Coal Burst
Regulatory approach to managing the hazard

Gas and Outburst Committee- Half Day Seminar - Wollongong NSW
22 November 2018
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Coal Burst Events
Austar Coal Mine
April 2014

On 15 April 2014, James Mitchell (49) and Phillip Grant (35) died when a major rib pressure burst occurred in a longwall development roadway.
On August 6, 2007, six miners were killed in a catastrophic coal burst when roof-supporting pillars failed and violently ejected coal over a half-mile area. Ten days later, two mine employees and an MSHA inspector perished in a coal outburst during rescue efforts.
On January 29, 2006, a longwall propman who was operating the tailgate drum of the shearer, was fatally injured when a coal burst occurred and pushed him into the No. 11 shield legs on the 12th East longwall face.
Austar Coal Mine
August 2016

A pressure bump of significant intensity was immediately followed by a “dynamic” ejection of coal from the longwall B2 face during production at Austar Coal Mine on 19 August 2016.

The ejection of coal from the face resulted in two workers being knocked to the ground and struck by small pieces of coal. They suffered no serious injuries.
Affects of a Coal Burst on a Longwall Tailgate

• The before and after photographs of a tailgate roadway affected by a coal burst.
Terminology
Coal burst events are associated with mining induced seismic activity, that is; an event that has been triggered by some form of mining process or activity and not naturally-occurring seismic events such as earthquakes.
Many terms are used to describe mining induced seismic activity.

- **Pressure Burst**
  - Rockburst
  - Coal burst
  - Pillar burst
  - Strain burst

- **Pressure Bump**
  - Shake-down
  - Coal Bump
  - Pillar Bump
  - Face Spitting
Publications

Dangerous incident – coal burst or rockburst

New dangerous incident type identified in Work Health and Safety (Mines and Petroleum Sites) Amendment Regulation 2018

Clause 179 of the Work Health and Safety Act and Petroleum sites Regulation 2014 prescribes dangerous incidents to the purposes of section 40G of the Work Health and Safety (Mines and Petroleum Sites) Act 2011 with the amended regulation coming into effect on the 11 April 2018. Three new additional incident types are now required to be reported:

- clause 179(10) – spontaneous combustion at a coal mine
- clause 179(16) – goaf subsidence at an underground coal mine
- clause 179(7)(g) – a coal burst or rockburst at an underground mine

This fact sheet provides guidance to mine operators on an coal burst or rockburst at an underground mine.

Mining induced seismic activity

Rockburst and coal burst events are associated with mining-induced seismic activity, that is, an event that has been triggered by some form of mining process or activity and not naturally occurring seismic events such as earthquakes. Examples include seismic activity associated with coal mine failure, high stress induced seismicity (HIS), ground movement associated with mine or production operations, jar failures or other mine-related activities at a rockburst or rockburst event.

The actual seismic event may be too close to or a mining occurrence, or may be too small to go far away with the other rock masses, although the resultant damage may be too small to be observed. The event is then considered a “false alarm” and is not considered a seismic event.

It is recognized that many events are used by the Australian mining industry for seismic or rockburst events. The following are terms that are considered appropriate for the Australian mining industry.

Notifiable mining induced seismic activity

Rockburst
A dynamic release of strain energy stored in the rock mass (direct or as an earthquake) resulting in large scale displacement and failure of intact rock, such that the rock fragments or material are ejected into the mining excavation.

The source of the energy is directly related to the stress levels within the rock mass, which feed the movement of the strain and the related stored energy. As a result, the triggers for the release of energy are complex, involving many factors.

coal burst
A strain burst is a form of rockburst, but involves lower levels of energy release.

NRS Resources Regulator
Coal Burst Principles
1. The stress environment must be sufficiently high to result in rock failure.
2. A situation must exist which can result in a state of unstable equilibrium.
3. A change in the loading system
4. A large amount of energy has to be stored in the system.
Coal Burst Contributing Factors

Contributing factors to a coal burst may include but are not limited to:

• Depth of cover
• Pillar/panel design and layout
• Lithology, particularly when thick, strong and rigid strata is overlying the seam being mined
• Geological features such as sandstone channels, seam rolls and faulting
• Seam thickness
Is Coal Burst a Principal Hazard?

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014

5 Meaning of principal hazard

In this Regulation, a principal hazard is any activity, process, procedure, plant, structure, substance, situation or other circumstance relating to the carrying out of:

(a) mining operations that have a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents in relation to any of the following:

(i) ground or strata failure,

(x) a hazard identified by the mine operator under clause 34 of the WHS Regulations.

YES
Coal Burst as a Principal Hazard

Work Health and Safety (Mines & Petroleum Sites) Regulation Division

2 Subdivision 1 – Identification of Hazards

23 Identification of principal hazards and conduct of risk assessments

(2) The operator must conduct, in relation to each principal hazard identified, a risk assessment that involves a comprehensive and systematic investigation and analysis of all aspects of risk to health and safety associated with the principal hazard.

(3) The operator, in conducting a risk assessment under subclause (2), must:

(a) use investigation and analysis methods that are appropriate to the principal hazard being considered, and

(b) consider the principal hazard individually and also cumulatively with other hazards at the mine or petroleum site.

Subdivision 2 - Principal Hazard Management Plans

C(3) A principal hazard management plan must:

(f) describe all control measures to be implemented to manage risks to health and safety associated with the principal hazard,
Managing Risks to Health and Safety
Part 3.1 Work Health and Safety Regulation 2017

35 Managing risks to health and safety

A duty holder, in managing risks to health and safety, must:

(a) **eliminate risks** to health and safety so far as is reasonably practicable, and

(b) if it is not reasonably practicable to eliminate risks to health and safety—minimise those risks so far as is reasonably practicable.

**Elimination**

**Mitigation**
Managing Risks to Health and Safety

Part 3.1 Work Health and Safety Regulation 2017
Clause 36 Hierarchy of control measures

Hierarchy of Controls

- Elimination
  - Physically remove the hazard
- Substitution
  - Replace the hazard
- Engineering Controls
  - Isolate people from the hazard
- Administrative Controls
  - Change the way people work
- PPE
  - Protect the worker with Personal Protective Equipment

Most effective

Least effective
Prediction (Predict)
‘Coal bursts remain a significant hazard for miners in the US and around the world.

While coal bursts cannot be predicted in advance, the risk can be estimated through careful evaluation of those factors known to be associated with coal bursts.’

Christopher Mark
Principal Roof Control Specialist
U.S. Mine Safety and Health Administration, Pittsburgh USA
Mine operators should consider:

• Burst history (seismic activity)
• Geological and geotechnical
• Monitoring
• Observation – Seismic – Vibration - Observation
• Mining method
• Mine layout
### Assessing Coal Burst Potential

#### Table 1: Coal Burst Risk Analysis Matrix for Pillar Recovery

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Cover</td>
<td>&lt;1200 feet (365 m)</td>
</tr>
<tr>
<td>Pillar Design</td>
<td>Meets NIOSH or other criteria, including barrier pillars</td>
</tr>
<tr>
<td>Multiple Seam Interaction</td>
<td>Stress shadow or AMSS Condition = “Green”</td>
</tr>
<tr>
<td>Roof Condition</td>
<td>Weak shale or similar, no massive strata within 50 feet</td>
</tr>
<tr>
<td>Floor Condition</td>
<td>Claystone or similar, no massive strata within 50 feet</td>
</tr>
<tr>
<td>Other Geologic Factors</td>
<td>Development only, meets NIOSH or other criteria</td>
</tr>
<tr>
<td>Pillar Recovery Method</td>
<td>Development Only, or Partial Pillar Recovery</td>
</tr>
<tr>
<td>Panel Width</td>
<td>&lt;350 feet (110 m)</td>
</tr>
<tr>
<td>Past History of Bursts</td>
<td>No burst history in the seam</td>
</tr>
</tbody>
</table>

#### Table 2: Coal Burst Risk Analysis Matrix for Longwall Mining

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Cover</td>
<td>&lt;1200 feet (365 m)</td>
</tr>
<tr>
<td>Pillar Design</td>
<td>Development only, meets NIOSH or other criteria</td>
</tr>
<tr>
<td>Multiple Seam Interaction</td>
<td>AMSS Condition = “Green”</td>
</tr>
<tr>
<td>Roof Condition</td>
<td>Claystone or similar, no massive strata within 50 feet</td>
</tr>
<tr>
<td>Floor Condition</td>
<td>Claystone or similar, no massive strata within 50 feet</td>
</tr>
<tr>
<td>Other Geologic Factors</td>
<td>Development only, meets NIOSH or other criteria</td>
</tr>
<tr>
<td>Past History of Bursts</td>
<td>No burst history in the seam</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of Factor</th>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Cover</td>
<td>1200 – 2000 feet (365 – 600 m)</td>
</tr>
<tr>
<td>Pillar Design</td>
<td>Longwall mines should use yield, abutment-yield, or interpillar barrier pillars as appropriate for depth and geology</td>
</tr>
<tr>
<td>Multiple Seam Interaction</td>
<td>AMSS Condition = “Yellow”</td>
</tr>
<tr>
<td>Roof Condition</td>
<td>Typical Western U.S. or Central Appalachian stratigraphy</td>
</tr>
<tr>
<td>Floor Condition</td>
<td>Strong, thick, and massive strata near the seam</td>
</tr>
<tr>
<td>Other Geologic Factors</td>
<td>Inadequate maps or remnant surrounded by gob (AMSS Condition = “Red”)</td>
</tr>
<tr>
<td>Past History of Bursts</td>
<td>Bursts history in the seam</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Cover</td>
<td>&gt;2000 feet (600 m)</td>
</tr>
<tr>
<td>Pillar Design</td>
<td>Inadequate maps or remnant surrounded by gob (AMSS Condition = “Red”)</td>
</tr>
<tr>
<td>Multiple Seam Interaction</td>
<td>AMSS Condition = “Yellow”</td>
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<td>Past History of Bursts</td>
<td>Bursts history in the mine</td>
</tr>
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Elimination (Prevent)
Coal Burst – Elimination (Prevent)

- **Mine design** – through changes to panel layouts and pillar system design.
- **De-stressing** - Pre-conditioning of ground ahead of mining for reduction in stored strain energy, including hydrofracturing, large diameter boreholes, water-infusion; blasting.
- **Operational controls** - to change the mining rate and cutting sequence to allow natural stress redistribution and relaxation at and near the mining face.
- **Elimination of conventional mining practices.**
Mitigation (Protect)
Coal Burst - Mitigation

- Use of **physical barriers** between the face area and the operators;
- Adoption of **safe standing zones** to remove persons from the vicinity of the cutting area, where this is found to be a particular burst-prone location;
- **Partial Automation** of the cutting and face area work processes;
- Adoption of **wait-times** after cutting, prior to personnel approaching the face area;
- **Full automation of the face-area mining process.**
Overview
Coal Burst
Strategy
Overview

- Coal burst is not well understood in Australia, however, the international experience is comprehensive and available to be drawn upon.

- Mine Operators have an obligation to assess the coal burst potential at their mine, it is a principal hazard.

- The legislation requires the mine operator to eliminate the hazard in the first order.

- Elimination starts with identification of the coal burst hazard potential before mining commences, this allows development of appropriate mine design to eliminate the coal burst hazard.

- Mine operators must invest in monitoring systems to understand and analyse burst events that have occurred. Build the coal burst data base.

- Industry needs to actively support research into coal burst, especially as mines are getting deeper, with larger extraction areas and multi-seam operations more viable propositions.
(1) In complying with clause 9, the mine operator of a mine must manage risks to health and safety associated with mining induced seismic activity at the mine.

(2) In managing risks to health and safety associated with mining induced seismic activity at the mine, the mine operator must:

(a) ensure, so far as is reasonably practicable, that appropriate equipment and procedures are used to provide for the monitoring, recording, interpretation and analysis of data relating to mining induced seismic activity and the behaviour of the mine in respect of that activity, commensurate with the level of risk,

(b) adopt, so far as is reasonably practicable, an effective seismic monitoring plan which contains trigger or action points to ensure that actions or procedures are undertaken on the occurrence of certain criteria specified in the plan, and

(c) ensure, so far as is reasonably practicable, that the design of the mine mitigates the damage arising from the sudden release of energy from the build-up of mining-induced stresses,

(d) ensure, so far as is reasonably practicable, that geotechnically engineered ground support systems are installed and those systems take into account the following:

(i) the intended life of the excavation,

(ii) the mining-induced stress changes and potential cycles of loading and unloading,

(iii) blast vibrations during development mining and from surrounding stopes,

(iv) the potential impact of voids and the management of voids,

(v) the tolerance for stability problems and rehabilitation,

(vi) the potential for rockburst, and

(e) ensure, so far as is reasonably practicable, that the ground support system is designed to contain events that have been or are expected to be expected to appropriate modelling, allowing for an appropriate factor of safety, and

(f) ensure that, so far as is reasonably practicable, mining by remote methods is implemented when mining areas at risk of high or unpredictable mining induced seismic activity, and

(g) ensure that mine design, mining methods and sequences, ground support design and assumptions and modelling are documented and reviewed on an on-going basis and, where necessary, revised.
Garvin Burns
Chief Inspector of Mines