MINING ELECTRICAL AND MINING MECHANICAL ENGINEERING SOCIETY.
An Engineers Australia Technical Society
NEWCASTLE BRANCH ABN 13 772 583 769

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In response to the inquiry investigation 483 "Anti-Circumvention Inquiry into slight Modification of Goods" wire ropes exported to Australia from the Republic of South Africa Mining Electrical and Mining Mechanical Engineers Society (MEMMES) was asked to respond to some questions being posed as part of a public response.

A number of avenues were taken to investigate and to give the best response to the questions, for example;

- informal discussions over the phone with industry wire rope experts and Mine regulators
- Face to face at Mining Engineering meetings and MEMMES meetings, end users and general mine engineering personnel.

MEMMES is a Society member of Engineers Australia (EA) with over 210 members. We hold meetings mainly in Newcastle, NSW and do attend other meetings at Dubbo, Cobar, Melbourne, Western Districts of NSW (Mudgee and Wagga Wagga), South Coast and Sydney. These are all major areas of coal and hard rock mining. In the past we held other meetings in Queensland and Western Australia. The meetings are organised and held on a monthly basis at different locations and do visit suppliers and end users. MEMMES members' backgrounds are typically personnel that are involved with either a supplier or end user for the mining industry. These include Electrical and Mechanical mine Engineers (Managers of Mechanical and Electrical Engineers) that run mines (open cut, underground and quarry operations and are ultimately responsible for the safety of the operations at these mines under legislation.

I Dominic Posavec have been the key person drafting this report. Being the Senior Vice President of MEMMES I have been tasked to complete this report to the best of our knowledge as mainly end users' of the wire rope products in open cuts and underground operations.

I have personally been in the mining industry for over 40 years. I was a tradesman, Mechanical Shift Engineer, Manager of Mechanical Engineering, General Manager for over 400 employees, Design Engineer, Part time as NSW Mines Inspector (similar to WorkCover Inspector) in both underground and open cut. I have a Mechanical Engineers Certificate of Competency and have further completed a degree from Newcastle University in Work, Health and Safety (6 years part time course – 3 years full time). My experience includes being an end user of wire products, supplier to the industry (not wire ropes) and now have my own consulting business which deals with all aspects of management and support for the industry including dealing with wire ropes. I have 33 different certificates which also include wire rope inspection and testing. I have well over 28 years of experience dealing

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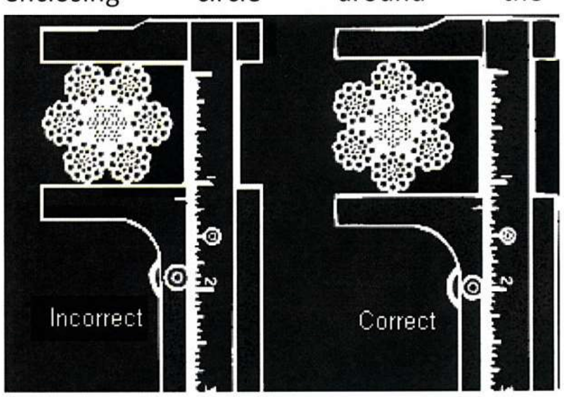
directly with wire ropes in both open cut as well as underground operations. I have also been through a number of manufacturing wire rope plants in the past.

Other personnel involved in this report review include, Industry experts in wire rope as suppliers and installers, auditors (NDT testing), end users such as Managers of Mechanical Engineering as well as Mechanical Mines Inspectors. These people involvement have always been as initial discussions whether at meetings, over the phone or readers of the final report dependant on the experience in the field. The wire rope manufacturers were not directly contacted for opinions to obtain the best neutral position. Installers and maintainers were not aware about the report and answered questions directly to the questions posed. The questions and answers were based on direct comparison between an 8 strand or lower compared to a 9 strand wire rope. I have listed the names, experience (385 years in total) and the company names of people that I have spoken with in writing this report and will be treated as confidential. This information will be available for the Anti-Dumping Commission for their review as a separate document.

Definitions of key terms used in the document

Actual Breaking Force:- Actual tensile force in kilonewtons (kN) required to break a test sample of the rope as nominated on either the manufacturer's original test certificate or the most recently issued rope testing certificate

Diameter of rope:- The transverse measurement through the centre of the smallest enclosing circle around the cross-section of the rope.



Impact and wear damage of wire ropes:- Steel wire ropes are often mechanically damaged during service. The rope might hit a steel or solid structure, thereby locally damaging some outer wires, or it might be dragged along a hard surface such as the overburden, creating a great amount of mechanical wear.

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Necking of the wire rope:-  Occurs when a wire breaks under tensile load exceeding its strength. It's typically recognized by the "cup and cone" appearance at the point of failure. The necking down of the wire at the point of failure to form the cup and cone indicates failure has occurred while the wire retained its ductility.

Safety Factors of ropes:- A measurement of load safety for wire rope obtained by using the following formula: Safety Factor - B/W where: B = nominal catalogue breaking strength of the Wire Rope, and W = calculated total static load. Also called - Design Factor. Typical safety factors of ropes tend to be between 6:1 and 10: 1 dependant on the conditions the ropes are working in and the application such as material carrying, men carrying, drag ropes, dump ropes etc. Use of NSW MDG 33.7 is useful guide for this type of work as there is no specific item for the open cut ropes and is a good general engineering principle.

Torsional resistance of ropes:- Resistance of the rope against twisting during use. This can be achieved by pre forming of the ropes as well as laying strands in different directions to counteract the twisting motion i.e. Inner and outer strands/cores.

Wire Rope:- A group of strands laid helically and symmetrically, with uniform pitch and direction around a central core of natural or synthetic fibre, or wire.

End user expectations

Manufacturers of ropes currently in Australia have not been contacted directly as mentioned before and information used in this report to develop the answers to these questions have been gathered from Australian Standards, NSW MDG guidelines, British Ropemans' handbook and practical Mechanical Engineering experiences by Managers of Mechanical Engineering from NSW mines. This document has been compiled mainly by end user input and known knowledge of firsthand experience throughout hundreds of years of expertise by MEMMES members, as well as known test results due to cropping of ropes on a regular basis and examinations by approved testing laboratories in Australia.

Rope manufacturers are asked to produce ideal ropes for mining Industry that are:-

- smaller in diameter
- designed with higher fill factors
- higher abrasion resistant
- contained with good oil penetration capabilities
- corrosion resistant
- designed with higher breaking loads for same diameter rope

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- designed with easier cleaning capabilities
- highly flexible
- designed to have less wearing properties
- a better control for impact damage
- able to withhold lubrication better
- designed to have good bending fatigue
- designed to have excellent non-rotational properties,
- suitable for all climate conditions (snow, rain, heat, dust)
- rubbing resistant against support rollers and rails such as drift systems in underground mines
- contained with suitable internal wire and strand support
- resistant to ingress of dirt and water
- able to achieve higher cycle times,
- manufactured for easier drum spooling

Please note that the above requirements are difficult to achieve for all ropes at times.

End user usage of ropes

The usage of wire ropes in Australia and in particular the high users of ropes, has been predominately in open cut mining operations for removal of overburden, raw materials and other minerals, underground coal, underground metalliferous mining, prospector mining and quarrying. The ropes manufactured for end use are typically for large plant and equipment such as;

- **Drag ropes** – In our opinion drag ropes are replaced on average every 8 to 10 weeks. The time it takes to change or end for end a rope, including pre-planning, set-up and clean-up time is approximately 22 hours. The main failures in drag ropes are either due to abrasive wear, impact damage or wire breaks at end sockets. The drag ropes suffer from heat damage more often due to rope dragging over hard material and boulders. The surfaces of the outer wires become heated due to the friction and then are subjected to rapid cooling. As a result of this process, the wire material can change phases and undesirable martensite can be formed on the worn-out surfaces of the wires.
- **Hoist ropes** – Our understanding is that the wire ropes are replaced on average every 8 to 12 months because of broken wires and wear due to cycle times, bending moments and sheave damage/wear. Time it takes to change the rope which includes pre-planning, set-up and clean-up time, is approximately 28 hours.

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- **Dump ropes-** Replaced on average every 5 to 8 weeks. Most rope damage occurs due to impact damage caused by raw materials.
- **Shovel ropes** - Replaced typically every 10 to 12 weeks. Damage is usually caused by abrasion, wear and corrosion.
- **Drum winder ropes in drifts** – Typically replaced on average every 6 years under standard conditions. The time it takes to change a rope which includes pre-planning, set-up and clean-up time, is approximately 32 hours. These ropes are closely monitored due to the high potential of an incident and the NSW Mining Industry use NSW MDG guidelines e.g. MDG 33.7, standards and legislative requirements to assist the Industry in rope management. Items such as safety factors of ropes, broken wires, cross sectional area losses and corrosion are closely monitored on a regular basis. Factors that affect this rope life are moisture in the drift, the number and type of support rollers, road maintenance, the number of broken wires in the rope, high wear areas of the rope, sudden stop of the dolly car (bouncing or shock loading), kinking and bird caging, cycle times, the number of rail turns on surface and underground, load ratings, how the rope is protected from rubbing on rails, the use of timber sleepers (location/numbers), drum diameter, lubrication method and frequency, sheave diameter and fleet angles, sheave diameter and maintenance, and support roller material.
- **Vertical shaft drum winder ropes** – Replaced on average every 8 to 10 years and in some cases longer. Similar factors affect this rope as per the point above (drum winder rope in drifts).
- **Friction winder ropes in vertical shafts** – Replaced on average 3 to 4 years dependant on cycle times. Main reason for replacement is wear, stretch, corrosion and loss of cross sectional area.
- **Balance ropes in friction winder systems –** Replaced on average every 3 to 4 years mainly due to corrosion.
- **Guide ropes for shaft cages** – Typically can last greater than 10 years. Major issues are corrosion and wear, broken wires due to dust and moisture exposure particularly in return shafts.
- **Conveyor LTU tension ropes** – Usually last 10 years or more

Dragline ropes, including suspension, Intermediate Boom Suspension (IBS), drag rope, hoist and dump ropes are a major driver of maintenance costs. These typically account for 10-15% of the total maintenance costs as we know it. The weekly rope inspection procedure used at present for drag and hoist ropes is very rudimentary. There is evidence that important parts of the ropes are not inspected and consequently, the risk of failure is

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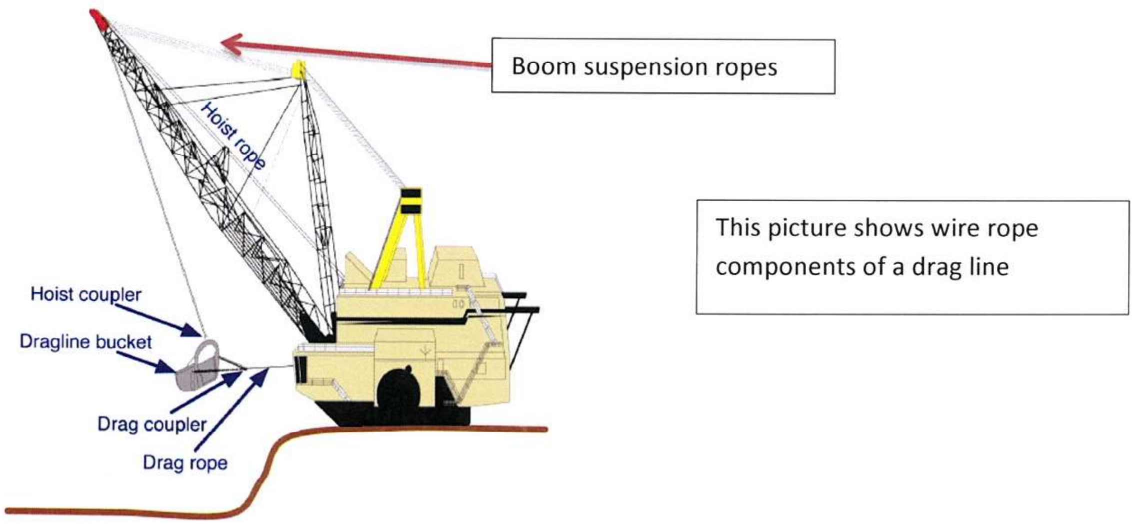
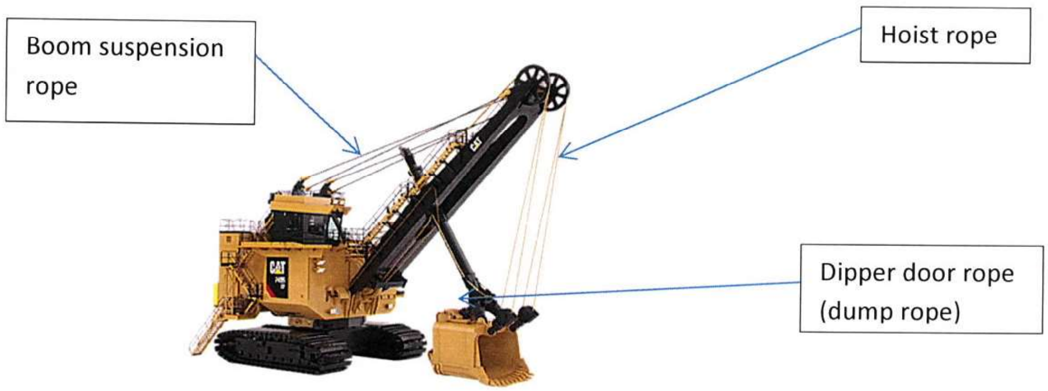
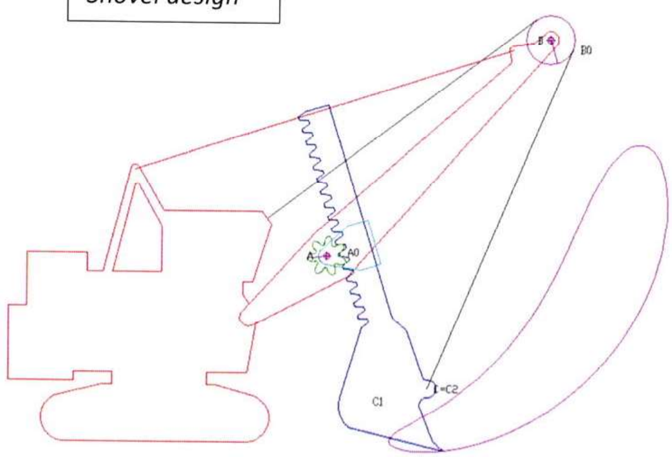
present. More comprehensive inspections are difficult to justify, considering the cost of a new pair of ropes and the opportunity cost of dragline downtime.



The operation of draglines in open cut mines hinges, among other things, on the integrity of the wire ropes. The integrity of ropes ensures that a safe operating environment is maintained under service. An understanding of the integrity of ropes also leads to better planning in terms of rope changes which can lead to favourable cost to production ratios. The breakage of a dragline hoist or drag rope during operation can have serious consequences. The potential energy carried in the ropes during operation can cause damage to wire rope accessories or surrounding structures because the ropes have a capacity to recoil at considerable speeds and can therefore cause damage through impact. The integrity of wire ropes is dependent on an understanding of rope deterioration mechanisms and experience. The deterioration is affected by the cyclic nature of loading in wire ropes during the dig, swing and dump cycles which leads to fatigue failure of different dragline rope types. Typical loadings experienced by individual wires in a rope are very complex and include a combination of tension, torsion, bending and shear. Other environmental conditions arising due to the above mentioned forces and interlocking of the wires can be inter-wire abrasive wear, impact damage, external abrasive wear, corrosion and external damage.



Shovel design



Operation of shovel

The shovel operates using several main motions:

- hoist - pulling the bucket up through the bank (i.e. the bank of material being dug)
- crowd - moving the dipper handle out or in to control the depth of cut and when positioning to dump
- swing - rotating the shovel between digging and dumping
- propel - moving the shovel unit to different locations or dig positions

A shovel's work cycle, or digging cycle, consists of four phases:

- digging
- swinging
- dumping
- returning

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The **digging** phase consists of crowding the dipper into the bank, hoisting the dipper to fill it, and then retracting the full dipper from the bank. The **swinging** phase occurs once the dipper is clear of the bank both vertically and horizontally. The operator controls the dipper through a planned swing path and dump height until it is suitably positioned over the haul unit (e.g. truck). **Dumping** involves opening the dipper door to dump the load, while maintaining the correct dump height. **Returning** is when the dipper swings back to the bank, and involves lowering the dipper into the tuck position to close the dipper door.

Wire ropes are one of the most heavily used components in a dragline and a shovel. They are subjected to harsh conditions during the regular usage in mining operations. Hoist ropes are subjected to fatigue due to the cyclic nature of load handling as well as due to the rope bending over the sheaves and the drum under load. This leads to wire breaks due to fatigue. Accumulation of a number of wire breaks close to each other can have a detrimental effect on the rope. Furthermore, to allow for the increasing demand for higher load capacity coupled with the inconvenience of having very large ropes, the factor of safety is often compromised, which increases the wear rate. Drag ropes are also subjected to heavy loads on drag lines. More importantly, they are allowed to drag along the rough mine surface subjecting them to external physical abrasion. This makes the life of drag ropes one of the lowest among those used in a dragline.

Wire ropes used in the mining industry are made of high carbon steel wires of different diameters and tensile strengths that have been cold drawn, producing very ductile, fatigue resistant properties, as well as very high strength. Wire ropes are typically manufactured to grades of 1570, 1770, 1960 and 2160 (Ref – Nobles wire rope information).

While ropes with 9 strands can be used in the same way and in the same applications as 8 or lower strand ropes, there are many factors that need to be well-thought-out before the change to a 9 strand rope can be considered a success. Such factors which are the end user key requirements are that;

- the diameter is the same, (If the diameter changes this could have an effect on sheaves and roller wear if larger or smaller diameter ropes are used).
- the tensile and braking strengths are the same or better,
- the safety factors are the same or better, -(Potential for longer life if safety factors increase and reduce risk of failure),
- the elongation during use remains the same, (rope cut to certain length in many instances and anchored between two points so any stretching could have an effect on life of rope unless there are systems in place to adjust tensions and elongation),
- less stock is kept on hand, (Reduces inventory stock and therefore reduces cost),

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- there is no necking (stretching) of the wire rope, (Causes wire and rope failure),
- they are impact and wear damage resistant, (Particularly when dragged through overburden during operations),
- they are corrosion resistant, (Controls environmental conditions better as coal has sulphur and combination with water creates Sulphuric Acid SO_4 as an example),
- they are torsional resistant, (Important as part of dragline and shovel operation as it creates hazards when the ropes are being changed on such a regular basis. The possible inbuilt torsion in the rope when disconnected needs to be controlled and is difficult at time as it is a hazard),
- the overall life of rope in same working conditions is increased,
- it is easier to replace a rope, (Easier to handle the rope during replacement and installation,
- it is easier to end for end a rope, (Allows to increase rope life in some circumstances),
- there is a decrease in the cost of the rope, (This in our opinion would not be the case for a 9 strand rope if based on equal labour costs)
- there is a decrease in the change out time, (Typically this would be the same in our opinion)
- there are no additional changes required such as sheave and drum changes, (Extremely important as once you start looking at the cost of these changes then it becomes uneconomical to do),
- the machining of drum or sheave grooves is not required,
- they are easier to lubricate and clean,
- they are easily inspected visually and
- the length of rope is the same.

Other factors that might be considered are end of rope attachments tooling and their interchangeability with the current system.

As part of the scope of works requested, this report compares the circumvention good (9 strand wire rope) and the goods subject of the notice (wire rope less than 9 strands). In this report, the assumption will be made that the **rope diameter will stay the same** as the current rope used, as there are other factors that come into play if the nominal outer diameter is changed even by small margins including the lay length and shape. Comparison will be made against the details supplied for Innovation Patent Application number AU 2018101211 A4 including the drawings therewith.

This application describes six different wire rope designs. Our report does not specifically deal with a particular rope design as each one of the rope designs has a different application

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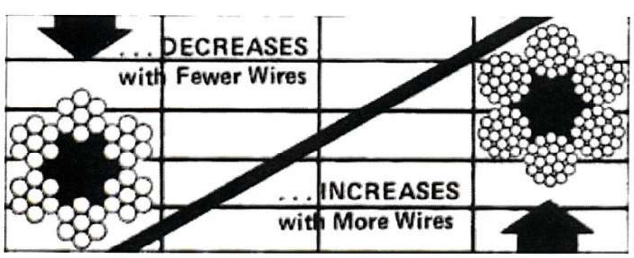
and functionality. They all have 9 strands. In our opinion ropes that are used in high corrosion areas would most likely use plasticised fill within the rope to stop any ingress of moisture internally to the rope core. This could cause flexibility issues in some circumstances that can lead to greater wear and greater bending moments and broken wires. Other ropes with greater number of fill wires would be more flexible and more likely have greater breaking strength then an 8 strand rope of similar diameter, but once again it would have to be assessed against its use as it adds additional weight of the rope and could cause handling and structural cracking issues. Each design has been designed for different applications and would have to be discussed individually at different operations for functionality and suitability including the original designers of plant. We all feel though that 6/6 diagram rope from the application would most likely be the rope to give the best drag rope in its application for drag lines. All other drawings of ropes would be installed specific to the installation, sheave designs, environmental, loading, wear, location conditions found at different mines.

Physical characteristic differences of a 9 strand wire rope compared to 8 or lower strand wire rope is considerable. The size of the wire and the number of strands alters the characteristics of the wire rope in many ways and is a significant change. While the diameter is assumed to be the same, internal design of wires, core design, number of strands, outer wire diameter, crushing resistance and internal wear resistance as well as changes in design, are considerable in both positive and negative ways as the below information will further explain.

Firstly, if an additional strand is added to the design of the currently used 8 or lower strand rope, this will mean that the wire diameters internally need to be reduced to keep the same diameter of the rope. With the introduction of smaller wire diameters in the rope and strand, the wire rope becomes more flexible which is a significant advantage of this type of rope in majority of cases.



Support increase with more wires

The addition of filler wires (wormings) between the strands is a major factor in the increase of cross sectional area of steel in a 9 strand rope and therefore increases the breaking force of the rope [The more steel you have the greater the rope strength].

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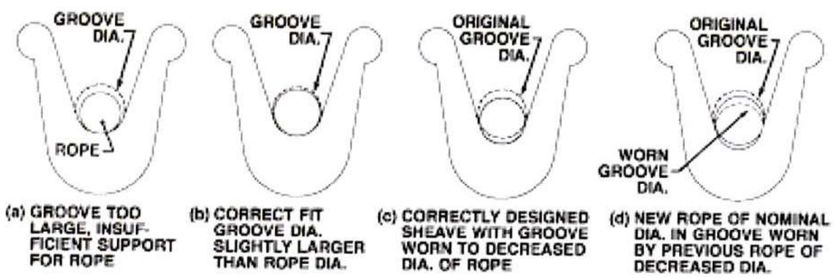
Other advantages that are known with the 9 strand rope are that there is a lot of wire rope and strand support due to the compactness of the wires within the rope. Its ability to have a larger independent wire rope core and the addition of the plastics to support the strands and wires within the rope can cushion the forces on the crown wires and also reduce fatigue due to bending. The plastics retain lubrication within the rope and keep the rope uniform in shape and therefore reduce wear/abrasion in particular around sheaves and drums. The plastics also protect against strand to core contacts, support the outer strands better and increase strength and crush resistance. The bending moments and fatigue fractures do reduce because the rope is more flexible as it moves around and bends in different directions during use.

In some cases, the addition of another strand could cause additional wear in sheaves even though it shows that there should be better rope support by the use of a 9 strand rope. This consideration of a new or different rope characteristic needs to be considered as per point (d) below and needs to be proven in the field. The out of plane rope tracking at the sheave could impose excessive side rubbing against the sheave groove as the lay of rope and length changes.



Rope sheave wear details

The additional flexibility of the 9 strand rope does allow for better handling when it is being replaced but is not a major factor as the ropes are typically handled by large winder systems and cranes and therefore very little manual handling is involved.

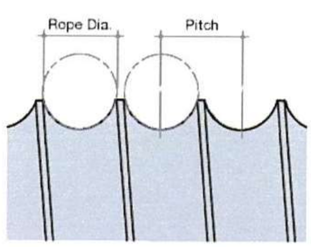
The ability in the design of the 9 strand rope to reduce rotation during installation and use, is a factor that needs to be considered but a rope with a lesser number of strands can also be manufactured to reduce this occurrence as the inner core can be placed in a different direction to the outer core if so requested.

Claim about the longevity of the rope is unknown at this stage but, due to its greater flexibility, it is most likely to be more durable in some circumstances but many other factors as listed below need to be considered to prove this claim.

The potential to increase the life of these ropes is a significant factor in the decision making, as even an increase of the life of the wire rope by 30% is considerable in cost savings due to the frequency of rope changes that occur as part of the mining processes in dragline and shovel operations. The industry does not believe that anything below a proven 30% increase in availability will justify the changes to occur from an 8 or lower strand to a 9 strand rope.

The major concern for end users of the 9 strand rope design is that it needs to be proven in the field. To achieve this, consideration needs to be given to the following factors which are not something that happens in a short period of time and the risks are high. Finding a window of opportunity for plant and equipment that runs at 98% availability to trial the rope, is a major issue against a known proven product.

1. As the outer wires of the strand are reduced in diameter and the inner wires even more so, the outer wires are more prone to wear, impact damage, flattening of the wires and have a greater exposure to corrosion.
2. Crushing of small diameter wires and the wires of different strands contact with each other at oblique angles inside each strand as well as on the rope core. The wires move relative to each other at these points under heavy contact pressures when the rope is bending over sheaves and drums which causes additional internal wear. Combined crushing and plastic wear can take place significantly deforming the wire cross-sections if the diameter of the wires is reduced.
3. Introduction of plastics does hinder visual inspections being carried out on at least a daily or weekly basis. It is impossible to visually see any broken outer wires of the side parts of the strand and the industry will need to rely more on the non-destructive testing of the wire ropes.
4. Groove size and contour changes on sheaves and drums - Grooves that are too small or tight can cause pinching and increased wear, while grooves that are too wide can cause flattening of the rope – both of which can reduce a rope's life.



Rope grooves on drive drums can affect rope life as possible machining of the rope groove may need to be completed if a 9 strand rope is fitted.

5. End attachments on wire ropes with 9 strands may need to be replaced dependant on the end attachment design. In some cases such as the use of cone and tail, the number of grooves in the end attachment needs to be specifically designed for the addition of the extra strand. This is mainly for the use in drift winding systems. End attachments restrict the free movement of wires, normally leading to broken wires adjacent to the end attachment. If broken wires are detected, cutting off the

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affected area and re-socketing can extend the rope's service life. Corrosion can be more prevalent in this area. Additional flexibility in this area by the 9 strand rope could be an advantage here.

6. The manufacturing process, in MEMMES' opinion, would have to be considerably greater due to the following factors based on equal wage structure:
   - Going from a 8 or lower strand rope to a 9 strand rope is a major design modification and changes the characteristics of the rope which would require additional engineering work.
   - The cost of "special" production runs increases significantly from a standard production run. To be cost effective, additional stock and storage room will be required either at end user or supplier facilities.
   - The management of ropes on site will increase (e.g. rotation and lubrication while in storage) over longer periods of time due to the additional purchases of spare ropes as a result of larger production runs. This could be counteracted if the 9 strand rope proves to be longer lasting in the same working conditions.
   - Ropes exposed to extreme heat, cold, dry, dusty or salty conditions during storage is common and could affect the rope's life depending on the location of the mines and storage facilities.
   - Additional revenue would be required at the time of purchase due to larger production runs.
   - The ability to obtain 9 strand ropes is difficult as they will need to be imported, unless consignment stock is available locally.
   - Tooling for set up needs to be reconfigured to suit the 9 strand wire rope in lieu of the current 6 or 8 strand ropes as it is more time consuming.
   - Additional maintenance costs of wire rope machines are inevitable. This is as a result of increased wear of components on the machines e.g. rollers and wire dies as longer wires are required for the production of the rope. New design of wire dies will also be required.
   - While the manufacturing processes are similar, the complexities of production are altogether different. Specific tooling and equipment would be required. Different production run times would change as the set-up is different and machines are not utilised fully during the changing process of the extra bobbins.
   - Additional manufacturing time would result in added cost because the price of wire production increases as there are a larger number of smaller wires being manufactured for the rope.
   - Additional pre-forming as well as the closing of the rope is required for a 9 strand rope in comparison to an 8 or lower strand rope.

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- Larger manufacturing facilities may be required for more complex equipment being used.
- There will be a decrease of a number of ropes being produced as a result of additional manufacturing required in making the smaller diameter wires for the inner wires of the strand and the core.
- Additional steel and grease is required if there is an increase in the number of strands in a rope, as more steel can be fitted in the cross section of the rope due to filler wires. This is an advantage as it increases breaking strength of the rope.

7. Switching ropes will not be a trivial matter for the end user. This decision would have to involve all personnel as well as all aspects of the business including the following:-

- Performance and feasibility has to be validated.
- Change management process takes time – many people would need to sign off on the change including the Mine Manager.
- Trialling and comparing ropes to confirm suitability in different mines would take time. This is because mines, even within the same company have different applications and requirements as no mines are the same.
- Additional labour input and additional hours will be required for closer monitoring during the trials thus reducing production times.
- Possible additional downtime if the 9 strand rope fails earlier than expected.
- Accounts department needs to be involved due to budgeting (additional initial costs against these codes).
- Supplier detail would need to be changed on the company computer system.
- Production personnel would need to be informed of the change.
- Mine Managers approval with a possible Board approval will be required.
- Mechanical Engineers approval and review of positives and negatives.
- Maintenance personnel would have to be informed and trained as they need to know what to look for during visual inspections such as different characteristics of the rope and strand.
- Costs involved in training of personnel.
- Lubrication standard would have to be changed dependant on the inner rope design.
- Possible different lubricant to be used as recommended by the manufacturer of the rope which means possible different supplier of oils and lubricants. These lubricants need to have the capability of penetrating into the core and strands.
- Tool Box Talks need to be conducted and information to personnel need to be conveyed advising them that different ropes are being used.

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- Possible different equipment to be utilised to change the rope due to the additional weight of the rope.
- Rope end attachments may have to be changed to suit the additional strand in the rope. Is it going to take longer to install? This typically would not be a factor but it could be dependent on the design.
- Additional costs to suppliers if the manufacturers are from overseas e.g. flights, accommodation for technical /engineering/design staff if issues occur.
- Additional involvement by mine site personnel if issues arise.
- Possible need to re-design the ropes to ensure they are fit for purpose.
- Possible reporting to senior staff explaining why the rope failed or why the end result was not achieved. However if it is achieved, the end result will be favourable and extremely cost effective for the mine if there is a 30% increase in life of the rope.
- Additional support costs (e.g. visits to mine sites) by suppliers of ropes will be needed initially.
- Additional contractor training/inductions will be required for suppliers by the mines.
- Resistance by mine operators of known previous issues of other imported goods as the mining industry may be reluctant to change unless guarantees are set in place due to the high risks in loss of production.
- Availability of rope product in an emergency is a major concern for the industry.
- The additional weight of the wire rope could have an effect on the plants' ability to lift or carry a load. This means less over burden removal, less carrying capacity by the plant which could have an effect on production of raw materials in some cases.
- Additional weight of the 9 strand rope in some cases could mean additional wear on plant components (e.g. support rollers and bearings). Additionally structure would have to be reassessed for the additional weight as this could lead to additional structure/weld failure and who would pay for this longer term.
- What would be the legality if a failure occurred and a Design Risk Assessment had not been done prior to rope replacement? Would the Original Equipment Manufacturer (OEM), the wire rope manufacturer or the mine site be liable? Typically the mine site is responsible as the PCBU, so the decision is crucial. These are some of the questions that would need to be considered during the Risk assessment as part of the change.
- Whether the OEM of the equipment would approve the use of a different rope on their equipment as they have already obtained compliance approval for their existing design. The original design would have a design Risk Assessment so

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therefore it would have included the type of rope, the weight of the rope, the type of attachments. Their original FEA would have taken into account load stresses on ropes as well as structure and end connections.

- Decision for the cost of the change would most likely be back to the supplier of the new rope design. This would include redesign of the equipment to suit the new rope design, initial supply and fitment of any parts that had to be changed, new design risk assessment, obtaining all new approvals, guarantees of stock supply including emergency supply, all onsite trials and all documentation changes such as maintenance and parts manuals.

8. Acceptance by mine site personnel, particularly for a change in the industry, is difficult and slow. All those that were contacted and those who assisted in the compilation of this report, preferred others to trial the 9 strand rope first, due to such high risks to the business in the event that the rope is unsuccessful.

9. In our opinion the following additional costs would be incurred:-
   - The transportation of ropes from the manufacturing plant overseas to the ports.
   - The import duties/shipping/handling in wharfs (e.g. Cranage) and freight insurance is also foreseen.
   - Possible exposure of rope to salt spray during sea transport and before delivery to mine sites. There would be additional costs to protect the ropes e.g. use of wrapping plastics, additional grease/oils etc.

All the additional cost difference would be justified if the wire ropes last longer during operation as it would reduce the number of times ropes need to be replaced or rotated in some cases. The less number of changes of the rope reduces labour costs; less cost in the use of the plant to change the rope (Cranes, winders) less wastage of rope drums and production uptime would increase. All this equates to better availability for production times and increases profit margins and efficiency.

Issues associated with imported goods that were made clear to MEMMES members during discussions always involved the reliability and the quality control requirements. This is particularly due to the criticality of the ropes being used, as many of the smaller diameter wires within the strands have not been proven in the industry for the 9 strand rope. On one occasion, after a major investigation of a failed rope, the samples of the tested wires from a rope was believed to show surface irregularities that were generated at the stage of wire production. The inability of the mine operators to easily visit/check the production process of the 9 strand rope, does not give them confidence of the product in some cases. There is

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always potential for end users to visit the production plants if necessary to achieve this but would take time and it would be a major financial cost to the business.

Potential improvements to the current design by the supplier may be required for specific conditions such as higher sulphur levels in the coal, exposure to salty water, for mines close to oceans or salty water in creeks and rivers in drier parts of Australia as well as extreme heat and dust exposure. Mines use recycled water with high mineral content with a potential to damage the rope easier in some cases due to the smaller diameter wire. According to the data provided, the 9 strand rope would most likely be suitable for majority of these conditions but needs to be confirmed and is an unknown.

The cost to promote the product (9 strand rope) would be considerable as the mines are spread all over the country and each mine site has its own different environmental conditions in which the ropes work and operate in. It is not something that can be done from a corporate level either as each mine would have to be approached individually for this to work. If the 9 strand rope was forced onto the mine by corporate, it is possible that it would not be accepted in a positive manner and there would be a major backlash by the maintenance staff and the operators of the mine.

<u>Summary and quick answers to the scope of work posed by Anti- Dumping Commission</u>

Q1. The ropes' physical characteristics are significantly different changing from an 8 or lower strand to a 9 strand rope. The flexibility of the 9 strand rope does improve and is in many cases a positive for the rope. The longevity of the 9 strand rope is expected to be greater, due to the ability in the design to add additional steel internally which improves the breaking strength of the rope. The flexibility of the rope, the addition of filler wires to increase rope strength and the potential for a longer life is very important in the design of the rope. The issue here is that the wires need to be smaller in diameter which would cause them to wear quicker, flatten easier, and be more prone to corrosion and impact damage. Flexibility is important for hoist ropes but wear resistance is important for drag ropes for example. Each rope design has its own application and need to be individually considered for different applications.

Q2. In our opinion the 8 or lower strand rope can be directly replaced by a 9 strand rope (dependant on operation environment and condition) in many cases but further investigations need to be conducted. The rope end connections, their interchangeability and areas near the socket ends need to be monitored closely as field trials are required to be conducted to gain confidence in its use. 8 Strand ropes would be more likely be better for drag ropes due to larger wire diameters but the introduction of a plasticised material in a 9

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strand rope is a positive for better wire protection for smaller diameter wires. In this case it is hard to determine which is better unless you do field trials.

Q3. The interchangeability of each rope for the end use is not a factor normally and can be easily installed in same positions but once again factors such as rope end attachments, sheave design, drum design, grooving design on drums, how the rope is maintained, inspection regime, change management process, training of personnel, possible loss of production and maintenance time if it fails prematurely need to be considered as part of the change.

Q4. While the plant and equipment is similar, there is a significant difference in the manufacturing process changing from an 8 or lower strand to a 9 strand rope. There are additional processes required as there is an extra strand to be manufactured, wire sizes and dies need to be redesigned and changed on the machine, additional bobbins need to be installed, greater number of wires and strands need to be pre-formed and closed during the rope production, longer set up time and possible different machines may be required. In our opinion this additional process time and manufacturing would constitute additional overall cost for the product if labour costs were comparable.

Q5. Customer preference at this time is inconclusive as it is a new product and change or going from a known proven product to a new design is a major risk to the business and many people need to be involved before adaptation can occur. Cost of additional monitoring during the trial period could be a significant loss to the business as the number of inspection times would have to increase and therefore would affect production and maintenance time. There is a risk of failure but, if it is proven to increase the life of the rope by 30% or better (quoted by end users), it would be a major success for the product and a large cost benefit for the end user. The issue will be which mine will want to take the risk to trial the new product as major analysis will be required to be completed. This would be a project on its own with staff involvement from many aspects of the business including contractors. 9 strand ropes 1/6 to 6/6 from the Application AU 2018101211 A4 would need to be individually assessed against location, application and usage for each application and each mine environment and condition.

<u>Opinion of the writers of the report</u>

Q1. It is estimated by MEMMES team members that the cost to manufacture the 9 strand rope compared to a less than 9 strand rope would be approximately 20% - 25% greater due to the additional production time for manufacturing smaller diameter wires, more strands, more pre-forming of strands, greater set up time, longer closing times for the rope, greater

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cost of material, manufacturing of the rope and import and transport costs. This is based on equal wage structure.

Q2. Cost effectiveness is an issue as these ropes would be "specials" and therefore runs of production would not be a common occurrence resulting in having to purchase additional ropes. Industry needs to consider additional storage area and maintenance of the ropes whilst in storage. In addition, having ropes available in an emergency situation may be a problem unless consignment stock is available by the supplier in Australia. In total it would take approximately 12 weeks for the delivery of the rope to the mine site (4 weeks for set-up time and the manufacture of the rope + 7 weeks for transportation by sea + 1 week delivery = **12 weeks**). The seven week shipping transport would not be required if the goods were manufactured locally and if the wire was available.

Selling costs or marketing would take longer initially as mines need to be convinced of the product first. Additional information, numerous mine site visits is foreseen and having the right people to market it would be crucial. The sales team must be knowledgeable in all aspects of their product and understand the different environmental conditions found at each individual mine. This knowledge takes years to develop.

Q3. In regards to suppliers of shovels used in the mining industry, one of the issues would be to ensure the end attachments are interchangeable with the new 9 strand rope. Another issue that concerns the Industry is the additional weight of the rope. This could have an impact on the carrying capacity of the buckets or plant. This normally would not be a factor on large equipment but needs to be considered. Additional weight would be an issue if the rope was being used in a drift as the end of rope load would need to be reduced due to the increased weight of the rope when safety factors are being calculated. Original OEM designers would also need to be consulted with to ensure there are no additional hazards being introduced. Risk assessments, change management, drawing updates, parts manual updates and many other factors will also have to be reviewed as part of the change for all 9 strand ropes.

Q4. The 9 strand wire rope is not a slight modification but a significant change to the design of the lesser 8 strand or lower rope. In many cases it is a positive design upgrade because of the additional flexibility, additional steel due to additional filler wires, increase in breaking strength, plastic filler design and better strand support. There may be issues as smaller diameter wires could be crushed, damaged and/or broken easier due to flattening of the wires in the strand during impact and rubbing. This is a concern which needs to be proven in the field.

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