












- **Standouts**

- High energy explosive in soft ground
- Explosive not manufactured to specification – ungasged
- Learning's not rolled back into practice

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- Company B
  - Experiences fume events at level 4 – 5
  - Usually 2 or more factors combine to give rise to the incidents
    - High energy / powder factor in soft ground
    - High level of confinement through pattern depth and timing
    - Improper product selection
    - Poor water resistance in product
    - Recommended sleep time constantly shortened
    - Communication of changes to product not effective
    - Holes are treated as wet or dry



- **Standouts**

- MMU calibration causing under fuelling
- Numerous complaints in field about the lack of water resistance in emulsions
- Loading of wet holes with ANFO as emulsion had run out.
- 18 bags used on wet shot that had planned for 200
- High p/f in soft ground.



## Investigations by contractor


- Contractor A
- Experiences fume events up to level 5
- Usually 2-3 factors combine to give rise to the incidents
  - High level of bench water and rain events
  - High energy / powder factor in soft ground
  - High level of confinement
  - Highly fractured and weathered ground
  - Significantly exceeding sleep times
  - Manufacture or use of out of spec explosive





- **Standouts**


- Pf of 1 in soft material
- Exceeding recommended depth for product
- Doubling sleep time for product
- Under fuelling through faulty MMU

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- Contractor B
  - Experiences fume events up to level 5
  - Usually 2-3 factors combined to give rise to the incidents
    - Ground water damaging bulk product
    - Sleep time reached
    - Design linked to production not fume prevention
    - High confinement through design/depth
    - Manufacture or use of out of spec explosive.



- **Standouts**


- MMU calibration causing under fuelling
- Inappropriate selection of bulk product – water resistance

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- Contractor C
  - Experiences fume events at level 2 - 3
  - Usually 2-3 factors combined to give rise to the incidents
    - Ground water damaging bulk product
    - Product selection hard to change
    - High energy product in soft ground
    - Education of blast designers and blast crews on contributors to fume
    - MMU calibration
    - Heavily faulted ground
    - High energy bulk explosive in soft ground



- **Standouts**

- Overloading in soft ground
- MMU calibration
- Decoupling of columns through timing

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- Contractor D
  - Experiences fume events to level 1 - 2
  - Usually 2-3 factors combined to give rise to the incidents
    - Ground water damaging bulk product
    - High energy product in soft ground
    - Timing especially in the area of a free face.
    - Heavily faulted ground



- **Standouts**

- Product selection
- Close timing causing damage/decoupling of explosive column



## Investigations by 3<sup>rd</sup> party

- Experiences fume events up to level 5
- Usually 4 or more factors combined to give rise to the incidents
  - Wet conditions
  - Inappropriate explosive product selection
  - Lack of a free face
  - High energy product in soft ground
  - Fast initiation timing





- **Standouts**

- Product selection
- Review the quality of raw materials
- Blast to free face
- Improve the use / water resistance of bulk product
- Use of lower energy product in soft ground
- Lack of load data



## Investigations by Inspectorate

- Experienced fume events up to level 5
- Usually multiple factors combined to give rise to the incidents
  - Blast design for dry product
  - Inconsistent approach to wet holes
  - Wet conditions damaging explosives
  - Overlapped initiation timing
  - MMU calibration
  - Ignoring manufacturing QC triggers
  - Failure to apply learning
  - High p/f in soft ground
  - High confinement
  - Ownership with multiple contractors



## Standouts

- Timing overlap in double stitched holes.
- Continuing to load when manufactured product failed QC.
- A JHA identified the risk of overloading and all controls in the JHA had been bypassed or missed.
- An office acquittal of raw materials.



## Common themes

- Top 5
  - High powder factor/energy in soft ground
  - High confinement through design - pattern, depth
  - Fast or overlapped initiation design
  - Poor water resistance in selected product
  - Fractured/weathered ground



## Room for improvement

- Applying investigation findings to eliminate fume.
- Reviewing the balance between production and fume generation
- Effective monitoring to validate reduction

