



**Industry &
Investment**

TECHNICAL REFERENCE

EES008-3

Electrical Engineering Safety

**Design of powered winding
systems**

A Prescriptive Approach

**Produced by Mine Safety Operations Branch
Industry and Investment NSW**

March 2011

Public comment period

Please note that this technical reference is published in draft form for the purpose of obtaining public comment.

Your feedback is welcomed and will assist with reviewing and improving the document. A feedback form is provided in the appendices for your convenience.

The closing date for public comment is Friday 20 May 2011.

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Foreword

Industry and Investment NSW (I&I NSW) has a vision for electrical engineering safety, which is:

“A mining and extractive industry that has eliminated death and injuries from electrically powered and electrically controlled equipment.”

Electrical engineering safety encompasses:

- Prevention of electric shock and burns, (electrocution, death or injury as a result of a shock, radiation burns, flash burns, burning particles and plasma)
- Prevention of electrical arcing and surface temperatures that have sufficient energy to ignite gas and/or dust
- Prevention of fires caused by the malfunction of electrical equipment
- Prevention of injury and death from unintended operation, failure to stop or failure to operate, of electrically powered and electrically controlled equipment
- Use of electrical technology to provide safe-guards and monitoring for non-electrical hazards and electrical hazards with a safety integrity level appropriate for the risk.

Supporting this vision is a philosophy of operation outlined in the Strategic and Operational Plan for Electrical and Engineering Safety in NSW Mines, which can be viewed at www.dpi.nsw.gov.au. The philosophy of operation embraces a **System Safety Approach**, applying the **Hierarchy of Risk Controls** and the **Risk Reduction Precedence**, and fostering a **Positive Safety Culture**.

Satisfactory electrical engineering safety has to be achieved in the context of the mining industry's increasing electricity consumption and its use of electrical technology, with resulting increases in size (power rating) and complexity. With this comes a changing risk profile. To adequately manage the safety risks posed by electrical equipment and technology the hazards, risks and risk controls need to be thoroughly understood. This understanding must be at an engineering level, so electrical engineers within the management structure of coal or mining operations will be responsible for development, periodic review and day to day implementation of the Electrical Engineering Safety aspects of a powered winding system.

This document is one of a series dealing with powered winding systems. These documents are consistent with the above philosophy of operation and are a key element in realising the vision and points 4 and 5 for electrical engineering safety listed above.

The documents in the series are:

- EES008.1 Design of Powered Winding Systems - Electrical Engineering Safety – General Requirements & Registration
- EES008.2 Design of Powered Winding Systems - Electrical Engineering Safety – Definitions and types of winders
- EES008.3 Design of Powered Winding Systems - Electrical Engineering Safety – a prescriptive approach
- EES008.4 Design of Powered Winding Systems - Electrical Engineering Safety – a Functional Safety approach
- EES008.5 Life-Cycle Management of Powered Winding Systems - Electrical Engineering Safety Requirements

Current legislation is consistent with this philosophy. In particular Clauses 107 and 113 of the Occupational Health and Safety Regulation 2001 recognise the high risk nature of mine winders, so legislation requires that the Director General design register and item register powered winding systems.

The purpose of this document is to facilitate, within an electrical engineering safety context, the design registration of powered winding systems and to assist coal and mine operators to maintain powered winding systems in a safe state.

Use of this document will:

- Enhance the management of safety risks associated with powered winding systems through good and safe electrical engineering practice
- Contribute significantly toward the prevention of unintended operation of mine winders and preventing any unintended operation from injuring personnel.

Use this technical reference to assess your Powered Winding Systems.

Use this technical reference as an aid to the design of Powered Winding Systems.

This technical reference will be used by Mine Safety Operations to assess powered winding systems for design registration purposes and routine assessment activities.

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1. Establishment

1.1 Title

This is the Mining Industry Technical reference – *Electrical Technical Reference for Design of Powered Winding Systems Electrical Engineering Safety – a Prescriptive Approach*.

1.2 Purpose

This document is intended to assist designers and manufactures of powered winding systems, including shaft sinking winders, by indicating parameters which will be considered in the assessment for design registration. It will also aid coal operators to obtaining item registration. It also provides specific information on the content of any submission for design registration. Full details of how to obtain design registration is given in Guidance Note GNC-005 NSW DPI Guidance Note – *Registration of Plant Designs*.

Note: Registration does not limit the responsibility of the designer, manufacturer and operator to ensure that the powered winding system is safe to operate.

This technical reference describes acceptable arrangements that can be tailored to suit the particular needs of an operation. It identifies some control measures relevant to electrical circuitry. It is intended to protect the safety of workers, others in the workplace and property.

1.3 Scope

This technical reference extends to all underground coal operations in NSW that use a powered winding system. This technical reference is intended to provide guidance for any person designing, implementing, managing or reviewing a powered winding system installation.

1.4 Authority

This is an electrical engineering safety technical reference and is recommended by the Mine Safety Operations branch of Industry and Investment NSW.

1.5 Definitions

Refer to EES008-2 *Design of Powered Winding Systems Electrical Engineering Safety – Definitions and Winder Types*.

1.6 Applicable legislation

Occupational Health and Safety Act 2000
Occupational Health and Safety Regulation 2001
Coal Mine Health and Safety Act 2002
Coal Mine Health and Safety Regulation 2006

1.7 Referenced Gazette Notices

Gazette Notice for Powered Winding systems

1.8 Referenced Standards and Guidelines

AS 4024.1 Series - Safety of machinery
AS4024.1604 Safety of machinery Part 1604: Design of Controls, Interlocking and guarding – Emergency Stop – Principles of design
AS60204.1 Safety of machinery – Electrical equipment of machines
AS 61508 Series - Functional safety of electrical/electronic/programmable electronic safety-related systems
AS 62061 Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
Guidance Note GNC-005 *NSW DPI Guidance Note – Registration of Plant Designs.*

1.9 Acronyms

AS: Australian Standard
AS/NZS: Australian New Zealand Standard
FMECA: Failure Modes and Criticality Analysis
OH&S: Occupational Health and Safety

1.10 Who is affected by this Technical Reference?

This Technical Reference is relevant for all operators of coal operations in New South Wales where there is a powered winding system.

2. Powered winding system safety related circuits, systems and devices – General Requirements

This chapter describes in detail the function of various safety devices utilized on Powered Winding System Safety Circuits.

This chapter should also be used as a guide for the design of new Powered Winding installations.

2.1 General

Full compliance required	This prescriptive approach requires full compliance with this document. Where it is not possible to apply any element of the prescriptive requirements, then an alternative engineering control shall be implemented using a functional safety approach.
Primary and secondary safety circuits	All Powered Winder systems shall be provided with a minimum of two safety circuits: 'Primary' and 'Secondary'. These safety circuits shall have sufficient independence such that if a secondary safety circuit action fails on demand, then the primary safety circuit will activate to bring the EUC safely to rest. This independence requires that each safety function has a sensor, logic solver, actuator combination that can't be adversely affected by the failure of other sensor, logic solver and/or actuator combination.
A third safety circuit	It is recommended that a third safety circuit, the 'Ultimate Safety Circuit' be employed to provide an additional measure of redundancy so that in an emergency situation, electric power or motive force to the winder is removed, totally independent to that of the primary and secondary safety circuits. Application of the ultimate safety circuit principle of design is commonly used by winder manufacturers.
Relationship between safety circuits	The designer / manufacturer (as part of the application for registration) shall clearly define the relationship between the ultimate, primary and secondary safety circuits and demonstrate the independence of each safety circuit. In addition, it must be clearly demonstrated that every device causing an initiation of an emergency stop operates independently to that of other safety devices of the remaining two safety circuits.
Decision not to use an ultimate safety circuit	Where a decision is made NOT to employ an 'ultimate safety circuit' the designer / manufacturer (as part of the application for registration) shall clearly define the relationship between the primary and secondary safety circuits and demonstrate the independence of each safety circuit. In addition, it must be clearly demonstrated that every device located in the primary safety circuit, causing an initiation of an emergency stop, operates independently to that of safety devices located in the secondary safety circuit.

The designer / manufacturer shall also clearly demonstrate the circumstances in which electric power or the motive force is removed from the prime mover in an emergency.

Listing of safety devices and functions

The identified listing of safety devices / safety functions for the ultimate, primary and secondary safety circuits are listed in Chapters 3, 4 and 5 respectively. These listings are not exhaustive as the design, type and operation of mine winders vary considerably depending on the application. A credible risk analysis will identify the necessary safety systems and components required for each mine winding installation.

Activation of safety device alarms

Activation of a safety device shall be evident through alarms (visible and audible). The activation shall be automatically logged.

All activations of safety devices shall cause the trip or the alarm to be latched and only be capable of being reset by authorised persons.

Power supply

The power supply to remote devices for safety circuits shall not exceed extra low voltage.

2.2 Ultimate Safety Circuit (Optional)

Independent operation

The ultimate safety circuit is designed to operate independently to that of the primary and secondary safety circuits. The Safety Integrity level of the ultimate safety circuit should be level two (SIL2).

Initiating emergency braking

The operation and / or failure of any function within the ultimate safety circuit should remove the motive force from the winder drive system and initiate the EUC control system emergency braking.

Restarting after emergency stop

In the event that any of the devices connected into the ultimate safety circuit have operated and brought the EUC to rest, the EUC control system cannot be operated until an authorised person has investigated the cause of the stoppage and has carried out the necessary remedial action before manually resetting the ultimate safety circuit in the EUC control system. The manual reset circuit should be SIL 2 in order to minimize the risk of the reset defeating the ultimate safety circuit during normal operation.

2.3 Primary Safety Circuit

Independent operation

The primary safety circuit is designed to operate independently to that of the ultimate safety circuit (if installed) and the secondary safety circuit. The Safety Integrity Level of the primary safety circuit shall be level two (2).

Emergency braking and restart

On the demand for primary safety circuit activation, the EUC shall be brought safely to rest and the emergency braking initiated. In the event that any of the devices connected into the primary safety circuit having operated, the EUC shall be inhibited from further operation until an authorised person has investigated the cause of the stoppage and has carried out the necessary remedial action before manually resetting the primary safety circuit. The manual reset circuit shall have a Safety Integrity Level not less than 2, to minimize the risk of the reset defeating the primary safety circuit during normal operation.

Winder not brought to stop

Where there is a demand on the secondary safety circuit and the winder is not brought to a controlled stop, the primary safety circuit shall be activated.

2.4 Secondary Safety Circuit

Independent operation

The secondary safety circuit is designed to operate independently to that of the ultimate safety circuit (if installed) and the primary safety circuit. The secondary safety circuit is essentially provided for all other routine stopping devices located within the EUC control system. The Safety Integrity Levels of the secondary safety circuit shall be at least level one.

The failure of any safety function within the secondary safety circuit shall bring the EUC to a controlled stop.

Automatic reset

In the event that any of the devices connected into the secondary safety circuit have operated and brought the EUC to rest, the EUC control system can be operated in a manner that will allow the automatic reset of the device or devices. If the automatic reset circuit malfunctions, it shall not defeat any portion of the secondary safety circuit.

2.5 Systems and devices

2.5.1 Brake Systems

2.5.1.1 Mechanical Brake Systems

A risk assessment, in particular a Failure Modes Effects and Criticality Analysis, should be used to identify Ultimate, Primary and Secondary Safety circuit components and actions of the braking system and clearly define the interface between electrical and mechanical components.

Where it is determined that a dangerous brake failure requires immediate action, such as application of emergency brakes, then the detection and emergency brake application circuits shall be in the primary safety circuit. Where the monitored condition is not considered to present an immediate safety demand, then this monitored condition can be located in the secondary safety circuit. Chapters 4 and 5 specify minimum brake system protection requirements.

2.5.1.2 Brake Monitoring

The braking system is critical to the safety of personnel. The mechanical components of the braking system shall be monitored for dangerous conditions and shall be fitted with devices to monitor brake release (lift), brake release failure, brake application (set), brake application failure, brake wear, brake temperature, broken brake linkages and, where applicable, brake counterweight operation.

An automatic functional check of the electrically controlled brake valves shall take place (in "real time") serving jointly the service and emergency brakes. The functional check shall take place in as short as possible time intervals.

The failure of the normal braking system to operate as intended shall activate the primary safety circuit.

Note: The braking system is critical to safety and the mechanical components of the braking system shall be monitored for dangerous conditions. The full range of brake system protection requirements should be determined by risk assessment. Where the monitored condition is not considered to present an immediate safety demand, then this monitored condition can be in the secondary safety circuit.

2.5.1.3 Brake path contamination

A risk assessment should address the possibility of deposition of water condensation or other contaminations affecting the efficiency of brake paths. The assessment should take account historic and sudden changes in atmospheric temperature and humidity. Where there is a possibility of contamination of the brake paths, engineering solutions should be developed to prevent the occurrence.

2.5.1.4 Brake testing

All Powered Winding Systems shall be fitted with facilities to carry out dynamic and static brake testing. The test facilities shall be designed to be of key or push button operation, requiring no other manual alteration to the EUC Control system to perform these tests. The key or pushbutton shall return to the normal operating position upon release.

2.5.1.5 Electrical Braking Systems

Electric braking, either regenerative or dynamic, shall be provided on all electrically driven mine winders. Electric braking shall be retained until it is proven that the mechanical brakes have been effectively applied. In particular, it is essential that electric braking is retained upon operation of any emergency stop. For mine winders driven by hydraulic, pneumatic or other means, see MDG 33.

2.5.1.6 Hydraulic Brake Unit Protection

The brake control circuit may allow the EUC to complete its cycle, but not recommence a new cycle if any of the following occurs:

- Low hydraulic oil level
- Low system pressure
- High oil temperature alarm.

2.5.2 Dead Man Control

A control switch, either hand or foot operated when upon release, automatically returns to the off position and causes application of the winder brakes, bringing the winder to a controlled stop.

Dead man controls are required for the manual operation of any winder and shall be used for the manual control of personal EUC's (conveyances) on Drift Winders and in some cases for the static and dynamic brake testing facility of any winder.

2.5.3 Door/Gate Interlocking – Shaft Winders

- 2.5.3.1** All EUC's (conveyances) shall be totally enclosed and fitted with doors/gates, electrically and mechanically interlocked as closed and locked before the EUC control system can be operated.
- 2.5.3.2** All collars and shaft entry positions/landings shall be fitted with doors/gates, electrically and mechanically interlocked as closed and locked before the EUC control system can be operated.
- 2.5.3.3** The term 'closed and locked' means that the mechanical interlocking devices located on the shaft entry and conveyance doors/gates shall be separately monitored as locked by an electrical interlock device. The electrical device shall operate independently to that of the door/gate electrical interlocks and shall cause the winder to stop in the event of loss of integrity of the mechanical interlock system.
- 2.5.3.4** The shaft entry and conveyance door/gates shall be designed in such a manner so that the door/gates cannot be opened unless the conveyance is positioned at a landing, and cannot be opened whilst the EUC conveyance is in motion.
- 2.5.3.5** When the conveyance is located at each of the shaft collars, shaft entry points or at shaft bottom, only then can the access gates or doors of both the EUC and the shaft collar, shaft entry point or shaft bottom be opened providing safe access or egress for personnel.
- 2.5.3.6** For automatic winders where personnel have entered the EUC (conveyance), the winder control system shall be designed in such a manner so as to only permit operation of the winder from within the EUC (conveyance) and only when shaft entry and conveyance door/gates are closed and locked.
- 2.5.3.7** For manually operated winders, where personnel have entered the EUC (conveyance), the winder control system shall be designed in such a manner so as to only permit operation of the winder after the shaft entry and EUC (conveyance) door/gates are both closed and locked

2.5.3.8 Bulk Winder Tubs - the requirements of paragraphs 2.5.3.1 to 2.5.3.7 apply equally to bulk winder tubs fitted with man riding facilities.

2.5.3.9 Failure of any of the above electrical devices shall cause the EUC (conveyance) to stop.

2.5.4 Door / Gate Interlocking – Drift Winders

2.5.4.1 A risk assessment shall be conducted to evaluate the risk to personnel when riding in the EUC (conveyance).

2.5.4.2 The outcomes of the risk assessment shall be entered into the safety file for the winder.

2.5.4.3 Where it has been determined there is a risk to the safety of persons riding in the EUC, the following EUC and platform door monitoring shall be required:

2.5.4.4 EUC's fitted with doors shall be monitored as closed and locked before the EUC control system can be operated.

2.5.4.5 Operation of any of these devices while the EUC is in motion shall cause the EUC to stop by operation of the emergency braking system.

2.5.4.6 Failure of any of these devices shall cause the EUC to stop.

2.5.5 Double Drum Shaft Winders Fitted with a Clutch

2.5.5.1 The clutch for a double drum Winder shall be interlocked with the braking system of the de clutched drum in such a manner that the clutch cannot be opened without the brakes being applied and that the applied brakes cannot be released without the clutch being engaged.

2.5.5.2 A double drum winder with clutch shall be provided with two separate brake systems for man riding, provided that any man transport only takes place with the drums coupled together.

2.5.5.3 A double Winder conveyance shall be provided with a separate depth indicator driven independently by each drum.

2.5.5.4 Double drum Winders with clutch shall be provided with a separate transmitter for the position indication.

2.5.5.5 A double drum winder with clutch shall have the position of the clutch indicated.

- 2.5.5.6** If the clutch of a double drum Winder is disengaged without the brake for the de clutched drum being applied, or if the brake is released without the clutch being engaged, the EUC shall stop by application of all brakes.
- 2.5.5.7** Each depth indicator, including the monitoring and operating apparatus of double drum winders with a clutch, shall be synchronized with the position of each conveyance in the shaft.

2.5.6 Drift and Shaft Profile Monitoring Drift and Shaft Profile Monitoring

To ensure the safe operation of the EUC and equipment transported into and out of the mine, all drifts and shafts that carry materials or equipment shall be fitted with profile monitoring. This profile monitoring shall address the following requirements:

- 2.5.6.1** Surface/Portal/shaft monitoring to detect equipment or loads that are outside the accepted profile of the drift or shaft.
- 2.5.6.2** At designated underground loading points and shaft or drift access points where equipment can be attached to or inside of the EUC cage or dolly car for transportation into or out of the mine, monitoring to detect equipment or loads that are outside the accepted profile of the drift or shaft.
- 2.5.6.3** Operation of these monitoring devices shall be 'fail to safety' concept in design and shall stop the EUC from any further movement in the selected direction. The EUC may only be returned to the point of loading after the cause of the stoppage is addressed.
- 2.5.6.4** Failure of any of these devices shall stop the EUC from operating.

2.5.7 Emergency Stop Facilities – Including Hand Operated Switches

- 2.5.7.1** Emergency stop switches shall be provided within the winder house, at all loading and unloading points, at all shaft entry points, at all call stations, within all conveyances, at arm's reach from any winder driver, at arm's reach from any static and dynamic brake testing facility and where ever else is considered necessary.
- 2.5.7.2** Emergency Stop devices shall comply with AS60204.1 and AS4024.1.
- 2.5.7.3** Emergency stop switches located within any EUC (conveyance) shall, when operated, cause the winder to stop at any position in the shaft or drift.
- 2.5.7.4** Emergency stop switches shall mechanically latch and shall operate into the primary safety circuit.

- 2.5.7.5** Emergency stop systems shall be designed so that upon operation of the device, the primary safety circuit is initiated and the winder brought to a stop through operation of the emergency braking system.
- 2.5.7.6** The EUC control system cannot be operated until an authorised person has investigated the cause of the stoppage and has carried out the necessary remedial action before manually resetting the primary and/or ultimate safety circuits in the EUC control system. (AS 60204 – Trapped Key)
- 2.5.7.7** The winder cannot be operated until the emergency stop switch is released at the point at which it was operated.
- 2.5.7.8** Where winders are fitted with an automatic 'call function' the winder shall not automatically operate upon release of the emergency stop switch.
- 2.5.7.9** Where automatic winders are driven manually, and for all manually operated winders, emergency stop switches are to be provided within arm's reach of the winder operator when the winder operator is located in his/her normal operating position.
- 2.5.7.10** Where automatic winders are driven manually, and for all manually operated winders; upon initiation of any emergency stop switch (other than the switch located adjacent to the winder operator), the winder shall be automatically brought to a stop without operation by the winder operator.
- 2.5.7.11** Other than emergency situations, the winder and EUC (Conveyance) control systems shall be designed so that upon initiation of any emergency switch the winder shall be brought to a stop independent to any voice and/ or manually operated signalling system.
- 2.5.7.12** Forming part of the functional safety analysis, consideration must be given to emergency stop circuits of equipment controlled by programmable devices. It is essential that the emergency stopping function of any circuit is not impaired in any way by a programme malfunction, equipment failure or application of software overrides.
- 2.5.7.13** Forming part of the functional safety analysis, consideration must be given to the retention of the electric or hydraulic retardation systems when emergency stop switches are operated.

2.5.8 Failure to Operate of the Primary Safety Circuit

If the Primary Safety Circuit fails to operate (when called upon to do so), the voltage and/or motive force shall be removed from the Winder Motor or drive system and cause subsequent operation of the winder emergency and or quick stop braking system.

2.5.9 Failure of the Incoming Power Source

Failure of the incoming power source, be it electric, hydraulic or a pneumatic supply, shall cause operation of the winder emergency and/or quick stop braking system.

2.5.10 Flashing Lights (Drift Winders)

To ensure the safe operation of the EUC and equipment transported into and out of the mine, all drifts shall be fitted with drift flashing lights.

These lights shall operate continually while the EUCs are in motion.

The lights shall be positioned so that persons can observe at least one light from any point in the drift.

2.5.10.1 Conveyance flashing lights

All personnel transport conveyances operating in a drift shall be fitted with flashing lights which shall operate continually while the conveyances are in motion. Consideration shall be given to the operation of the flashing lights at the same time as the pre start alarm. The conveyance flashing lights are additional to the pre-start alarm.

The EUC (conveyance) flashing lights shall be readily seen and be of a different colour and operating frequency to that of the fixed flashing lights located in the drift.

The conveyance flashing lights shall also be of differing colours on either end of the Control EUC (conveyance) to visually indicate the travelling direction of the Control EUC (conveyance).

When any additional personal transport conveyances are connected to the Control EUC the most inbye conveyance shall be fitted with a flashing light operating at the same colour and frequency to that of the inbye flashing light fitted to the control EUC (conveyance).

2.5.11 Gearbox / Drive Monitoring

Gearbox/Drive monitoring is required for EUC control systems. Real time sensors should be installed to monitor the following items:

- bearing vibration
- high bearing temperature
- high lubricating oil temperature
- low lubricating oil level.

2.5.12 Gear Loss Protection

- 2.5.12.1** A safety device shall be fitted to monitor any winder drum position and speed and allow comparison against any limits, switches or devices operating in the primary safety circuit. An engineering assessment and a risk assessment shall determine the allowable limits of differences between the winder drum speed monitoring and the primary safety circuit devices. The gear loss protection shall operate at 15% overspeed.
- 2.5.12.2** It is customary to monitor the complete system from the non coupled end of the drive motor to the end of the gear train driven by the winder drum where such gear train incorporates overspeed protection, back up overwind limits conveyance position indicator drive system, encoders and other safety related devices.
- 2.5.12.3** Some winder drive systems are directly coupled to the winder drum without the provision of an interposing gearbox. In this case, in order to monitor the integrity of the drive motor coupling to the driven end of the winder drum and to monitor the integrity of the drive train system coupled to the non driven end of the winder drum, it is necessary to provide 'gear loss protection' from the opposite drive end of the drive motor to the end of the gear train driven by the winder drum.

2.5.13 Hard Wire Control Systems

- 2.5.13.1** Where the control signals to and from the EUC (conveyance) and associated control systems, including control stations, are connected via cabling the following requirements shall be provided:
- 2.5.13.2** A single electrical fault shall not cause the EUC to move or fail to stop (e.g. Short Circuit, Open Circuit, High Resistance or Earth Fault).
- 2.5.13.3** All cabling between the EUC and the EUC Control system associated with the Ultimate and Primary Safety Circuits shall be SIL 2 capable.

2.5.14 Indicators

- 2.5.14.1** Every winder shall be provided with a depth indicator accurately showing the position of the conveyance in a shaft or drift. The location of each shaft/drift entry shall be clearly marked on the depth indicator. The depth indicator may be analogue or digital. Where there are two conveyances fitted to a winder the location of each conveyance shall be shown on indicator. Double drum winders with a clutch shall have a separate depth indicator for each conveyance. Each depth indicator, including the monitoring and operating apparatus of double drum winders with a clutch, shall be synchronized with the position of each conveyance in the shaft.

- 2.5.14.2** Every electrically driven winder shall be provided with instrumentation showing the load current or torque of the motor.
- 2.5.14.3** Every winder operating at speeds in excess of 2 metres per second shall be provided with a speed indicator graduated in metres per second.

2.5.15 Keps (Chairs, Catches, Dogs or Keeps)

A device used to support the EUC conveyance while loading and unloading operations are carried out, thus preventing slack rope from occurring. The device and the control system shall be designed so that it cannot be withdrawn while the weight of the conveyance is resting upon it is minimised, and/or until the winder has taken up the stretch in the rope(s), thus preventing any sudden drop or rise of the conveyance upon withdrawal. The circuitry operating keps (chairs, catches, dogs or keeps) shall be SIL2 rated.

2.5.16 Load Sensing

- 2.5.16.1** In order to ensure the safe operation of the EUC and equipment transported into and out of the mine and where Powered Winding Systems are designed to carry both personnel and heavy materials on different occasions, a risk assessment shall be undertaken to determine the engineering requirements, including load sensing, to automatically predetermine the speed of the winder for the intended load attached to the EUC (conveyance).
- 2.5.16.2** The risk assessment shall also address procedures for safely transporting heavy machinery in and out of the shaft or drift.
- 2.5.16.3** The outcome(s) of the risk assessment shall be entered into the safety file and any deviation from the above requirements shall be shown to provide an equivalent level of safety.

2.5.17 Overspeed Devices

- 2.5.17.1 Drift Winders** Drift winders shall be provided with an overspeed device driven by the conveyance (dolly car) and set to operate at 115% of the nominated winder speed.

Activation of this device shall cause operation of the EUC dump brake system and bring the winder to rest by operation of the quick stop function. This device shall be connected into the Primary Safety Circuit.

2.5.17.2 Winder Drums All winder drums shall be provided with an overspeed device fitted to the opposite drive end of the winder drum and set to operate at 110% of the nominated winder speed.

Activation of this device shall cause operation of the emergency braking system through operation of the Primary Safety Circuit.

2.5.17.3 Winder Motors All winder motors shall be provided with an overspeed device fitted to the non- drive end of the winder prime mover and set to operate at 112% of the nominated winder speed.

Activation of this device shall cause operation of the emergency braking system through operation of the Primary Safety Circuit.

Where the ultimate safety circuit is used this overspeed device is to be installed in the Ultimate Safety Circuit.

2.5.18 Over Travel Devices

2.5.18.1 Double Drum and Single Rope Winders All double drum and single rope shaft winders shall have at least two physical over travel devices fitted in the head frame and at least two physical over travel devices fitted at shaft bottom to prevent an over travel condition from occurring.

2.5.18.2 Friction (Koepe) Shaft Winders All friction (Koepe) Winders shall have at least two physical over travel devices fitted in the head frame and have at least two physical over travel devices fitted in the opposite side of the headframe for cage / cage and or cage / counterweight combinations.

2.5.18.3 Drift Winders All drift winders shall have at least two physical over travel devices fitted on the gantry and at least two physical over travel devices fitted at the drift bottom to prevent an under wind condition from occurring.

2.5.18.4 Ultimate Over and Under Travel Limits (SIL2 rated) All winders shall be fitted with a suitable ultimate over travel and ultimate under travel switch located in the headgear and shaft bottom (for a shaft winder) and end of track (gantry) and track bottom (for a Drift winder).

Note: In the case of multiple rope friction winders ultimate over travel switches may be mounted in either side of the headframe in lieu of the shaft bottom for the combination of two tub bulk winders, two cage winders and cage / tub – counterweight combination winders.

Each Ultimate Over and Under Travel limit shall be provided with a mechanical and electrical latching system capable only of being manually reset at the location of the device and shall operate in such a manner as to prevent the winder from being moved in either direction in the headframe of shaft winders and in either direction at the end of the gantry of drift winders.

These devices shall have a SIL 2 rating and shall be operated by the EUC (and counterweight where applicable) and shall operate into the Primary Safety Circuit and cause removal of the motive force from the EUC drive and control system and apply the emergency brakes.

Note: Where an ultimate safety circuit is used the ultimate over travel limit shall operate into the ultimate safety circuit.

The position of the ultimate over travel limit shall allow for system inertia and shall allow for the EUC (and counterweight where applicable), to be brought safely to rest without striking end of travel structural buffers or stops.

2.5.18.5 Final Over Travel Limits

All winders shall be fitted with suitable final over travel and final under travel switches or devices located in the headgear and shaft bottom (for a shaft winder) and end of track (gantry) and track bottom (for a drift winder).

These devices and related circuitry shall be SIL 2 capable and operated by the EUC conveyance (and counterweight where applicable) and shall operate into the Primary Safety Circuit and cause removal of the motive force from the EUC drive and apply the emergency or quick stop braking system, independent to that of the ultimate and secondary safety circuits.

The position of the final over and under travel limit devices shall allow for system inertia and shall allow for the EUC conveyance (and counterweight where applicable), to be brought safely to rest without striking end of travel structural buffers or stops or entering the zone of protection of the ultimate over and under travel limits.

Upon initiation of the final over or under travel limit each device shall mechanically and electrically 'latch out' in such a manner as to prevent the winder from being operated in either direction.

2.5.18.6 'Back Up' Over and Under Travel Limits Driven by Winder Drums

All physical over and under travel limits shall be 'backed up' by limits or other devices driven by the winder drum and such devices shall duplicate the physical limits located at the shaft bottoms and headframes for shaft winders and at the gantry and drift bottom for drift winders.

These limits / devices shall operate into the Primary Safety Circuit and cause removal of the motive force from the EUC drive and apply the emergency or quick stop braking system.

Note: Where an ultimate safety circuit is used the ultimate over travel 'back up' limits or devices shall operate into the ultimate safety circuit.

2.5.18.7 Over and Under Travel 'back out' devices and procedures

Provision shall be made to 'back out' from any over or under travel condition.

The manually operated switch or device utilised for the 'back out' procedure shall be designed as 'spring return to off' upon release.

Procedures shall be established whereby an authorised person shall investigate the cause of the over travel condition and shall only cause operation of the 'back out' system until it is safe to do so.

The 'back out' system shall only permit the winder to be operated in the opposite direction to that of the initiation of the detecting device or limit switch.

Circuitry associated with 'back out' systems shall be SIL2 rated.

2.5.19 Plat Gates

Plat gates shall be electrically and mechanically interlocked in the manner described in paragraph 2.5.3 and form part of the EUC – shaft entry electrical and mechanical interlocking system.

The designer must ensure that the design of the plat gate is such that no person is exposed to open sections of the shaft when the plat gate is positioned, thus providing safe access and egress for personnel.

Note: Plat gates are also sometimes designed to provide the function of a kepin that it secures the conveyance, preventing slack rope from occurring during loading and unloading operations. In this instance, and in addition to the requirements of this clause, the system shall be designed in a manner described in Paragraph 2.5.15.

2.5.20 Quick Stop Facilities – Drift Winders

All Drift Winder Control Systems shall incorporate 'Quick Stop' facilities as part of the control system design. The purpose of the 'Quick Stop' Facility is to provide controlled braking of Personnel Transport EUC's in order to prevent no more than two metres of slack rope developing when the Personnel Transport EUC is at rest.

An initiating device shall be provided in all personnel conveyances attached to the winder rope and shall be accessible to all personnel from any part of the EUC (conveyance) including multiple carriages or decks.

As part of the functional safety analysis consideration must be given to the retention of the electric or hydraulic retardation systems when the quick stop function is operated.

2.5.21 Radio Frequency (R/F) Links

In cases where control signals (eg. raise, lower etc) to and from the EUC and associated control stations are connected via any form of radio frequency (R/F) Link the following requirements shall be provided:

- RF Carrier Loss Monitoring (Carrier Detect)
- Data Error Check Monitoring (Watch Dog)

Where Data Error Check monitoring (Watch Dog) is employed on the EUC (conveyance) of Drum Drift Winders the Radio Control System operational time for detection of data error shall be calculated to prevent excessive slack rope being generated on the EUC.

Note: The motion detection device (Paragraph 2.5.25.5) fitted to drift winder conveyances can also assist in the prevention of the development of excessive slack rope on Drift Winders.

Where control devices forming part of any safety circuit are connected via R/F the following requirements shall be satisfied:

- R/F shall not be used for ultimate safety circuits
- Loss of R/F the signalling system (carrier detect) shall cause the EUC to be brought safely to rest
- Where the R/F is associated with the primary safety circuit functions, in the event of loss, the primary safety circuit shall be activated
- Where the safety R/F is associated with secondary safety circuit functions, in the event of loss, the secondary safety circuit shall be activated. Alternatively, the primary safety circuit can be activated.

2.5.22 Safe Coiling Protection – Double Drum, Single Rope Shaft and Drift Winders

A device shall be fitted to the winder drum to detect 'unsafe coiling' of the winder rope.

Upon detection of any unsafe coiling the winder shall stop by operation of the Secondary Safety Circuit.

2.5.23 Safety Circuit Cabling

Where control devices forming part of any safety circuit are connected via cabling (electrical or fibre optics) the following requirements shall be provided:

A single electrical fault shall not cause the EUC to move unexpectedly or fail to stop. (Typical faults are: Short Circuit, Open Circuit, High Resistance and Earth Fault).

Where the safety circuit cabling is associated with the primary safety circuit functions, in the event of (a), the primary safety circuit shall be activated. Where the safety circuit cabling is associated with secondary safety circuit functions, in the event of (a), the secondary safety circuit shall be activated. Where the safety circuit cabling is associated with an ultimate safety circuit functions, in the event of (a), the ultimate safety circuit shall be activated.

2.5.24 Safety Monitoring of EUC (conveyance) Drift Winders

2.5.24.1 EUC (conveyance) Door / Gate monitoring

A risk assessment shall be conducted to evaluate the risk to personnel when riding in the conveyance.

The outcomes of the risk assessment shall be entered into the safety file for the winder.

Where it has been determined there is a risk to the safety of persons riding in the conveyance the following is required:

Conveyances fitted with doors shall be monitored as closed and locked before the EUC control system can be operated.

Operation of any of these devices while the conveyance is in motion shall cause the conveyance to stop by operation of the emergency braking system.

The failure of any of these devices shall cause the EUC to stop.

2.5.24.2 EUC (conveyance) Dump Brake System Operation and Protection

The EUC (conveyance) dump brake system of the drift winder is critical to safety. The mechanical components of the braking system shall be monitored for dangerous conditions.

The full range of brake system protection requirements should be determined by an engineering assessment.

Where it is determined that a dangerous brake failure requires immediate action then the detection and application circuits shall be in the primary safety circuit.

Where the monitored condition is not considered to present an immediate safety demand then this monitored condition can be in the secondary safety circuit.

EUC (conveyance) Application of Dump Brakes

The drift winder control system shall be designed in such a manner so as to automatically prevent the lifting of the EUC dump brakes clear of the track by operation of the hydraulic system until all slack rope has been taken up by the winder drum.

EUC (conveyance) Hydraulic Brake Pressure

All personnel transport conveyances that have a hydraulically operated braking circuit shall have a device fitted to monitor the pressure. The failure of this device to detect minimum pressure for safe application of brakes shall cause the conveyance to be brought safely to rest.

- 2.5.24.3 EUC Dead Man Control** Drift Winder EUC(s) (conveyances) shall be provided with a 'dead man' control forming part of the EUC forward and reverse directional control device. The device shall return to the off/stop position when released by the operator.
- 2.5.24.4 EUC (Conveyance) Derail Switch** All Personnel Transport EUCs operating on a Drum Drift Winder shall have a device fitted to detect derailing of the EUC. Upon detection the powered winding system shall stop by application of the emergency braking system.
- 2.5.24.5 EUC (conveyance) Motion Detection Device** EUC (conveyances) shall have a device fitted to detect motion of the conveyance. Failure of this device to detect motion shall cause the winder to come to a stop. This device will assist in the detection of slack rope and hence reduce the possibility of developing kinks in the winder rope.
- This device shall detect the uncontrolled loss of motion of the conveyance independent of the conveyance control system, i.e. shall operate into the local control system of the conveyance and upon detection of loss of motion shall cause operation of the conveyance 'dump brake system' and subsequent operation of the winder drum braking system. The device shall also sense movement of the conveyance and compare the conveyance movement to that of the winder drum rotation and shall cause the winder to stop upon the occurrence of a predetermined speed difference.
- An engineering assessment shall be conducted to determine an acceptable speed differential between the motion of the conveyance and the movement of the winder drum and an acceptable time delay (if any) before operation of the conveyance dump brake system. The assessment shall also give due consideration for the requirement for the deposition of no more than two metres of 'slack rope' in the drift when the conveyance is brought to rest.
- 2.5.24.6 EUC (conveyance) Overspeed Protection** An overspeed device located on the conveyance shall activate the primary safety circuit and conveyance dump brakes when the speed is 115% of maximum designed speed of the winder.
- 2.5.24.7 EUC (conveyance) Quick Stop Facility** All Drift Winder Control Systems shall incorporate 'Quick Stop' facilities as part of the control system design. The purpose of the 'Quick Stop' Facility is to provide controlled braking of personnel transport conveyances in order to prevent no more than two metres of slack rope developing when the conveyance is at rest. An initiating device shall be provided in all personnel conveyances attached to the winder rope and shall be accessible to all personnel from any part of the EUC (conveyance) including multiple carriages or decks. As part of the functional safety analysis consideration must be given to the retention of the electric or hydraulic retardation systems when the quick stop function is operated.

2.5.25 Serial or Parallel Data Transfer

Where communications are established between the EUC, the EUC Control system and any associated field stations or devices, via any form of serial or parallel data transfer the communication method shall be monitored and provide the following:

- (a) Communication Error Check
- (b) Communication Failure/Loss.

2.5.26 Shaft or Drift Obstruction Protection

Any deliberate obstruction placed in a shaft or drift that is deployed for maintenance or unloading of equipment shall have its position monitored by a safety device or devices. The winder control circuitry shall ensure that the EUC cannot unintentionally travel in the direction of, or make contact with, an obstruction. Where any approach is intentional, the speed, direction and location of the EUC shall be constantly under control to prevent a collision.

2.5.27 Signalling and Communication Systems

2.5.27.1 Requirements for all Mine Winders

All Personnel Transport EUCs operating on powered winding systems shall be provided with a suitable means to:

- Give audible and visual signals to; and
- Receive audible and/or visual signals from; and
- Communicate by speech;

With any place where any such means of signalling and communication is necessary to enable the powered winding system to be used safely.

Where a failure of any of the above devices is detected the primary safety circuit shall be activated and the winder brought to a stop.

In order to operate the winder in an emergency, a risk assessment shall be conducted to establish safe operating procedures In the event of failure of the signalling system. The outcomes of the risk assessment shall be entered into the safety file.

2.5.27.2 Manually Operated Mine Winders including Shaft Sinking Winders – Additional Requirements

These requirements do not apply to automatic winders with provision for manual operation provided that the existing visual and audible signalling systems are utilised.

In addition to the requirements of Clause 2.5.28.1, signalling systems installed on all manually operated mine winders shall be provided with a signal confirmation system whereby 'signals sent' from shaft entry levels, cage, tub, kibble and / or staging are automatically compared (using a monitoring system) with those 'signals returned' by the winder operator.

Any discrepancy detected between signals sent and signals returned shall prevent the winder from moving independent to that of the winder operator.

Visual and audible alarms shall warn the winder operator of the occurrence of a signal discrepancy.

It is strongly recommended that 'rapper'/'knocker' type signalling systems not be used because of the risk of inadvertent operation of the signalling system by falling material and/or loss of all or part of the signal line

Where 'rapper'/'knocker' signalling systems are used, the system shall be designed with 'fail to safety' concepts in that a break or slackening of the signal line shall cause the winder to stop.

'Rapper'/'knocker' signalling systems may be used as a 'back up' to existing signalling systems for use in an emergency.

Where more than one signalling system is installed i.e. kibble and staging etc, an interlocking system shall be established whereby only one signalling system can be utilised at any one time.

The operation of each signalling event shall be recorded.

**2.5.27.3
Multiple
Winders**

Where more than one powered winding system is installed in a single shaft or drift visual and audible signals shall of a different colour and tone respectively.

2.5.28 Slow Down and Creep Speed Zones All Winders

Slow down and creep speed zones shall be established on approach to the gantry and drift bottom of drift winders and the on the approach to the shaft collar and shaft bottom sidewinders.

**2.5.28.1
Special
Requirements
for Drift
Winders**

The designer shall take particular care in establishing a safe slow down speed when ascending and approaching the change of gradient between the drift and the gantry. The established speed creep speed must be such that a "whipping" action due to system inertia does not occur, thus preventing an over run of the winder rope and also preventing a "run back" situation.

2.5.29 Torque Proving Circuit

A torque proving detection circuit shall be provided to confirm that the electrical drive system is available before allowing the primary brakes on the winder to be released.

Note: The torque sensing test is critical to ensure that sufficient torque is available to control the load attached to the winder rope and thus prevent any possibility of a runaway occurring due to a 'freewheeling' situation.

2.5.30 Voice Communication System

All EUCs (conveyances, cages kibles) capable of Personnel Transport shall have an adequate voice communication system installed.

The system shall provide the ability for two-way voice communication between the operator of the EUC, the EUC winder control room, call stations associated with the EUC and an operations room (if applicable).

If the above locations are unmanned the system shall provide the ability for the operator of the EUC, in the case of an emergency, to establish communications with site personnel at other identified areas where personnel are present.

A 'back up' voice communication system shall be provided in the event of failure of the primary communication system.

The 'back up' voice communication system shall be capable of operating totally independent to that of the installed system.

Procedures shall be developed for the use of both the voice communication system and the 'back up' voice communication system.

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2.5.31 Single Point Suspension of Shaft Cables that Supply Electrical and Communication Services to EUC Conveyances – Over Tension Protection

A risk assessment shall be conducted to determine the need for over tension protection of single point suspension cables connected to conveyances in shafts.

Consideration should be given to the detection of the over-tension of single point suspension cage cables.

This detection device should operate before the tension applied to the cable exceeds the safe working load/strain of the cable.

Where the device incorporates a shear pin a secondary means of support to prevent the cable falling into the shaft shall be installed.

The shear pin should be monitored and an alarm activated when the shear pin operates.

2.5.32 Slack Rope Protection

For all winder types a safety device shall be installed to ensure that in the event of slack rope being detected the EUC (conveyance) shall stop.

2.5.32.1 Drift Winders

In the case of drift winders the slack rope control system shall prevent no more than a calculated value of two metres of slack rope being developed at any point throughout the length of travel following the operation of the quick stop function.

In the event of the occurrence of a slack rope condition and the winder is brought to a stop; the winder control system design shall only permit the winder to be driven in the outbye direction, while the slack in the rope is taken up.

Where the conveyance dump brakes have operated procedures must be developed to specifically address the dangers arising out of energising the Dump Brake system in order to lift the dump brakes clear of the track; an engineering solution shall be addressed to prevent the dump brakes being energised whilst ever the slack rope condition exists.

Note: Due to the 'Procedural' aspects of this activity special attention shall be directed toward competency of operators in controlling the outbye direction of the winder to remove slack rope. Particular attention shall be paid to this activity in the risk assessment in relation to isolation and access as the operator will need to inspect the rails and rope for possible causes of the slack rope condition.

2.5.32.2 Shaft Winder

The slack rope device shall detect the occurrence of a slack rope condition in the event of a 'hang up' in the shaft by the cage, tub or counterweight and in the case of shaft sinking winders the tub, kibble, cage and staging (where applicable).

The slack rope detection device is usually attached to a rope immediately above the EUC (conveyance).

Where winders are manually operated, and where automatic winders are placed in the manual mode, the initiation of the emergency braking system following the detection of a slack rope condition shall be independent to that of the winder operator.

An engineering solution and associated procedures shall be addressed to minimise the occurrence of a slack rope condition with particular reference to the nature and type of devices and procedures employed to remove slack in the rope.

Due to the 'Procedural' aspects of this activity special attention shall be directed toward competency of operators in controlling the direction of the winder to remove slack rope. Particular attention shall be paid to this activity in the risk assessment in relation to isolation and access as personnel will need to inspect the shaft, cage, tub kibble or counterweight for possible causes of the slack rope condition and for possible damage to the EUC (cage), fixed guides or rope guides.

Note:

2.5.33 Tail Rope Protection (Friction – Koepe Winders)

A safety device shall ensure that in the event of entanglement or twisting of tail ropes being detected in a shaft winding system the EUC shall stop by operation of the primary safety circuit.

2.5.34 Warning Devices

**Pre-start
Warning**

To ensure the safe operation of the conveyance and equipment transported into and out of the mine all EUC control systems shall be fitted with pre-start warning alarms.

These alarms shall be sounded before any movement of the conveyance.

The alarm shall operate for sufficient time to allow persons to avoid any danger.

The length of time shall be determined by risk assessment and will need to consider all possible scenarios of operation of the winding system.

These alarms shall be located in the winder house, at all points within the drift or shaft where routine work is carried out, and where persons embark or disembark from the conveyance.

An alarm shall also sound from the conveyance before any movement of the conveyance.

Where more than one powered winding systems are installed adjacently in a single shaft or drift pre-start warning alarms shall be of a different colour and tone respectively.

2.5.35 Winder Controls

Winder controls located at shaft or drift entry points shall be positioned in such a manner as to prevent operation from within the conveyance.

For all winder types, where personnel have entered the conveyance, the winder control system shall be designed in such a manner so as to only permit operation of the winder from within the conveyance and only when shaft entry and conveyance door/gates are closed, locked and proven locked, and where plat gates/doors are fitted, the plat gates/doors are raised or disengaged and locked and proven locked.

For all shaft winder types, personnel within the conveyance cannot open the conveyance door gates, unless the conveyance is located at the surface, pit bottom or at a shaft entry point and in addition, where plat gates/doors are fitted, the plat gates/doors are secured, positioned and locked.

The interlocking of shaft entry gates/doors, conveyance gates/doors and plat gates/doors shall be designed to operate independently to that of any winder operator so that the conveyance cannot be moved unless shaft entry and conveyance door/gates are closed, locked and proven locked, and where plat gates/doors are fitted, the plat gates/doors are raised or disengaged, locked and proven locked.

2.5.36 Winder Drum Pit Protection

It is recommended that any winder drum, and associated brake paths, is not housed in a pit or sump. However, any pit required to house the winding drum and brake paths shall be adequately drained and protected with a monitoring device. This device shall operate before the brake path (disk) becomes contaminated. It is customary to provide separate alarm and trip functions.

2.5.37 Winder Sump Protection

Any blind or un-drained shaft sump below collar level that is required to house the winder tail ropes and guides/guide ropes shall be protected with a monitoring device to detect falling material and rising water that may cause damage to any winder mechanical or electrical equipment. This device shall operate before the components become contaminated. It is customary to provide for both alarm and trip functions.

2.5.38 Winder Guide Rope Tension Protection – Counterweights

Where winder guide ropes are tensioned by counterweights and there is a possibility of build up of material under the counterweights, a protective device shall be installed to stop the winder before the occurrence of unacceptable loss of tension of the guide rope.

3. Powered winding system safety related devices – Specific Requirements – Prescriptive compliance approach

This prescriptive approach requires full compliance with this chapter. Where it is not possible to apply any element of the prescriptive requirements, then an alternative engineering control shall be implemented using a functional safety approach.

This chapter lists the minimum specific safety devices required for each winder type and system.

The list is not exhaustive, as additional protective devices and systems may be required depending on each specific winder design.

3.1 Ultimate Safety Circuit Elements

3.1.1 Ultimate Safety Circuits for ALL Types of Winders

3.1.1.1 **Ultimate over travel limit device** shall be located within the headframe in respect to vertical shaft winders and at the end of the gantry in respect to drift winders.

3.1.1.2 **Ultimate under travel limit device** shall be located at the shaft and drift bottoms respectively.

Note: Friction winders may have an ultimate over travel limit in the headframe for one conveyance and may have an ultimate under travel limit in the headframe for the opposite conveyance or counterweight in lieu of locating the under travel device at the shaft bottom.

3.1.1.3 **Ultimate over travel limit 'back up' device** shall be driven by the winder drum, duplicating the physical ultimate over travel limit located at the shaft headframe or drift gantry.

3.1.1.4 **Ultimate under travel limit 'back up' device** shall be driven by the winder drum, duplicating the physical ultimate under travel limit located at the shaft or drift bottom respectively.

3.1.1.5 **Winder Motor / motive force (hydraulic/pneumatic) over speed device** shall be installed and the over speed device set to operate at 112% of the nominal speed of the winder.

3.1.1.6 **Failure to operate of the Primary Safety Circuit.**

3.1.1.7 **Failure of electric, hydraulic or pneumatic power source.**

3.1.2 Ultimate Safety Circuit Elements – Additional Requirements for Double Drum Winders Fitted with a Clutch

A separate ultimate over travel limit and a separate ultimate under travel limit for each conveyance, supported by duplicated limits driven by the winder drum.

3.1.3 Ultimate Safety Circuit Elements – Additional Requirements for Subsystems of Double Drum Winders without a Clutch

A separate ultimate over travel limit in the headframe for one conveyance and may have an ultimate under travel limit in the headframe for the opposite conveyance or counterweight in lieu of over travel device at the shaft bottom.

3.1.4 Ultimate Safety Circuit Elements – Additional Requirements for Shaft Sinking Winders

Shaft Sinking Winders shall have ultimate over travel limits and ultimate under travel limits for both the kibble and/or conveyance where the end of travel position varies between the two modes of transport.

3.2 Primary Safety Circuit Elements

Primary Safety Circuit Elements for ALL Winder Designs

- Brake System Protection – Application and Release
- Communication Error Check Monitoring
- Communication Failure/Loss Monitoring
- Conveyance Door/Gate Monitoring
- Data Error Check Monitoring (Watch Dog)
- Dead Man Control
- Emergency Stop Facilities
- Failure of electric, hydraulic or pneumatic power source
- Failure to operate of the Secondary Safety Circuit
- Final over travel “back up” limit
- Final Over Travel Limit Protection
- Final under travel “back up” limit
- Final Under Travel Limit Protection
- Gear Loss / Broken Shaft Protection
- High Level Drum Pit flood
- Load Sensing device
- Motor overspeed

Radio Control
RF Carrier Loss Monitoring (Carrier Detect)
Shaft / Drift obstruction Monitoring
Signal Confirmation facility
Slack Rope Device
Torque Sensing Device
Winder drum overspeed
Winder Drum Over speed Device
Winder Speed Profile Monitoring

3.2.1 Primary Safety Circuit Elements – Additional Requirements for Drift Drum Winders

EUC Conveyance – Application of Dump Brakes
EUC Conveyance brake failure detection

Note: Where it is determined that a dangerous brake failure requires immediate action, then the detection and application circuits shall be in the primary safety circuit. Where the monitored condition is not considered to present an immediate safety demand, then this monitored condition can be in the secondary safety circuit.

EUC Conveyance Derail switch
EUC Conveyance Door / Gate monitoring
EUC Conveyance Hydraulic Pressure
EUC Conveyance Motion Detection Device
EUC Conveyance Over Speed Protection
EUC Conveyance Quick Stop Facility
EUC Slack Rope Protection

3.2.2 Primary Safety Circuit Elements – Additional Requirements for ALL Shaft Winders

Door Gate Monitoring / Interlocking EUC (conveyance)

Door Gate Monitoring / Interlocking Shaft Entry

High Level Guide Rope Loss of Tension Protection. (Where guide ropes are installed and are tensioned by counterweights).

Keys / Chairing Beams Proving Device (where applicable)

Plat Gate Monitoring / Interlocking (where applicable)

3.2.3 Primary Safety Circuit Elements – Additional Requirements for Friction M&M Shaft Winders

Rope Creep Device

Tail rope Wander / Protection device

3.2.4 Primary Safety Circuit Elements – Additional Requirements for Bulk Friction Shaft Winders

Flask and tub gate/chute securing / interlocking systems

Note: For the purposes of man riding systems on bulk friction winders, flask and tub gate/chute securing / interlocking systems shall be SIL 2

Rope Creep Device

Tail Rope Wander / Protective Device

3.2.5 Primary Safety Circuit Elements – Additional Requirements for Double Drum Winders fitted with a Clutch

A double drum winder with clutch shall be provided with two separate brake systems for man riding, provided that any man transport only takes place with the drums coupled together

A separate final over wind limit and a separate final under wind limit for each conveyance.

De clutch interlocking

Single Drum De clutch Protection Device

3.2.6 Primary Safety Circuit Elements – Additional Requirements for Double Drum Winders without a Clutch

Final over wind limit protection shall be fitted in the headframe for one conveyance and a final under wind limit shall be fitted for the opposite conveyance at shaft bottom.

3.2.7 Primary Safety Circuit Elements – Additional Requirements for Shaft Sinking Winders

Brake System Protection - Application & Release, for each of the kibble / conveyance and staging winch drums

Declutch interlocking (where applicable)

Emergency Stop Facilities for each of the kibble / conveyance and staging winch drums.

Final over wind limits and final under wind limits shall be installed for both the kibble and the conveyance where the end of travel position varies between the two modes of transport.

Gear Loss/Broken Shaft Protection for each of the kibble/conveyance and staging winch drums.

Load Sensing device for each of the kibble / conveyance and staging winch drums.

Monkey Separation Limit Device for any kibble/monkey combination.

Radio Control for each of the kibble / conveyance and staging winch drums.

Signal Confirmation facility for each of the kibble / conveyance and staging winch drums.

Single Drum De clutch Protection Device (where applicable)

Slack Rope Device for each of the kibble/conveyance and staging winch drums.

Stage location proving device

Stage tilt device

Torque sensing device for each of the kibble / conveyance and staging winch drums.

Winder speed profile monitoring for both the kibble / conveyance and staging winches.

Winder drum over speed device for both the kibble / conveyance a

3.3 Secondary Safety Circuit Elements

3.3.1 General Requirements

The secondary safety circuit is designed to operate independently to that of the ultimate safety circuit (if installed) and the primary safety circuit. The secondary safety circuit is essentially provided for all other routine stopping devices located within the EUC control system. The Safety Integrity Levels of the secondary safety circuit shall be at least level one. The failure of any safety function within the secondary safety circuit shall bring the EUC to a controlled stop.

In the event that any of the devices connected into the secondary safety circuit have operated and brought the EUC to rest, the EUC control system can be operated in a manner that will allow the automatic reset of the device or devices. If the automatic reset circuit malfunctions, it shall not defeat any portion of the secondary safety circuit.

3.3.2 Secondary Safety Circuit Elements for ALL Winder Designs

Air / Hydraulic Unit Protection
Brake Wear/Lift Protection
Gearbox/Drive Condition Monitoring
High Level Drum Pit flood protection (where applicable – the drum is constructed in a 'pit', and may be prone to flooding)
Low Level Drum Pit flood Protection Alarm (where applicable)
'Normal' over wind or routine stopping position
'Normal' under wind or routine stopping position
Safe Coiling Protection
Shaft / Drift Profile Monitoring
Visual and audible signalling systems at all shaft/drift entry points
Visual and audible signalling systems within all conveyances
Winder Call Facilities (where applicable)

3.3.3 Secondary Safety Circuit Elements – Additional Requirements for M&M Friction Winders, Bulk Friction Winders, Single Rope Drum Shaft Winders, Single Rope Rack and Pinion Hoists and Double Drum Winders Fitted with or without a Clutch

Low Level Guide Rope Loss of Tension Protection Alarm (where applicable)
Winder Sump Protection

3.3.4 Secondary Safety Circuit Elements – Additional Requirements for Drift Drum Winders

Automatic Shunting Points Device
EUC (conveyance) Motion Detection Device

3.3.5 Secondary Safety Circuit Elements – Additional Requirements for Shaft Sinking Winders

Shaft Collar Interlocking: Interlocking shall be provided to ensure that when personnel are riding in the EUC (conveyance) stone tipping systems cannot be operated and the shaft collar is completely covered to prevent loose materials from falling down the shaft.

Tipping chute interlocking: Interlocking shall be provided to ensure that when personnel are to enter and ride in the EUC (conveyance) the winding engine motive force cannot operate unless tipping chutes are clear of the EUC (conveyance).

Winder Interlocking: Where there is more than one winding system used in the same shaft (e.g. staging and cage/kibble winches) effective interlocking shall be utilised and the system designed so that when one winding system is in use the other winding system cannot be used in any other alternate mode

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4. Appendices

Feedback Sheet

Your comment on this Technical Reference is essential for its review and improvement.

Please make a copy of this Feedback Sheet and send your comments to:

The Senior Inspector of Electrical Engineering
Mine Safety Operations
Industry and Investment NSW
PO Box 344
Hunter Region Mail Centre NSW 2310
Phone: (02) 4931 6641
Fax: (02) 4931 6790

How did you use (or intend to use) this Guideline?	
What did you find most useful about the Guideline?	
What did you find least useful about the Guideline?	
Do you have any suggestions to improve the Guideline?	

Thank you for completing and returning the Feedback Sheet.

I&I NSW Contact details

I&I NSW offices located in coal mining regions.

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