Final Project Report

Protection systems for decline shaft systems in South African mines

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Research agency :  Turgis Consulting (Pty) Ltd.
Project number  :  SIM 04 05 01
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Executive Summary

Small winders installed in decline or incline shafts and winzes pose a significant risk to the safety of mine workers whose work closely interfaces with these installations. There have been incidences of fatalities and severe injuries caused by runaway conveyances in decline shafts over the years. This project’s primary objective was to make recommendations for actions necessary for the reduction of risks posed by potential runaway conveyances in decline shafts. It was thus necessary to understand what was installed, how, and what risks were associated with the installations, before a recommendation for improvement could be made.

Eleven mines were visited. Confidential interviews were held with mine officials at the mines visited, to get a feel for the hazards faced in these installations. Sketches of the installations observed were made and discussed in some detail in the report. The SAMRASS database was interrogated for the relevant accident statistics. Inspectors of machinery were interviewed and their comments considered in the compilation of the final recommendations. Workshops were held with a pool of experienced consultants, as well as the SIMRAC expert panel members. A literature study was conducted and previous relevant work by SIMRAC, and mining houses was taken into consideration in the compilation of the guide.

The following were among the most significant findings and inferences:

- Risk is significant in terms of fatalities and injuries per year, based on SAMRASS and anecdotal reports.
- Installations estimated at between 1700 and 2500 – no official record for unlicensed winders is available.
- Huge diversity of safety devices and their deployment.

The major hazards resulted from the following failures:

- Rope breakages
- Operational control failure
- Winder control failure
- Design shortcomings

Risk alleviation devices available to the industry were discussed, assessed for suitability, and recommended for various applications. This was done through a document entitled: “Guide for the safe design, installation, operation and examination of small winding plant in decline shafts and winzes”. The “Guide” carried a sketch and a short description of the operation of the device, as well as a spreadsheet suggesting combinations of devices to be installed for safer operations of both licensed and unlicensed winders in decline shafts and winzes.
Preface

This report relates to recommendations compiled by Turgis Consulting (PTY) LTD during the SIMRAC project SIM 04 05 01 commissioned to investigate the risk of potential runaway conveyances operating in decline shafts and winzes in the South African mining industry.

A guide document, “Guide to the minimum requirements for the functional design, installation, operation and examination of Small Winding Plant when used in decline shafts or winzes” completed for this project.

This document supplements SIM 04 05 01 and can be obtained from:

Mine Health and Safety Council
2nd Floor
23 Jorissen Street
Braamfontein, 2017
Tel. 011 358 9180
Fax. 011 403 1821
Acknowledgements

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Mr W Masztalerz Senior Inspector of Machinery at the DME Head Office, Pretoria
Mr Bill Pautz Engineering Manager Anglogold

I would like to thank the management of all the 11 mines for their assistance during the information gathering stages of the project. Thanks also to FFE for allowing us the use of their “Onboard braking system” and the supply of sketches for this system.

Finally, thanks to the project team at Turgis Consulting, for all their effort to make this project a success.
11.2.18  Lockout device: ................................................................. 30
11.2.19  Marshalling Device:.......................................................... 30
11.2.20  Motor protection devices:.................................................. 31
11.2.21  Over and under wind protection devices:......................... 31
11.2.22  Permissible loads and number of cars:............................... 31
11.2.23  Phillips warning device:.................................................... 31
11.2.24  Safety circuit: ................................................................. 31
11.2.25  Safety rope across rope attachment:................................. 32
11.2.26  Location of winding engine: .............................................. 32
11.2.27  Slack rope derailing device (“Blair device”)....................... 33
11.2.28  Slack & Tight rope monitoring device: ............................. 34
11.2.29  Tank trap: .................................................................... 34
11.2.30  Tank trap status indication: .............................................. 34
11.2.31  Winding engine in motion warning alarm and indications: ... 34
11.2.32  Rope wear protection side rollers: .................................... 34
11.2.33  Special devices for shaft sinking applications: ................. 35
11.2.34  On-board braking system: .............................................. 36
11.3 Part 2: Recommended safety devices and when they may be used. 38

Part 3: Minerals Act and regulations that are applicable and recommended for small winding plant ........................................ 40
11.4 Mandatory requirements for Small Winding Plant............... 42
11.5 Mineral Act and Regulations That Are Applicable For Licensed Winding Plant 43
11.6 Mandatory Requirements For Licensed Winding Plant ............ 46
11.7 Mine 1 Underground inter-level Decline winch .................... 47
11.8 Mine 2 Sub Incline Shaft (Visit 12 August 2004) ..................... 49
11.9 Mine 3 Conveyor Decline Winder ................................. 51
11.10 Mine 4 Sub Incline Shaft (Visit 19 August 2004) .................. 52
11.11 Mine 5 Incline Shaft (Visit 24 August 2004) ....................... 54
11.12 Mine 6 Decline Material Winder (Visit 31 August 2004) ....... 56
### Glossary of abbreviations, symbols and terms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMRASS</td>
<td>S A mines reportable accident statistics system</td>
</tr>
<tr>
<td>HIRA</td>
<td>Hazard Identification Risk Assessment</td>
</tr>
<tr>
<td>DME</td>
<td>Department of Minerals and Energy</td>
</tr>
<tr>
<td>EMTAC</td>
<td>Engineering and Machinery technical advisory committee</td>
</tr>
<tr>
<td>SIMRAC</td>
<td>Safety in Mines Research Advisory Committee</td>
</tr>
<tr>
<td>AMRE</td>
<td>Association of Mine Resident Engineers</td>
</tr>
<tr>
<td>SWP</td>
<td>Small Winding Plant</td>
</tr>
<tr>
<td>LW</td>
<td>Licensed Winding Plant</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

The SAMRASS database indicates that 25% of all accidents in the mining industry are within the transportation and machinery area. Of the 25%, some 7% is in the conveyance area of transportation, which includes vertical and incline conveyance systems. A large portion of the 7% occurs in small winders, most of which are unlicensed. Previous SIMRAC research has concentrated on vertical winders only, but recent events have shown that more fatalities and severe injuries have resulted from runaway conveyances operating in decline shafts. This work aims to assess the prevalence and significance of this risk, thereafter recommend actions that would reduce the risk.

The Mine Health and Safety Act requires that employers conduct a risk assessment of all workplaces through the HIRA process. This document will provide some information that will enable mine management to assess and manage their risks better.

The Department of Minerals and Energy (DME) do not keep a complete record of all small winder installations (by choice), and for this reason, it is imperative that a representative number of mines were visited. Mine officials as well as members of the Inspectorate were interviewed in the process of determining the size and prevalence of the risk of accidents because of runaway conveyances. Codes of practice developed and used by the more established mining houses were also perused.

The criteria for the success of this study would be the determination of the significance of this risk, and the production of a guide composed of a suite of actions to be considered in the design, installation, operation and maintenance of small winder systems operating in declines.

2 OBJECTIVE OF THE STUDY

The objective of the study is to:

1. Assess the prevalence and significance of risk due to runaway conveyances
2. The production of a guide of actions to be taken in order to reduce the risk
3. Suggestions for the improvement of the SAMRASS

3 RESEARCH METHODOLOGY

In order to achieve the first objective, it was necessary to study the SAMRASS data so that the history of accidents on decline conveyances could be established. It was decided that the study period would be the immediate past five years. A team member visited the DME in Pretoria, where he obtained some reports on all accidents in the area of interest over the stated period. Each of the reports was analysed to determine the number of fatalities and injuries, the circumstances surrounding the accident, and the probable cause. The results were summarized in Tables 1 and 2.

The study involved visits to some mines in order to see some installations and observe operating and examination procedures. Sketches were made of the installations seen.
Comment was made of the team’s impression of the safety aspects of the installation and how it was operated. Safety devices that were seen in use were reported on.

Workshops were held internally with team members and other professionals with experience with decline shaft winding installations and operations. A workshop was also held with the SIMRAC’s EMTAC group, who provided guidance on the format of the final deliverable, to ensure that it addressed the needs of the stakeholders adequately. It was at this workshop that deliverables 2 and 3 were requested.

The second objective was achieved by performing a generic risk assessment on the decline systems, where potential hazards and solutions were identified. Appropriate combinations of safety devices were suggested for different operational duty.

The suggested improvement to the SAMRASS database was based on the difficulties encountered during the assessment of decline shaft accidents. Insufficient time was spent on this, as it was a deliverable requested when the project was almost completed. The suggestion was meant to render the database user-friendlier.

4 RESULTS AND DISCUSSIONS

4.1 SAMRASS Statistics

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Caught in moving machinery</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Struck by moving Machinery</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Struck by Runaway Machinery</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

The results in Table 1 show that the most fatalities involving decline shaft systems are due to machinery still under control, coming into contact with people (4 out of a total of 8). Deaths caused by runaway rail bound machinery are 3 out of 8 recorded. The numbers under discussion are small in the total scheme of mine accidents, however, none in the industry would argue against the fact that one death is simply one too many. Therefore, arguably, these numbers become significant.

There are 17 accidents that resulted in injuries during the period in question. Most of them involved people being struck by moving machinery, and caught in moving machinery. Not surprising was the statistic zero injuries for accidents involving runaways. Whenever a runaway machine came into contact with a person, the result was a fatality. What was also noticeable was the ratio between
injuries and fatalities. Approximately, for every two injuries, there was one fatality, for the area of decline conveyance systems (refer “Totals”, in Table 2). The ratio calculated at 0.47 (8 divided by 17). Comparing this ratio with the yearly ratios (Table 3) for the thrust area of machinery emphasizes the severity of accident in decline conveyances.

**TABLE 2 - SUMMARY OF FATAL ACCIDENTS AND REPORTABLE INJURIES IN DECLINE SHAFTS**

<table>
<thead>
<tr>
<th>Accident</th>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatalities</td>
<td></td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Injuries</td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

If the respective ratios were to be used as a proxy for severity, then decline shaft accidents involving rail bound conveyances were about 7 to 8 times (i.e., 0.47 divided by 0.06) more devastating, in terms of causing fatalities, than other machine related accidents. It could be argued, therefore, that, even if the numbers of accidents in decline shafts are low compared to the totals involving machine related accidents, their severity makes them very significant.

Anecdotal evidence also indicated that there could be a lot more decline shaft accidents, which are recorded under other categories by error. It is surmised that most are recorded under “materials handling” when they should be under decline/incline conveyances. The general consensus within the inspectorate was that decline shafts were very dangerous places. Certainly, the exposure to risk is higher in decline shafts than in vertical shafts. People do not “walk” or work in vertical shafts while conveyances are running. It just does not happen. This cannot be said of decline shafts, rules or no rules; people walk or work while conveyances are in motion. People are in close proximity with moving conveyances by virtue of having to load or unload these vehicles. The quickest and perhaps impractical solution would be to separate men and machinery entirely. Perhaps this could be considered for new designs of shafts, where there could be dedicated barrels for men and for materials separately. A senior member of industry suggested that while systems that have been engineered for use in Australia, United Kingdom and Europe were extremely robust in terms of safety, South African systems tended to have many peripheral devices introduced as “knee-jerk” reactions to problems. This view may be supported by the huge diversity of safety devices and limited standardisation in the industry.

Statistics also show that most of these accidents occur in unlicensed winders, otherwise commonly referred to as Small Winding Plant, which are not subjected to rigorous legislation requirements. Perhaps it should be suggested that if all winders were treated as licensed, there would be far fewer accidents.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>FATAL ACCIDENTS</th>
<th>REPORTABLE ACCIDENTS</th>
<th>Ratio of fatalities to injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>89</td>
<td>1476</td>
<td>0.06</td>
</tr>
<tr>
<td>2000</td>
<td>69</td>
<td>1227</td>
<td>0.06</td>
</tr>
<tr>
<td>2001</td>
<td>81</td>
<td>1324</td>
<td>0.06</td>
</tr>
<tr>
<td>2002</td>
<td>97</td>
<td>1325</td>
<td>0.07</td>
</tr>
<tr>
<td>2003</td>
<td>76</td>
<td>1239</td>
<td>0.06</td>
</tr>
<tr>
<td>2004</td>
<td>47 (June 04)</td>
<td>712</td>
<td>0.07</td>
</tr>
</tbody>
</table>

4.2 SAMRASS Database

The SAMRASS database is huge. It contains lots of data, but the extraction of the data is a specialised function, which is performed by a dedicated person at the DME offices in Pretoria. The present official is very helpful, but the system has inherent “access to information” challenges. The following problems arise when accessing this data:

- Information is not in a readily useable format, such as in tabular or graphical form.
- System is not flexible enough to allow generation of user-formatted reports.
- Not available on Internet, therefore one has to travel to the DME Head Office in Pretoria for any information, and requires an expert to extract information.
- Data integrity or accuracy remains a challenge.

4.2.1 Suggestions for improvement

The following is suggested for consideration in order to improve the quality and accessibility of SAMRASS:

- Upgrade to a more modern software package with built-in search capability using pre-identified keywords. These must be used in accident reporting fields.
- Define categories and link them, such that it can be possible to select any area, say, “shafts”, and be able to “drill” down to “decline shafts”, “station”, etc. It should then be possible to select “cause of accident”, say, and get a list such as “runaway conveyance”, “struck by moving conveyance”, “caught in moving conveyance” etc. Selecting any of these should list all accidents (within a selected time period), indicating severity, that is, whether the accident caused a fatality or an injury.
• Make system available on the DME’s Website for easier access, without travelling to Pretoria. This should only be considered once the system has been upgraded as suggested above.

4.3 Mine Visits

The sections depicted in Figures 1 to 5 are “typical” of some configurations seen during mine visits.

![Diagram of Rail and Chairlift Configuration]

**FIGURE 1 - RAIL AND CHAIRLIFT CONFIGURATION**

The rail and chairlift configuration was installed as shown in Figure 1 above. There was also an emergency trip wire by the chairlift, and a pull wire alongside the rail tracks to be used to stop the winder in an emergency, or as a marshalling device in case of derailments. There was interlocking between the conveyance and the chairlift so that only one of the two could be operated at the same time.

Such configurations can be operated safely and legally. They however still pose danger, as people would still walk in them, albeit illegally. They require closer supervision and monitoring, such that the safety operation procedures are not breached, or circumvented.
The rail and conveyor configuration was also popular. The pull wires worked as described in Figure 1. There was no formal walkway provided, in the belief that people would not walk when machines were working.

This double drum configuration provided for a walkway to be used during shaft examination. Shaft examination would only take place when the winder was locked out.
This arrangement provided for two separate compartments, separated by bratticing of various construction. The bratticing material ranged from piping, angle iron or channel iron sections of variable sizes. Posts, which were mostly from piping, were grouted into the footwall and the horizontal sections linked the posts by bolts or welds. None appeared robust enough to stop a derailed runaway conveyance from entering the walkway compartment. They were probably designed to stop a derailed conveyance from coming into contact with people. No additional safety devices, such as marshalling wires were seen with this configuration.

Figure 5 depicted the configuration for a continuous rope, single track system with a chairlift on the one side. No other safety devices were evident, except for a pull wire alongside the chairlift. For safety reasons, the two machines were interlocked, such that only one of them could be operating at any one time. The continuous rope conveyance has an on board operator/driver.
A detailed account of the above configurations and the safety devices installed at each of the site visited can be found in Appendix B.

4.4 SAFETY DEVICES IN USE

The sites visited deployed a variety of safety devices and in a variety of combinations, depending on whether the winder was licensed or not. Generally, the installed combinations were as reflected on Table 4 below. The deployment was described as “Always in use”, “In regular use”, “Seldom used” and “Never used”. In the case of licensed winders, the devices specified by law featured in the “Always in use” column.

Table 4: - SAFETY DEVICES AND THEIR DEPLOYMENT

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>Licensed Winders (x)</th>
<th>Unlicensed Winders (o)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deacon device</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Bell/brake interlock complete</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Main brake Spring Applied Hydraulic Released</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Mechanical brake foot/handle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety circuit to thrust brake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overwind device with backout facility</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Underwind with backout facility</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>H/Gear overwind “Tarzen trip wire ultimate”</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Crash beam</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Depth indicator</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Over speed devices “various”</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Warning &amp; flashing lights</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Pull wires</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marshalling devices</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Cross interlock with other equipment running in shaft</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Drop rails in shaft</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Stopping blocks on stations (+ farm gates)</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Lockable farm gates on bank and stations</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Barricades for bell ringers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety rope across attachments</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Safety slings</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Blair derailing device</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Illumination</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Audible warning devices</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Locking out devices</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Safety Device</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Gradient on bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latch to stop conveyance running back (Monkey device)</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Slack/tight rope monitoring device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slack rope device</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>On-board braking system</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Tank traps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deadman switch on control lever</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Three-turn warning</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Directional warning device</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Station stopping devices</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Restricted access to shafts</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Cam gear overwind/underwind</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>protection devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drop rail drop set status indication to driver</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>Slave or dolly car to prevent uncoupling of rope</td>
<td>X</td>
<td>O</td>
</tr>
</tbody>
</table>

A census was conducted to estimate the number of decline/incline conveyances installed in the whole industry. The Inspectorate does not keep a record of unlicensed winders or winzes. Letters were sent out to the mines, through the AMRE, requesting that each mine submit a return giving the number of decline conveyances run at their mine. There was no response to this request. Therefore, another way had to be found to enable this estimation to take place.

The mines visited had a total of 78 decline conveyances. Thus an average number per mine was estimated as 7.8. There are about 45 registered gold platinum, chrome and diamond mines, (SIMRAC records for levy paying mines), and assuming that they are all underground mines, the total decline conveyances installed would be about 1700. This figure might be grossly inaccurate, but that was the best estimate, under the circumstances.

5 CAUSES OF RUNAWAYS

This is a summary of a workshop held to determine the causes of runaway conveyances. It was concluded that the most significant causes of runaways were rope breakage, winder control failure, insufficient supervision at the brow and structural failure of coupling or buffer. Each one of them was reduced down to specific causes of failure. The information contained in this section forms the basis of understanding the conditions that may predispose runaway situations. Understanding these equips the end user with the knowledge required to be able to formulate plans that lead to effective reduction of the risk of runaways. The safety devices and procedures recommended in the guide in Appendix A are aimed at minimizing some of these failures.
5.1 **Rope Breakage:**

- **Mechanical:**
  - Fall of objects in shaft.
  - Kinking against sidewall/hangingwall.
  - Rope handling.
  - Fouling structures (e.g., Roller brackets).
  - Poor coiling.

- **Corrosion:**
  - Water from above.
  - Lying in water on footwall.
  - Humid areas.

- **Wear:**
  - Grinding against footwall/sidewall/hangingwall.
  - Grinding on broken rollers.
  - Poor maintenance.
  - Missing rollers.
  - Sheave or brow roller design.

- **Design:**
  - Ensure rope can carry load.
  - Correct rope for application.
  - Corrosion protection.
  - Harsh braking especially due to thruster brake on trip-outs.
  - Overloading prevention.

5.2 **Winder Controls:**

- Coarse acceleration control.
- Over wind.
- Under wind.
- Thruster brake operation/application and effectiveness.
- Fail safe devices.
- Overspeed devices.
- Power failure.
- Dead man’s device.
- Mechanical failure.

5.3 **Brow Supervision:**

- Procedure for loading, including checks against overloading and inadequate coupling.
- Shaft protection not adequate – uncontrolled entry to shaft by rolling stock.

5.4 **Coupling/Buffer Breakages:**

- Structural strength of buffers, couplings, pins, shackles and bolts.
- Not coupled properly.
Non use of properly designed equipment.

Once the rope has broken a runaway of the conveyance is inevitable. Ropes break for a variety of reasons ranging from poor design and specification of the rope, to maintenance and operational issues. In the majority of cases, the rope is attached directly to the leading car in a span. The rope has to be detached from an empty car and reattached onto a full car. The rope is dragged on the ground and suffers mechanical abrasive wear, as well as gathering moisture, which eventually causes the rope to rust and corrode away. It is also susceptible to be run over by cars being pushed in and out of the shaft. Therefore a safer situation would be one that keeps the rope attached the conveyance at all times, such as the use of pilot cars (Figure 10), bogies and bridles (Figure 7), as explained in the guide in appendix A.

If the winder controls fail, a runaway may result, unless there are additional fail-safe devices couple with the winder circuitry. The guide provides the most effective combinations of devices to minimize the occurrence of runaways due to winder control failures.

Where separation of people and machinery is effective in the shaft, the only areas of the shaft where people and machine interface is on the brow and on the station. This is where the loading and coupling of cars takes place. The operations here are predominantly manual. Where the rope is detached from out-going cars and attached to in-going cars, rope is “paid out” to enable sufficient slack to attach or detach. The attached conveyance is then manually pushed over the brow. Here, accidents of the “struck by” and “caught in moving machinery” take place. If too much rope is paid out, the conveyance goes over the brow and accelerates down the shaft until the rope gets taut enough to support it. The forces that can be generated are sometimes enough to break the rope and result in a runaway. Therefore, strict supervision of brow activities and devices such as drop sets (Figure 11) of sufficient design strength are paramount to avoid maiming accidents and runaways. The guide specifies some of these and how they should be deployed.

Coupling and buffer breakages can undo all the good operational and maintenance practices on the rope and winder. The result of any one of these failing is a runaway. Care must be taken to ensure an engineering design, installation and maintenance of couplings and buffers.

Proper design and operation of drop rails and drop sets can prevent the devastation effects of runaways. One such combination is depicted in Figure 10 below. The crucial criterion is to design the drop rails such that they are easy to operate and maintain, and that they are of sufficient strength. They should be interlocked such that when one is up, the other is down, and that when cars are being manoeuvred at the brow, the shaft side drop rail is always down.

Where other cars are attached to a lead or pilot or slave car, a safety sling should always be used, as indicated in Figure 17.
A Blair device could also be used to stop or derail a runaway conveyance, as shown in Figure 15.

Runaways could also occur on the “up wind”, which is very rare. The driver of the winder would normally be in danger of being hit by such a runaway. Figure 8 indicates the installation of a crush beam that would safely stop the conveyance before it got to the driver’s position.

Appendix A lists and describes many safety devices that can be considered for use in decline shaft systems, to prevent accidents due to conveyance runaways.

6 MAINTENANCE:
Three of the four items listed as causes of runaway in section 5 are maintenance dependent. Unlicensed winders are not covered by the structured maintenance requirements stipulated by law for licensed winders. Site-specific checklists must be generated, which show the standards against which the results of the checks are compared. It is recommended that the following checks be done by a competent persons, who are by a person appointed in terms of Regulation 2.13.2 of the Minerals Act, as a minimum requirement for all unlicensed winders:

6.1 Daily:
- Check front end of the rope for wear and mechanical damage.
- Check for correct operation of the service and emergency brakes.
- Check that brow rollers are in good working condition.

6.2 Weekly, in addition to the above:
- Check that rope is not fouling against sidewall/footwall/hangingwall.
- Check that rope is coiling correctly and is free of kinks.
- Check for rope wear, corrosion and broken wires or strands.
- Check for correct operation of winder controls, such as overwind and underwind devices, overspeed and any other safety devices installed.
- Check that sheave profile (where installed) are correct for the size of rope.
- Check that buffer bolts and couplings between cars and coupling pins are in good condition.

6.3 Monthly, in addition to the above:
- Clean and dress the rope with appropriate grease.
- Check that safety slings (where used) are in good condition, replace as necessary.

7 TRAINING
The need for training courses that are focused on enhancing people skills in the recognition and the appreciation of hazards around their environment cannot be over emphasized. SIMRAC research has repeatedly shown the role played by the individual in the occurrence of accidents. GAP 857 – “Hazard recognition learning programmes in the transportation thrust area” found that a significant proportion of accidents in this area involve people who
do not ordinarily work on, or operate transportation systems. The “outsiders” may not have undergone safety training that encompassed hazards pertinent to transportation systems. Therefore it is important to include not only the operators, but also all other people likely to pass through areas where transport operations are conducted.

8 CONCLUSIONS

The following conclusions may be draw from the above results and discussion:

- Risk of fatal accidents is high in decline/incline shaft systems, particularly as there are a large number of these installations in the industry.
- The severity of accidents resulting from runaway conveyances is 7 to 8 times greater than other transport and machinery accidents in the mines.
- The following failures result in runaway situations; rope breakage, winder controls, buffer and couplings.
- Winder ropes would be better preserved, and therefore less likely to break, by use of systems where the rope remained permanently attached to the conveyance.
- Use of dedicated shaft barrels for the transportation of materials only, and for use by personnel only, would reduce the risk of accidents due to machines striking or running over people.
- Better design of winder, its controls, rope, landings, as well as use of appropriately engineered safety devices can alleviate the risk of runaway conveyances.
- More robust designs would limit structural failures of rope, buffers and couplings, thereby reducing the incidence of runaways.
- The SAMRASS database requires upgrading.

9 RECOMMENDATIONS

The following are the recommendations made from this study:

1. All winders, licensed and unlicensed, must be subjected to diligent professional engineering design processes.
2. All decline/incline shaft systems to consider the use of devices suggested in the “Guide” in Appendix A.
3. All safety device designs used in the decline/incline shaft systems must be approved by a professional engineer.
4. Tank traps to be considered for stopping runaway conveyances in decline shafts, during shaft sinking operations.
5. Future decline/incline designs to consider automation of materials handling procedures in order to reduce man-machine contact.
6. Future systems to consider, where conditions allow, separate and dedicated shafts for man and materials.
7. Strict and diligent maintenance regimes to be adopted for all winders irrespective of their legal status.

8. Relevant training which emphasizes hazard recognition to be adopted for all operators and all those who may have reason to pass through areas where transport systems operate.

9. Stakeholders to decide on the relevance of regulation 16.58 with regards to its applicability to decline/incline shafts and winzes.

10. For SAMRAS database improvement suggestions, refer to section 4.2.1.

10 REFERENCES


8.2 SIMRAC report GAP 225. 1996. Practical guide to the risk assessment process.


8.2 Guideline for Unlicensed Material Inclines (revision 04) - Anglogold
APPENDIX A

Guide as to the minimum requirements for the functional design, installation, operation and examination of Small Winding Plant when used in decline shafts or winzes

11 SCOPE OF GUIDE

This guide covers proposed minimum requirements for the functional design, installation, operation and examination of Small Winding Plant (licensed and unlicensed) when used in incline shafts or winzes. Where possible, sketches are used to illustrate the suggested arrangement. The guide suggests that there should be little difference between the requirements for licensed and unlicensed winders, as the risks are similar.

The first part of the guide describes safety devices that may be used, providing sketches, where appropriate.

The second part provides a spreadsheet listing the appropriate device to use under different circumstances, such as hoisting of materials only, men only, or combinations thereof.

Part three gives a list of the relevant regulations and indicates the circumstances under which they are applicable, as quick reference for the reader.

The authors cannot emphasize strongly enough the importance of site and design specific technical risk assessment on the entire system before construction.
11.1 Flowchart Summarizing the Recommendations Made

**DECLINE CONVEYANCES**

**New installation**

**STATUS**

- **Licensed**
  - yes
  - Chapter 16 – Minerals Act, plus consider on-board braking
  - In addition to Chapter 16:
    - Professionally design and install
    - Maintain as if licensed
    - Automate materials handling
    - Figure 13 & 14 for upper landing design
    - Figure 4 for demarcating walkway from rail compartment
    - Use bridle or pilot car arrangement
    - Consider relevance of Regulation 16.58
  - no
  - Men share barrel
  - no
  - In addition to regulation 16:
    - Maintain as if licensed
    - Automate materials handling, where possible
    - Select appropriate safety devices from “Guide”, professionally design and install
    - Use bridle or pilot car arrangement
    - Consider use of Tank traps
    - Consider on-board braking systems
  - yes
  - yes
  - yes

- **Existing**
  - Licensed
    - yes
    - yes
    - yes
    - Chapter 16 – Minerals Act, plus consider on-board braking
11.2 Part One: Names and Description of Safety Devices That May Be Used In Incline Shafts and On Winzes

11.2.1 Backing out facility:
This facility will allow the winding engine driver to back-out of an over or under wind condition by applying sufficient power in the correct direction to move the conveyance out of an over or under wound condition.

11.2.2 Barricades for bell ringers:

![Figure 6 - Barricade for Bellringer](image)

**FIGURE 6 - BARRICADE FOR BELLRINGER**

Where it might be required for personnel to enter the bottom flat end of a winze or incline shaft and when signals need to be transmitted from this area a robust barricade must be provided to protect such persons from runaway equipment as shown in Figure 6.

11.2.3 Bell-brake interlocking device:
A bell-brake interlock consists of circuitry that will automatically prevent the conveyance from being raised or lowered after the winding-engine driver has given a signal on the circuit of the locked-bell system, until he has received a signal on each of the circuits on which he gave a signal. This interlock will also not allow the driver to transmit signals while the main brake is not fully applied.

11.2.4 Brakes:
Where a winding engine is not equipped with one fail safe main brake acting directly on the winding drum/s such winding plant must be equipped with two independent braking systems, one of which will be automatically applied if the safety circuit trips.
- Each brake must be capable of holding the maximum permissible load at the bottom of the incline without slipping.
• Each brake must be capable of stopping the moving conveyance safely, when running the conveyance at maximum permitted speed at maximum permitted load.

11.2.5 Brake interlocking:
A limit switch that will monitor “Brakes on” and “Brakes off” shall be installed in such a way that the safety circuit cannot be reset if the brakes are not in the “on” position.

11.2.6 Bridle/Bogie:
Bridles or bogies are used to transport material cars up and down service inlines either loose or attached to the bridle

![FIGURE 7 - BRIDLE ARRANGEMENT AT SHAFT BOTTOM](image)

The system is made up of a rectangular frame known as a bridle that is mounted on four wheels on the incline track with the one side connected to the winding rope. A set of dolly wheels installed to the upper side of the frame allows that portion of the frame to be elevated when the frame enters the top landing to such an elevation that material cars that have been hoisted may be pushed out and other cars may be pushed into the frame. Downward movement of the winder will cause the bridle top end to lower and the cars to roll down held in position by the bridle and within the bridle frame. At the lower end of the incline the bridle will be brought to halt on a horizontal track, and its lower end be lifted by means of a motorized chain block to such a height that cars may be removed or placed. The lower end of the bridle is
provided with a robust plate that is used as a pusher against which the car bumper rests while being pushed up or being lowered. Some applications have the cars attached to the top end of the bridle by means of a link with links between the cars.

11.2.7 Controller neutral position:
The controller neutral position is a limit switch interlocked with the safety circuit to prevent resetting of the winding engine when the controller is not in neutral.

11.2.8 Crash beam:

![Crash Beam Diagram](image)

**FIGURE 8 - CRASH BEAM ARRANGEMENT**

This is a strong beam or combination of beams constructed at the end of the upper winding path that will prevent the conveyance from running into the winding engine position.

11.2.9 Cross-interlocking winding engine and chairlift:
This is an interlock that will automatically prevent the simultaneous operation of a winder and a chairlift in the same shaft when not required.

11.2.10 Deacon device:
The device comprises a kink in the incline shaft rails with one side of the rail slightly elevated to derail the conveyance in a preferred direction should the conveyance cross the device above creep speed. This device is indicated in Figure 9.
11.2.11 Dead-man switch:
When the control lever is released, it must return to the neutral position, or the control lever must be manually depressed to operate the controller.

11.2.12 Drop rails:
Refer to Figure 10. These are made up of strong sets of steel beams of which the upper end is connected to a hinge supported in the hanging and the other end of the set lying on the footwall in the shaft. The non-hinged side is placed upwards in the shaft at a maximum angle of 45 degrees. This end is attached to a rope which may be connected to a pneumatic or hydraulic cylinder or a counterbalance which is used to pull the front end up high enough for the passage of a conveyance or the lowering to the footwall to capture a run-away conveyance or other rail bound equipment. These devices should be subject to proper structural design review.

11.2.13 Drop set:
Refer to Figure 11. These are robustly designed sets of rails of which the lower sides are connected onto the edge of the floor of the landing by means of a hinge with the upper side of the rail set hanging in the shaft to allow the conveyance to pass through underneath it. When the upper end is lowered the ends will rest on the conveyance rail and allow the conveyance to roll out on that station. The set’s non-hinged end is suspended from a steel wire rope and is raised or lowered by means of a hand operated counterweight or a cylinder either pneumatically or hydraulically driven. Because of the danger of the possibility of these devices moving from a fully open position to a
closed position they must be locked in an out position by means of a padlock placed as far as practically possible to the end of the upper end of the set.

FIGURE 11 - DROP SET ARRANGEMENT AT A LANDING BELOW BANK

Where such devices are operated by air or hydraulics the piston rods must be equipped with manually resettable levers that will automatically latch when the drop set has been pulled to the out position to prevent the drop set from creeping out of the parked out position should compressed air or hydraulic pressure fail. The controls for such devices must be kept locked when not used. These devices should be subject to proper structural design review.

11.2.14 Drop rail and drop set status to driver:
These are indications to winding engine drivers to show whether drop rails and/or drop sets are fully open or fully closed.

11.2.15 Emergency stop:
This is a conspicuously shaped and colour pushbutton placed within easy reach of the driver, which will trip the safety circuit of the winding engine as well as the main circuit breaker when operated. The driver will use this device in an emergency such as when the winder will not respond to normal control inputs.
11.2.16 Fail-safe brake:
Such a brake is made up of a spring applied hydraulic released brake or a weight applied hydraulic released brake, which will automatically apply if the power to the drive motor is tripped. It must be capable to hold the maximum permissible attached load at the bottom of the shaft without slipping.

11.2.17 Headgear ultimate trip ("Tarzan wire"):
This device consist of a limit switch mounted in the headgear connected to a thin copper wire spanned across the compartment which will be broken should the conveyance move past this point. The breaking of the copper wire will cause the limit switch to trip the primary and secondary safety circuit. The operation of this device must be set to trip after the primary over winds. The resetting of this device should only be performed by an appointed person. For this reason, some applications insist on the use of a special wire that is not easily obtainable at the operation. In this way, it is easy for supervision staff to see when an ultimate overwind has occurred even if not reported.

11.2.18 Lockout device:
This device is a means of locking out the winding engine in such a manner that it may only be able to be driven once the locking out means has been unlocked. No work should be performed in the shaft or on the winder unless this device is activated.

11.2.19 Marshalling Device:
This is a device that will trip the winding engine should the conveyance derail or partially derail in the shaft. It consists of insulated wires at a low electrical potential, running down the shaft close to the conveyance to trip the winder should the conveyance touch any of the wires. The circuit is also so configured that the winder will be stopped, should any one of the wires break. These trip wires must be installed from just below the bank to just above the first station below the bank and just below stations, to just above the next station.

FIGURE 12: ARRANGEMENT SHOWING MARSHALLING DEVICE
11.2.20 Motor protection devices:
These devices are made up of an overload relay rated for the drive motor and an instantaneously rated earth leakage device for the primary power supply to the winding engine drive motor.

11.2.21 Over and under wind protection devices:
These are the primary devices provided to prevent any conveyance from being hoisted beyond a predetermined safe height in the upper part of the winding compartment and from being lowered beyond a predetermined safe depth in the lower part of the winding compartment. Their operation must trip the winder safety circuit.

11.2.22 Permissible loads and number of cars:
A notice indicating the maximum and permissible loads for various materials must be displayed in the winding engine room, bank and at all established landings below the bank.

A notice indicating the number of material cars or mineral hoppers, which may be raised or lowered, must be displayed in the winding engine room, at the bank and at all landings below the bank.

11.2.23 Phillips warning device:
Under unbalanced winding operations the unintended application of motive power in favour of the unbalanced load may cause the winding engine to accelerate instantaneously when the brake is released and may cause injury to persons or damage to equipment. This device consists of an alarm which will warn the driver immediately, when power is applied in favour of the unbalanced load (“in the wrong direction”), while the conveyance is in the upper or lower area of the shaft.

11.2.24 Safety circuit:
Every winding plant must be equipped with a fail-safe safety relay that will interrupt the power supply to the motor and apply the fail-safe brake or brakes should any safety device operate.

Where the power supply to the safety circuit is a Line and Neutral supply the Neutral must become coil side of the system and be earthed at one spot only and as close as possible to the supply point. The Line side of the supply must be equipped with protection devices that interrupt the power supply at a current that is smaller than the safe operating current of the lowest rated (current) safety device used. No safety devices may be installed on the coil side of a safety circuit of such a supply.

Where the power supply to the safety circuit is from a centre tap supply the centre tap must be earthed at one spot only and as close as possible to the supply point. Both the other legs of the supply must be equipped with protection devices that interrupt their respective power supply at a current...
that is smaller than the safe operating current of the lowest rated (current) safety device used. Safety devices may be fitted on coil sides of the power supply for centre tap power supplies.

11.2.25 **Safety rope across rope attachment:**
This is a rope connected between the main winding rope thimble and the conveyance to keep the winding rope attached to the conveyance should the rope attachment between the rope and conveyance fail. Refer to Figure 13.

![FIGURE 13: ARRANGEMENT OF PILOT CAR, MATERIAL CARS AND SAFETY SLING](image)

11.2.26 **Location of winding engine:**
- The preferred location for the winding engine is in a cubby, as shown in Figure 14 below. This arrangement allows the attached bogie or car to be lowered onto the upper landing, via a drop set, with the rope taught. The winch is mounted close to the brow, such that the rope is elevated and no brow roller is required. The driver’s chair is elevated such that there is a line of site with the drop set. This arrangement has the safety feature that rail bound equipment on the top landing cannot be accidentally pushed into the shaft as the shaft is always protected by a drop set in either the up or down position. If the winding engine is situated in a dead end it must be ventilated with an electrical fan interlocked with the winder such that, if the fan is not running the winder safety circuit will be tripped.
The alternative location for the winch is on the top landing as shown in Figure 15 below. This arrangement requires protection devices to prevent rolling stock from being accidentally pushed over the brow into the shaft.

11.2.27 Slack rope derailing device (“Blair device”)

FIGURE 14 - WINCH CUBBY IN INCLINE, ABOVE TOP LANDING, CLOSE TO BROW

FIGURE 15 - ARRANGEMENT SHOWING WINDER MOUNTED ON UPPER LANDING, FURTHER AWAY FROM THE BROW

FIGURE 16: SLACK ROPE DERAILING DEVICE (BLAIR DEVICE)
This device, as shown in Figure 16, will cause the conveyance to be stopped or derailed and thrown off the rails to a preferred side when the winding rope becomes slack or breaks. It consists of a pawl mounted on the conveyance that is kept away from hooking on the footwall by means of a fly rope connected between the top end of the winding rope splice and the pawl. When the rope becomes slack, or breaks, the pawl swings anticlockwise (by virtue of a weight difference between the ends either side of the pivot point), resulting in the back end of the pawl digging into the footwall.

11.2.28 Slack & Tight rope monitoring device:
This device will cause the winder to be tripped should the tension of the winding rope become less than a predetermined value as for slack rope and should the tension in the rope exceed the safe working load as for when the conveyance gets stuck in the upcoming mode. The tension of the winding rope is measured either by a strain gauge mounted in the rope attachment or from load cells mounted below the winding sheaves.

11.2.29 Tank trap:
This is when a portion of the rail or both rails have been purposely removed where the rail crosses a sump into which the conveyance or a portion of the conveyance will drop, when passing over it and be prevented from running further.

11.2.30 Tank trap status indication:
This is an indication to the winding engine driver whether the tank trap is ready for crossing or not. It will also prevent derailment of conveyance if rails are not properly aligned.

11.2.31 Winding engine in motion warning alarm and indications:
Such indications and alarms must be provided where persons are allowed to walk in walkways in incline shafts or where a chairlift is provided when; such a shaft is served by a winder, whenever the winder goes into motion. Both sound and lights may be used.

11.2.32 Rope wear protection side rollers:
Strictly speaking, these are not safety devices, but can preserve the safe condition of a winder rope, if properly installed and maintained in a serviceable condition. Figure 17 shows a typical arrangement of side rollers in a “turnout”. Maintenance of all rollers in the shaft such that they are kept in a serviceable condition is vital for longer rope life and the prevention of mechanical damage of the rope.
11.2.33 Special devices for shaft sinking applications:

Shaft sinking in decline shafts can be very dangerous, particularly to the people working at the bottom of the shaft. Any runaway conveyances are likely to end up at shaft bottom, causing resultant injuries. Therefore, special precautions must be put in place to avoid incidences such as these. There are many ways to barricade shaft bottom during sinking operations. Perhaps the more practical ones include the tank trap and the deacon device, both of which have been described above.

The operation of the tank trap should be such that when the conveyance is up-stream of it, the section of rail over the trap should be in the “out” position, thereby causing any conveyance that comes over it to derail and fall into the “capture” sump. The rail is put into the “in” position when an expected conveyance is approaching. This requires good communications between shaft bottom and the engine driver, regardless of whether the system is manual or not. The key for this device is the correct dimensioning of the sump, such that a runaway conveyance does not “jump” over it and continue on its run down the shaft.

The Deacon device has a weakness in that the derailment of the conveyance may not necessarily stop the conveyance sliding down the shaft, dependent on the angle of inclination of the shaft. It could be considered to erect a robust barricade in the area where the conveyance is designed to derail in order to “catch” it and stop its further progress down the shaft.
11.2.34 On-board braking system

This is a braking system installed onboard a pilot, slave car or bogie, which is weight or spring applied, and hydraulically released (Figures 18 to 21). These can be used on manned pilot cars, or unmanned rolling stock, as activation can be either through a preset over-speed governor, or a manual valve. This brake offers very good protection against runaways.

Figure 18 - Railhugger bogie with brakes off

Figure 19 - Railhugger bogie with brakes on

The “Track brake” version is shown in Figures 18 and 19. When hydraulic pressure is exhausted due to the operation of a governor over-speed device, or by manual operation of a hand valve, the weight of the vehicle is transferred to the brake shoes, which make contact with the top of the rail to effect retardation.
Figure 20 shows the “Pinch brake” version, where brakes are held off the same way as in the “Track brake” version described above, and is activated in exactly the same way. The difference is that the brake shoes “grab” onto a special set of rails installed between the rolling stock rails. It is reputedly more efficient than the above version.

The calliper brake version is as shown in Figure 21. Hydraulic pressure the brakes off. Activation is the same as in the other versions discussed above. It operates on a similar rail installation as the “Pinch brake” version, but it is of a higher capacity than the other versions.
## Part 2: Recommended safety devices and when they may be used

**LEGEND:**
- LM = Licensed Winder
- SWP = Unlicensed Winder

### Table 5: RECOMMENDED SAFETY DEVICES AND WHEN THEY MAY BE USED

**SAFETY DEVICES FOR LICENCED WINDERS AND SMALL WINDING PLANT USED IN INCLINE SHAFTS WHERE FULL AND EMPTY CONVEYANCES ARE NOT INTERCHANGED**

<table>
<thead>
<tr>
<th>SAFETY DEVICES &amp; SAFETY SYSTEMS</th>
<th>LW</th>
<th>SWP</th>
<th>LW</th>
<th>SWP</th>
<th>LW</th>
<th>LW</th>
<th>LW</th>
<th>LW</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Rock Winding only</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Required by Reg.16.8</td>
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<tr>
<td>Mat. Winding only</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.9</td>
</tr>
<tr>
<td>Men Winding only</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.9.2</td>
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<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Required by Reg.16.10</td>
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<tr>
<td>Men &amp; Rock Winding</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.43.5</td>
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<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.43.6</td>
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<td>Incline Shaft During Sinking</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.57</td>
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</table>

**Drum Winders above 250kW licensed noted as LW & small winding plant noted as SWP compliance**

<table>
<thead>
<tr>
<th>SAFETY DEVICES &amp; SAFETY SYSTEMS</th>
<th>LW</th>
<th>SWP</th>
<th>LW</th>
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<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.8.1</td>
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<tr>
<td>Overwind &amp; overspeed prevention devices</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.8.2</td>
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<td>Slack rope device</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Required by Reg.16.9</td>
</tr>
<tr>
<td>Speed indicator &amp; tachograph &gt; 5m/sec</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.10</td>
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<td>Bell-brake interlocking device</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Required by Reg.16.43.5</td>
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<td>Call-bell system</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Spring keeps &amp; jack catches</td>
<td>Yes</td>
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<td>Detaching hooks</td>
<td>Yes</td>
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<td>No</td>
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<td>Yes</td>
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<td>Station demarcation &amp; plan</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Only LW requirement Reg.16.61.1.1</td>
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<td>Prevention of inadvertent access</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Functional specifications of station safety devices</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Energy absorption capacity of safety devices</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Prevent un-authorised operation or removal of</td>
<td>station safety devices</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Only LW requirement Reg.16.61.2.4</td>
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<td>Approval of safety devices by engineer</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Parking of mobile machine in shaft station</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Entering under own power to shaft station by</td>
<td>self-propelled machine</td>
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<td>Yes</td>
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<td>Weekly exams of signalling arrangements</td>
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<td>Monthly rope examinations</td>
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<td>Monthly rope connections &amp; sheave examinations</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Manager to provide a driver’s log book</td>
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<td>A true report of winding engine by driver</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Special instructions to driver</td>
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<td>Regulation 16.55 warnings</td>
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<td>Entries scrutinised by appointed persons</td>
<td>Reg 16.95.1</td>
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<td>Yes</td>
<td>Yes</td>
<td>Not specified for SWP IN Reg.16.82</td>
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### SAFETY DEVICES & SAFETY SYSTEMS

<table>
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<tr>
<th>Rock Winding only</th>
<th>Mat. Winding only</th>
<th>Men Winding only</th>
<th>Men &amp; Mat. Winding</th>
<th>Men &amp; Rock Winding</th>
<th>Men, Rock &amp; Mat. Winding</th>
<th>Incline Shaft During Sinking</th>
<th>Comments</th>
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<td>LW</td>
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**Other Safety Devices and Safety Systems:**

- **Fail safe main brake:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Primary over & underwind backing out facility:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Headgear/ultimate/Tarzan wire tripping wires:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Crash beam above ultimate tripping wire:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Marshalling devices:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Not recomd.
- **Drop rails in shaft where conveyances are changed:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Not recomd.
- **Barricades for bell ringers and persons detaching & attaching rollingstock:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Safety rope across attachments on conveyance:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Slack rope derailing device (Blair Device):** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Winding engine locking out device:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Dead-man switch on driver's control lever:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Directional (Phillips) warning device:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Drop rail & drop set status indication to driver:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Drop set locking out devices:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Tank traps' status indication to driver:** N/A N/A N/A N/A N/A N/A N/A N/A N/A Recommend
- **Winding engine in motion warnings & alarms:** N/A N/A N/A N/A N/A N/A N/A N/A N/A Recommend Recommended where persons walk in shaft
- **Full wires in shaft to trip winding engine:** N/A N/A N/A N/A N/A N/A N/A N/A N/A
- **Cross interlocking winding engine with chairlift in same shaft:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Barricade between winding conveyances & chairlift or walkway:** Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend Recommend
- **Dead-end for shaft bottom for interlevel winding:** N/A Where applic. N/A Where applic. N/A Where applic. N/A Where applic. N/A Where applic. Where applic.
Part 3: Minerals Act and regulations that are applicable and recommended for small winding plant

- Regulation 6.6 – Ladder-ways
- Regulation 6.8 – Bratticing of travelling ways
- Regulation 15.1 - Stationary lights
- Regulation 15.2 – Machinery to be illuminated
- Regulation 16.1 – No conveyance of persons without permission
- Regulation 16.5.1 – Starting, stopping and lifting power of winding engine (Recommended this Regulation to be instituted)
- Regulation 16.5.2 – Lifting power of engine (Recommend this Regulation to be instituted)
- Regulation 16.6.1 – Adequate brakes
- Regulation 16.6.2 – Holding power of brake or brakes
- Regulation 16.6.4 – Flanges or horns
- Regulation 16.6.5 – Minimum turns of rope on drum
- Regulations 16.6.7 to 16.6.10 inclusive – Operating levers (Recommend this regulation to be instituted)
- Regulations 16.6.11 to 16.6.13 inclusive – Locking devices and clutches
- Regulation 16.7 – Depth indicator (Recommend this Regulation to be instituted)
- Regulation 16.8 – Three-turn warning device
- Regulation 16.9 – Overwind prevention device and overspeed prevention device (Recommend this Regulation to be instituted)
- Regulation 16.16 – Adequate strength of rope, bar, link, chain or other connection
- Regulation 16.17 – Accidental disconnection
- Regulation 16.20.1 and 16.20.2 – Suitability of rope
- Regulation 16.21 – Joined rope
- Regulation 16.23 – Use of old rope
- Regulation 16.27.1 – Examination of attachments and test run (Recommend to be conducted and at least by a competent person)
- Regulation 16.30.1 – Definitions
- Regulation 16.42.1 – Signalling systems
- Regulation 16.43 – Electrical signalling systems
- Regulation 16.43.1 – Two separate systems
- Regulation 16.43.2 – Locked–bell system
- Regulation 16.43.3 – Driver can distinguish between different signals
- Regulation 16.43.4 – Locking of signal mechanism
- Regulation 16.43.5 – Bell–brake interlocking device
- Regulation 16.43.6 – Call-bell system
• Regulation 16.43.7 – Accessibility of call-bell
• Regulation 16.43.8 – Tone of bells
• Regulation 16.43.9 – Telephone in place of call-bell
• Regulation 16.44 – Other systems-approval
• Regulation 16.46 – Special signals
• Regulation 16.47 – Offence
• Regulation 16.48 – Access to conveyance
• Regulation 16.51 – Provision for crossing shaft
• Regulation 16.52 – Entering winding compartments
• Regulation 16.53 – Winding during repairs
• Regulation 16.54 – Repairs in shaft
• Regulation 16.55 – Driver to be specially warned
• Regulation 16.57 – Spring keps or jack catches
• Regulation 16.61.1 to 16.61.4 inclusive – Station safety devices and self propelled mobile machines at shaft stations (Recommend this Regulation to be instituted)
• Regulation 16.66 – Loading of explosives
• Regulation 16.67 – Riding outside conveyance
• Regulation 16.70 – Overfilling of conveyance
• Regulation 16.71 – Fastening projecting material
• Regulation 16.72 – Trial run of winding plant
• Regulation 16.73 – Appointed persons to examine winding plant and shaft
• Regulation 16.74.2 – Appointment of persons to examine signalling arrangements and respective safety devices
• Regulation 16.77 – Duty when defect is discovered
• Regulation 16.80 – Shaft log book
• Regulation 16.81 – Driver’s log book (Recommend this Regulation to be instituted)
• Regulation 16.82 – Scrutinize entries into driver’s log book
• Regulation 16.85 – Driver not to be distracted
• Regulation 16.86 – Responsibilities of winding-engine drivers
• Regulation 16.87 – Interference with signalling arrangement
• Regulation 16.92 – Notices required at winding plants
• Regulation 16.93 excluding 16.93.3.1 & 16.93.3.2 – Requirements at shafts being sunk
• Regulation 16.94 – Small winding plant – Permit not required
• Regulation 16.95.1 – Small winding plant - Regulations not applicable
• Regulation 16.95.2 – Small winding plant – Record book or card system
• Regulation 16.95.3 – Small winding plant – Breaking strength of winding rope
• Regulation 16.96 – Small winding plant – Competency of driver
11.4 Mandatory requirements for Small Winding Plant

- No modifications may be made to any safety device or to the safety circuit without the written permission of the Engineer.
- A logbook must be kept for each individual small winder installation, in which a true report of the results of every inspection is entered and duly signed by the appointed persons making such entry.
- All winch drivers, incline shaft operators and engineering persons responsible for the safe operation of the winding plant must be appointed. Appointment and duties of all appointed persons referred to above to be displayed in the relevant logbook.
- Only material cars, with buffer connections, designed to be used in incline shafts, and which can be connected with an approved type of draw bar shall be used.
- Pre-use inspection of the equipment must be carried out by the winch driver and appointed operators.
- Electromagnetic testing must be done whenever a new rope is installed, and at 3-monthly intervals thereafter.
- Where persons may have access to the incline for travelling on foot or by chairlift, lockable gates must be installed to prevent persons from having access to the shaft. These gates must be kept locked while the winder is in motion.
- Where the top landing runs out on the horizontal or close thereto an approved stopping device must be installed on the brow of the incline to prevent rolling stock from entering the shaft accidentally. The brow stopping device must be interlocked with the stopping device referred to in Regulation 16.61.2.2 such that it can only be lowered when the bank access stopping device is in the safe position. The brow stopping device must also be interlocked with a drop rail situated 15 metres below the brow, such that it can only be lowered if the drop rail is in the fully lowered position and conversely, the drop rail can only be raised if the brow stopping device is in the safe position.
- Where applicable, drop sets must be installed on all established landings. A drop rail must be installed in the shaft, 15 metres above the established landing. The drop set and drop rail on established landings must be mechanically or electrically interlocked in such a way that when the drop set is lowered the drop rail above the respective landing is also lowered.
- The drop set must be interlocked such that it can only be lowered when the rope end is positioned between the drop set and the drop rail of the respective landing.
11.5 Mineral Act and Regulations That Are Applicable For Licensed Winding Plant

- Regulation 6.6 – Ladder-ways
- Regulation 6.8 – Bratticing of travelling ways
- Regulation 15.1 - Stationary lights
- Regulation 15.2 – Machinery to be illuminated
- Regulation 16.1 – No conveyance of persons without permission
- Regulation 16.2.1 – Winding plant to have a permit
- Regulation 16.2.2 – Application for use
- Regulation 16.2.3 – Inspector to issue permit
- Regulation 16.2.5 – Where permit to be kept
- Regulation 16.2.7 - Regulations applicable
- Regulation 16.3 – Periodic test
- Regulation 16.4 – Mass of a person
- Regulation 16.5.1 – Starting, stopping and lifting power of winding engine
- Regulation 16.5.2 – Lifting power of engine.
- Regulation 16.6.1 – Adequate brakes
- Regulation 16.6.2 – Holding power of brake or brakes (Drum type winder)
- Regulation 16.6.3 – Holding power of brake or brakes (Friction type winder)
- Regulation 16.6.4 – Flanges or horns
- Regulation 16.6.5 – Minimum turns of rope on drum
- Regulation 16.6.6 – Slip where friction drive
- Regulations 16.6.7 to 16.6.10 inclusive – Operating levers (Recommend this regulation to be instituted)
- Regulations 16.6.11 to 16.6.13 inclusive – Locking devices and clutches
- Regulation 16.7 – Depth indicator
- Regulation 16.8 – Three-turn warning device
- Regulation 16.9 – Overwind prevention device and overspeed prevention device
- Regulation 16.10 – Speed indicator and tachograph
- Regulation 16.11 – Construction of cages
- Regulation 16.12 – Construction of other conveyances
- Regulation 16.13 – Roof of cover
- Regulation 16.14 – Examination platform
- Regulation 16.15 – Trailers
- Regulation 16.16 – Adequate strength of rope, bar, link, chain or other connection
- Regulation 16.17 – Accidental disconnection
- Regulation 16.18 – Annealing of attachments
- Regulation 16.19 – Record of heat treatment
- Regulation 16.20.1 and 16.20.2 – Suitability of rope
• Regulation 16.21 – Joined rope
• Regulation 16.23 – Use of old rope
• Regulation 16.24 – Spare rope
• Regulation 16.25 – Test of new rope
• Regulation 16.27.1 – Examination of attachments and test run
• Regulation 16.27.2 – Recording results of examination and test run
• Regulation 16.28.1 and 16.28.2 – Particulars of rope to inspector
• Regulation 16.30.1 – Definitions
• Regulation 16.30.2 – Determining minimum allowable breaking strength
• Regulations 16.32.1 to 16.32.3 inclusive – Multiple ropes
• Regulation 16.33 – Factors of safety, winding ropes
• Regulation 16.34.3 – Breaking strength of ropes
• Regulation 16.35 – Breaking strength of ropes
• Regulation 16.39 – Factor of safety, balance rope
• Regulations 16.41.1.1 to 16.41.1.4 inclusive – Cutting, recapping and testing of ropes
• Regulations 16.42.1 to 16.42.3 – Signalling system where persons are conveyed
• Regulation 16.43 – Electrical signalling systems
• Regulation 16.43.1 – Two separate systems
• Regulation 16.43.2 – Locked–bell system
• Regulation 16.43.3 – Driver can distinguish between different signals
• Regulation 16.43.4 – Locking of signal mechanism
• Regulation 16.43.5 – Bell–brake interlocking device
• Regulation 16.43.6 – Call-bell system
• Regulation 16.43.7 – Accessibility of call-bell
• Regulation 16.43.8 – Tone of bells
• Regulation 16.43.9 – Telephone in place of call-bell
• Regulation 16.44 – Other systems-approval
• Regulation 16.45 – Code of signals
• Regulation 16.46 – Special signals
• Regulation 16.47 – Offence
• Regulation 16.48 – Access to conveyance
• Regulation 16.49.1 & 16.49.2 inclusive – Code to be posted up
• Regulation 16.51 – Provision for crossing shaft
• Regulation 16.52 – Entering winding compartments
• Regulation 16.53 – Winding during repairs
• Regulation 16.54 – Repairs in shaft
• Regulation 16.55 – Driver to be specially warned
• Regulation 16.56 – No warning to driver for sinking shaft bottom work
• Regulation 16.57 – Spring keps or jack catches
• Regulation 16.58 – Detaching hooks
• Regulation 16.59 – Retarding device
• Regulation 16.60 – Over-run clearance
• Regulation 16.61.1 to 16.61.4 inclusive – Station safety devices and self propelled mobile machines at shaft stations
• Regulation 16.62 – Simultaneous winding of men & material
• Regulation 16.63 – Travel with material
• Regulation 16.64 – List of permitted material
• Regulation 16.65 – Persons authorized to travel with material
• Regulation 16.66 – Loading of explosives
• Regulation 16.67 – Riding outside conveyance
• Regulation 16.70 – Overfilling of conveyance
• Regulation 16.71 – Fastening projecting material
• Regulation 16.72 – Trial run of winding plant
• Regulation 16.73 – Appointed persons to examine winding plant and shaft
• Regulation 16.74 – Appointment of persons to examine winding plant
• Regulation 16.75 – Examination by engineer of winding equipment and ropes
• Regulation 16.77 – Duty when defect is discovered
• Regulation 16.78 – Machinery record book
• Regulation 16.79 – Rope record book
• Regulation 16.80 – Shaft log book
• Regulation 16.81 – Driver's log book
• Regulation 16.82 – Scrutinizing, countersigning & storage of driver's log book
• Regulation 16.83.1 & 16.83.2 – Winding drivers to have a certificate
• Regulation 16.84 – Record of certificate to be kept
• Regulation 16.85 – Driver not to be distracted
• Regulation 16.86 – Responsibilities of winding-engine drivers
• Regulation 16.87 – Interference with signalling arrangement
• Regulation 16.88 – Appointment of on-setter
• Regulation 16.89.1 & 16.89.2 – Who may give signals
• Regulation 16.90 – On-setter to have knowledge of shaft operations
• Regulation 16.91 – Special duties of on-setters
• Regulation 16.92 – Notices required at winding plants
• Regulation 16.93 excluding 16.93. 3. 1 & 16.93.3.2 - Requirements at shafts being sunk
11.6 Mandatory Requirements For Licensed Winding Plant

- No modifications may be made to any safety device or to the safety circuit without the written permission of the Engineer.

- Written permission must be obtained from the inspector to be exempted from some of the Regulations should a licensed winding engine not be used for the transport of men.

- All drivers, incline shaft operators and engineering persons responsible for the safe operation of a winding plant which is exempted for above, must be appointed. Appointment and duties of all appointed persons referred to above to be displayed in the relevant logbook.

- Pre-use inspection of the equipment must be carried out by the driver and appointed operators in the case where an exemption has been granted for above.

- Only material cars, with buffer connections, designed to be used in incline shafts, and which can be connected with an approved type of draw bar shall be used.

- Electromagnetic testing must be done whenever a new rope is installed, and at 3-monthly intervals thereafter.

- Where persons may have access to the incline for travelling on foot or by chairlift, lockable gates must be installed to prevent persons from having access to the shaft. These gates must be kept locked while the winder is in motion.

- Where applicable, drop sets must be installed on all established landings.

- The drop set must be interlocked that it can only be lowered when the load on the rope end is positioned between the drop set with a distance of not more than 5 metres between the lower end of the lowest load and the drop set in its lowered position on the respective landing.

Regulation 16.58 requires special mention as no detaching hooks seem to have been installed in decline shaft or winzes, as required by this regulation. The stakeholders need to make a decision as to whether or not the regulation bears any relevance to decline shafts and winzes.
APPENDIX B - MINE VISIT NOTES

11.7 Mine 1 Underground inter-level Decline winch
(Visit 4 August 2004)

The installation is made up of the following:

- A decline layout consisting of a rail on the one side and a chair lift on the other side of the decline.
- A slightly inclined section towards the declined shaft at the upper level and a horizontal section on the lower level.
- An enclosed bridle running on four wheels on a rail in which material cars are placed for lowering or raising by means of a winch.
- A 75Kw single drum winch on the upper level equipped with:
  - A signalling system interlocked with the safety circuit.
  - A thruster brake, which applies braking power onto the drive motor coupling when the safety circuit is tripped.
  - A mechanical brake, which is applied manually.
  - A backing switch for backing out of over and under winds.
  - A dial type depth indicator with over and under wind protection switches mounted at the back of the indicator.
  - A lock-out facility.
- A conveyance which consists of an enclosed bridle which:
  - Is pulled into a camel back to elevate the front end on the upper level by means of rollers mounted on both sides of the upper end of the bridle.
  - Activates a stopping switch when the conveyance has reached its correct stopping position where material and other cars can be removed or placed. This stopping switch also act as an initial over wind protection device from which the driver may drive down be means of a backing switch.
  - Activates a further over wind switch approximately 600 mm higher than the initial switch which act as an ultimate over wind protection device from which the driver may not back out from. Any backing out from this position is by an electrician bridging out the switch to enable moving out of the ultimate tripping position.
  - Is equipped with a strong flat buffer plate at its lower end, against which the material car’s buffer rests. The plate is wide and long enough to negotiate all buffer heights without allowing the car’s buffer to slip in over or under the bridle’s buffer while entering the inclined section of the shaft from either direction.
- Other safety devices and arrangements comprise of:
- Permission has been granted by the DME to raise or lower stretcher cases by means of the winch.
- Cross interlocking with the chair lift to prevent both installations to operate simultaneously.
- Warning and flashing lights at the top and bottom of the decline while the winch is in motion.
- One set of hand operated drop rails at the upper end and another set of drop rails at the lower end of the decline.
- Stopping blocks of the beam type placed in a hole between the rails to prevent inadvertent access of rolling stock into the decline.
- Lockable gates on the upper and lower levels, which are kept closed to prevent persons from having access to rolling stock handling areas around the decline or the chair lift.
- A very strong barricade at the one side of the decline bottom, which may act as a protection shield for the persons placing or removing cars, operating the drop rails in the lower part of the decline and conducting signalling.
- A safety rope across the rope attachment.
- Proper illumination of the entire area.

- Other arrangements to control safe operation of the system are:
  - A driver's logbook is provided which follows the same routine as is used for licensed winders.
  - The use of a “Small Winder Logbook”
  - Non-destructive testing of winch rope and attachments at regular intervals.
  - Daily and weekly inspections by appointed artisans.
  - Operation of winches by appointed drivers after undergoing training.
  - Cutting rope front ends at regular intervals.

- Notes with respect to such applications:
  - The installation, in the state it is, was as a result of the experience of serious and fatal accidents that have occurred in the past. Such accidents were caused by:
    - Buffers braking loose while been transported in the decline when the rope was attached to the buffer of the rolling stock which was handled, hence the idea of placing the rolling stock into an enclosed bridle.
    - Substandard rope attachment to the rolling stock, hence the provision of a bridle permanently connected to the winding rope.
    - The running down the decline of rolling stock placed into the upper portion to be attached to the winding rope or the running away of rolling stock in the same position when disconnected from the winding rope, hence the provision of a bridle of which the side towards the decline is
kept on the rails to prevent cars from getting to the decline unless they are held inside a bridle.

- Winding ropes or attachment failures while rolling stock is in the shaft and running uncontrolled down the decline where persons are at the bottom of the decline, hence the provision of a substantially strong barricade to protect such persons.
- Nothing to capture anything running uncontrolled down the decline, hence the provision of drop rails.
- Making persons aware that the winch was in motion was obtained by warning lights.
- Maneuvering when not required was ensured by the provision of a signaling arrangement, which would result in the winch to be tripped out if maneuvering was attempted when not required.
- Without the use of a driver’s logbook it was not possible to know if an appointed driver was driving the winch, whether the driver inspected the winch or tested the brakes before putting it in use, whether artisans conducted examinations and tests or what work was done on the winch.
- Access control of persons by means of lockable gates ensured unauthorized persons be prevented from access to winding operations.
- Access control of rolling stock made it safer for decline personnel, where rolling stock was handled by locomotives or other persons within the decline area.
- An important feature of this arrangement was that the bottom end of the shaft formed a dead end to prevent a run-away object from running into the haulage where cars are taken away from or brought to the decline.

11.8 Mine 2 Sub Incline Shaft (Visit 12 August 2004)

The shaft consists of a double drum rock/material non-licensed winder, hoisting 5 ton payload skips in a 25degree incline shaft, which is 516 m long at 5 m/s. Double drop sets are provided on the bank while only single drop sets are provided on the underlay side on the stations below the bank to handle material on that side. Such drop sets are operated by means of pneumatic cylinders which are equipped with manual released safety catches to keep the cylinder in the parked position (drop rail out of use) should the air pressure fall below the holding capacity of the respective cylinder.

Although the winder is not licensed, it is treated in the same manner as a licensed winder and the following inspections, devices and rules are applied:

- A driver’s logbook is provided where entries by the appointed drivers, all inspections by appointed artisans, personnel working in the shaft are reflected.
• A machinery record book where daily and weekly inspections by respective artisans, weekly signalling tests, monthly rope inspections by the engineer and annual inspection results are entered.
• Monthly inspections of the winder by outside authorities.
• Three-monthly non-destructive rope tests by outside authorities.
• Dynamic braking tests by outside authorities.
• Rail alignment tests by outside authorities.
• Non-destructive tests on critical winding components.
• A maximum of two material cars may be attached to the skip by means of two slings and buffer pins.
• A similar double sling is provided between the first and second car.
• A single sling between the winding rope thimble and the skip.
• Any equipment, that are not material cars, that may be raised or lowered in the shaft like hoppers, bogies and locomotives is done by a qualified rigger.
• Material cars are also provided with a safety sling, which connects the cars to the skip.
• Shaft examinations are done by walking up or down the shaft with the winder’s safety circuit tripped.
• The following shaft safety devices are provided:
  o Two removable stopping blocks placed between the rails in the tunnel in the shaft area.
  o A chain, that may be disconnected which is anchored between the hanging and the footwall as close as possible to the shaft gate.
• Further safety devices and interlocks were provided:
  o Spring applied hydraulic released brakes.
  o Lilly controllers for over speed, under wind and over wind protection complete with backing out facilities.
  o Cam gear over and under wind secondary protection.
  o Ultimate over wind protection switches in the headgear.
  o Limit switches on drop set cylinders to indicate to the driver when the drop rails are not in the out position.
  o Safety chains between the end of drop set and the hanging to secure the drop rails should the safety latch on the cylinder fail or should any component between the cylinder and the drop set fail.
  o Limiting the maximum winding speed when any drop set indicates to be lowered into the shaft.
  o Marshalling devices on both sides of the shaft conveyances.
  o Signal interlocking.
  o Brake wear alarm and trip.
  o Brake and control levers that move to the on or neutral positions respectively when not held off by the driver.
  o Three turn warning.
Phillips wrong directional warning.

11.9 Mine 3 Conveyor Decline Winder

This system consisted of a decline with a rail on the one side and a suspended conveyor on the other side. There was no brattice wall between the conveyer and the conveyance. The winch of single drum configuration was mounted far enough the decline to ensure proper rope coiling on the drum with a crash beam across the shaft and a latched anti runback device between the bank and the crash beam to capture the conveyance should the rope or attachment between the rope and the conveyance fail as a result of an over wind.

The installation was used initially to sink the decline at an inclination of 10 degrees. Its duty was to hoist the sinking waste by means of 6 ton hoppers, to lower bogies which housed rails, water, air and ventilation piping, explosives, mining materials and components for a suspended conveyor. Above mentioned rolling stock to be taken down the decline would enter the shaft on the bank level be pulled up the decline to a point where the respective rolling stock cleared the switch on the rail that entered the shaft, the switch closed and the stock lowered. At the appropriate level the switch on that level would be switched to allow the descending conveyance to exit the shaft. Cars raised to the bank would exit the shaft by pulling the car past the bank switch, switching the switch and lowering the load to roll out of the shaft.

Ensuring that the risk in run-away of rolling stock with sinking persons in the shaft bottom was controlled, the following considerations were applied:

- A slave car was used to:
  - To maintain some load on the winding rope and ensure that good rope coiling was maintained.
  - Prevent persons to connect or disconnect the winding rope end.
  - Carry a red flashing lamp that would warn persons working on the conveyor or in the decline to be aware of the conveyance.
- The slave car was fitted with a fly rope across the rope splice and rope attachment that would allow weight biased pins lower into the footwall to stop or derail the slave car should the winding rope become slack or fail or should the rope attachment fail.
- A substantially strong set of drop rails was fitted in the shaft just below the bank and another set was placed above the shaft bottom. The latter set was moved down as the shaft was sunk to ensure that the distance between the bottom and lower set of drop rails were kept to a reasonable minimum.
• A tank trap where the rails were moved aside by means of a pneumatic cylinder was provided above the lower set of drop rails which would not allow the lowering of rolling stock without been authorized by the shaft bottom persons.
• Hoppers were sent to CSIR where buffer and carriage tests were conducted to ensure that those hoppers used in the decline met some minimum factors of safety.
• Only rolling stock that was identified by a certain colour coding was allowed to be handled in the decline.
• Such rolling stock was examined on a daily basis and records were kept on their condition and of repairs done.

The winder was equipped with the following safety devices:

• Signal interlocking.
• Over and under wind protection switches mounted on the depth indicator complete with backing out facilities.
• Ultimate headgear over wind switch.
• Maximum speed over speed protection.
• Automatic movement of control lever to neutral when not held in any direction.
• Manual brake lever fully on and fully off to ensure that signals could not be transmitted by the driver while the machine was in motion, that the machine could not be reset when in motion and that the machine would not trip if the driver’s signalling buttons are bumped while the machine was in motion.

The following inspections and records were applied:

• Daily inspections by the driver, who was an appointed person, artisans were entered into a winder logbook.
• Daily inspections by artisans were entered into a small winder machinery record book.
• Weekly inspections were recorded in the driver’s logbook as well as the machinery record book.
• Weekly signalling inspections were recorded in both logbooks.
• Winding rope front ends were cut and tested at 6-monthly intervals.
• Winding rope back ends were cut at 6 monthly intervals.
• Monthly rope inspections are conducted by the responsible engineer.

11.10 Mine 4 Sub Incline Shaft (Visit 19 August 2004)

The shaft consists of a double drum rock/material licensed winder, skips in a 20 degree incline shaft, which is 1,130 m long at 5 m/s. Double drop sets are provided on the bank and on the stations below the bank to handle material on both
sides. Such drop sets are equipped with manually resetable weight biased bars, which prevent the respective drop set to move into the shaft when not required.

The winder is treated as a licensed winder and the following inspections, devices and rules are applied:

- A driver’s logbook is provided where entries by the appointed drivers, all inspections by appointed artisans, personnel working in the shaft are reflected.
- A machinery record book where daily and weekly inspections by respective artisans, weekly signalling tests, monthly rope inspections by the engineer and annual inspection results are entered.
- A shaft inspection logbook where weekly shaft inspection results are recorded.
- Monthly inspections of the winder by outside authorities.
- Three-monthly non-destructive rope tests by outside authorities.
- Dynamic braking tests by outside authorities.
- Rail alignment tests by outside authorities.
- Non-destructive tests on critical winding components.
- A maximum of two material cars may be attached to the skip by means of two slings and buffer pins.
- A single sling is provided between the first and second car.
- A single sling between the rope thimble and the skip.
- The skips are provided with “Blair Devices”, which are drop-out bars on the skip chassis which when the respective winding rope end is detected to be slack by means of a fly rope connected between the rope splice and the Blair Device will allow the Blair Device to derail the respective conveyance towards the sidewall when moving down.
- Any equipment, that are not material cars, that may be raised or lowered in the shaft like hoppers, bogies and locomotives is done by a qualified rigger.
- Material cars are also provided with a safety sling, which connects the cars to the skip.
- Shaft examinations are done by walking up or down the shaft with the winder’ safety circuit tripped.
- The following shaft safety devices are provided:
  - Two removable stopping blocks placed between the rails in the tunnel in the shaft area.
- Further safety devices and interlocks were provided:
  - Spring applied hydraulic released brakes.
  - Lilly controllers for over speed, under wind and over wind protection complete with backing out facilities.
  - Cam gear over and under wind secondary protection.
  - Ultimate over wind protection switches in the headgear.
Hinged holdback devices in the headgear which allow the skip to move to the crash beam but will not allow the skip to run down the decline should the winding rope be severed.

Spring applied skip slow-down devices between the ultimate headgear trip and the crash beam.

Marshalling devices on both sides of the shaft conveyances.

Signal interlocking.

Brake wear alarm and trip.

Brake and control levers that move to the on or neutral positions respectively when not held off by the driver.

Three turn warning.

Phillips wrong directional warning.

11.11 Mine 5 Incline Shaft (Visit 24 August 2004)

The installation is made up of the following:

- A 485 m long 10degree decline layout consisting of a rail on the one side and a bratticed walkway on the other side of the decline.
- A slightly inclined section towards the declined shaft at the upper level and a horizontal section on the lower level.
- An enclosed bridle running on four wheels on a rail in which material cars are placed for lowering or raising by means of a winch.
- A 90Kw single drum winch on 84 Level running at 2.5 m/sec equipped with:
  - A signalling system interlocked with the safety circuit.
  - A hydraulic applied disc brake, which applies braking power onto the drive motor coupling when the safety circuit is tripped.
  - A spring applied disc brake on the winding drum, which is applied when the safety circuit is tripped.
  - A backing switch for backing out of over and under winds.
  - A dial type depth indicator with tamperproof primary and secondary over and under wind protection switches mounted at the back of the indicator.
  - A lock-out facility.
  - A slack/tight rope monitoring facility operated from a load cell placed below the sheave wheel. This unit is connected to the safety circuit of the winch in such a way that, it may only be reset by an electrician when activated.
- A conveyance which consists of an enclosed bridle which:
  - Is pulled into a camel back to elevate the front end on the upper level by means of rollers mounted on both sides of the upper end of the bridle.
  - Activates an over wind switch which act as an ultimate over wind protection device from which the driver may not back out from. Any backing out from this position is by an electrician bridging out the switch to enable moving out of the ultimate tripping position.
• Is equipped with a long link on the lower side of the bridle from where buffers of material cars are connected.

• Other safety devices and arrangements comprise of:
  o Upper and lower attendants do not allow persons to enter the walk way in the incline while the winch is in motion.
  o Access gates at the top and bottom of the decline to prevent persons from entering the decline when the winch is to be put into motion.
  o One air operated drop rail at the upper end of the decline at a position of 15 m from the brow.
  o An air operated hinge which lifts the upper portion of the tracks at the lower end of the decline to form a tank trap/drop rail means of stopping run-away rolling stock.
  o Stopping blocks of the beam type placed in a hole between the rails to prevent inadvertent access of rolling stock into the decline.
  o A stopping block immediately below the brow between the tracks.
  o Gates on the upper level, which are kept closed to prevent persons from having access to rolling stock handling areas around the decline equipped with limit switches to prevent the winch from being operated when such gates are not closed.
  o A very strong barricade at the one side of the decline bottom, which may act as a protection shield for the persons placing or removing cars, operating the drop rails in the lower part of the decline and conducting signalling.
  o A “Deacon Device”, which consists of an offset and one side elevated of the rails around mid shaft to derail the bridle and contents should there be a runaway. The winder is so configured that it will enter this area at a reduced speed from any side.
  o A winch over speed switch.
  o A safety rope across the rope attachment.
  o Proper illumination of the entire area.

• Other arrangements to control safe operation of the system are:
  o Permission was granted by the Department of Minerals and Energy to raise or lower stretcher cases by means of this installation.
  o A logbook is provided at the winch, which is used by persons for recording repairs.
  o The use of a “Small Winder Logbook”
  o Non-destructive testing of the winch rope three monthly intervals by outside authorities.
  o Weekly inspections by appointed artisans.
  o Operation of winches by appointed drivers after undergoing training.
  o Monthly inspections of the shaft by the responsible engineer and mine overseer.
  o Three monthly engineer’s inspections of the whole installation.
- Annual original equipment supplier’s inspections and tests.
- Cutting rope front ends at 6-monthly intervals.

11.12 Mine 6 Decline Material Winder (Visit 31 August 2004)

This system consists of an endless rope licensed material winder operating two track mounted carriages onto which two material cars can be loaded to each carriage on the one side of the decline and a chair lift on the other side of the decline. An operator control cabin is attached to both sides of the set of carriages from where the winding machine is controlled by means of a leaky feeder system. The whole operation is pushbutton controlled but may also be driven by a winding engine driver. Slow maneuvering and destination is conducted by the operator by means of a “Bell Tronics” system with lockable key pads mounted on stations and in the control cabins referred to above.

The decline is 1,200 m long at 14 degrees with some vertical changes at some stations. There are no horizontal deviations in the tracks. The upper carriage is connected to the winding rope on its underside. This coupling is normally mounted at the same distance above the rails. Where vertical rail displacement occurs that cannot ensure the same rope distance the rope is kept below the normal height by means of rollers, which are under torsion pressure. Before the rope attachment to the upper car moves across these rollers a wedge will force the wheels to open to let the rope lift up. Another wedge mounted on the other side of the rope clamp will allow the rope to be placed back in its normal position held down by the rollers.

The carriages are running at 2 m/sec. Motorized crawls with motorized chain blocks are provided on landings to load and unload material cars, some landings at 14 degrees and some on the horizontal.

The winder is licensed to convey the operator and his assistants as well as stretchers in a car that is kept on the bank level.

The operator normally uses the leading control cabin when travelling between the bank and or landings below the bank.

The winder is equipped with a safety circuit which will shut off drive motor power and apply spring applied/hydraulic released disc brakes when:
- An over or under wind has occurred.
- When the ultimate trip wire has been activated.
- When an over speed has occurred.
• When the electronic shaft counter sensed differentiation that exceeded the preset limits.
• When the call bell has been activated.
• Electronic controller failures.

The winder is also equipped with locking out and backing out facilities.