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श्रम एंव रोजगार मंत्रालय/ Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय/ Directorate General of Mines Safety

DGMS (Tech) Circular No. /S &T /2026/ 09 Dhanbad, Date 27.08. 2026

To,

All Owners, Agent and Managers of Coal and Metalliferous opencast mines

Subject: Fracturing of strata/ground by using Carbon Phase Transition Rock Breaking Technique (CPTBT) in opencast mines – reg.

Carbon Phase Transition Rock Breaking Technique (CPTBT), also known as a carbon dioxide-based blast-free rock-breaking technique, has been experimentally studied for fracturing of strata/ground in one Indian mine. The results of the trials conducted so far have been found to be encouraging and indicate the potential suitability of the technique for controlled rock-fracturing applications in mines.

Since the technique does not involve the detonation of conventional explosives, the generation of induced ground vibration is substantially reduced, thereby minimizing the potential adverse effects of vibration on nearby structures, mine infrastructure, equipment and other installations, subject to the prevailing geological and site-specific conditions.

The technique utilises the rapid phase transition and expansion of liquid carbon dioxide (LCO_2) into gaseous CO_2 within a specially designed high-pressure tube/cylinder placed in a borehole, thereby generating pressure sufficient to fracture the surrounding rock mass without the use of conventional explosives so the risk of uncontrolled projection of rock fragments (fly rock) is substantially reduced in comparison with conventional blasting.

The technique has potential advantages in situations where conventional blasting is undesirable or may pose additional risks. In particular, its use can substantially reduce dependence on explosives for suitable rock-fracturing operations and may be advantageous at locations where structures or other sensitive installations are situated within the danger zone of blasting. The ground vibration associated with CPTBT is expected to be comparatively lower than that associated with conventional explosive blasting, subject to site-specific conditions and the design of the operation.

CPTBT may also be experimented for use in mines or areas having hot strata or other conditions where the use of explosives may pose a risk of premature initiation. As the technique does not involve the use of conventional explosive charges, its adoption may eliminate the risks specifically associated with the storage, transportation, handling and charging of explosives for such rock-fracturing operations, subject to compliance with all applicable statutory safety requirements and conditions prescribed by the competent authority.

The experimental observations further indicate that CPTBT can provide satisfactory rock fragmentation and may be used in conjunction with a suitable **rock breaker** for achieving the desired degree of fragmentation and secondary size reduction.

In view of the above, and with a view to promoting the adoption of safer and suitable alternative rock-fracturing technologies, the following technical guidelines shall be followed by mine management while adopting CPTBT in opencast mines.

1. Scope

These guidelines shall apply to the use of Carbon Phase Transition Rock Breaking Technique (CPTBT) for fracturing of strata/ground in opencast coal and metalliferous mines, subject to compliance with all applicable statutory provisions.

The technique shall be adopted in any mine only after establishing, through a site-specific scientific assessment, the suitability of the ground conditions and the design parameters to be followed for its application, based on an appropriate scientific study, and obtaining prior No objection from Chief Inspector cum Facilitator of mines confirming to the suitability of the proposed application and adequacy of the control measures for managing the hazards associated with high-pressure CO_2 systems.

2. Risk Assessment and SOP

2.1 A detailed site-specific risk assessment shall be carried out before adoption of CPTBT, covering, inter alia: high-pressure CO_2 release; failure of rupture disc/activation system; non-initiation or incomplete discharge of a charged tube; projectile hazards; CO_2 accumulation and asphyxiation; cold burns/frostbite; instability of fractured rock/strata; handling and transportation of charged tubes; electrical/ignition hazards.

2.2 Based on the risk assessment and manufacturer's guidelines, Standard Operating Procedure (SOP) shall be prepared, by the Mine Manager and implemented at workplace.

2.3 The SOP shall specifically provide for the safe handling, isolation, recovery and/or controlled depressurisation of CO_2-filled tubes in the event that the tube fails to discharge or the borehole plug/vent arrangement fails to function as intended.

3. Supervision and Competency

3.1 Fracturing of strata/ground by CPTBT shall be carried out under the direct supervision of a person holding at least a Manager's Certificate of Competency.

3.2 Only specially trained and authorised work-persons shall be permitted to handle, transport, charge, place and otherwise deal with high-pressure CO_2-filled tubes.

3.3 A competent person, specifically trained in the handling, transportation, charging and initiation of the high-pressure CO_2-filled tubes, shall be authorised to carry out initiation using the approved initiation system.

4. Design and Preparation of Boreholes

4.1 The borehole diameter, depth, burden, spacing, number of holes, number of rows and other site-specific parameters for CPTBT shall be based on the findings of the scientific/experimental study conducted at the mine or other duly established technical study applicable to the particular geological and mining conditions.

4.2 The area proposed for CPTBT shall be clearly demarcated on the mine surface plan and correspondingly marked in the field.

4.3 Adequate stemming shall be provided to control the ejection of fractured material and premature ejection of the CO2 steel tubes from the holes. Measures shall be taken to ensure that fractured projectiles do not travel beyond the prescribed safe limit of 10 m from the point of fracture initiation.

5. Inspection of CO_2 Tubes and Equipment

5.1 Every CO_2-filled steel tube/cylinder and associated component shall be inspected before use.

5.2 Tubes having dents, cracks, corrosion, deformation, damaged threads, leaking valves, defective safety devices or expired test certification shall not be used.

5.3 Each tube shall have a unique identification number and the relevant information regarding filling, quantity of CO_2, date of filling, prescribed service life and number/frequency of use shall be recorded.

5.4 Filling of the tubes shall be carried out only at an approved/designated filling station using suitable equipment and under controlled conditions. The filled quantity shall conform to the manufacturer's specifications.

5.5 A standard protocol shall be established and implemented for the examination and inspection of all CO_2-filling steel tubes including its components after their use in each round of strata/ground fracture in the mine to ensure free from any physical defects. Non-destructive testing (NDT) of all CO_2-filling steel tubes used for fracturing strata/ground shall be conducted periodically as per original manufacturer recommendations.

5.6 A procedure and guidelines for the identification, isolation and safe disposal/discarding of defective or unserviceable CO_2-filling steel tubes shall also be formulated in consultation with the original manufacturer and a competent scientific/testing agency and shall be strictly followed.

5.7 The heating element shall be stored properly and shall be prevented from any fire hazards.

6. Personal Protective Equipment

Persons engaged in handling, transportation, charging and initiation shall be provided with and shall use appropriate PPE. The PPE shall be selected considering the hazards of sudden high-pressure release, projectile generation, extreme cold and CO_2 exposure.

7. Handling and Transportation

7.1 CO_2 tubes shall not be dropped, dragged, rolled or subjected to impact or excessive vibration.
7.2 Suitable tube carriers, lifting cradles, cylinder trolleys or other approved handling arrangements shall be used.
7.3 Tubes shall not be lifted by the valve assembly, heating cable or neck fittings.
7.4 During transportation, tubes shall be securely fastened in an upright position, with protective caps/valve guards fitted, and shall be carried in a well-ventilated or open-body vehicle.
7.5 Charged tubes shall not be transported in passenger cabins and shall be protected from direct heat, sunlight, impact and other sources capable of increasing the internal pressure.
7.6 Suitable warning signage indicating the presence of pressurised CO_2 tubes shall be displayed on the vehicle used for transportation.

8. Charging and Placement

8.1 Charging of liquid CO_2 shall be carried out only by trained and authorised persons at the designated filling facility.
8.2 Leak detection shall be carried out using an approved method, such as a soapy-water test, and open flame shall not be used for leak detection.
8.3 The charged tube shall be inserted gently into the designated borehole and positioned in accordance with the approved design.
8.4 The area shall be barricaded and access controlled before initiation.

9. Danger Zone and Initiation
9.1 Before initiation of charged CO_2 tubes, the competent person/authorised Foreman and Assistant Manager shall ensure that all persons within a radius of 500 metres have taken proper shelter and that the applicable provisions relating to blasting/danger zone are complied with.
9.2 A warning siren or other effective warning signal shall be given before initiation.
9.3 Initiation shall be carried out only from a safe and protected location using a suitable initiation apparatus of a type that does not pose any danger and is certified by the manufacturer in accordance with the standards laid down by the Bureau of Indian Standards (BIS) or relevant international standards.

10. CO_2 Monitoring and Re-entry

10.1 Since CO_2 is heavier than air and may accumulate in low-lying or poorly ventilated locations, appropriate precautions shall be taken against CO_2 accumulation.
10.2 Calibrated CO_2 and O_2 detectors shall be provided to check the accumulation of CO_2.
10.3 No person shall be allowed to re-enter the place where the rock breaking operations have been done with LCO_2 unless the CO_2 is cleared and unless a period of at least 20 minutes has elapsed from the time of initiation.

11. Non-Initiation/Misfire of CO_2 Tube

11.1 A charged but non-initiated CO_2 tube shall be treated as a high-pressure vessel/hazard until it is conclusively established that the pressure has been safely released.
11.2 No person shall attempt to drill, cut, heat, hammer, manually vent or otherwise interfere with a suspected non-initiated tube.

11.3 The area shall remain barricaded and access shall be restricted.
11.4 The manufacturer-prescribed waiting period and written mine SOP for safe approach, isolation, depressurisation and recovery shall be strictly followed.
11.5 Only trained and authorised personnel shall be permitted to deal with such tubes. The source SOP specifically requires non-initiated tubes to be treated as pressurised vessels until safe depressurisation/discharge is confirmed.
11.6 Where safe recovery is not possible, the borehole may be dealt with in accordance with an approved procedure, after confirmation of pressure decay and with appropriate measures to prevent future interaction with the location.

12. Electrical and Static-Electricity Precautions

12.1 Metallic CO_2 transfer lines, manifolds, cylinder racks and firing panels shall be suitably bonded and earthed.
12.2 Where non-metallic sections are unavoidable, conductive or static-dissipative hoses shall be used and suitably bonded.
12.3 The integrity of the earthing system shall be checked before commencement of CPTBT operations and the relevant readings/checks shall be recorded.
12.4 CPTBT charging and initiation shall not be undertaken where a flammable atmosphere or explosive dust cloud is present in the vicinity of manifolds or borehole collars.

13. Documentation and Record Keeping

13.1 A record of every CPTBT operation shall be maintained in a bound paged book or in a retrievable, non-editable electronic record.
13.2 A record of each round of fracturing of strata/ground, showing the pattern of shot holes and the particulars of spacing & burden of holes, hole depth, number of holes initiated in the round, weight of the liquid CO2 filled in tube/hole, total weight of the liquid CO2 filled in tubes/round, stemming column length (s), initiation pattern(with proper sketches), activation time, percentage of CO2 after initiation at place of experiment, percentage of O_2 after initiation at place of experiment, results of ground vibrations observed (PPV, frequency & air over pressure), fragmentation, throw, back-break, breakage pattern and distance up to which flying fragments travelled shall be maintained in a bound paged book kept for the purpose and countersigned by the Manager/Agent/Owner of the mine.
13.3 The record shall be maintained by the competent person in charge of the operation and countersigned by the Mine Manager.

14. General
14.1 CPTBT shall be adopted only after carrying out a site-specific risk assessment and establishing the suitability of the technique for the geological and mining conditions.
14.2 The manufacturer's technical and safety instructions shall be followed in addition to the requirements contained in this Circular.
14.3 No relaxation from any statutory requirement shall be presumed merely on account of the use of CPTBT instead of conventional explosives.
14.4 The provisions relating to precautions while handling apparatus under pressure shall also be strictly complied with.
14.5 Mine management shall ensure that all persons associated with CPTBT operations are adequately trained, competent and medically fit for the work assigned to them.

All concerned mine managements are therefore advised to ensure strict compliance with the above guidelines while adopting CPTBT for fracturing of strata/ground.

27/02/26

(Ujjwal Tah)
Directorate General of Mines Safety
& Chief Inspector-cum-Facilitator