WINDIMURRA VANADIUM PTY LTD

**WINDIMURRA VANADIUM PROJECT**

# MECHANICAL BASIS OF DESIGN

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# C O N T E N T S

## 1.0 SCOPE

This Basis of Design covers the requirements for the selection, design, manufacture, supply, inspection and testing of mechanical equipment.

## 2.0 APPLICABLE DOCUMENTS

The work shall conform to the latest edition of the following documents:

### 2.1 SAA Standards and Codes

| | |
|---|---|
| AS 1065 | Non-destructive testing - Ultrasonic testing of carbon & low alloy steel forgings |
| AS 1100 | Technical Drawing Part 201 - Mechanical Drawing Indication of Surface Texture |
| AS 1110 | ISO Metric Hexagon Precision Bolts & Screws |
| AS 1111 | ISO Metric Hexagon Commercial Bolts and Screws |
| AS 1112 | ISO Metric Hexagon Nuts, including thin nuts, slotted nuts and castle nuts |
| AS 3678 | Hot-rolled structural steel plates, floor plates and slabs |
| AS 2784 | Endless Wedge Belt & V-belt Drives |
| AS 1217 | Acoustics - Determination of Sound Power Levels of Noise Sources |
| AS 4100 | Steel Structures |
| AS 1252 | High Strength Steel Bolts with Associated Nuts and Washers for Structural Engineering |
| AS 1269 | Acoustics - Hearing Conservation |
| AS 1275 | Metric Screw Threads for Fasteners |
| AS 1403 | Design of Rotating Steel Shafts |
| AS 1418 | SAA Crane Code (including hoists & winches) |
| AS 1511 | SAA High Strength Structural Bolting Code |
| AS 1532 | Short Pitch Transmission Precision Roller Chains and Chain Wheels |
| AS 1553 | Covered Electrodes for Welding |
| AS 1554 | Part 1- Welding of Steel Structures |
| AS 1627 | Part 5 - Pickling Steel Surfaces |
| AS 1654 | Limits & Fits for Engineering |
| AS 1666 | Wire Rope Slings |
| AS 1755 | Conveyors - Safety Requirements |
| AS 1796 | SAA Welder Certification Code |
| AS B8 | Methods for the Colouring and Marking of Foundry Patterns |
| AS 2938 | Gears - Spur & Helical - Guide to Specification & Rating |
| AS B66 | Worm Gearing (inch series) |
| AS 1101 | Part 3 - Welding & non-destructive examination |
| BS 4235 | Part 1 - Metric Keys and Keyways |
| AGMA 6010-F97 | Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives |

Where there is no applicable Australian Standard the appropriate ISO, British, American, German, or other approved standard shall apply, in that order.

### 2.2 Other Publications

| | |
|---|---|
| Industrial Ventilation | Published by the American Conference of Governmental Industrial Hygienists. |

## 3.0 TECHNICAL REQUIREMENTS

### 3.1 Units

SI metric units shall be used on all drawings and in calculations.

### 3.2 Materials

All materials used in the construction or assembly of equipment shall be new, non-defective and suitable for the duty.

### 3.3 Limits and Fits

Limits and fits shall be in accordance with AS 1654.

### 3.4 Tolerances

Equipment shall be manufactured to the tolerances shown on the drawings.

When tolerances are not specified the following tolerances shall apply:

| | |
|---|---|
| Machined components | $\pm$ 0.25mm |
| Small welded or cast components | $\pm$ 1.5mm |
| Large welded or cast components | $\pm$ 3.0mm |

### 3.5 Surface Finish

All machine surface finish designations shall be clearly noted on all workshop drawings and shall be in accordance with AS 1100 Part 2. The Centre-Line Average (CLA) method shall be used, with surface roughness expressed in microns.

All machining to a specific CLA value shall be verified against a roughness comparator.

Where surface finish is not defined, it shall be rough machined to CLA Value 3.2.

### 3.6 Screw Threads

Unless otherwise specified, all screw threads shall be ISO coarse pitch series in accordance with AS 1275.

Unless otherwise specified, all bolts and nuts shall conform to one of the following Australian Standards:

AS 1110
AS 1111
AS 1112

Where proprietary items of equipment are used, the Maker's standard of threads may be accepted subject to approval by the Engineer. Where machinery is specially constructed, threads, nuts and bolts shall be in accordance with Paragraph 1 of this Clause.

For normal static applications bolts shall be provided with nuts and lock washers. However, where bolted connections are subject to extreme vibration, self-locking all metal nuts shall be used and all bolts, screws, etc. which are assembled into blind holes shall be treated with a thread locking compound such as Loctite or equal prior to assembly. Alternatively, Nyloc nuts or Huck bolts and nuts may be selected for extreme vibration conditions.

Stainless steel hold down bolts and fasteners shall be used for equipment requiring frequent removal and replacement for maintenance purposes.

Clearances for fitted bolts shall be in accordance with the drawings or as otherwise stated. Wherever practicable, all holes for fitted bolts shall be reamed on assembly in the Contractor's works and the mating components including the bolts shall be match marked by metal stamping.

Taper washers shall be used wherever necessary on bolted connections.

## 3.7 Shafting

In general, shafts shall be designed in accordance with AS 1403.

Shafts made from forgings shall be ultrasonically checked prior to machining in accordance with AS 1065 and test certificates issued.

## 3.8 Keys and Keyways

Unless otherwise specified, all keys and keyways shall be in accordance with BS 4235. The grade of key material shall be clearly shown on all drawings.

## 3.9 Heat Treatment and Stress Relieving

Where heat treatment or stress relieving is specified, the procedure shall be fully described on the drawings or specification

s. Where directed by the Engineer, a certificate from an approved NATA registered testing laboratory shall be provided.

## 3.10 Castings

All castings specifically produced for the project shall conform to the following:

(i) Patterns and core boxes shall be made from best quality and well seasoned pattern making timber, adequately constructed for repetitive use. All jointing shall be by screws.

(ii) Patterns and core boxes shall be painted in accordance with AS B8.

(iii) Patterns shall be clearly marked with metal stamps showing Equipment, Part and Drawing Numbers.

(iv) Castings shall undergo fettling, cleaning and finishing in accordance with the appropriate Australian Standards. All castings shall be certified for metallurgical verification and free of porosity.

(v) Patterns will become the property of the Principal.

## 3.11 Packs and Shims

All packs shall be made up to the required thickness using the minimum number of separate pieces, with a flat surface free from indents or burrs.

All shims shall be cut from plate or cold rolled sheet free from indents or burrs. Edges shall not protrude beyond mating surfaces.

## 3.12 Welding

Unless otherwise specified, all arc welding shall be in accordance with AS 1554.

All weld symbols shall be in accordance with AS 1101 Part 3.

All welding shall conform to either GP (General Purpose) or SP (Special Purpose) categories as defined in AS 1554 PT 1. The categories shall be used for the following purposes:-

(a) GP - Minor brackets carrying light fittings, electrical cable trays, etc.

(b) SP - All other connections.

Where welding is specified or shown on the drawings as "full strength structural weld" this shall be taken to mean a weld of SP (Special Purpose) category.

Lifting lugs, alignment pads and all similar temporary attachments shall be of the same material as the parent metal and the same welding materials and procedures shall be used. All lifting lugs shall be normalised.

Where specified, welded components shall be stress relieved. No further welding will be permitted after stress relieving.

For all highly stressed welds a test sample shall be made and tested by an approved laboratory and a procedure submitted for approval. The approved procedure shall be strictly adhered to during welding.

## 3.13 Fastening

All non-structural fastening of mechanical equipment shall have the fasteners coated with approved anti-sieze compound, Kopr Kote or equivalent at final assembly.

## 3.14 Coated Flanges and Rubber Gaskets

All rubber to rubber, rubber to epoxy and rubber to metal mating flanges are to be coated with colloidal graphite or equivalent at final assembly.

# 4.0 TESTING

## 4.1 Destructive Tests

Destructive testing of samples or items shall be carried out by a NATA. registered laboratory.

## 4.2 Non-Destructive Tests

Non-destructive testing shall be carried out only by personnel approved by the Engineer.

Where visual inspection or the use of dye penetrants reveals surface cracks, ultrasonic or X-ray examination shall be used to establish the extent of the cracks.

## 4.3 Shop-run Tests

Unless otherwise specified, rotating equipment is to be shop run to ensure correctness of assembly.

# 5.0 PACKAGING AND PROTECTION

After final inspection and before delivery, all machined surfaces shall be given a coat of a suitable rust- preventative such as Shell Ensis SDC or Balm Blue Parts Coater or approved equivalent.

The mating surfaces of components permanently assembled prior to painting shall be uniformly coated with an approved rust-preventative prior to assembly. Surfaces which will be packed or shimmed shall be coated with an approved rust preventative.

To prevent brinnelling of bearings, shafts shall be blocked to relieve the bearings of load during transportation.

# 6.0 NOISE

The sound pressure level of each piece of equipment when operating under design conditions at the Site, shall be less than 85dB(A) relative to 20 micropascals when measured as set out in AS 1217 at any point where personnel may be required when the equipment is running. Measurement and control of noise shall be in accordance with AS 1269.

The $L_{eqA8}$ (Equivalent Continuous Sound Level for Eight Hours) of noise for equipment or location/installation of equipment shall be less than or equal to 85dB(A). $L_{eqA8}$ is defined in AS 1269. Where appropriate, the $L_{eq}$ value must be assessed on the basis of a twelve (12) hour shift and extrapolated to an eight hour $L_{eq}$ ($L_{eqA8}$).

# 7.0 GEARS AND GEAR TYPE SPEED REDUCERS

## 7.1.1 General Requirements

(a) General

For general requirements, reducers should be of the parallel shaft helical type. Bevel helical shaft mounted units shall be used for conveyor drives.

If approved by the Engineer, single reduction worm reducers for low power (less than 20kW) or intermittent drives may be used. This type of unit will not be permitted where inertia forces are transmitted through the unit to a brake on the high speed side. In this case, bottom worm type shall be used.

(b) Applicable Standards

Unless otherwise approved by the Engineer, all gears and gear speed reducers shall be in accordance with the applicable Australian Standards, the standards of the American Gear Manufacturer's Association or relevant DIN standards as listed in Section 2.1 of this Basis of Design.

## 7.2 Technical Requirements

(a) General

Unless otherwise approved by the Engineer, gears shall be selected for continuous 24 hour operation at full motor load.

All gears shall be capable of safely withstanding the full stalled torque of the driving motor.

The power rating of each gearbox shall be at least equal to the demand power multiplied by a nominal service factor of 1.50, and otherwise not less than the AGMA values for the various load classifications and service duration. Gearboxes shall be capable of 6 evenly spaced starts per hour.

Thermal rating shall be based on an ambient shade temperature of 50°C.

When equivalent thermal power exceeds the natural thermal rating of the reducer, auxiliary fan cooling shall be provided, of the high speed shaft mounted type. Water cooling of lube oil is not permitted.

Where a braking torque is applied to the high speed shaft and the braking torque exceeds the motor starting torque, then the braking torque shall be used in the selection of the speed reducer.

All speed reducers shall be fitted with an identification plate which shall clearly show the following data:

- The model number
- Gear ratio
- Mechanical rating kW
- Oil type
- Oil quantity.....litres
- Mass including oil....kg

(b) Case Construction

Gear boxes shall be of cast iron or fabricated mild steel construction. The internal surfaces of the casing shall be protected against corrosion damage.

(c) Bearings

Bearings shall be of heavy duty rolling type with a minimum adjusted L10 life of 50,000 or preferably 100,000 continuous hours for the installed power of the drive train.

(d) Seals

All gear box seals shall be suitable for operation in a highly abrasive dust laden atmosphere and shall be high pressure water hose proof.

Seals of the spring lip type shall be used.

The seal shall be protected by an angular grease ring and multi-labyrinth seal.

The seals shall be of the split type.

(e) Shaft Extensions

Unless otherwise specified all helical speed reducers shall be supplied with both input and output shaft extensions. These shaft extensions shall be identical to the standard shafts and shall be fitted with steel covers. Similarly, shaft mounted reducers shall be dual handed and be fitted with 'Stuwe' shrink discs or an equivalent approved by the Engineer on the output side.

(f) Lubrication

'Splash' lubrication is preferred to forced lubrication.

Where pressurised lubrication is required, a low pressure cut out switch suitable for the operating pressure range and a pressure gauge with isolation valve shall be provided.

Oil filters shall be of the canister type mounted in pairs to facilitate filter replacement.

Unless otherwise approved by the Engineer, all gear housings shall include the following fittings, which shall be located in easily accessible positions:

(i) A dust tight dip stick, clearly marked with the maximum and minimum oil levels.

(ii) A replaceable element filtered breather of adequate capacity and suitable for operation in a dust laden atmosphere. This filter shall be set on a vertical standpipe 75mm high.

(iii) An oil drain point of 20mm minimum diameter with a 20mm minimum diameter gate valve and blanked tee piece.

(iv) A magnetic sump plug.

(v) An oil inlet fitted with a 20mm minimum diameter standard screwed plug.

(g) Cooling Fans

Fans may be mounted on the high speed shaft of speed reducers to assist with the thermal rating. Fans shall be adequately guarded and shielded from falling material. If a fan is located between the reducer housing and the input coupling then the fan and its safety guard shall be of split construction.

### 7.3 Installation

To maintain correct oil level, gear boxes shall be mounted horizontally. For special applications where horizontal mounting is not practical, details of internal lubrication shall be subject to the approval of the Engineer.

All units shall be mounted on machined base plates which shall be integral with the motor base and with not less than 1.5mm of removable shims. Adjusting screws shall be provided to facilitate longitudinal and transverse alignment.

The size of the adjusting bolt shall be adequate for the intended duty. The same size of bolt shall be used for motor alignment.

Non shaft mounted units shall be connected to driven and driving shafts with flexible couplings in accordance with Section 8.0 of this Basis of Design.

Where vapour phase inhibitors are used they shall be removed prior to filling the gearbox.

## 8.0 MECHANICAL COUPLINGS

### 8.1 General Requirements

Couplings shall generally be radially and angularly flexible.

For general applications, couplings fitted to speed reducers shall be of the Flender N-EUPEX type, or equivalent approved by the Engineer for both high and low speed shafts.

### 8.2 Technical Requirements

(a) General

Couplings shall be selected in accordance with the Manufacturer's recommendations, with a minimum service factor of 1.5 based on the full rated motor power or, if greater, the braking torque.

Couplings and the method of shaft attachment used shall be designed to safely withstand the full stalled torque of the driving motor.

The component parts of couplings of the same type and size shall be fully interchangeable.

Where brake discs are fitted to high speed couplings they shall be fitted to the speed reducer side of the coupling.

(b) Construction

Couplings shall be suitable for operation in a highly abrasive dust laden atmosphere and shall be high pressure waterproof.

(c) Shaft Attachment

All coupling bores shall be machined concentric with the coupling body.

Unless otherwise specified, couplings shall be attached to their shafts using a light interference fit equal to H7 p6 as defined in AS 1654, and a British Standard rectangular parallel key.

For special applications and where specifically approved by the Engineer in writing, the use of locking ring assemblies or tapered shafts and the SKF oil injection method of attachment may be used.

(d) Guards

All couplings shall be fitted with guards which shall be in accordance with the Section 2.10 of this Basis of Design and with Standard Drawings.

Where practical, guards shall be hinged to provide quick access to the couplings.

(e) Alignment

All couplings shall be aligned in accordance with the Manufacturer's recommendations.

To ensure maximum coupling life every effort shall be made to minimise coupling alignment errors. Unless otherwise specified, couplings shall be aligned such that the radial and angular errors measured at the coupling periphery do not exceed the Manufacturer's recommendations or the following value for $\Sigma$

$\Sigma$ = 0.0005 x shaft diameter
e.g. 200mm shaft permissible error = 0.1mm;

# 9.0 BELT DRIVES

## 9.1 Service Factors

Service factors shall be in accordance with the Manufacturer's recommendations with due regard to drive duty, minimum pulley diameter and belt speed.

## 9.2 Drive Ratio

For general application the maximum ratio shall be 3:1. For pump drives the maximum drive ratio shall be 2:1. Drive ratios shall be such that standard stock pulleys are used wherever possible.

## 9.3 Minimum Pulley Diameter

Minimum pulley diameter shall be in accordance with the belt manufacturer's recommendations.

### 9.4 Wheel Attachment

All belt pulleys shall be attached to their shafts with Taper-Lock bushes or equal and British Standard parallel keys.

### 9.5 Take-Up

All belt drives shall be provided with take-up adjustment. Adjusting bolts shall be robust and easily accessible.

### 9.6 Multi Belt Drives

For general application the maximum number of individual belts per drive shall be five and a minimum of two. When more than five belts are required, banded belts shall be used.

## 10.0 ROLLER CHAIN DRIVES

### 10.1 General Requirements

All roller chains and sprockets shall be of approved manufacture.

Unless otherwise approved by the Engineer, all roller chains and sprockets shall conform to AS 1532.

### 10.2 Technical Requirements

(a) Service Factors

Service factors shall be in accordance with the manufacturer's recommendations with due regard to the drive duty and pinion size, but shall not be less than 1.5.

(b) Drive Ratio

For general applications the maximum drive ratio shall be 3:1, except where specifically approved by the Engineer. Drive ratios shall be such that standard stock chainwheels and sprockets are used wherever possible.

(c) Minimum Number of Teeth

For general applications, sprockets shall have not less than 19 teeth.

(d) Multi-Strand Chain

All multi-strand chain drives shall be limited to a maximum of three strands.

(e) Chain Speed

Chain drives shall not be used for direct speed reduction from an electric motor.

The maximum speed of chain drives shall be in accordance with manufacturer's recommendations, with due regard to pinion size, maximum reduction ratio, tooth hardness and the lubrication system to be used.

(f) Wheel Attachment

Chain wheels and sprockets shall be attached to their shafts with Taper-Lock bushes and British Standard parallel keys.

(g) Take-Up

All chain drives shall be provided with adequate take-up adjustment. Provision shall be made for this facility in the chain case. Adjustment screws shall be robust and easily accessible. Jockey sprockets are non-preferred.

(h) Chain Cases

All oil lubricated chain drives shall be fitted with oil tight chain cases. These shall be suitable for operation in a highly abrasive dust laden atmosphere with seals of the double washer type.

Inspection ports shall be provided at mid span for tension checks and at each wheel for checking tooth wear. These inspection ports shall be fitted with dust and high pressure water proof covers and located above the oil level.

The permissible chain sag shall be clearly marked adjacent to the central inspection port.

All chain cases shall be fitted with an oil drain plug, oil filler point and an oil level dip-stick.

All other chains shall be fitted with approved guards which shall be in accordance with the requirements of all relevant Authorities having jurisdiction.

All chain cases and guards shall be installed so that they are easily removable.

(i) Lubrication

Lubrication of chain drives shall be in accordance with manufacturer's recommendations.

## 11.0 BALL AND ROLLER BEARINGS AND HOUSINGS

### 11.1 General Requirements

All bearing housings shall be of approved manufacture and unless otherwise specified shall be of the split housing type.

For shafts up to and including 140mm diameter SSN 500 series housings shall be used. For shafts of 150mm diameter and over SD 3100 series housing with 4 bolt mounting shall be used.

In a continuous arduous work environment, e.g. conveyors, bearing housings shall be taconite seal type, as advised by the Engineer.

## 11.2 Technical Requirements

(a) For general applications, all bearings shall be of the self-aligning ball or spherical roller type mounted on adaptor sleeves in accordance with manufacturer's recommendations. Withdrawal sleeves shall be provided on bearings with shafts 200mm diameter and greater. Provision shall be made for mounting and dismounting using hydraulic nuts.

Each pair of bearings supporting a shaft shall have one fixed and one floating bearing. The fixed end shall be clearly marked on the housing.

Type W33 bearings shall be used for all spherical roller bearing applications on conveyors.

All bearings shall be selected for an adjusted L10 life of 50,000 or preferably 100,000 hours under full installed power conditions inclusive of dynamic loadings or 100,000, preferably 150,000 hours under design full load conditions, inclusive of dynamic loadings.

(b) Housings

For general applications, housings shall be manufactured from high grade cast iron.

For special applications, spheroidal graphite cast iron of grade G83 or cast steel shall be used where specified.

The base of the housing shall be machined parallel to the bore as well as the ends of the mounting foot unless otherwise specified. Elongated holes shall be provided for the mounting bolts. The top part of the mounting foot shall be spot faced to give an area large enough to allow standard plain washers to be used under the head of the mounting bolts. Lifting lugs or eye bolts shall be fitted to housings for shafts 150mm diameter and larger.

Unless otherwise specified, all housings shall be drilled and tapped 10-32 UNF-2B x 8 deep and fitted with studs for the attachment of Bruel and Kjaer Type 4370 accelerometers. Two studs shall be provided in the base of the housing, on the same and most accessible side, set approximately 45° either side of the vertical centreline. A flat, ground surface of diameter 22mm shall be provided surrounding each stud. Each stud shall protrude 2.5mm from the housing and shall be fitted with a Bruel and Kjaer test point marker.

When bearings are fitted to the dead end of a shaft, a steel blanking plate shall be provided to seal off the open end.

Housings shall be set square to the shaft such that the radial gap measured between the labyrinth seals at any two diametrically opposite points does not vary by more than 0.5mm.

For conveyor pulleys and similar uses, plummer blocks shall be mounted directly to machined mounting pads without shims unless necessary for pulley alignment. The exception is that drive pulley blocks shall be

supported on a minimum of 6mm removable shims below the mounting flange.

Spring washers shall be fitted under the mounting bolt nuts and plain washers under the bolt heads. Nuts shall be installed so that they are readily accessible.

If, for clearance reasons the nuts have to be located above the mounting foot, then a plain and a spring washer shall be used.

(c) Lubrication and Seals

Lubrication of bearings shall be in accordance with manufacturer's recommendations.

Bearing housings shall be fitted with axial labyrinth seals. Bearing housings shall be drilled 1/4" BSP in the centre of the housing. Tecalamit industrial round head steel nipples 4785/13 shall be installed except where the bearing is connected to a centralised lubrication system. Bearings shall be capable of being lubricated without removing safety guards.

For high speed shafts such as fan bearings, grease relief valves shall be fitted.

Where external cooling of bearings is required a closed circuit oil system with an air cooled radiator shall be provided and oil seals used.

Where access to bearings is limited e.g. bend and counterweight pulleys, external remote grease lines shall be fitted. The lines shall terminate at a common grease manifold and be constructed of flexible braided rubber hose.

(d) Standard Drawings

Bearings shall be installed in accordance with standard drawings.

## 12.0 PLATEWORK AND LININGS

### 12.1 General

(a) The work covered in this Basis of Design shall comply with the recommendations of the latest edition of the Australian Standard AS 4100 "Steel Structures" and all standards referred to therein.

(b) Shop Drawings

Shop drawings shall show the extent of shop fabrication, giving consideration to maximum sizes which can be transported and likely methods of erection. All chute sections shall be manufactured in one piece as shown on the design drawings.

The platework drawings shall give dimensions, details of the method of shop fabrication, assembly and member connections together with the mass of each item.

## 12.2 Materials

(a) Structural Steel

Unless otherwise specified structural steel - plate and shapes - and fasteners shall comply with AS 4100.

Steel sections shall have a minimum yield strength of 250 MPa.

Strip steel and plate shall be Grade 250 to AS 3678.

(b) Linings

(i) Linings shall be used rail, 15/3 chrome molybdenum white iron, Bisalloy, Duaplate, rubber, ceramic or epoxy, as specified on the drawings.

(ii) Chrome molybdenum liners shall comply with Standard Drawings.

(iii) Ceramic liners shall be Carborundum "Durafrax" or equal as approved by the Engineer and shall comply with Standard Drawings.

(iv) Where mild steel studs are welded to Bisalloy linings, welding procedures and testing of stud welding equipment and welded studs shall be as specified by the Engineer.

(v) Unless otherwise specified rubber linings shall be Tip Top "Remaline 35" (SST35) or equal as approved by the Engineer, cold bonded to steelwork in accordance with the following procedure and the rubber manufacturer's recommendations.

- Before abrasive blast or any other cleaning, all weld splatter shall be removed from the metal surface, all sharp edges ground down and all surfaces cleaned free of contaminants including chalked paint, dust, grease, oil, chemicals and salt.

- Oil and grease shall be solvent cleaned, loose rust or solids removed and the surface shall be washed with non-toxic detergent in water.

- The metal surface shall be abrasive cleaned to AS 1627, Part 4 - Class 2.5.

- Air used for blast cleaning shall be clean and dry with no traces of oil or moisture.

- Blast cleaning shall ensure that surfaces of joints, angles, pits and weld areas are brought to the required standard.

- After blasting, all dust and grit shall be removed from pockets and corners using compressed air, contamination of all surfaces shall be avoided and one coat of Tip Top "CN Metal Primer" or equal shall be applied to the surface to be lined.

- Bonding adhesive shall be Tip Top "SC 2000 with R F Hardener" or equal, as approved by the Engineer, applied in

accordance with the rubber manufacturer's recommendations to provide a minimum bonding peel strength of 9N/mm between metal surface and rubber lining.

(vi) Where ceramic tiles are to be bonded on top of the rubber, bonding of the tiles shall be in accordance with the following procedure and the rubber manufacturer's recommendations.:

- Tiles shall be cleaned using ICI "Genclean" cleaning solvent or equal, as approved by the Engineer and the tile surface to be bonded shall be coated with one coat of "Chemlock 205" primer or equal, as approved by the Engineer.

- The rubber lining shall be buffed, if not already prepared by the rubber manufacturer, to improve adhesion and cleaned using ICI "Genclean" or equal, as approved by the Engineer.

- Tiles shall be cold bonded to the rubber lining. Bonding adhesive shall be Tip Top "SC 2000 with RF Hardener" or equal as approved by the Engineer, applied in accordance with the manufacturer's recommendations and shall provide a minimum bonding peel strength of 5N/mm between tile and rubber lining.

- Sample bond tests shall be carried out to check correctness of procedures and bond peel strength. Tests shall be carried out using the same procedures and samples of the rubber, tiles and adhesives employed in the work so as to provide a test sample to demonstrate the effective bonding of each batch of work completed.

- After bonding of tiles, a curing time of at least 50 hours shall be allowed before tiled structures are moved, such that subsequent handling shall not cause tiles to be dislodged.

(vii) Epoxy linings shall be trowellable abrasion resistant lining Peerless "Epigen 806", or equal as approved by the Engineer.

Metal surfaces to be lined shall be precleaned and abrasive blast cleaned, prior to lining application.

The epoxy lining shall be applied using a trowel and in accordance with the lining manufacturer's recommendations, and finished to a smooth and flat surface. A sample of the finished surface shall be submitted to the Engineer for approval, before any epoxy linings are applied.

(viii) Polyurethane linings shall be trowellable abrasion resistant and have a Shore 'A' hardness of 88 plus or minus 2.

Metal surfaces to be lined shall be precleaned and abrasive blast cleaned, prior to lining application.

The polyurethane lining shall be applied using a trowel and in accordance with the manufacturer's recommendations, and finished to a smooth and flat surface. A sample of the finished surface shall be

submitted to the Engineer for approval, before any polyurethane linings are applied.

### 12.3 Design and Fabrication

(a) Design

Unless otherwise specified, detailed design of all platework shall be in accordance with AS 4100.

(b) Fabrication

Unless otherwise specified, fabrication of all platework shall be in accordance with AS 4100.

(c) Marking

All platework shall be marked before leaving the fabrication shop to facilitate identification and erection at Site.

Each section of platework shall have the following information painted on, in a conspicuous position and in letters at least 20mm high:

- order/contract number
- part number
- Engineer's drawing number

(d) Standard Drawings

Standard drawings shall be used for the design, manufacture and installation of platework and liners, where applicable.

## 13.0 HYDRAULIC SYSTEMS

### 13.1 Design Criteria

(a) Climatic

Hydraulic power equipment shall be designed for external installation. The maximum ambient shade temperature shall be taken as 50°C DB, 33°C WB. The equipment shall be high pressure water proof and suitable for operation in abrasive dusty environments.

### 13.2 Equipment Requirements

(a) Oil Reservoir

The oil reservoir capacity shall be sufficient to maintain a safe working fluid level during the operating cycle. The capacity shall not be less than four times the total pump displacement per minute.

The oil reservoir shall be provided with an air breather cartridge and container. The cartridge shall be a replaceable type.

A sight glass of durable construction shall be provided to indicate oil level. The sight glass shall be clearly marked with maximum and minimum oil levels.

Accessible oil fill and drain plugs of at least 40mm diameter shall be provided. The oil drain shall be fitted with a minimum 40mm diameter gate valve and screwed blank plug. The oil drain point shall be located such that oil may be easily drained off and collected.

Inspection covers of sufficient size to allow cleaning of the insides of the tank shall be provided. Covers shall be a bolted type.

The reservoir shall be fitted with a magnetic sump plug and a drip tray.

(b) Pumps

The hydraulic pumps shall be provided with leakage compensation provision where energy conservation can be achieved to prevent unnecessary pump operation against high circuit pressure.

Unless noted otherwise the hydraulic power pack shall be designed for continuous 24 hour per day operation. Bearings shall be designed for a calculated minimum adjusted L10 life of minimum 50,000 hours, preferably 100,000 hours.

(c) Filters

A full flow oil filter shall be provided on the low pressure return lines to the reservoir. The filter shall be of the dual change over type to protect against a blocked filter case. Indication of a blocked filter shall be provided by means of a blocked filter switch. The filters shall be capable of filtering out particles larger than 10 micron, or in accordance with the requirements of the associated equipment. Further filters shall be provided as required.

(d) Pressure Gauges

Pressure gauges shall be provided on each hydraulic power pack to indicate the hydraulic pump discharge pressure and the return pressure. Pressure gauges shall be glycerine filled and fitted with isolation valves to allow replacement.

(e) Heat Exchangers

Heat exchangers shall be selected to match the duty of the drive, considering the oil operating temperature and the ambient conditions stated. Maximum allowable oil temperature is 60°C.

(f) Labels

Oil resistant labels shall be fixed to equipment stating relief valve settings, oil grades, fill quantities and operating pressure settings.

## 13.3 Piping

Flexible lines shall be avoided where possible, except for connections where there will be relative movement between the connected components.

Hydraulic lines up to 40mm nominal bore shall be jointed using an approved flareless bit type fitting. For pipes in excess of 40mm, nominal bore full penetration welded connections shall be used. Flanges shall be provided to allow removal of lines for access and maintenance. Flanges shall be suitable for the design pressure.

Where internal scale buildup has occurred or welding has taken place, hydraulic pipes shall be acid pickled in accordance with AS 1627 Part 5 after fabrication is complete.

Nitrogen charged accumulators shall be provided where operating units are mounted remotely from the hydraulic power source and long piping runs are involved, or where hydraulic shock loads may occur.

System air bleed points shall be readily accessible and clearly indicated.

# 14.0 COMPRESSED AIR

## 14.1 General

The compressed air supply system shall be designed to provide a nominal operating pressure of 700kPa at outlet points for general service applications and instrumentation.

Provision shall be made for an oil free, dry air supply where required for instrumentation.

## 14.2 Air Compressed Units

Air compressor units shall be designed as complete systems, incorporating inter and after coolers, control units, metering equipment and receivers

Air receivers shall be designed in accordance with AS1210.

## 14.3 Drains

Automatic drains shall be provided at the low points on all piping runs for the removal of condensate.

# 15.0 LUBRICANTS AND HYDARULIC FLUIDS

## 15.1 Lubricant and Hydraulic Fluid Specification

Generally lubricants shall be selected from the following list:

| | |
|---|---|
| Mobil Delvac 1340 | Mobil Delvac 1350 |
| Mobilube HD 85W-140 | |
| Mobilgear 629 | ATF 220 |
| Mobilgear 632 | DTE 26 |
| Mobilgrease 77 | |
| Mobilplex 45 | Mobilgear 636 |
| Mobil Synthetic | SHC 626 |

Other lubricant types may be employed only with the written permission of the Engineer to suit the Principal's requirements.

Lubrication frequency shall be based on the manufacturer's recommendations.

## 16.0 LUBRICATION EQUIPMENT

### 16.1 Grease Nipples and Grease Lines

All grease nipples shall be steel industrial round head type Tecalemit catalogue no. 4785/13 or approved equal. All pressure lines to metering valves shall be galvanised steel pipe to A.P.I. 5L STD weight designation. Distribution lines to individual grease points shall be 6mm copper tubing. For applications requiring flexibility, 6mm single braided rubber hose shall be used. Hoses shall be Duffield D800-4 or an equivalent approved by the Engineer.

All grease pressure lines and distribution lines shall be suitably routed to avoid potential pinch points. All lines shall be suitably saddled with distribution lines saddled every 300mm. All grease lines shall be suitably sized for pressure drop.

### 16.2 Centralised Manual Lubrication Systems

All grease points shall be easily accessible from walkways and platforms. Small bore steel tubing shall be used if required to bring the grease point to an accessible location. Rubber hose shall be used where necessary to accommodate movement. Where there are two or more grease points on an item of equipment then individual hoses shall be used to distribute the grease from a central location. Where there are ten (10) or more individual grease points at one location a lever operated centralised grease lubrication system shall be used. Where there are less than ten (10) grease points at one location individual grease nipples shall be used, mounted on a central block.

### 16.3 Automatic Distribution Systems

If the lubrication interval is once weekly or more frequent than once weekly, then an automatic distribution system shall be provided consisting of an electric operated pump and metering devices. The pump shall be a Lincoln Centro-Matic Model 1849 or equal approved together with reservoir and gauges. Metering devices shall be Lincoln Centro-Matic Model SL.1 or equal approved. No timer is required to be supplied with the pump. The electric motor drive will normally be activated by a remote PLC system. A micro switch shall be provided and located on the pump reservoir. This shall indicate low reservoir level to a remote PLC.

All lubricating oil pumps, filters, coolers and other such equipment shall be fitted with well sloped drip trays. All lubricant drain points shall be located a minimum of 250mm above floor level.

### 16.4 Lubrication System Drawings

A detail drawing shall be provided indicating the lubrication flow diagram and piping arrangement, quantity of grease and the greasing interval required for each point. For automatic grease distribution systems the drawing shall also indicate the frequency and period of electric motor operation.

### 16.5 Testing of Systems

All lines shall be filled with grease and the system proved.

## 17.0 MECHANICAL BRAKES

### 17.1 General Requirements

All mechanical brakes shall be of approved manufacture. For general applications, brakes shall be of the disc type set by spring and released by electromagnet using a 415V AC power supply.

### 17.2 Technical Requirements

(a) Duty

The brakes shall be selected to match the application and the expected maximum number of stops per hour. In the case of belt conveyors, this shall be taken as 10 stops per hour.

The equipment shall be designed to operate in an abrasive, dust laden atmosphere with an ambient shade temperature of 50°C.

(b) Discs

All discs shall be dynamically balanced by the manufacturer. The discs shall be nodular graphite cast iron construction and incorporating cooling vents where necessary.

Each disc shall be attached to its shaft using an H7 p6 light interference fit as defined in AS1654 and a British Standard rectangular parallel key.

(c) Calipers

The action of the calipers shall be controlled by an electromagnet of the fail-safe type.

The caliper units shall be provided with a self-adjusting stroke mechanism to compensate for pad wear.

The units shall be suitable for mounting in any orientation from horizontal mounted through wall mounting to top mounting.

## 18.0 GUARDS

### 18.1 General

(a) Guards shall be designed in accordance with AS 1755 to prevent injury to persons and shall be provided at every dangerous part of all moving machinery.

Guards shall be planned into the design of the machine or machinery and shall not in themselves provide a hazard.

(b) Where machinery design necessitates moving components that may cause injury, then adequate guards shall be provided to prevent injury under all circumstances. Typical examples of equipment requiring guards include:

(i) Nip points between conveyor belt pulley and conveyor belt where such nip points are within reach of a walkway.

(ii) Shear points where two components of a machine approach each other within 90mm and the shear point is within reach of personnel.

(iii) Chutes or equipment where there is possibility of personnel falling into moving or hazardous equipment.

(c) Guards shall be provided to prevent accidental contact with nip points or shear hazards where the nip point or shear hazard exists up to a height of 2500mm above any floor, platform level or stored goods or materials. Guards shall be provided to prevent accidental contact by persons or parts of clothing being caught, e.g. between belt and pulley, chain and sprocket, cable and sheave, or drum and block.

(d) The use of exposed projecting parts such as keys, bolts and set-screw heads on rotating members shall be avoided wherever possible. Where this is not possible such projecting parts shall be provided with guards. Guards shall be provided over all exposed shaft couplings and collars.

(e) All openings to hoppers and chutes shall be suitably protected where there is danger of personnel falling into the opening. Hoppers or chutes shall be provided with access openings so that, as far as possible, any necessary cleaning or inspection may be carried out without entering the hopper or chute.

The sides of open hoppers or chutes shall be high enough to prevent material falling into working areas below and to prevent injury to personnel by contact with moving equipment parts such as conveyors. Conveyor chutes shall be designed to prevent material bouncing out.

Chute doors shall be so located that when open they do not create a hazard to personnel during normal operation of the plant.

(f) At conveyor loading, unloading, work station, transfer or discharge points, adequate safeguards in the form of guard rails, fences or close fitting guards shall be installed to prevent injury to personnel.

(g) Guards shall be provided to prevent the possibility of inadvertently stepping upon moving plant. Hand railing and toe boards shall be provided in accordance with the requirements of AS 1657.

(h) Where there is the possibility of trapping personnel between moving equipment and any fixed object, there shall be a minimum clearance of 460mm; for example, a moving tripper or a shuttle conveyor.

(i) All gravity take-ups on conveyors shall be completely enclosed with removable panels for maintenance and shall be stopped off at 230mm from ground.

(j) Safety painting of guards shall be in accordance with the Standard Specification for colour coding and colour finishes.

## 18.2 Construction

(a) Guards shall be of mesh or equivalent construction and shall be designed to prevent personnel reaching into the danger area.

Where sheet metal guards are approved, these shall be not less than 1.5mm thick.

The above requirements are not intended to exclude other methods of construction provided they meet the requirements for prevention of access.

Where a guard is so situated that a person may climb or rest upon it, such guard shall be capable of sustaining without permanent distortion, a mass of 75kg placed in any position upon it, together with a simultaneous force of 250N applied horizontally in the same or any other position.

(b) Guards shall be designed so that the distance between any nip point or shear hazard and the nearest point of access is as follows, where reach is restricted by the position of the guard to:-

| | |
|---|---|
| Arm reach | 1000mm from under arm to fingertips |
| Elbow reach | 500mm from the inside elbow to fingertips |
| Wrist reach | 280mm from wrist to top of middle finger |
| Finger reach | 150mm |
| Vertical reach | 2500mm maximum when standing on toes |

The above dimensions include an allowance made to obtain clearance from the danger areas.

(c) The size of mesh or other openings in the guard and the distance of the guard from the danger point shall be as follows:

(i) Size of mesh of opening 9mm maximum:
Working clearance only required. Wire thickness not less than 1.5mm.

(ii) Above 9mm up to 50mm square:
Guard at least 150mm from danger point. Wire thickness not less than 3.0mm.

Where complete enclosure with a guard is not provided, fence type guards shall be used and the height of the guard and the distance of the guard from the danger point shall be in accordance with AS 1755. The size of mesh or other openings shall be not greater than 9mm where the nip point is up to and including 150mm from the guard and not greater than 50mm square where the nip point is in excess of 150mm from the guard.

(d) Where removal of the guard is infrequent for inspection or maintenance purposes, it shall be fixed in position so that it cannot readily be removed without the use of tools. Preference shall be given to the use of wedge type fixings for those guards requiring frequent removal.

Where required for inspection or maintenance purposes, hinged inspection doors may be provided in the guard, hinged in such a way that there will not be a tendency for the door to be left in the open position.

Guards for driven pulleys shall have provision for tachometer access built into them.

Where inspection or cleaning covers are provided and their removal exposes dangerous parts of the conveyor which are within reach, such covers shall be clearly labelled "DANGER - Isolate drive before removing cover".

(e) Lifting handles or lugs shall be provided where required for the safe removal or opening of guards.

(f) Large guards with any dimensions in excess of 1800mm shall not be fabricated in one piece without the approval of the Engineer. Large guards shall be easily assembled in component parts that do not exceed 16kg mass. All component parts of the guard shall interlock together to form a rigid and safe assembly.

(g) Standard Drawings

Where possible guards shall comply with the requirements of Standard Drawings.

## 19.0 CRANES AND HOISTS

### 19.1 General

Cranes and hoists shall be designed in accordance with AS1418 and amendments.

Gantry types cranes shall be fitted with facilities to prevent uncontrolled travel and overturning.

### 19.2 Crane Classification

Unless otherwise approved maintenance cranes and hoists which work intermittently shall be classified as follows:

| | |
|---|---|
| Workshop cranes | Class 2 |
| Plant maintenance cranes | Class 2 |
| Manual cranes and hoists | Class 1 |

All powered motions shall have a minimum of two speeds.

## 20.0 WIRE ROPE, CHAINS AND SLINGS

### 20.1 General

All equipment which includes wire rope and/or chains under tension load shall conform with AS 1418 and AS 1666.

Wire ropes used for conveyor take-ups or pneumatic/electric winches used for tripper conveyor movements shall be galvanised. All other wire ropes shall not be galvanised.

## 21.0 DUST COLLECTION

### 21.1 Objective

The objective of all dust control measures is to protect all employees from the harmful effects of unacceptable levels of dust.

The objective is not to remove dust per se but to ensure that dust levels at the "working place" are at an acceptable standard.

In protecting employees from dust, the principal aim is to reduce the levels of dust by all practical means. When an employee must be exposed to high dust levels suitable dust masks must be worn. For short term use, the 3M 9920 face mask or equivalent is acceptable.

### 21.2 General

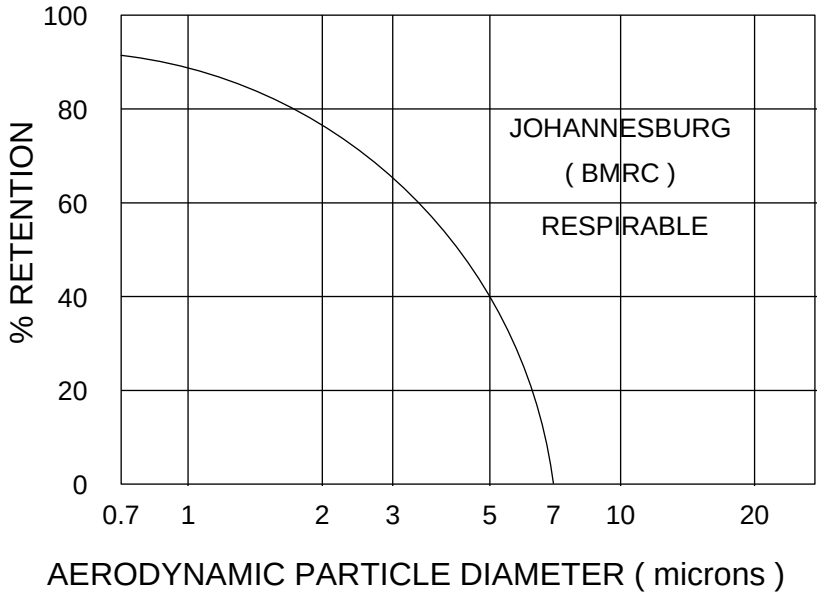
Atmospheric contaminants, for the purposes of the Mines Regulation Act, are grouped into three categories:

- Dust, Fibres and Gases or Fumes

Dust is further divided into inert or nuisance dust, and siliceous and toxic dusts. These terms are all defined in Regulation 8.10(1) of the W.A. Mines Regulations Act regulations.

Total dust loading for work places under the W.A. Mines Regulation Act regulations is presently 10mg/m3.

Respirable dust is that fraction of dust retained on the filter of a size selective sampler designed to perform generally in accordance to a standard set by the Ventilation Board of W.A. At present, this is the Johannesburg Respirable Dust Curve.




The Threshold Limit Value (TLV) for siliceous dust is 0.13mg/m3 of respirable dust. The TLV for respirable dust (nuisance) is 3.35mg/m3. This TLV is based on a 12 hour working day.

### 21.2.1 Siliceous Dust

Siliceous dust is airborne dust containing quartz material (SiO2). As the health dangers are associated with the respirable fraction of siliceous dust the sampling method is designed to collect that fraction which, for the purposes of the Act, is known as "Respirable Dust".

### 21.2.2 Inert or Nuisance Dust

Inert or nuisance dust is dust other than siliceous dust or those dusts referred to in Regulation 8.10(7). For determination of concentration, "total dust" sampling is employed, being the mass of dust retained on the filter of a non-size selective gravimetric sampler.

### 21.2.3 Toxic Dust

Toxic dusts are specifically covered in Regulation 8.10.(7) and are dusts which are harmful by virtue of their chemical composition.

## 21.3 Statutory Compliance

Dust control measures shall comply with the requirements of the Mines Regulations.

## 21.4 Dust Collection Equipment

The type of dust collector for each duty shall be specified to meet the criteria. The minimum performance shall be 90% efficiency for collection of 1 micron particle size. The Engineer will be required to approve dust collection equipment upon submission of technical data.

## 21.5 Straight Ductwork

Straight ductwork shall normally be constructed from 3mm minimum thick black steel plate and from 5mm minimum thick black steel plate for bends of 45° or less and for transitions. Ducts shall be of fully welded construction with bolted flange connections at a maximum spacing of 6m. Care shall be taken to keep the number of joints to a minimum. Bolted connections shall be made gas tight with rubber gaskets of 3mm thickness.

Horizontal runs of ductwork should be avoided. Ductwork should be run to avoid bends and to space bends at least 10x pipe diameter apart.