

REPORT OF THE COMMITTEE CONSTITUTED FOR ASSESSMENT OF BALANCE GEOLOGICAL COAL RESOURCES AND RECOVERABLE COAL RESOURCES IN THE COUNTRY

A: Background

At various forums of the Government, issues like quantum of coal resources available in the country and its balance life at projected production levels, are deliberated upon for various decisions like optimal production levels vis-à-vis available extractable resources, balance life of our coal resources, need for continuation of coal resources exploration, need for upgradation of mining technology, etc.

Total explored geological resources in proved/measured, indicated and inferred categories are documented and reported by the Geological Survey of India (GSI) annually. Based on relevant information like coal extracted till date, resource sterilization and balance extractable resources is presently being assessed for reporting at various Government forums using the recoverability ratio of 4.7:1 (geological: extractable) as per the T L Shanker Committee Report titled 'The Report (Part-II) of Expert Committee on Road Map for Coal Sector Reforms' of Oct-2007.

Considerable time has elapsed since the aforesaid Shanker Committee Report. The geo-mining status of the balance available geological resources has also undergone changes over the years. It was felt by Ministry of Coal, GOI that the recoverability ratio of 4.7:1 needs to be re-visited and re-calibrated to the present geo-mining outlook in terms of mineability of the balance coal resources and the latest mining technology.

B: Committee formation by MoC

Accordingly, MoC vide their letter no. 17022/4/2012-CRC-IVoIII-Part (2) (FTS-341219) dated 24.04.23 constituted a committee with the following **Terms of Reference**:

1. Assessment of Balance Coal Resources available for mining in the blocks.
2. Formulate framework / guidelines to assess recoverable coal resources.
3. Suggest framework / mechanism for assessment & reporting of –

- a. Coal extracted & resources sterilized due to mining in each block.
- b. Balance Geological & Extractable coal resources in coal blocks.
- c. Coal resources not taken up for mining in the present mining plan.

The committee constitution is given below:

1. CMD, CMPDI - Chairman
2. Dy. DG, Coal Section, GSI - Member
3. Director, CRD, CMPDI - Member
4. Director, P&D, CMPDI - Member
5. Director Technical, SCCL - Member
6. Director, NA (for non CIL blocks) - Member
7. Regional Executive Director, NTPC - Member
8. Director, CCT Section, MoC - Member Secretary

C: Present Practice in CMPDI to calculate extractable resources in CIL blocks:

A coal block can be either fully projectized, i.e. all the geological coal resources are taken into the proposed mine boundary, OR it can be partly projectized, i.e. some part of the coal block is not taken into the mine boundary (due to various constraints like detailed exploration, surface restrictions, geo-mining complexities, economic viability, etc.).

1: For Projectized blocks

For Projectized coal blocks, Total Geological Resource, Geological Resource Projectised and Extractable Resource are available in the Project Report.

Difference between Geological Resource Projectised and corresponding Extractable Resource is taken as the resource sterilization (i.e. losses).

Every year the balance extractable resource is calculated by subtracting annual production of project / mine from the extractable resource of previous year.

2: For Un-Projectized blocks

For Unprojectised coal blocks, Extractable Resource is calculated by dividing the total geological resources of the coal block by 4.7 in line with the recommendation of T L Shanker Committee i.e. geological resource: extractable resources = 4.7:1. Thus about 21.3 % of total geological resources would be extractable.

D: Main Considerations for the assessment of balance recoverable resources and resource sterilization

1. For projectized coal blocks, the firmed up data of geological resources and corresponding extractable resources would be available in the mining plan / project report. For unprojectized resources, some ratios/criteria would be needed for arriving at extractable resources and sterilization / resource-loss.
2. Coal resources lying at greater depth of say 600 m or more may have lower recoverability. Similarly, resources lying under major surface constraints like eco-sensitive zones, heavily built-up areas, etc. may also have lower recoverability.
3. Information regarding mineability of any coal resource left unprojectized in a block should be included in mining plans.
4. Unprojectized resources that have potential for mining in future should not be included in resource-losses / sterilization.
5. Resources that are presently uneconomical may not be included in resources losses / sterilization since they may become viable in future.
6. Data of CIL Blocks and identified but un-allocated non-CIL blocks should be arranged by CMPDI. Data of allocated non-CIL blocks should be arranged by the Director (T), NA, MOC, and data of SCCL should be provided by Director (T), SCCL.
7. Data inputs should be collected through a well-structured format to capture the sterilization, recoverability, mineability, etc. while addressing the above considerations.

Such a format could become the framework for annual reporting of geological and extractable resources in future. The criteria developed by the Committee could become a part of such a framework.

E: Data collection:

An input format (enclosed as **Annexure-1**) was designed to collect data for CIL and Non-CIL Blocks. The single format covered all types of blocks, viz. fully projectized, partly projectized and unprojectized. The MS Excel format had provision for giving data on the following:

- Total geological resources of a block,
- Projectized geological resources as per mining plan / PR,
- Extractable resources corresponding to the projectized geological resources as per mining plan / PR,
- Resources, grade range and depth range of unprojectized part of partly projectized blocks / fully unprojectized blocks,
- Unprojectizable resources along with reasons,
- Technology-wise (Opencast or Underground) break-up of geological and extractable resources in unprojectized block based on defined criteria (ref. below).
- Total Extractable Resources block-wise for projectized and unprojectized parts of all blocks.
- Estimation of recoverability ratio and sterilization ratio.

Using the above data, the recoverability and sterilization ratios would be calculated as follows:

Recoverability Ratio = Total Extractable Resources in the Block / Total Geological Resources in the Block.

Sterilization Ratio = (Total Geological Resource – Corresponding Extractable Resource) / Total Geological Resource in the Block.

F: Criteria for Assessing Extractable Resources for OC and UG mines:

Criteria for deciding extractable resources for opencast and underground mining in case of fully unprojectized blocks and unprojectized parts of partly projectized blocks was communicated to the block owners as follows:

1. From gross geological resources, consider 90% of proved resources, 70% of indicated resources, and 40% of inferred resources to arrive at net geological resources. (As considered in TL Shanker Committee Report and presently being followed as standard practice; and also adopted by this Committee)

2. **For Opencast**, consider the following scenarios:
 - a. **Scenario-1**: 70% of net geological resources up to 200 to 300 m depth (or more depending on the cumulative thickness of coal seams) as opencastable.
 - b. **Scenario-2**: 60% of net geological resources up to 200 to 300 m depth (or more depending on the cumulative thickness of coal seams) as opencastable.
 - c. **Scenario-3**: 47% of net geological resources up to 200 to 300 m depth (or more depending on the cumulative thickness of coal seams) as opencastable. (As per data of 41 Opencast Project Reports planned by CMPDI in last few years, extraction percentage for opencast mines works out to 47%.)

3. **For Underground**, consider the following scenarios:
 - a. **Scenario-1**: 30% of net geological resources up to a depth of 600 m as extractable. Some block-specific / locality-specific special considerations may be taken into account but the same should be mentioned in remarks column.
 - b. **Scenario-2**: 20% of net geological resources up to a depth of 600 m as extractable. Some block-specific / locality-specific special considerations may be taken into account but the same should be mentioned in remarks column.
 - c. **Scenario-3**: 18% of net geological resources up to a depth of 600 m as extractable. Some block-specific / locality-specific special considerations may be taken into account but the same should be mentioned in remarks column. (As per data of 17 Underground Project Reports planned by CMPDI in last few years, extraction percentage for underground mines works out to 18%.)

[Rationale behind these 3 scenarios:

Scenario-1: This is an optimistic scenario where in ideal conditions 70% of geological resources can be extracted by opencast and 30% by underground mining.

Scenario-2: This is a less optimistic scenario where 60% of geological resources can be extracted by opencast and 20% by underground mining.

Scenario-3: This is the realistic scenario where based on analysis of 41 opencast project reports and 17 underground project reports prepared by CMPDI in last few years, 47% of geological resources can be extracted by opencast and 18% by underground mining.]

4. In the following cases, locked resources should be **excluded** from gross geological resources:
- a. Complex geo-mining conditions rendering mining by OC and UG technologically unfeasible.
 - b. All environmentally sensitive areas including and not limited to
 - i. Notified Eco-sensitive zones (ESZ) for protection of National Parks (NP) & Wildlife Sanctuaries (WLS).
 - ii. Areas lying within 1 km of Protected Areas,
 - iii. More than 1 sq.km size of very dense forest (VDF).
 - iv. All Protected Areas notified under Wildlife (Protection) Act, 1972, viz., Tiger Reserves/Corridors (TR), Elephant Corridors.
 - v. Other prohibitive areas, e.g. River Regulatory Zone (RRZ) in Maharashtra, etc.
 - c. Areas with CBM overlap.
 - d. Blocks with > 40% Forest cover for OC and > 70% for UG.

G: Data Analysis

The format was used by all concerned for providing the data of CIL blocks, SCCL blocks, and other non-CIL blocks.

The received data was analysed in the 3 scenarios explained under para F.2 and F.3.

Scenario-1: 70% of net geological resources as opencastable and 30% as underground.

Scenario-2: 60% of net geological resources as opencastable and 20% as underground.

Scenario-3: 47% of net geological resources as opencastable and 18% as underground. (As per data of 41 Opencast Project Reports and 17 Underground Project Reports planned by CMPDI in last few years, extraction percentage for opencast mines works out to 47% and for underground mines it works out to 18%.)

The sterilization and recoverability ratio for the 3 scenarios were accordingly estimated and the same is tabulated below:

Scenario	Opencastable (%)	Underground (%)	Net Geological Resources (Mtpa)	Opencastable Resources (Mtpa)	Underground Resources (Mtpa)
Scenario-1	70%	30%	15000	10500	4500
Scenario-2	60%	20%	15000	9000	3000
Scenario-3	47%	18%	15000	7050	2700

Data Analysis: Estimation of Recoverability and Sterilization Ratios (figs. In Million tonnes)

Sl. No.	Scenario	Total Geological Resources	Geological Resources Projectized	Total Extractable Reserves of Projectized blocks	Balance Extractable Reserves as on 1.4.23	BGR to be Projectized	Part of BGR that cannot be Projectized	Part of GR that can be Projectized	Extractable Reserve of Unprojectized BGR	Tot Extractable Reserves= P+UP	Total Resources Sterilized	Recoverability Ratio	Sterilization Ratio
1	Scenario-1 (Considering OC Extraction - 70%, UG Extraction - 30%)	422396.14	97508.64	57557.12	43818.98	324887.49	87003.86	237883.68	86421.99	143979.11	278417.03	0.34	0.66
2	Scenario-2 (Considering OC Extraction - 60%, UG Extraction - 20%)	422396.14	97508.64	57557.12	43818.98	324887.49	87003.86	237883.68	68463.42	126020.54	296375.60	0.30	0.70
3	Scenario-3 (Considering OC Extraction - 47%, UG Extraction - 18% (as per data of OC and UG PRs prepared by CMPDI for CIL in last 5 years)	422396.14	97508.64	57557.12	43818.98	324887.49	87003.86	237883.68	55922.31	113479.43	308916.70	0.27	0.73

It may be noted that total coal resources as per the inventory of **Indian Coal and Lignite Resources-2023** published by GSI as on 01.04.2023 is about 378 Billion Tonnes. However, the total resources in the above assessment is about 422 Billion Tonnes. This is because in the blocks identified for detailed exploration/ auction the estimated/ expected resources are about 10-12% more than resources than the GSI inventory, and this increase becomes apparent when additional drilling is done during regional/detailed exploration.

This increase occurs mainly due to:

- a. Addition of area during detailed exploration from the point of view of mineability of a block, e.g. extension on dip/strike side, etc.
- b. Increase in resources estimate after detailed exploration, especially in lower seams where original boreholes had not reached.

Few case studies are presented below to substantiate the aforesaid statement.

1. Hemagiri Block – As per GSI inventory report of 1992 total indicated reserve of 226.82 million tonnes of coal was estimated for this area. Only 3 boreholes were drilled up to bottom seam and the resources of the lower seams were estimated based on influence area of 3 boreholes only.

However, for detailed exploration, after annexing some additional area, the block was divided into Hemagiri Sec-I and Hemagiri Sec-II. Accordingly, the estimated resources on pro-rata basis up to the bottom seam with increased area stood at about 5300 million tonnes as compared to 226.82 million tonnes earlier estimated in GSI inventory.

Such adjustments take place in a number of blocks with similar nature of resource reporting.

2. Rajgaon Block: In this block, GSI inventory has reported 982.81 million tonnes Indicated resources in about 12 sq km area in Rajmahal coalfield. However, considering future mineability, the block had to be extended in the dip side and the final block area stood at about 51 sq km with an expected resource of about 3900 million tonnes. Often the regionally explored blocks have similar revision in expected/ estimated resource after further exploration.

[Few more blocks viz. Deonad, Patratu South Extension, Dighi Dharampur North, Dighi Dharampur South, Barwatoli, Mausingha etc. which were not regionally explored earlier, are expected to have a considerably higher amount of resources which will become apparent after detailed exploration.]

H: Conclusions and Recommendations:

1. **Outcome of Data Analysis:** The table above, showing analysed data for CIL blocks, SCCL blocks, and the un-allocated non-CIL blocks (i.e. almost 85% coal blocks in the country), gives following details for the 3 scenarios, viz. (1) 70% OC; 30% UG, (2) 60% OC; 20% UG, (3) 47% OC; 18% UG:

- Total geological resources
- Geological resources projectized
- Total Extractable Resources of Projectized blocks
- Balance Extractable Resources as on 1.4.23 of projectized blocks
- Balance Geological Resources to be Projectized
- Part of Balance Geological Resources that cannot be Projectized
- Part of Geological Resources that can be Projectized
- Extractable Resources of Unprojectized Balance Geological Resources
- Total Extractable Resources for Projectized and Unprojectized Resources
- Total Resources Sterilized
- Recoverability Ratio
- Sterilization Ratio

As on 01.04.2023 (after excluding the mined out coal resources) in the Scenario-3 (47% OC; 18% UG), the balance available extractable resource is likely to be about 89 Billion Tonnes. [considering 43.81 BT from projectized blocks and $55.92 \times 0.22 / 0.27 = 45.56$ BT from unprojectized blocks; i.e. total = $43.81 + 45.56 = 89.37$ BT.] It may be noted that a total of about 87 BT of geological resources cannot be projectized as of now due to factors mentioned under para F.4 above (guidelines).

2. Recoverability Ratio and Sterilization Ratio:

Of the 3 scenarios, the Scenario-3 is based on actual recent project planning experiences. Therefore, Scenario-3 can be adopted as the most probable projection for future, i.e. overall recoverability of 27% and corresponding sterilization of 73%.

However, taking into consideration the unforeseen constraints (delays in land acquisition resulting into sub-optimal mine profile causing increased resource losses, unforeseen geo-mining complexities like faults, etc.) resulting into lower extraction percentage, the likely recoverability may be 4% to 5% lower than the estimated figure, i.e. **overall recoverability of 22% and corresponding sterilization of 78%** appears more likely.

The recoverability and sterilization ratios assessed through this exercise (Ref. para H.2 above) matches with the recommendations of the TL Sankar Committee Report of 2007.

Ideally, in view of technology upgradation the extraction percentage should have been higher than the figure in TL Shanker Committee Report. However, due to progressively increasing depth of workings and constraints due to eco-sensitive zones, CBM areas, etc. the actual workable area and resources have reduced, thus offsetting the expected increase in extractability due to technology upgradation.

3. Framework for future assessment and reporting of balance geological and extractable resources and resources sterilized:

The framework (criteria/guidelines and format) adopted by the Committee is proposed to be used for future assessments and reporting of balance geological and extractable resources and the resources sterilized.

The format used by the Committee is enclosed as **Annexure-1** and can be utilized for collecting data as on the 1st April of the assessment year. A suitable agency selected by Ministry of Coal may then undertake the compilation and reporting in line with the criteria/guidelines and formulae used by the Committee in this report.

The criteria/guidelines given under para-F above should be used uniformly by all block owners for assessment of extractable resources. In para F.2 and F.3 the criteria for Scenario-3 should be adopted due to reasons explained above under para-H.2. The formula under para H.2 above is proposed to be utilized for arriving at the recoverability and sterilization ratios.

The Committee felt that since mining activities are likely to proceed into deeper resources in future and with growing difficulties in land acquisition and environmental/forestry clearances, the recoverability is likely to reduce progressively.

Also many unprojectized blocks undergo projectization every year. **So, this exercise for assessing balance extractable resources and the recoverability ratio needs to be repeated every 5 years.**

Meanwhile, the recoverability ratio of about 22% of total geological resources may be adopted for a reasonably reliable estimation of balance extractable resources for coal bearing areas where projectization is awaited.

International Benchmarks: The geological structure and mineability characteristics of coal deposits/coalfields in India, e.g. depth of occurrence, seam gradients, coal quality, strata conditions, geological disturbances (like faults, thinning and washout of seams, variations in gradient), etc. differ significantly from those of other countries. The recoverability ratio for Indian coal deposits would therefore differ from the coal deposits of other countries.

ANNEXURE-1 : FORMAT FOR COLLECTING INPUTS FROM BLOCK OWNERS FOR ASSESSMENT OF BALANCE GEOLOGICAL AND EXTRACTABLE RESOURCES

BASE DATA				PROJECTISED PART														UNPROJECTIZED PART														RECOVERABILITY / STERILIZATION RATIOS											
S.No.	Company	Coalfield	State	Name of Coal Block (Rationalised block in case of CIL blocks)	AREA (sq.km.)				Total Geological Resources (MT)				Geological Reserves projectized (MT)				Total Extractable Reserve (MT)	Balance Extractable Reserve as on 01.04.23 (MT)	Balance Geological Resources (BGR) to be Projectized (MT)						Part of BGR that CANNOT be Projectized in future (due to technological and/or other reasons) (MT)					Part of BGR that CAN be Projectized in future (MT)				Technology-wise projectization of BGR (MT)			Extractable Reserves of Unprojectized BGR (MT)			Tot Extractable Reserve in Block=Total Extractable Reserve in Projected Part + To be Extractable Reserve in Unprojectized Part (MT)	Total Reserves Sterilized in a Block (MT)	Recoverability Ratio	Sterilization Ratio
					Explored	Partial explored	To be Explored	Total	Proved	Indicated	Inferred	Total	Proved	Indicated	Inferred	Total			Proved	Indicated	Inferred	Total	Tentative Grade Range	Approx. Depth Range (m)	Proved	Indicated	Inferred	Total	REASONS/REMARKS	Proved	Indicated	Inferred	Total	OC	UG	Total	OC	UG	Total				
1	2	3	4	5	6	7	8	9=6+7+8	10	11	12	13=10+11+12	14	15	16	17=14+15+16	18	19	20=10-14	21=11-15	22=12-16	23=20+21+22	24	25	26	27	28	29=26+27+28	30	31=20-26	32=21-27	33=22-28	34=31+32+33	35	36	37=35+36	38	39	40=38+39	41=18+40	42=13-41	43=41/13	44=42/13