

# NSW Minerals Industry OHS Conference 2008

## Stream - Equipment Design

A case study of two NSW DPI incident investigations and the results from testing conducted on a winder haulage rope and chain components

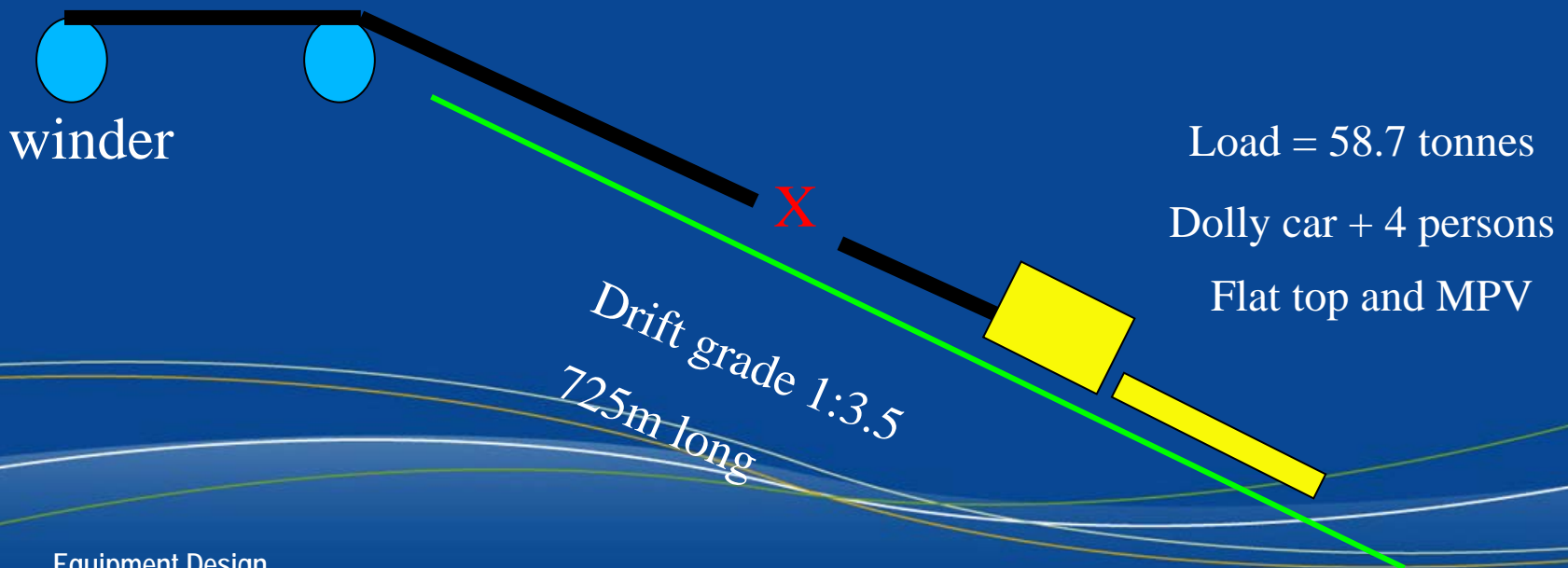
Tony Smith - Senior Investigator NSW DPI

Wally Koppe – Inspector of Mechanical Engineering NSW DPI

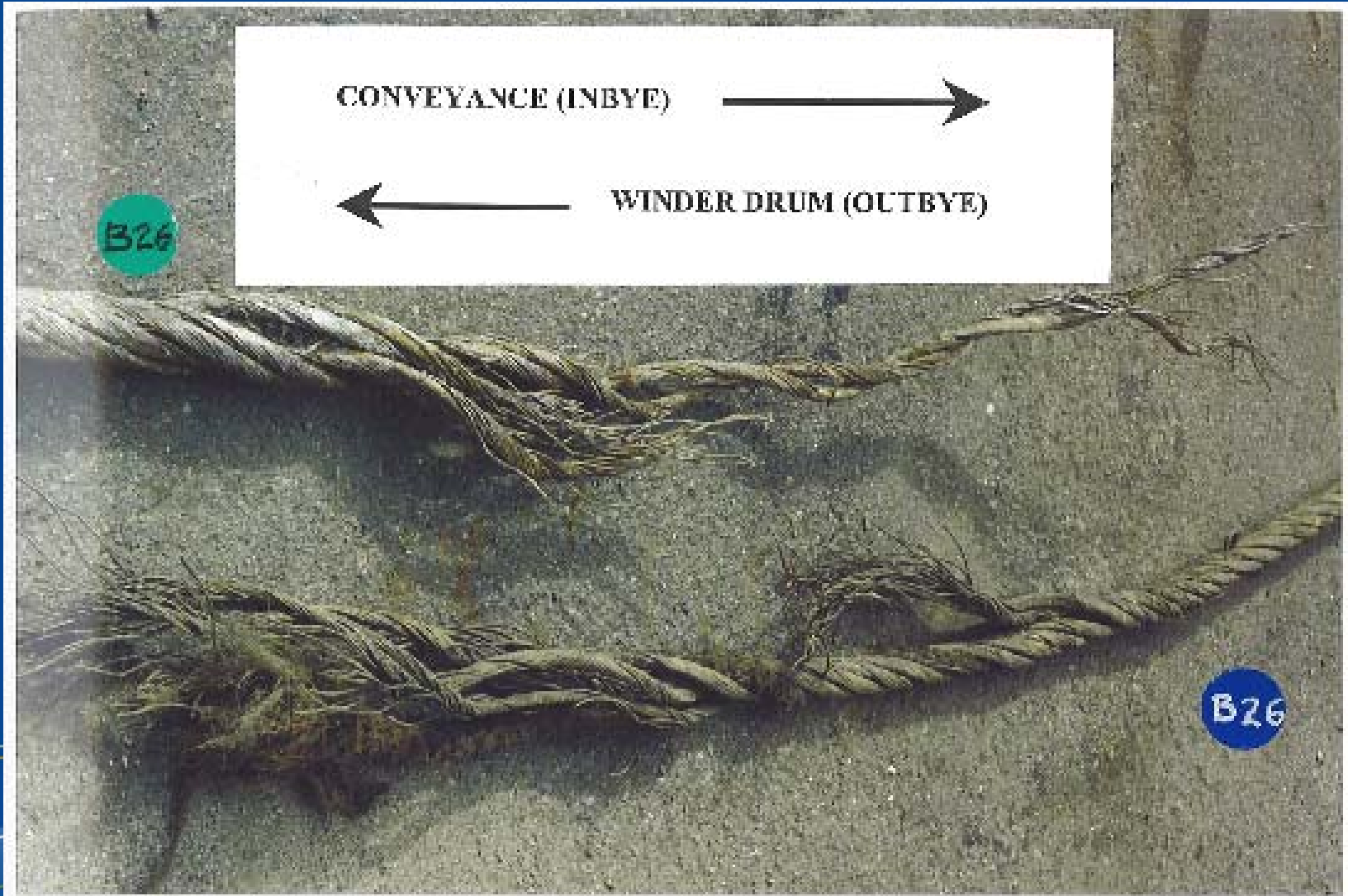


# Case Study One – Failure of a Winder Haulage Rope

- Incident Date 6 May 1999 the 52mm drift haulage rope broke after being in service for 15 months
- Rope rated at 1828kN (186 tonnes)
- 80 t capacity winding system



# Failed Haulage Rope



# Consequence of Failed Rope



# Consequence of Failed Rope



Longwall chock  
chock carrier  
MPV travelled  
40m from flat top

Tyre tread cut from tyre casing  
as ejected from flat top



## Inspection and Testing

Rubbing on stationary steelwork in excess of 35 locations

Water in contact with rope in excess of 14 locations

## Dynamic Testing

Investigation carried out by mine

Dynamic factor of safety is much lower than the static factor of safety



- Non destructive testing
  - Inbye 90m of rope NDT
  - Outbye rope NDT examined at wire rope plant
  
- LMA is not directly proportional to actual loss of strength
  
- Outer wires contribute 57% to 66% of total strength of wire rope



Photograph No. D26 – NDT set-up

- Destructive testing
  - Resin end testing
  - Grip testing
  
- Relationship between NDT measured LMA and loss of actual strength
  
- Effects of obstructions in drift were clear

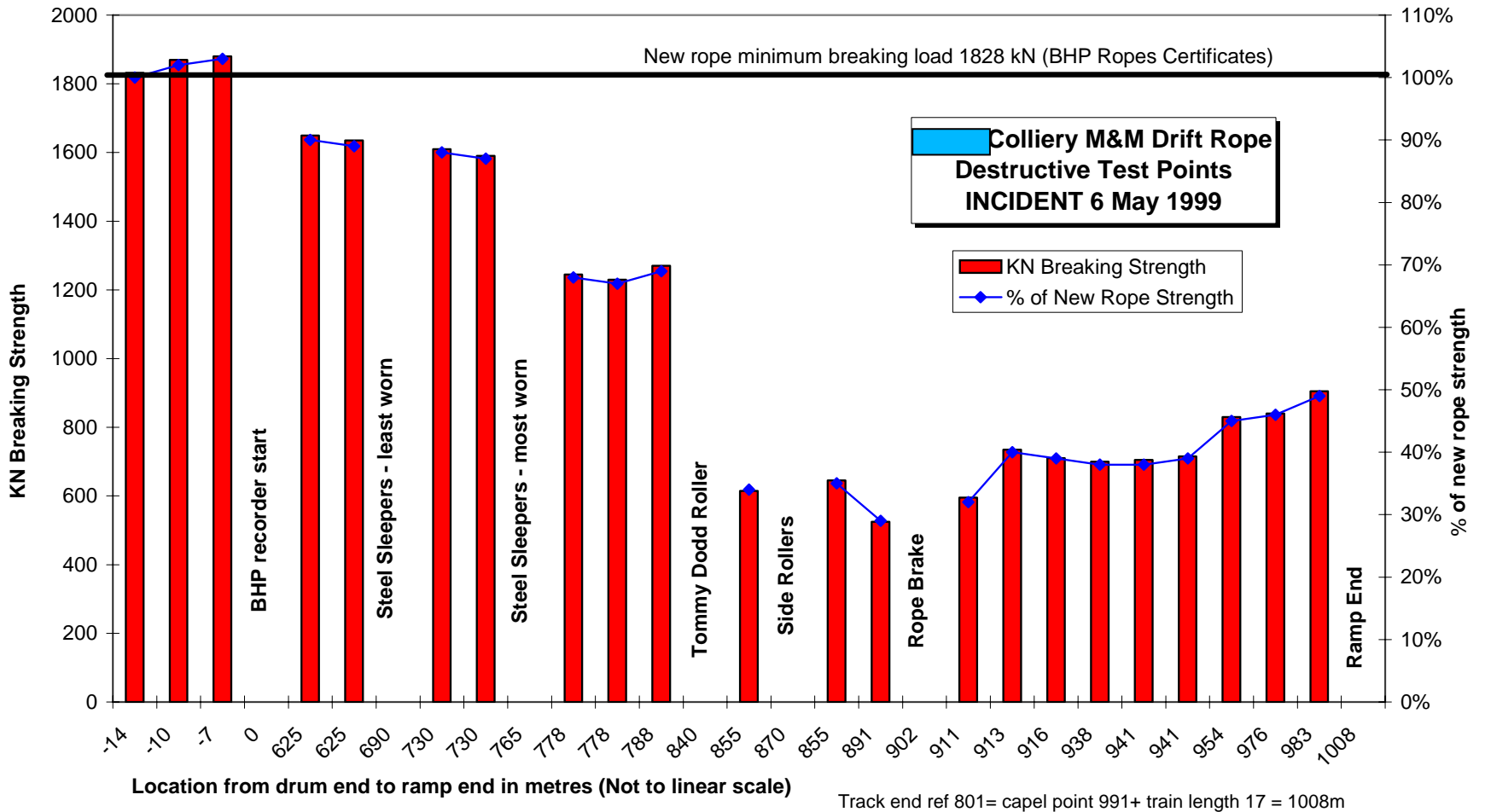


Photo No. 1Y/1 - Rope sample before testing



Phot No. 1Y/2- Rope sample after testing

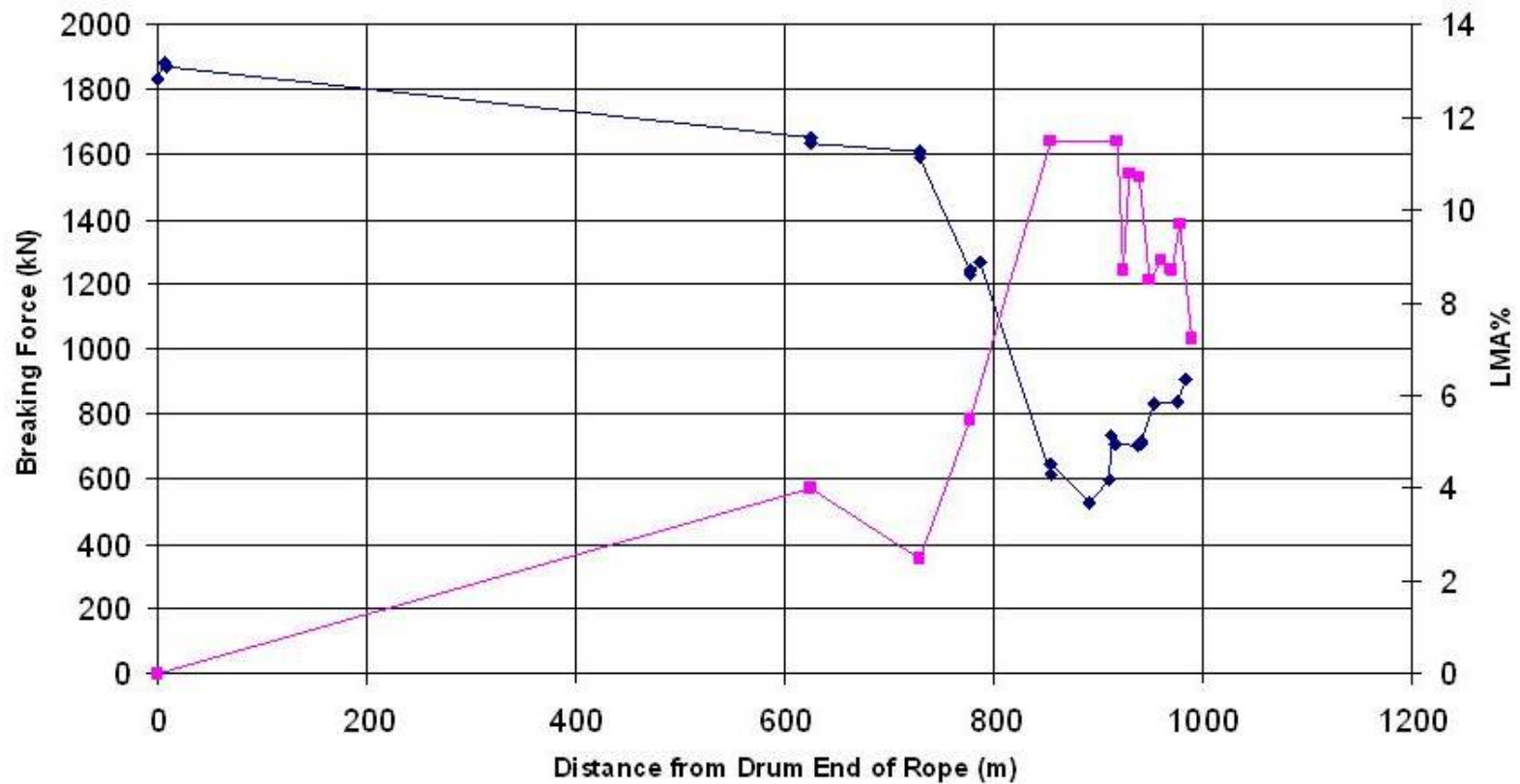
# Destructive Test Results



# Breaking Force Vs LMA

**Breaking Force Vs Loss of Metallic Area  
Relative to Position in Rope**

◆ Breaking Force  
■ %LMA



- Rope Diameter Measurements
  - Using diameter loss to identify strength is not considered accurate
  - Significant diameter loss may occur after being placed in service due to bedding of rope components
  
- Individual Wire examination and Analysis
  - New rope and 8 samples of broken rope were chemically and microstructure analysed
  - Individual wires tested for tensile strength, torsion and reverse bend cycles as per AS 3569-1989

- Publicise the DPI report
- Encourage regular audits of winders and wire ropes by experts
- AS 4812 was published in 2003.
- Encourage use of auto systems to limit maximum loads on ropes to an envelope suitable for the load.

## Case Study Two

### Failure of a Chain Connector

- Incident Date 28 May 2004
- Underground coal mine installing a longwall
- Two 1.8m length chain sets reeved around a longwall shearer ranging arm
- 20mm herc alloy chain assembly failed at the connector
- Connector placed in side loading
- Components rated at WLL 9.8 tonne in reeved pull

# Chain connectors placed in side pull



Post  
incident

simulation  
of Chain  
connector in  
side pull

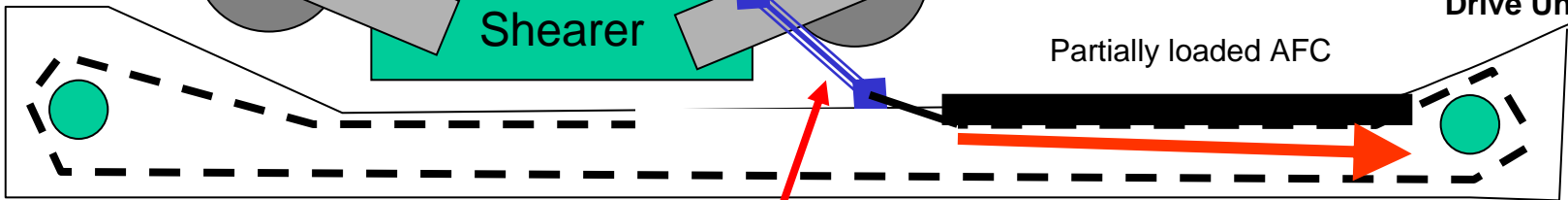
1 JUN 2004

# Effective forces at time of incident

**36 tonne max.  
pull by shearer**

Chain sling assembly  
**WLL of 9.8 tonne**  
in a reeved pull

Maingate  
Drive Unit



**Chain  
Component  
Failure**

**Resistance of 269 tonnes**

Maingate drive held  
Stationary by brake system  
1320 kN per strand

Tailgate  
Free to rotate

Tailgate  
Drive Unit

Partially loaded AFC

Shearer

# Connector straight pull test

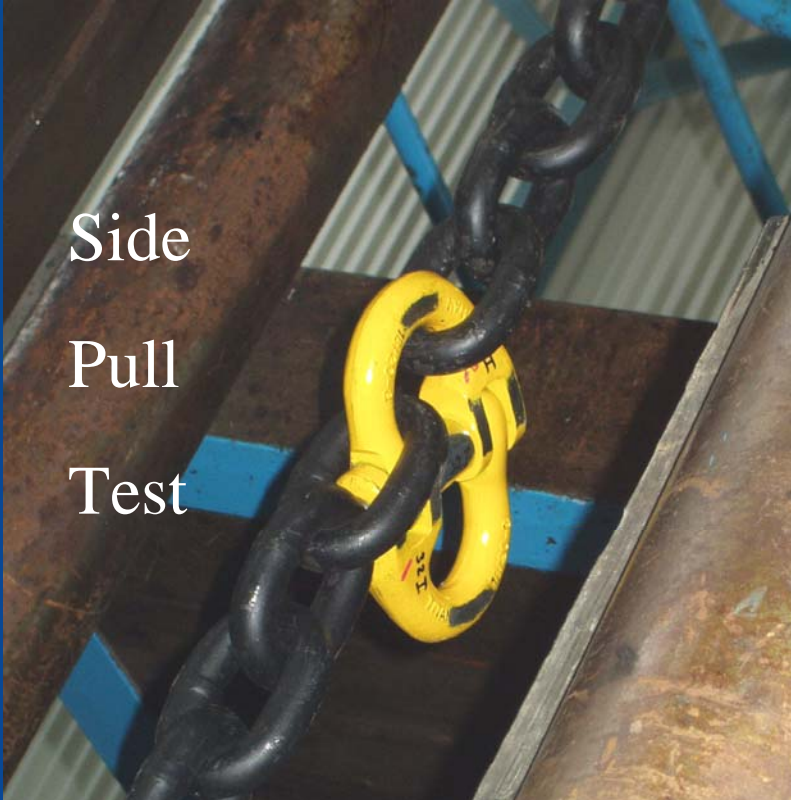
Straight  
Pull  
Test



- Ultimate load 470kN 47.9 tonnes
- Pin sheared into 4 pieces
- Legs intact and deformed

# Connector side pull test

Side  
Pull  
Test



Connector arm failed.  
Similar failure mode to  
connector involved in  
the incident

- Ultimate load 236kN 24.1 tonnes
- Failed connector body near eye
- 52% less than AS 3766-1990 requirement (in straight pull)

- Standards of Mechanical Engineering practice
- Supervision and training
- Fatigue management
- Original Equipment Manufacturers (OEM) and Suppliers of Lifting and Pulling Mining Equipment

- Chain sling arrangements in Australian Standards to be modified to reflect best practise .
- *“Assemble only one chain or fitting to each Hammerlock type body half.”*
- Identify working load limits (WLL) of all lifting and pulling equipment

- Development of a mining industry certified competency based training course.
- Ensure clear lines of authority
- Contractor Management systems to clearly define the scope of work and supervisory role of the contractor.

- OEM to assemble chains with only one load bearing component on any one end of a connector
- OEM/Suppliers to supply adequate instructional documentation for assembly, installation and safe use of equipment supplied.
- OEM/Suppliers to identify pulling forces and weight of equipment supplied.

When mines are preparing lifting and pulling work procedures they should take the opportunity to:

- ensure compliance with Working Load Limit (WLL) of pulling and lifting equipment.
- ensure information is readily available at the work site to identify forces applied to pulling and lifting equipment.
- ensure a competent person supervises and takes responsibility for all pulling and lifting tasks.

- Safety Alerts published for both incidents
- Conducted an industry seminar on winder systems
- Ongoing Audit of powered winding systems through to 2009
- Consultation with Australian Standards Committees, OEM's and mining industry
- Legislative changes incorporating design and plant registration for winding systems

- CD available free of charge
- CD contains all reports
- Contact DPI publications – Maitland
- [www.dpi.nsw.gov.au/minerals/safety](http://www.dpi.nsw.gov.au/minerals/safety)