

Standard Operating Procedures under sub rule (5) of rule 34A of MCDR, 2017 for carrying out drone survey and submission of Digital Aerial Images of Mining areas to Indian Bureau of Mines

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Introduction

To leverage the use of technology, it has been proposed to use a combination of digital aerial (Drone and satellite) images to monitor mining activities in the country.

The digital aerial images as an emerging technology is increasingly being used in agriculture, environmental, geology, mining, town planning and forestry applications and other applications.

Through Satellite imagery, one can view the activities that took place on the ground without human interventions. This can be applicable to the mining sector and mining activities can be monitored through the space. Based on the time series satellite imageries for different periods, change detection study in the mining activities of a mine could be studied mainly pertaining to lateral changes in a broad view. Volumetric calculations can also be done based on stereo pair satellite imageries with certain degree of error.

Drone, typically operate at much lower altitudes as compared to satellites and are also able to provide unique data with regard to spatial resolution and angle of view. Compared to satellite images, drone images can provide lower ground sample distances (GSD) or higher spatial resolutions on the ground.

Drone technology can be extensively applied in the mining sector, i.e. for

- i. Carrying out overall survey of mine for monitoring the mining and allied activities in and around the mining area.
- ii. Lease boundary demarcation using the Ground Control Points (GCPs) and geo-referencing of the leases, monitoring of illegal mining activities etc.
- iii. Volumetric estimation of excavation, reclamation and periodical stock piles monitoring.
- iv. Change detection analysis over a period of time using previously surveyed data.
- v. Monitoring of land use and environmental impact in and around mining area.
- vi. Virtual inspection of mines for regulatory purpose.
- vii. Preparation of contour survey and survey map for filing to various regulatory agencies as well internal use of the industry.

The advantages of Drone Survey are

- (i) Drone Survey in mining improve the overall efficiency of large mine site and quarry management by providing accurate and comprehensive data detailing site conditions in a very short time.
- (ii) The data accuracy and authenticity is better than the traditional survey.

- (iii) High resolution (cm level) data of Drone provides high accuracy and more precise volumetric measurements than traditional surveying methods.
- (iv) Stockpiles of irregular shape and exhibiting craters can be easily surveyed with great precision than using traditional methods.
- (v) Drone Survey is faster, less human intervention in mine and easily-repeatable mining surveys at low cost.
- (vi) Changes between two surveys can be tracked and highlighted automatically.
- (vii) Drone aerial images can be used to generate point clouds, digital surface models, digital terrain models and a 3D reconstruction of a mining site, including its stockpiles.
- (viii) Helps in creating a digital data base which can be used and retrieved at ease and compared.
- (ix) Data generated over a period of time can be stored in digital platform and the time series data can be compared. The data can be used for systematic and scientific mine closure planning, monitoring of reclamation, rehabilitation activities in lease area.

With the above objectives in view, Government of India, Ministry of Mines has amended Mineral Conservation and Development Rules (MCDR), 2017 in the year 2021 requiring submission of digital images by the lessee/ preferred bidders to the IBM. The provisions of rule 34A of MCDR are as follows:

“Rule 34A —(1) *Every lessee having—*

- (a) *an annual excavation plan of one million tonne or more in a particular year; or*
- (b) *leased area of fifty hectare or more,*

shall carry out a drone survey of the leased area and upto hundred metres outside the lease boundary in the month of April or May every year and submit the processed output [digital elevation model (DEM) and Orthomosaic] images obtained from such survey or any other format as may be specified by Indian Bureau of Mines to the Controller General, Indian Bureau of Mines on or before 1st day of July every year:

(2) Every lessee, other than those covered under sub-rule (1), shall submit soft copy of high resolution Georeferenced Orthorectified Satellite images of the leased area and upto hundred metres outside the lease boundary taken in the month of April to June of every year, to the Controller General, Indian Bureau of Mines on or before 1st day of July of the that year in the standards formats such as GEOTIFF along with metadata, or any other format as may be specified by Indian Bureau of Mines in this regard:

Provided that the lessee who has submitted images under sub-rule (3) shall not be required to submit the images under this sub-rule for the year in which images are submitted under sub-rule (3).

(3) Every lessee shall carry out a drones survey of his leased area and upto hundred metres outside the lease boundary within six months before submission of any mining plan document or modification thereto to the Indian Bureau of Mines for approval and shall submit processed output [digital elevation model (DEM) and Orthomosaic] images obtained from such survey to the concerned Regional Controller of Mines and the Controller General, Indian Bureau of Mines along with the application for approval or modification of mining plan:

Provided that the lessee who has submitted the images under sub-rule (1) on or before the 1st day of July falling immediately before submission of mining plan document, shall not be required to submit the same under sub-rule (3).

(4) All preferred bidders who are issued with a letter of intent for grant of a mining lease shall carry out a drone survey of the mining block granted through auction and upto hundred metres outside the block boundary and submit the processed output [digital elevation model (DEM) and Orthomosaic] images obtained from such survey along with the mining plan to the Regional Controller and the Controller General, Indian Bureau of Mines.

(5) The standard operating procedure for carrying out the drone survey and form of the data to be submitted shall be specified by Indian Bureau of Mines from time to time:

Provided that the Indian Bureau of Mines may prescribe any alternate mechanism for survey and submission of data or images other than the mechanism specified in sub-rules (1) to (4), in case of any restriction on use of drones under any law for the time being in force regulating the use of drones”.

Accordingly the following standard operating procedure is proposed to be followed for carrying out drone survey and submission of digital aerial images and satellite imageries to IBM by the mineral concession holders.

PART-I

Standard Operating Procedure for carrying out Drone Survey and submission of digital images to Indian Bureau of Mines.

(See sub rule (1) and (5) of Rule 34A of Mineral Conservation & Development Rules, 2017.

1. Drone Agency Registration and Permissions

Registration with IBM is not required for taking up the drone survey in mining areas. Drone Agencies desirous to undertake mine surveys shall adhere to all the rules, regulation, guidelines etc. notified by Directorate General of Civil Aviation (hereafter referred as DGCA) from time to time. Drone Survey must be conducted as per rules prescribed by the Ministry of Civil Aviation.

The survey may also be carried out by lessee themselves by following all the applicable rules and guidelines as mentioned above.

Prior to flying of Drone, the lessee shall check the airspace map published by DGCA in the given link <https://digitalsky.dgca.gov.in/airspace-map/> or published by DGCA from time-to-time and shall obtain necessary DGCA permission prior to flying in Red and Yellow zones.

2. Drone Specification

Drones used for the survey should be DGCA approved and should possess mandatory safety features as notified by DGCA from time to time.

3. Sensor/Camera Specification and output data resolution:

The camera used in the Drone should be of minimum 20 mega pixel or above resolution RGB camera with capability to capture high quality undistorted pictures. Camera should have the resolution to capture the images less than 5 cm Ground Sample Distance (GSD) or 5 cm per pixel.

The Resolution of Digital Elevation Model (DEM) should be 15 cm per pixel or better.

4. Drone flying path and flying height:

In order to ensure the generation of a height model photogrammetrically (e.g. Digital Surface or Digital Terrain model, DSM & DTM), images should be acquired with proper overlap. The Drone survey should be planned in such a way that the forward (front) overlap should be minimum 80% and lateral (side) overlap should be minimum 70%.

The Flying Height of the Drone should be as per DGCA prescribed limits, however, the resolution of the Drone image should be very high i.e. up to

5cm GSD or 5cm per pixel or better. Camera angle nadir direction should be vertically downwards (90-degree angle) while carrying out survey.

5. Survey Area:

The survey should cover the entire mining lease area capturing all mining, allied activities and **100m** beyond periphery of the mine lease boundary to monitor the environmental impact and ascertaining any excavation therein. The flight path plan & the numbers of flights taken to cover the entire area shall be provided to IBM along with the output data. For leases having common mine boundary, the survey may be limited up to the lease boundary for the sides the lease shares common boundary with another lease.

6. Ground Control Points (GCPs) for Drone Survey:

Before undertaking Drone Survey, each mine must establish at least five GCPs per sq. km. of lease area or part thereof with calibrated/certified DGPS instrument. If the area is less than one sq. km. the minimum GCPs required shall be four nos. The GCPs should be well distributed all over the Survey area. GCP must be easily visible in the images obtained from Drone survey. The Dimensions of GCPs thus established should be minimum 50 cm by 50 cm (marked as X with high contrast colours). At least three permanent GCP shall be placed at undisturbed locations and has to be covered in the subsequent surveys to cross check the error in change detection and other analysis. The error of GCP should be less than 5 cm. The Boundary pillars should not be considered as permanent ground control points.

7. Drone Survey Time

In order to maintain consistency in quality of images, it is recommended to carry out the Drone survey in better light condition when the sun is overhead to minimise the shadows in photographs and it is also suggested to avoid partly cloudy days and high winds.

8. Co-ordinate Reference system

The Co-ordinate reference system to be used for acquiring the Drone survey images will be Geographic Coordinate System (GCS) with WGS84 Datum and Decimal Degrees / Degree Minute Seconds as units. The ortho-mosaic shall be submitted in the Universal Transverse Mercator (UTM) with WGS-84 datum and units as Meters. The GCPs survey data and boundary pillar co-ordinates data shall be submitted in latitude and longitude (Deg. Min. Sec.) format in WGS 84 datum. The precision of the data submitted in GCS with WGS84 Datum should be in the format as (DD MM SS.SSSSSS)".

9. Preservation of Raw and Processed Data

As per rule 34A of MCDR 2017, Lessee shall submit processed output images obtained from drone survey to IBM. The lessee shall keep the raw

and processed data of each survey in safe custody with them for a minimum period of five years and if at any stage the raw and processed data are required by IBM for verification purpose then the same will be made available to the IBM.

10. Data output and formats

The following data output will be provided by each lessee to IBM for the preceding financial year;

Sl. No.	Data type	Format
1.	Orthomosaic image of lease area including 100m buffer zone.	.tiff (geo tiff)
2.	Digital Elevation Model (3D) – DSM & DTM	.tiff (geo tiff)
3.	GCPs data (Datum-WGS 84, GCS)	.shp and MS-Excel
4.	RMSE Report	.txt/.doc
5.	Map of the mining lease showing area of; a) actual excavation (mineral and waste), b) Mineral storage c) Subgrade dump, d) Waste dump, e) Afforestation, f) Backfilled, reclaimed and rehabilitated area Within the lease for the preceding financial year;	.shp (in WGS 84 Datum in UTM Projected Coordinate system)
6.	Lease boundary pillar co-ordinates (as authenticated by state government should be submitted both in GCS and PCS in Datum WGS 84)	.shp and MS-Excel
7.	Drone Survey log sheet	.doc

11. Submission of Data to IBM

The processed output data of the drone survey as per Para ten above shall be submitted in soft copy only in storage media (i.e. external hard disk) on or before 1st day of July every year along with the details of the survey carried out as per the format annexed to this SOP at the following addresses.

(1) The Chief Mining Geologist, Indian Bureau of Mines,
GM&MM Cell, 1st Floor, A- Block
Indira Bhavan, Civil Lines,
Nagpur- 440001, Maharashtra

(2) Respective Regional Offices
Indian Bureau of Mines

Output data submission form for Drone survey for the year.....

Sl. No.	Particulars	Details
1.	Name of the Mine	
2.	Name of the lessee, Address, Phone and email	
3.	Location of the mine (Village/taluka/District/State)	
4.	Total Lease Area (Ha)	
5.	Mine code	
6.	IBM Registration Number under rule 45 of MCDR, 2017	
7.	Mineral	
8.	Method of mining (Opencast/Underground)	
9.	Name of the Drone Agency	
10.	Remote Pilot license No.	
11.	Unique Identification Number (UIN No.) of Drone	
12.	Category of Remotely Piloted Aircraft (Nano/ Micro/ Small/ Medium/ Large)	
13.	Type of Drone (fixed wing/multi rotor) with specification	
14.	Survey Start Date and End Date and time (DD/MM/YYYY) complete log sheet to be provided	
15.	Name of the pilot and observation during the survey (if any)	
16.	Type of Sensor/camera used along with specification	
17.	Height of the flight (above ground level) and altitude (meter) of ground where Drone flid	
18.	Total Number of GCP's	
19.	Device used for the collection of GCP	
20.	Total RMSE (Root Mean Square Error)	
21.	Name of the Agency who have processed the output data	
22.	Software used for processing the data	
23.	Proposed excavation during the preceding year as per Mining Plan (in cu.m) (mineral and waste)	
24.	Actual excavation during the preceding year in cu.m (mineral and waste) as per Annual Return submitted to IBM	
25.	Data folder name and size	
26.	UTM Zone considered in Projected Coordinate System	

Date:

Place:

Signature of Lessee

PART- II

Standard Operating Procedure for submission of Satellite Imageries to Indian Bureau of Mines.

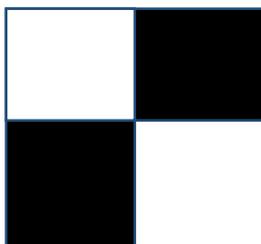
(See sub rule (2) of Rule 34A of Mineral Conservation & Development Rules, 2017.

1. Satellite image specification

Satellite image to be submitted to IBM should be of high resolution preferably 1.12m or better, multispectral (RGB) and cloud free Geo-referenced Orthorectified satellite image covering the lease boundary with at least 100m buffer taken in the month of April to June of every year.

2. Ground Control Points (GCP) for Satellite image

For geo-referencing of satellite image, each mine shall establish at least 3 permanent GCP in or around the mines area with calibrated certified DGPS instrument. The GCP shall be marked in a cover free and open to sky place so that it can be identified in satellite image. The dimension of the GCP shall be 2.5 times the resolution of the satellite image so as to be clearly visible in the satellite image. For example: If the satellite image is having resolution of 1m then the dimension of GCP shall be 2.5m. The permanent GCPs can be established over the top of the mine office or some other permanent site within the mine clearly visible to sky.



Example of GCP marking

3. Procurement of Satellite image

The National Remote Sensing Centre (NRSC) of the Indian Space Research Organisation (ISRO)/DOS is vested with the authority to acquire and disseminate all satellite remote sensing data in India, both from Indian and foreign satellites. Lessee may approach NRSC to order the satellite images through User Order Processing System (UOPS) an online web application maintained by NRSC. Users can specify their area and period of interest along with the sensor and product selection. The url of NRSC website is <https://www.nrsc.gov.in>

4. Co-ordinate Reference system

The Co-ordinate reference system to be used for acquiring the satellite image will be Geographic Reference System with WGS84 Datum and Decimal Degrees / Degree Minute Seconds as units. The geo-referenced orthorectified satellite image shall be submitted in the Universal Transverse Mercator (UTM) with WGS-84 datum and units as Meters. The GCPs survey data and boundary pillar co-ordinates data shall be in latitude and longitude (Deg. Min. Sec.) format in WGS 84 datum.

5. Data output and formats

The following data output will be provided by each lessee to IBM for the preceding financial year;

Sl. No.	Data type	Format
1.	Georeferenced Orthorectified satellite image of lease area including 100m buffer zone	.tiff (geo tiff)
2.	Meta data	.txt/ .doc
3.	GCPs data (Datum-WGS 84, GCS)	.shp and MS-Excel
4.	RMSE Report	.txt/ .doc
5.	Map of the mining lease showing area of: a) Actual excavation (mineral and waste) b) Mineral storage c) Subgrade dump d) Waste dump e) Afforestation f) Backfilled, Reclaimed and rehabilitated area Within lease during the preceding year.	.shp (in WGS84 Datum in UTM Projected Coordinate system)
6.	Lease boundary pillar co-ordinates (as authenticated by state government should be submitted both in GCS and PCS in Datum WGS 84)	.shp and MS-Excel

6. Submission of Data to IBM

The high resolution orthorectified Satellite images shall be submitted in soft copy only in storage media (i.e. external hard disk) on or before 1st day of July every year along with the details of the survey carried out as per the format annexed to this SOP at the following addresses.

(1) The Chief Mining Geologist, Indian Bureau of Mines,
GM & MM Cell, 1st Floor, A- Block
Indira Bhavan, Civil Lines,
Nagpur- 440001, Maharashtra

(2) Respective Regional Offices
Indian Bureau of Mines

Output data submission form for satellite image for the year.....

Sl. No.	Particulars	Details
1.	Name of the Mine	
2.	Name of the lessee, Address, Phone and email	
3.	Location of the mine (Village/taluka/District/State)	
4.	Total Lease Area (Ha)	
5.	Mine code	
6.	IBM Registration Number under rule 45 of MCDR, 2017	
7.	Mineral	
8.	Method of mining (Opencast/Underground)	
9.	Details of Satellite from which image has been taken	
10.	Date of acquisition of image	
11.	Total Number of GCP's	
12.	Device used for collection of GCP	
13.	Total RMSE (Root Mean Square Error)	
14.	Proposed excavation during the preceding year as per Mining Plan (in cu.m) (mineral and waste)	
15.	Actual excavation during the preceding year in cu.m (mineral and waste) as per Annual Return submitted to IBM	
16.	Data folder name and size	

Date:

Place:

Signature of Lessee