Ultra Lightweight Ventilation Tubes

West Cliff Mine NSW

The Problem

The installation of temporary ventilation tubes in underground coal mine development panel operations is used to control gas and airborne dust levels at the coal face. During the development mining process operators are frequently required to lift and handle the ventilation tubes.

For some time fibreglass ventilation tubes have been used for this purpose. Each fibreglass tube weighs between 33kg and 40kg and is 618mm in diameter and 2.5 to 3 metres in length. Installation of the tubes requires two operators to lift and carry each tube a short distance over uneven, unstable or slippery ground to the back of the continuous miner where it would be manually lifted from the floor above their heads to secure its position to the roof. A functional task analysis has shown that a single person installing fibreglass vent tube is required to occasionally lift 30 kg (75 per cent x 40kg) from floor to above shoulder height and undertake a bilateral carry of 30kg.

Over time the tubes can become progressively heavier with the accumulation of sludge and repairs to fibreglass that add to the tube weight. The tubes also become harder to fit together as they become older and their fibreglass ends split and fray.

These factors combined can result in increased exposure of workers to the potential risk of:

- musculoskeletal injury to the shoulders, neck or back, due to the heavy weight and awkwardness of the load;
- awkward postures associated with working overhead;
- lifting the load through range from floor to roof;
- environmental conditions (poor lighting, often wet/slippery/uneven ground, may be standing on platform of miner or not); and
- sudden exertion of high force to lift tube and the suction pressure pulling the tube in.

Over the last five years at Illawarra Coal, 30 per cent of all musculoskeletal injuries involved back, neck or shoulder. Heavy repetitive manual handling, such as installing and removing ventilation tubes, is a likely cause of these injuries

Solution

A project team established at West Cliff Mine, which included development operators, engineers, coordinators and health and safety representatives, embarked on a project to reduce manual handling risk in development panels; particularly in relation to shoulder and back injuries. Workshops and presentations were held in which information from injury data, hazard reporting and behavioural peer on peer observations were analysed.

Functional task analyses were undertaken within the development panel using the JobFit System task assessment tool and crew members were consulted in the process. Training sessions and workshops were provided to crews on managing musculoskeletal disorders and identifying, assessing and controlling risks associated with manual tasks. Handling fibreglass ventilation tubes was identified by operators as one of their top five hazardous manual tasks (see Table 1).

As ventilation is necessary for safe operations underground it was not possible to eliminate the handling of ventilation tubes altogether. The project team then looked at options for substituting the fibreglass tubes with a lighter weight product. A carbon fibre manufacturer was sourced to produce a lighter weight ventilation tube and it was trialled at the mine. Carbon fibre is a very strong and light fibre-reinforced polymer. It has a very high strength to weight ratio.

Rank	Development team - Top five highest risk manual handling tasks	% of participants that agreed
1	Handling/ hanging old vent tubes	75%
2	Lifting CM cable into hangers, reclaiming CM cable and services	75%
3	Installing and removing belt structure, rollers, belt advance	58%
4	Installing bolts from CM, bolting	50%
5	Roof Mesh onto C/M	42%

Table 1: Top 5 hazardous manual tasks in development, as nominated by operators during workshops in 2011

The carbon fibre ventilation tube weighs 9kg and is the same size as a fibreglass tube. The carbon fibre tubes are four times stronger and can handle sixteen times the differential pressure of fibreglass tubes. They have been purpose built to be compatible with existing tubes and were introduced into underground production for a trial in June 2011.

The tubes have been used successfully in one of our development panels for the past nine months. They are lighter and easier to use, have better wear and durability, better strength, collapse less often, are easier to fit together as the ends do not fray and generally last longer. Accessories (T pieces, 45Ð and 90Ð bends, end caps and regulator tubes) as well as flat tubes and flat-to-round adapters have since been designed and ordered.

During implementation, we sought feedback from development operators on the new ultra light weight vent tubes. Everyone surveyed reported that they were easier to use and required less physical exertion to install and retrieve. Some of the comments from operators included:

- "Very light weight, awesome"
- "They are unreal, great idea"
- "Very light, easy to put up. Get rid of the old ones"
- "The sooner we get rid of the older tubes the better. Less injuries".
- "More tubes more quickly. Old tubes are hazardous"
- "Lighter the better. Thank you"
- "It's the best thing that I've seen introduced to underground coal mining in the last 10 years"

There have been no reports of injury with the carbon fibre vent tubes and reducing the weight of the tube (from 35-40kg to 9kg) has substantially reduced the risk of injury associated with this task.

Photo 1: Carbon fibre ventilation tube weighing 9kg

Photo 2: Carbon fibre ventilation tube in production underground mine

Photo 3 and 4: Accessories made from carbon fibre

Application of risk management principles

The site adopted a number of risk management principles in identifying the hazard, assessing the risk, determining a lighter weight alternative to the heavy fibreglass tube and implementing/integrating the carbon fibre tubes into the production process. Project team members were systematic in assessing the problem. The team was transparent and inclusive, and consulted all relevant stakeholders; including operators, engineers, coordinators, health and safety representatives and carbon fibre manufacturers, to ensure that all available knowledge and expertise was utilised in determining the most appropriate and effective controls. The ultra light carbon fibre ventilation tubes underwent certification by the manufacturer to MDG3006 MTR8 (fire resistance and electrical resistance tests) and Illawarra Coal site introduction of new equipment requirements and risk assessment prior to being introduced underground, including updates to job instructions. Tool box talks kept operators informed of progress during the project.

An implementation program with trials was undertaken over a number of months. Following the introduction of the new tubes into the panel, feedback was sought from the operators and a further functional task analysis completed.

Consultation processes

The project team consulted widely with operators, engineers, coordinators, health and safety representatives and carbon fibre manufacturers throughout the project. The team reviewed the current state of the existing fibreglass ventilation system and determined a suitable ultra light weight alternative. Team members consulted with the site HSEC committee and behavioural awareness committee and participated in pre-shift 'tool box talks' to explain the new carbon fibre tubes being trialled.

Benefits and Effects

Since the introduction of the ultra light weight tubes into our development panel feedback from our operators has been very positive. By substantially reducing the weight of the tube from 35-40kg to 9kg, the physical exertion required to lift the tube into an overhead position is substantially lessened. Since the implementation of the ultra lightweight tubes there have been no reports of injury or illness associated with the task. The new tubes are lighter, fit together more easily, are stronger, have greater tolerance to damage and are inherently fire retardant. Additionally, the tubes have enabled productivity gains as they take less time to lift and install and less time to retrieve/recover.

The working environment conditions in underground coal mining do present additional challenges for tasks that involve materials handling; such as poor visibility, uneven and unstable ground, wet and slippery floor. Whilst we are constantly working on improving the work environment conditions by addressing roadway standards, substituting fibreglass with a substantially lighter weight material (carbon fibre) has enabled a reduction in manual handling risk associated with this task.

An unexpected benefit that has arisen from the success of the project is the endeavour by the site to remove other heavy lifting tasks by substituting heavier materials (such as steel) with carbon fibre. The site is investigating options in relation to manufacturing a carbon fibre belt spool to replace the existing steel 150kg belt spool and SMV bonnet.

Transferability across the industry

The carbon fibre ventilation tubes are compatible with current fibreglass ventilation tubes and can be integrated within current ventilation systems. There is widespread transferability across the mining industry. Carbon fibre may also be used as an alternative to steel for other equipment in mining.

Innovation and originality

Implementing a carbon fibre ventilation tube (9kg) is both innovative and original in the mining industry. To our knowledge, West Cliff Mine is the first underground coal mine site in NSW to trial these tubes and only one of two sites in Australia.