Outburst Threshold Limits

Current Research Outcomes

Dennis Black and Naj Aziz
University of Wollongong

ACARP Research Scholarship – C18004

University of Wollongong

PacificMGM
Mining and Gas Management Consultants

Acknowledgment

Project funding
- ACARP – Research scholarship C18004

Provision of gas testing data
- Anglo Coal Australia
- BHP Billiton
- Peabody Energy
- Xstrata Coal

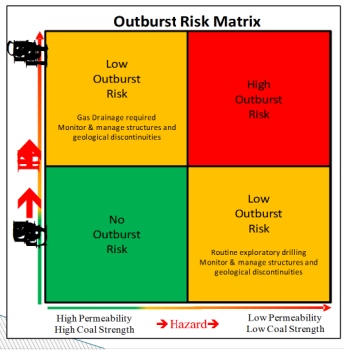
Supply of gas data
- GeoGAS

PhD Research Project

- ***Factors affecting the drainage of gas from coal and methods to improve drainage effectiveness***
  - Specific emphasis on improving gas drainage from CO2 rich and generally difficult drainage zones present in the Bulli seam
  - Detailed analysis of gas testing data (fast desorption method) identified strong relationships among test results
  - Non-Bulli seam mines were approached and provided data to expand the analysis

Outburst Risk

- Gas content – considered the major outburst risk factor
  - Gas content, Saturation, Permeability, Coal Strength
- Gas content reduction – principal risk reduction action



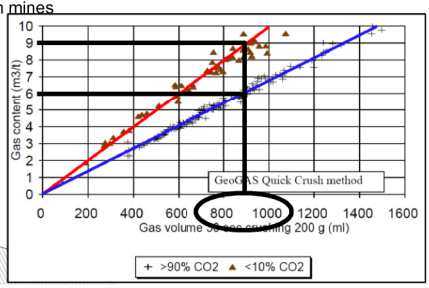
Bulli seam Threshold Limit (Lama, 1995)

- Level 1 threshold: 6.4 m3/t (CO2) & 9.4 m3/t (CH4)
  - In close proximity to geological structures
  - Development rate up to 50 m/day
  - If development rate limited to 10-12 m/day the Level 1 TLV could be safely increased by 20%
- Level 2 threshold: 10.0 m3/t (CO2) & 12.0 m3/t (CH4)
  - When no geological structures are present within 5.0m of the excavation during roadway development
- Safety factor of 19% - considered higher than gas content measurement error (Lama)

Bulli seam Threshold Limits (DMR s.63)

Outburst Threshold Limits – non-Bulli seam

- Desorption Rate Index (DRI) proposed by Williams and Weissman (1995)
  - DRI – related to gas volume liberated from a 200 gram coal sample after crushing for 30 seconds
  - Dataset presented (Gas Content V DRI) – notable difference between CO2 and CH4
- Bulli seam TLV (CH4) of 9.0 m3/t corresponds to DRI of 900
- Bulli seam TLV (CO2) of 6.0 m3/t corresponds to DRI of 900
- DRI900 methodology accepted by Industry for determining OB TLV for non-Bulli seam mines



Outburst Threshold Limits

1995-2000

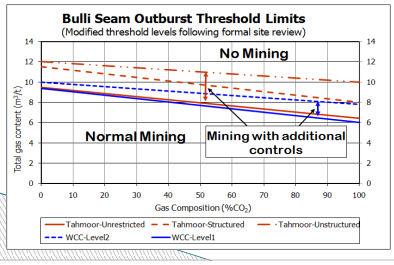
- TLV very effective in managing outburst risk
- **No fatalities** since introduction of TLV
- Prevailing mine conditions enabled relatively easy compliance – TLV generally accepted

2005-2010

- Mines are encountering more difficult conditions
  - Additional drilling
  - Production delays
  - Loss of reserves
- TLV now being questioned - considered conservative
- Reviews underway to support raising TLVs
- Are the 1995 s.63 TLV's really too conservative?

Outburst Threshold Limits – Recent Changes

- Two Bulli seam mines have increased outburst TLV
  - New TLV in place for about 5 years
  - No outburst incidents (*where gas content reduced below TLVs*)
  - Effective outburst management plans
- TLV (normal mining) – effectively unchanged
- Additional TLVs added – subject to additional controls
  - Not greater than the Level 2 TLV proposed by Lama (1995)



Additional controls:

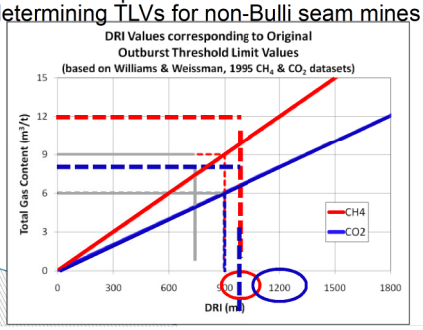
- **Increased drilling density**
- **Restricted mining rate**
- **Increased coal core sampling & analysis**

Significant Questions

1. Given recent increases to Bulli seam TLV should the DRI methodology be reviewed?
2. Does DRI900 continue to be an appropriate basis for determining TLV for non-Bulli seam mines?
3. Has the relationship between Gas Content and DRI, for CH4 and CO2 changed (from 1995)?
4. Is the relationship between Gas Content and DRI, for CH4 and CO2 representative of all Bulli seam conditions?

Impact of increased Bulli seam TLVs

- Assume relationship between Gas Content and DRI, for CH4 and CO2, remains valid
  - Bulli seam CH4 TLV (12.0 m3/t) corresponds to DRI of 1200
  - Bulli seam CO2 TLV (8.0 m3/t) corresponds to DRI of 1200
- **DRI1200** replaces DRI900 as the Index value for use in determining TLVs for non-Bulli seam mines



Relationship between Gas Content and DRI

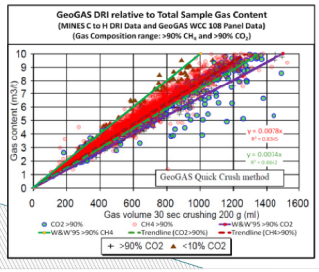
- Does the Gas Content V DRI relationship (CO2 & CH4) remain valid for current Bulli seams conditions
- Extensive analysis of core sample gas content test results
- Representative dataset compiled
  - 8 Australian undergrounds mines
  - 4,785 samples

Mine Reference	State	Samples	DRI Data	Gas Composition
Mine A	NSW	527	No	Mixed CH_4 - CO_2
Mine B	NSW	414	No	Mixed CO_2 - CH_4
Mine C	NSW	770	Yes	Mixed CO_2 - CH_4
Mine D	QLD	1,047	Yes	CH_4
Mine E	NSW	441	Yes	CO_2
Mine F	QLD	383	Yes	CH_4
Mine G	QLD	393	Yes	CH_4
Mine H	QLD	810	Yes	CH_4
TOTAL SAMPLES		**4,785**		

- Gas composition >90% CH4 – 575 samples
- Gas composition >90% CO2 – 2,903 samples

Gas content relative to DRI

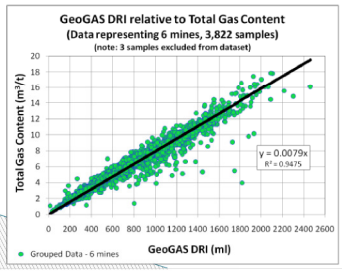
- Bulli seam data presented by Williams & Weissman, 1995
  - QM(CH4) = 0.010 x DRI
  - QM(CO2) = 0.0067 x DRI
- Average of current data
  - QM(CH4) = 0.0078 x DRI
  - QM(CO2) = 0.0074 x DRI



- Minimal difference between CO2 and CH4
- Independent of coal seam conditions
- Independent of gas composition
  - Similar result found in separate studies

Total gas content V DRI relationship

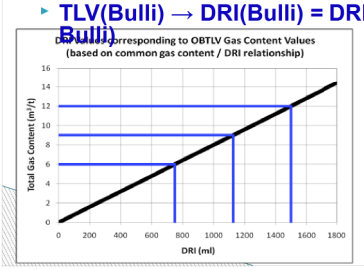
- Total gas content relative to DRI
  - Very strong and consistent relationship
  - **QM = 0.008 x DRI**
  - Independent of location, coal type and gas composition
  - Differs from the CH4 & CO2 data presented in 1995
    - Impacts the DRI900 methodology for determining TLVs for non-Bulli seam mines



14

Impact on Outburst Threshold Limits

- DRI – good indicator of total gas content
- TLV for CH4 has a different DRI to the TLV for CO2
  - TLV = 12 m3/t → DRI = 1,500
  - TLV = 9 m3/t → DRI = 1,125
  - TLV = 6 m3/t → DRI = 750
- Consistency of data, independent of coal seam type & location suggest Universal nature of the QM-DRI relationship
- **TLV(Bulli) → DRI(Bulli) = DRI(non-Bulli) → TLV(non-Bulli)**



- ∴ **TLV(Bulli) = TLV(non-Bulli)**
- A TLV deemed applicable to the Bulli seam applies equally to non-Bulli seam mines

Conclusions

- Extensive data analysis – 8 mines & thousands of samples
- Analysis indicates **DRI900** is no longer a valid index value for determining TLV for non-Bulli seam mines
- Strong relationship between QM and DRI
  - Independent of coal properties, including gas composition
  - **QM = 0.008 x DRI** applies to 6 mines analysed
  - Separate DRI values for CH4 and CO2 TLV
- TLV applicable to the **Bulli seam** is directly transferrable to **non-Bulli seam** mines
- Areas requiring further research
  - Expand QM-DRI database – additional Australian underground mines
  - Analyse mining experience in areas of high gas content (close to and above current TLV)