Time.

11.12. Annexure X: Robust Policy



CIRCULAR

Sub: Revised robust policy on the physical verification process of ore of the Odisha Mining Corporation Ltd.

The Board of Directors in its 420th meeting held on 27.03.2017 have approved the following policy on the physical verification process of ore of the Odisha Mining Corporation Ltd.

(A) NEW ORE STACKS TO BE ON GROUND WITH INITIAL LEVEL RECORDED:-

- (i) No new ore stack shall be made without taking initial level of the stacking ground w.e.f. 1.4.2017. The stacking ground shall be planned in advance, properly levelled & initial recorded before stacking of material.
- (ii) RM shall constitute a committee consisting of field officials of Mining, Geology, Finance & Survey wing of the Region/Mines to record the initial level of the new stacking ground.
- (iii) The RM shall approve the initial level taken by the committee and a copy of the above initial in soft & hard copy duly authenticated by the Members of the Committee & RM shall be retained at Mines, Regional Office and Production Section, HO for record.
- (iv) The above recorded initial level shall be used for computation of the volume of the ore stack.

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3) PHASING OUT OF ORE STACKS HAVING UNKNOWN BOTTOM CONTOUR:-

- (i) It is decided to freeze the stacks with unknown bottom contour at different mines. For the purpose, it is decided to discontinue stacking of fresh ore on the existing ore stacks with unknown bottom contour w.e.f. 1.4.2017. The Regional Manager concerned shall prepare a list of all such stacks having unknown bottom contour as on dtd.31.3.2017 and send the same to Production Section, HO for record.
- (ii) It is decided that unless the ore stacks having unknown bottom contour is exhausted completely, no sale of same variety of ore (grade & size of ore) shall be made from the fresh stacks. As and when ore from any such stack is completely exhausted, the same information shall be intimated to Production Section, HO for record.
- (iii) All effort shall be made to exhaust the ore stacks having unknown bottom contour at the earliest. Production Section, HO in consultation with the concerned Regional Manager & G.M. (S&M) HO, shall workout a time bound action plan for complete exhaustion of the ore stacks not having known bottom contour. The said action plan shall be placed before the meeting of the Audit Committee of the Board within one month from the approval of the policy.

(C) CONVERSION FACTOR (CF):

- (i) Determination of accurate Conversion Factor of the ore stocks is very crucial for estimating the quantity of ore in a particular stack. Conversion Factor of ore stock may vary due to compactness caused by the self-weight of the ore & plying of HEMMs on the ore stack.
- (ii) All RMs with the help of their analytical agency shall assess the Conversion Factor of old ore stacks as well as fresh ore stacks of the mines under their region. RM shall constitute an internal Multi-Disciplinary Committee who shall supervise the procedure adopted by the analytical agency to arrive at the conversion factor. One official from the Office of the concerned Dy. Director of Mines/Mining Office shall also be invited to witness the process. The Conversion Factor(s)

derived in the process shall be used judiciously for the purpose of computation of weight of the ore stock during the Ore Verification Process. This process shall be completed by 31.3.2017 & the report indicating the Conversion Factors(s) derived shall be kept at the Mines, Regional Office & Production Section, HO for record. This process of determining the CF shall be done once in every year and the record shall be made available to the Annual Physical Verification team for the purpose of computation of tonnage.

(D) VOLUME CALCULATION:

- (i) The stacks having regular shape with a quantity of around 10,000 MT or less (as per book of accounts) shall be measured by conventional tape measurement and volume to be calculated by the geometrical shape of the stack and the quantity shall be estimated by applying approved conversion factor.
- (ii) The stacks having quantity more than 10,000 MT shall be measured by using Total Station and volume shall be computed by SURPAC and the quantity shall be estimated by applying approved conversion factor.
- (iii) As the initial level of the ore stacks is required to calculate the volume of the ore stacks, a high level internal Multi-Disciplinary Committee shall be constituted by HO to freeze the initial level of the ore stacks having unknown bottom contour which shall be used to arrive the volume of the ore stacks till its exhaustion. The committee shall submit its report within 1.4.2017. A copy the Committee's report along with recommended initial level shall be kept at the mines, Regional Office & Production Section, HO for record.

(E) FREQUENCY OF PHYSICAL ORE VERIFICATION:

- (i) The physical ore verification of each mine shall be done by the end of 1st quarter & 3rd quarter by the internal committee of the same mine.
- (ii) Apart from the above quarterly ore verification, Half yearly and Annual ore verification shall be conducted during the 1st week of October and April respectively by committee constituted by HO.
- (iii) Production Section, HO with the approval of the MD shall constitute committee comprising of the following officials (not belonging to the same mine) for undertaking Half yearly/Annual verification of Ore Stock at different mines/locations.
 - (i) Two surveyors out of which at least one surveyor should have adequate knowledge in use of Total Station and SURPAC
 - (ii) One Geologist.
 - (iii) One Mining Engineer/ Manager (Min)
 - (iv) One executive from Account wing.

The above committee shall be headed by a Sr. Official of Mining/Geology discipline of rank E-4 or above.
- (iv) Before arrival of verification team required bush cleaning/accessibility to the stacks / proper shaping/ terracing and any other ancillary work required to smoothly carry out the measurement shall be completed by the concerned Manager(Min) of the mines in charge of the ore stock.
- (v) Location of the stacks with internal nos.(not the no. used for the purpose of stack removal) are to be shown in a surface plan prepared & authenticated by concerned officials and handed over to the verification committee during the physical verification.

ADJUSTMENT OF BOOKS OF ACCOUNTS:-

- (i) Adjustment in the books of accounts shall be made only after complete exhaustion of particular ore stock(s) by deducting the handling loss from the book stock. For this purpose, stacking of a particular variety of ore shall be discontinued in the old stock(s) from a particular date preferably 1st April of the year. Thereafter the same variety of ore produced shall be stacked on new ore stack with initial level recorded. Sales of the said variety of ore shall be made only from the old ore stacks till complete exhaustion. After complete exhaustion, the difference between the book balance and the sold quantity till that particular date shall be considered as handling loss. In case the above handling loss is within the permissible limit as approved by the Board in its 402nd meeting, correction of books of accounts will be made after obtaining due approval of the MD by the Production Section. If, the % of handling loss is beyond the permissible limit, the matter shall be placed before the Board for decision on case to case basis.
- (ii) In all cases except the above described procedure for accounting the handling loss, the tolerance level of discrepancy in quantity of ore noticed between book balance and verified balance shall be within 5%, and the book balance shall be kept intact for maximum three years w.e.f. financial year 2016-17. If at the end of three years, the stock remains, then provision for negative variation quantity shall be made.

In case the discrepancy in quantity is beyond 5%, the said variety of ore stock (grade & size) will be re-verified by a higher level team constituted by HO & action will be taken as per recommendation of the team after due approval of MD.

Revised Robust Policy

Odisha Mining Corporation Limited



1 Introduction

Odisha Mining Corporation Limited (OMC) is the largest State Public Sector Undertaking in mining industry having presence in Iron ore, Chromite, Bauxite, Limestone, Manganese, other Major & Minor (Decorative) minerals. Owing to its presence across numerous commodities and large-scale production, it is imperative for OMC to maintain the policy for physical verification & accordingly adjustment in the books of account to be done to maintain high levels of transparency.

The purpose of this policy –

- To set out the standard for physical verification of the ore/product stocks
- To prescribe the permissible limit for the variation in the quantity of ore/product
- To establish the procedure for adjustment in the books of account

There are existing norms on ore loss in OMC mines, circulated vide letter no. 14600/OMC/P&T/2013 dated 16-Nov-2013 and robust policy on the physical verification process of ore, circulated vide letter no 5111/OMC/P&T/2017 dated 15-April-2017. This policy will supersede the existing norms to make the policy robust.

2 Applicability of this Policy

The provisions of this policy are applicable to all OMC establishments including but not limited to

- Head Office & Regional Offices
- Mines (Opencast/Underground)
- Stockyard situated inside/outside of the Mining Lease area where OMC is owner of the product
- COBP
- Ferro-Chrome Plant
- Railway Siding within the Mining Lease area
- Railway Siding located outside of the Mining Lease area where the transportation of products & Loading are done by OMC

3 Ore Stock Yard

- Every new ore stock yard shall be made in the area earmarked for ore stacking in the approved Mining plan. Before commencement of stacking, the area shall be planned in advance & properly levelled. Stockyard shall be developed and maintained to ensure proper storage of size-wise and grade-wise Product/Ore.
- Each finished product stock shall be allotted with a unique identification number by respective Mine Manager. The same shall be communicated to respective Regional Manager & Production Section, HO.
- Details like area, location, grade, size, unique identification number to be displayed on board fixed at every stockyard.
- For every new stock yard, recording of original ground level (OGL) is mandatory.

4 Measurement of Original Ground Level (OGL)

This section outlines the procedures for managing stockyard with unknown or known original ground levels (OGL).

4.1 Measurement and declaration of OGL of stock having unknown/assumed initial level -

- Stacking of fresh ore on the existing ore stockpile with unknown or assumed initial level shall be discontinued w.e.f. notification of this policy. Any fresh stacking on stockpiles with unknown/assumed OGL requires prior approval from the Managing Director through Production Section and Director (Operations).
- **Existing Stockyards:**
 - Operating Mines:** Complete exhaustion of existing stockpiles with unknown/assumed OGL to be done within six months from the notification of the policy.
 - Non-operating Mines:** Complete exhaustion of stockpiles to be done within six months of readiness for operationalization of mine.
- **Extensions:** If complete exhaustion of stocks are not possible/feasible within the initial timeframe, approval of Managing Director to be taken by Production Section with justifications through Director (Operations) for time extension subject to maximum 3 years. In case of legal/statutory constraints preventing exhaustion of stockpile within 3 years, justification must

be provided by the Regional Manager to the Managing Director through Production Section for further action. This justification must be reviewed every year until the stockpile is exhausted.

4.2 Measurement and declaration of OGL for stocks having known Initial level -

- **Recording Initial Levels:** When a new stackyard is required to be created, the Mines Manager/Regional Manager must inform the Production Section (HO). Accordingly, Production Section shall constitute a committee consisting of field officials of Mining, Geology & survey wing not belonging to the same mine to record the initial levels as mentioned in clause no. 8 of SOP of Ore & OB Measurement.
- **Approval and Retention:** The Regional Manager shall approve the recorded initial level taken by the committee. A signed copy (soft and hard) of the record will be maintained in the Mine, Regional Office, and Production Section, HO for future reference.
- **Periodic Exhaustion of Stockyard:** Each stockpile must be completely exhausted once in every three years. In case of legal/statutory constraints preventing exhaustion of stockpile within 3 years, then justification must be provided by the Regional Manager to the Managing Director through Production Section for further action. This justification must be reviewed every year until the stockpile is exhausted.

5 Physical stock verification

5.1 Type & frequency of physical survey -

The following frequency of different types of physical surveys shall be carried out in various establishments –

Table 1 Frequency of Survey

#	Type of survey	Survey Instrument	Existing Frequency mentioned in SOP of Ore & OB Measurement	Recommended Frequency & Timing
1	Stock verification by Internal survey team constituted by HO	Total Station or Drone as per discretion of Director (Operation)	Half Yearly (Point no. 3.5 of approved SOP of Ore & OB Measurement)	Half Yearly (End of Second quarter & Fourth quarter)

2	Stock verification by External team	Total Station or Drone as per discretion of Director (Operation)	Annually (Point no. 3.6 of approved SOP of Ore & OB Measurement)	Annually (End of Third quarter)
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5.2 Formation of Survey Team for physical stock verification

5.2.1 Formation of Internal Survey Team for physical stock verification -

The formation of internal survey team for physical stock verification is mentioned in the approved SOP of Ore & OB measurement as clause no. 9.4.3. This clause (9.4.3) is amended as mentioned below -

- Production section at HO shall prepare the schedule for Internal stock verification as per defined frequency in section 5.1.1.
- The Production Section with due consultation with the concerned section shall constitute an internal survey team with the approval of Managing Director.
- The internal survey team shall consist of
 - Surveyor – 2
 - Geologist - 1
 - Representative of Mining section - 1
 - Representative of Finance section - 1
- The above-mentioned survey team shall be headed by a senior official of Mining/Geology discipline of rank E-4 or above and these officials shall not belong to the same mine.
- Production section shall inform the Regional Manager of the concerned mines regarding the internal survey team and period of carrying out stock survey.
- Internal survey team shall carry out internal stock verification as per procedure mentioned in SOP of Ore & OB Measurement.

5.2.2 Onboarding of Reputed Survey Agency for physical stock verification as external team

The onboarding of the reputed survey agency for the purpose of physical stock verification by external team is mentioned in the approved SOP of Ore & OB measurement as clause no. 9.4.4. This clause (9.4.4) is amended as mentioned below -

- For the purpose of physical stock verification by external survey agency, any Government or

Government recognized institute of national repute or reputed private agency having experience in physical verification of stocks in the mines shall be onboarded to carry out the survey.

- Production section shall co-ordinate with the external survey agency & schedule the date of survey and inform the Regional Manager of the concerned mines regarding the external survey team and period of carrying out stock survey.
- In case, onboarding of reputed survey agency is not possible due to some unavoidable circumstance, the survey shall carry out by the internal survey team constituted as per clause 5.2.1 of this policy with the approval of the Managing Director. The member of the internal survey team constituted for this purpose should not be the same as those conducting the survey at the Second & Fourth quarter.

5.3.1 Physical stock verification by internal survey team of OMC

The physical stock verification by internal survey team of OMC to be done as mentioned below –

- a) Site preparedness before the survey** – As mentioned in clause 9.4.1 of SOP of Ore & OB measurement.
- b) Formation of internal survey team for physical stock verification** – As mentioned in clause 5.2.1 of this Policy.
- c) Pre-requisites before the commencement of survey** – As mentioned in clause 9.4.5 of SOP of Ore & OB measurement.
- d) Stock verification** –
 - Before start of the survey, it should be ensured that the operation has been suspended in the concerned stack.
 - It is the responsibility of the Process Coordinator to ensure that no addition and/or sale of material from the stack happens during the period of the measurement.
 - Survey to be conducted by the internal survey team.
 - In case of any quantity supposed to be stacked during the survey period, it shall be stacked separately.
 - In case of any dispatch scheduled from the stack, it shall be taken from some other stack in a staggered manner.
 - Survey shall be done with appropriate equipment as mentioned in survey

instruments as per section 5.1 of this policy.

- The survey shall be done based on pre-established reference survey stations with known values. No change in reference survey stations would be allowed, without a prior written approval from the Head – Production Section.
 - The stacks having regular shape with a quantity of 500 tones or less shall be surveyed by conventional tape measurement and volume to be calculated by the geometrical shape of the stack.
 - The stacks with a quantity of more than 500 tones shall be surveyed using the prescribed survey instruments and accessories.
- e) **Sign off the survey** – As mentioned in clause 9.4.7 of SOP of Ore & OB measurement.
- f) **Determination of Volume and Tonnage** – As mentioned in clause 9.4.8 of SOP of Ore & OB measurement.
- g) **Reporting with Production Section in the MIS** – As mentioned in clause 9.4.10 of SOP of Ore & OB measurement.

5.3.2 Physical stock verification by external team

The physical stock verification by external survey team of OMC to be done as mentioned below –

- a) **Site preparedness before the survey** – As mentioned in clause 9.4.1 of SOP of Ore & OB measurement.
- b) **Onboarding of external survey team for physical stock verification** – As mentioned in clause 5.2.2 of this Policy.
- c) **Pre-requisites before the commencement of survey** – As mentioned in clause 9.4.5 of SOP of Ore & OB measurement.
- d) **Stock verification** –
- Before start of the survey, it should be ensured that the operation has been suspended in the concerned stack.
 - It is the responsibility of the Process Coordinator to ensure that no addition and/or sale of material from the stack happens during the period of the measurement.
 - Survey to be conducted by the reputed external team.
 - In case of any quantity supposed to be stacked during the survey period, it shall be

stacked separately.

- In case of any dispatch scheduled from the stack, it shall be taken from some other stack in a staggered manner.
 - Survey shall be done with appropriate equipment as mentioned in survey instruments as per section 5.1 of this policy.
 - The survey shall be done based on pre-established reference survey stations with known values. No change in reference survey stations would be allowed, without a prior written approval from the Head – Production Section.
 - The stacks having regular shape with a quantity of 500 tones or less shall be surveyed by conventional tape measurement and volume to be calculated by the geometrical shape of the stack.
 - The stacks with a quantity of more than 500 tones shall be surveyed using the prescribed survey instruments and accessories.
- e) **Sign off the survey** – As mentioned in clause 9.4.7 of SOP of Ore & OB measurement.
- f) **Determination of Volume and Tonnage** – As mentioned in clause 9.4.8 of SOP of Ore & OB measurement.
- g) **Submission of the Deliverables by Reputed External Team** – As mentioned in clause 9.4.9 of SOP of Ore & OB measurement.
- h) **Reporting with Production Section in the MIS** – As mentioned in clause 9.4.10 of SOP of Ore & OB measurement.

6 Conversion Factor

- Determination of accurate conversion factor of the ore stockyard is very crucial for estimating the quantity of ore in a particular stock. Conversion factor of ore stock may vary due to compactness caused by the self-weight of ore & plying of HEMMs on the ore stack.
- The conversion factor shall be determined product & size wise.
- Conversion factor shall be determined by a reputed external agency for the determination of Bulk density/Loose density/Conversion factor.
- Conversion factor shall be determined once for every new stockpile.
- The procedure for Bulk density/Loose density/Conversion factor measurement for stock survey shall be done as mentioned in clause 7.2 of SOP of Ore & OB measurement.

7 Adjustment in the books of account

7.1 Stocks having unknown/assumed OGL -

7.1.1 For Non-Operative Mines –

- Stocks with unknown/assumed OGL must be completely exhausted within six months from the operationalization of the mine or extension thereof & the quantity shall be adjusted after complete exhaustion of stocks by deducting the handling loss quantity from the books of account.

7.1.2 For Operative Mines –

- Stocks with unknown/assumed OGL must be completely exhausted within six months from the notification of the policy or extension thereof & the quantity shall be adjusted after complete exhaustion of stocks by deducting the handling loss quantity from the books of account.

7.2 Stocks having known OGL -

- Stocks with known OGL must be completely exhausted once in every three years or extension thereof & the quantity shall be adjusted after complete exhaustion of stocks by deducting the handling loss quantity from the books of account.

7.3 Provisioning in Accounts for non-exhausted quantity during a Year / upto the period of 3 years -

- Financial provisioning to be made in the accounts annually for handling loss quantity based on the annual physical ore verification statement for the stockpiles not completely exhausted.

7.4 Handling Loss Calculation -

- The calculation for handling loss will be the book balance of the particular stock minus physical verified balance at the time of fourth quarter divided by total quantity handled. The total quantity handled will be the sum of opening balance, Receipt & Dispatch during the fiscal year.
- Handling loss is to be computed based on the quantity handled in that particular stock since inception of the stockyard or last assessed year whichever is earlier. The maximum permissible % of loss will be 0.60% per annum for the stock.
- The formula for Handling Loss is -

$$\text{Handling loss (\%)} = ((\text{Book balance} - \text{Physical verified balance (MT)}) / \text{Total quantity handled (MT)}) \times 100$$

Where:

- Book balance = Book balance at the time of stock exhaustion (MT)
- Physical verified balance = Physical quantity verified in the fourth quarter (MT)
- Total quantity handled = Opening balance + Receipt + Dispatch (MT)

7.5 Approval for Adjustments in Books of Accounts

- If handling loss quantity of the stock falls within the permissible limit (0.60% per annum), then adjustment in the books of account will be made after obtaining due approval of the Managing Director.
- If the handling loss quantity of the stock is beyond the permissible limit as prescribed above, the matter shall be placed before the Board with proper justification & adjustment in the books of account will be made as per recommendation of Board.

7.6 Management of non-moving stocks or discontinued products

- Non-moving Stockpiles containing less than 1,000 MT of ore or discontinued products for more than two years and, shall be sold or to be converted to other product or to be merged in one stock having the same grade range & same physical size after the weighment subject to a one-time measure within one year of notification of the policy.
- If exhaustion or conversion or merging isn't possible/feasible due to unavoidable circumstances, the justification of the same to be given by Regional Manager to Managing Director through Production Section (H.O.) for further course of action. This justification will be reviewed annually until the stockpile is exhausted, converted or merged.

7.7 Transit loss during truck transport -

- There is loss in mineral quantity occur during the road transportation due to various reason such as spillage, dust emission & vibration. This loss is known as Transit loss. So, there is adjustment to be done in the books of account for such Transit loss.
- The transit loss to be considered only when ore is weighed at both source & destination of OMC whether inside the lease or beyond that.
- The Transit loss will be the loss in the quantity during transportation divided by the quantity loaded at the source. The maximum permissible % of Transit loss will be 0.40% per annum.
- The formula for Transit Loss is -

$$\text{Transit Loss (\%)} = \left(\frac{\text{Quantity loaded (In MT or Cum)} - \text{Quantity received (In MT or Cum)}}{\text{Quantity loaded (In MT or Cum)}} \right) \times 100$$

Quantity Loaded = Quantity loaded at the Source (In MT or Cum)

Quantity Received = Quantity loaded at the Destination (In MT or Cum)

- If the transit loss quantity of the stock falls within the permissible limit (0.40% per annum), then adjustment in the books of account will be made after obtaining due approval of the Managing Director.
- If the transit loss quantity of the stock is beyond the permissible limit as prescribed above, the matter shall be placed before the Board with proper justification & adjustment in the books of account will be made as per recommendation of Board.

8 Policy Review Guidelines

- To keep the policy updated and relevant after implementation, it shall be reviewed time to time but not later than 5 years as management feel appropriate to incorporate any new technological improvements, process improvements and infrastructural developments, that shall improve the process.
- After implementation of this policy, Production section should communicate the board about the efficacy of this policy once in every year.
- The incorporated changes in the policy shall be approved by the board before implementation across OMC.