DEBSWANA

CONVEYOR STANDARD

DEBSWANA

3040-00000-04-5106-STD-M-011

ISSUE 01

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1. Purpose and Objectives

Significant number of High potential and fatal incidents in the mining industry has originated from conveyor systems. Identified causes and contributing factors include:

a. moving machinery,

b. exposed rotating equipment and nip points,

c. failure to isolate energy sources or stored energy

d. equipment failure, and

e. Non-adherence to operating/ maintenance procedures.

The above factors are exacerbated when operability and maintainability is not considered in the design of conveyor systems, therefore specific requirements are included.

2. Aim

To eliminate or minimise the risk of fatalities, injuries and incidents arising from the use of conveyor systems in fixed plants.

To ensure functional requirements are achieved through sound design, operating and maintenance practices.

To ensure uniformity and consistency of practice.

3. Scope

This Standard applies to a conveyor system and related equipment installed in a fixed plant for the transport of material.

Mobile and Underground Conveyors are excluded from the standard.

4. Definitions

Refer to document 3040-00000-04-5106-STD-000 for definitions.

5. Applicable Regulations and Standards

The conveyor system and the operation thereof shall conform to the following legislation and standards:

a. The Botswana Mines, Quarries, Works and Machinery Act (MQWM Act) (Chapter 44:02)

b. The Botswana Mines, Quarries, Works and Machinery Regulations

c. The Botswana Mines and Minerals Act, 1999

d. Debswana Fatal Risk Control Standards (FRCS) and Guidelines

e. Debswana equipment specific requirements/ specifications.

Reference has also been made to relevant South African legislation and national standards (SANS) where the requirements offer a greater degree of clarity or are more applicable to those contained in Botswana legislation. In particular reference has been made to The Mine Health and Safety Act 29 of 1996, The Occupational Health and Safety Act 85 of 1993 and South African National Standards.

Compliance to the regulations and standards are mandatory.

5.1 Conflicting Requirements

In the event of conflict between requirements as stated in this document and the applicable references contradict national acts, laws and regulations, the more stringent requirement shall apply.

5.2 Implementation of Requirements

Application of the Standard is mandatory at all Debswana projects and operations. This mandatory nature is indicated by the use of the word "shall" within the Standard.

In some places, the word "should" is used. This means that the primary intent remains, but specific circumstances may mean that implementation of the requirement is not reasonably practicable.

Any deviation from the requirements set forth in these Standard shall be formally approved following an exemption procedure.

The exemption procedure comprises the following steps:

a. Documented and detailed description of the implementation difficulties

b. Documented and detailed risk assessment of the situation under proposed alternative control measures

c. Documented formal approval from the Group Discipline Managers that the level of risk as a result of the alternative control measures is understood, tolerable for the organisation and in line with the Debswana vision of Zero Harm.

5.3 Statutory Requirements

The design, installation, operation and maintenance of conveyor systems shall conform to the requirements as stated in the Mines, Quarries, Works and Machinery Regulations. Attention is drawn to the following regulations, but conformance should not be limited to these:

Regulation 166. Provisions for permanent lighting: surface

Regulation 180. Remote control by electricity

Regulation 264. Gangways and runs

Regulation 265. Guard-rails for gangways, etc.

Regulation 266. Platforms, etc. to be unobstructed

Regulation 330. Standard of construction

Regulation 331. Guards

Regulation 333. Warning device before starting

Regulation 334. Emergency stop device

Regulation 335. Cleaning

Regulation 337. Walkways

Regulation 338. Crossing places

Regulation 339. Spillage from conveyors

Regulation 340. Installation

Regulation 341. Overheating

Regulation 342. Inspection of rollers and bearings

Regulation 343. Lubricants

Regulation 344. Clearing and dust

5.4 Debswana Standards and References

The following standards requirements are mandatory for the design of Conveyors:

- ISO 5048
- Conveyor Equipment Manufacturers Association (CEMA).
- SANS 948
- SANS 971
- SANS 1431
- SANS 1313
- SANS 1366
- SANS 1173
- SANS1669
- SANS 10313
- 3040-00000-04-5106-STD-M-010 Mechanical Equipment Design
- 3040-00000-04-5106-STD-M-012 Base Frames
- 3040-00000-04-5106-STD-M-013 Steel Cord Reinforced Conveyor Belting
- 3040-00000-04-5106-STD-M-014 Fabric Conveyor Belting Standard
- 3040-00000-04-5106-STD-M-015 Cold Splicing of Plied Conveyor Belting
- 3040-00000-04-5106-STD-M-016 Hot Splicing of Textile Reinforced Conveyor Belting
- 3040-00000-04-5106-STD-M-017 Splicing of Steel Cord Reinforced Conveyor Belting
- 3040-00000-04-5106-STD-M-018 Conveyor Pulleys and Shafts
- 3040-00000-04-5106-STD-M-019 Belt Conveyor Idlers and Rolls
- 3040-00000-04-5106-STD-M-020 Ropes and Sheaves for Belt Conveyors
- 3040-00000-04-5106-STD-M-021 Guarding of Conveyor System
- 3040-00000-04-5106-STD-M-030 Open Grid Flooring and Walkways
- 3040-00000-04-5106-STD-M-040 Fire Standard
- 3040-00000-04-5106-STD-S-001 Design of Steel Structures

6. Planning and Design

6.1 Conveyed material characteristics

a. For detail information on material characteristics, reference shall be made to the Process Design Criteria for each project / plant.
b. A data sheet shall be drawn up for each conveyor reflecting the assumed and applied values.
c. Surcharge angles selected for the conveyor's volumetric calculation shall take the particle size and moisture content of the applicable material into account.
d. Volumetric calculations shall be based on lowest anticipated bulk density unless a correction factor is applied in the calculations.
e. Power calculations shall be based on highest anticipated bulk density unless a correction factor is applied in the calculations.
f. The design shall be based on relevant and representative material test work.
g. Test work shall include material flow, particle size distributions, bulk density, inherent moisture, abrasiveness, surcharge angle and angle of repose as a minimum.

6.2 Conveyor Design

a. Conveyor designs shall be in accordance with the latest ISO 5048 Standard and Continuous mechanical handling equipment and guidelines prepared by Conveyor Equipment Manufacturers Association (CEMA).
b. Equipment shall be designed according to the requirements stipulated in this standards and the Debswana Standard Mechanical Equipment Design (3040-00000-04-5106-STD-M-010)
c. Conveyors shall be designed for continuous operation.
d. Conveyors shall be designed for starting under full design load and worst case partial loading conditions.
e. Conveyors shall be designed for multiple starts within an hour (minimum 6).
f. All equipment shall be designed:
    i. To be intrinsically safe and easy to operate and maintain,
    ii. To facilitate inspection, maintenance, cleaning and repairs,
    iii. To ensure satisfactory operation under the conditions prevailing at the site of the works,
    iv. To run without undue vibration or excessive noise,
    v. To prevent undue stress being produced by temperature changes.

6.2.1 Structural Design of Conveyor Installations

a. All conveyor structural designs shall be signed off (certified) by a Professional Engineer prior to the installation thereof.
b. Environmental conditions that could have an impact on the overall structural design e.g. geological conditions, geotechnical surveys, location, climatic conditions, etc, shall be included in the design.
c. Structural designs shall conform to the Debswana Standard, Design of Steel Structures (3040-00000-04-5106-STD-S-001).
d. All structures shall be designed for 100 % belt loading. The ultimate strength of the structure must be validated for flooded belt conditions which will be treated as an emergency load case. Serviceability requirements may be disregarded for this condition.
e. The conveyor head frame shall be designed to withstand the forces imposed on it by the conveyor under all operational conditions.
f. The head frame shall be free standing and shall not transmit any forces into the conveyor gantries.
g. The head frame support steelwork shall be designed to withstand the maximum head frame load.
h. The drive and take-up sections may be incorporated into elevated gantries provided the gantry is designed to withstand the forces imposed on it.

i. Wherever a conveyor is elevated to the extent that maintenance or inspection will be difficult or impossible from ground level, elevated or gantry sections with inspection and maintenance walkways shall be provided.
j. The elevated section shall adequately support both the carrying and return strands of the conveyor belt.
k. Idlers and idler spacing on the elevated section shall be as for the run of conveyors section.
l. The elevated sections at the head end of conveyors shall be designed to tie-in with the head frame, without transmitting or receiving any forces from the head frame.
m. A minimum of 150 mm clearance between belt and structures are required.
n. No cat ladders are permitted whatsoever.
o. Heavy duty conveyor modules and civil foundations must be considered at chute discharge or material impact regions.
p. All conveyor structures shall be earthed according to the earthing design.

6.2.2 Gantries

a. Suspended conveyors stringers are preferred.
b. 36 m long span gantries are preferred where a considerable distance of environmentally sensitive area must be crossed.
c. Constructability and crane access shall specifically be considered.
d. Open gantries is generally used on all conveyor structures unless a specific need exist to use a box type gantry.
e. Box gantries shall be considered on conveyors significantly elevated above ground level or where the use can be motivated.
f. Gantries are to have welded side panels and bolted top and bottom lacing to suit transport limitations.
g. Standard 12, 18, 24 and 36 meter gantries shall be used wherever possible taking cognisance of project standardisation.
h. Where substantial additional loads e.g. piping, cabling etc shall be carried by a gantry, the design shall specifically cater for these. Minor loads such as a 50 mm diameter pipe or small cabling may be disregarded subject to the discretion of the designer.
i. Gantries shall be designed to carry the full load of spillage.
j. Gantry support legs shall be mounted with slotted hole connections in stool base plates for ease of erection.
k. Sliding joints and pin joints shall be installed on gantries to ensure forces are not transferred to other structures.
l. Maintenance access shall be provided to crawls, take-up towers etc.
m. To eliminate a natural draft and propagation of fire, approximately 30 % of the sides shall be left un-sheeted. Translucent sheeting is therefore generally not required on environmental and boxed gantries.
n. Open gantries shall be equipped with doghouse type roof sheeting which allows access to idlers.
o. Walkways shall be side sheeted on the outside. Where wide cable racks are affixed to the outside of handrails, side sheeting shall be omitted on that specific side only.
p. Doghouse type sheeting shall be installed on all conveyors such that the conveyed material is shielded from the prevailing wind direction.
q. Doghouse sheeting shall allow access from the enclosed side such that the sheeting line is terminated approximately in the middle of the wing roll.

6.2.3 Design of Drainage System for Conveyor Belt Installations

a. The design shall include an appropriate drainage system in accordance with site conditions along the conveyor and at the tail pulley area to ensure the efficient drainage of water from seepage of fissure water, cleaning operations and dust suppression (automated or manual dust suppression systems).
b. The design of the drainage system must take the fire suppression system into account

c. Where a conveyor belt is installed in an incline appropriate measures must be taken to prevent possible drowning due to excessive accumulation of water at the bottom of an incline that might affect the tail -end.

6.3 Standardisation

a. Conveyor designer shall standardise equipment as far as practically possible with equipment in use at operations for optimum spares holding and interchangeability.
b. Equipment shall be designed to optimise life cycle costs considering the operating life as specified for the specific project.
c. All equipment shall be selected according to the preferred vendor equipment list applicable to the specific installation, where equipment is not indicated on the list, approval shall be obtained from the engineer.

6.4 Vertical inclination

a. The maximum permissible angle of inclination shall be dictated by the material, characteristics of the particular design.
b. The maximum inclination angle shall not exceed 13 degrees.
c. Where material run-back on the conveyor is expected (e.g. conveyors exclusively handling screened oversize or spherical type lumps) conveyor inclinations shall not exceed 10 degrees.
d. The top of the tail pulley shall be positioned at a lower level than the load point trough to provide effective drainage of water.
e. The incline at loading points shall be between minimum 0.5 degrees and maximum 5 degrees.
f. Drainage of water for conveyors with multiple loading points shall be considered.
g. Conveyor installations where the risk of water accumulating in a low point exist, and cannot drain freely from the conveyor, shall be covered or alternative means shall be provided to remove the water prior to start up.

6.5 Dynamic Forces

a. Dynamic calculations shall be performed for conveyor systems to ensure safe and reliable conveyor operation.
b. Dynamic calculations shall consider the worst case combination of conveyor loading and geometry.
c. Dynamic effects shall be taken into account in the calculation of belt tensions and counterweight requirements under all load conditions of the conveyor. As a minimum, the following load cases shall be analysed for all conveyor systems:
    i. Acceleration,
    ii. Coasting,
    iii. Braking (if applicable),
    iv. Emergency stop, and
    v. Aborted start.
d. Starting equipment shall be designed that the belt is not over-stressed when started under full load or worst case partial load conditions, or any transient condition.
e. Where transient waves poses a risk, transient forces shall be included in design loads.
f. The likelihood of transient waves occurring, shall be designed out as far as possible.
g. A suitable factor, taking cognisance of the start-up device, shall be applied to the calculated dynamic start-up tensions when calculating the required concave radius.

6.6 Concave Curves

a. Conveyors with concave curves shall be designed to ensure that the belt shall not lift off the radius during start-up, empty, normal or worst case loading conditions. (The belt mass used for these calculations shall be based on 50 % top cover wear.)

b. Center tension in the curve area shall be limited to 115 % of the maximum rated tension for the particular belt.
c. The edges of the belt shall not buckle in the curve area.
d. On all conveyors featuring trippers (eg. stockpile feed conveyors), the belt shall not lift off the radius during start-up or normal operation under the following conditions:
    i. 15 % loading of the conveyor's maximum design capacity in the curve is applied,
    ii. Tripper operating in the worst case position,
    iii. Loading of the belt is such that the highest possible tension is simulated in the curve, and
    iv. Belt mass is based on 50 % top cover wear,
e. Belt-lift control shall only be considered where it is not possible to satisfy these criteria and by approval from the engineer.
f. Where the rear tangent point in a conveyor and tripper system is close to the feed chute, worst case loading conditions shall be applied to ensure that the belt will under no circumstances lift into the chute, structures or skirt sections.

6.7 Convex Curves

a. The additional stress imposed on the idlers as a result of the convex curve shall not compromise idler roll shaft deflections and bearing life.
b. Edge tension in the curve area shall be limited to 115 % of the maximum rated tension for the particular belt.
c. The centre of the belt shall not buckle in the curve area.

6.8 Conveyor Capacities and Volumetric Fill

a. Conveyor design capacities shall be calculated from the Process Design Criteria and clearly documented as part of the Process Flow Diagrams.
b. Only the approved flow sheet capacities shall be used for detail conveyor designs.
c. Volumetric loading shall be calculated using method listed in ISO 5048, but modified as stipulated:
    i. For the design material flow rate, the belt loading shall not exceed 80%, where 100% loading is based on the standard edge clearance as stipulated in ISO 5048.
    ii. The maximum loading based on the peak instantaneous flow rate shall not exceed 100% of allowable cross sectional area based on the ISO 5048 standard edge clearance.
    iii. The maximum lump size shall be considered as loaded on top of the material profile and contacting the belt outside of the calculated edge distance. The highest position of contact for this maximum sized lump shall not be outside of the required 100% loading edge distance stipulated by ISO 5048. This implies that for very large lump sizes, the allowable loading percentage may drop below 80%.
    iv. The cross-sectional area of material on the conveyor shall be calculated assuming a circular top profile intersecting with the belt edges at the angle of dynamic surcharge.
    v. Where a conveyor is loaded on an incline section, the volumetric capacity shall be decreased in accordance with ISO 5048.

6.9 Conveyor Speed and Width

a. Belt speed and width shall be selected giving balanced consideration to
    i. Material Characteristics,
    ii. Volumetric Loading,
    iii. Spillage,
    iv. Conveyor lift,
    v. Conveyor length,

vi. Maximum particle size and Particle Size Distribution,
vii. Standardisation,
viii. Safety,
ix. Capital and operational cost, and
x. Energy efficiency.

b. Belt speed shall be based on considerations taking the full operational envelope, site conditions and materials into account.
c. The general philosophy of wide and slow belts shall be adopted with the recommended speeds as shown in Table 1.

Table 1: Conveyor Speeds

Application	Speed
Incline conveyors	< 4 m/s
Plant surface transfer conveyors	2 to 3 m/s
Overland conveyors	< 4.5 m/s

d. Initial kinetic energy of the lumps entering the transfer chutes shall be minimised by way of conservatively slow belt speeds and chute designs to prevent damage to receiving belt.
e. Lower speed shall be selected for conveyors with multiple feed points to reduce the risk of spillage.

6.10 Feed factors

a. In order to cater for fluctuations in feed to the conveyors, the feed factors indicated in Table 2 shall be used as a guideline:

Table 2: Feed Factors

Application	Feed Factor
Belt and apron feeders where steady stream controlled feed is expected.	1.1
Vibrating, table feeders etc. where surges and significant short term flooding may occur on the receiving conveyor belt	1.15 -1.25 (Depending on the feeder type
Reciprocating feeders	1.7
Where there is no feed control e.g. Langlaagte chutes under hoppers / box fronts	2.0
The above factors shall be incorporated in the conveyor designs but will not be reflected in the flow sheet capacity.	

6.11 Conveyor artificial friction factor "f"

a. The guideline design values for the coefficient of friction f for idler resistance and flexure of the material and the belts, are shown in Table 3.

Table 3: Feed Factors

Application	Friction Factor	
Overland conveyors	fc = 0.019	fr = 0.017
Curved overland conveyors	fc = 0.0195	fr = 0.018
In-plant conveyors	fc = 0.02	fr = 0.022
In-plant ROM conveyors	fc = 0.022	fr = 0.022

b. A friction factor of 0.022 shall be used for surface conveyors with an adjusted length factor Lo of 60m for all conveyors longer than 100 m.

c. The above factors serve only for static analysis. Visco-elastic friction, indentation resistance and idler resistance calculations shall be included in the design of long overland conveyors.

6.12 Conveyor Drive Systems

a. The design, selection and layout of the drive systems for conveyors shall be determined by the power, tension and wrap requirements.
b. In the case of multi drives, the load shall be divided into equal sizes to standardise drive selections.
c. The absorbed power at the drive pulley shall be calculated in accordance with the latest ISO 5048 standard, "Continuous mechanical handling equipment", using the artificial friction factors "f" being selected from the section above.
d. The absorbed power at the motor shall be calculated taking the gearbox and fluid coupling efficiency into consideration.
e. For VSD units, the efficiency of 0.97 shall be used, unless otherwise certified by the OEM.
f. Installed power for single conveyor drives shall be a minimum of 10% more than the absorbed power when selecting a motor.
g. Installed power for multiple drives shall consider load sharing and a minimum factor of 10% more than absorbed power, however for large drives this shall be subject to the approval of the engineer to ensure that drives are not significantly oversized.
h. The drives for incline, surface transfer and main overland conveyors shall be sized for the full length of conveyor as per the conveyor route profiles and design capacity.
i. Single head drive configurations may be considered for large conveyor drives (> 250 kW) where the head is elevated one floor level only and unobstructed maintenance access together with the installation of facilities to change out all components are provided.
j. Where drive sizes are 250 kW and smaller, elevated drive installations (in excess of a single floor) may be considered provided that provision is made to remove the drive, drive pulley and components to a conveniently located platform which can be accessed via overhead cranes or lowered to the ground level by crawl beam and/or lifting equipment.
k. Head pulley drives up to 90 kW is permitted on cantilevered conveyors, such as over stockpiles.
l. Drives with an installed power exceeding 22 kW shall be fitted with a soft starter i.e. fluid coupling or electronic.
m. The selection of the type of soft starter shall be subject to the approval of the engineer.
n. The minimum clearance between a conveyor drive and structural steelwork shall be 500 mm, consideration shall be given to the guarding arrangement around pulleys to ensure the clearance is achieved.
o. Right-angled, bevel helical gearbox units shall be used in a preferred shaft mounted configuration.
p. Shaft mounted drives shall comprise of a base frame on which the torque arm, motor, reducer, high speed coupling and guards are mounted.
q. Shaft mounted drives shall be supported off a torque arm and pulley shaft.
r. The output shaft of the reducer shall be fitted with a rigid flange type coupling for mounting onto the drive pulley coupling.
s. No hollow shaft reducers are allowed.
t. The drive station layout shall be such that torque arms are always under compression.
u. The torque arm design shall be such that no misalignment forces shall be transmitted to the reducer low-speed shaft.
v. The torque arm position shall be selected to minimise the static and dynamic load transmitted to the low speed shaft.

w. Low speed shaft and bearings shall be designed to accommodate the worst load conditions i.e. drive weight and torque reactions combined.
x. Allowance shall be made for mounting condition monitoring equipment (initially or retrofitted) to drive components.

6.12.1 Base Frames

a. Base frames shall be so designed that handling, shaft rotation and base plate position relative to a drive may be easily altered.
b. Base frames shall conform to the Debswana Base Frames Standard (3040-00000-04-5106-STD-M-012)

6.12.2 Couplings

a. Couplings shall conform to the Debswana Mechanical Equipment Design Standard (3040-00000-04-5106-STD-M-010).
b. All couplings and shafts shall be adequately guarded according to FRCS requirements.
c. All low speed couplings shall be of the rigid flange type, accurately aligned and fitted to shafts via locking elements (no keyways allowed on shafts).
d. The drive supplier shall fit the rigid couplings to the pulley at the pulley supplier's premises.
e. Installations with high inertia where the start-up time exceeds the capability of fluid coupling (50 seconds), Variable Speed Drives (electrical VSD's) shall be fitted.
f. The motor output shafts size shall be confirmed to support the loading from large fluid coupling sizes.

6.13 Brakes

a. Only disk brakes shall be used. If disk brakes are not an option due to specific reasons, approval for using other types shall be subject to approval by the Debswana Engineer.
b. Automatic brake compensation mechanisms shall be used.
c. All brakes shall be supplied with position indicating limit switches interlocked with the drive.
d. All brakes shall be sized to have the same minimum operating cycles per hour as the conveyor starts per hour (refer to conveyor data sheet).
e. Brakes shall be configured to be fail-safe (i.e. normally closed).
f. Critical braking systems shall be fully redundant, i.e. there will be a back-up brake to ensure that the conveyor will stop within the required time if the main brake fails.
g. Wear indication shall be incorporated in the brake design.
h. Mechanical lockout for braking mechanisms shall be provided for maintenance purposes.

6.14 Belting

i. Steel cord conveyor belting shall comply with the latest Debswana Steel Cord Reinforced Conveyor Belting Standard (3040-00000-04-5106-STD-M-013) and Steel Cord Reinforced Conveyor Belting (SANS 1366).
j. Fabric conveyor belting shall comply with the latest Debswana Solid Woven Conveyor Belting Standard (3040-00000-04-5106-STD-M-014) and General Purpose Textile Reinforced Conveyor Belting (SANS 1173).
k. PVC impregnated solid woven conveyor belting shall comply with the latest Debswana Solid Woven Conveyor Belting Standard (3040-00000-04-5106-STD-M-014) and Fire Retardant Textile Reinforced Conveyor Belting (Solid woven PVC, SANS 948 and SANS 971).
l. All conveyor belting shall be selected with consideration of the following:
    i. Maximum design tensions,
    ii. Belt width
    iii. Service conditions

iv. Material properties and
v. Standardised list of belting already in use at operations.

m. Ply belting to be natural rubber, minimum 3 ply with suitable top and bottom covers, minimum 3 mm and 2 mm respectively.
n. The top to bottom cover ratio shall not exceed 3:1 and vendor standard ratios shall be considered in selecting cover thickness.
o. Conveyor belt final selection shall be based on the calculated tension taking standardisation into consideration.
p. In determining the length required, allowance shall be made for hot vulcanized splicing.
q. Mechanical clips may only be used in emergency situations.
r. Conveyor belt type (in terms of strength, weight, stiffness etc.) shall not be changed from the initial design without having the change approved and signed off by a design specialist.

6.14.1 Belt service factors

a. The minimum service factors as indicated in Table 4 shall be applied to all conveyors based on the normal steady state tensions.

Table 4: Service Factors

Application	Service Factor
Solid woven belting	10
Fabric ply belting	10
Steel cord belting	6.67

6.14.2 Belt Jointing

a. Conveyor belts will be joined in accordance with the latest Debswana Specifications:
   i. Cold splicing of plied (textile) conveyor belting (3040-00000-04-5106-STD-M-015),
   ii. Hot splicing of textile reinforce conveyor belting (3040-00000-04-5106-STD-M-016), or
   iii. Splicing of steel cord reinforced conveyor belting (3040-00000-04-5106-STD-M-017),

   whichever is applicable to the selected conveyor belting.
b. The conveyor belt splicing shall be done in consultation with the conveyor belt manufacturer and only by approved contractors of the conveyor belt manufacturer.
c. Only Belting supplier approved splicing equipment shall be used to perform splicing.

6.14.3 Belt installation Winch/Splice station/Replacement and maintenance of belting

a. Provision shall be made for easy access to replace and repair belting.
b. A belt replacement study shall to be conducted.
c. Provision shall be made for the placement of a belt reel holder at the head end or tail end of every conveyor belt. In cases where the reel cannot be accommodated at the head or tail, provision shall be made at the take-up section.
d. A belt maintenance station shall be provided such that:
   i. The belting to be replaced may be easily pulled off the conveyor,
   ii. The replacement belting may be easily pulled onto the conveyor without the risk of damaging the belting or structures,
   iii. No removal of main structural components shall be done to replace conveyor belting,
   iv. Splices may be easily and accurately made.
   v. Provision to install the belt press,
   vi. The splicing area is protected from the elements,
   vii. Splice area shall be able to take the weight of the belt press and at least four persons.

viii. Splice area shall be the length of the splice plus 1m on either side of splice length wide
ix. Splice area shall be able to support the mass if filled with spillage
x. Splice area shall be a flat surface free from tripping hazards and allowing a flat splice surface.

e. Provision shall be made to install suitable winches to facilitate the initial and any subsequent pulling-in of a new belt. These will be located to pull the belt up from the tail end as well as to pull the return side down from the head end,
f. Sheaves may be permanently mounted but the winches shall be installed on prepared mounts and connected as required.
g. The belt maintenance station for overland conveyors shall be provided with outdoor industrial power outlets for 220 volts (2x) and 550 volts (1x) and water.
h. The floor of the belt maintenance station shall be concrete.
i. Provision to fit belt clamps shall be provided as part of the structural design.
j. Sufficient means of securing and isolating the potential energy in the conveyor belt shall be included in the design.
k. Belt clamps shall comply with the CMA specification MC-01.
l. Records of splices shall be kept in a splice logbook.

6.15 Holdbacks

a. A full risk assessment per conveyor belt shall be carried out prior to selection of the holdback considering:
   i. Material loading combinations on conveyor.
   ii. Drive loading conditions during start–up, abort start, normal running and jammed take-up or belt.
   iii. Abnormal conditions such as wash down.
   iv. Stored energy.
   v. Repair of conveyor components with a fully loaded incline.
   vi. Maintenance belt clamp of 60 kN capacity.
   vii. Assistance from anti-runback idlers.
   viii. Load release.

b. Where the design dictates the need for a holdback, external or reducer integrated units may be considered. Due consideration shall be given to prevent run back in the instance where the reducer is removed.
c. Low speed holdback, mounted directly onto the drive pulley shaft or the intermediate reducer shaft, are preferred.
d. For external holdbacks shall be mounted horizontally to reduce bearing loading.
e. Although stiff support steel is required to transfer the holdback reaction forces, the torque arm end of an external unit must not be rigidly attached. This will prevent damage to the bearings of the device.
f. The mounting of the torque arm must not permit any slack between the device and the support steel. Cushioning between load contact surfaces is precluded.
g. Nip points at the torque arm shall be prevented or guarded.
h. A rubber insertion, at least 20 mm thick shall be provided between the mounting bracket and holdback arms.
i. Holdback selection must be based on the calculated runback load of the belt in conjunction with a dynamic impact factor. The holdback rating shall not be less than the maximum torque capacity of the gearbox.
j. Holdbacks shall be marked with an arrow to show direction of free shaft rotation.
k. Holdbacks shall consistently provide instantaneous and positive back-stopping, without significant backlash regardless of oil viscosity.
l. Holdbacks shall not require any adjustment.
m. Visual checking of oil level shall be possible regardless of whether the conveyor is operating or stationary.

n. Holdbacks shall be of rigid steel manufacture.
o. Holdbacks shall be provided with filling and draining facilities suitable for use irrespective of the mounting angle of the unit.
p. Holdbacks shall be located on the opposite side to which the drive is attached on the pulley
q. Electrical holdbacks shall not be used.
r. Where multiple drives are fitted with holdbacks, the holdbacks shall be of the load sharing type.
s. Where required, turn down of the shafts may be considered to accommodate maximum bore for selected backstop, provided that permissible shaft stresses are not exceeded.
t. The maximum allowable shaft turndown is 20% of the main shaft diameter (bearing shaft diameter).
u. For standardization purposes, the selection of the internal holdbacks shall be based on the highest torque requirement across the range of affected conveyors.
v. Standardised reducer units must be interchangeable, hence internal holdbacks must be fitted for all these.
w. Internal holdbacks shall be removable from the reducer and the reducer rotation direction on the input/output shaft shall be clearly indicated.
x. Clear visual direction identification must be provided on reducers.

6.16 Anti-runback idlers

a. Anti-runback idlers are generally not required on conveyor belts which have a lift of less than 7 m. Special cases may however occur. Calculations and a risk assessment are therefore still required.
b. In designing new steep incline conveyors, consideration shall be given to increase the carry idler spacing to enhance the friction breaking force should a belt failure occur.
c. In determining the number of anti-runback idlers required, a conservative friction factor of no more than 0.3 must be used. This value caters for wet belts, condensation associated with temperature change and build up of dust on contact surfaces.
d. The following design parameters shall be considered when selecting anti-runback idlers:
    i. 3-roll idler sets are preferred
    ii. The installation pattern, which formed the basis of the design calculations, shall be adhered to.
    iii. Areas where anti-runback idlers are installed shall be clearly marked to indicate it.
    iv. Emergency conditions such as the jamming of the tail pulley or feed chute blockage shall be considered.
    v. Where conveyors are equipped with 5 roll idler sets, the wing rolls should never be fitted with anti-runback idlers since the contribution to braking friction is negligible.
e. Anti-runback idlers shall not be installed in place of a positive holdback.

6.17 Pulleys and shafts

a. Pulleys and shafts shall be strictly in accordance with the latest Debswana Specification, Conveyor Pulleys and Shafts (3040-00000-04-5106-STD-M-018), and SANS Specification, Conveyor Belt Pulleys, SANS 1669.
b. All pulleys shall have lagging.
c. Hooking points shall be provided to pull belting away from pulleys for lagging of pulleys to be done in situ.
d. Drive pulleys shall be lagged using 6 mm thick smooth ceramic tiles epoxy bonded using a high bond epoxy, directly to the pulley shell.
e. Rubber lagging is acceptable for non-drive pulleys.

f. No conveyor pulleys shall be crowned.
g. No ceramic lagging shall be used where a pulley is installed on the dirty side of conveyor belt.
h. The lagging philosophy of the operation shall be considered when conducting SIB designs and projects.
i. Drive pulley shafts shall be designed to enable shaft mounting of the reducers.
j. All pulleys shall be designed to ensure a fatigue life equivalent to 100 000 nominal hours of operation at the steady state design loads or a minimum cycle life of 1x106 load cycles.
k. Design calculations shall consider all worst case conditions, including but not limited to transient belt tensions, blocked chute conditions etc.
l. All pulleys shall be supported on two separate bearings.
m. Drive pulleys shall not be overhung from reducer bearings.
n. Pulley designs shall be based on the pulley shaft accepting the total resultant force of the belting tensions, pulley mass and shaft mounted drive (i.e. the stiffness of the shell shall be ignored for the purpose of shaft calculations.
o. Where there is more than one conveyor in a system/plant, the designer shall optimise pulley sizes between the various conveyors to limit:
    i. Number of pulley designs (Diameter and Shaft sizes per conveyor width), and
    ii. Number of bearing sizes
p. Plummer blocks shall be the split type.
q. Spherical roller bearings with an adapter sleeve shall be used.
r. Plummer blocks with its bearings to be fitted with an easily accessible grease nipple. Inaccessible grease point must be equipped with a hydraulic hose and grease block to facilitate safe remote manual lubrication.
s. Plummer block orientation shall be such that the bearing force acts through the base of the plummer block.
t. Cap bolts shall never be under tension.
u. Steel end caps shall be used.
v. Bearing temperatures on critical belts will be monitored at the head, tail, drive and take-up pulleys.
w. All pulley approach points will be fitted with nip protection.
x. The number of pulleys must be kept to a minimum when designing new conveyors.

6.18 Idlers

a. Idlers shall be in accordance with the latest Debswana Standard, Belt Conveyor Idlers and Rolls (3040-00000-04-5106-STD-M-019), and the latest SANS Specification, SANS 1313 Conveyor Belt Idlers.
b. Idler spacing selection must be done by balancing the capital expenditure, operational costs, energy losses and belt life.
c. All idler bases shall be sequentially numbered in the factory to ensure correct assembly
d. Bearings shall be adequately sealed to retain the lubricant and effectively prevent the ingress of dirt and moisture.
e. “Lubricated for life” type rolls shall be used.
f. The maximum allowable idler shaft deflection is limited to 6 minutes at the designed throughputs.
g. The minimum idler life shall be 50 000 hours.
h. Where self-training rolls are used, a minimum of 3 self-training rolls per conveyor shall be used: one 10 m in front of the head end, one after take-up and one on the return belt before the tail end.
i. Self-training roll placement and layout shall be such that dirt pick-up on the trainers preventing it from functioning is prevented.
j. Self-training roll pivot points shall be shielded from dirt ingress.

6.18.1 Troughing idlers

a. Carry idlers shall be specified individually for each conveyor, based on the material, particle size distribution, etc.
b. Carry idlers shall be designed based on the peak capacity.
c. Carry idlers shall be at fixed angles, adjustable idler frames are not allowed.
d. The 3 roll idler configurations are preferred. 5 roll idler configurations may be considered for belt widths exceeding 1200 mm.
e. The preferred troughing angle is 35° although 45° and higher may also be used when justified and approved by the Debswana engineer.
f. The head frame or the stringers leading up to the head frame shall include a transition section to flatten the belt in accordance with the CEMA recommendations, precautions shall be taken to prevent spillage at this point.
g. Head and tail transitions are to be designed to run out to 0° by installing the appropriate transition idlers. 3 idler sets are generally required.

6.18.2 Impact idlers

a. Impact resulting from the transfer of material shall be absorbed by impact idlers.
b. Standard steel rolls can however be used on -20 mm material.
c. Impact idlers shall be 45° trough, rubber disk rolls to be used for coarse material.
d. Where impact is abnormally high, a torsion rubber mounting system is to be considered in conjunction with rubber disk idlers. The rubber torsion mounting arrangement is to be approved by the Debswana Engineer.
e. Idlers located within the skirted area at loading points will be mounted on quick release mountings which will allow the complete idler frame to be lowered for idler roll replacement.
f. Impact beds should not be used.

6.18.3 Return idlers

a. Return idlers shall be specified individually for each conveyor, based on length, belt width, tracking difficulties, etc.
b. All conveyors 1200 mm wide and above should be 10° vee, 2 roll return idlers, subject to belt troughability and the specific detail design.
c. As a guideline, conveyors below 1200 mm wide should be fitted with single roll flat return idlers unless troughability calculations prove otherwise.

6.19 Take-up units

a. Take-up travel shall be sufficient to accommodate the following:
    i. Dynamic elongation of the belt due to varying belt tensions, thermal effects etc.
    ii. Plastic elongation due to permanent belt stretch.
    iii. Take-up must make provision for belt storage such that **five splices** in case of overland conveyors and **three splices** in the case of shorter plant conveyors is catered for.
b. All conveyors with horizontal pulley centres 30 metres and longer shall be provided with gravity take-ups, either vertical or horizontal to suit the design.
c. For short conveyors (less than 30 m) mechanical screw take-ups may be used.
d. Allowance shall also be made for sufficient movement for splicing, and where applicable, for rope tie offs on horizontal take-up trolleys.
e. The take-up shall include the counterweight or winch, sheaves, steel wire rope, attachments, etc. to maintain the required belt tension under all operation conditions.
f. The desired counterweight mass should be made up with plate packs in a support cradle. Consideration may be given to properly drained counterweight boxes in order to facilitate the use of steel punchings or similar material, given the high cost of steel plates.

g. Steelwork, walkways, stairs platforms, etc. to afford safe and adequate operational and maintenance access shall be provided.
h. Take-up installations shall be readily accessible, and shall be above ground level.
i. All take-up components shall be protected against spillage.

6.19.1 Fixed take-up arrangement

a. Where fixed take-ups are used, the mechanical tensioning screw shall not protrude into a walkway in any part of its adjustment range.
b. Where hydraulic jacks are used for fixed take-ups, they shall include pressure gauges for adjustment purposes and screws with locking nuts to keep the take-up in position.
c. Typical arrangement drawings shall be submitted to confirm correct interpretation of all take-up requirements.
d. The tensioning mechanism of all take-up trolleys shall be such that the resultant force is aligned with the belt tension direction.

6.19.2 Automatic take-up arrangement

a. Automatic take-ups shall be provided on all conveyors exceeding 30m between centres of head and tail pulley.
b. Automatic take-ups shall be of the horizontal or vertical gravity assisted type.
c. If winch take-ups are the best design option for a specific application, permission for its use shall be obtained from the Debswana Engineer.
d. To secure the take-up box in its maintenance position, mechanical locking mechanisms shall be provided on the take-up steelwork to enable mechanical locking of the counter-weight box in this position, together with a lockable pin to ensure the safety mechanism has been locked in its fail safe position, and to prevent the safety pin from falling out.

6.19.3 Gravity take-ups

a. For all gravity take-ups, an electrically operated winch shall be provided for lifting and lowering the counter-weight box for maintenance purposes.
b. The electrical winch shall be equipped with local control panel and a mechanism that prevents un-controlled unwinding of winch.
c. All winches and their cables shall be guarded at all places where potential nip points and other hazards are created.
d. To secure the vertical take-up box in its maintenance position, mechanical locking mechanisms shall be provided on the take-up steelwork to enable mechanical locking of the counter-weight box in this position, together with a lockable pin to ensure the safety mechanism has been locked in its fail safe position, and to prevent the safety pin from falling out.
e. For vertical take-ups, the maximum allowable unsupported belt length within the take-up is 8 meters.
f. Gravity take-up towers shall be of sufficient height to accommodate the change in the length of the conveyor belting under all operating conditions with a minimum of 500mm travel distance before any object will be encountered.
g. Gravity take-up towers shall have a buffer at the bottom. This buffer shall be able to absorb the impact of the free falling take-up weight to prevent damage to the structural components. The preference is to use a sand box with screed closure.
h. No gravity take-up weights shall be situated above other structures and equipment.
i. Stairway or cat ladder (maximum 8m high) access shall be provided to the top of all take-up towers.
j. A 1.5 meter wide clear working space platform all around the vertical take-up, at the highest lifting position of the take-up pulley shall be provided for maintenance purposes, including stairway or ladder access.
k. If the counterweight box is situated high enough to cause damage when dropped in the event of belt failure, an energy absorbing catch system shall be incorporated to prevent damage and injury.

l. For vertical take-ups, a roof shall be fitted above the tensioning pulley in the take-up tower.
m. The roof shall have a 45 degree slanted roof.
n. For material with an angle of repose greater than 35 degrees, the slope of the roof shall be the material angle of repose plus 10 degrees.
o. The roof shall be orientated such that falling material is diverted off the belt.
p. Vertical take-up counter weight shall be provided with suitable guide channels to ensure positive location of the counterweight in the guides.
q. Vertical gravity take-up should have a clearance between frame and guides of approximately 10 mm per side.
r. The take-up trolley longitudinal wheel centres will have a ratio of $\sqrt{2}$:1 in relation to the width of the trolley as a minimum. This aspect ratio shall apply to vertical gravity take-up carriages as well.
s. The take-up trolley must have locating wheels on one side and floating wheels on the opposite side of the carriage.
t. Provision shall be made for the take-up trolley to be locked in position, and the two belt strands entering and exiting the horizontal take-up to be clamped during maintenance activities.

6.19.4 Ropes, sheave wheels and fittings

a. Ropes and Sheaves shall be in accordance with the latest Debswana Standard, Take-up Ropes and Sheaves for Belt Conveyors (3040-00000-04-5106-STD-M-020).
b.
c. The selected rope diameter shall be based on a minimum factor of safety of 4:1.
d. The minimum rope diameter shall be 16mm.
e. Minimum sheave diameters shall be according to rope manufacturer requirements.
f. Rope tension shall not be transferred to sheave wheel mounting bolts as shear or tension.
g. Thimbles and other equipment shall be rated, certified and stamped.
h. Ropes under tension shall be protected to prevent injuries to personnel in event of belt or rope failure.

6.19.5 Horizontal take-up trolley components:

a. Rail supports be of adequate width and strength.
b. Care shall be taken to ensure straightness before and after welding and particularly after galvanising if applicable.
c. The track diameter of the wheels shall not be less than 200mm.
d. Suitable means shall be provided to prevent the carriage lifting off the rails.
e. Rubber buffers of substantial size shall be fitted to the take-up steelwork to prevent damage in the event of belt failure.
f. Rail cleaners shall be fitted at both sides of each wheel.
g. Trolley wheel nip points shall be guarded.
h. Trolleys and the surrounding structures shall be designed to allow maintenance access to all components.
i. Soft end stops shall be fitted to the trolley mechanism.

6.19.6 Counter-weight boxes

a. Counter-weight boxes shall have a 4,5mm thick removable hood/cover to prevent intrusion of foreign materials between the belt and the pulley.
b. The cover shall be pitched at 45° to prevent the build-up of such material.
c. Ballast materials shall be thicker than 3mm.
d. Vertical take-up boxes shall be provided with lifting lugs for rigging the counter-weight box to its position at the maintenance platform when the winch is not useable.

e. All ballast material in the counter-weight box shall be evenly spread over the box and thus not resulting in load couple acting on the guide frames.
f. The allowable tolerance of the counter-weight mass shall be specified by the conveyor designer.

6.20 Belt scrapers

a. A primary and two secondary belt scrapers shall be fitted at all head pulleys.
b. Scrapers shall be installed and aligned to the supplier's recommendations and shall be adjusted to remove at least 95% of all spilled material from the belt.
c. All belt scrapers shall be designed to use only components that are readily available in the country where the belt will be constructed and used.
d. Scrapers shall be adjustable and self-compensating for wear.
e. Sufficient space for servicing is to be allowed.
f. Belt scrapers must be easily and safely accessible for maintenance purposes.
g. All scrapings from the belt cleaner shall be deposited onto the receiving conveyor by means of a dribbling chute.
h. Dribble chutes will be lined with UHMW liners with a 6mm thick rubber backing or manufactured from stainless steel polished on the sliding surfaces.
i. Openings in the chute where scrapers are installed shall be covered.

6.21 Belt ploughs

a. V-return ploughs shall be installed on the following positions:
    i. Between the tail pulley and loading chute
    ii. Before the return belt enters the vertical take-up tower
    iii. Before horizontal take-up sections.
    iv. At drive stations prior to the HT snub pulley
    v. Before intermediate drives.
    vi. At any location where there is a risk of material spillage on the return belt entering a pulley.
b. Care must be taken to position tail scrapers such that material is not scraped into the tail guard area or other equipment. A dedicated area shall be provided for the scrapings to be safely discharged.
c. Where V-return idlers are used, the positioning of the plough must be such that proper contact between the belt and plough is maintained. Flat return idlers must be provided.
d. Where access to one side of the belt for cleaning purposes is not available, bias ploughs shall be installed so that material is scraped off to the side where access is readily available.
e. Where ploughs are installed on elevated conveyors, safety precautions due to falling material shall be taken. Easily cleanable catchment boxes should be installed.

6.21.1 Belt washing systems

a. Belt washing systems shall be incorporated in belt conveyor systems when necessitated by the risk of ploughs and scrapers not cleaning sufficiently.
b. Spray bars shall be fabricated from 3CR12 materials or better.
c. Belt wipers shall be fitted to prevent water spillage.
d. A suitable and adjustable spray nozzle system shall be installed below the return belt.
e. A lockable hand isolation valve and electrical solenoid valve shall be installed on the spray water feed line.
f. Two polyurethane lined squeezers, one above the belt and one below the belt shall be installed.
g. The belt wash chute and drain system shall be designed to prevent material build-up.
h. Spray bars at the rear of the dribble chutes shall be adjusted in such a way that no build-up of material will occur in the chute.

i. Spray bars for belt cleaning shall be installed at an angle of approximately 30° from the vertical facing the incoming belt.
j. Provision for feed water filtration shall be provided.
k. Run off water shall be controlled and included in the PFD's.

6.22 Skirting

a. Continuous skirting is to be used for multiple load points onto a single belt. Flared skirting or spaced skirting shall only be incorporated into the design with the prior approval of the Engineer.
b. Skirting rubber shall be 40 shore hardness or below.
c. Used conveyor belting in skirt seal locations is prohibited.
d. All conveyor feed chutes shall be equipped with steel supporting skirting to contain material at the feed point.
e. Skirts shall extend a minimum distance of 1 m past the stabilized material on the belt.
f. Chute skirt covers to be easily removable.
g. All discharges below crushers, centrifuges etc. shall be fully enclosed to eliminate spillage completely.
h. High angle troughing idlers may be considered to eliminate long and high maintenance skirting on conveyors with multiple loading points.

6.23 Deck plates

a. Deck plates shall be provided in the following locations:
    i. Underneath all loading areas.
    ii. Over vertical take-up bend pulleys.
    iii. At discharge pulleys.
    iv. Over horizontal take-up sections.
    v. Over ground drive stations.
    vi. At any other location where spillage onto the return belt or equipment would lead to equipment damage or operational stoppages.
b. Deck plates shall span the above areas completely to provide adequate protection.
c. Deck plates shall be made of 3CR12 material or other approved material by the Debswana Engineer.
d. Deck plates shall be suitably stiffened as required by application.
e. Deck plates shall be fitted underneath the carrying rolls between the stringers.
f. Decking plates shall be bolted for easy replacement.
g. Where deck plates are used to contain spillage, all associated guards shall have sufficient space to enable proper washing and cleaning of deck plates.
h. Guards at deck plates shall incorporate horizontal slots to allow easy cleaning with hose pipes and prevent water from splashing back where applicable.
i. Deck plates shall be designed to support the material that can accumulate on top of it.

6.24 Chutes

a. The minimum width of the conveyor feed chutes (measured inside of liners) shall be 2,5 times the maximum particle size. The width of such feed chutes shall not exceed 2/3 of the conveyor belt width.
b. Chutes shall be designed to pass the peak load continuously, without spillage or buildup, and to transfer it to the receiving equipment smoothly and equally distributed across the receiving equipment. The chute shall also pass the maximum lump size without blocking, hanging-up or spilling or excessive wear, and shall transfer it to the receiving equipment such that the possibility of damage is minimized.
c. Chute material shall be according to the project specific requirements, taking the corrosiveness of the environment, feed material and the design life of the plant into consideration.
d. Before any chute can be installed, the supplier shall submit to Debswana material flow test results and dynamic modelling of the supplied chute.
e. In order that belt wear may be minimised, all transfer chutes shall be designed in accordance with the following principles:
    i. All chute designs shall be based on friction characteristics obtained from bulk solids flow test for material on material and material on liner surfaces,
    ii. In determining chute angles, the co-efficient of friction between the wear material and the material shall be taken into account.
    iii. The functional design of transfer chute arrangements shall prevail over mechanical and structural considerations,
    iv. Material velocity throughout the entire chute shall be designed in accordance with measured friction characteristics for direct sliding and sliding under impact conditions,
    v. Material transferred to chutes shall impinge on the chute at the least practical angle of impact,
    vi. Where unavoidable and to eliminate impact wear in the top section of the chute, in-line dead boxes will be permitted subject to material properties.
    vii. Where a chute transfers material onto a belt conveyor, the difference in the velocities of the material in the direction of the conveyor, and the belt shall be within 10% of the belt velocity for average friction characteristics of the material on the chute liner surface,
    viii. The kinetic energy of the largest particle reasonably anticipated on a receiving conveyor belt shall not exceed 500 joules,
    ix. Where the stopping time of a conveyor is such that it may deliver more material to the receiving equipment than the receiving equipment can absorb without the possibility of spillage or blockage overloading, provision shall be made for the conveyor head chute to accommodate the overrun material. The amount of overrun material to be accommodated shall be based on the peak capacity of the conveyor,
    x. The chute angle at the bottom of the chute shall be minimum 5° steeper than the friction angle for direct sliding.
    xi. Material flow shall be simulated for all chutes.
f. The material flow simulations shall include the following sensitivities:
    i. Changes to the normal distribution of material size within the specified particle top and bottom size
    ii. Changes to the density of the material, variances of ±20%.
    iii. Changes in moisture, variances of ±5%.
    iv. Changes in conveyor speeds, where VSD's are used.
g. Material flow simulations shall be used to determine the chute design and wear liners specification.
h. Surge bin capacity shall allow for brake failure conditions when brakes are applied to limit the run out time.

i. Chutes shall be designed to accommodate wear protection and shall be designed to facilitate access for maintenance purposes.
j. Where VSD's are employed the flow variances shall be incorporated in the design of the chute.
k. Chutes volumes shall be sufficient to accommodate the difference between the feed and receiving conveyors carry-over material due to difference in run-out time.
l. All chute sections connected with flanges shall be sealed with continuous rubber impregnated gaskets to prevent dust leakage or water spillage.
m. Head chutes shall be designed in sections and the split line shall be designed to allow easy removal of the head pulley.
n. Openings between the chute and surrounding walkways and platforms shall not be wider than 50mm.
o. Blocked chute detectors shall be positioned such that build-up cannot occur on the detector.
p. Access shall be provided to chute level dector positions for maintenance and inspections.
q. The safety guards covering the pulley shafts exiting head end chutes shall form part of the head chute design.
r. Chute design shall accommodate dust extraction and suppression requirements where applicable. The velocity of dust shall be kept to a minimum regardless of whether dust extraction or suppression is applied. Connection flanges shall be supplied for dust suppression or extraction equipment where such systems are required.
s. The impact pressure on the chute and on the receiving equipment shall be kept to a minimum and shall not exceed 8 kPa.
t. The angle of impact, i.e. the angle between the material stream and the impacting surface, shall be minimised and shall preferably be less than 20°.
u. Suitable support for the chute shall be provided. In designing the chutes, the forces likely to be encountered as a result of large lumps passing through the chute shall be taken into account.
v. Where appropriate, deflector chutes must be provided at ploughs, take-up and drives.
w. When chute plates have to be stiffened, care must be taken in positioning stiffeners so that no water traps occur or clashes with liner bolts.
x. Although chutes need to be suitably stiffened in line with the liner selection, over stiffening must be avoided.
y. New ceramic tiles have a high co-efficient of friction, which must be considered when conveying fines.
z. Light weight chute inspection doors must be provided with welded hinges. To prevent finger injuries, these doors shall always open sideways, never to the top or bottom.
aa. All chutes shall be provided with 600 x 600 mm inspection doors. Doors shall be positioned out of the material flow stream and it shall be safe to open during operation.
bb. Safe access shall be provided to all inspection hatches.
cc. Maintenance hatches shall be bolted in position to ensure that access shall only be granted under controlled conditions.
dd. Lifting lugs shall be designed and positioned for the replacement of the complete chute including all material in deadbox areas.
ee. Personal anchor points shall be provided for safe access to chutes where platforms are not installed.
ff. Where possible, the head snub pulley must be located within the main chute so that the fines can be carried away with the main flow of material. The chute back plate must be positioned such that there will be no build-up of the fine material.
gg. The guideline for the required clearance between the belt and chute is obtained by the ratio of the selected belt width divided by 12.

hh. Blocked chute detection will be installed at all conveyor discharge ends in accordance with the latest Debswana Standard, Conveyor belt protection systems.

6.25 Safety and guarding

a. All safety guards shall be in accordance with the latest Debswana Standard, Guarding of Conveyor System (3040-00000-04-5106-STD-M-021).
b. In addition, guarding shall conform to the requirements of Debswana FRCS 5-Equipment Safeguarding.

6.25.1 Guarding design and mounting

a. In areas where maintenance access is required, guarding must be designed to swivel along the vertical plane (bullet type hinges are not permitted).
b. The opposite end must be fixed with bolts so that physical work must be done to gain access. This type of guards can typically be used within horizontal take-up areas of conveyors. The swivel door must be removable by two persons.
c. The above requirement does not apply when the removal of guarding is not required for maintenance and change-out of equipment, belt replacements etc. This type of guarding is considered to be fixed.
d. Fixed panels shall be mounted using M16 fixing bolts (min 4 bolts per panel). Bolts and nuts shall be easily accessible for installation of the guard. Suitably designed fixing brackets shall be used.
e. Where swivelling guards are not deemed possible or practical where access is required, specific care must be taken to ensure that the removal of all panels can be safely done by one person.
f. Guard lifting handles must not protrude into the walkways.
g. Greasing points must be safely accessible without the removal of guards. Inaccessible points must be equipped with a hydraulic hose and grease block located at convenient location.
h. Conveyor under-belt guards must be provided on elevated sections to provide a working platform to replace return idlers and to prevent large objects e.g. idlers to fall to the ground but not to cause material build-up. The preferred construction is to have welded mesh panels, welded into a frame which is bolted into the gantry steelwork.

6.25.2 Conveyors above thoroughfare and operational areas

a. All areas where a conveyor crosses over any thoroughfare, operational area, equipment or structure, protection shall be provided against falling objects.
b. Specific cross over or cross under points at belt conveyors shall be provided for pedestrians and vehicles where required.
c. Vehicle access shall be a minimum of 4500mm wide and 2500mm high, but access shall be sized for the maximum size of vehicle that may pass under the conveyor.
d. A study shall be done and documented to determine the maximum size of vehicle that will pass under each conveyor crossing.
e. Crossings shall be clearly indicated and marked with signs and road markings. Height restrictors shall be installed 20m before and after a crossing.
f. On ground level, both sides of the access servitude shall be guarded off by means of removable hand railing or suitable barrier.
g. For vehicle thoroughfares, suitable means (such as barriers or bollards) shall be provided to minimise the likelihood of collisions with the conveyor structure and civil structures, and to minimise the damage should collisions occur.
h. Where clearance between the floor or ground level and the underside of a belt conveyor structure is more than 1500 mm but less than 2500 mm, vehicle access shall be prevented using suitable barriers and signage.

i. Where clearance between the floor or ground level and the underside of a belt conveyor structure is more than 500 mm but less than 2100 mm, pedestrian access shall be prevented using suitable barriers and signage.
j. Height restriction signs shall be put in place on separate structures on either side of vehicle access routes below conveyors.

6.26 Falling object protection

a. Falling object protection shall be provided in all areas where a conveyor crosses a road, pedestrian walkway, equipment or structure – either in the form of under pans, solid flooring or separate roofed structures below the conveyor.
b. Falling object protection shall be designed and constructed to protect against falling idler rolls as well as the maximum possible material size.
c. Falling object protection shall be designed to support the maximum amount of material (including spillage) that can accumulate inside it.
d. Where the conveyor spans areas where people or vehicles can be present and under pans are selected as the means of providing protection, they shall conform to the following:
    i. Under pans shall span the entire width of the conveyor, excluding the walk ways.
    ii. Under pans shall be made from 3CR12 plate (mesh shall not be used) or other suitable material.
e. Where it is considered more appropriate to protect access routes under conveyors with separate roofed structures (canopies) the design shall be submitted for approval by the Engineer.

6.27 Conveyor Crossings

a. Cross-overs and cross-under's shall be installed to ensure that all areas will be reached without having to climb onto the conveyor belt.
b. Sufficient clearance must be provided to enable persons to pass safely under and or cross over the belt. A minimum clearance of 2.1m from the ground is required.
c. The cross over, consisting of proper ladders or stairways must be provided for accessing the conveyor belt.
d. Areas where personnel are required to pass underneath the belt, will be guarded according to the FRCS requirements.
e. The design must allow for cross overs at maximum intervals of 300m or less as dictated by site conditions.
f. Every head end section of every transfer area must have a belt cross over on either side of the head section. This is to provide safe access for maintenance work and repairs on either side of the elevated head pulley, where items such as chutes, scrapers and sprayers can be accessed safely.
g. All cross-overs designs must cater for the following:
    i. Personnel using it cannot come into contact with any moving parts of the conveyor.
    ii. The cross over must have kick-plates installed 100mm high to prevent persons from slipping onto the moving conveyor.
    iii. The material used in the construction of the cross over must prevent persons from slipping and sliding when using the cross over.
    iv. The cross over must be provided with hand railing and knee railing.
    v. Lighting must be adequate at cross-overs and cross-under's.

6.28 Conveyor Walkways

a. Walkways and platforms shall be designed according to the Debswana Standard for Open Grid Flooring and Walkways (3040-00000-04-5106-STD-M-030).

b. Double sided walkways shall be constructed where the conveyors are elevate off the ground more than 1.8 meters. These walkways shall have a minimum of 750mm wide free clearance.
c. Where clearances are less than 750mm that section of the conveyor must be guarded off to prevent accidental contact with the conveyor. This situation should be avoided where at all possible.
d. Areas where drive train and electrical panels are installed must be taken into account and special care must be taken not to restrict workspace in these areas. A minimum working platform of 1m wide shall be provided in such areas.

6.29 Fire Detection Systems

a. The design of fire detection and suppression systems for conveyor belts shall conform to the requirements of the Debswana Fire Standard (3040-00000-04-5106-STD-M-040).

6.30 Design of Safety Devices

a. All devices listed below shall be treated as safety critical interlocks which may not be bypassed for normal conveyor operation.
b. Each interlock trip shall result in a conveyor trip i.e. resulting in a fail-safe state for the entire conveyor system.
c. Provision for bypass for abnormal conditions may only be made through PLC Software and logged accordingly.
a. All equipment shall be compliant to Debswana, General Requirements for Instrumentation, Programmable Logic Controllers and Supervisory Control and Data Acquisition Systems and Conveyor Belt Protection Systems specification.
b. All safety devices shall be tested at intervals determined by the operations and risk management, but shall not exceed 6 months between tests.

6.30.1 Lockout Devices

a. Isolation and lockout shall be in accordance with FRCS 6: Isolation and lockout requirements.
b. Lockout devices shall be effective and easily accessible and must be available on each and every conveyor, also considering the alternative energies that require lockout, i.e. gravity, potential etc.
c. The lock-out operation must ensure that the main source of supply is isolated from the prime mover.
d. The lock-out device may not be dependent on the control system of the conveyor belt.
e. It is recommended that field Isolators be installed at the conveyor drives to enable easy lock out operations.

6.30.2 Pull Key Installations

a. Every conveyor belt shall be equipped with effective means for stopping the conveyor, situated along the entire length of the conveyor on both sides.
b. Pull keys or a pull key tensioning device shall be installed around the tail end of the conveyor and installation shall be around the tail-end guard. The guard shall not be able to be removed without the tensioning device being unsecured. Once the tensioning device is unsecured, the conveyor belt shall trip.

6.30.3 Belt Slip Protection

a. Belt speed devices shall be fitted to all conveyors.

6.30.4 Take-up Over Travel

a. Take-up over travel protection shall be located at the extreme positions of travel of a counterweight and / or moving take-up device.

b. There shall be two levels of protection at each point of position detection, namely limit detection and ultimate limit detection.

6.30.5 Blocked Chute Detection

a. Blocked chute detection devices shall be installed at the discharge of the conveyor belt to prevent contact of discharged material with the belt. The devices shall be selected according to the individual applications and consideration should be given to the material composition, preferably dry and free flowing.

6.30.6 Belt alignment

a. Alignment switches shall be installed at a minimum at the head end, tail end, load points and take-up sections of the conveyor.

6.30.7 Magnetic Removal of Tramp Iron

a. Belt magnets shall be provided where necessary to protect the conveyor belt by removing magnetic objects. A magnetic detector shall be fitted after the belt magnet to trip the conveyor belt in the event of failure of the removal action Personnel and Equipment protection requirements.
b. Automatic markers shall be installed to mark the position of the detected magnetic material.

6.30.8 Pre-Start Warning Systems

a. Pre start warning devices shall be installed along the entire length of the conveyor belt system to warn personnel that the conveyor belt is about to start moving.

6.30.9 Conveyor Belt Speed Monitoring and Control

a. Start up speed monitoring, and running speed control philosophy shall be determined in a design criteria document which defines the parameters for belt speed monitoring and control and associated instrumentation for approval by the Engineer.

6.30.10 Lightning Protection

a. The conveyor belt protection system shall be electrically isolated from the control system and control networks in accordance with the requirements of SANS 10313 or BS 6651.

6.31 In-plant Maintenance Facilities

a. In designing or selecting the equipment, attention shall be given to the ease of operation and maintainability of the plant as well as operational costs.
b. The design and selection of equipment shall be directed towards minimizing maintenance and maintenance durations.
c. Crawl beams, equipped with crawls but not lifting tackle, strategically placed so that all heavy lifts required to maintain the plant and equipment may be safely and easily carried out shall be provided.
d. Conveyor equipment shall be designed to be removed by crawl beams as far as possible. The need and use of Mobile cranes shall be limited.
e. Equipment must be arranged so that overhead crawl or lifting beams provide simple and adequate suspension for in situ stripping and/or removal to an external workshop.
f. Crawl beams shall be fitted over equipment that is not accessible by the overhead crane including all transfer towers, bins and silos.
g. Crawl beams shall be fitted with manual trolleys.
h. Stop blocks shall be fitted to both ends of the crawl beams.
i. The safe working load, SWL, must be stenciled onto both sides of crawl beam web after passing load test certification.
j. No lifts, including construction activities, shall take place on a new crawl beam prior to passing load test certification.

6.32 Cleaning operations

a. All floors under conveyors in wet areas should be concrete and easily accessible for skid steer loaders (bobcat) without obstacles.
b. Skid steer loaders (bobcat) access is required around conveyor tail end areas and inside tunnels.

7. AMENDMENT HISTORY

Issue no	Effective date	Date last revised	Amendment details
01	01 January 2018		First issue

8. RELATED DOCUMENTS

Document no.	Document name	Issue date	Date of next review