Key Results of Investigations
Aims of investigation

To identify contributing factors
To identify clear/root cause
To roll the findings back into operations to:
  – Eliminate repetition of the incident
  – Better manage recurrence of the incident
  – To improve investigation of further incidents
• To educate others

Remember the investigation is to determine the cause of “excessive generation of oxides of nitrogen”

Utilise the template in the QGN to guide your investigation
Types of Investigation

- By site
- By contractor
- By third party
- By inspectorate
Investigations by Site

- Company A
- Experiences fume events up to level 4 to 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
  - Inadequate stemming depth
  - Poor water resistance in selected product
  - Incorrectly manufactured product
• **Standouts**

  - High energy explosive in soft ground
  - Explosive not manufactured to specification – ungassed
  - Learning’s not rolled back into practice
• 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
• 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
• 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
• 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 3rd 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