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Title: **Splicing and Repairs of Steel Cord - and Textile/Plied Reinforced Conveyor Belting**

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TABLES

1. INTRODUCTION

This standard is for the on-site splicing of steel cord - and textile/plied reinforced conveyor belting. This document also includes repairs of belting on site as well as at the manufacturer's premises. All parameters to be adhered too unless otherwise indicated by the belt manufacturer. This standard merges previous Eskom standards and is a replacement for those standards. A list of the superseded standards can be obtained from the Eskom document management centre.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document is a standard on:

- Splicing of steel cord - and textile/plied reinforced conveyor belting on site, both hot and cold processes are described, and
- Repairs of steel cord - and textile plied belting both on site and at the manufacturer's premises.

2.1.1 Purpose

To provide a detailed conveyor splice and repair standard enabling the user to enforce strict quality control throughout the process. The standard will cover all fundamentals required in conveyor belt splicing and repairs.

2.1.2 Applicability

To be utilised at all Eskom thermal power stations where steel cord and textile/plied splicing and repairs are undertaken.

2.2 NORMATIVE/INFORMATIVE REFERENCES

The following standards contain provisions that, through reference in the text, constitute requirements of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are required to ensure the most recent revisions of standards below are used.

2.2.1 Normative

[1] SANS 1366:2013: Steel cord Reinforced Conveyor Belting.

[2] SANS 1173:2013: Fabric Reinforced Conveyor Belting.

[3] SANS 485:2009 Edition 1: Conveyor Belting - Splicing of steelcord conveyor belting.

[4] SANS 484-1:2009 Edition 1: Conveyor Belting - Step splicing for multiply textile reinforced rubber covered conveyor belting - Hot-splicing method.

[5] SANS 484-2:2009 Edition 1: Conveyor Belting - Step splicing for multiply textile reinforced rubber covered conveyor belting - Cold-splicing method.

[6] ISO 9001, Quality management systems and requirements.

2.2.2 Informative

[7] The Occupational Health and Safety Act, Act No. 85 of 1993 (OHS Act).

2.3 DEFINITIONS

Definition	Description
Approved	Approved in writing by the Engineer
Client	Eskom Generation Group
Competent Supervisor	Supervisor from the Eskom Generation Group trained in basics of belt splicing
Contractor	Company to execute the splice or repair.
Engineer	The responsible engineer at the Eskom Generation Group
Repair	A repair is defined as any work performed on a conveyor belt after the original pressing where any material has been removed and/or replaced irrespective of size
Splicer	Contractor representative who is trained to execute the splice.
Splicer Supervisor	Team leader for Contractor who is trained to execute the splice

2.3.1 Classification

- **Controlled Disclosure:** Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
BW	Belt width
CSIR	Council for Scientific and Industrial Research
cm	Centimetre
ºC	Degree Centigrade
d	Diameter of steelcord
ERID	Eskom Research and Innovation Centre
h	hour
kN/m	kilo Newton per metre
kPa	kilo Pascal
MPa	Mega Pascal
mm	millimetre
N	Newton

P	Nylon
PTW	Permit to Work
QCP	Quality Control Plan

2.5 ROLES AND RESPONSIBILITIES

Contractor : To ensure compliance to the requirements outlined in this standard

Client/Supervisor : To apply the requirements in this standard during the repair or splicing of a belt to ensure strict quality control of the process and thereby providing quality assurance on behalf of Eskom.

2.6 PROCESS FOR MONITORING

Quality control process including attached check sheets.

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. TECHNICAL REQUIREMENTS TO BE SPECIFIED FOR BELT SPLICING

- The Client shall be responsible to issue Appendix A fully completed with all required information (including clause 3.1.1) to the Contractor after placing the order.
- If the Client requires the service of the third party inspectorate he must ensure that the order is placed timeously.

3.1 WORK AND SERVICES TO BE PROVIDED:

There shall be a free interchange of information between the Contractor and the Client.

3.1.1 Work and services to be provided

To assist the belt splicer to achieve required results when doing the belt splice, the following work and services over and above what is required in Appendix A is required:

3.1.2 General information provided by the client, this information may form part of the main contract:

- The date of task (splice),
- Site location, contact person telephone number and email address,
- A job description/scope of work,
- The services if available and their location i.e air, electrical power, water, and
- Safety requirements laid down by the client.

3.1.3 Information exchange

- The client must provide the contractor with a datasheet for the conveyor belt being spliced,
- The contractor must provide the client with a copy of the design of the splice for the conveyor with a drawing indicating dimensions of the splice a day prior to the contractor arriving on site, and
- The contractor provides the client with a quality control plan to be approved by the client prior to the splice. An example of a typical QCP can be found in Appendix E.

3.1.4 Past history of installation to be provided by the Client (If available)

A description of the difficulties experienced and previous belt failures, if any shall be included. This shall include:

- Any effects of chemicals added to material being conveyed,
- Wet or dry duty belt,
- The temperature of conveyed material,
- The presence of oil and grease,
- Any previous belt misalignment, and
- Any unusual mechanical problems.

3.1.5 Details of working environment to be provided by the Client

- Safety including electrical lock out of the conveyor system,
- Under cover or in the open,
- Dusty environment, and
- Ease of access.

3.1.6 Conveyor belt splicing pre-work and commissioning

The Contractor is to work closely with the client operators during the execution of the work. The bullets below describes the pre work to be undertaken before the splice is undertaken as well as the requirements after completion of the splice.

- For a new splice, position splice at the most convenient position for the splicer (splice position must be clearly marked),
- Client to electrically lockout system,
- Client to remove belt tension through take-up system and contractor to clamp belt on both sides of the splice. Enough belt slack must be provided between the belt clamps,
- Client to prepare splice area. Remove idler frame, conveyor canopies if necessary,
- After completion of the splice the client will:
  - Sign off QCP,
  - Refit idler frame/canopies,
  - Re-tension belt,
  - Run belt and check/adjust belt training,

- Sign off contractors' job card check that job card is fully filled in.

3.1.7 A competent supervisor performs the following duties:

- Verification that conveyor belt system is safe to work on,
- Supervise and execute conveyor belt splicing pre-work and commissioning,
- Check/verify:
  - Personal Protective equipment of splice work team,
  - Contractor's inspection list for splicing equipment, and
  - QCP checklist for splicing material.
- Liaise between the work site and client's maintenance/operational/production management,
- Support Splicer team in providing required services – air, potable water, electrical power supply,
- Re-commission the conveyor belt system, and
- Verify QCP during belt splicing at nominated hold points (See Appendix G).

In breakdown situations try to keep the waiting time as low as possible. Immediately after a breakdown has occurred, place splice order onto Contractor with an estimated time to be on site.

3.2 WORK AND SERVICES TO BE PROVIDED BY THE CONTRACTOR

Additionally to executing the belt splice, the Contractor is also responsible for the following:

- Providing the client with the predicted date and time of arrival on site,
- Confirm understanding of job description/scope of work,
- Indicate which client's staff is required for the job (e.g. fitters to dismantle and reassemble the conveyor fittings in the work area),
- Highlighting any particular hazards likely to arise to client's staff from the contractor executing the splicing work,
- Indicate any special instructions to expedite the work (e.g. temporarily fencing off the work area) as well as any services required i.e. Air, water and electrical power,
- The Contractor should have a specification sheet of his rubber compounds that he receives from the rubber compounder. These need to be evaluated beforehand as to determine the conditions that will transpire once the rubber has cured.
- Personnel of the Contractor assigned to undertake belt splices shall be fully trained in respect of:
  - First aid inclusive of treatment for exposure to chemical products used during splicing,
  - The execution of splicing for steel cord and plied/textile conveyor belting. The Contractor will issue proof of training in this respect of individuals. This proof of training will be available on request,
  - The Contractor's ISO 9001 Quality Management standards and associated documentation,
  - Client's standard for splicing of steel cord/textile conveyor belting,
  - Client's induction programme for Contractors,
  - Providing client with risk assessment package,

  - Adhering to lock out standards,
  - Working in accordance to ISO 9001 standards. The Contractor must provide all checklists indicating hold points as well as record critical parameters to provide assurance of a quality splice. The Contractor shall submit signed off checklists to the Client after completion of the work, and
  - Ensuring to it that the materials are used within the recommended shelf life period.
- While working, the area must be protected from the weather, dust and direct sunlight,
- Adequate and suitable tools must be in good and safe working order. The Contractor shall submit a signed-off checklist to the Client before starting with the work (See Appendix C),
- When working with solvents and solutions all safety precautions are to be followed as well as closing the lids of containers immediately after use,
- From the Contractor's workshop until the splice is complete on site no splicing material is left in the sun,
- Safety data sheets must be available at site for all products requiring this documentation,
- Humidity levels in the air must be measured and the contractor to ensure that the levels are within the acceptable levels described later in the document prior to any splice work commencing.
- Datasheet with all parameters to be provided to the client for evaluation including starting time, ambient temperature, humidity, and top and bottom element temperatures throughout the ramp/vulcanising/cooling periods (See Appendix I),
- For steel cord belting the contractor must supply an edge bar sample to an Eskom representative, this sample is to be taken for destructive testing to determine the pull out strength, and
- Submit invoice to the client within an agreed time frame.

3.3 PROCESS TO BE FOLLOWED ON ARRIVAL AT SITE

Prior to arrival on site the contractor is to ensure that he discusses all requirements with the site representative including arranging access, safety and induction requirements.

On arrival at site, the following general process is usually followed:

- Check in at station main gate (in accordance with the particular site process),
- Contact the client's authorised person (competent supervisor),
- Check the permit and sign the Workmen's Register,
- Liaise with the client's staff to ensure that splicing pre-work has been done, and
- Declare all tools at the security gate.

3.4 ADDITIONAL SPLICE EXECUTION REQUIRMENTS

3.4.1 General

- The Client may employ a third party inspectorate or use Client's personnel to implement witness and hold points as required by the quality control checklist. The Contractor shall not proceed beyond a witness point until agreed by the third party inspectorate and/or the Client supervisor,

3.4.2 Belt information

- The splicer shall verify the brand name, age, type, class and width of the belts to be spliced from the Client's records, and
- The client shall provide the brand name, the age, type, class and width of the belts to be spliced with the order number to the Contractor if available (Appendix A).

3.4.3 Splicing work station

- The splicer shall determine, in conjunction with the engineer/supervisor, the position of the splicing workstation to ensure the best possible splice,
- The splicer supervisor shall take a humidity reading before commencing with the splice preparation. A proper tent cover shall be erected over the splice workstation if:
  - The humidity is exceeding 70%. Heaters shall be provided by the splicing contractor to dry the air inside the tent cover, or
  - There is enough reason to expect rain or fog during the splicing exercise.

3.4.4 Splice proximity

No two splices shall be made within a length of the belt less than or equal to the centre distance between two drive pulleys.

3.4.5 Splicing material

- Material to be used for splicing as per the original belt manufacturer and is to be sourced from proprietary manufacturers of conveyor belt splicing materials. All materials will have a date of manufacture on the packaging and the shelf life must be clearly indicated. Cover material will have a nominal Shore hardness specified by the material manufacturer.
- The splicer ensures that all the materials used in the splice are compatible with the belt to be spliced.

3.4.6 Age limits

No material can be used for splicing if the expiry date has been exceeded. The contractor will provide proof of the expiry date for all material used.

3.4.7 Splicing site services.

- The client shall provide electricity at the following voltages if available:
  - 500V,
  - 380V, and
  - 220V

  The splicing contractor is to provide the client with his requirements. If the available supply does not meet the Contractor's requirements, the Contractor shall provide a portable generator. Voltage drop at vulcanising press shall not exceed 5 %.

3.4.8 Safety Guidance

- The splicer, his personnel and the personnel of the client shall comply to the safety Regulations and codes of the Client.

- Good housekeeping practices shall be observed at all times and the precautions listed below shall be taken when handling jointing materials used in the preparation of vulcanised joints:
  - do not use in a confined unventilated area,
  - avoid breathing the vapours,
  - wear tight protective clothes, safety goggles, gloves and ear plugs,
  - avoid contact of the materials with the skin and eyes. In case of accidental contact, treat the affected area with large quantities of water (or with the reaction agent recommended by the cement/paste manufacturer). For eyes, follow the same treatment and immediately obtain medical assistance,
  - containers of cement/paste shall be kept closed at all times except when actually in use,
  - smoking shall be prohibited,
  - accidental spillage shall be cleaned immediately. The application of any absorbent dry powder will help to remove stickiness and facilitate the removal of the spillage, and
  - after work completion all containers and knife blades shall be removed from the site.

3.5 PROCEDURE FOR CHECKING SPLICING EQUIPMENT

- Prior to departure to the splice site, the splice supervisor shall:
  - Ensure that all required tools are available and fit for use,
  - Ensure that the following are suitable and that the calibration certification is current for the equipment listed in the table below,

Table 1: Calibration and Testing

ITEM	ACTIVITY	RECOMMENDED INTERVAL
Hygrometer (Humidity Meter)	Calibration	Annually
Thermocouple gauges	Calibration	Quarterly
Platen	Temp. stability	Quarterly
Pressure gauges	Calibration	Quarterly
Cylinders	Press test, even load spread	Annually
Electrics	Correct contact and safety	Annually
Thermostat	Calibration	Quarterly
Rubber Hardness meter	Calibration	Annually

3.6 STANDARD FOR SETTING UP VULCANIZING PRESS AND TABLES (APPENDIX F AND APPENDIX G)

- Remove all canopies, idlers and idler brackets from the splicing area ensure no damage to any permanent instrumentation e.g. Long line protection,
- Ensure that there is adequate lighting

- Assemble the bottom traverses so that:
  - The top surface of the bottom platen is level with the top of the troughing roller. If necessary, use timber boards to achieve this,
  - The outer traverse is at least 25 mm outside the bias line,
  - Position the bottom platen such that the edges are parallel to the direction of the run of belt and the platen overlaps the splicing joint by a minimum of 150 mm in the belt direction,
  - Frames shall be erected on either side of the platens and between the nearest adjacent idlers to facilitate alignment of the belts to be spliced. Frames shall be securely clamped to the conveyor structure,
  - Erect wooden boards on each side of the platen a minimum of 250 mm wider overall than the belt and 3 m long, and
  - Ensure that the top surfaces of the boards are at the same level as the top surface of the bottom press platen and that the table is stable.
- Totally enclose the work area such that there is no ingress of rain or dust. Dusty areas shall be thoroughly dowsed with water 5 m on either side of the splice.

3.7 DETERMING THE SPLICING GEOMETRY

The following rules apply in determining the geometry of the splice:

3.7.1 Bias Angle

- Bias angle = 16.6°, or
- The bias angle is calculated as 0.3 BW,
- Belt length needed for the splice = splice length + (0.3 x BW.)

  where:

  BW = belt width

3.7.2 Minimum splice length for fabric belting and steel cord

3.7.2.1 For plied textile belting

- The minimum length of belting required to make a standard lap joint is derived from the following expression:
- 0.3 x BW + (np – 1) x S

  where:
  - BW is the width of the belting (mm),
  - np is the number of plies,
  - 0.3 is derived from the natural tangent of the bias angle of 16.6°,

- S is the minimum step length (strength of belt divided by number of plies). Where belting is used of a strength and fabric rating not given in Table 2 it is recommended that, as a guide, the step length given in this table for the next higher fabric rating given by dividing the belt strength by the number of plies should be used. For example, a belt strength of 1 000 kN/m with 6 plies would give a fabric rating of 1 000/6 = 167 kN/m. From this table, the next higher fabric rating would be 200 kN/m, giving a step length of 250 mm. For belting with an ultimate tensile rating of 2 000 kN/m or greater it is advisable to consult the manufacturer of the belting for the dimensions of joints.

Table 2: Determine Splice Length

1	2	3	4	5
Type	**No of plies**	**Fabric rating [kN/m]**	**Step length, S (minimum) [mm]**	**Maximum length of belting required for joint (length of joint and bias) [mm]**
315/3	3	100	150	0,3BW + 300
400/3	3	125	200	0,3BW + 400
500/3	3	160	200	0,3BW + 400
630/3	3	125	200	0,3BW + 600
630/4	4	200	250	0,3BW + 500
630/5	5	126	200	0,3BW + 600
800/4	4	200	250	0,3BW + 750
800/5	5	160	200	0,3BW + 800
1 000/4	4	250	300	0,3BW + 900
1 000/5	5	200	250	0,3BW + 1000
1 250/4	4	315	350	0,3BW + 1050
1 250/5	5	250	300	0,3BW + 1200

3.7.2.2 For steel cord belting determine splice length according to the table below.

Table 3: Splice length for Steel Cord belting

Belt Class [kN/m]	Splice Type	Dimensions [mm]	
		L1	L2
St 500	1	650	--
St 630	1	650	--
St 800	1	700	--
St 1 000	1	700	--
St 1 250	1	900	--
St 1 600	1	1 000	--
St 2 000	2	1 200	600
St 2 500	2	1 500	750
St 3 150	2	1 800	900
St 4 000	3	2 700	900

L1 = Length of the splice along centre line of belt

L2 = Length of each step for 2 and 3 stage splices

Note : For belts having strengths greater than 4 000 kN/m, or for belts having differing configurations, refer to the belt manufacturer for splice details. These splices must be agreed with the Client before commencing with work.

3.8 STANDARD FOR ALIGNMENT AND BELT POSITIONING (SEE APPENDIX F AND APPENDIX G)

- Ensure that the belt has been pulled in the correct way if new (top cover on top). For plied textile belting note the direction of travel of the belt to ensure that leading edge of splice is on the non-carrying side (pulley side) to avoid contact with the scrapers,
- Ensure that the belt is central on the conveyor supporting rollers/frames,
- Line the belting up in both directions for a minimum distance of 6 m from the splice,
- Determine splice length in accordance with the section above,
- For plied textile belting:
  - Determine number of steps (number of plies minus one),
  - Determine length of steps (one third of belt width),
- Ensure that the belt ends overlap on the bottom platen by a minimum of the splice length + (0.3 x BW) + 200 mm,

- Establish the centre line of each belt end by marking points at 500 mm intervals, going back along the belt for a minimum of 6 m and join by means of a chalk line,
- Tension the belt by pulling the ends together with belt clamps ensuring that the belt clamps are at least 3 m away from the belt ends. Note that new belt stretch must be taken into consideration when positioning take up,
- Once aligned, the belt should be firmly clamped to the platform (outside the area where the splice is to be constructed), and
- At the end of the uppermost belt, mark off a reference line at right angles to the centre line, close to the end of the belt.

3.9 PROCESS FOR PLY STRIPPING FOR PLIED TEXTILE BELTING

3.9.1 Preparation of non-carry side of belt

- From the centre line mark a 90º reference using a set square,
- From the reference line on the one side mark off the bias along the edge of the belt,
- On the edge of the belt from the bias mark measure off the steps of the belt,
- From the reference line on the opposite side measure off the steps of the splice,
- Join all markings across the belt using a chalk line,
- Carry out bias cut,
- Cut rubber cover along the marked rubber edges with knife held vertically and pull off rubber cover with pincer pliers,
- Fold belt back, (non-carrying side) draw a line parallel to bias and cut 30 mm from belt end. Cut belt cover along 30 mm line at a 45º angle without damaging top ply. Pull off rubber cover with pincer pliers,
- On the carrying side, parallel to splice length line, mark additional 30 mm. Cut at 45º angle without damaging ply and belt edges. Pull off 30 mm wide strip with pincer pliers,
- Cut rubber edges of belt flush, (If applicable - mould belt edges)
- Cut top ply 30 mm from belt cover with ply knife, and pull off first ply and cover using grip tongs and ratchet rope puller,
- Proceed removing covers and plies for all steps.

3.9.2 Preparation for carrying side of belt

- Superimpose the belt ends ensuring correct alignment of the belt edge. Secure both ends outside the splice area using clamps to avoid displacement,
- Transfer the edge of the top textile ply of the non-carrying side to the carrying side for the bias cut. Transfer textile steps on non-carrying side to carrying side,
- Carry out bias cut on carrying side,
- Draw a line 30 mm from bias cut and mark edges,
- Cut the cover of the 30 mm line at 45º angle ensuring no damage to the ply. Pull off with pincer pliers,

- Cut cover edges with knife held vertically, pull off and cut rubber edges flush,
- Proceed with steps as previously,
- Joint both belt ends and check whether the joints and the steps are matching perfectly with each other, if not rectify. Ensure that the edges are aligned, and
- Any moisture shall be removed by means approved of by the Client.

3.10 PROCEDURE FOR COVER REMOVAL FOR STEEL CORD (SEE APPENDIX H)

- On the upper belt draw the transverse oblique lines across top cover as follows.
  - Starting at the Reference Line at the end of the belt, mark the bias of 0.3 x BW off on one belt edge and from this mark the overall splice length. The overall splice length is then marked off along the other edge. Mark oblique lines with chalk line. Transfer marks to edges of both belts and mark oblique lines on remaining covers,
  - Note that for 90° edged platens no bias is required. However, the internal configuration of the splice shall be as for trapezoidal platens,
  - On the back cover make a 45° chamfered cut along the oblique line furthest from the belt end and a vertical cut along the oblique line at the belt end ensuring that sufficient cover is left on the cables,
  - Remove the cover strip using a Don Carlos knife or approved equivalent and a series of small cuts producing a rough surface. Leave a thin layer of rubber covering the steel cords,
  - Remove the solid rubber edge of the belt from the splice area,
  - Separate the cover rubber at an acute point formed by the belt edge and the oblique cut which defines the belt edge,
  - Fix a clamp to the belt and a ratchet rope puller
  - Repeat the steps above for the top cover.
- Any moisture evident shall be removed,
- Mark off the cord ends for parent and mating cords (this will vary with type of splice).
- Remove the rubber between the cords, leaving a thin film of rubber over the cord, and cut off at the inner end of the splice, in line with the marking for the end of the mating cord.
- Cut the cords to length using cable shears at the leading end of the splice in line with the marking and remove the excess belt. Ensure that cable shears are sharp to produce a clean cut and ensure that cords do not fray. **No individual cords are to be cut out of the splice without the approval of the Engineer.** In the event that this is not possible, then removal of cords shall be recorded in the Quality Plan.
- Any corrosion or evidence of poor cord to rubber bonding shall be recorded and reported to the Engineer. The Competent Supervisor must take photographs for record keeping.

In the event of corrosion or poor bonding:

- Remove all loose rubber surrounding the cord/s using a clean wire brush,
- Clean the cord/s using lint free cloth or a clean dry brush,
- Brush apply one uniform coat of an approved metal to rubber to the cord/s, and
- Allow the primer to thoroughly dry ensuring there are no runs, bubbles or tears

- Tie the cords together in bundles of approximately ten (10) to prevent tangling.
- Using the edge marks transferred from the upper belt cover and repeat steps above for the bottom cover.

3.11 PROCEDURE FOR SPLICE ASSEMBLY FOR PLIED TEXTILE BELTS (SEE APPENDIX G)

- Lightly buff the textile steps and rubber edges using a polisher ensuring no damage occurs to the textile. The intermediate rubber shall not be buffed off entirely, just enough to ensure that the high spots are flush,
- Bridge or joint gaps must be buffed with a rotating wire brush,
- All buffing dust shall be cleaned off with a brush,
- Clean all buffed rubber areas (sides and bridges) with cleaning solvent,
- Apply one coat of heating solution to both ends and allow to dry completely,
- Apply second coat on both ends (all ply steps),
- Apply intermediate skin gum to non-carrying side, stitch down using roller stitcher to remove any trapped air,
- Ensure that splice steps joins and edges are aligned correctly,
- Remove plastic from intermediate rubber. Lay the splice surfaces together and stitch from inside to outside to remove any trapped air,
- Fill both bridges or joint gaps with cover rubber and stitch vigorously, and
- Cover both bridges with silicon paper or pressure equalising cloth.

3.12 PROCEDURE FOR SPLICE ASSEMBLY FOR STEEL CORD BELTS (SEE APPENDIX H)

- Extra care and attention shall be taken when joining belts of differing thickness (i.e. new to aged). In such cases, the cover shall be feathered to match the aged belt thickness.
- Roughen the edges of the diagonal cut in the vulcanised rubber with a polisher and buff attachment and remove all buffing dust. Do not buff the cords.
- Care to be taken not to degrade the belt.
- With both ends of the belt turned back on the bench, dry clean the chamfer.
- Give the chamfer and each cord two coats of splicing cement and allow drying between coats.
- Place a piece of lightweight shirting fabric on the bottom platen, smooth out creases.
- Lay the non-vulcanised cover panel ensuring that its bonding layer is uppermost on the bottom press platen. Lower each belt end in turn onto the un-vulcanised cover and mark off the exact length required.
- Cut the cover to shape such that the chamfered ends will mate with the belt ends
- Coat the bonding layer with splicing cement and allow to dry.
- Lower the belt ends in turn to mate the chamfer on the belt with the chamfer on the unvulcanised cover panel.
- Hammer the joint ends well down with a rubber hammer. Apply a further coat of splicing cement to the non-vulcanised cover panel.

- Using the existing belt alignment marks, draw a splice line along the centre of the splicing area using a chalk line.
- Ensure that the cords are clean and dry then lay the cords as per splice type starting from the centre and alternating outwards. A minimum of 2.0 mm and a maximum of 4.0 mm are required between each cord. No part of a cord shall be less than 15 mm from the edge of the belt after final trimming,
- Fill the spaces between adjacent cords with strips of bonding compound which has been cleaned immediately prior to laying and press vertically alongside the cable just placed. Lay the bonding compound around the ends of the cords. Fill any gaps at the ends of the new laid cords with bonding compound,
- Ensure that the cords are parallel and that all of the cords are included in part of the joint,
- Using strips of freshly cleaned cover stock, build up the edge of the splice, outside of the steel cord section level with the top of the cords,
- Apply a final coat of splicing cement to the prepared area and allow to dry,
- Lay the top cover panel onto the prepared cord carcass with its integral bonding layer downwards towards the cords. Remove the entrapped air with an awl before sealing with the pressure roller,
- Trim the upturned edges of the un-vulcanised cover and remove the excess edge rubber using a knife and a straight edge,
- Place a sheet of lightweight shirting fabric on top of the prepared splice such that the fabric overlaps the ends of the splice and onto the existing belting,
- Lay a strip of shirting fabric 100 mm wide over each point where the top cover sheet joins the existing belting.

Note: The vulcanising temperature and pressure, as recommended by the splicing kit manufacture, must be logged in the datasheet (Appendix I)

3.13 PROCESS FOR CURING FOR PLIED TEXTILE BELTING (SEE APPENDIX G)

- In the event that the press has to be relocated to cater for the correct splice length, the leading edge of the splice shall be cured first. Subsequent press locations shall overlap the previous position of the press by 50 mm,
- Clamp edge irons of the correct gauge (approximately 3 mm less than nominal belt thickness) firmly against the side of the splice,
- Position the upper platen such that it matches the lower platen,
- Position the upper traverses and tighten the pre-tensioning bolts. It is important that bolts are tightened in a sequence, which will ensure a uniform load,
- When the transverses are placed under pressure the temperature of the platen should be greater than 50ºC and the gauge pressure greater than 0.3 MPa,
- Increase the gauge pressure to a minimum of 1.2 MPa as the temperature rises to 115ºC ensuring that the alignment is correct. During the heating cycle maintain the platen temperature at 110°C to 115°C for a period of 10 minutes to allow full flow of splice materials by switching the platens off at 115°C and switching on at 110°C. After 10 minutes allow temperature to increase to full curing temperature of 145°C,
- Required hydraulic pressure should be calculated for the particular press in use, taking into account ram diameters,

- Start the curing time measurement when the press platen reaches 145°C. A guide to curing times is given in Table 5,
- Curing takes place at 145 ± 2°C with the temperature kept as stable as possible,
- In unfavourable conditions protect the edges of the press by fabric or wooden shields,
- Once the cure is complete keep joint under full hydraulic pressure until the platens have cooled down to below 80°C, and
- Forced cooling by compressed air or water is permitted,
- A tarpaulin cover must be placed over the press when the heating commences.

3.14 PROCEDURE FOR CURING FOR STEEL CORD BELTING (SEE APPENDIX H)

The splicing technology is a chemical reaction of rubber at a given temperature. The mixed compound is in a vulcanised state (rubber has plastic characteristics). The finished product is in a vulcanised state (vulcanised rubber has elastic characteristics). The vulcanisation is a chemical process, where loose molecule groups cross-link with each other. The vulcanisation is the transition of rubber from plastic into elastic characteristics. This is an irreversible process.

- In the event that the press has to be relocated to affect the correct splice length, the leading edge of the splice shall be cured first. Subsequent press location shall overlap the previous position of the press by 50 mm.
- Clamp edge irons of the correct gauge (approximately 1 to 2 mm less than nominal belt thickness) firmly against the side of the splice.
- Position the upper platen such that it matches the lower platen.
- Position the upper traverses and tighten the pre-tensioning bolts. It is important that bolts are tightened in a sequence, which will ensure a uniform load.
- When the transverses are placed under pressure the temperature of the platen should be greater than 100°C, and the specific pressure should be greater than half of the vulcanising pressure.
- Increase the specific pressure to full vulcanising pressure as the temperature rises to the vulcanised temperature

Note: The vulcanising temperature and pressure, as recommended by the splicing kit manufacture, must be logged in the datasheet (Appendix I)

- Start the curing time measurement when the press platen reaches vulcanising temperature. A guide to curing times is given in Table 4.

Note: it is advisable to consult the materials manufacturer's recommendations with regard to curing times. As a guide every increase in belt thickness by 1 mm requires prolonging curing time by 3 minutes.

- Curing takes place at the manufacturers recommended temperature (within + 5°C) and must be maintained during the vulcanising process.
- In unfavourable conditions protect the edges of the press by fabric or wooden shields.
- Once the cure is complete keep joint under full hydraulic pressure until the platens have cooled down to 80°C.
- Forced cooling by compressed air or water is permitted,
- A tarpaulin cover must be placed over the press when the heating commences.

3.14.2 The Control System

The control system is a very important part of the overall performance. The controller is viewed as important from the control point of view balancing the temperatures within the desired curve and more important throughout the vulcanising period. In most cases the monitoring is done manually onto a datasheet and afterwards the client would gather this data and use Microsoft Excel to draw the points and plot them against the theoretical curve for acceptance. The relationship between temperature; pressure and time is viewed as critical.

The requirement is time based on ramp at ±3°C per minute and 3 minutes per mm belt thickness for vulcanising. Maximum vulcanising temperature is 145°C (within ±2°C). This applies to steel cord and ply conveyor belting that is hot spliced.

3.14.3 Hot Vulcanisation Process

- Requirements are:
  - Sulphur and accelerator chemical reaction,
  - Temperature 145ºC,
  - Pressure min. 7-8 kg/cm^2,
  - Time 3 minutes/mm belt thickness from 12 mm upwards, and
  - Material shelf life 12 months at 20ºC

Note: that it is advisable to consult the materials manufacturer's recommendations with regard to curing times.

3.14.3.1 Vulcanising periods (averages)

Table 4: Vulcanising periods (averages)

Total Belt Thickness [mm]	Vulcanising period [minutes]
Up to and including 6	25
Over 6 up to and including 12	30
Over 12 up to and including 20	36
Over 20 up to and including 26	60
Over 26 up to and including 32	78
Over 32 and up to and including 38	96
Over 38 and up to and including 46	114

3.14.4 Cold Vulcanisation Process

- Requirements are:
  - Sulphur and accelerator chemical reaction,
  - Temperature ambient,
  - Pressure initial stitching,
  - Time determined by recommendation on adhesive approximately 15 mins – 1 hour, and
  - Material shelf life 24 months at 20ºC.

4. REPAIRS OF STEEL CORD AND FABRIC REINFORCED CONVEYOR BELTS

For a detailed explanation on the belt construction, refer to SANS 1173 (2013) for textile reinforced belting and SANS1366 (2013) for steel cord reinforced belting.

4.1 MANUFACTURING/FACTORY REPAIRS

- Prior to any repairs being undertaken on a new belt, the contractor must submit their repair procedure to the engineer for approval,
- Only hot vulcanised repairs will be accepted for new belts. The vulcanisation process will be in accordance to Section 3.14.3 above,
- No conveyor belt shall be accepted if the total number of repairs exceeds 1 for every 50 m^2 of manufactured belting,
- The area of the belt roll is calculated using belt width x length and includes the top and bottom cover,
- Repair size shall not exceed 100 x 100 mm,
- Repairs where there is no cable damage may be repaired in the same way as any belt in that the damaged area is thoroughly cleaned and dried. The damaged elements such as cover, plies, insulation, gum etc., must be replaced and the new elements cured. The curing parameters for a repair must be the same as for a normal splice as detailed in the preceding sections,
- If the cable has been exposed it is important to use the manufactures recommended cable cement and cable insulation gum at that point,
- No repairs on new belts will be allowed where cables have been damaged. No splices will be accepted on a standard conveyor belt roll length, and
- Every factory repair done shall be documented and submitted with the conveyor belt roll data pack to the client.

4.2 ON SITE REPAIRS OF USED BELTS

- For on-site repairs on used belts, only hot repairs will be accepted as permanent repairs. The hot vulcanisation process shall be in accordance with Section 3.14.3 above,
- An on-site repair procedure shall be submitted by the repair contractor, and approved by the engineer prior to any repair being undertaken,
- In preparation for the repair of belt the rubber covers and the carcass materials must be cleaned and all contaminants removed. Water soluble contaminants are cleaned by first scraping off as much of the contaminant as possible and then washing off whatever remains. Oils and greases should be removed by using a cleaning solvent,
- Repairs where there is no cable damage may be repaired in the same way as any belt in that the damaged area is thoroughly cleaned and dried. The damaged elements such as cover, plies, insulation, gum etc, must be replaced and the new elements cured. The curing parameters for a repair must be the same as for a normal splice as detailed in the preceding sections. If the cable has been exposed it is important to use the manufactures recommended cable cement and cable insulation gum at that point,

- If damage is more extensive, sections of new cable shall be worked in. This makes a more extensive repair as the new lengths of cable shall extend 200 to 400 cm each side of the broken area and a large vulcaniser is usually required. The covers shall be removed along with insulation gum from between the cables. The new cable sections shall be placed between the old broken ones extending 200 to 400 cm each side of the break. Cable cement, insulation gum and covers shall be applied and the repair cured,
- Replacement of fabric in Fabric Reinforced belts is optional. This is frequently just filled with insulation gum and cover gum, especially if the damage is in areas not receiving excessive impact. Large centrally located repairs would normally have the fabric replaced as this would be for impact protection, which is the prime purpose of the fabric,
- The curing parameters for a repair must be the same as for a normal splice.

4.3 WORK AND SERVICES TO BE PROVIDED:

4.3.1 Work and Services to be provided by the Belt Manufacturer/ repair contractor

Additionally to executing the belt repair, the Belt Manufacturer/ repair contractor is also responsible for duties listed below:

- The belt manufacturer/ repair contractor shall issue proof of training for individuals undertaking the work to show that they have been trained with respect to the repair of conveyor belting. This proof of training (certification) and competency level (years of experience) of the individuals shall be available on request,
- Working in accordance to ISO 9001 procedures. The belt manufacturer/ repair contractor shall provide all quality control checklists to the client for approval prior to the work commencing,
- While working, the area shall be protected from the weather, dust and direct sunlight,
- Adequate and suitable tools shall be in good and safe working order,
- When working with solvents and solutions all safety precautions shall be followed, i.e.by closing lids of containers immediately after use,
- Prior to repair work commencing, the contractor will measure the humidity of the air and ensure that it does not exceed 70%, any moisture on the belt will be removed by drying the repair surface, and
- Datasheet from appendix I must be completed

4.1 BELT REPAIR EQUIPMENT

The same requirements applicable to splicing equipment are applicable to the equipment used to undertake repairs. Refer to Section 3.5 above. In addition the following requirements will also be applicable.

4.1.1 Press

- The press shall be capable of exerting the required pressure and maintaining a controlled temperature to suit the range of belting constructions to be repaired as detailed in the preceding sections under splicing,
- The platens shall be of suitable design to ensure uniform loading across the surface of the belting,
- The press shall be checked at regular intervals with a straight edge to ensure platen flatness and for even temperature distribution,

- The platens shall be at least 100 mm wider than the belting to be repaired and the overlap of the platens on to the portion of the belt outside the repair area shall be a minimum of 50 mm,
- For the edge repair, the mould bars (side-bars) shall be slightly thinner (one millimetre) than the belting to be repaired to constrain the repair width and to prevent the repair spreading under pressure, and

4.2 QUALITY ASSURANCE PROVISIONS

4.2.1 Quality management system

ISO 9001 Quality Management Process shall be applied at all times. It is the responsibility of the Contractor to review Quality Requirement documentation and to provide such documentation at arrival on site.

4.3 QUALITY PLAN

The Contractor shall submit a quality plan at time of quotation/arrival on site for review by the Engineer.

A sample quality plan is given in Appendix F and G.

4.4 RECORDS

- The Contractor shall keep the following records for a minimum period of 36 months from conclusion of the contract:
  - Name of the business unit,
  - Conveyor Number,
  - Job Number /Order number,
  - Splice/repair Number,
  - Batch numbers and date of manufacture of splicing/repair materials,
  - Curing pressure and temperature measured at 15 minute intervals,
  - Finished splice dimensions (i.e. length and thickness measured at both edges and centre) or repair dimensions,
  - For belt repairs, records shall be kept of the checks for flatness and temperature distribution of platens,
  - Splicing or repair date,
  - Splice or repair contractors name, and
  - Hardness of splice/repair.

4.5 MATERIAL CERTIFICATION

Materials used for covers complies with the requirements as defined in SANS 1366 and SANS 1173.

4.6 QUALITY CONTROL

4.6.1 Access

The Clients representative shall have access at all reasonable times to inspect the splice/repair and curing compliance with this specification. An inspection checklist for use by the Clients representative is given in Appendix G and H.

4.7 GUARANTEE OF SERVICES

The Contractor shall guarantee his workmanship and materials for a minimum period of three (3) years following the completion of the splice. For steel cord belting there shall be a one (1) year guarantee against visual evidence of oxidation/corrosion of the steel cords.

All repairs done on conveyor belting shall carry the same guarantee as the parent belt

4.7.1 Shelf Life of Materials

- All material should be stored at an ideal temperature of between 16°C to 18°C.
- Solutions are marked with “Expiry Dates”;
- Rubber marked with “Manufacturing Date”;
- Batch numbers of the products must be recorded on the relevant Quality Control documentation, and
- The datasheet identifies all the possible rubber compound tests that are required to determine suitability with conveyor belting used in ESKOM.

4.7.2 Rubber Characteristics used by the Contractor

The contractor must capture the rubber characteristics used on the table found in Appendix J.

4.7.3 Data Sheet

The datasheet must be compiled when the contractor starts the press recording the temperatures of the top and bottom element against time every five (5) minutes. The humidity and ambient temperature can be recorded once of, when the press starts to ramp from ambient temperature. The ramp/vulcanising and cooling temperature/times must be recorded until the press is removed at 80°C. Limits imposed on the vulcanising temperature in loss of power after 70°C in the ramp phase and cooling phase temperature up to 130°C the complete splice must be redone.

4.7.4 Monitoring Equipment

The instruments used to record data are a hand-held humidity/temperature measurement instrument. A digital hand-held instrument monitors the temperatures of the press elements. Thermocouples are mounted on the top and bottom elements to provide temperature of both elements throughout the vulcanising process. Spare thermocouples should be available in case the thermocouples are damaged. A minimum of three (3) thermocouples shall be used.

4.7.5 Critical Factors for Splicing and Repairs

4.7.5.1 Weather Conditions

These parameters shall be adhered to before a splice preparation can start:

- Relative Humidity : should be below 70%
- Sun : do not expose material to direct sun
- Dust : less than 2 mg/cm³

4.7.5.2 Recommended Time Allowance for work completion for splices

Table 5: Time Allowance for plied textile belting

Width of Belt [mm]	Class of Belt EP500/4 EP 630/4		Class of Belt EP 800/4 EP1 250/5	
	Cold	Hot	Cold	Hot
1 200	5 hours	8 hours	5½ hours	8 hours
1 350	5 hours	8 hours	6 hours	8 hours
1 500	5½ hours	8 hours	6½ hours	8½ hours
1 800	6 hours	8 hours	7 hours	12 hours
2 100	7 hours	11 hours	8 hours	12 hours
2 400	8 hours	12 hours	9 hours	12 hours

Table 6: Time allowance for hot splicing of steel cord belting

Width of Belt [mm]	Class of Belt	Class of Belt	Class of Belt
	St 630/800	St 1 250	St 1 600
1 200	8 hours	8 hours	10 hours
1 500	8 hours	8 hours	10 hours
1 800	8 hours	8 hours	11 hours

4.7.5.3 Job Preparation

The Contractor obtains all the necessary information with respect to belt class, belt width, scope of work, start time of work, location and on-site conditions. Good information allows for the correct selection of materials, tools needed, equipment and team to undertake the work.

4.7.5.4 The Materials (Cold Splicing textile/ply)

The material requirements are very dependent on the application. All of the materials used should have a shelf life and used within pot life. Material should be free of contamination and moisture:

- Adhesive/hardener. (Adhesive must achieve 12 N/mm in pull-out test),

4.7.5.5 The Materials (Hot Splicing Textile/Ply)

The material requirements are very dependent on the application. All of the materials used should have shelf life and used within pot life and free of contamination and moisture:

- Adhesive/hardener. (Adhesive must achieve 12 N/mm in pull-out test)

4.7.6 Calibration of Equipment

When the contractor purchases expensive equipment such as presses the performance of the press over 100 splices reduces proportional over time. The calibration of this equipment is undertaken every six (6) months. All of the components such as hydraulic cylinders mounted within the beams, hydraulic jack, gauges, heating elements, thermocouples, hand held instruments (such as thermometer and hygrometer) and the controller must be calibrated regularly. Test certificates must be verified before the press can be used. Previous history of the calibration can be requested from the contractor.

4.7.7 Condition Monitoring

- No textile/ply condition monitoring is in place as yet.
- Presently all the steel cord conveyor belting within Eskom Power Stations is condition monitored via a non-destructive testing method. All signatures of the splices are recorded in a data package. All corrective measures are based on the results from the test. An average steel cord splice should last a minimum of fifteen (15) years.

4.7.8 Evaluation Principles

The client will use various tools at his disposal for evaluation purposes of the splices performed. One method would be the temperature/time/pressure data supplied by the contractor. Shore hardness mapping measurement of the surface of the completed conveyor belt splice (non-and carrying side of belt). For steel cord belting edge bar sampling performed at ERID or a full width pull out test performed at CSIR in Johannesburg according to SANS 1366 pull-out “as received and after reheating” formulas can be performed.

The summary of the test report from the testing is as follows:

- Steel Cord Belt Splices (hot)
- Temperature/time/pressure data;
- Shore hardness mapping of splice surface top and bottom covers;
- Pull Out Strength (N/mm)
  - As Received: = 14d + 24; [new belt from factory before splicing]
  - After reheating: = 14d + 19; [aged - and belting that has been vulcanised again]
  - Edge bar sample; pull-out test (ERID)
    - 85% of original belt strength for new belt;
    - 70% for belt < 10 years old and
    - 50% for belt > 10 years old.

- Full width pull-out test (CSIR) [new belt] **> 100% of original belt strength; limited to maximum of 1 200 mm belt width.**

Splice Identification Practices

- Each splice will have embossed on the top cover the contractor's emblem with splice number and date of splice. The identification details must be positioned approx. 150 mm from the edge of the conveyor belt.

Each splice shall be marked as follows:

  - Markings shall be a minimum of 1.5 to 2 mm deep and within 150 mm of the belt edge.
  - Steel stencil plates positioned within the vulcanising press on the return side of the belt.
  - Contractor's name or logo.
  - A unique splice number.
  - Month and year completed
  - Letter size shall be 50 mm (minimum)

- No splice will be accepted unless all requirements within this document have been met.

4.8 TEST AND INSPECTION

4.8.1 Dimensions

After dismantling the platens, the joints shall be checked for dimensions and straightness (the maximum edge length deviation is 1.5 mm) and also for any excess rubber which should be removed where necessary.

4.8.2 Hardness and visual inspection

- After completion of the splice/repair the splice/repair must be inspected for any defects such as blisters or lifting. The splice/repair supervisor together with the clients engineer will determine whether the defects are acceptable,
- After completion of the splice/repair the hardness of the material in the splice/repair area, must be measured with a shore hardness tester. Test results must be compared with the data sheet of the splice-kit supplier,
- For splices/repairs select nine (9) places on both the top and bottom covers (i.e. three (3) across the leading edge, three (3) across the centre and three (3) across the trailing edge) and record the hardness obtained. See Appendix F and G for splices and Appendix L for belt repairs,
- The average shore hardness obtained for the splice/repair shall be within five (5) units of the nominal hardness as specified by the materials manufacturer,
- Any individual reading of more than five (5) units below the nominal hardness specified by the materials manufacturer shall be cause for investigation and possible rejection. This deviation must be reported to the clients engineer, and
- When taking the hardness measurement, the splicer/repairer must consider the temperature of the splice/repair. Higher temperature may yield incorrect readings.

4.9 CLEAR THE PERMIT TO WORK (PTW)

After the splice is completed the contractor has to clear the permit with the client supervisor before the commissioning of the conveyor installation.

4.10 VISUAL CHECK FOR SPLICE STRAIGHTNESS

By means of a chalk line, create a grid across the entire surface of the splice as follows:

- Lines at right angles to the belt travel at 100 mm centres,
- Lines in the direction of the belt travel at 100 mm centres, and
- After running the belt check for gross distortion of the grid pattern.

4.11 COMMISSIONING

The client supervisor must give immediate feedback to the splicer in respect of any non-conformance (e.g. Splice skewness etc.) after commissioning of the conveyor installation.

4.11.1 Destructive Testing for steel cord belting

There are three basic tests performed on belting. One is being pull-out of the edge bar sample. The acceptance criteria for the edge bar sample is >85% of original belt strength. The other is the full width belt pull-out test conducted at the CSIR in Johannesburg. The full width test is conducted on a splice situated equally between two (2) 4 metre lengths of steel cord belting. The acceptance criteria is >85% of original belt strength. All tests are static pull out parameters.

The last test is the dynamic test whereby the specimen is exposed to cyclic loads at 36% of belt strength for dwell times of ten (10) seconds and release tension to 3.6% and again hold the force for another dwell period of ten (10) seconds. This is undertaken over 10 000 cycles.

In all tests a third party tests the specimens in a laboratory under controlled conditions.

4.11.2 Non-Destructive Testing for steel cord belting

Non-destructive testing of the belt joint is limited. The belt can be flexed at the joint to check if there are weak areas due to lack of adhesion. When steel cord splices are tested the Shore hardness of the rubber may give a good indication of the degree of rubber cure. Shore hardness, 24 hours after the vulcanising press was removed, may not exceed 65 ± 5 Shore A. No area in the splice may exceed this specified criteria. Generally the splice should be evenly recorded in all eight plains.

4.12 TESTING EQUIPMENT

- All the testing is done with a hand-held Shore A durometer or IRHD meter would be suitable instrument to carry out such a test.
- All temperature/humidity recording is done via Thermo-Hygro instrument or equivalent. The top and bottom element temperatures monitoring via surface contact with the use of a Digital Thermometer or equivalent.

4.13 REQUIREMENTS FROM CONTRACTOR BY THE CLIENT

The contractor when complete with his splice/repair should provide the client with the following:

- Completed data sheet and checklists as specified in the document,
- Edge bar sample, and
- Any concerns noted through the vulcanising procedure.

4.14 LEAVING SITE

- After establishing that the joint/repair is sound and neatly made, all equipment shall be cleaned and removed. All waste material shall be removed and the immediate area around where the work has been carried out shall be cleaned.
- Finally, the belt shall be commissioned by the client ideally in the presence of the contractor and then re-inspected to ensure that the joint/repair is satisfactory. Documentation, including the signing-off of any permit to work (Workmen's Register), shall be completed and the client advised that the work has been completed.

5. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Henk Fourie	Chief Engineer Bulk Materials Handling
Andrew Matlala	Chief Engineer Bulk Materials Handling
Tiyani Khosa	Senior Engineer Bulk Materials Handling

6. REVISIONS

Date	Rev.	Compiler	Remarks
November 2016	0	M. Bagus	Final Draft Document for Internal Review Process
November 2016	0.1	M. Bagus	Final draft for Comments Review Process
December 2016	0.2	M. Bagus	Final draft after Comments Review Process
December 2016	1	M. Bagus	Final Document for Authorisation and Publication
December 2016	1.1	M. Bagus	Updates made to baseline by Henk Fourie Final Draft
December 2016	2	M. Bagus	Final Rev 2 for Authorisation and Publication
November 2017	2.1	M. Masina	Added Reference to SANS 485,SANS484-1, SANS484-1
November 2017	3	M. Masina	Final Rev 3 for Authorisation and Publication

7. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Ismail Atiya
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- Henk Fourie

- Tiyani Khosa
- Andrew Matlala
- Andries Wiid

8. ACKNOWLEDGEMENTS

- Dennis Child

APPENDIX A: INFORMATION TO BE PROVIDED BY THE CLIENT TO THE CONTRACTOR TEXTILE PLIED BELTING

ORDER NO: _____

BUSINESS UNIT: _____ JOB NO: _____

SPLICER NAME: _____ CONTRACTOR: _____

CONVEYOR NO: _____ SPLICE NO: _____

SPLICE TYPE: _____ DATE: _____

1	Title, number, date and issue of this Document:	
2	Location of conveyor:	Incline conveyor/surface conveyor*
3	Contact person on site:	
4	Tel no:	
	Fax no	
5	Belt width:	
6	Belt class:	
7	Belt manufacturer:	
8	Original belt (parent belt)	
9	No. of plies	
10	Splice length	TBD by Contractor
11	Insert spec	
12	Cover thickness:	
13	Top	
	Bottom	
	Cover material:	
14	Top	
	Bottom	
	Weather conditions	
15	Splice type Aged to Aged:	
16	New to aged	
17	Estimated time of arrival at site required	
Signed:		Date:

APPENDIX B: INFORMATION TO BE PROVIDED BY THE CLIENT TO THE CONTRACTOR FOR STEEL CORD BELTING

ORDER NO: _____

BUSINESS UNIT: _____ JOB NO: _____

SPLICER NAME: _____ CONTRACTOR:_____

CONVEYOR NO: _____ SPLICE NO: _____

SPLICE LENGTH: _____ _____SPLICE TYPE:_____ DATE: _____

1	Title, number, date and issue of this Document:	
2	Location of conveyor:	Incline conveyor/surface conveyor*
3	Contact person on site:	
4	Tel no :	
	Email :	
5	Belt width:	
6	Belt class:	
7	Belt manufacturer:	
8	Original belt (parent belt)	
9	No. of cords	
10	Cord diameter	
11	Splice length	TBD by Contractor
12	Insert spec	
13	Cover thickness:	
14	Top	
	Bottom	
	Cover material:	
15	Top	
	Bottom	
	Weather conditions	
16	Splice type Aged to Aged:	
17	New to aged	
18	Estimated time of arrival at site required	
Signed:		Date:

APPENDIX C: TOOLS

The following minimum tools are recommended for belt splicing:

	Condition checked	
	Yes	**No**
Vulcanising press		
Roller stitchers (2, 4, 12 and 50 mm)		
Wire brush (rotary)		
Polisher		
Rubber mallet		
Soft hand brushes		
Ratchet rope puller and pulling cables		
Chalk		
Chalk string		
Awl		
Stanley knife (or equivalent)		
Stanley blades (or equivalent)		
Saddler's knife (shoemaker)		
Saddler's pliers		
Cutting knife (straight blade, Don Carlos or equivalent)		
Paring knife (offset blade)		
G clamps		
Whetstone		
Steel rule		
5m Tape measure		
Rubber hardness meter		
Buffing attachments		
Edge irons		
Set square		
Belt and press support frames		
Solution application brushes		
Ply knife		
Ply lifter		
Grip tongs (eccentric clamp)		
Rope sling		

STEEL CORD SPLICE

The following minimum tools are recommended for belt splicing:

	Condition Checked	
	Yes	**No**
Vulcanising press		
Pressure roller		
Pressure roller (double acting)		
Wire cutter or cable shear		
Wire brush (rotary)		
Polisher		
Rubber mallet		
Standard mallet		
Soft hand brush		
Hand vice/eccentric clamp/frog clamp		
Ratchet rope puller and pulling cables		
Cutting pliers		
Chalk		
Chalk string		
Awl		
Pricker roller		
Scribing knife		
Saddler's knife		
Saddler's pliers		
Cutting knife (straight blade, Don Carlos or equivalent)		
Paring knife (offset blade)		
Scissors		
Screw clamps		
Whetstone		
Steel rule		
5m Tape measure		
Rubber hardness meter		
Hand drill		
Buffing attachments		
Edge irons		
Set square		
Belt support frames (6 off)		

APPENDIX D: MATERIALS

A proprietary manufacturer of conveyor belt splicing materials or other approved source shall supply materials used for a splice.

LIST OF MATERIALS FOR A STEEL CORD SPLICE

- Cover stock (including bonding layer).
- Bonding compound strips between each steel cord
- Splicing cement
- Cleaning solvents (cleaning of rubber covers only, not to be used for steel cords)
- Shirting, used between heating platens and rubber
- Rubber to Steel Primer (ECORRLOK VS20) or approved equivalent

Note:

- Chlorinated solvents must not be used for washing the stripped steel cords, nor for thinning cements applied to the steel cords. Residual Chlorinated solvents react with the zinc coating on the steel cords during the vulcanising process and may cause severe loss of adhesion.
- Urethane or Cellulose sponges, clean and dry brushes and new clean cohite cotton rugs are preferred for cleaning and cementing steel cords and should be properly disposed of after use.

  Re-cycled rags have been experienced to contaminate the steel cord surfaces. Paper towels may not be used

LIST OF MATERIALS FOR A TEXTILE PLIED BELT SPLICE

- Cover stock (including skin gum).
- Splicing cement (heating solution)
- Cleaning solvents
- Shirting, used between heating platens and rubber

APPENDIX E: QUALITY PLAN FOR TEXTILE PLIED BELTING

ORDER NO: _____
BUSINNESS UNIT: _____JOB NO: _____

SPLICER NAME: _____CONTRACTOR: _____

CONVEYOR NO.: _____ SPLICE NO: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____DATE: _____

QP NO	**ACTIVITY**		**ACTION**		
		CLAUSE NO.	**SPLICER**	**BUSSINNESS UNIT**	**THIRD PARTY**
1	Arrange for permit to work		V	A	A
2	Establish type and class of belt		A		W
3	Establish work station		A		W
4	Check splice proximity		V		W
5 5A	Check materials Record batch numbers and date of manufacture		V A		 V
6	Check splicing equipment		V		
7 7A	Set up press and tables Inspect set up		A		W
8 8A	Align belt Inspect alignment		A		W
9	Remove covers		A	W	W
10 10A	Trial assemble splice Inspect trial assembly		A		W
11 11 A	Final assemble splice Inspect final assembly		A		 W
12	Pre-cure inspection				W
13 13A	Cure splice Record cure parameters		A A		 V
14 14A	Inspect splice Record dimensions		A		 V
15	Clear the permit		H	A	V
16	Commission splice		H	V	A

QUALITY PLAN FOR TEXTILE BELTING

(continued)

CURE STARTED: ..... CURE COMPLETE: .....

CURING PARAMETERS		
TIME	**PRESSURE**	**TEMPERATURE**

COMPLETE CURE RESULTS					
LOCATION	**THICK. [mm]**	**SPLICE LENGTH [mm]**	**HARDNESS (SHORE A)**		
			LOCATION	**TOP BRIDGE**	**BOTTOM BRIDGE**
Leading edge			Left hand		
Centre			Centre		
Trailing edge			right hand		
	Average hardness				
	Nominal hardness				

SIGNED: _____ _____
Supervisor Splicer Supervisor / Engineer

APPENDIX F: QUALITY PLAN FOR STEEL CORD BELTING

ORDER NO: _____

BUSINNESS UNIT: _____ JOB NO: _____

SPLICER NAME: _____ CONTRACTOR: _____

CONVEYOR NO: _____ SPLICE NO: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____ DATE:_____

NO	ACTIVITY ESKOMQP SPECIFICATION No	CLAUSE NO:	ACTION	
			SPLICER	BUSINESS UNIT OR THIRD PARTY
1	Arrange for permit to work/Isolation of conveyor belt		V	A
2	Inspect availability and condition of tools (Appendix B)		A	V
3	Verify age, type and class of belt		V	A
4	Establish work station		A	A
5	Check splice proximity		H	A
6	Check materials		A	V
7	Record batch numbers and date of manufacture		A	V
8	Check splicing equipment		A	V
9	Set up press and tables		A	A
10	Inspect set up		A - H	W
11	Align belt		A – H	W
12	Inspect alignment		A – H	W
13	Remove covers		A	-
14	Check for moisture on steel cords		A	
15	Inspect cords for oxidation and corrosion		A – H	A
16	Corrosion Protection of Cords		A	W
17	Final assemble splice		A	W
18	Inspect final assembly		A – H	W
19	Pre-cure inspection		A	W
20	Cure splice		A	W
21	Record cure parameters		A	V
22	Inspect splice		A	A
23	Record dimensions		A	V
24	Clears permit		A	V
25	Commission conveyor		V	A

Legend: A – Action V – Verification H – Hold W - Witness

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

QUALITY PLAN FOR STEEL CORD BELTING (PAGE 2 OF 2)

CURE STARTED:_____ CURE COMPLETE:_____ AMBIENT

TEMPERATURE:_____ °C (at start) _____

HUMIDITY PERCENTAGE: _____ % (at start) _____

CURING PARAMETERS		
Time	**Pressure**	**Temperature**

COMPLETE CURE PARAMETERS										
LOCATION	**THICK. [mm]**	**SPLICE LENGTH [mm]**	**Recommended hardness from manufacturer**	**HARDNESS (SHORE A)**						
				TOP COVER			**BOTTOM COVER**			
Leading edge										
Centre										
Trailing edge										
Average hardness										
Nominal hardness										
Hardness of conveyor belt										

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

APPENDIX G : INSPECTION CHECKLIST FOR FABRIC BELTING

BUSINESS UNIT: _____ JOB NO.: _____

SPLICER NAME: _____ CONTRACTOR: _____

CONVEYOR NO: _____ SPLICE NO: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____ DATE: _____

F1	SET UP	YES	NO
	QC plan Approved and available		
	Working station suitable for splicing		
	Top surface of bottom platen level with top of troughing roller (if applicable)		
	Platten edges parallel to direction of run of belt		
	Wooden boards approximately 250 mm wider than belt		
	Top surfaces of boards are same level as top surface of bottom press platen		
	Tables are stable with a minimum length of 3 m		
	Rolls & brackets adjacent to splice removed		
	All splicing materials to specification and within recommended shelf life		
F2	ALIGNMENT	YES	NO
	Belting is lined up in either direction for a minimum distance of 6 m		
	Belt is central on the conveyor of supporting rollers		
	Ends overlap on the bottom platen		
	Overlap is sufficient		
	Centre line is established for a minimum of 6 m		
	Chalk reference lines are drawn across the ends of each belt		
	Belt is firmly clamped to the platform (outside the splice area)		
F3	PREPARATION AND ASSEMBLY	YES	NO
	Splice length correct (equal to belt width, min.)		
	Step length correct (1/3 of belt width)		
	Textile steps buffed		
	Buffing dust brushed		
	First coat heating solution applied - dry		
	Second coat heating solution applied		
	Skin gum applied and stitched		
	Bridges filled and stitched		

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

INSPECTION CHECKLIST for fabric belting (Continued)

BUSINESS UNIT: _____ JOB NO.: _____

SPLICER NAME: _____ CONTRACTOR: _____

CONVEYOR NO.: _____ SPLICE NO.: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____ DATE: _____

		YES	NO
	Belt ends laid and vigorously stitched		
	Entrapped air removed before sealing		
	Edges of un-vulcanised splice trimmed to width		
	Shirting cloth 100 mm wide over bridge		
	Trial assembly satisfactory		
F4	PREPARATION AND ASSEMBLY (Continued)	YES	NO
	Chamfers cleaned with solvent and dry		
	Shirting cloth placed over the bottom platen and smoothed		
	Pre-heat on bottom press platen is 50°C		
	Belts aligned to within 1 mm		
F5	CURING	YES	NO
	The temperature of the platen is 50°C		
	The length of splice is correct		
	Alignment is correct		
	Upper platen is positioned to match lower platen		
	Traverses correctly positioned		
	Temperature held between 110 and 115°C for 10 minutes		
	Curing temperature reaches 140°C		
	Pre-tensioned bolts are uniformly tightened		
	Pressure reaches 1.2 MPa		

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

INSPECTION CHECKLIST for fabric belting (Continued)

BUSINESS UNIT:_____ JOB NO.: _____

SPLICER NAME: _____ CONTRACTOR:_____

CONVEYOR NO.: _____ SPLICE NO.: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____ DATE:_____

F5	TESTING	YES	NO
	Dimensions within tolerance		
	Edges straight		
	Excess rubber removed		
	No blistering		
	No lack of adhesion		
	Shore hardness within tolerance		
	Commissioning satisfactory and Engineer's approval obtained		

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

APPENDIX H: INSPECTION CHECKLIST FOR STEEL CORD BELTING

BUSINESS UNIT: _____ JOB NO: _____

SPLICER NAME: _____ CONTRACTOR:_____

CONVEYOR NO: _____ SPLICE NO: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____ DATE: _____

F1 SET UP	**YES**	**NO**
Work station suitable for splicing:		
Top surface of bottom platen level with top of troughing roller:		
Platen edges parallel to direction of run of belt:		
Wooden boards approximately 250 mm wider than belt:		
Top surfaces of boards are same level as top surface of bottom press platen:		
Tables are stable with a minimum length of 3 m:		
F2 ALIGNMENT	**YES**	**NO**
Belting is lined up in either direction for a minimum distance of 6m		
Belt is central on the conveyor supporting rollers		
Ends overlap on the bottom platen		
Overlap is sufficient		
Centre line is established for a minimum of 6 m		
Chalk reference lines are drawn across the ends of each belt		
Belt if firmly clamped to the platform (outside the splice area)		
Belt has been checked for age		
Splice length according to Table 3		
F3 CORDS	**YES**	**NO**
Sufficient rubber has been separated from the cords		
Cover strips removed producing a non-smooth surface		
Thin layer of rubber covering the steel cord		
Rubber between cords removed leaving a thin film of rubber over the cord		
Cords checked for damage and corrosion Cords suitably protected against Corrosion		
Cords tied together in bundles		
Cords brushed with clean dry brush		

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

INSPECTION CHECKLIST FOR STEEL CORD BELTING

BUSINNES UNIT: _____ JOB NO: _____

SPLICER NAME: _____CONTRACTOR: _____

CONVEYOR NO: _____ SPLICE NO: _____

SPLICE LENGTH: _____ SPLICE TYPE: _____DATE: _____

F4 SPLICE ASSEMBLY	YES	NO
Edges of diagonal cut in the vulcanised rubber chamfered Length of splice is correct		
Roughed with a polisher and buff attachments		
No degradation		
Chamfer cleaned		
Bonding compound cleaned with solvent and dry		
Shirting fabric placed over the bottom platen and smoothed		
Non-vulcanised bottom cover cut to size and shape. Bonding layer uppermost		
Bonding layer and steel cords coated		
Belts aligned		
Cords are parallel		
All cords included in the joint		
No individual cords are cut out		
All spaces filled with bonding compound		
Cords are dry		
Edge of the splice cover stock level with top of cords		
Top cover laid onto cord carcass with bonding layer downwards		
Edges of un-vulcanised splice trimmed to width		
Shirting fabric overlaps ends of the splice Shirting fabric 100 mm wide over each join		
F5 CURING	**YES**	**NO**
The temperature of the platen is within manufacturers recommendation		
Upper platen is positioned to mach lower platen		
Transverses correctly positioned		
Curing temperature reaches manufacturers recommendation ±5 °C		
Pre-tensioning bolts are uniformly tightened		
Pressure reaches Manufacturers recommendation		

SIGNED: _____ _____

SPLICER SUPERVISOR SUPERVISOR/ENGINEER

INSPECTION CHECKLIST STEEL CORD BELTING

BUSINNESS UNIT:_____ JOB NO: _____

SPLICER NAME: _____CONTRACTOR: _____

CONVEYOR NO: _____SPLICE NO: _____

SPLICE LENGTH: _____SPLICE TYPE: _____ DATE: _____

F6 TESTING	YES	NO
Dimensions within tolerance		
Edges straight		
No excess rubber		
No blistering		
No lack of adhesion		
Shore hardness within		
tolerance No gross distortion		
of the grid Commissioning		
satisfactory		

APPENDIX I: DATA SHEET

DATA SHEET				
Date:		**Plant:**		
Conveyor No.		**Top cover**		
Pressed Used:		**Bottom cover**		
Belt width:		**Ambient temp.**		
Class:		**Humidity [%]**		
Time start:		**Time Stop:**		
Time (every 5 minutes)	**Top Element [ºC]**	**Bottom Element [ºC]**	**Pressure [bar] <100ºC**	**Pressure [bar] <145ºC**

APPENDIX J: RUBBER CHARACTERISTICS USED BY THE CONTRACTOR

Technical Parameters (raw rubber)	Contractors Values
Composition (natural rubber?)	
Adhesion (N/mm)	
Tensile Strength (MPa)	
Tensile Strength after ageing (%) (SABS Method 869)	
Elongation at Break (%)	
Elongation at Break after ageing (%)	
Hardness Shore A	
Abrasion mm^3)	
Density (g/mm^3)	
Tear Growth Resistance (structure) (N/mm)	
Modulus 100 (N/mm^2)	
Modulus 300 (N/mm^2)	
Rebound resistance (%)	
Ozone Resistance (48h/50pphm) step (DIN 53 509)	
Resistance to liquids (DIN 53 521)	

APPENDIX K : (QUALITY CONTROL PLAN)

SITE INFORMATION

Site Condition …….....

Accessibility …….....

Temperature (° C) …….....

Humidity (%) …….....

Time arrived on site …….....h.....

PLANT DETAILS

Belt KKS No …….....

Defect No …….....

Permit No …….....

Responsible Person …….....

Tel …….....

Time PTW Issued …….....

Workers Register …….....

BELT DATA

Location of the Conveyor …….....

Incline Conveyor

Surface Conveyor

Belt Manufacturer …….....

Belt Class …….....

Approx. Length …….....

Insert Spec …….....

Number of Cords …….....

Cord Diameter …….....

Cover Thickness Top …….....

Bottom …….....

General Condition of the Belt …….....

Rubber Top Cover Type M ❑ Type N ❑

Rubber Bottom Cover Type M ❑ Type N ❑

Rubber Type Top SBR ❑ NR ❑ IR ❑ NBR ❑

Rubber Type Bottom SBR ❑ NR ❑ IR ❑ NBR ❑

Batch No …….....

Belt Width (mm) …….....

SPLICE DETAILS (Type of Press Used)

Hydraulic Yes ❑ No ❑

Air Cooled Yes ❑ No ❑

Water Cooled Yes ❑ No ❑

Press Manufacture …….....

Year of Manufacture …….....

Serial No …….....

Heater Elements 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑

Supporting Beams 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑

Gauges 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑

Manufacture …….....

Thermometer Yes ❑ No ❑

Temperature (° C) …….....

Difference in Temperature (° C) …….....

Hydraulic Pump (bars) MAX …….....

Compressor (bars) MAX …….....

Power Supply 380V ❑ 525V ❑ 65 A ❑

Mobile Diesel Generator Yes ❑ No ❑

Welding Socket Yes ❑ No ❑

Using Diesel Generator Total Amps …….....

Red Phase (Amps) …….....

White Phase (Amps) …….....

Blue Phase (Amps) …….....

SPLICE STANDARDS

Splice Type Aged to Aged ❑ New to Aged ❑

Time Started …….....h.....

Time Complete …….....h.....

Length of Splice (mm) …….....

Marking of Splice Yes ❑ No ❑

Top Cover Removed Yes ❑ No ❑

Bottom Cover Removed Yes ❑ No ❑

Buffed Leading and Tail Edge Yes ❑ No ❑

Cut Steel Cord Wires to Length Yes ❑ No ❑

Method Used to cut Steel Cord Wires …….....

Corrosion of Steel Cord Visible Yes ❑ No ❑

Marked Centre Line of Belt Yes ❑ No ❑

Assembled Press Bottom Beams …….....

Assembled Lower Heater Elements …….....

Marked and Installed Bottom Cover …….....

Thickness One Sections …….....

Two Sections	…….....	
Place Sections of Belt on Rubber	Yes ❑	No ❑
Centre Line	Yes ❑	No ❑
Check Centre Line of Belt with Steel Cord Wires	…….....	
Apply Solution for Steel Cord Wires	Yes ❑	No ❑
Start from Centre Outwards	Yes ❑	No ❑

SPLICE VULCANISING TIME

Assembled Press	…….....	h.....
Start Diesel Generator/Welding Socket	…….....	h.....
Record Amps on Diesel Generator	Yes ❑	No ❑
Ambient Temperature Reading (° C)	…….....	
Reaching 145° C	…….....	h.....
Vulcanising Period (X minutes/mm)	…….....	
Total Thickness of Belt (mm)	…….....	
Total Period Calculated from Belt Thickness	…….....	
Completed Vulcanising Period	…….....	h.....
Ambient Temperature (° C)	…….....	

Cooling Down Period (145° C)	START	…….....	h.....
Cooling Down Period (125° C)	COOLING	…….....	h.....
Cooling Down Period (100° C)	COOLING	…….....	h.....
Cooling Down Period (80° C)	COOLING	…….....	h.....
Cooling Down Period (60° C)	COOLING	…….....	h.....

Completed Cooling Down	…….....	h.....
Removing of Press	…….....	h.....
Cleaning of Area	…….....	h.....

CONDITION OF SPLICE

Physical Condition Acceptable Yes ❑ No ❑

Comments……
……
……

SPLICER

Date …….....

Name …….....

Contractor …….....

Job No …….....

Signature …….....

ESKOM APPROVAL

Date …….....

Name …….....

Position …….....

Department …….....

Unique No …….....

Order No …….....

Signature …….....

APPENDIX L: SHORE HARDNESS MEASUREMENT FOR BELT REPAIRS

COMPLETE CURE PARAMETERS					
LOCATION	**REPAIR DEPTH. [mm]**	**REPAIR SIZE [mm x mm]**	**RECCOMMENDED HARDNESS FROM MANUFACTURER**	**REPAIR HARDNESS (65 SHORE A +/-5)**	
				Top cover	**Bottom cover**
Leading edge					
Centre					
Trailing edge					
Average hardness					
Nominal hardness					
Hardness of conveyor belt					

SIGNED: _____ _____

Splicer Supervisor Supervisor / Engineer