

SOP FOR CONTROLLED ROCK BLASTING AND VIBRATION MONITORING

Controlled Rock Blasting Near Existing Operating Facilities:

The work involves excavation in hard rock through controlled blasting in close proximity to existing operating power plant structures, equipment, underground utilities, and operating systems. The nearest existing structures may be located at distances of less than **20 m** from the blasting location.

The Contractor shall execute all blasting operations strictly through Controlled Blasting Techniques, such as:

1. Line Drilling
2. Pre-splitting
3. Cushion Blasting
4. Smooth Blasting
5. Deck Charging
6. Delay Blasting using Electronic Detonators or Nonel Detonators.
7. Reduced Charge Per Delay (CPD)

The Contractor shall submit a detailed Controlled Blasting Methodology for approval before commencement of blasting work. The methodology shall include:

1. Blast design
2. Hole diameter
3. Hole spacing
4. Burden
5. Stemming length
6. Maximum charge per delay
7. Delay sequence
8. Initiation system
9. Predicted PPV
10. Predicted vibration frequency
11. Fly rock control measures
12. Dust suppression measures
13. Blast mats wherever required
14. Emergency response plan

No blasting shall be permitted without written approval of the methodology.

Seismographic Monitoring:

The Contractor shall deploy minimum two calibrated Digital Engineering Seismographs during every blast. One seismograph shall be installed near the nearest existing critical structure. Another shall be installed near any other sensitive structure identified by the Engineer. The instrument shall record at minimum:

1. Peak Particle Velocity (PPV)

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2. Vibration Frequency
3. Three-axis vibration
4. Time history
5. Waveform
6. Air overpressure
7. Distance from blast
8. Charge per delay

The equipment shall have valid calibration certificates not older than one year.

Mandatory Blast Report:

Every blast shall be accompanied by a Blast Monitoring Report containing:

1. Blast number
2. Date and time
3. Weather condition
4. Blast location
5. Distance to nearest structure
6. Number of holes
7. Hole depth
8. Hole diameter
9. Total explosive quantity
10. Maximum Charge Per Delay (CPD)
11. Delay sequence
12. Initiation system
13. PPV
14. Dominant frequency
15. Air overpressure
16. Blast sketch
17. Seismograph report
18. Signature of Blasting Engineer

Permissible Ground Vibration Limits:

For protection of existing operating plant, all structures, equipment, underground services, cable trenches, TG foundations, boiler foundations, control buildings, cooling water systems and other critical installations, the maximum permissible Peak Particle Velocity (PPV) shall not exceed the following limits.

Distance from Existing Structure	Maximum PPV	Minimum Dominant Frequency
Less than 20 m	3 mm/s	>30 Hz
20–50 m	5 mm/s	>25 Hz
50–100 m	8 mm/s	>20 Hz
More than 100 m	10 mm/s	>15 Hz

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The Contractor shall ensure that blasting parameters are designed such that the measured PPV always remains below the specified limits.

Frequency Requirement:

The dominant vibration frequency shall preferably remain above **25–30 Hz** while blasting near operating plant structures since higher frequencies generally produce significantly lower structural response than low-frequency vibrations. Low-frequency vibrations below **10 Hz** shall not be permitted near existing foundations.

Trial Blast:

Before commencement of production blasting, the Contractor shall perform trial blasts. The trial blast shall establish:

- Safe Charge Per Delay (CPD)
- Vibration attenuation relationship
- Site constant (K)
- Attenuation exponent (n)
- Scaled distance relationship
- PPV prediction equation

Only after approval of trial blast results shall production blasting be permitted.

Immediate Suspension Criteria: Blasting operations shall immediately stop if:

- PPV exceeds permissible limits.
- Excessive air overpressure is observed.
- Fly rock occurs outside the blasting zone.
- Visible cracks develop in existing structures.
- Excessive settlement is noticed.
- Instrumentation fails.
- The Engineer directs suspension.

Further blasting shall only recommence after revision of the blast design and approval by the Engineer.

Contractor's Responsibility: The Contractor shall be solely responsible for:

- Safety of existing structures.
- Protection of operating equipment.
- Underground utilities.
- Cable trenches.
- Pipe racks.
- Electrical installations.
- Instrumentation systems.
- Any damage arising from blasting.

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Any damage resulting from blasting shall be rectified by the Contractor at his own cost without any additional financial implication to the Owner.

Recommended Monitoring Frequency:

- Every blast shall be monitored.
- Continuous vibration records shall be maintained.
- Daily blast reports shall be submitted.
- Weekly vibration trend analysis shall be submitted.
- All electronic data shall be handed over to the Owner.

Technical Recommendations:

Since the existing operating plant is within approximately 20 m of the proposed excavation, the recommend adopting limits more stringent than those in common blasting standards. Specifically:

- **Target PPV:** $\leq 3 \text{ mm/s}$ (absolute maximum 5 mm/s only with specific approval and no adverse response observed).
- **Preferred dominant frequency:** 30–60 Hz.
- **Charge per delay:** Establish through site-specific trial blasting and continuously optimize based on measured vibration data.
- **Detonators:** Electronic delay detonators are preferable over conventional NONEL systems due to their superior timing accuracy and improved vibration control.

Notes:

1. Work shall be done in line with DGMS guidelines including safety measures at site.
2. A separate expert agency for control blasting as per technical specification to be assigned.
3. In case, controlled rock blasting in not feasible near to the existing structures, alternate rock breaking methods i.e. chiselling or chemical cracking shall be adopted.