



**NSW  
Resources  
Regulator**

**TECHNICAL REFERENCE GUIDE**

# **POWERED WINDING SYSTEMS**

**Part 2: Drift winders**



### Document control

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# 1. Introduction

## 1.1. Scope and application

Part 2 of the *Technical reference guide: Powered winding system* series covers the specific design requirements applicable to drift winders.

**Note:** As outlined in the table below, the following parts of this series apply to drift winders:

- Part 1 – General requirements
- Part 4 – Ropes
- Part 5 – Control systems

WINDER TYPE	APPLICATION OF TRG: POWERED WINDING SYSTEMS				
	Part 1: General requirements	Part 2: Drift winders	Part 3: Vertical shaft drum and friction winders	Part 4: Ropes	Part 5: Control systems
Drift	☑	☑		☑	☑
Vertical shaft drum	☑		☑	☑	☑
Vertical shaft friction (koepe)	☑		☑	☑	☑
Shaft sinking	☑		☑	☑	☑
Emergency	☑		☑	☑	☑

Part 2 of the series is for designers, manufacturers, owners and end users with consideration to:

- designing new PWS
- verifying new PWS
- applying for design registration of PWS
- altering existing PWS
- carrying out five-yearly audits of PWS
- reviewing PWS designs after an incident
- altering, maintaining or repairing PWS.

## 1.2. Abbreviations and definitions

For the purposes of this guide, the abbreviations and definitions in *Technical reference guide: Powered winding systems – Part 1: General requirements* apply.

## 1.3. References

Refer to the Appendix for a list of Australian and International Standards noted in this series

**Note:** All Standards referred to in this series relate to the 2019 revision of the Standard, as amended from time-to-time.

## 2. Drift winders design and construction

### 2.1. General description and layout

A drift haulage is a system of shaft winding in a declined shaft or tunnel the gradient of which does not exceed 1 in 3. A drift haulage winder is a single drum winder hauling conveyances, which travels on rail tracks in an inclined shaft.

The drift haulage has a slope inclined to the horizontal. Therefore, the rope must be supported by rollers for the complete distance from the drum to drift bottom. Any horizontal curves must be equipped with both horizontal and vertical rollers to control and protect the rope.

Figures 1 – 4 below show a:

- drift haulage system layout
- drift haulage control car on top ramp
- typical drift winding room
- typical drift winder drive arrangement.

Figure 1 Drift haulage system layout

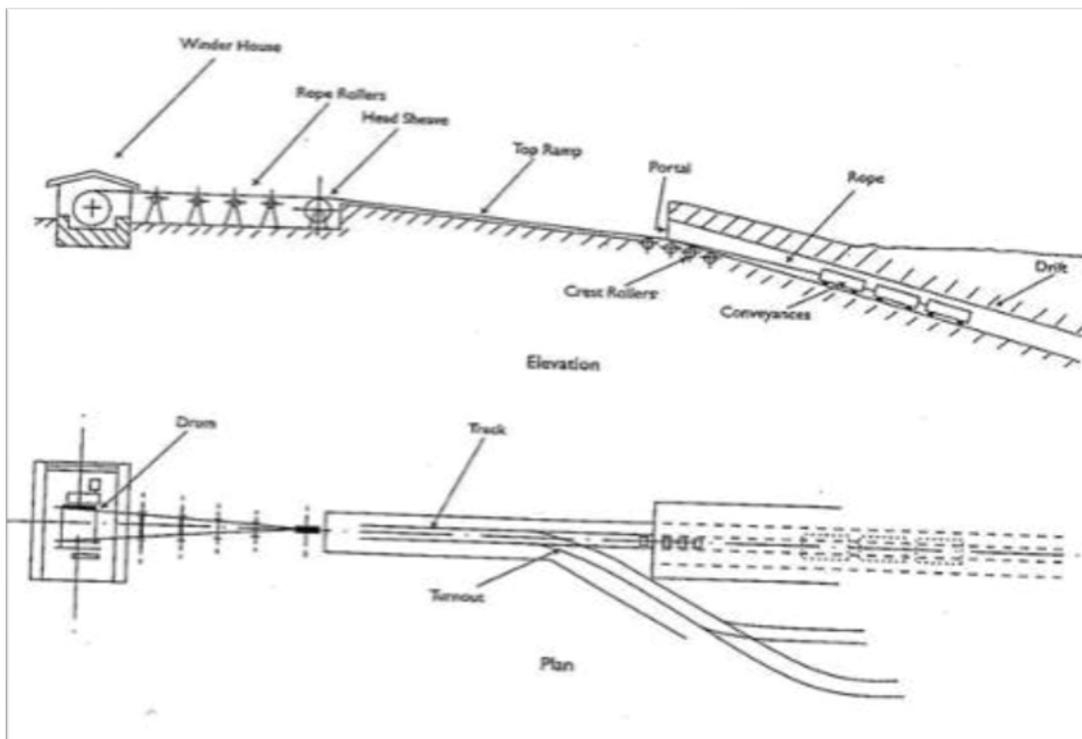


Figure 2 Drift haulage control car on top ramp

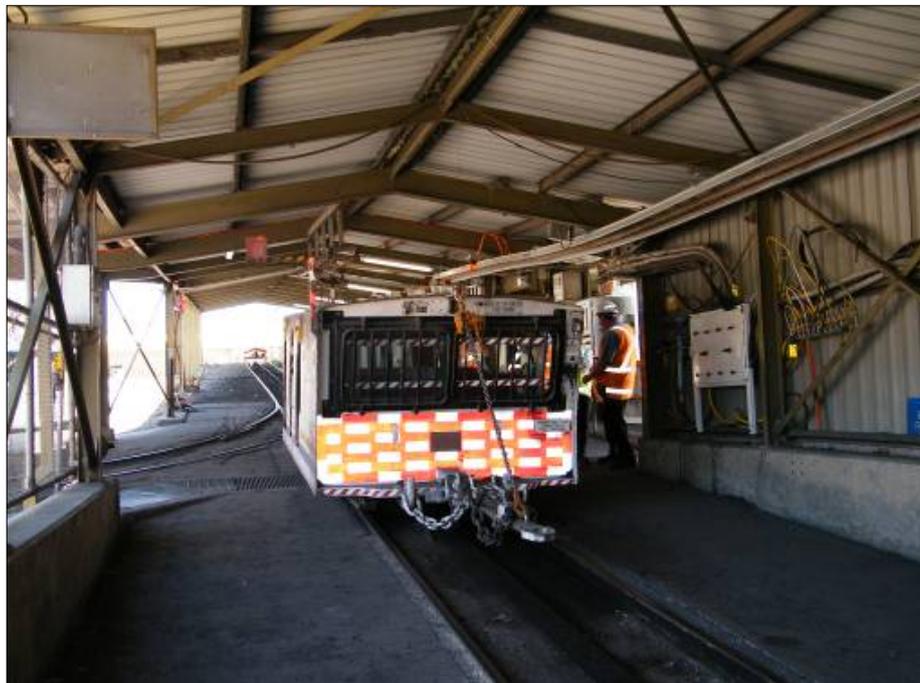


Figure 3 Typical drift winding room



Figure 4 Typical drift winder drive arrangement



### 2.1.1. General parameters

To maintain some uniformity of drift haulage parameters, the following parameters are established and generally accepted in the mining industry:

- The general drift gradient for personnel and materials winding is 1 in 3.5.
- The rail used for the drift track should be based around Australian Standard (AS) 1085.1 with the 41 kg/m rail size recommended and in common use. Fasteners, support and joint assemblies can also be referenced in the AS 1085 series of Standards (refer to the full name of these Standards in Appendix A). Other standard rail sizes and gauge may be shown considered and applied accordingly within this part of the series.
- The standard track gauge for drifts should be 1067 millimetres. This is the measurement between the inside head of the rails.
- The standard rope for drift haulage use is typically preformed triangular (flattened) strand rope of grade 1770 MPa wire.

## 2.2. Drift profiles, gradients and layout

### 2.2.1. Drift tracks and turnouts

Before beginning the final design, representations of the winder, headsheave, top ramp and turnouts must be virtually positioned in relation to the portal. The length of ramp needed and the turnout configuration must be determined by the train length and the storage or parking turnouts required.

### 2.2.2. Track tolerances

To maintain the drift track in an acceptable condition, consider using the following tolerances:

- The tolerance on the straight track rail gauge (including wear) should be -0.00 to +5 millimetres. On curves, the tolerance may be increased to +5 to +10 millimetres to prevent the possibility of derailment. The tolerances may be varied in accordance with the drift transport track braking system that is used.
- The tolerance on the rail head width should be 0.00 to -4 millimetres. (i.e. a 4 millimetres wear allowance).
- The maximum deviation in height across the track on straight sections should be 10 millimetres from the horizontal.
- The maximum allowable twist over any 5 metre length of track should be 10 millimetres.

### 2.2.3. Rail track connections

Any standard rail connection may be used. Connections are typically bolted with fishplates, however, rails may be butt welded. The track and track connections must be shown compatible to the conveyance track brake system used on the conveyances.

### 2.2.4. Rail track support

The track must be supported in the drift on hardwood, concrete or steel sleepers. On ramp sections, the track may be fastened to concrete ramps using steel sleeper plates and clips.

### 2.2.5. Rope support

The rope must be protected against rubbing on the mine floor, rib and other obstructions during its use. It might be necessary to provide rope supports and guides to provide this protection against wear and

damage in both horizontal and vertical pathways. Particular attention should be given to areas such as shunts, loading ramps, slope transitions.

The rope must be protected against rubbing on concrete or steel rail track supports (see the example in Figure 5).

*Figure 5 Drift rope guide roller*



## 2.2.6. Conveyance brake system

When selecting the rail mounting and rail connection, consider the type of conveyance brake dump system being used. The conveyance track brake system must be shown compatible and effective when working in conjunction with the rails and rail connections.

Conveyance braking systems must be used whenever persons are transported in such conveyances.

The operating environment, such as water and potential corrosion, is an essential consideration because this can affect braking efficiencies.

Limits for wear within the conveyance brakes and rails, rail alignment, operating clearances, variations in friction values and working environment must be taken into account to meet design outcomes and required deceleration rates during emergency conditions.

The designer must carry out and provide static, dynamic and testing procedures that demonstrate the system performs as intended. These tests and recommended frequencies must be provided to the end user.

Particular design attention must be given to consider the routine maintenance and testing requirements of the brake system. Particular attention should be given to top ramp walkways, rail joints, routine maintenance and test areas.

### 2.2.7. Top and bottom ramps

The slope has a top and bottom section of lesser slope than the drift proper to allow for loading/unloading of people and materials. Figure 6 shows a typical drift surface loading ramp.

*Figure 6 Typical drift surface loading ramp*



The top ramp section provides enough distance to accommodate the train, including material flat tops, the top turnout trackwork and structure, overtravel and over-run areas, including the headsheave support.

The top ramp is built from concrete or steel fabrication or a combination of both. The top ramp gradient should be within the applicable range of:

- 1 in 15 to 1 in 12 for manually operated winders, or
- 1 in 12 to 1 in 8 for automatic winders.

The steeper gradient on automatic winders is required to ensure the conveyance moves away at the same time as the winder drive operates at all times of operation. This also ensures no slack rope is provided into the PWS.

The top ramp must be fitted with the following safety devices:

- end of travel limit device, and
- end of track limit device.

**Note:** These limits are required in addition to any drum limits on the winder.

The distance from the first end of travel limit device to the end of track must be sufficient to accommodate the length of the train when the device trips the winder in an emergency stop at the maximum ramp speed.

The bottom ramp should be a section of track at the end of the bottom vertical curve. The length of the bottom ramp should be long enough to accommodate the full train length. The normal bottom ramp track gradient is 1 in 20.

The bottom ramp must be fitted with the following safety devices:

- end of travel limit device, and
- end of track limit device.

### 2.2.8. Vertical curves

Vertical curves should be as large as practical. Small curves can create rope wear problems at the top crest curve, undue crest roller wear and problems with vehicle coupler mechanisms. Track curves should be checked to ensure they can be negotiated without fouling.

The normal vertical radius should be at least 100 metres.

The top crest radius should be fitted with crest rollers spaced unequally to avoid rope vibrations.

Allow for adequate drainage of the top crest rollers to avoid contamination of the roller bearings and to prevent corrosion.

## 2.2.9. Horizontal curves

Horizontal turnout curves must be large enough to allow free movement of the vehicles onto the ramp.

The standard turnout curve is 30 metres radius.

Guide rollers and timber sleepers should be used to control and protect the rope at the turnouts.

## 2.2.10. Multiple seams

The drift haulage may be used to service multiple seams. Appropriate loading/unloading stations and control systems must be installed at each loading area.

When designing the drift and interseam turnout systems, give consideration to the control and protection of the rope. The main drift from portal to drift bottom must be straight. Avoid turns, changes in direction, or gradient changes in the drift whenever possible.

## 2.2.11. Ramps

Ramp stations must be designed considering the safety of personnel getting on or off conveyances, or loading/unloading materials from flat-tops or other transporting vehicles. Factors to be considered include adequate grade, surface treatment, adequate clearance for unloading, lighting, safety signs, buffers and loading facilities.

## 2.3. Drift haulage control systems

Special attention must be given to the design of devices required for the safe control of drift haulages.

The safety devices required to safely operate and control the drift haulage system must be designed and incorporated into the electrical control system.

The requirements and guidance for the electric/electronic equipment used to control winders is detailed in *TRG: Powered winding systems – Part 5: Control systems*.

## 2.4. Slope loads

### 2.4.1. Force required to move a body on an inclined plane

The elementary problem of mechanics common to all drift haulage systems is that of moving a body on an inclined plane. Figures 7-8 show vector forces involving this body on an incline:

Figure 7 Vector forces involving a body travelling upward on an incline

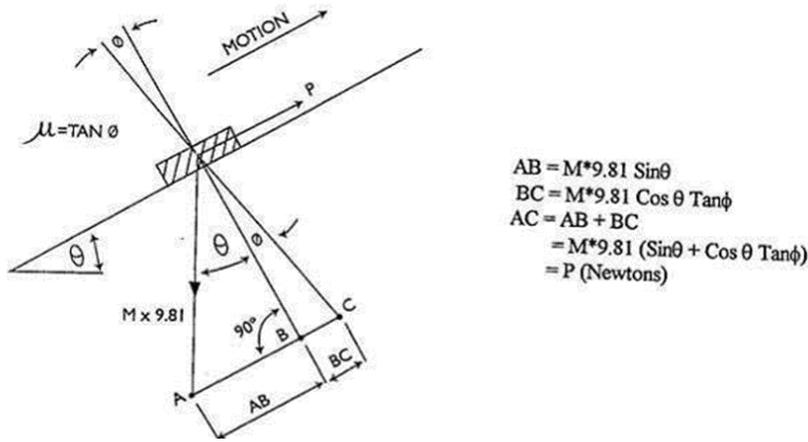
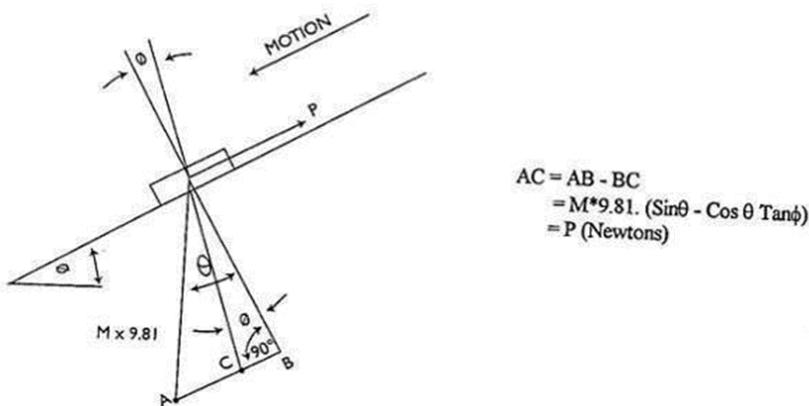


Figure 8 Vector forces involving a body downward on an incline



### 2.4.2. Motion up the plane (drift)

Suppose that a body of mass M (kilograms) rests on a plane inclined at an angle  $\theta$  to the horizontal, and that when the plane is tilted through a certain small angle  $\phi$  from the horizontal, the body just begins to slide down the plane. In other words, the coefficient of friction  $\mu = \text{Tan } \phi$ . For conveyances and rolling stock with track in good order, the angle  $\phi$  varies between 2.5 and 3.5 degrees.

When the body is moved up the inclined plane by a force P applied parallel to the plane we have from Figure 7 (refer clause 2.4.1 'Force required to move a body on an inclined plane'):

$$P = M * 9.81 (\text{Sin } \theta + \text{Cos } \theta \text{ Tan } \phi) \text{ (Newtons)}$$

### 2.4.3. Motion down the plane (drift)

Similarly, to prevent a body of mass M (kilograms) sliding down a plane (see Figure 8 above in clause 2.4.1 'Force required to move a body on an inclined plane') the hold back force applied parallel to the plane:

$$P = M * 9.81 (\sin \theta - \cos \theta \tan \phi) \text{ (Newtons)}$$

### 2.4.4. Static force on the drift

When calculating static factors of safety for rope or components used on conveyances, or for static brake capacity calculations, the frictional component is deleted in the plane equation and the static force to hold the mass M (kilograms) becomes:

$$P_{\text{static}} = M * 9.81 * \sin \theta \text{ (Newtons)}$$

### 2.4.5. Static rope force in the drift

Similarly, the static force for the rope may be calculated and should be added to the static 'end of rope' load mass for factor of safety calculations. The worst position of the load should be considered, i.e. near the drift bottom on the maximum slope. Therefore for drum brake static capacity calculations, the loads must include both the 'end of rope' loads and the rope slope loads.

### 2.4.6. Downward slope conveyance acceleration rates

In general, downhill or down grade conveyance accelerations will be governed by the ramp and drift slope and the various frictions in the system. For fully automatic haulage systems, where no persons are present, the ramp slope and mass of the control car are critical in getting the conveyance to accelerate on its own from a stop position on the ramp. Calculations should be provided to show that conveyances can accelerate on their own accord when and as required by the system operation.

Typically, a manually operated haulage system with minimum conveyance mass of 7 tonnes requires a ramp slope of at least 1 in 15 to provide this condition.

For automatic haulage systems with control car weight less than 10 tonne end of rope load, a top ramp slope of at least 1 in 10 is required.

For automatic haulage systems with control car weight greater than 10 tonne end of rope load, a ramp slope of at least 1 in 12 is required.

For design calculations use grade acceleration rates in the order of 0.5 to 0.75 metres/sec<sup>2</sup>.

MODE	WEIGHT (TONNE)	GRADE (MINIMUM)
Manual	>7	1:15 (3.8 deg)
Automatic	<10	1:10 (5.7 deg)
Automatic	>10	1:12 (4.8 deg)

## 2.5. Winding speeds and accelerations

The safe speed for drift winders depends largely on the condition of the rail track. Contemporary drift haulages are located in drifts with a drift slope of about 1 in 3.5. Steeper slopes and unsuitable brakes on transport conveyances have created problems stopping the conveyances in runaway incidents.

Drift haulage speeds suitable for a well-maintained track are three to four metres/second for personnel riding, and up to two metres/second for heavy materials winding.

Accelerations and decelerations for drift winders must be no more than 0.75 metres/sec<sup>2</sup> on the drift, and no more than 0.5 metres/sec<sup>2</sup> on the turnout.

## 2.6. Rollers

### 2.6.1. Rope rollers

To support the rope in the drift, suitable rope rollers must be provided. The rollers must only support the rope mass and should not be subjected to any rope tension from the end of rope mass.

The rope rollers can be supplied commercially and are mounted in the drift at intervals of from 4 to 7 metres depending on the rope mass and speed.

Roller spacing's should be staggered Stagger to help prevent rope vibrations from the rope pitch.

Where turnouts are located in the drift, suitable wooden sleepers or rope rollers or a combination of both must be used to protect the rope from abrasive wear as the rope crosses the rails and to prevent it making contact with the rib. The rope working environment must prevent the ropes from rubbing on anything abrasive or that may contaminate it including stone, coal, steel and concrete.

The rope rollers support the rope from the drum to the headsheave. These rollers will vary in width from the widest roller near the drum, to the narrowest roller near the headsheave. The distance between the rollers will depend largely on the mass of the rope.

The distance from the drum to the headsheave will generally be about 40 metres. The fleet angle of 1.5 degrees should not be exceeded.

The distance between rollers must not allow the natural frequency of oscillation to cause vibration and resonance to the rope. The centre-to-centre distance of the rollers should be varied to avoid this.

The distance between rollers anywhere in the system should be such as to ensure that the angle of bending over the sheave by the rope is less than 4 degrees. Larger angles will constitute a severe bend.

Rollers should be positioned at least 10 millimetres below the straight line from headsheave to drum.

The roller should have rope flanges to contain the rope and an outer polyurethane sleeve that protects the rope.

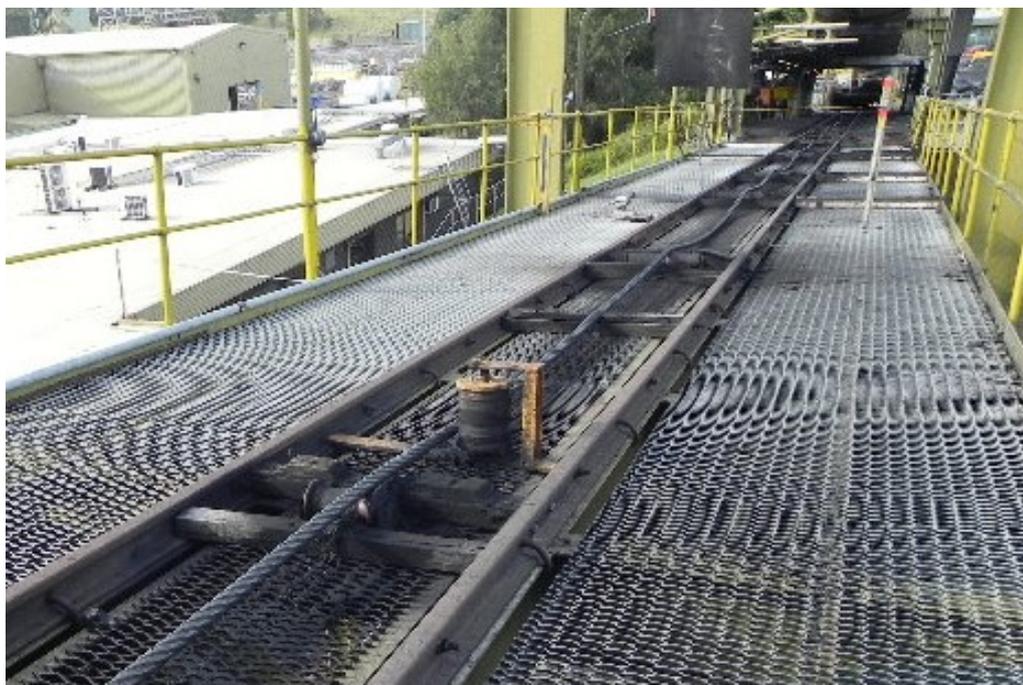
*Figure 9 Typical drift support and guiding rope rollers*



*Figure 10 Drift haulage gantry rope rollers*



*Figure 11 Drift haulage gantry support and guide rope rollers*



## 2.6.2. Crest rollers

The rope is supported and controlled at the top vertical curve at the portal by crest rollers. The crest rollers are subjected to the full rope tension forces and should be designed for fatigue life and to rope break tension plus 20%.

Crest roller spacing will be governed by rope tensions. Spacing should be checked to ensure vibrations are not induced by the rope natural frequencies.

Crest roller spacings should be staggered to avoid vibrations that could be caused by the rope pitch.

*Figure 12 Drift rope haulage crest rollers*



## 2.7. Headsheave supports and ramp structure

Headsheave support structures must be designed to resist the maximum rope break tensions plus 20% without failure. For this condition, failure means 'no longer able to support the winder working loads and subsequently may present a risk to persons'.

Figure 13 Drift winder headsheave



## 2.8. Foundation

### 2.8.1. Winder house and headsheave foundations

Winding house and headsheave foundations must be designed for rope break tension plus 20% before failure. For this condition, failure means 'no longer able to support the winder working loads'.

### 2.8.2. Foundation design

Foundation design for winder drums, associated machinery, headframes and headsheave supports, and rope roller supports including crest and side guide or turnout roller support structures must be undertaken, and/or checked by a competent civil design engineer.

A complete set of foundation calculations and drawings, certified by a person accredited to do so, should be provided in the plant safety file.

The foundation design must be carried out to the relevant Australian Standard civil and structural codes.

### 2.8.3. Foundation bolts

All foundations must use multiple foundation bolts to transmit loads to mass concrete.

Bolt calculations for both fatigue loadings and rope break or strength loadings must be included in the foundation calculations.

Bolt tightening torques must be included in the calculations. Foundation design should consider maximum bolt loadings transmitted to the mass concrete by bolt tightening to a maximum torque of  $0.65 \times$  proof stress of bolt material.

## 2.9. Control, personnel cars, flat tops and material transport conveyances

The design of conveyances used in drifts with a gradient not exceeding 1 in 3 must comply with AS/NZS 3785.8. This Standard is applicable to all conveyances including control, personnel cars, flat tops and other material transport conveyances.

*Figure 14 Typical control and personnel car*



### 2.9.1. Control cars

The control car is the car that is permanently attached to the end of haulage rope. For manually operated winders, this car is fitted with all control equipment needed to safely control the normal functions of the haulage, for transporting personnel and materials in the drift.

The control car must have sufficient mass to enable it to accelerate from rest on the top ramp without the winder tripping out on the slack rope limits.

For automatic winders the control car must be fitted with a derail device that will signal the winder to apply the emergency brakes if the control car derails.

Hydraulic pumps needed to charge the car braking system should be accessible to allow pumping from a position that will not cause injury if the car moves during the pumping up operation. The car dump valve should be readily accessible in case it is needed during the operation.

### 2.9.2. Personnel cars

Personnel cars are attached to the control car to form a train (see figure 15). Capacities of cars and train length are a function of the production and safety considerations for mine workers, together with the working environment and respective limitations for loading and unloading. 40 person personnel cars are common in a larger mining operation.

The personnel car hydraulic pump up system should be designed to have individual car system oil returned to a tank in each car.

Hydraulic pumps required to charge the car braking system should be accessible to allow pumping from a position that will not cause injury if the car moves during the pumping up operation. The car dump valve should be readily accessible in case it is needed during the operation.

Individual personnel cars should be capable of being pumped up without the oil transferring to other cars.

Figure 15 Drift haulage control and personnel cars (personnel transport system)



### 2.9.3. General: Control and personnel cars

The following applies to both control car and personnel cars:

- Cars should be designed for the following track parameters:
  - minimum vertical curve 30 metre radii
  - minimum horizontal curve 25 metre radii
  - minimum length of straight between curves of opposite hand 1370 millimetres.
- The wheelbase should not be less than 36% of the body length.
- The end throw of the car body on the sharpest curve should not exceed 100 millimetres.
- The suspension should be able to cater for a maximum local rail depression of 50 millimetres at any single wheel without the tread of any wheel leaving the rail.
- The design must allow for a car, fully loaded at one end, overhanging one axle, and empty elsewhere, to transmit to the rails at the remaining axle or bogie, a vertical static force of not less than 25% of the tare weight of the car.

- The design must allow for the car, fully loaded down one side only, overhanging the two wheels (or four bogie wheels), to transmit to the rails at the opposite side of the car, a vertical static force of not less than 25% of the tare weight of the car.
- The design must be based on a passenger mass of 120 kilograms.
- The height of the centreline of the coupling from the level rail when unladen should be 300 millimetres.
- Structural design must be as required by AS/NZS 3785.8.
- The main load-bearing members, or chassis, of cars must have sufficient tensile strength (UTS) to resist a design rope break load (rope break  $\times$  1.2).
- The main load bearing members, or chassis, must be capable of withstanding a compressive load of 100 kN without permanent deformation.
- Safety hooks and chains must be fitted to all cars as required by AS/NZS 3785.8.
- The transverse centre distance between the safety chain hooks should be between 750 millimetres and 1067 millimetres.
- All conveyances, inclusive of any track braking systems, must be shown to be compatible with the drift and rail profiles and curvatures.

#### 2.9.4. Personnel riding conveyance brakes

Each personnel riding car must be fitted with a track brake system as required by AS/NZS 3785.8.

For single axle cars using pad type dump brakes, the brake shoes should be secured to the underside of the frame of the car immediately adjacent to each wheel and outside the wheel base.

For cars with bogie systems using pad type dump brakes, the brake shoes should be mounted on the bogie centre line between the bogie wheels.

All track brake systems must be constructed so that when operating, all brakes must contact the rail to independently carry the load (e.g. no brake will lift off the rails due to rail misalignment, weight transfer etc.).

In addition to the requirements of AS/NZS 3785.8, the personnel cars must be equipped with:

- a manually operated pump for generating the required operating pressure for the braking system
- a pressure relief valve set to the required operating pressure for the braking system

- a pressure gauge, in visual range of manual car operation, marked with the normal working pressure declared by the manufacturer of the system
- a manually operated valve to apply the brakes, in an emergency, on each car and to any other car to which they are connected
- an overspeed device in the control car and driven from the rail wheels, to apply the brakes, in the event of overspeed in either direction, within the application times given in AS/NZS 3785.8. The overspeed device must be capable of being tested up to the maximum nominated speed plus 15% with the car stationary. The speed of the overspeed trip required to apply the brakes must be specified by the designer.
- the hydraulic fluid used in any system should be suitable for the operating requirements of the system. Ambient temperatures, operating pressures and seals, and fire risks should be considered.

### 2.9.5. Conveyance brakes performance testing

The rail track brakes on any personnel carrying car must, in the case of an emergency, stop the conveyance, or train, at not less than  $0.5 \text{ m/s}^2$  as required by AS/NZS 3785.8. The track brake system must be designed to allow accessibility for testing, examination and maintenance.

**Note:** Recommended range for safe deceleration rates for persons are noted as between  $1 \text{ m/s}^2$  and  $5 \text{ m/s}^2$  and further detailed in Part 1 'General requirements' of this series.

Performance testing of the emergency brake system such as dump brakes or similar design, where it is shown that the brakes will act on the rails on which they are operating to stop the car within the decelerations rates required by AS/NZS 3785.8 should be carried out at least every 12 months.

Record of performance tests should be maintained in the plant safety file. The records should be available at all times. Such records must include the state of the rails on which performance testing was undertaken. For example, the rails may be wet, dry, sunken, straight. Such record should be objective, accurate and factual.

The designer must nominate minimum performance outcomes relating to the conveyance brake system. The designer must nominate all necessary controls to ensure the operator maintains this Standard. This includes all necessary life cycle maintenance schedules such as tests and checks including wear limits of rails and other components as may be necessary to ensure design operation is achieved.

## 2.10. Flat-tops and materials transporters

The drift haulage system may be used to transport materials between the surface and seams. This involves using flat-tops of various designs to carry materials such as rubber-tyred vehicles, mining equipment and supplies. For automatic haulages, generally the flat-top is coupled directly to the control car. The flat-top may be attached directly to the end of the rope socket for high payload applications, which would otherwise exceed the maximum winder capacity if attached to the control car.

Flat top design, including couplings, safety chains, and structural design, must comply with AS/NZS 3785.8.

The flat-top body strength members or chassis must be designed to resist the tensile force equivalent to the design rope break force. If the design includes cover plates for decking and underframes in the strength calculation, an adequate corrosion allowance must be provided.

The flat-top body or chassis must be designed to resist a minimum compressive force of 100 kN without permanent deformation.

Every flat-top must be fitted with safety chains. The transverse centre distance between the safety chain hooks should be 750 millimetres to 1076 millimetres and generally match the centre distance on the control car.

The design must also consider the following:

- flat-top function and overall dimensions required by the end user
- negotiation and required operating clearances for both vertical and horizontal curves encountered at the mine site under both full and empty load conditions
- sufficient inspection covers to fully inspect bogies, axles, wheels and pins to inspect and maintain the flat-top
- sufficient and rated load tie-down points to fully secure the load under maximum emergency winder brake conditions must be provided. Where special purpose vehicles are used, the tie-down points must be in positions that will fully support the load under all conditions.

**Note:** This note applies only to drift winders:

Formal risk assessment and associated written control procedures should be in place if a mine requires the removal of the control car to transport materials directly from the end of the rope. Special attention is drawn to the potential of stored rope torque energy prior disconnect of the conveyance, together with any personal communication systems that may be required to ensure the load is being safely transported at all times in the drift.

*Figure 16 Example of drift haulage control car and flat top (materials transport system)*



## Appendix

### Standards referenced in this series

#### Relevant Australian Standards

AS 1065	AS 1065 Non-destructive testing - Ultrasonic testing of carbon and low alloy steel forgings
AS 1085.1	AS 1085.1 Railway track material – Steel rails
AS 1085.2	AS 1085.2 Railway track material - Fishplates
AS 1085.3	AS 1085.3 Railway track material - Sleeper plates
AS 1085.4	AS 1085.4 Railway track material - Fishbolts and nuts
AS 1085.7	AS 1085.7 Railway track material - Spring washers
AS 1085.8	AS 1085.8 Railway track material - Dogspikes
AS 1085.10	AS 1085.10 Railway track material - Rail anchors
AS 1085.12	AS 1085.12 Railway track material - Insulated joint assemblies
AS 1085.13	AS 1085.13 Railway track material - Spring fastening spikes for sleeper plates
AS 1085.14	AS 1085.14 Railway track material - Prestressed concrete sleepers
AS 1085.17	AS 1085.17 Railway track material - Steel sleepers
AS 1085.18	AS 1085.18 Railway track material - Screw spikes and threaded inserts
AS 1085.19	AS 1085.19 Railway track material - Resilient fastening assemblies
AS 1085.20	AS 1085.20 Railway track material - Welding of steel rail
AS 1085.21	AS 1085.21 Railway track material - Turnouts, switches and crossings
AS/NZS 1170.0	AS/NZS 1170.0 Structural design actions - General principles
AS 1171-1998	AS 1171 Non-destructive testing - Magnetic particle testing of ferromagnetic products, components and structures
AS 1210-2010	AS 1210 Pressure vessels

AS 1403	AS 1403 Design of rotating steel shafts
AS 1554.1	AS 1554.1 Structural steel welding –Welding of steel structures
AS/NZS 1554.4	AS/NZS 1554.4 Structural steel welding - Welding of high strength quenched and tempered steels
AS/NZS 1554.5	AS/NZS 1554.5 Structural steel welding - Welding of steel structures subject to high levels of fatigue loading
AS 1657	AS 1657 Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1670.1	AS 1670.1 Fire detection, warning, control and intercom systems - System design, installation and commissioning - Fire
AS 1710	AS 1710 Non-destructive testing - Ultrasonic testing of carbon and low alloy steel plate and universal sections - Test methods and quality classification
AS 1735.2	AS 1735.2 Lifts, escalators and moving walks - Passenger and goods lifts – Electric
AS 2574	AS 2574 Non-destructive testing - Ultrasonic testing of ferritic steel castings
AS 2671	AS 2671 Hydraulic fluid power - General requirements for systems (ISO 4413, MOD)
AS 2759	AS 2759 Steel wire rope - Use, operation and maintenance
AS 2788	AS 2788 Pneumatic fluid power - General requirements for systems (ISO 4414, MOD)
AS 3507.2	AS 3507.2 Non-destructive testing - Radiographic determination of quality of ferrous castings
AS 3569	AS 3569 Steel wire ropes - Product specification
AS 3600	AS 3600 Concrete structures

AS 3637.1	AS 3637.1 Underground mining - Winding suspension equipment - General requirements
AS 3637.2	AS 3637.2 Underground mining - Winding suspension equipment - Detaching hooks
AS 3637.3	AS 3637.3 Underground mining - Winding suspension equipment - Rope cappings
AS 3637.4	AS 3637.4 Underground mining - Winding suspension equipment - Drawbars and connecting links
AS 3637.5	AS 3637.5 Underground mining - Winding suspension equipment - Rope swivels and swivel hooks
AS 3637.6	AS 3637.6 Underground mining - Winding suspension equipment - Shackles and chains
AS 3751	AS 3751 Underground mining - Slope haulage - Couplings, drawbars, and safety chains
AS 3785.1	AS 3785.1 Underground mining - Shaft equipment - Shaft overwind safety catch system
AS 3785.2	AS 3785.2 Underground mining - Shaft equipment - Shaft winding arresting systems
AS 3785.3	AS 3785.3 Underground mining - Shaft equipment - Drum winding gripper systems
AS/NZS 3785.4	AS/NZS 3785.4 Underground mining - Shaft equipment - Conveyances for vertical shafts
AS 3785.5	AS 3785.5 Underground mining - Shaft equipment - Headframes
AS/NZS 3785.6	AS/NZS 3785.6 Underground mining - Shaft equipment - Fixed guides, rope guides and rubbing ropes for conveyances
AS 3785.7	AS 3785.7 Underground mining - Shaft equipment - Sheaves

AS/NZS 3785.8	AS/NZS 3785.8 Underground mining - Shaft equipment - Conveyances for inclined shafts
AS 3990	AS 3990 Mechanical equipment - Steelwork
AS 4024	AS 4024 safety of machinery series of standards
AS 4024.1	AS 4024.1 Series Safety of Machinery (all sub-Parts as applicable)
AS/NZS 4024.1204	Safety of machinery – Electrical equipment of machines - General requirements (IEC 60204-1:2016 (ED. 6.0) MOD)
AS 4024.1503	Safety of machinery- Safety-related parts of control systems—General principles for design’
AS 4024.1604	Safety of machinery - Design of controls, interlocks and guarding—Emergency stop—Principles for design
AS 4100	AS 4100 Steel structures
AS 4730.2	AS 4730.2 Mining - Winding equipment - Braking systems
AS/NZS 4812	AS/NZS 4812 Non-destructive examination and discard criteria for wire ropes in mine winding systems
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS 61508 Series	Functional safety of electrical/electronic/programmable electronic safety-related systems
AS 61511	AS 61511 series of standards ‘Functional safety – Safety instrumented systems for the process industry sector’
AS 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
AS/NZS ISO 9001	AS/NZS ISO 9001 Quality Management Systems - Requirements
AS ISO 31000	AS ISO 31000 Risk management - Guidelines

## International standards

ISO 286-1	ISO 286-1 : Geometrical product specifications (GPS) - ISO code system for tolerances on linear sizes - Part 1: Basis of tolerances, deviations and fits
BS 7608	BS 7608 Guide to fatigue design and assessment of steel products
ISO Guide 73	ISO Guide 73 Risk management - Vocabulary
ISO 4309	ISO 4309 Cranes - Wire ropes - Care and maintenance, inspection and discard
ISO 4413	ISO 4413 Hydraulic fluid power - General rules and safety requirements for systems and their components
ISO 4414	ISO 4414 Pneumatic fluid power - General rules and safety requirements for systems and their components
IEC 31010	IEC 31010 Ed. 2.0 (Bilingual 2009) Risk management - Risk assessment techniques
ISO 12100	ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction
Other Reference	Safe man riding in Mines parts 1A and 1B, parts 2A and 2B, being the first and second report of the National Committee for Safety of man riding in shafts and unwalkable Outlets.
SABS 0293	Condition assessment of steel wire ropes on mine winders code of practice
ASTM E1571 – 11(2016)e1	Standard Practice for Electromagnetic Examination of Ferromagnetic Steel Wire Rope